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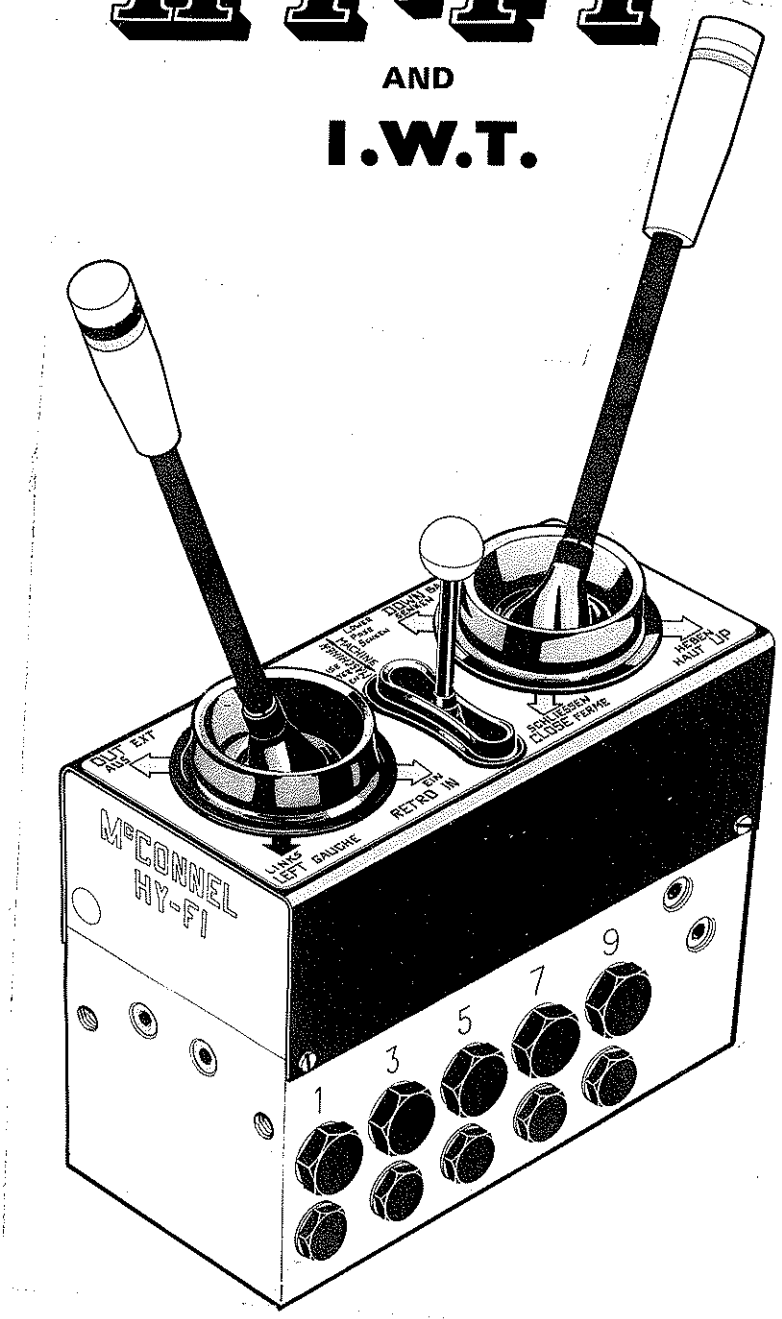
SERVICE AND SPARE PARTS MANUAL

HY-FI

AND

I.W.T.



INTRODUCTION

This service manual is written to give a competent mechanic a better understanding of how the Hy-fi works. If he does not have this knowledge the Hy-fi remains a mystery and much time and effort can be wasted in attempting to correct a minor fault.

LIST OF CONTENTS

1. DESCRIPTION

The design of the McConnel hydraulic fidelity control valve, or as it is commonly called the 'Hy-fi' is a complete departure from the conventional type of control valve found on most hydraulic equipment. Selective assembly of spindles, tolerance fitted to finely honed and polished bores are dispensed with in the Hy-fi control valve.

2. The Hy-fi consists of a multi-passage drilled and tapped aluminium alloy block into which capsule-type components are assembled. There is no metal to metal contact of moving parts within the block itself so the problem of wear is largely confined to the replaceable capsules. These capsules consist of different code lettered check valves and locked line relief valves which have their rated pressure stamped on them. Other capsule-type components are the main relief valve similarly stamped, the cut-off valve and the spindle and bobbin assemblies.

Several variations of the Hy-fi are to be found operating on a wide range of McConnel equipment. Basically all Hy-fi's are similar; they utilize the same parts which are interchangeable from one control box to another.

The models of Hy-fi vary according to the application. The check valves and relief valve settings are altered to suit requirements. Obviously the lowering action of a fork lift must be very different to the quite fast dropping action required on the main arm when digging a trench.

Both two lever and three lever models are available giving a control to either four or five double-acting ram circuits respectively.

All models of the Hy-fi are parallel circuit open-centre valves. Where an 'open or closed centre' system is required then a simple flip-lever mounted on the side of the Hy-fi is incorporated.

3. FAIL SAFE

All Hy-fi's have the built-in feature of FAIL-SAFE, where in the absence of an oil supply when the hydraulic pump is not operating the machine will not move if the operating levers are accidentally touched.

4. SERVICING

Much effort has gone into the design of the Hy-fi so that it can be serviced or even completely overhauled without removing the unit from the machine and without even disconnecting a hose except possibly the low pressure return hose. Unlike the valves in an internal combustion engine, the Hy-fi spindles can be removed and replaced in alternative sections. Check valves, relief valves, actuators are also interchangeable.

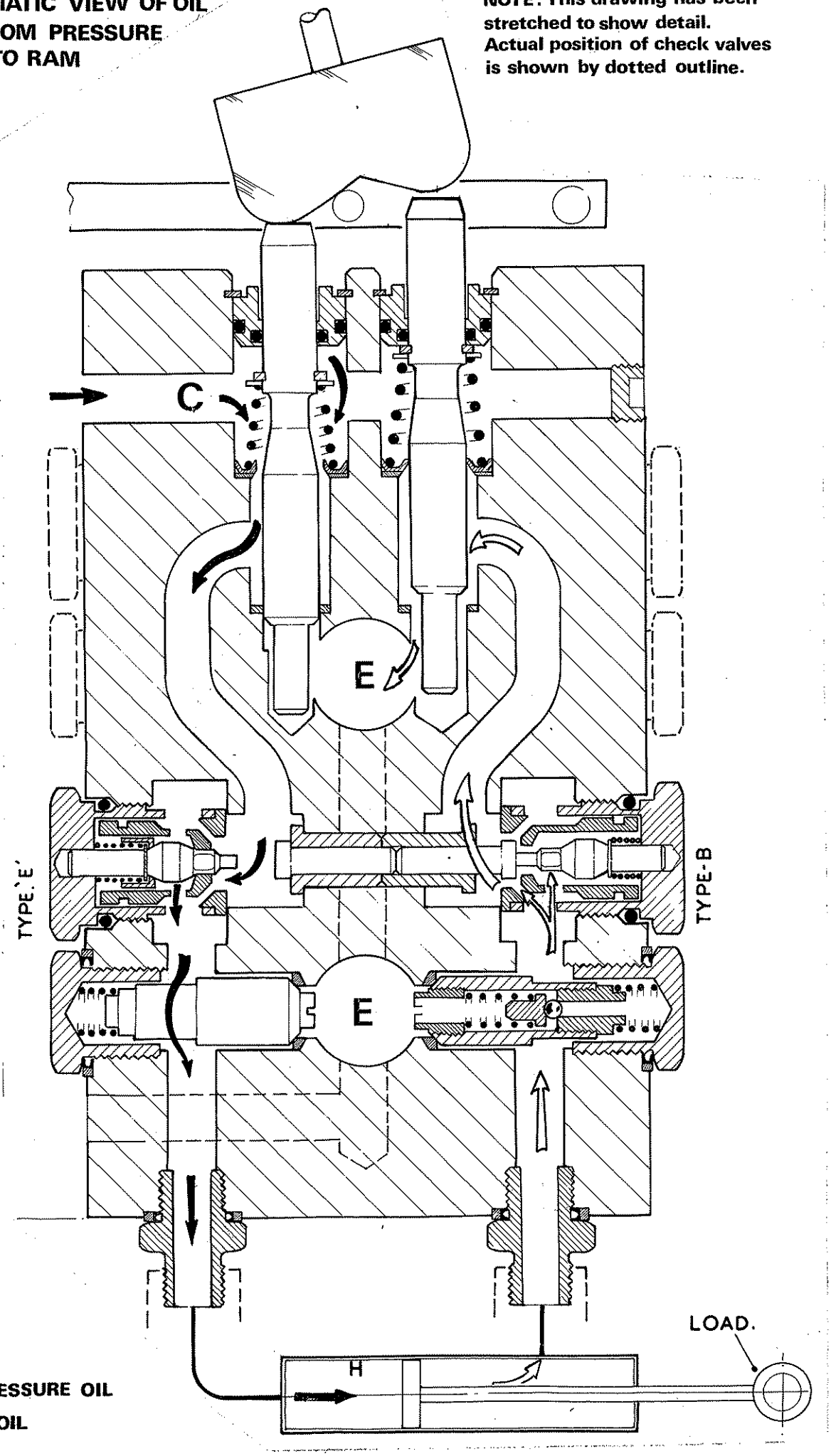
The Hy-fi can be serviced with a minimum of special tools and remarkably, no feeler gauges or measuring instruments are needed. The only measurement required is an approximate one; about the folded thickness of a cigarette pack.

5. LEVER GEOMETRY

The geometry of the operating levers and rockers make it possible to operate all services simultaneously while making it impossible to pressurize both sides of one service at the same time.

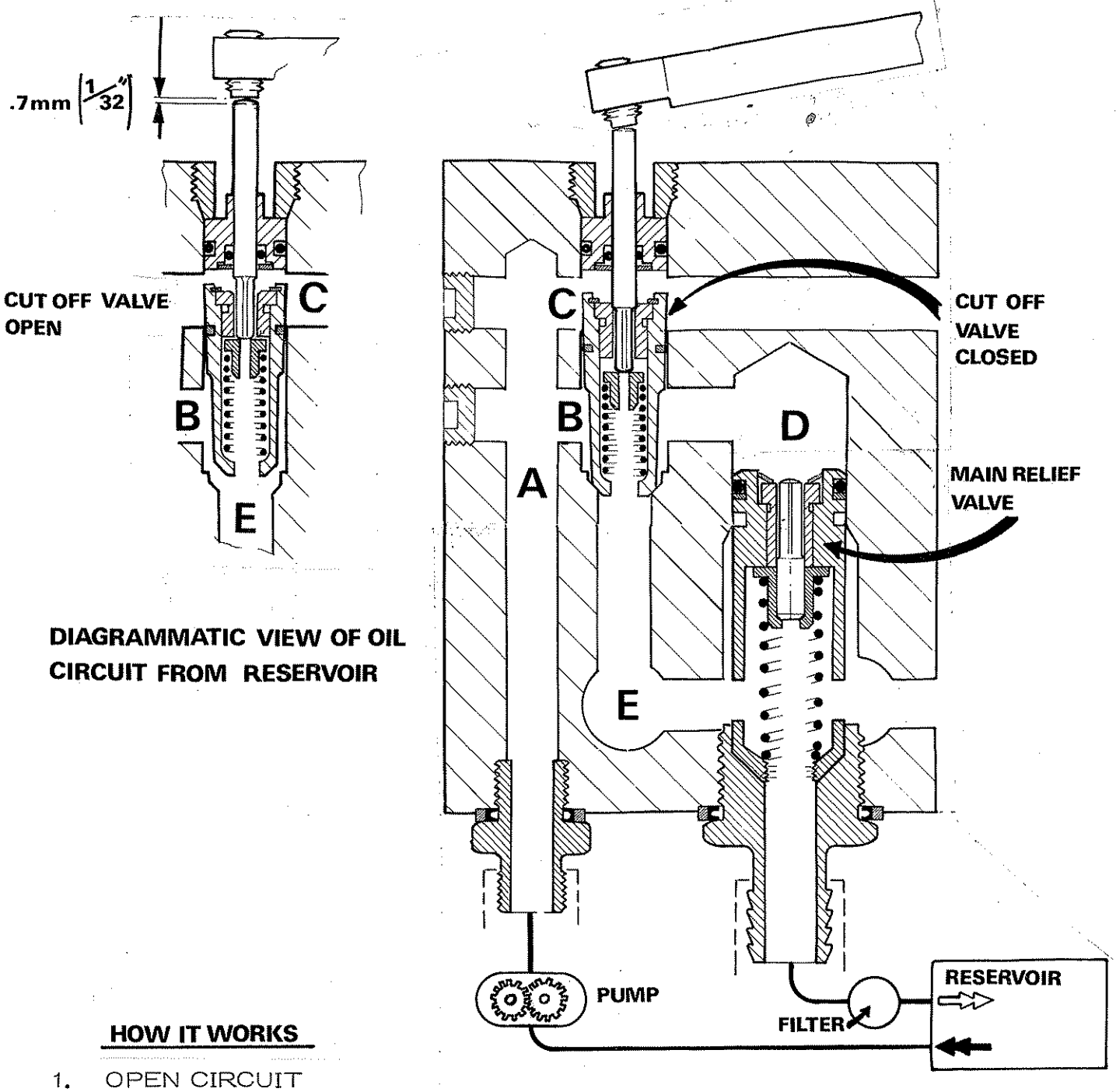
DIAGRAMMATIC VIEW OF OIL CIRCUIT FROM PRESSURE GALLERY TO RAM

NOTE: This drawing has been stretched to show detail. Actual position of check valves is shown by dotted outline.



➡ HIGH PRESSURE OIL

⇨ RETURN OIL



DIAGRAMMATIC VIEW OF OIL CIRCUIT FROM RESERVOIR

HOW IT WORKS

1. OPEN CIRCUIT

With the hydraulic pump operating and all levers and spindles in the neutral position oil is supplied through gallery A and passes through drilled cross passages B and C. Passage C is the high pressure gallery which feeds all the spindles. Gallery D which is connected to C via B is also a high pressure gallery through which the oil will flow past the main relief valve only when the systems rated pressure is exceeded. Oil passes through the side gallery B, down past the open seat of the cut-off valve to the low pressure return gallery E, through and around the lower section of the main relief valve and out of the return connection through the filter and back into the oil reservoir.

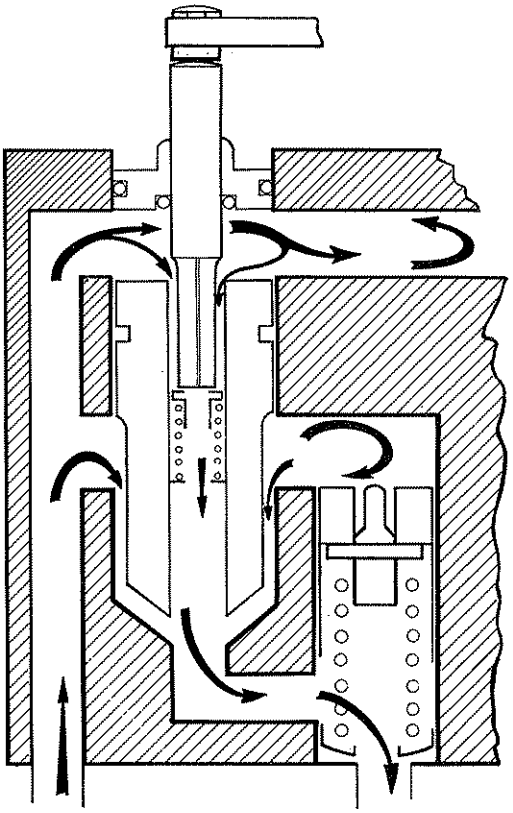
2. CLOSED CIRCUIT

Any movement of a control lever to depress a spindle automatically operates the cut-off valve which stops all oil from entering gallery E and returning to the reservoir. As the pump continues to deliver oil into the Hy-fi but it cannot return, pressure builds up within the high pressure gallery C. Movement of a control lever however has also depressed a spindle allowing oil to flow to a ram.

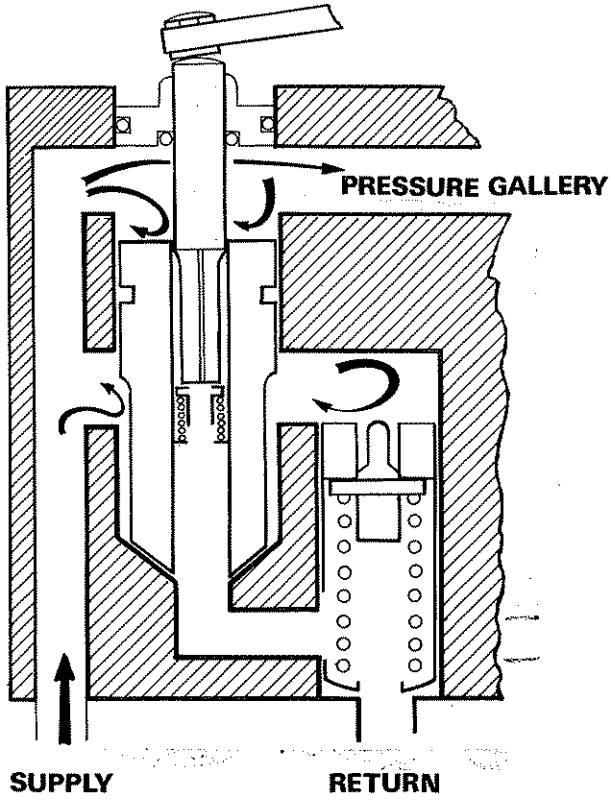
3. CUT-OFF VALVE

The cut-off valve is situated in the top of the control block to the right side of the operator and is seen as a projecting needle held in place by an allen-headed tappet screw located in a cross bar. The needle passes through a brass bobbin and its fluted end rests within a hollow centred cartridge. The cartridge is seated to the low pressure gallery E. A split ring around the cartridge allows free movement of the cartridge within the bore without creating pressure inbalance between the top and lower sections of the bore.

When oil is flowing through the Hy-Fi on 'Open' circuit, the cartridge is lifted off its seat thus lifting the needle against the tappet screw. Oil is allowed to flow down past the needle flutes and through the hollow cartridge centre as well as around the cartridge and past the open seat.

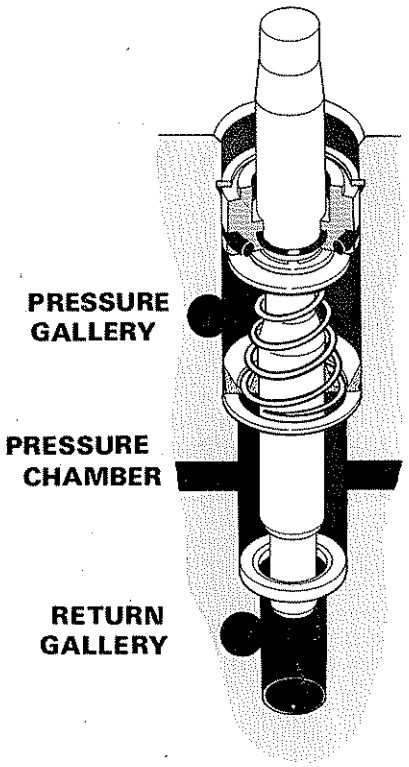


When the circuit is 'Closed', the tappet screw pushes the needle down, forcing the cartridge onto its seat before its fluted end of the needle overcomes the tension of the return spring within the cartridge. The fluted end of the needle then disappears inside the cartridge so cutting off the oil flowing by the flutes. This action although happening very quickly is in two stages and progressive. Cut off is now complete.



4. SPINDLE OPERATION

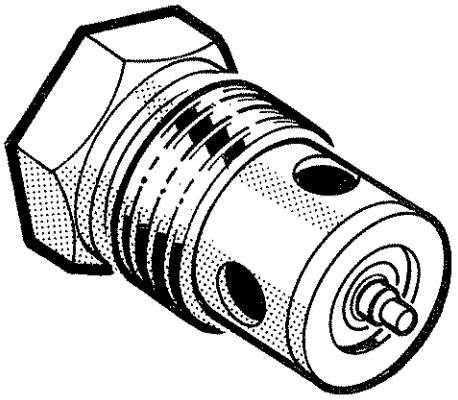
Spindles are held in position by brass bobbins which are secured in the alloy block by a snap ring. The lower side of the spindle is supported by the cup seal. The spindle is in effect suspended within the block. Rocker movement depresses the spindle allowing its tapered shank to enter the cup seal. At the same time the bottom of the spindle enters a ring seal and blocks off the passage to the return gallery. Oil is now free to flow past the open cup seal into the pressure chamber area. A return spring neutralizes the spindle when the lever is released.



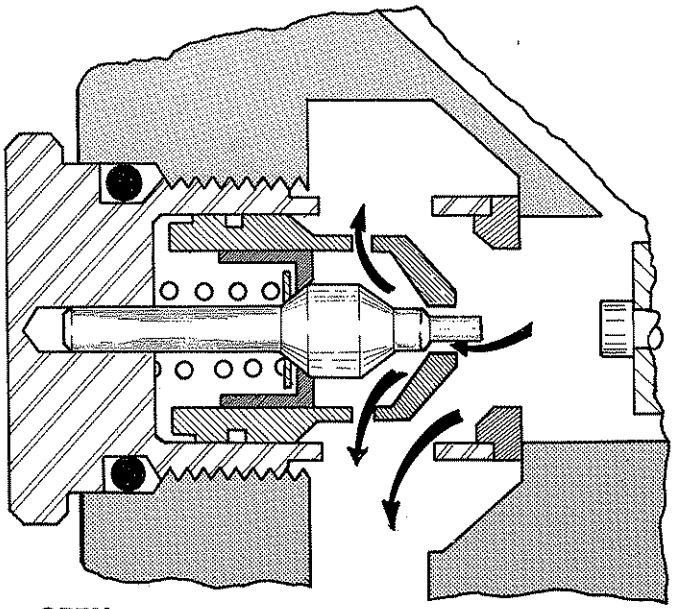
5. CHECK VALVES

On most types of valve where the lowering of a fully loaded bucket is controlled by the actual opening of a spindle some form of lockout or check valve is often employed. Inertia and acceleration of a heavily loaded bucket can automatically push the lockout wide open which in turn causes cavitation on the delivery side, the check valve to close, arresting the weight suddenly, hence, lowering in a jerky movement.

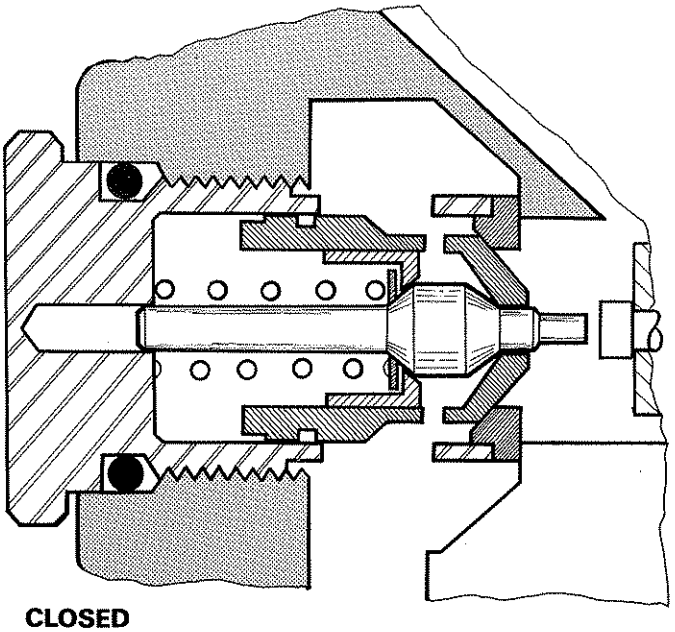
Cavitation is caused by inertia and acceleration of the load which in turn causes the ram piston to move at such a speed that the oil delivery from the pump cannot keep up with it. As a result a vacuum or sudden pressure drop would allow the check valve to close when not required. On the Hy-Fi control valve the speed of check valve opening and closure is governed by the close fit of the check valve needle in a blind hole in the base of the check valve, this acts as a damper or 'dashpot' to control its movements. Some types of check valve have an additional piston damper.



When a check valve is working correctly, there should be a few inches of further movement of the arm after the operating lever is released. On a cold morning for example a loaded bucket will probably drop 12 inches or more before coming to rest when the main arm is being lowered. This is because the cold oil is thicker and so takes a longer time to fill the dash-pot.



OPEN



CLOSED

Check Valve Operation

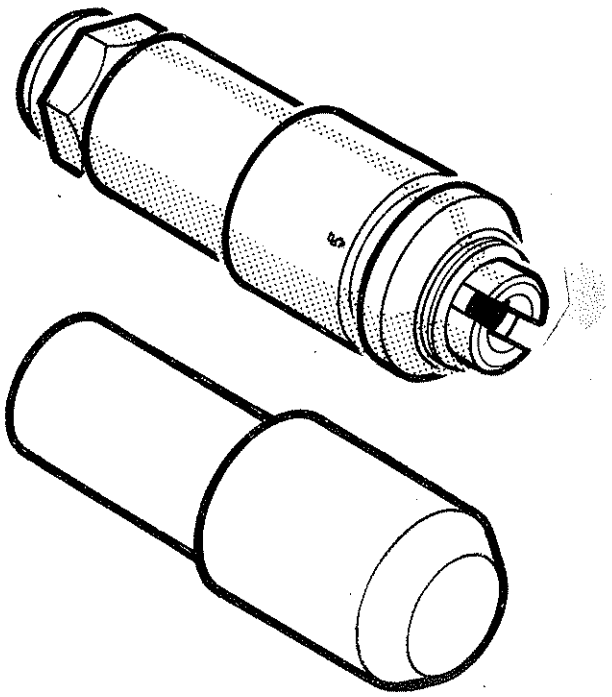
Oil entering the pressure chamber builds up pressure against the check valve piston which opens against the resistance of a spring loaded needle. The speed at which the piston opens accelerating the oil through the check valve and out to the work port is governed by the 'dash pot' action of the needle shank which is located in a blind hole in the bottom of the check valve body. The needle shank and blind hole have a tolerance build of .0005". The looser fit giving a quicker piston movement. Additionally some types of check valve are fitted with damper sleeves.

6. LOCKED LINE RELIEF VALVES

Each circuit except the bucket section is provided with locked line relief valves and their action is to prevent overload and damage to the machine. For example picking up a heavy load at near reach and discharging at far reach at 90° to the machine could cause the tractor to tip over.

The valve in the form of a cartridge is fitted into the lower orifice of the alloy block and is pre-set to dump oil at excessive locked line pressures through the body of the valve back into the low pressure return gallery.

The pressure setting of the cartridge is stamped on its casing. The noughts are omitted. The cartridge is held in place by a light spring and its seat rests against a nylon seal.



a) Bucket circuit

Excessive locked line pressures cannot be generated within the bucket circuit in which case valve blanks are fitted instead. The nylon seals and light pressure springs are still required.

b) Slew or Swing Circuit - Cross Port Relief

Applicable to the slew or swing circuit only. Employs the same cartridge as the other circuits protecting the system against overload eg. bringing a loaded bucket to rest. The relief cartridge passes excess oil through its body and discharges it directly across to the opposite relief valve which lifts completely off its seat and allows the oil to enter the work port of the opposite ram. As the slewing circuit uses two single acting rams of the same capacity, exactly the same quantity of oil discharged from one ram enters the other. This ensures that no cavitation and resultant sloppiness occurs in the slewing mechanism.
There are three important points to note about the slew sections:-

1/ There are no nylon seals in the work ports.

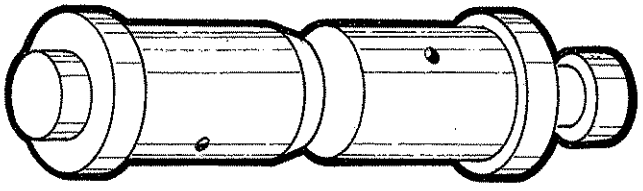
2/ Heavier springs are fitted to hold the cartridge against its seat.

3/ The low pressure return gallery which is drilled from the supply and return end of the block, stops short of the slew section, therefore it is not possible to adapt the hose layout to the operator's personal preference e.g. operating the slew section with right hand lever.

7. ACTUATORS

These are two pairs of shouldered pistons in each circuit that shuttle between the check valve needles . Their function is to open the check valve on the unpressured side of the ram allowing the oil to return via the open lower spindle seal to the return gallery.

Oil pressure building up in the pressure chamber forces the two pairs of pistons across the block. The larger diameter piston moves slightly before the smaller one because of its larger surface area. This staggered movement is called a two-stage action. It eliminates hammering and gives a progressive response. Being of unequal length, the smaller pistons travel farther than the larger ones, to engage with the projecting needle of the opposite check valve, forcing the needle back into its 'dash pot'. The check valve piston is now free to move back from its seat, allowing the oil to flow through it.
Restoring the spindle to neutral collapses pressure within the chamber and the check valve needle return spring recloses the check valve.

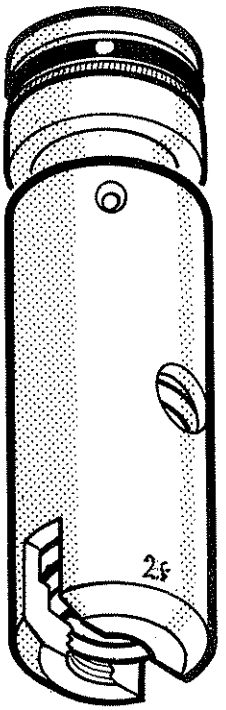


8. MAIN RELIEF VALVE

The main relief valve is a pre-set cartridge located adjacent to the low pressure gallery and is held in place by the oil return connection. The valve only comes into operation when the pressure in the high pressure gallery exceeds its rated pre-set pressure. A needle is held against its seat by spring tension obtained by a sleeve nut. After calibration the sleeve nut is crushed by an indent to lock the threads. Early model relief valves employed Loctite to secure the threads.

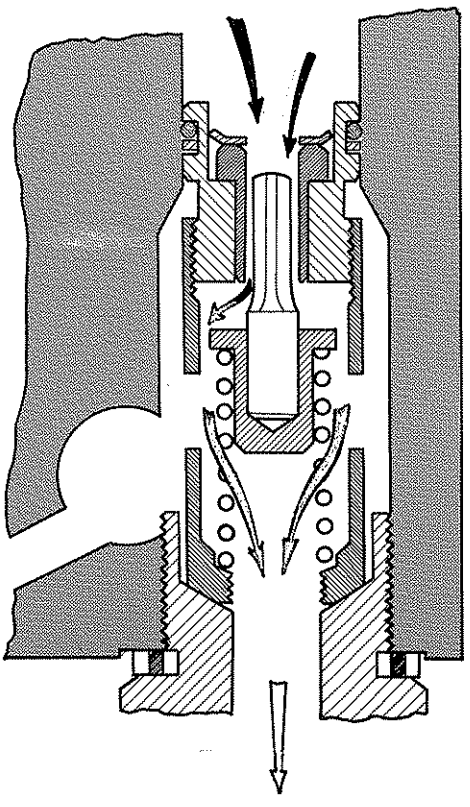
The pressure setting of the valve is stamped upon the sleeve nut as follows:-

2 = 2000 psi
21 = 2100 psi
225 = 2250 psi
25 = 2500 psi



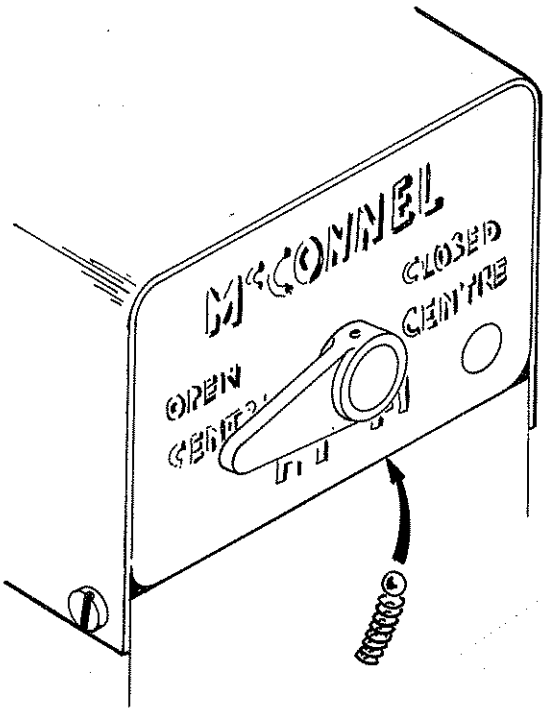
Main Relief Valve operation

When the pressure within the Hy-fi reaches the relief valve setting, the fluted needle overcomes spring pressure, moves off its seat and allows oil to escape through the body of the valve to the return port.



9. OPEN/CLOSED CENTRE SYSTEMS

This function is required if the Hy-Fi is being operated by a tractor with a closed centre hydraulic system. The flip lever which operates a cam closes the cut-off valve and allows the pressure to rise within the block when the levers are in neutral. This condition is also necessary if a linkage mounted machine is being operated by an integral tractor pump where there is no means of diverting oil from external services supply. On some tractors eg. Massey Ferguson; the linkage isolation valve diverts the oil from the linkage lift cylinder. It does not isolate external services. Thus it is necessary to close off the Hy-Fi to stop the oil returning to reservoir. Pressure can now build up in the tractors lift cylinder for the machine to be raised on the tractor's linkage.



It is essential that the open centre condition is restored after the machine is lowered to the ground and before work is resumed, otherwise severe overheating of the oil will result.

NOTE Care must be taken when removing the rocker assembly not to lose the spring and ball retained beneath the cam end cap.

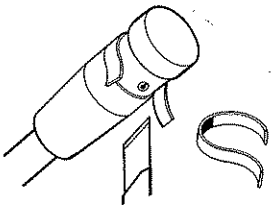
SERVICING THE HY-FI

Before attempting to service or dismantle the Hy-Fi, the whole machine should be placed in a position where dust and dirt cannot be blown into it. The exterior of the unit should be cleaned off and the top of the block should be thoroughly cleaned after removing the rocker assembly if work is to be carried out on the spindles or cut-off valve.

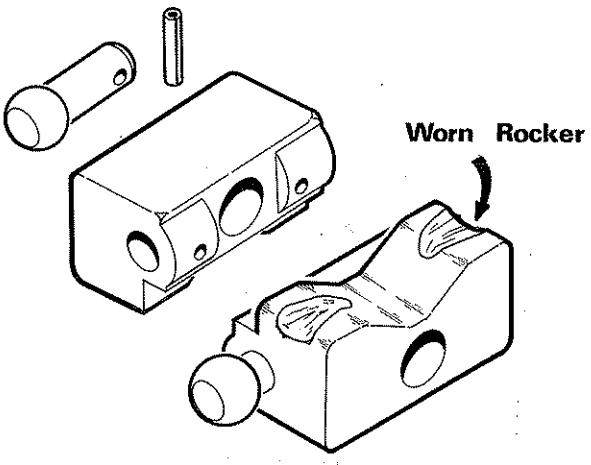
NOTE: It should not be necessary to remove the Hy-Fi from the machine, therefore do not disconnect any high pressure hoses.

1. Operating levers & rocker assembly

a) Handles If it is ever necessary to replace the plastic handles they can be removed from the levers by carefully cutting away the identification rings to reveal the retaining roll pin. New rings can be assembled more easily in the groove if they are immersed in warm water first.



b) Rockers These can gradually wear down to give a sloppy movement on the handles. They can eventually become so badly worn that the spindles are not fully depressed ie. giving a slow machine movement. When renewing rockers, also examine the tops of the spindles for roughness and burrs and smooth off as necessary. Apply a coating of grease to the underside of the rockers and renew the grease during routine servicing.
The ball end of the rocker can be located in either end for left or right hand application.



c) Protective boots
The Hy-Fi should not be allowed to continue in service with the rubber boots cracked or perished. Water and grit settling on the rocker mechanism can cause rapid wear and also affect the spindle tops and cut-off needle.

2. Cut-off Valve

Remove lever and rocker assembly complete. Withdraw the cut-off needle. Loosen and remove the ring nut and remove the brass bobbin by grasping with a pair of needle nose pliers. Do not place the pliers inside the bobbin. The cut-off cartridge can now be removed by pushing a sliver of hard wood into the hollow centre and lifting it out complete.

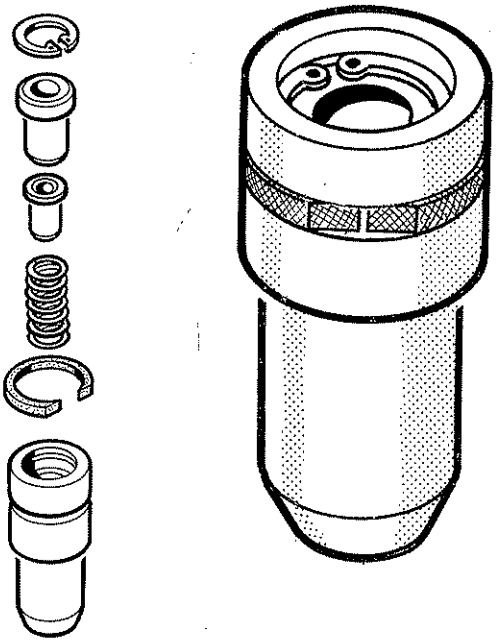
There are four problems associated with the cut-off valve.

a) i) Sticking cut-off needle This gives a continual closed circuit condition - with constant operation of the main relief valve. Symptoms are:- Oil gets very hot. Tractor engine appears to be labouring when both levers in neutral - striking the handles a glancing blow can sometimes restore open circuit.

Examine the cut-off needle closely for signs of erosion especially in the area where the needle enters the brass bobbin. After a period of work rapid cooling off can form condensation droplets on the needle shank under the metal shroud. If the machine is standing for a period before further use the needle can remain in the down position. Light lapping of the needle is permitted with crocus cloth or a fine grade (400) vehicle body repair paper.

ii) Sticking cut-off cartridge

It is possible for the cartridge to jam itself in the bore. The condition can be relieved by filing a light chamfer around the top outer edge of the cartridge. Do not substitute an 'O' ring in place of the split ring around the cartridge.



b) Collapsed needle return spring

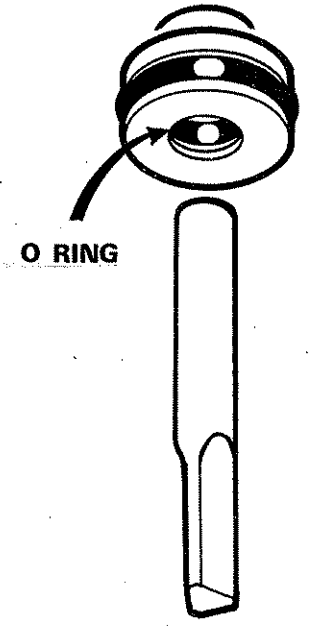
Symptom is Hy-Fi on continual open circuit therefore no response when levers are operated. The needle will remain down and will be seen as an excessive gap at the tappet screw.

NOTE: Do not confuse with a sticking needle which will also give an excessive gap, but the control box will be on closed circuit.

The cartridge must be replaced as a complete assembly - Although it can be dismantled the small components are not supplied separately.

c) Oil leaks

Usually caused by withdrawing the needle for examination and then replacing it down through the brass bobbin. There is a small 'O' ring inside the bobbin which can be easily damaged by the needle flutes. If the needle is withdrawn, then the bobbin has to be removed so that the needle can be passed up through it.



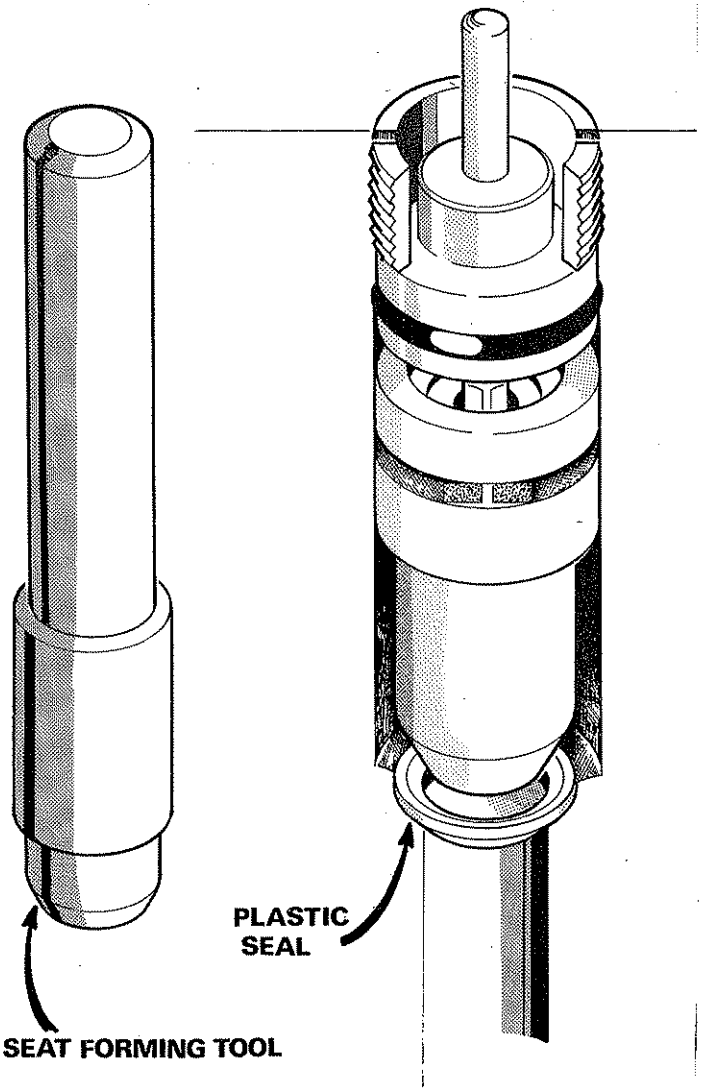
d) Cut-off Valve Seat

A plastic seal is located beneath the cartridge and is a push fit in the bottom of the bore. Occasionally the seal has been lifted by the flow of oil passing over it and the cartridge 'hammering' down has knocked it out of shape. It is then washed out and can sometimes be found trapped against the side of the main relief valve. Seal failure of this nature happens very suddenly and is recognised by the Hy-Fi remaining in 'open' circuit and a tappet adjustment gap of approx 5/32". This measurement is made up by the 1/32" permitted clearance plus the approximate 1/8" thickness of the seal.

Check the serial number of the Hy-Fi block.

February 1973 (2/4S model 44KD29)
(3/5S model 06KL91)

From these serial numbers and date the seal has been omitted and the cartridge seats directly in the block.



A seat forming tool part number 80 04 268 should be used if the Hy-Fi is being converted. The tool which is a close fit in the bore impact forms a seat in the alloy metal by striking the end a moderate blow with a hammer.

When reassembling the valve in the block, the gland nut should be screwed down until it is just flush with the surface of the block and then secured with a light centre punch mark against the slot.

3. SPINDLE ASSEMBLY

a) To remove spindle, press the brass bobbin down with the tool provided. The cut away portion of the bobbin depressor should be adjacent to the snap ring lugs. This allows a pair of snap ring pliers to grasp and withdraw the snap ring.
Lightly tap the top of the spindle. The spring will cause the bobbin to rise in the block until its '0' ring reaches the snap ring groove.
Place a hammer handle flat across the top of the block to act as a fulcrum. Firmly grasp the top of the spindle (the top section has a reduced diameter and has a rougher finish for this purpose) and with a leverage against the hammer handle withdraw spindle and bobbin assembly. The conical spring, cup seal, backing washer and lower spindle seal can now be removed.

b) Snap ring groove

Clean and closely examine the condition of the snap ring groove in the block. If the groove is so badly mutilated that it fails to hold the snap ring when the control unit is under pressure then the block is scrap.

Although it may be possible for a local machine shop to effect a repair, F.W. McConnel Ltd. can only supply a replacement block for the transfer of parts.

It is most advisable to renew the snap rings whenever repairs are carried out to the spindle assembly.

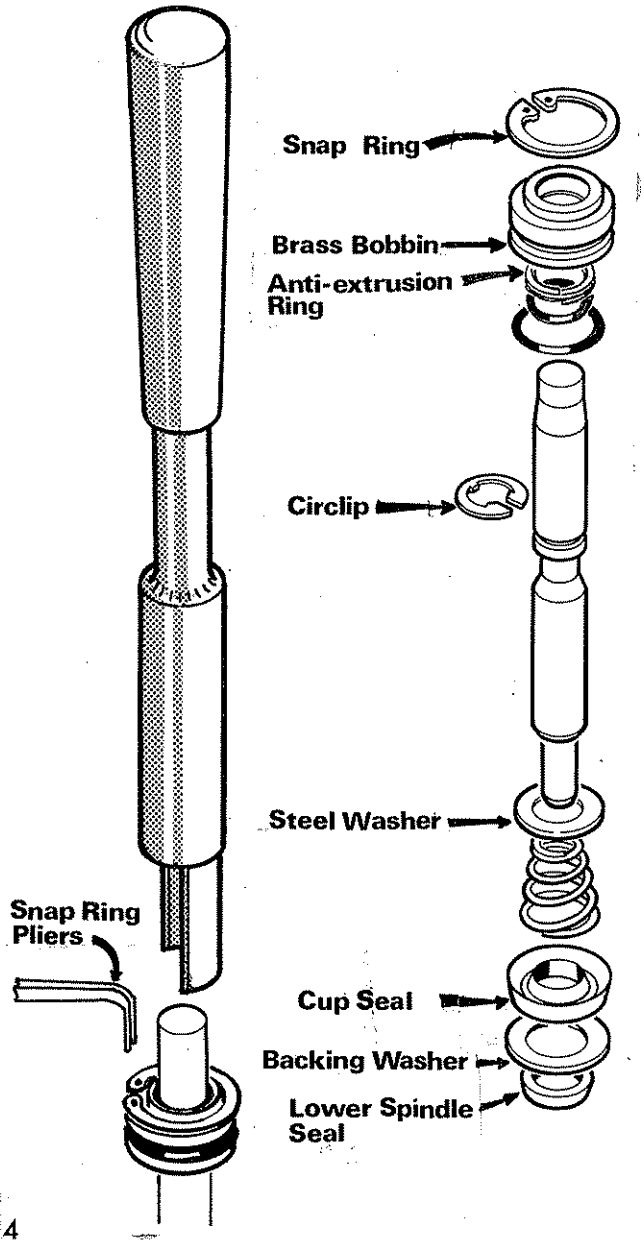
c) Spindle

Examine the spindle especially in the area of the circlip. Scrap the spindle if the circlip groove is damaged. A steel washer was added beneath the circlip after January 1973. Hy-fi Serial No. 44KD08 & 06KL20. Wear on the spindle area where it passes through the bobbin is usually caused by an accumulation of grit which can quickly affect the internal '0' ring to give oil leakage at that point.

Note:
In an emergency the circlip retaining the rocker pivot is the same as the spindle circlip.

d) Spindle bobbin

The brass bobbin has a stepped inner bore which allows the spindle a moderate amount of misalignment without sticking. If a sticking spindle occurs, remove the complete assembly and transfer it to an alternative section. If the trouble now occurs in the previously trouble free section then the brass bobbin is at fault and should be replaced.



e) Cup Seal

After a long period of service, if the control box is being overhauled it is good practice to renew all the cup seals.
The symptom of a cracked or broken cup seal is that it's the only service that continues to work. This condition can be further verified by continuing to hold that service until the main relief valve blows, while at the same time, any service on the other lever becomes operational.

Note:

(1) If two or more cup seals are damaged, oil will always escape through the damaged seal that is not being operated!

(2) A cracked seal is often capable of withstanding pressures up to 1500 psi or more. Hence a low reading on a pressure gauge will jump up to full systems rated pressure when the faulty circuit is operated.

f) Lower Spindle Seal

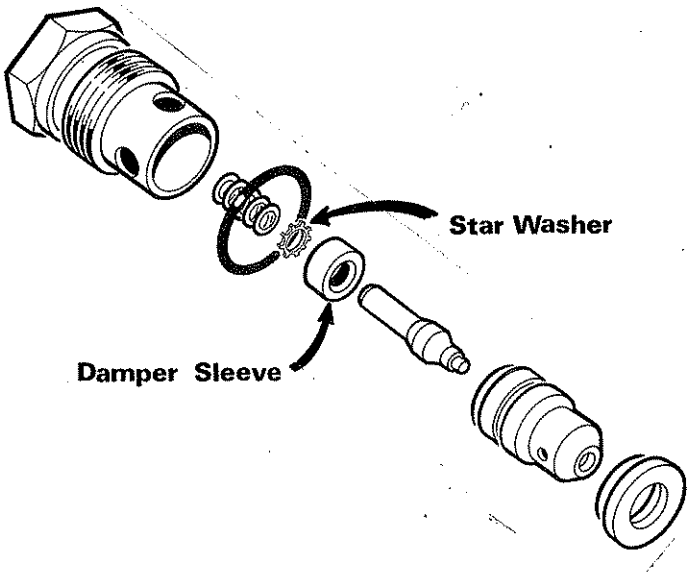
Seal failure here is recognised by the one service that fails to work. Seal failure is not common and is more likely to be rubbish trapped by the spindle due to a ram seal breaking up etc. When replacing this bottom seal ensure its located the right way up with the chamfer uppermost. It is a light push fit in the lower bore.

4. CHECK VALVES

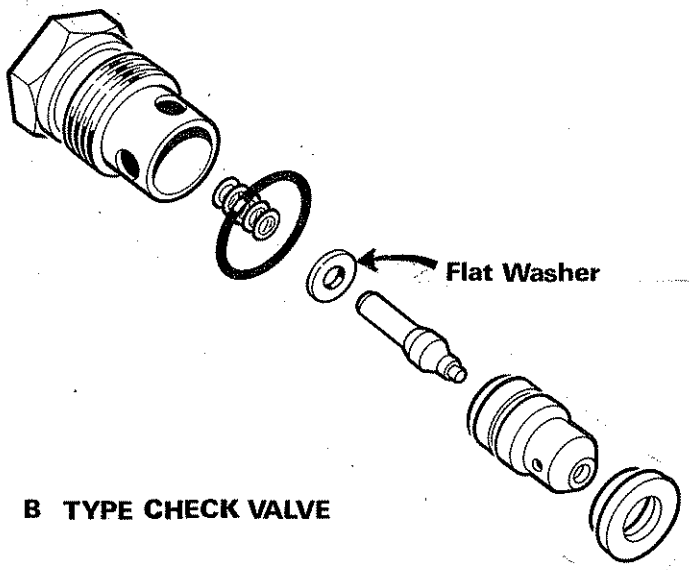
Before carrying out any work on the check valves, ensure the machine is lowered to the ground. To ascertain whether a check valve is at fault it should be removed and exchanged in the block for another of the same category. Check valve types 'E' and 'D' can be interchanged for test purposes only. If the problem is cured but reappears on the alternative circuit then the check valve is faulty.

Use a 1.1/8" AF thinwall socket and unscrew the check valve slowly. Any locked line pressure within the work port must be allowed to escape. This locked line pressure can sometimes cause the check valve to come apart as it is being unscrewed from the block. The end cap of the check valve is a light press fit into the body and can be opened with a light tap on the back of an old knife blade or ground hacksaw blade in the joint.

Clean and examine all the components particularly the needle seating in the piston and the needle shank. If any part requires replacing, then the check valve should be replaced complete. The finely matched components of a check valve are not supplied separately. The internal construction of the check valves vary considerably. The hole size in the piston, the needle nose, a damper sleeve and whether or not a star washer or flat washer is fitted is dependent on the work it has to perform.



Assemble the check valve completely making sure that the needle can be depressed in the body and secure the end cap by a light tap with a piece of hard wood. It should be noted that the face of the end cap is a seal that seats against a shoulder within the block. Check valves should be tightened to approx. 70 ft lbs torque.

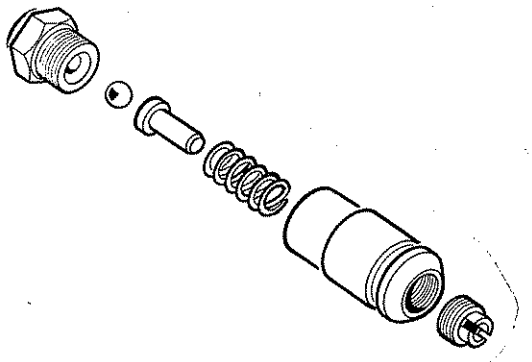


B TYPE CHECK VALVE

5. LOCKED LINE RELIEF VALVES

All locked line relief cartridges are the same but they are set at different pressure ratings which are stamped on the barrel. Four settings are currently used and are identified thus:-

25 = 2500 psi
3 = 3000 psi
4 = 4000 psi
5 = 5000 psi



After calibration, the adjusting screw thread is crushed by an indent in the recessed portion of the barrel. Earlier type relief valves were centre-popped around the adjusting screw shoulder. No attempt should be made to alter the calibration of the valve.

If the ball is being held off its seat by dirt it is sometimes possible to clear the obstruction. Place a small piece of hard rod against the ball and grip the assembly in the edge of a vice. Compress the spring slightly and apply the nozzle of a compressed air line against the open end of the valve. Alternatively, the hexagon headed seat can be unscrewed to dismantle the valve. Reassemble the hexagon screw threads with 'Loctite'.

The relief valve seats against a plastic seal which is a light push fit in the work port.

Slew Section

The slew or swing circuit relief valves which do not return the oil to the low pressure gallery do not have plastic seals, also, the retaining springs are of heavier gauge than the springs holding the other valves. When operating correctly the slew circuit relief valves make a squealing sound when the arm is moving at full speed and the operating lever is released.

If the seat of the valve in the alloy block is scratched or damaged, leakage will occur. The seat can be reformed by using an impact forming tool part number 80 04 255. Place in the bore and strike with a moderate hammer blow.

Relief valve blanks are fitted to both sides of the bucket circuit and for test purposes, one of these can be 'borrowed' to replace a suspect valve. Under no circumstances should a blank be allowed to remain in the circuit after completion of test.

6. ACTUATORS

It is most unusual for the actuators to give trouble. In the unlikely event of an actuator sticking, it can be dislodged by removing the check valve and actuator on the opposite side of the block and passing a rod through the pressure chamber. A more common fault is for the actuators to drop out when the check valves are removed for servicing.

The actuators which are two pairs of shouldered pistons are not matched selectively and can therefore be freely interchanged. They do not have to form any hydraulic seal and so can be cleaned up with fine emery cloth to remove any burrs. A sticking actuator can be recognised by both hoses to the hydraulic ram 'kicking' when the rod is in mid-stroke ie. the actuator is failing to move across and open the 'un-pressured' check valve.

CAUTION : If the weight is not on the ground when attempting to dislodge a sticking actuator, the ram hose end should be loosened so that the escaping oil will allow the arm to be lowered.

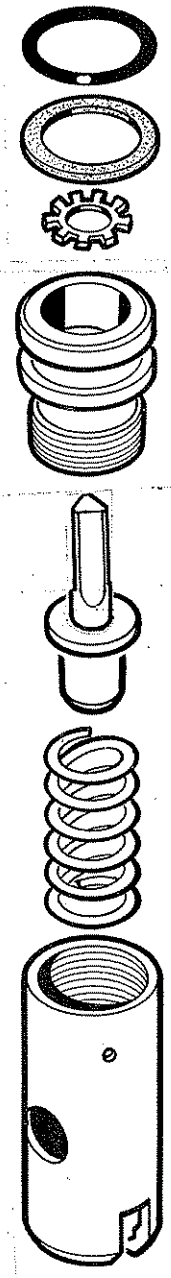
7. MAIN RELIEF VALVE

The main relief valve is removed from the block by taking out the return connection using a 1.5/16" A.F. spanner. Into the base of the valve screw a ½" UNF bolt two or three turns; a slight tug on the bolt now, will dislodge the valve.

If the pressure setting of the relief valve appears to be low, examine the '0' ring around the head of the valve first. A damaged '0' ring will give a low pressure reading.

Relief valves that are secured with 'Loctite' can be dismantled by gripping the valve head in a 'soft-jaw' vice and unscrewing the sleeve nut with a pair of vice-grips. Before attempting to dismantle, the length of the complete valve should be carefully measured with a Vernier calliper so that it can be reassembled to the same measurement. Final setting of the relief valve must be carried out using an accurate pressure gauge. After callibration the threads should be crushed by an indent.

It is sometimes possible to dislodge any rubbish trapped in the valve by inserting a short length of hard rod against the needle and gripping the assembly in the edge of a vice. Compress the spring slightly and apply the nozzle of a compressed air-line against the open end of the valve.



FAULT FINDING

When 'trouble-shooting' a Hy-Fi on a machine the oil if possible should be at operating temperature.

Try and isolate the problem into one of the following areas:-

1. Supply.
2. a) Rocker assembly. b) Cut off valve.
3. Spindles.
4. a) Check valves. b) Locked line relief valves.
5. Main relief valve.
6. The rams.

Much time can be lost in working on the Hy-Fi when the problem can be either:-

No. 1 The supply of oil from the pump.
No. 6 An internally leaking ram.

The symptom of machine failure should be carefully studied to determine in what area the fault lies.

2.a) Rocker assembly

Broken or badly worn rockers are recognised by a sloppy lever movement. A broken one giving no response and a badly worn one can fail to push the spindle to the full extent of its travel ie. oil flow restricted, giving a slow response.

2.b) Cut-off valve

Failure of cut-off valve is usually sudden and every service is affected. A cut-off valve sticking will result in blowing the main relief valve when the levers are in neutral and consequent oil overheating. The machine is still operational. Tappet gap is excessive and the engine labours. The needle return spring or seat collapsing will mean that the Hy-Fi remains on open circuit therefore there will be no response from any lever. Symptom is recognised by excessive gap at tappet screw. No alteration in engine note.

Adjustment of the tappet screw is approximately 1/32" (.75 mm) with the engine stopped or the oil supply cut off.

3. Spindles

Failure of 'O' rings in the spindle bobbins will be evidenced by external oil leaks. Broken return springs or sticking spindles will affect the individual services. Usually accompanied by a 'clicking' noise. Cup seal failure can be diagnosed by being the only service that continues to work at full power. Leaking cup seals on more than one service can give a steady loss of power. The pressurised oil will escape past the cracked seal in the service that is not selected. It should be borne in mind that the spindles in no way control or 'hold' the load. To illustrate this fact it would be possible to raise to maximum height a fully loaded bucket, stop the engine or oil supply and then completely remove every spindle in the block'.

4.a) Check valves

Failure of a check valve - damaged needle, worn seat, or dirt will cause it to leak and will be shown up in an individual service by failing to hold against a 'load' ie. main arm drops when levers are in neutral. It will not result in loss of power.

4.b) Locked line relief valves and seats

Symptoms of failure are the same as the check valve but as the locked line relief valve discharges to the low pressure gallery, a badly leaking valve can additionally show up with a loss of power on that individual service.

5. Main relief valve

Failure of main relief valve will affect all services. If jammed open; symptom will be no power - also caused by failed 'O' ring. If jammed shut (the sleeve nut can screw itself up through insufficient locking of the threads) the pump can burst'. If possible avoid dismantling the main relief valve.

Note: When trouble-shooting a Hy-Fi system on the PA6 or 'D' range machines a steady and elusive loss of power when the pump, main relief valve and all seals are in good condition, can be traced to internal leakage in the Instant Weight Transfer Valve.

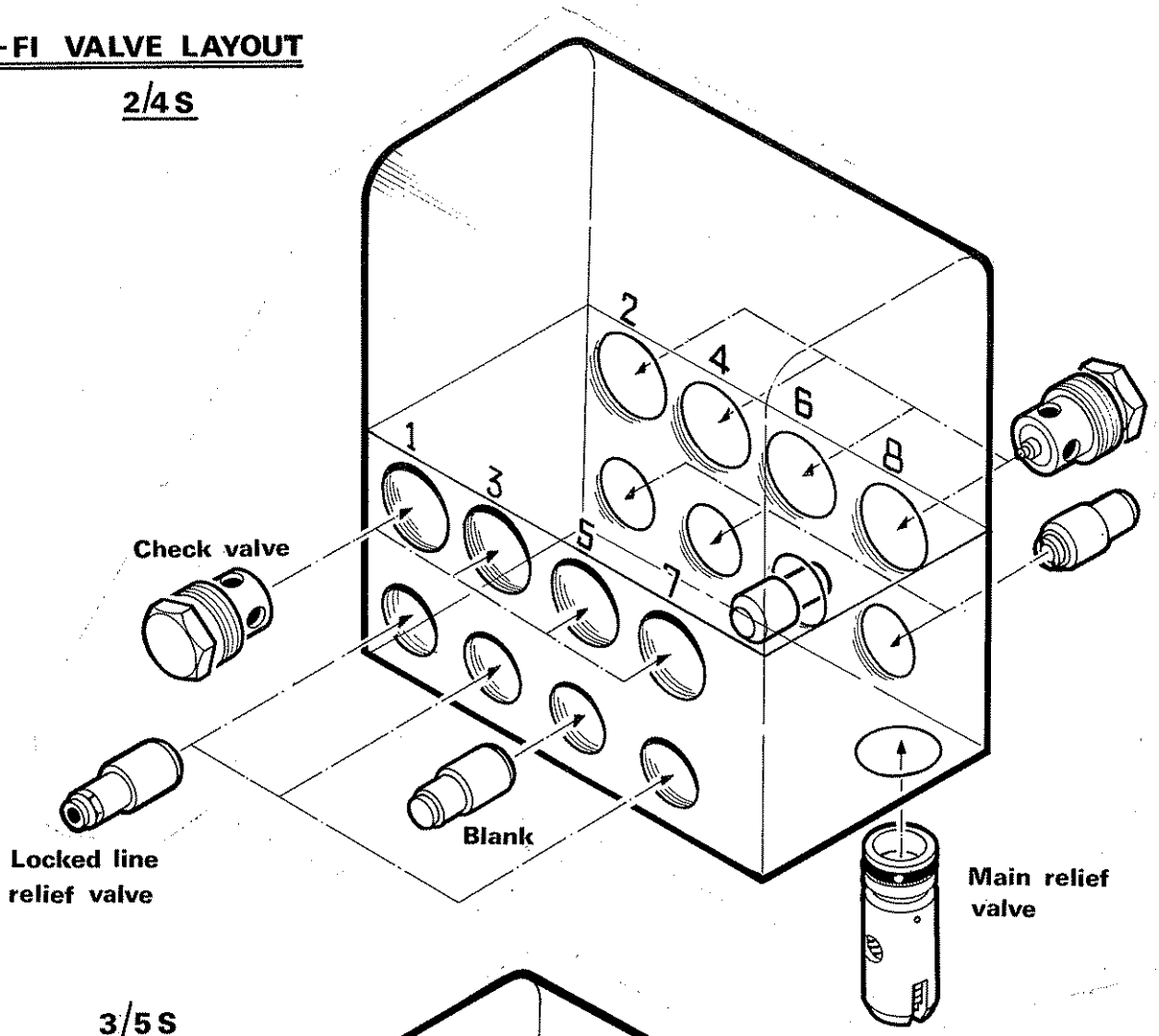
HY-FI FAULT FINDING CHART

Note: This Hy-Fi fault finding chart is compiled by assuming that the hydraulic pump has been checked and is in good condition.

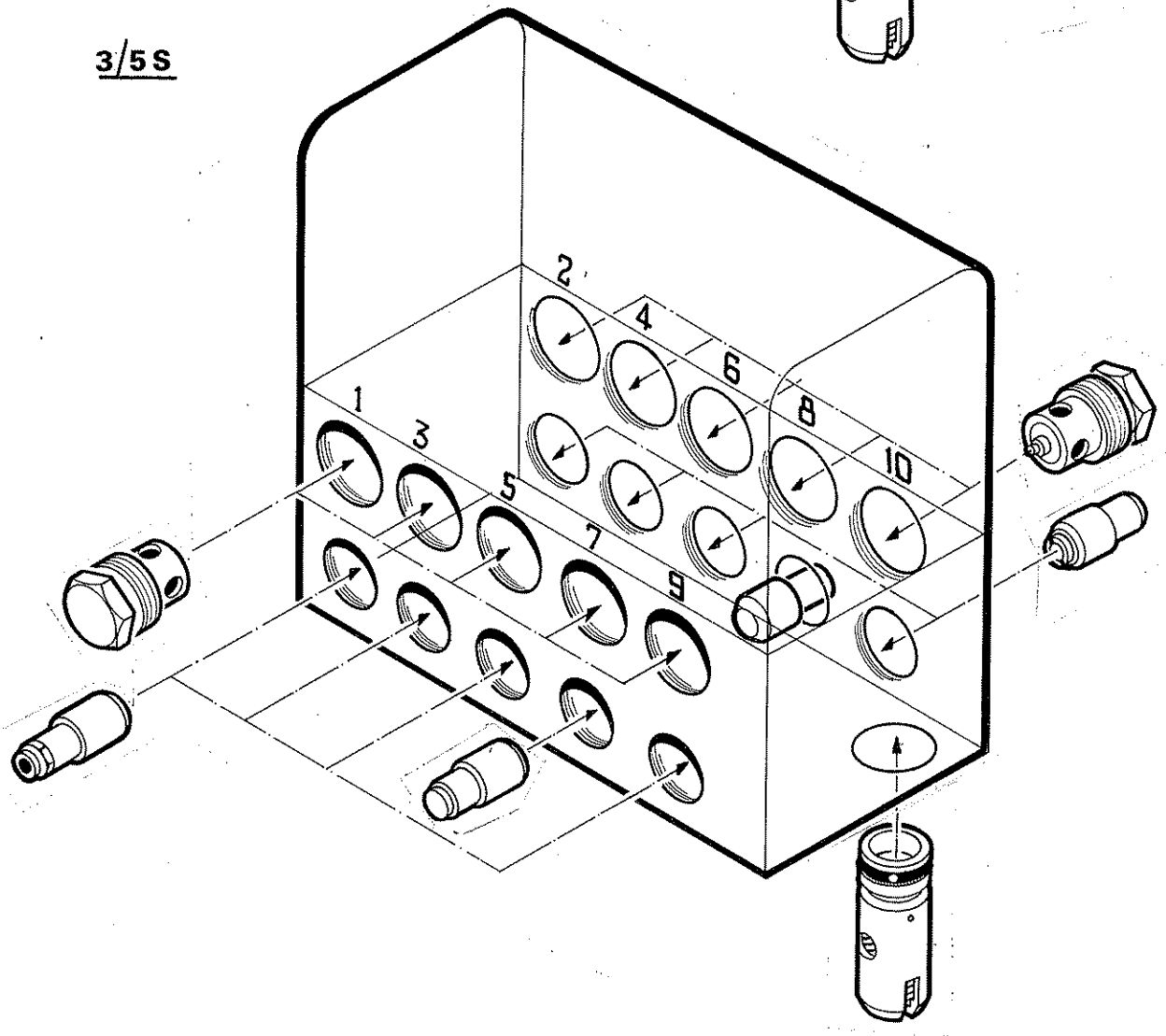
SYMPTOM	FAULT
No response to any lever.	No oil supply. Cut-off valve adjusting screw unwound. Cut-off valve seat swept away. Cut-off needle seat or return spring collapsed. Main relief valve jammed open.
Slight response to all levers but no power.	Incomplete cut-off action - incorrect tappet adjustment. Badly damaged 'O' ring on main relief valve. Damaged cut-off valve seat.
Good response to all levers but lacks power on all services.	Main relief valve faulty. Main relief valve 'O' ring damaged. Leaking cup seals on more than one spindle.
Only one service operational:- other services slow or lack power.	Broken cup seal on the working spindle. Hold down until main relief valve blows- services on other lever now at full power.
Only one service fails to work.	Lower spindle seal damaged.
Partial loss of power on one service only.	Lower spindle seal damaged. Locked line relief valve leaking. Locked line relief valve seat damaged.
Full pressure to ram but no movement.	Spindle jammed on return side of service. Check valve fails to open on return side. Damaged or seized actuators.
Cut-off valve continues to operate when levers are in neutral. (Oil overheats).	Cut-off cartridge jammed in its bore. Incorrect tappet adjustment. Lever mechanism seized up.
Main relief valve continues to blow when levers are in neutral.	Cut-off cartridge jammed in its bore. Incorrect tappet adjustment. Lever mechanism seized.
Failure to hold load when levers in neutral.	Check valve leaking. Locked line relief valve leaking. Locked line valve seat damaged. Ram leaking.

HY-FI VALVE LAYOUT

2/4 S



3/5 S



HY- FI VALVE CHART

2/4 S						
	MACHINE					
	PA 6 S/12 D 14		PA 5 12/CN		TST 20/30	
Section	Check Valve	LLRV in P.S.I.	Check Valve	LLRV in P.S.I.	Check Valve	LLRV in P.S.I.
1	A	2500	A	2500	H	3000
2	A	2500	A	2500	H	3000
3	B	5000	B	5000	D	5000
4	D	5000	D	5000	H	5000
5	B	Blank	B	Blank	H	Blank
6	B	Blank	B	Blank	H	Blank
7	E	3000	E	3000	E	3000
8	B	5000	B	5000	B	5000
	Main Relief Valve 2250 P.S.I.		Main Relief Valve 2000 P.S.I.		Main Relief Valve 2100 P.S.I.	

3/5S				
	MACHINE			
	PA 44		PA 6 & 14E with GRAB ROTATOR	
Section	Check Valve	LLRV in P.S.I.	Check Valve	LLRV in P.S.I.
1	A	3000	A	2500
2	A	3000	A	2500
3	E	5000	B	5000
4	D	5000	D	5000
5	E	5000	A	3000
6	E	5000	A	3000
7	B	Blank	B	Blank
8	B	Blank	B	Blank
9	E	3000	E	3000
10	B	4000	B	5000
	Main Relief Valve 2500 P.S.I.		Main Relief Valve 2250 P.S.I.	

INSTANT WEIGHT TRANSFER VALVE

INSTANT WEIGHT TRANSFER (I.W.T.)

On machine models PA6 and the 'D' range which are driven from a pto operated pump, provision is made for a pair of IWT arms to engage with the tractor draft links transfering tractor weight to the machine. This gives greater stability and digging power.

1. How it Works

The valve that controls this operation, hand operated on the PA6 and foot operated on the 'D', has supply and return ports connected by banjo unions to the Hy-Fi supply and return hoses. When the control lever is in operating position oil pressure is transmitted through the centre port spring housing and into the valve body via the flats on the needle valve. The check valve balls are lifted off their seats and oil flows under pressure to the two single acting rams. The check valves prevent oil returning and all backlash is taken out between tractor and machine.

To allow the machine to be raised, a cam operated push rod forces a ramped bobbin to unseat the check valve balls and collapse the pressure in the rams. At the same time, the ramped bobbin engages the fluted needle valve and closes it in the bush to prevent oil pressure loss in the Hy-Fi while the rams are exhausting.

2. Fault Finding

a) If the check valves fail to hold pressure and the rams drop back, remove any dirt particles under the ball and against the seat. If the ball seat is damaged, lightly tap the larger (5/16" diameter) ball against its seat using a brass or soft steel rod. If hammered too deeply the essential clearance between the large and small balls will be lost.

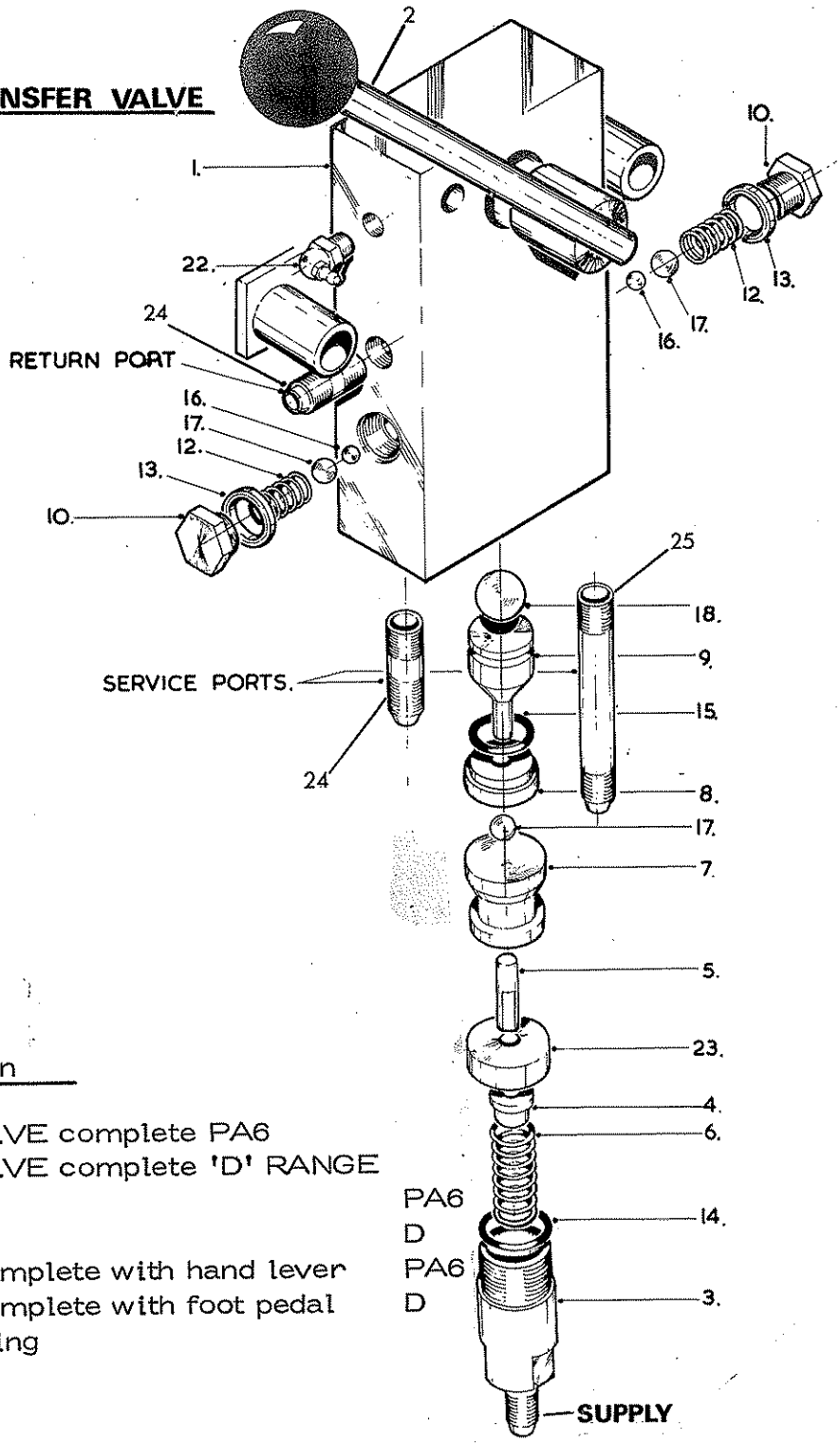
b) If the check valve (ref number 17) is damaged or contaminated with dirt particles the IWT rams will work but the constant leakage of oil to the return line can be a steady source of power loss in the main hydraulic system. An indication that this is occurring is the body of the valve will be unusually warm, caused through the transfer of oil. Verify by disconnecting the return hose at the IWT valve and observing if oil is discharged from the return port when the system is pressurised. The check valve can be reseated in the same way as the ram check valves.

c) Oil leakage from lever cam is caused by failure of the 'O' ring on the push rod.

3. Dismantling the Valve

This is best accomplished by removing the supply port complete with spring and both the service pipe ports. Bring the valve down with a sharp blow onto a block of hard wood. Reassemble in the order shown in the exploded drawing.

INSTANT WEIGHT TRANSFER VALVE



Ref No.	Part No.	Qty	Description
	81 16 300	1	I.W.T. VALVE complete PA6
	81 16 250	1	I.W.T. VALVE complete 'D' RANGE
1	81 16 025	1	Valve body
1	81 16 251	1	Valve body
2	81 16 026	1	Camshaft complete with hand lever
2	81 16 001	1	Camshaft complete with foot pedal
3	81 16 002	1	Spring housing
4	81 16 003	1	Follower
5	81 16 004	1	Needle
6	60 00 110	1	Spring
7	81 16 006	1	Bobbin
8	81 16 007	1	Seat
9	81 16 008	1	Push Rod
10	81 16 009	2	Plug
12	81 16 011	2	Spring
13	86 50 102	2	Bonded Seal
14	86 00 402	1	'O' ring
15	86 00 108	1	'O' ring
16	09 05 107	2	Steel Ball 7/32" diameter
17	09 05 110	3	Steel Ball 5/16" diameter
18	09 05 118	1	Steel Ball 9/16" diameter
22	09 01 124	1	Grease fitting
23	81 16 016	1	Bush
24	81 16 012	2	Stub connection JIC short
25	81 16 013	1	Stub connection JIC long

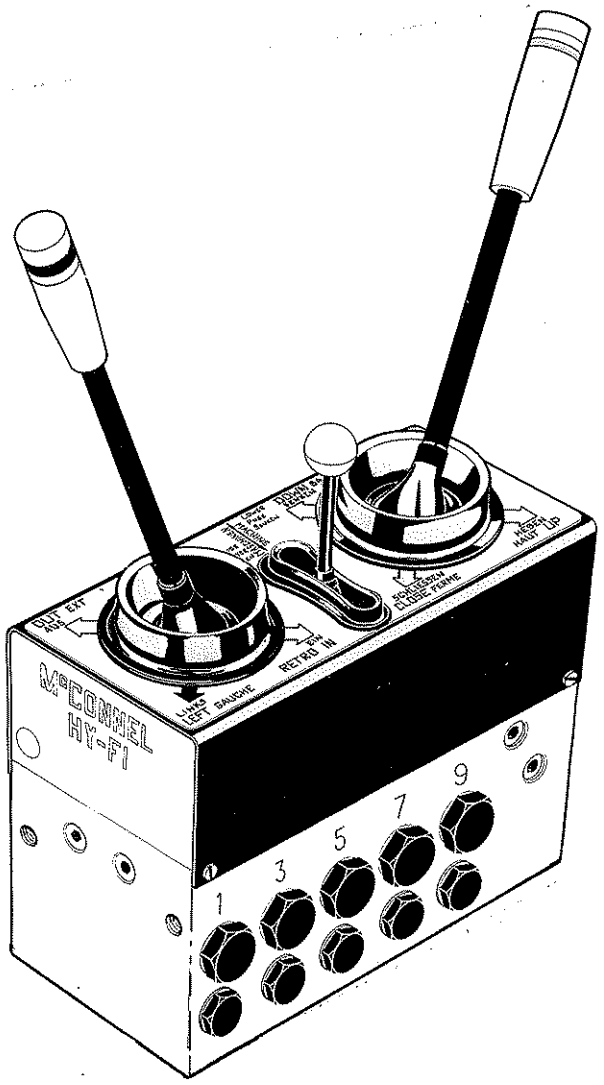
HY-FI SERVICE TOOL KIT

Part No.	Qty	Description
80 04 008	1	HY-FI TOOL KIT complete
80 04 004	1	.Internal circlip pliers
80 04 005	1	.1 1/8" AF Machined socket
80 04 006	1	.1" AF Machined socket
80 04 007	1	.1 5/16" AF Tubular spanner
80 04 269	1	.Hy-Fi Spindle bobbin depressor
80 04 268	1	.Hy-Fi Cut-off seat forming tool
80 04 003	1	.Seal extractor hook
09 06 012	1	.3/16" Allen key
09 06 020	1	.5/16" Allen key
02 11 205	1	.½" x 2½" UNF bolt
80 04 255	1	.Slew seat forming tool

Other useful data

81 14 125	Hy-Fi spares kit
86 99 114	Hy-Fi seal kit - 2/4S model
86 99 117	Hy-Fi seal kit - 3/5S model

SPARE PARTS MANUAL



USE ONLY McCONNEL SPARE PARTS

To be assured of the latest design improvements purchase your genuine replacements from the original equipment manufacturer F.W.McConnel Ltd. through your local dealer or stockist.

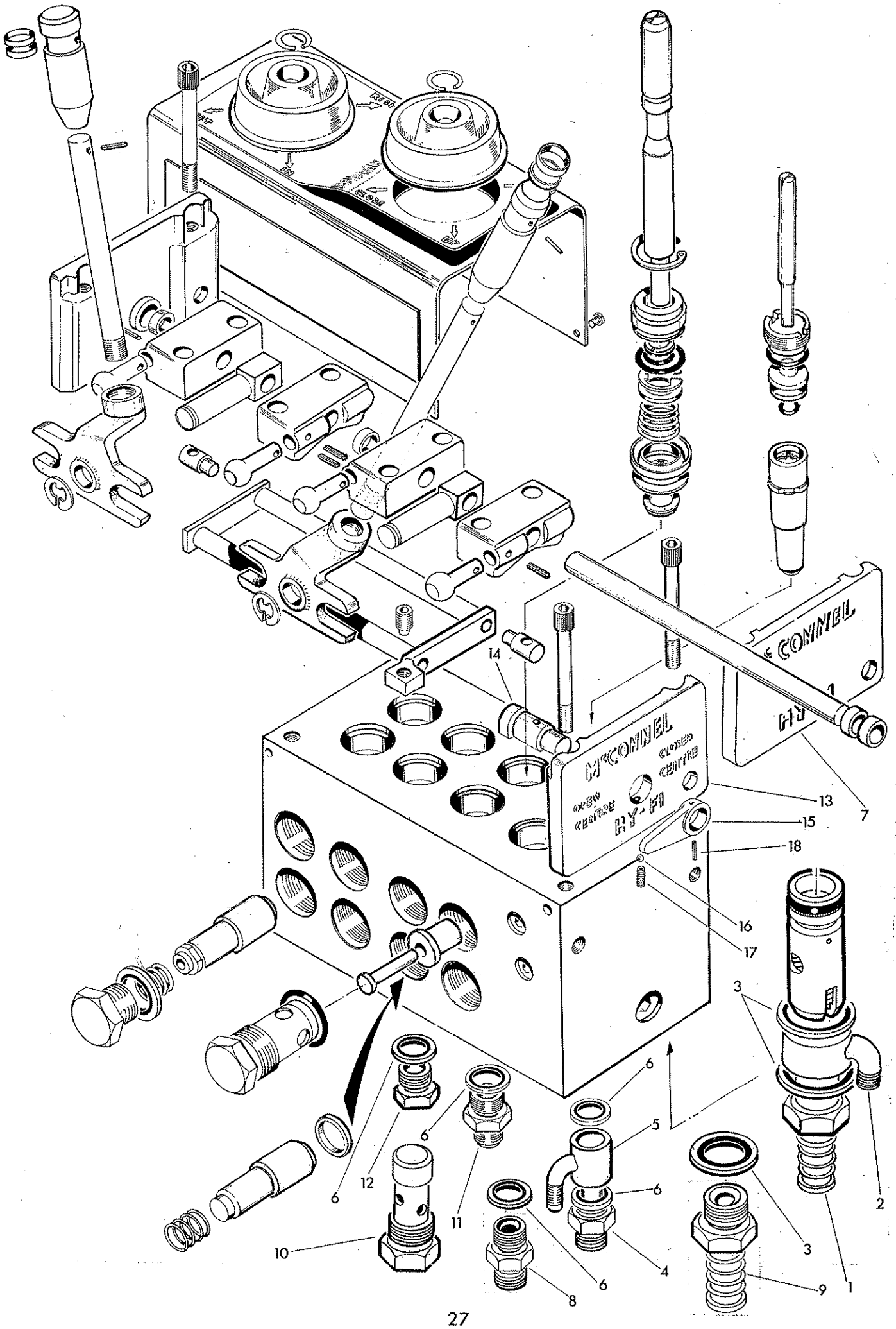
Always quote machine type and serial number as well as the part number.

Design improvement may have altered some of the parts listed in this manual - The latest part will always be supplied when it is interchangeable with an earlier one.

THE DOT SYSTEM

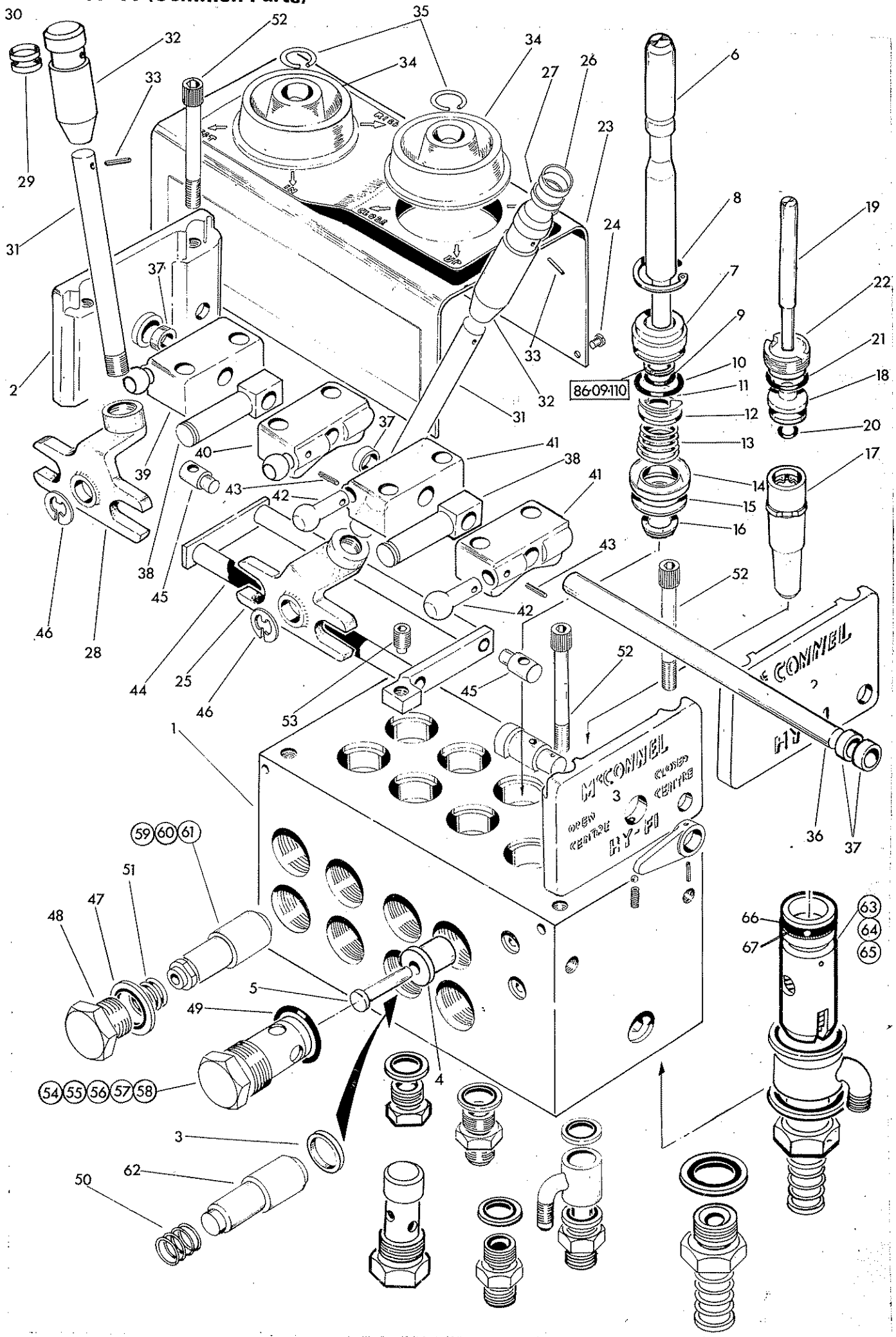
Many spares are supplied as Assemblies or as Sub assemblies and to help the customer determine the composition of an Assembly the Dot System is used. The Main Assembly will not show a dot preceding its description and is printed in BLOCK CAPITALS. Subsequent listed parts are preceded by one or more dots until the next major assembly is reached. An increase in the number of preceding dots indicates that the item is an associated part of the preceding item. Whenever the number of dots are decreased by one this indicates the termination of an assembly.

2-4S HY-FI (Variable requirements)



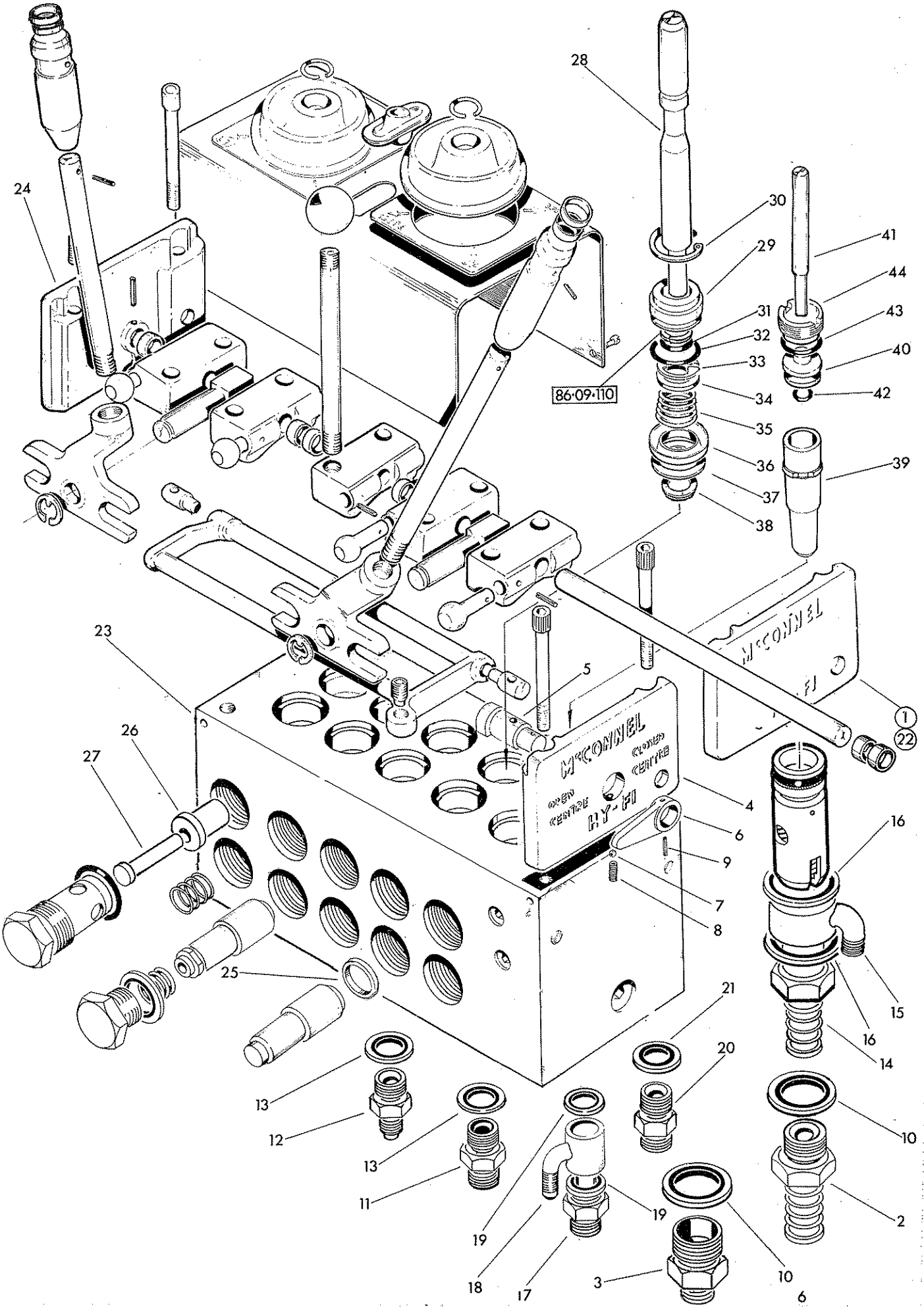
Ref	Part No	Qty	Description
			2-4S HY-FI VARIABLE REQUIREMENTS
	81 14 401		HY-FI PA6
1	81 14 068	1	.Return banjo bolt
2	81 14 066	1	.Return banjo
3	86 50 218	2	. 1.1/8" dia. bonded seal
4	81 14 067	1	.Supply banjo bolt
5	81 14 065	1	.Supply banjo
6	86 50 103	2	.3/8" BSP bonded seal
7	81 14 253	1	.End bracket right hand
8	71 03 062	8	.3/8" BSP - ¾" JIC Union
6	86 50 103	8	.3/8" BSP bonded seal
	81 14 400		HY-FI PA5 OPEN CENTRE
9	81 14 015	1	.Return connection
7	81 14 253	1	.End bracket right hand
	81 18 400		HY-FI PA5 OPEN/CLOSED CENTRE
9	81 14 015	1	.Return connection
	81 14 403		HY-FI PA5 CLOSED CENTRE for J DEERE
10	81 18 007	1	.Return adaptor
The following three items are common to all PA5 Hy-fi:-			
3	86 50 218	1	. 1.1/8" bonded seal
8	71 03 062	9	.Connection 3/8" BSP - ¾" JIC
6	86 50 103	9	. 3/8" BSP bonded seal
	81 14 404		HY-FI TST 20 OPEN CENTRE
7	81 14 253	1	.End bracket right hand
	81 14 015	1	.Return connection
	81 14 407	1	HY-FI TST 20 OPEN/CLOSED CENTRE
	81 18 007	1	.Return adaptor
The following four items are common to both TST 20 Hy-fi:-			
3	86 50 218	1	. 1.1/8" bonded seal
11	10 75 115	7	. Union 3/8" BSP ½" JIC
12	80 03 001	2	. 3/8" BSP plug
6	86 50 103	9	. 3/8" BSP bonded seal
	81 14 405		HY-FI TST 30 OPEN CENTRE
7	81 14 253	1	. End bracket - right hand
9	81 14 015	1	. Return connection
	81 14 408		HY-FI TST 30 OPEN/CLOSED CENTRE
10	81 18 007		. Return adaptor
The following five items are common to both TST 30 Hy-fi:-			
3	86 50 218	1	. 1.1/8" bonded seal
8	71 03 062	5	. Union 3/8" BSP ¾" JIC
11	10 75 115	2	. Union 3/8" BSP ½" JIC
12	80 03 115	2	. 3/8" BSP plug
6	86 50 103	9	. 3/8" BSP bonded seal
The following six items are common to all open/closed Hy-fi:-			
13	81 18 251	1	. End bracket - right hand
14	81 18 002	1	. Cam sleeve
15	81 02 010	1	. Lever
16	09 05 108	1	. Ball
17	81 14 009	1	. Spring
18	04 21 516	1	. Spring dowel 5/32" dia. x 1" long

2-4S HY-FI (Common Parts)



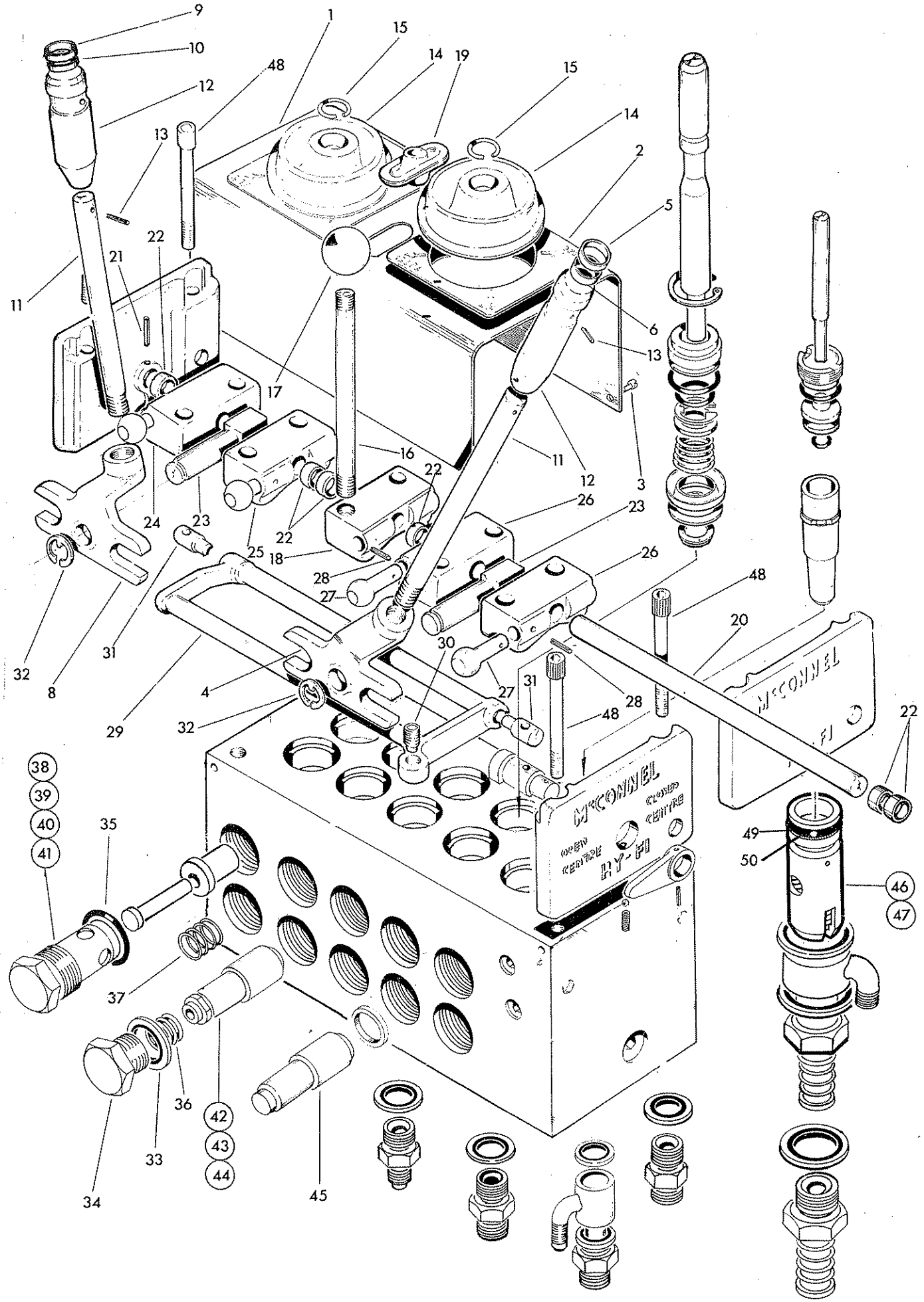
Ref	Part No	Qty	Description
			2-4S HY-FI (cont'd) COMMON PARTS
1	81 14 251	1	.Main body
2	81 14 252	1	.End bracket - left hand
3	81 14 014	6	.L.L.R.V. nylon seat (not slew ports)
4	81 14 047	8	.Actuator 1st stage
5	81 14 050	8	.Actuator 2nd stage
6	81 14 001	8	.Spindle
7	81 14 002	8	.Bobbin c/w circlip and '0' rings
8	81 14 077	8	..Circlip
9	86 00 401	8	..'0' ring
10	86 00 110	8	..'0' ring
11	81 14 058	8	.Internal circlip
12	81 14 081	8	.Spindle washer
13	81 14 003	8	.Conical spring
14	81 06 022	8	.Seal
15	81 14 004	8	.Backing ring
16	81 14 005	8	.Seal
17	81 14 006	1	.Cut-off piston assembly
	81 14 032	1	.Cut-off insert assembly c/w needle, '0' rings etc.
18	81 14 012	1	..Cut-off bobbin
19	81 14 013	1	..Needle
20	86 00 103	1	..'0' ring
21	86 00 111	1	..'0' ring
22	81 14 069	1	.Ring nut
23	81 14 255	1	.Cover
24	81 14 057	4	.Self-tapping screw
	81 14 037	1	.Lever assembly - right hand
25	81 14 073	1	..Lever pivot - right hand
26	81 14 060	1	..Ring yellow
27	81 14 061	1	..Ring green
	81 14 038	1	.Lever assembly - left hand
28	81 14 074	1	..Pivot - left hand
29	81 14 062	1	..Ring red
30	81 14 063	1	..Ring black
The following items 31 to 33 (incl) are common to both lever assemblies:-			
31	81 14 075	1	..Lever handle
32	81 14 053	1	..Knob
33	04 20 812	1	..Spring dowel 1/8" dia. x ¾" long
34	81 14 028	2	.Boot
35	04 05 108	2	.Wire ring
36	81 14 029	1	.Shaft
37	81 14 031	4	.Spacer
38	81 14 030	2	.Handle pivot
39	81 14 055	2	.Rocker assembly - left hand
40	81 14 054	2	.Rocker assembly - right hand
The following items 41 to 43 (incl) are common to both rocker assemblies:-			
41	81 14 033	1	..Rocker
42	81 14 034	1	..Ball end
43	04 20 812	1	..Spring dowel 1/8" dia. x ¾" long
44	81 14 035	1	.Lever
45	81 14 036	2	.Pin
46	81 14 058	2	.Circlip
47	86 50 104	8	.Bonded seal ½" BSP
48	81 14 026	8	.Locked line plug
49	86 00 402	8	.'0' ring
50	81 14 024	6	.Locked line spring
51	81 14 025	2	.Locked line spring (slew port only)
52	02 42 203	4	.Socket headed capscrew 3/8" UNC
53	81 14 056	1	.Socket headed screw
54	81 14 150		.Check valve 'A' type
55	81 14 149		.Check valve 'B' type
56	81 14 153		.Check valve 'D' type
57	81 14 154		.Check valve 'E' type
58	81 14 083		.Check valve 'H' type
59	81 14 103		.Locked line relief valve 2500 psi
60	81 14 101		.Locked line relief valve 5000 psi
61	81 14 100		.Locked line relief valve 3000 psi
62	81 14 027		.Locked line relief solid valve
63	81 09 101		.Main relief valve 2250 psi
64	81 09 100		.Main relief valve 2000 psi
65	81 09 105		.Main relief valve 2100 psi
66	86 00 103		.. '0' ring
67	81 14 079		.. Back-up ring

For quantities and valve positioning see page 21-22


86·09·110
MCONNEL
HY-FI
OPEN CENTRE
CLOSED CENTRE

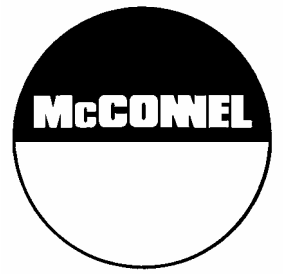
Ref	Part No	Qty	Description
			3-5S HY-FI VARIABLE REQUIREMENTS
	81 17 405	1	.3-5S PA 44 Open Centre
1	81 14 253	1	. End Bracket - right hand
2	81 14 015	1	. Return connection
	81 17 410		3-5S PA 44 OPEN/CLOSED for J.Deere
3	81 17 011	1	. Return connection
4	81 18 251	1	. End bracket - right hand
5	81 18 002	1	. Cam sleeve
6	81 02 010	1	. Lever
7	09 05 108	1	. Steel ball
8	81 14 009	1	. Spring
9	04 21 516	1	. Spring dowel 5/32" dia. x 1" long
The following items 10 to 13 (inclusive) are common to both PA 44 HY-FI s'			
10	86 50 218	1	. 1.1/8" bonded seal
11	71 03 062	7	. Union 3/8" BSP ¾" JIC
12	81 17 010	4	. Union 3/8" BSP 7/16" JIC
13	86 50 103	11	. 3/8" BSP bonded seal
	81 17 400		3-5S 14E with rotator (OPEN CENTRE)
14	81 14 068	1	. Return banjo bolt
15	81 14 066	1	. Return banjo
16	86 50 218	2	. 1.1/8" bonded seal
17	81 14 067	1	. Supply banjo bolt
18	81 14 065	1	. Supply banjo
19	86 50 103	2	. 3/8" BSP bonded seal
20	71 03 062	10	. Service port connection 3/8" BSP - ¾" JIC
21	86 50 103	10	. 3/8" BSP bonded seal
22	81 14 253	1	. End bracket - right hand
			3-5S HY-FI COMMON PARTS
23	81 17 251	1	. Main body
24	81 14 252	1	. End bracket - left hand
25	81 14 014	8	. L.L.R.V. nylon seat (not slew ports)
26	81 14 047	10	. Actuator 1st stage
27	81 14 050	10	. Actuator 2nd stage
28	81 14 001	10	. Spindle
29	81 14 002	10	. Bobbin c/w circlip and '0' rings
30	81 14 077	10	. Circlip
31	86 00 401	10	. '0' ring
32	86 00 110	10	. '0' ring
33	81 14 058	10	. Internal circlip
34	81 14 081	10	. Spindle washer
35	81 14 003	10	. Conical spring
36	81 06 022	10	. Seal
37	81 14 004	10	. Backing ring
38	81 14 005	10	. Seal
39	81 14 006	1	. Cut-off piston assembly
	81 14 032	1	. Cut-off insert assembly c/w needle '0' rings etc.
40	81 14 012	1	.. Cut-off bobbin
41	81 14 013	1	.. Needle
42	86 00 103	1	.. '0' ring
43	86 00 111	1	.. '0' ring
44	81 14 069	1	. Ring nut

3-5S HY-FI Continued



Ref	Part No.	Qty	Description
			3-5S HY-FI COMMON PARTS (cont'd)
1	81 17 252	1	.Cover c/w label
2	81 17 012	1	..Label
3	81 14 057	4	.Self-tapping screw
	81 14 037	1	.Lever assembly - right hand
4	81 14 073	1	..Lever pivot
5	81 14 060	1	..Ring yellow
6	81 14 061	1	..Ring green
	81 14 038	1	.Lever assembly - left hand
8	81 14 074	1	..Lever pivot - left hand
9	81 14 062	1	..Ring red
10	81 14 063	1	..Ring black
The following items 11 to 13 (incl) are common to both lever assemblies:-			
11	81 14 075	1	..Lever handle
12	81 14 053	1	..Knob
13	04 20 812	1	..Spring dowel 1/8" dia. x ¾" long
14	81 14 028	2	.Boot
15	04 05 108	2	.Wire ring
	81 17 002	1	.Centre lever assembly
16	81 17 009	1	..Lever handle
17	09 03 121	1	..Knob
18	81 17 006	1	..Rocker
19	81 17 001	1	.Centre lever boot
20	81 17 003	1	.Shaft
21	04 20 816	1	.Spring dowel 1/8" dia. x 1" long
22	81 14 031	6	.Spacer
23	81 14 030	2	.Handle pivot
24	81 14 055	2	.Rocker assembly - left hand
25	81 14 054	2	.Rocker assembly - right hand
The following items 26 to 28 (incl) are common to both rocker assemblies:-			
26	81 14 033	1	..Rocker
27	81 14 034	1	..Ball end
28	04 20 812	1	..Spring dowel 1/8" dia. x ¾" long
29	81 17 004	1	.Cut-off lever
30	81 14 056	1	.Socket set screw 3/8" UNF
31	81 14 036	2	.Pin
32	81 14 058	2	.External circlip
33	86 50 104	10	.Bonded seal ½" BSP
34	81 14 026	10	.Locked line plug
35	86 00 402	10	. '0' ring
36	81 14 024	8	.Locked line spring
37	81 14 025	2	.Locked line spring (slew ports only)
38	81 14 150		.Check valve 'A' type
39	81 14 149		.Check valve 'B' type
40	81 14 155		.Check valve 'D' type
41	81 14 154		.Check valve 'E' type
42	81 14 103		.Locked line relief valve 2500 p.s.i.
43	81 14 101		.Locked line relief valve 5000 p.s.i.
44	81 14 100		.Locked line relief valve 3000 p.s.i.
45	81 14 027		.Locked line relief solid valve
46	81 09 101		.Main relief valve 2250 p.s.i.
47	81 09 103		.Main relief valve 2500 p.s.i.
48	02 42 203		.Socket cap screw 3/8" UNC
49	86 00 103		.'0' ring
50	81 14 079		.Back-up ring

For quantities and valve positioning see page 21-22



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