K3V112DT

INSTRUCTION

MANUAL

KAWASAKI PRECISION MACHINERY OF AMERICA
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Date: July 2004

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CONTENTS PAGE

1. SPECIFICATIONS
1.1. Installation 2
1.2. Porting Identification 2
1.3. General Specifications 3
1.4. Regulator Characteristics 5
1.5. Cross Sectional Drawings 6
1.6. Hydraulic Schematic 6

2. CONSTRUCTION and FUNCTIONS
2.1. Pump Construction 7
2.1.1 Rotating Group 7
2.1.2 Swash Plate Group 8
2.1.3 Valve Cover Group 8
2.2. Regulator Functions 9
2.2.1. General Description 9
2.2.2. Torque Summation Control (Total Horsepower) 11
2.2.3. Negative Control (Negacon) 16

3. DISASSEMBLY and ASSEMBLY
3.1. General Precautions 21
3.2. Tools 22
3.3. Disassembly 23
3.4. Assembly 27

4. MAINTENANCE STANDARDS
4.1 Part Inspection 32

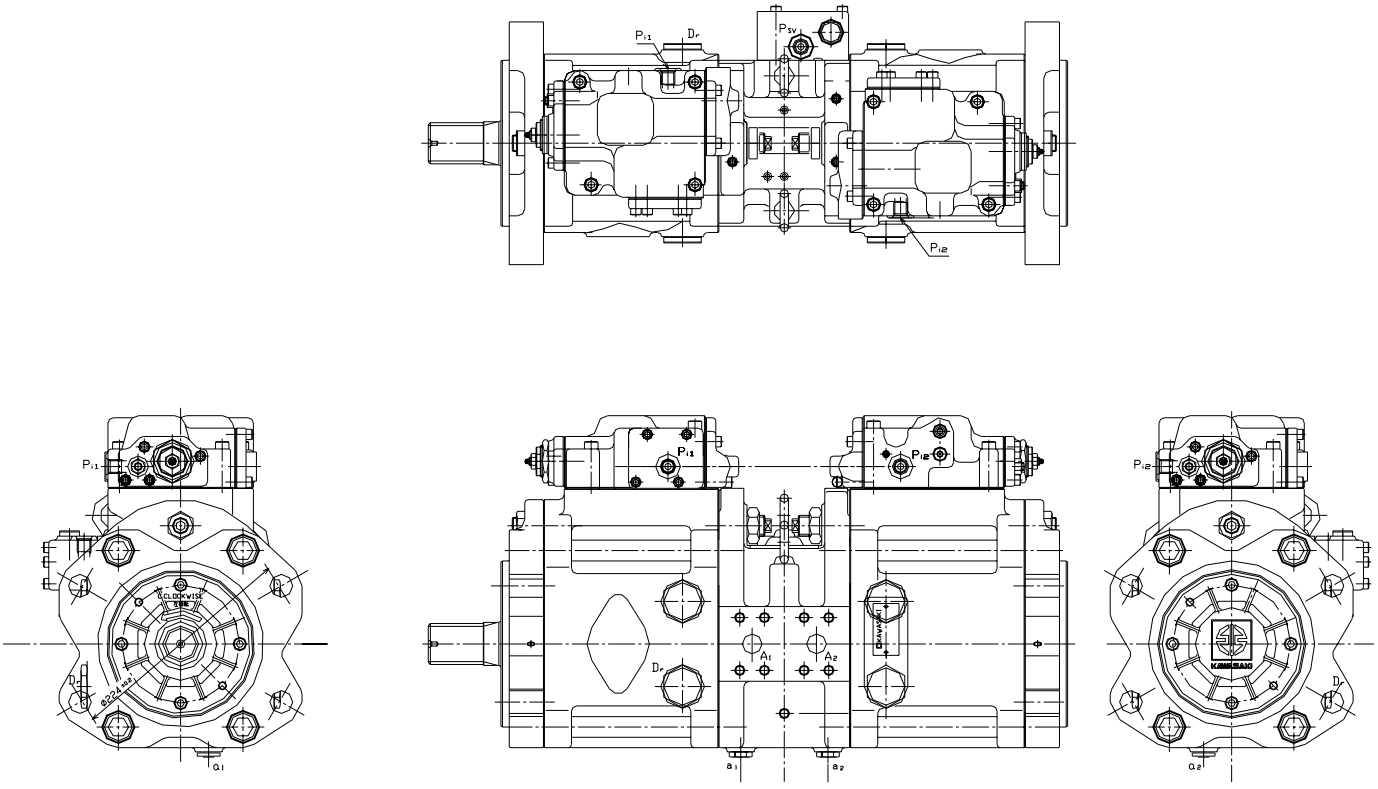
5. TROUBLE SHOOTING
5.1. General Comments 33
5.2. Basic Pump 34

6. SPARE PARTS
6.1. Cross Sectional Drawings 35
6.2. Parts Listings 38

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1. SPECIFICATIONS

1.1. Installation



1.2. Porting Identification

Ref.	Port Name	Port Size
$A_{1, 2}$	Delivery Port	SAE 6000 psi ¾”
B_1	Suction Port	SAE 2500 psi 2 ½”
D_r	Drain Port	G ¾ - 20
$P_{i1, 2}$	Pilot Port	G ¼ - 15
P_{SV}	Servo Assist Port	G ¼ - 15
$a_{1, 2}$	Gauge Ports	G ¼ - 15

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1. Specifications (cont.)

1.3. General Specifications

1.3.1. Pump

Displacement :-	2 x 55 cc/rev
Maximum Self Priming Speed :-	2,600 min^{-1}
Maximum Boosted Speed :-	3,000 min^{-1}
Actual Operating Speed :-	2,100 min^{-1}
Rated Pressure :-	320 bar
Maximum Pressure :-	350 bar
Maximum Available Flow Rate :-	2 x 115 L/min
Maximum Input Torque :-	319 Nm
Maximum Input Power :-	70 kW
Direction of Rotation :-	Counter Clockwise
Control Characteristics :-	Simultaneous Total Horsepower Control Negative Flow Control Variable Horsepower Control Two Stage Maximum Flow Control
Minimum Suction Pressure :-	-0.1 bar (Self Priming) ; +1 bar (Boosted)
Maximum Suction Pressure :-	+10 bar
Allowable Mean Case Pressure :-	1 bar
Allowable Surge Casing Pressure :-	4 bar
Working Fluid :-	Anti-Wear Hydraulic Fluid
Temperature Range :-	-20^{o} ~ 95^{o}C
Oil Viscosity Range :-	10 ~ 200 cSt Working
Recommended Filtration :-	Nominal 10 micron (Full Flow Return Line)
Fluid Cleanliness :-	ISO 4466 / 1986 Code 18/15
Pump Casing Capacity :-	2 Litres

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1. Specifications (cont.)

1.3. General Specifications (cont.)

1.3.2. Pump Control Settings (Pump Speed 2,100 min^{-1})

Variable Power Shift Range :- 70 ~ 44 kW
Two Stage Flow Control Flow Setting :- 2 x 95 L/min (@80 bar)
Two Stage Flow Control Operating Pressure:- 38 bar
Minimum Flow Rate:- 2 x 21 L/min (@80 bar)
Negative Control Pilot Pressure Range:- 11.7 bar ~ 32.2 bar

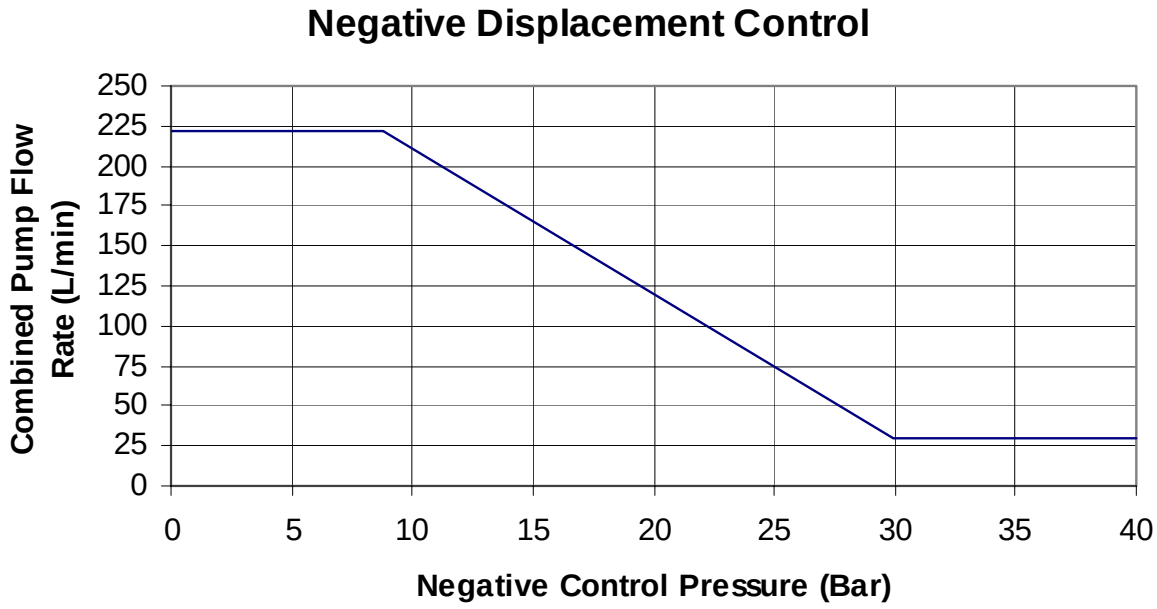
1.3.3. Control Adjustment Rates

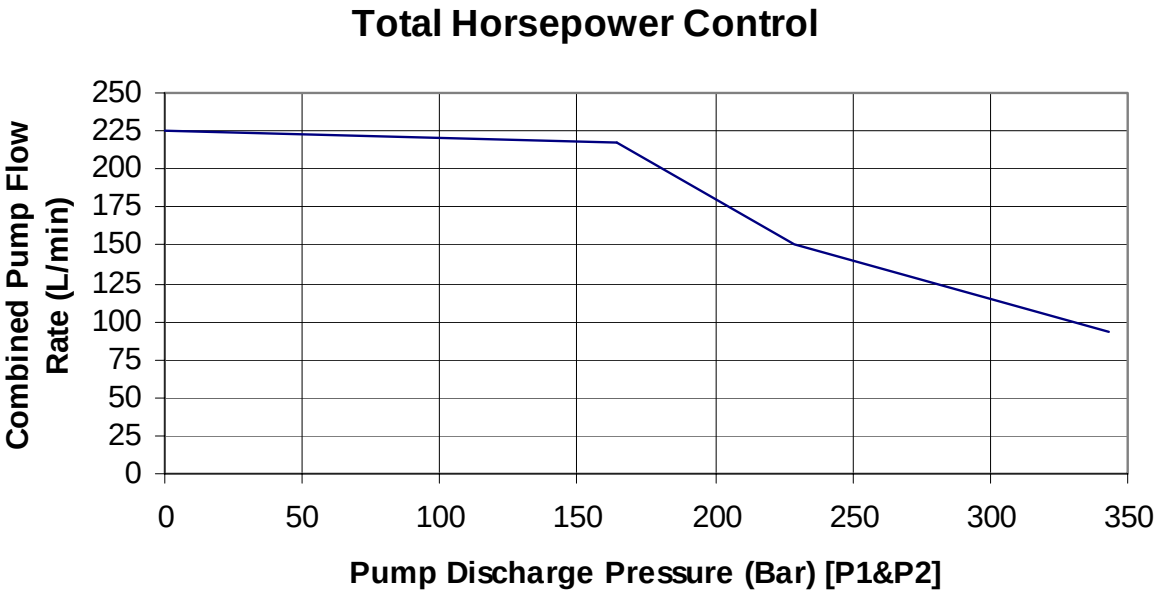
Adjustment	Adj. Ref.	Change for ¼ clockwise turn of the referenced adjuster
Maximum Displacement	954	- 1.55 cm^3/rev {-3.26 L/min}
Minimum Displacement	953	+ 1.55 cm^3/rev {+3.26 L/min}
Two Stage Flow Control	642	- 3.77 cm^3/rev {-7.92 L/min}
Negative Control Pilot Pressure	924	+ 1.63 bar {+7.47 L/min}
Outer Spring, Power Control	625	+ 18.8 bar & +10.7 L/min {equivalent to +31.4 Nm}
Inner Spring, Power Control	626	+ 26.8 bar & +5.6 L/min {equivalent to +26.4 Nm}

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1. Specifications (cont.)

1.4 Regulator Characteristics

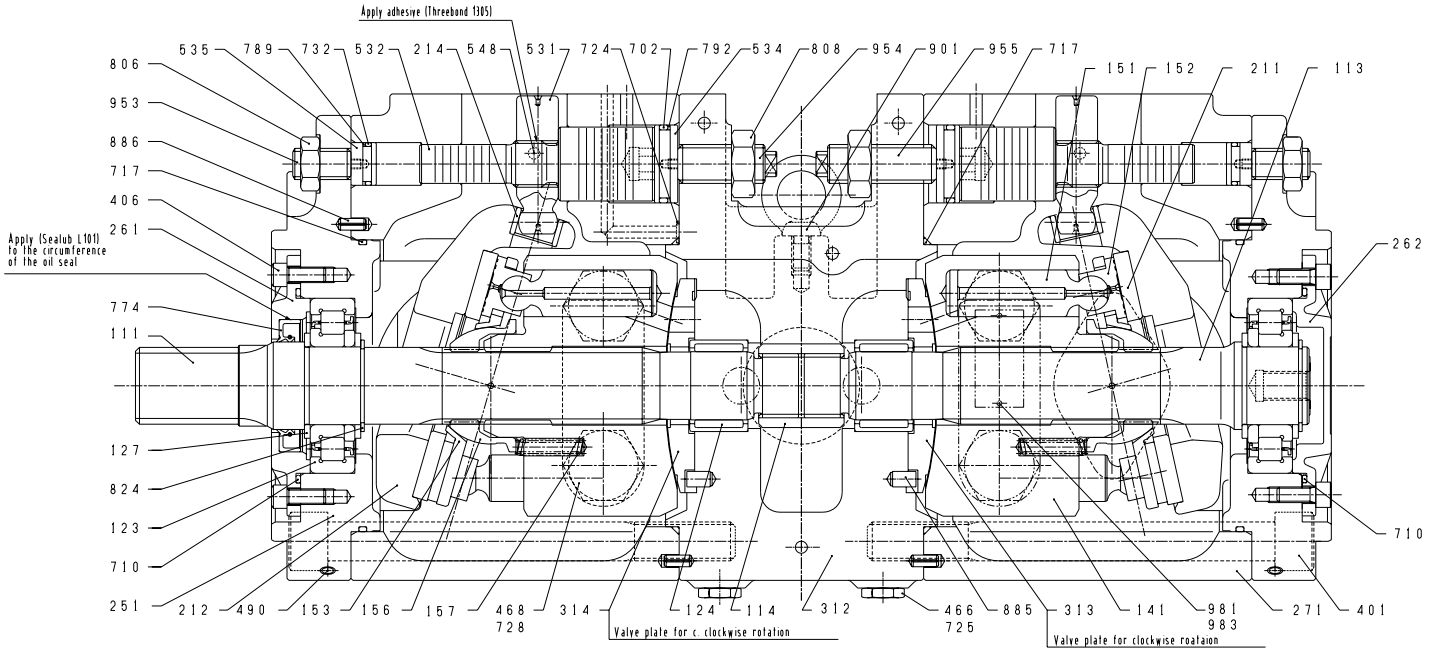




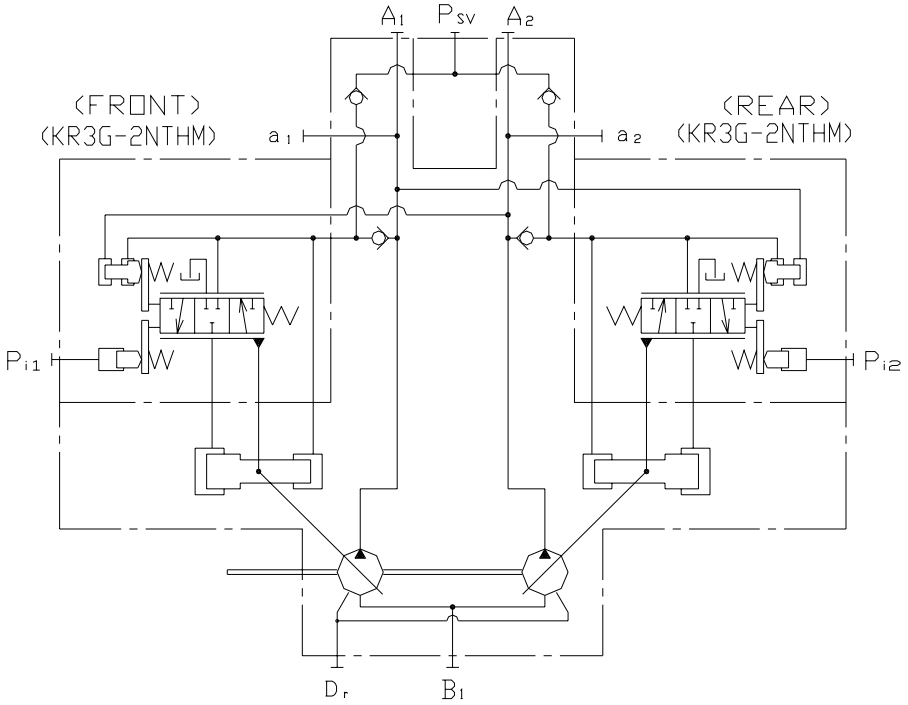
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1. Specifications (cont.)

1.5. Cross Sectional Drawing



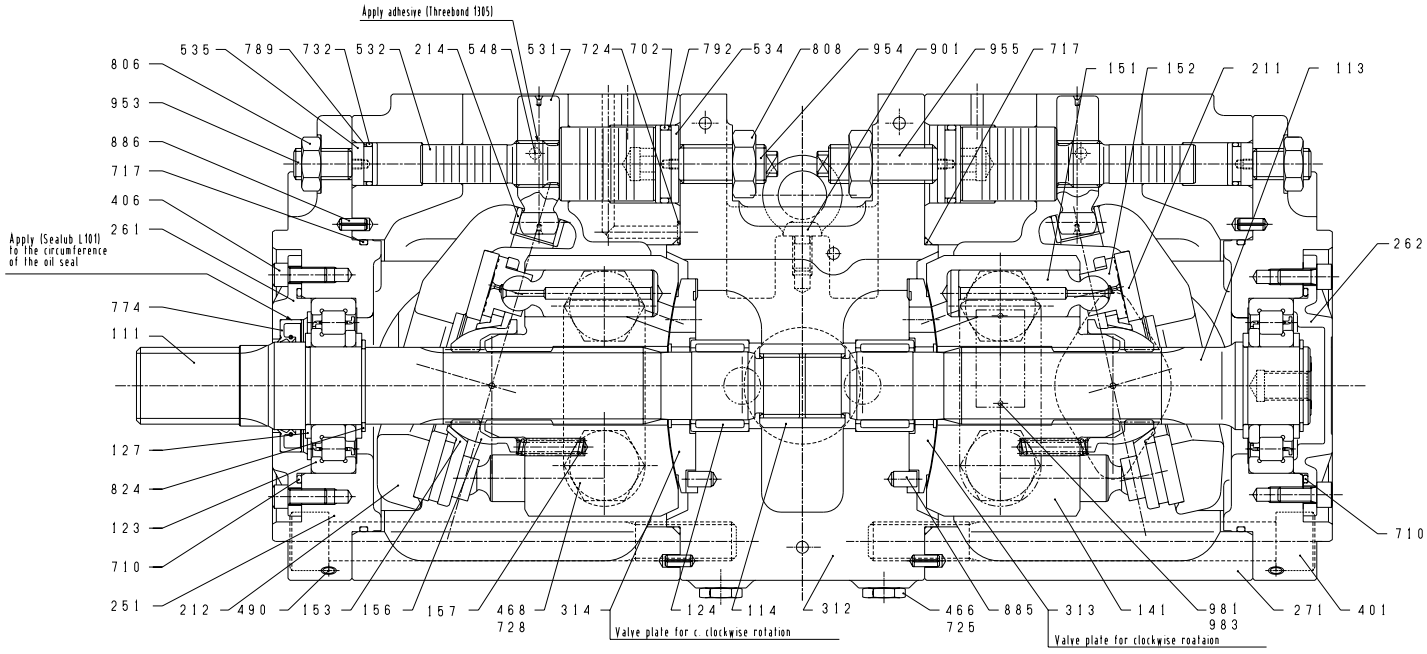
1.6. Hydraulic Schematic



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2.0 CONSTRUCTION and FUNCTIONS

2.1. Construction



The components of the K3V pump can be divided into three sub-groupings: -

Rotating Group - which provides the main rotary pumping action
Swash Plate Group - to vary the pump's delivery flow rate
& Valve Cover Group - which provides the switching of oil between suction and delivery ports.

2.1.1 Rotating Group

This is composed of the drive shaft (111), cylinder block (141), pistons (9 x151), shoes (9 x 152), setting plate (153), spherical bush (156), spacer (158) and cylinder springs (9 x 157). The drive shaft is supported at both its ends by bearings (123 & 124). The drive shaft is coupled to the cylinder block through a splined section. The shoe is swaged over the spherical end of the piston so as to form a spherical ball joint. In addition the shoe has a hydrostatic pocket so as to effectively balance the hydraulic thrust developed by the piston pressure so that the shoe can lightly slide against the shoe plate (211). Additionally the subgroup consisting of the pistons and shoes are pressed against the shoe plate by the cylinder springs, which act through the setting plate and the spherical bush. The force developed by these cylinder springs also press the cylinder block against the valve plate (313)

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2. CONSTRUCTION and FUNCTIONS (cont.)

2.1. Construction (cont.)

2.1.2. Swash Plate Group

This is composed of the swash plate (212), shoe plate (211), swash plate support (251), tilting bush (214), tilting pin (531) and the servo piston (532). The swash plate on the reverse side to the shoe location is of a cylindrical form which is “pillow” supported by the hydrostatic bearing provided by the swash plate support. The tilting bush is inserted into the swash plate and into this is installed the spherical portion of the tilting pin which in turn is coupled to the servo piston itself. Any linear movement of the servo piston produced by regulator pressure applied to either of its ends is thereby translated through the tilting pin into an angular movement of the swash plate which thereby varies the tilting or swash angle of the pump. Screw adjusters and lock nuts are available to adjust the factory set maximum (954) and minimum (953) tilting angle conditions.

2.1.3. Valve Cover Group

This is composed of the valve cover (312), valve plate (313) and valve plate pin (885). The valve plate with its two “melon” shaped ports is installed onto the valve plate being located by the valve plate pin. These two ports serve to supply and exhaust oil to and from the cylinder block. The oil passage switched by the valve plate is connected to the externally piped suction and outlet pressure ports through the valve cover.

When the pump’s drive shaft is driven by a prime mover, the cylinder block being spline coupled to the shaft will also rotate. If the swash plate has been tilted, the pistons arranged in the cylinder block due to the shoe being retained on the swash plate surface will both rotate with the cylinder block and reciprocate once per revolution. Paying attention to one such piston then it will move away from the valve plate for half a rotation (suction stroke) and move towards the valve plate for the second half of rotation (oil delivery stroke). The larger the tilt angle is the longer the piston stroke and thereby the higher is the pump’s displacement. If the swash plate tilting angle however is zero then the piston makes no stroke and thereby delivers no oil.

In the case of the K3V63DT tandem pump this has the construction whereby two pumps complete with their individual regulators are connected together by a coupling (114) within the central valve block (312) and that the drive shaft on the front pump (111) is connected to the prime mover. The oil suction port is common to both the rear and front pumps. The two pumps however are each provided with independent delivery ports.

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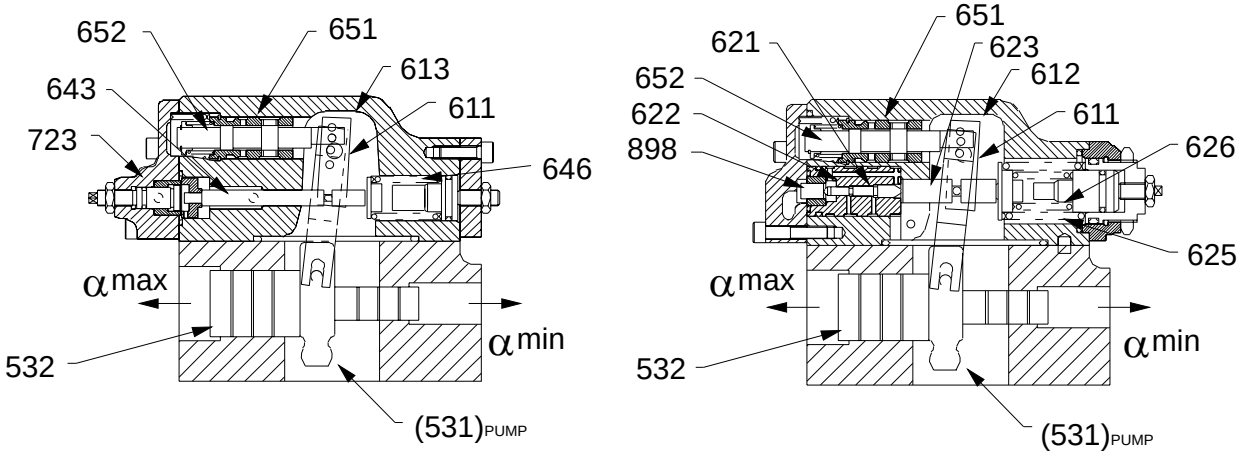
2.2. Regulator Functions

2.2.1. General Description

The KR3 series regulators have been designed to give varied controlled options for the K3V series of axial piston pumps ideally suited to their application to excavator type systems.

The control options covered are:

a) Total Power Control (Torque Summation)
b) Power Shift
c) Negative Displacement Control
d) Two Stage Maximum Flow Control



The operation of the regulator utilises a follower-type lever linkage system (611) connected between the pump's servo piston (532), the main control spool (652) and the regulator body (613) itself. This lever arrangement is activated by a series of pilot pistons (621 & 643) together with their associated control springs (625, 626 & 646) from which the relevant regulator control characteristic is obtained. The use of such a feed back lever arrangement from the servo piston ensures a highly responsive and accurate control system.

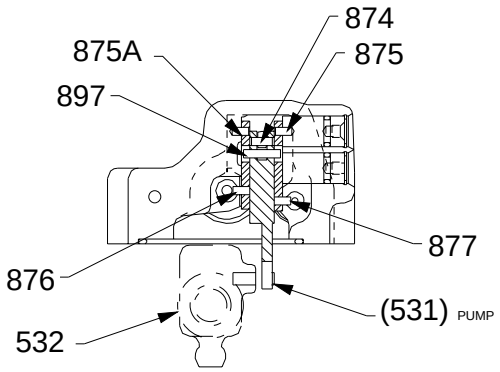
The servo piston (532) is connected through the pivot point (531) to the swash plate of the pump. Movement of the servo piston (532) to the left increases pump displacement and to the right reduces it.

The servo piston (532) itself has an area ratio of 4:1 whereby the smaller piston area to the right is continuously connected to the pump's outlet pressure. The larger diameter area of the servo piston to the left is fed from the main regulator spool (652), which as it pressurises this servo piston area progressively reduces the pump displacement.

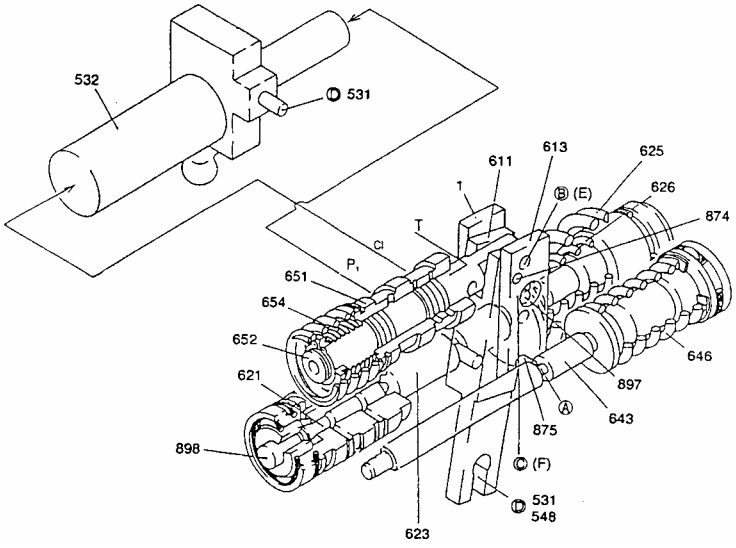
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2.2. Regulator Functions (cont.)

2.2.1. General Description (cont.)



The various lever and linkage arrangements within the regulator assembly are illustrated above. The main feedback lever is shown in the centre where the servo pivot (531) couples it to the servo piston. The spool pivot (874) couples the lever directly to the main control spool. Additionally the feedback pivot (897) couples this feedback lever to both the displacement lever (to the right) and to the power lever (to the left). The displacement lever is anchored to the regulator body by the fixed pivot pin (875) whereas the power lever is anchored in a similar manner by the fixed pivot (875A).

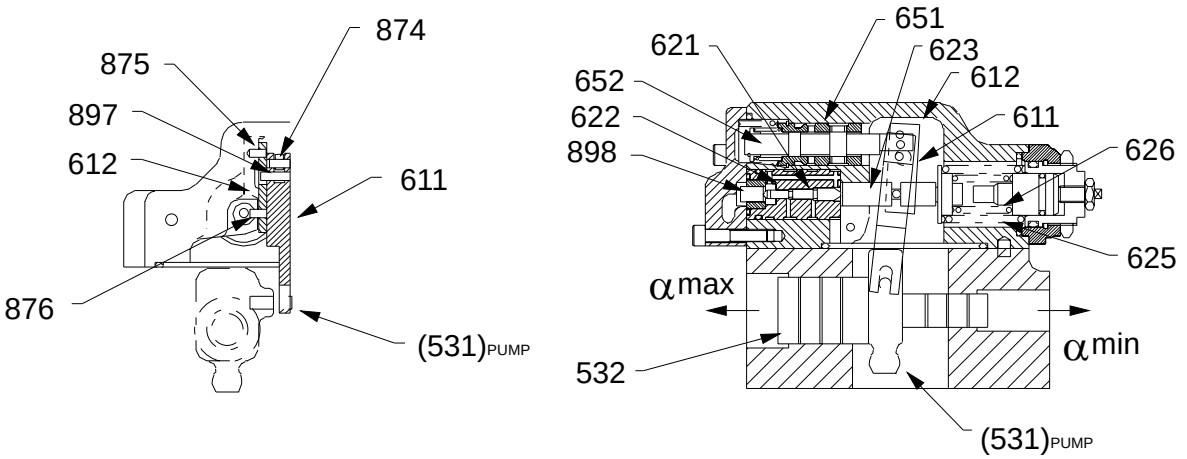


In order, to better understand the functioning of this assembly, the regulator itself will now be split into two separate halves. Firstly viewing the Power or Torque Summation Control (to the left) and then later that of the Negative Displacement control (to the right)

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2.2. Regulator Functions (cont.)

2.2.2. Torque Summation Control



The above sections specifically show the Torque Summation Control with their necessary feedback mechanisms. These figures should be studied such that a general familiarisation of the mechanism is built up. The following description will help in this understanding.

Pump outlet pressure is fed into the larger stepped diameter area of the Power control piston (621). Pressure feedback from the second pump unit is in addition fed into the smaller stepped diameter area. These two stepped areas are equal.
The consequence of which is that both pumps destroke together to the same displacement condition. The force so produced is balanced by the spring preload created by the inner (626) and outer (625) power springs. At low pump feedback pressures only the outer spring (625) is active and as combined pumps pressure force on the piston (621) increases then the inner spring (624) also becomes active. Consequently a change in spring rate changes at some point which provides the characteristic curve.

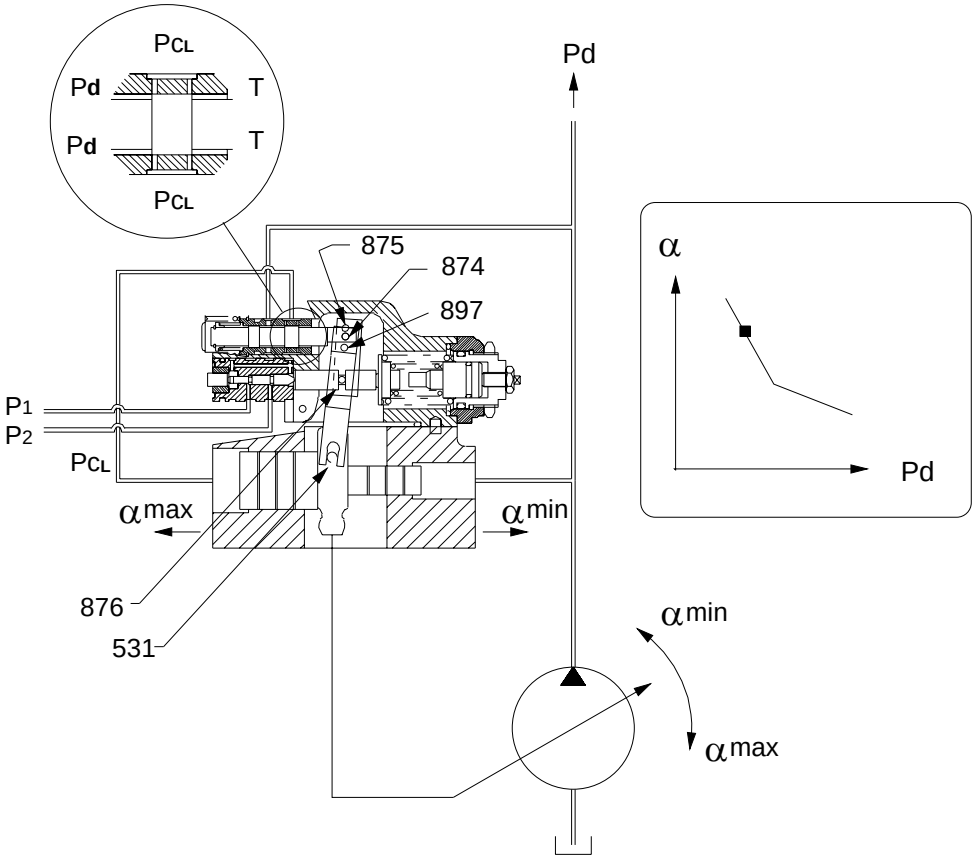
Movement of the piston (621) under the action of these pump(s) pressure forces is transmitted by the power push rod (623) against the springs (624 & 625). This movement shifts the power control lever (612) on its fixed pivot (875A) towards the right of the diagram. This movement is transmitted from the power control lever (612) via the feed back pivot (897) to the feedback lever (611), which rotates “clockwise" slightly around the servo pivot (531). As the feed back lever (611) is also connected to the main spool (652) via (874) this causes the main spool to port pressurised oil to the larger diameter area of the pump’s servo piston, which in turn begins to destroke the pump. This action results in the main feedback lever (611) to shift in an anti-clockwise direction. A state of equilibrium will eventually exist whereby the servo piston position and thereby pump displacement is so maintained that the main control spool is back in a central metering condition. In this condition the pressure fed to the servo pistons larger diameter will maintain equilibrium.

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2.2. Regulator Functions (cont.)

2.2.2. Torque Summation Control (cont.)

Main Spool & Sleeve Metering



The following sequence will assist in understanding the operation.

Pressure P1 is connected to the delivery port of the front pump section, whereas P2 is connected to the rear pump delivery port.

For this explanation we will consider P1 & P2 as being connected together at the same pressure. (I.e. Both pumps loaded at the same delivery pressures.)

The diagram above illustrates the balanced condition whereby the Power Piston force is balanced against the Power Spring Pack force, the Main Spool metering position is in a null position and is porting enough fluid to the Large Servo Piston to maintain a force balance across the servo piston.

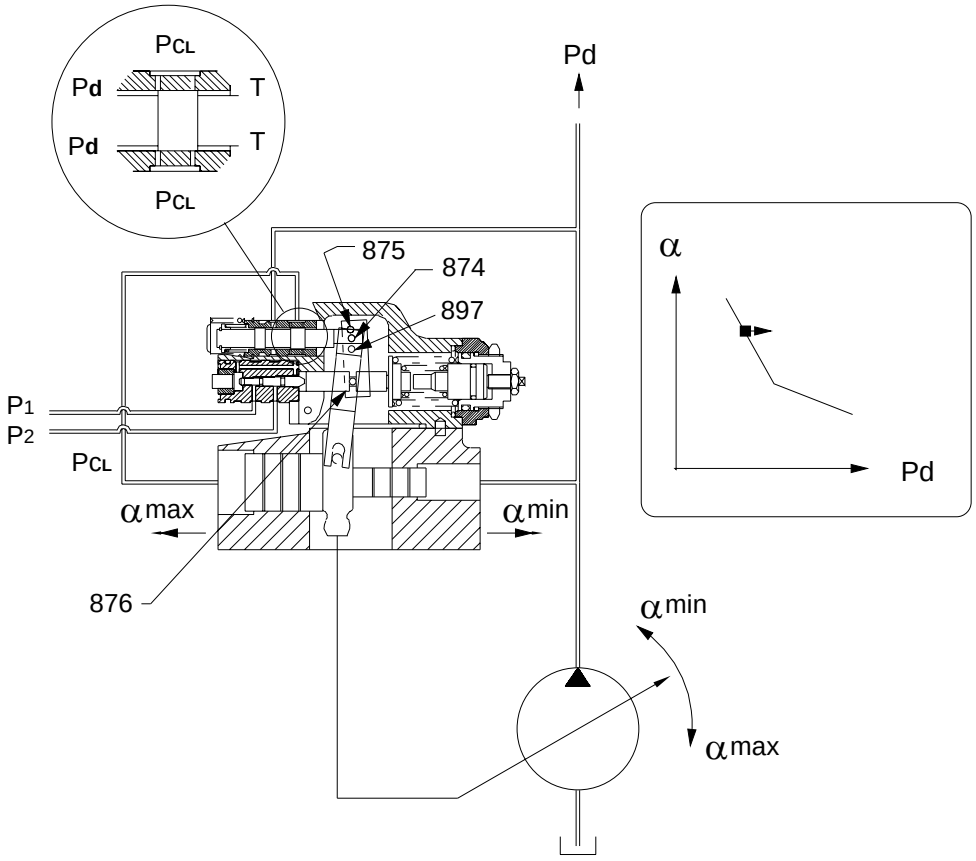
At this condition the Large Servo Piston pressure is approximately ¼ of the pumps delivery pressure. The Feed Back Lever is keeping a check on the position of the Swash Plate, which in turn moves the Main Spool to correct any error. The various positions of levers & pistons should be noted.

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2.2. Regulator Functions (cont.)

2.2.2. Torque Summation Control (cont.)

Main Spool & Sleeve Metering



As the delivery pressure increases at P1 & P2 the Power Piston compresses the Power Spring Pack, the linear movement of the Power Push Rod causes the Power Lever to pivot around Fixed Pivot 1 towards the right.

This movement is transmitted from the Power Lever to the Feed Back Lever via the Feed Back Pivot.

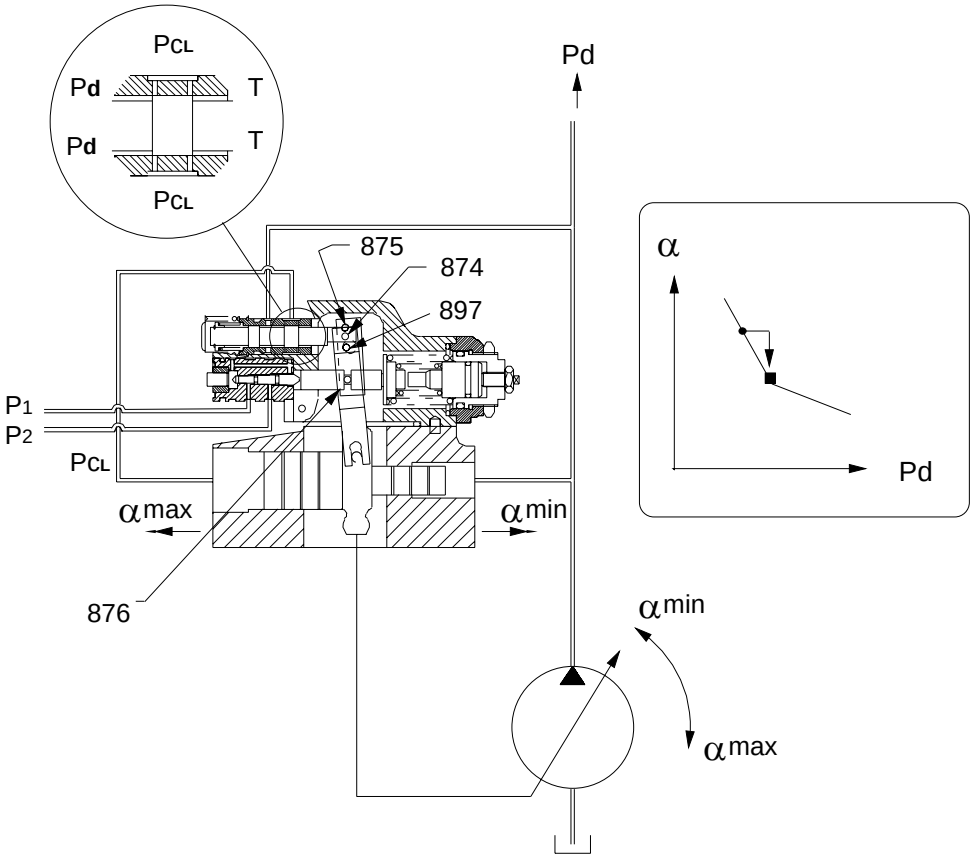
The Feed Back Lever now rotates “clockwise” around the Servo Pivot slightly and causes the Main Spool to move to the right through the Spool Pivot point.
The enlarged view of the Main Spool metering now shows delivery pressure being ported to the Large Servo Piston (i.e. P_d to P_{CL}.)

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2.2. Regulator Functions (cont.)

2.2.2. Torque Summation Control (cont.)

Main Spool & Sleeve Metering



This develops on the previous figure whereby this time the Servo Piston has now moved further to the right and closer towards minimum displacement.

As can be seen the various lever angles have changed from the previous figure.

As the Servo Piston has moved to the right the Feed Back Lever has now rotated about the Feed Back Pivot, causing the Main Spool to move back to the null position to the left of its previous position.

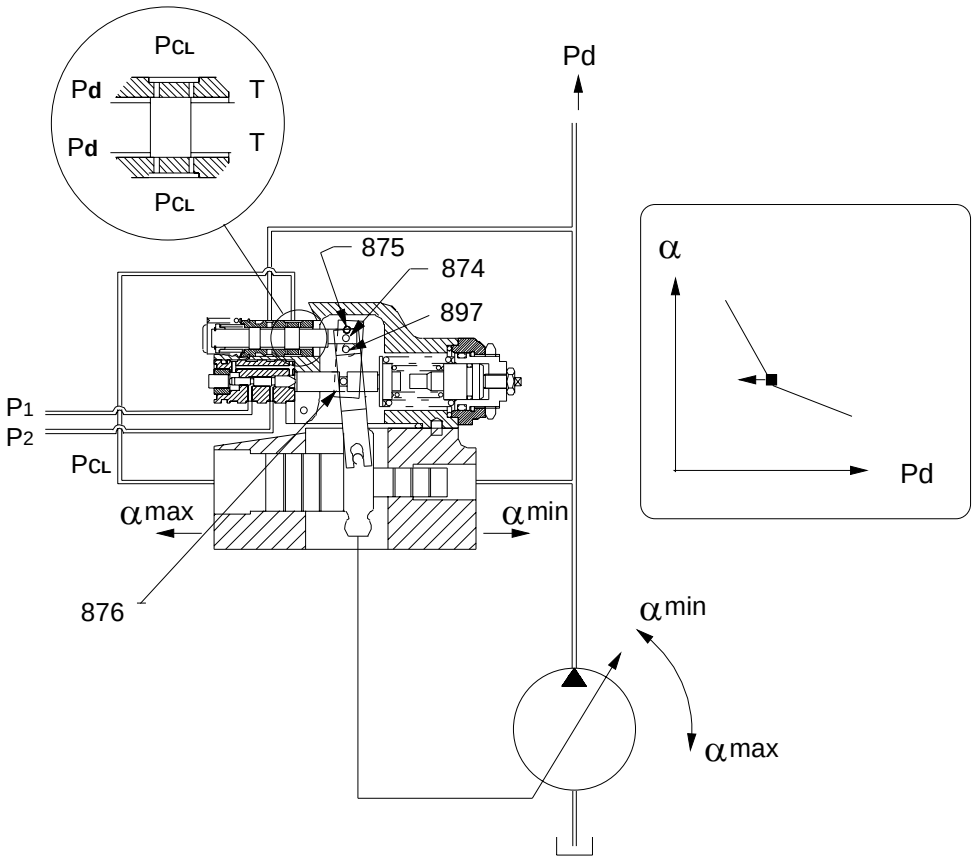
Once again the Main Spool is porting enough fluid to maintain the pressure balance across the Servo Piston and hence the new Swash Plate position.

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2.2. Regulator Functions (cont.)

2.2.2. Torque Summation Control (cont.)

Main Spool & Sleeve Metering



This figure details a fall in delivery pressure, this time the Power Spring Pack releases and moves the Power Push Rod to the left of its previous position as the Power Piston force has now reduced due to the reduction in delivery pressure.

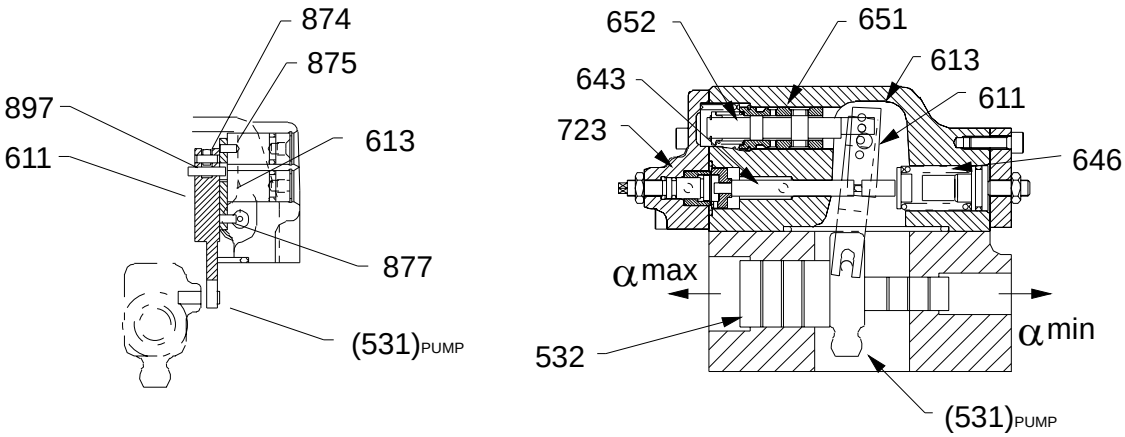
Again the movement of the Power Lever is transmitted via the Feed Back Pivot and the Main spool's compression spring, eliminates backlash by pulling the Main Spool to the left which thereby meters the Large Servo Piston pressure to tank pressure. As the small side of the Servo Piston is connected to the pump delivery pressure the Servo Piston moves to the left such that the displacement of the pump increases towards maximum.

When the Servo Piston has reached its position the Feed Back Lever causes the Main Spool to control once more at the null position and steady state control is once again achieved.

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2.2. Regulator Functions (cont.)

2.2.3. Negative Displacement Control



The above sections specifically show the Negative Displacement Control with its necessary feedback mechanisms. These figures should be studied such that a general familiarisation of the mechanism is built up. The following description will help in this understanding.

The Negative control pressure signal acts onto the left end of the displacement piston and push rod (643). The force so produced is balanced by the spring preload created by the displacement pilot spring (646).

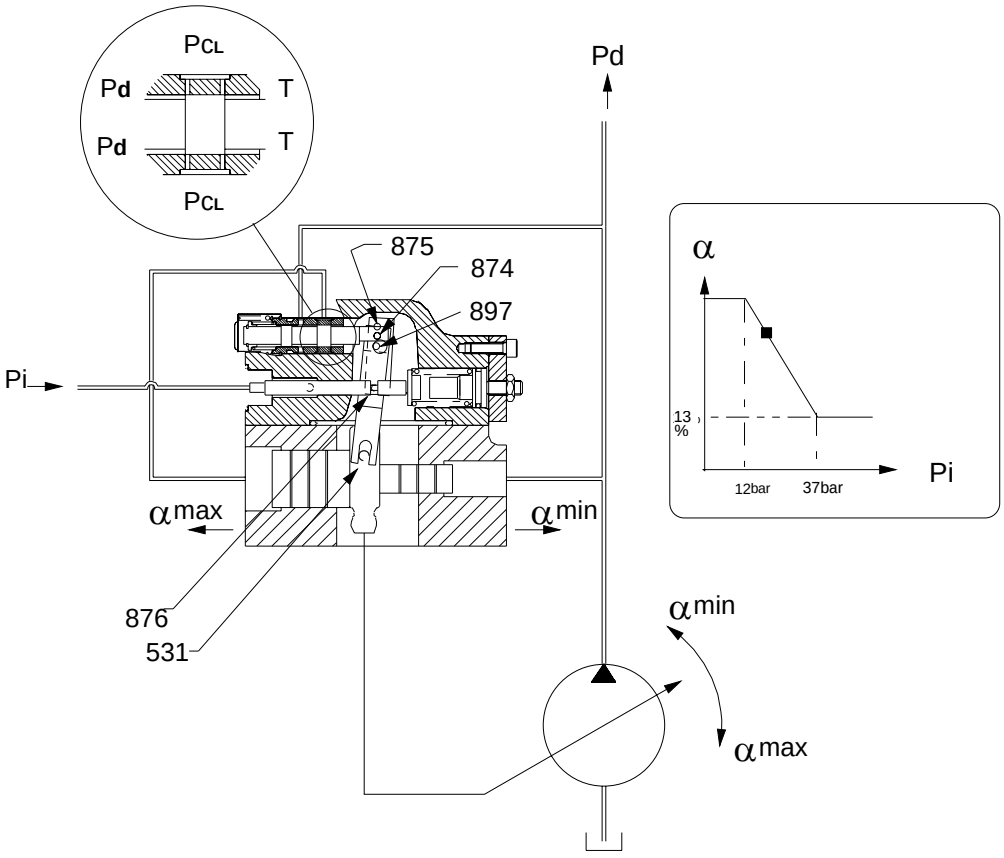
Any imbalance in this force creates a movement of the displacement control lever (613) on its fixed pivot (875). A movement of the piston to the right is transmitted from the displacement control lever (613) via the feed back pivot (897) to the feedback lever (611), which rotates “clockwise” slightly around the servo pivot (531). As the feed back lever (611) is also connected to the main spool (652) via (874) this causes the main spool to meter pressurised fluid to the larger diameter area of the pump’s servo piston, which in turn begins to destroke the pump. This action results in the main feedback lever (611) to shift in an anti-clockwise direction. A state of equilibrium will eventually exist whereby the servo piston position and thereby pump displacement is so maintained that the main control spool is back in a central metering condition. In this condition the pressure fed to the servo pistons larger diameter will maintain equilibrium.

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2.2. Regulator Functions (cont.)

2.2.3. Negative Displacement Control (cont.)

Main Spool & Sleeve Metering



The following sequence will assist in understanding the operation.

Pressure Pi is connected to negative control pressure signal.

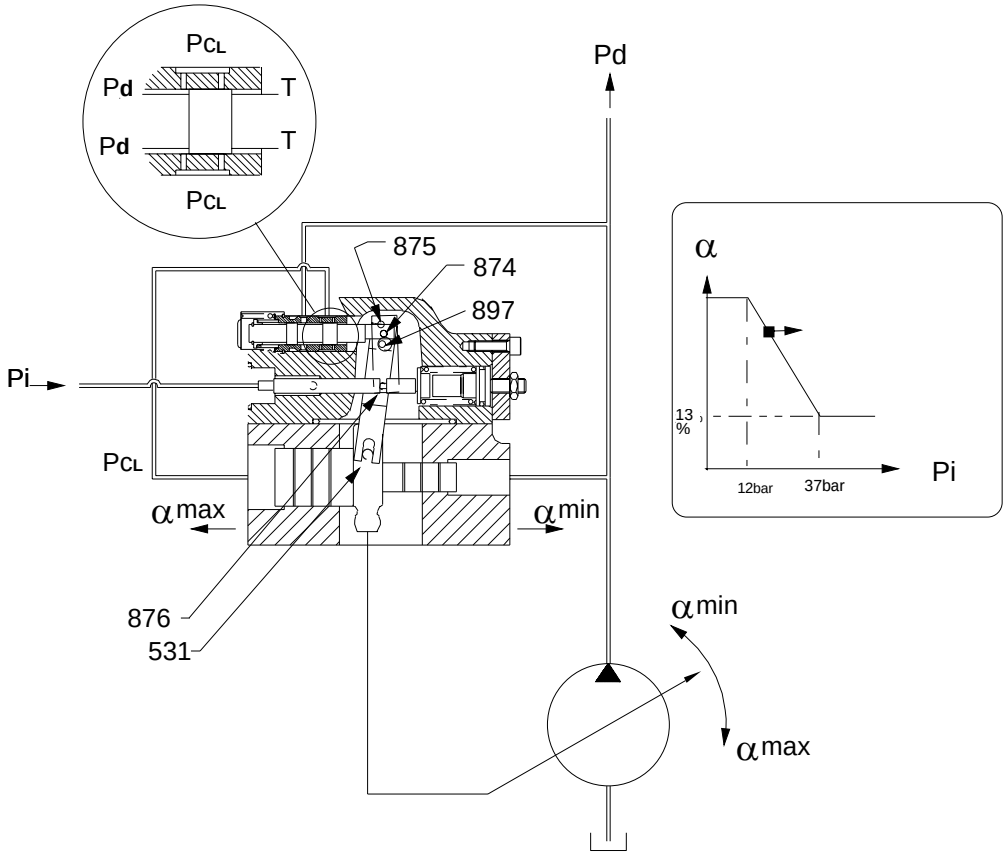
The diagram above illustrates the balanced condition whereby the Displacement Piston force is balanced against the Displacement Spring force, the Main Spool metering position is in a null position and is porting enough fluid to the Large Servo Piston to maintain a force balance across the servo piston.
At this condition the Large Servo Piston pressure is approximately ¼ of the pumps delivery pressure. The Feed Back Lever is keeping a check on the position of the Swash Plate, which in turn moves the Main Spool to correct any error. The various positions of levers & pistons should be noted.

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2.2. Regulator Functions (cont.)

2.2.3. Negative Displacement Control (cont.)

Main Spool & Sleeve Metering



As the negative pressure control signal (Pi) increases the Displacement piston compresses the Displacement Spring, the linear movement of the piston causes the displacement Lever to pivot around Fixed Pivot 2 towards the left.

This movement is transmitted from the Displacement Lever to the Feed Back Lever via the Feed Back Pivot.

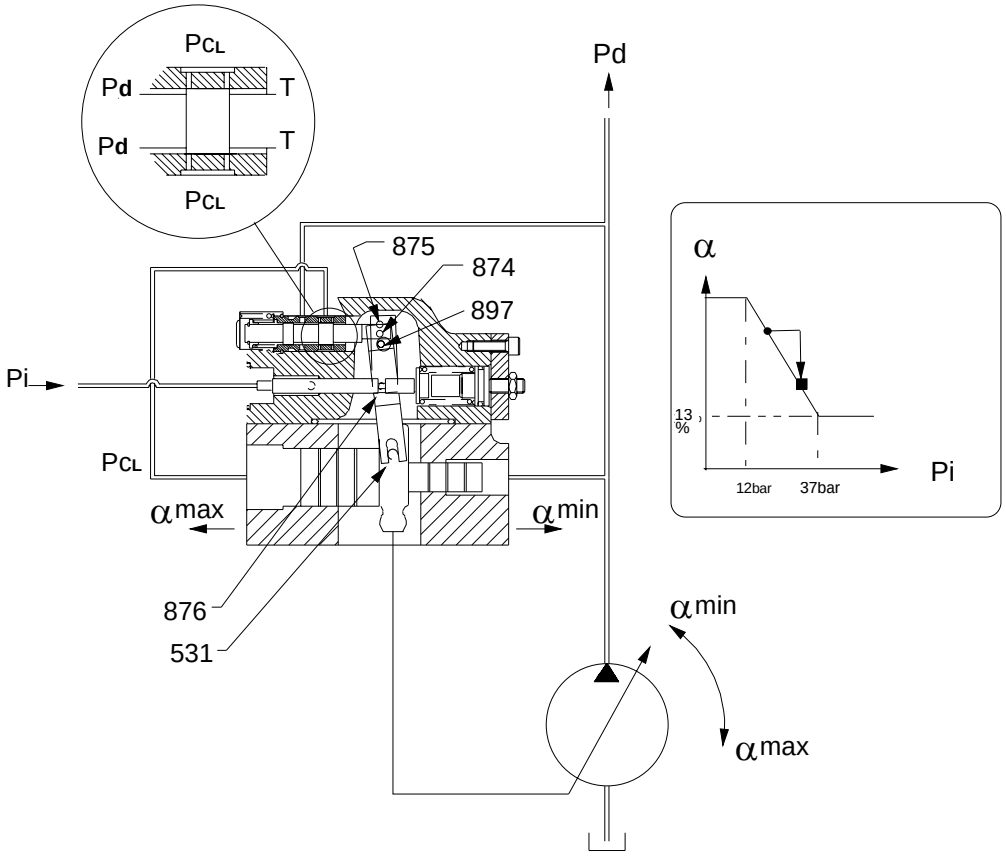
The Feed Back Lever now rotates “clockwise” around the Servo Pivot slightly and causes the Main Spool to move to the right through the Spool Pivot point.
The enlarged view of the Main Spool metering now shows delivery pressure being ported to the Large Servo Piston (i.e. P_d to P_{CL}.)

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2.2. Regulator Functions (cont.)

2.2.3. Negative Displacement Control (cont.)

Main Spool & Sleeve Metering



This develops on the previous figure whereby this time the Servo Piston has now moved further to the right and closer towards minimum displacement.

As can be seen the various lever angles have changed from the previous figure.

As the Servo Piston has moved to the right the Feed Back Lever has now rotated about the Feed Back Pivot, causing the Main Spool to move back to the null position to the left of its previous position.

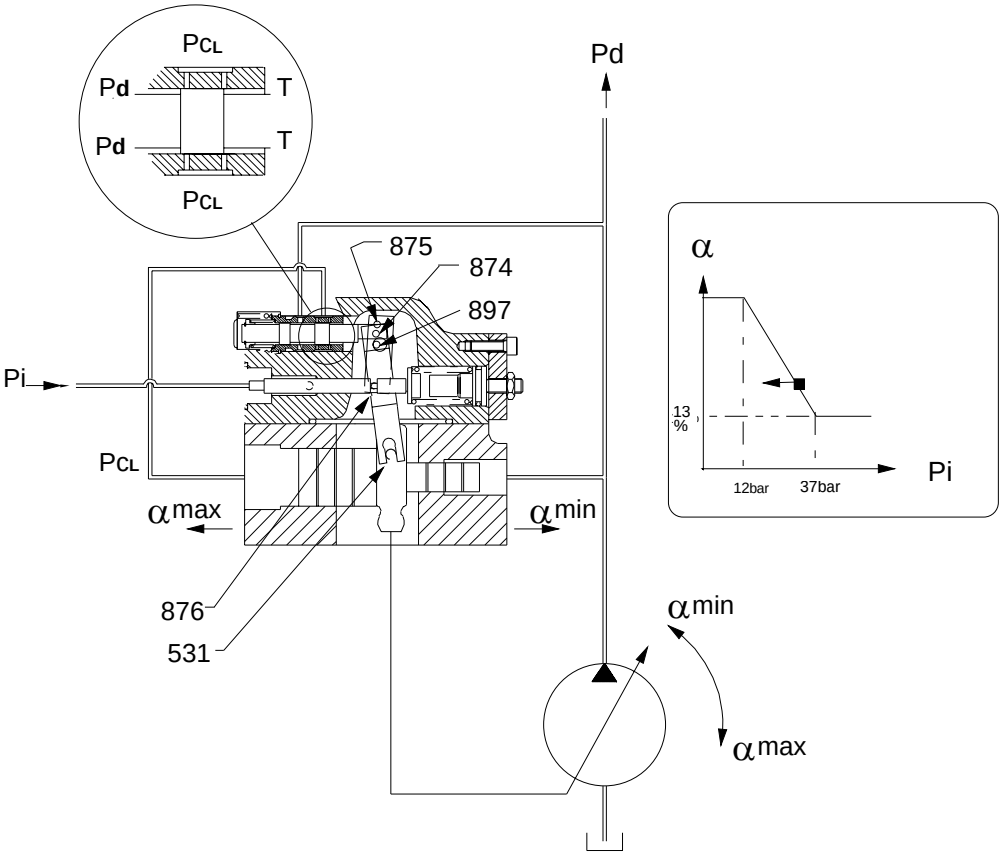
Once again the Main Spool is porting enough fluid to maintain the pressure balance across the Servo Piston and hence the new Swash Plate position.

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2.2. Regulator Functions (cont.)

2.2.3. Negative Displacement Control (cont.)

Main Spool & Sleeve Metering



This figure details a fall in the negative control pressure, this time the Displacement Spring releases and moves the Piston to the left of its previous position as the Displacement Piston force has now reduced due to the reduction in control pressure.

Again the movement of the Displacement Lever is transmitted via the Feed Back Pivot and the Main spool's compression spring, eliminates backlash by pulling the Main Spool to the left which thereby meters the Large Servo Piston pressure to tank pressure. As the small side of the Servo Piston is connected to the pump delivery pressure the Servo Piston moves to the left such that the displacement of the pump increases towards maximum.

When the Servo Piston has reached its position the Feed Back Lever causes the Main Spool to control once more at the null position and steady state control is once again achieved.

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3. Disassembly and Assembly

3.1. General Precautions

a. All hydraulic components are manufactured to a high precision. Consequently, before disassembling and assembling them, it is essential to select an especially clean place.

b. In handling a main pump, pay full attention to prevent dust, sand, etc. from entering into it.

c. When a pump is to be removed from the machine, apply caps and masking seals to all ports. Before disassembling the pump, re-check that these caps and masking seals are fitted completely, and then clean the outside of the assembly. Use a proper bench for working. Spread paper or a rubber mat on the bench, and disassemble the pump on it.

d. Support the body section of the casing carefully when carrying or transferring the pump. Do not lift by the exposed regulator, third pump etc.

e. This manual does not refer to the disassembly and reassembly of a regulator, a gear pump or any other accessory valving attached to the pump. These items being considered disposable items in their own right. Please therefore do not disassemble or reassemble them unless absolutely essential.

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3.2. Tools

Before disassembling the pump, prepare the following tools beforehand.

Name of tool	Quantity	Size (mm)
Vice mounted on bench (soft jaws)	1 unit	
Hexagon wrench	Each 1 piece	4, 5, 6, 8 and 14
Socket wrench	Each 1 piece	19 and 27
Spanner	Each 1 piece	19 and 27
Screwdriver	2 pieces	Medium Size
Plastic Headed Hammer	1 piece	
Adjustable Angle Wrench	1 piece	Medium Size
Pliers	1 piece	Type TSR-160
Steel Bar	1 piece	Approx. size 10 x 8 x 200
Torque Wrench	1 piece	Capable of tightening specified torques
Loctite #262	1 piece	

For tightening torques please refer to Spares Section (6.0)

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3.3. Disassembly

3.3.1 Before disassembling, spread rubber sheet, cloth or similar material over the overhaul workbench top so as to prevent parts from being damaged. Remove dust, rust and other contaminants from surfaces of the pump with cleaning oil.

3.3.2 Remove the drain port plug (468) and drain off the hydraulic oil from the pump casing.

a. Remove all plugs from both the front and rear pumps.

3.3.3 Remove the hexagon socket headed bolts and remove regulator from front pump.



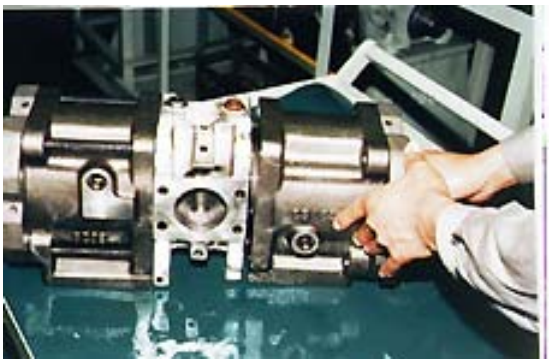
a. Similarly, remove the regulator from rear pump.

3.3.4. Loosen hexagon socket head bolts (401) which tighten the swash plate support (251), pump casing (271) and valve block (312).

a. If a gear pump or is fitted to the rear surface of the pump, then remove it before working on the pump unit.

b. Repeat this sequence for both the front and rear pumps.

3.3.5. Place pump horizontally on the workbench with its regulator-mounting surface face down. Remove the hexagon socket head bolts (401) and separate the pump casing (271) from it's valve block (312).

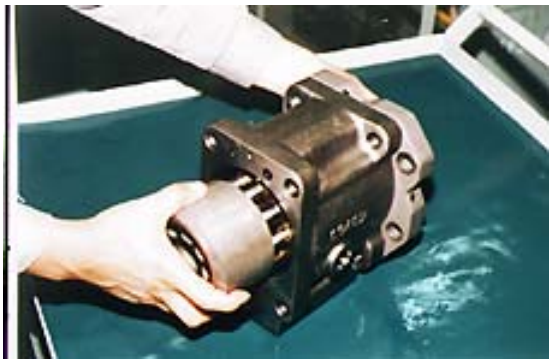


a Before lowering this surface onto the bench, spread the rubber sheet on to the work bench so as to prevent this surface from being damaged.

b. Repeat this sequence for both the rear and front pumps.

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3.3.6. Lift the cylinder (141) out of the pump casing (271) straight over the drive shaft (111). Additionally extract the pistons (151), set plate (153), spherical bush (156) and cylinder springs (157) simultaneously.



a. Take care not to damage any of the sliding surfaces of the cylinder, spherical bush, shoes, swash plate, etc.

b. Repeat this sequence for both the rear and front pumps.

3.3.7. Remove the hexagon socket head bolts (406) and remove the seal cover (Front) (261).



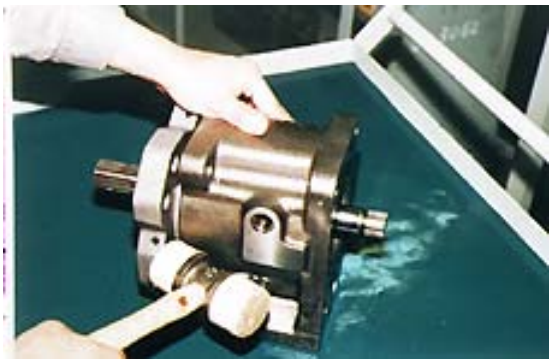
a. By fitting a bolt into the “pulling-out” tapped hole of the seal cover, will easily remove it.

b. Take care not to damage the oil shaft seal installed in the cover.

Similarly for the rear pump, remove the hexagon socket headed bolts on rear pump, and remove it’s seal cover (Rear) (261) and rear cover (262).

IF a gear pump is fitted, remove this first.

3.3.8. By tapping lightly on the flange section of the swash plate support (251) where it interfaces with the pump casing side, separate the swash plate support from it’s pump casing.



a. Remove the drive shaft simultaneously with it’s swash plate support.

b. Repeat this sequence for both the rear and front pumps.

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3.3.9. Remove the shoe plate (211) and swash plate (212) from the pump casing (271).



a. Repeat this sequence for both the rear and front pumps.

3.3.10. Tapping lightly on the external shaft end of drive shafts (111, 113) with plastic hammer, extract each drive shaft from it's swash plate support. If required, extract the rolling bearing (123), bearing spacer (127), and snap ring (824) from the drive shaft (111,113).



a. Repeat this sequence for both the rear and front pumps.

b. Don't reuse the bearings that you have extracted.

3.3.11. Remove the valve plates (313, 314) from the valve block (312).



a. These may be removed during sequence 5.

If required, execute sequence 12 and 13.

3.3.12. Remove the stopper (L)(534), stopper (S)(535), servo piston (532) and tilting pin (531) from pump casing (271).

a. In removing the tilting pin, use a protection shield to prevent the pin head from being damaged.

b. Loctite has been applied in production to the fitting areas of the tilting pin and servo piston, so care must be taken to prevent servo piston damage.

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3.3.13. Remove the needle bearing (124) and spline coupling (114) from the valve block (312).

a. Don't remove the needle bearing unless it definitely requires replacement.

b. Don't loosen the hexagon stroke adjustment nuts of valve block or swash plate support. If loosened, the flow setting will be changed.





This completes the disassembly procedure.

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3.4. Assembly Procedure

3.4.1. Fit the servo piston (532), tilting pin (531), stopper (L)(534) and stopper (S)(535) to the pump casing (271).

a. In tightening the servo piston and tilting pin to the pump casing, use a protector to prevent the tilting pin head and feedback pin from being damaged.

b. Apply loctite (medium) to the threaded section of tilting pin and servo piston and allow to set.



3.4.2. Fit the swash plate support (251) to it's pump casing (271), by tapping the former lightly with a hammer.

a. Repeat this sequence for both the rear and front pumps.

3.4.3. Place pump casing with its regulator-fitting surface down on the bench. Fit the tilting bush of the swash plate to it's tilting pin (531), and then fit the swash plate (212) to it's swash plate support (251) correctly. Simultaneously fit the O-ring.



a. Confirm with ones fingers that the swash plate is bedded down correctly by ensuring that it could be removed smoothly.

b. Apply grease to the sliding sections of the swash plate and swash plate support, and then smoothly fit the drive shaft through it.



c. Repeat this sequence for both the rear and front pumps.

In the case that one has disassembled the roller bearings then sequence 4 and 5 should be followed.

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3.4.4. Install the bearing spacer (127) on to the drive shaft (111,113), and then next install the roller bearing (123) to this drive shaft.



3.4.5 Install the snap ring (824) onto the drive shaft (111,113).

3.4.6. Fit the drive shaft assembly (complete with bearing (123), bearing spacer (127) and snap ring (824)) to it's swash plate support (251).



a. Do not tap the drive shaft with a hammer as damage may occur.

b. Assemble the shaft assembly into it's support by tapping the outer race of bearing lightly with plastic hammer. Fit them fully, using steel bar or so on.

c. Repeat this sequence for both the rear and front pumps.

In the case that an oil seal has been replaced follow sequence 3.4.7.



3.4.7. Install the new oil seal (774) into the seal cover (F)(261) and seal cover (R()(263).

3.4.8. Assemble the front seal cover (F)(261) into the pump casing (271) and fix it with the hexagon socket head bolts (406). Similarly, assemble the rear seal cover (R)(261) or rear cover (263) into pump casing (271) and fix it with hexagon socket head bolts.



a. Apply grease lightly to the oil seal within the seal cover.

b. Assemble them carefully, taking full care not to damage the oil seal.

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3.4.9. Install the cylinder springs (157), spacer (158) and spherical bush (156) onto the cylinder (141). Fit the pistons (151) and shoe (152) through the set plate (153).

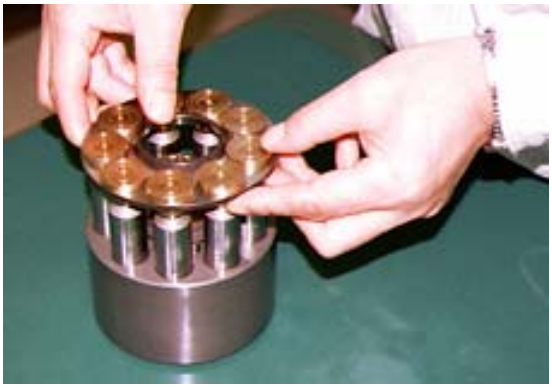
a. Repeat this sequence for both the rear and front pumps.

3.4.10 Assemble the piston shoe (151,152) and set plate (153) group onto and into the cylinder bores of the cylinder (141), springs (157), spherical bush (156) and spacer (158) group.

a. Repeat this sequence for both the rear and front pumps.







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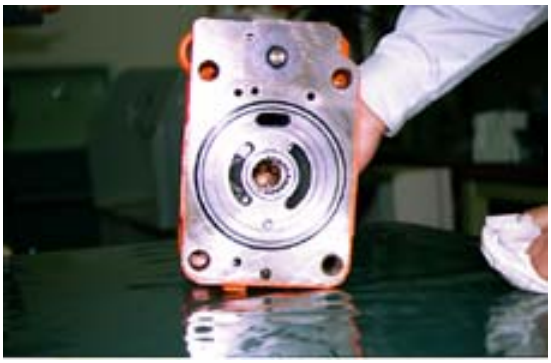
3.4.11. Fit the splined phases of the retainer and cylinder sub-assembly into the pump casing.



a. Repeat this sequence for both the rear and front pumps.

b. If the needle bearing has been replaced then follow sequence 12.

3.3.12 2 Install the needle bearing (124) and splined coupling (114) into the valve block (312).



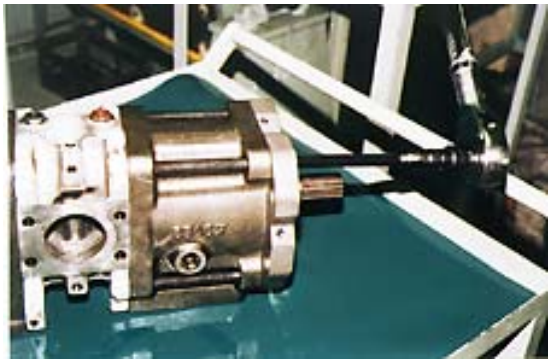


3.4.13. Fit the valve plate (313) on to the valve block (312), utilising the location pin.

a. Take care not to the mistake the suction and delivery directions of the valve plate.



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3.4.14. Fit the valve block (312) to it's p casing (271) , and tighten the hexagon socket headed bolts (401). Simultaneously install the O-Ring.

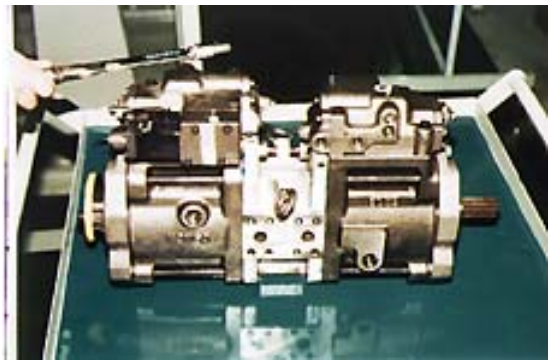
a. Repeat this sequence for both the rear and front pumps.

b. It is easiest to assemble the rear pump first.

c. Take care not to mistake the Valve plate / Valve Block direction of rotation.

NOTE: For clockwise rotation (viewed from input shaft side)
Fit the valve block with the regulator up and with the delivery flange left, when viewed from shaft end.

NOTE: For counterclockwise rotation (viewed from input shaft side)
Fit the valve block with the regulator up and with the delivery flange on the right side, when viewed from the shaft end.



3.4.14. Place the feedback pin of tilting pin into the feedback lever of regulator. Then fit the regulator and tighten the hexagon socket head bolts.

a. Take care not to mistake the regulator of the front pump for that of the rear pump.

3.4.15. Fit the drain port plug (468).

a. Repeat this sequence for both the rear and front pumps.

This concludes the reassembly procedure.

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4. MAINTENANCE STANDARDS

4.1. Part Inspection

Part Name	Inspection Item	Criterion and Measurement
Cylinder	Existence of scratches, discoloration, hair cracks, erosion, wear or seizure on sliding surface or bores.	In case of damage in these areas, replace whole rotating group.
Piston	1) Existence of scratches, wear, cracks or seizures on sliding surface. 2) Indentation, cracks or dents on neck	In case of damage in these areas, replace whole rotating group.
Shoe	1) Existence of scratches, indentation, erosion, wear or scuffing on sliding surface. 2) Wear, scuffing or deformation on shoe surface. 3) Indentation or crack around caulked area.	In case of damage in these areas, replace whole rotating group.
Swash Plate Support	1) Scratches, discoloration, scuffing or seizure at shoe plate location surface. 2) Scratches, wear, scuffing or seizure at pillow bearing sliding surface.	Replace
Shoe Plate	1) Scratches, erosion, wear, scuffing or seizure at sliding surface. 2) Scratches, discoloration, scuffing or seizure at mounting surface.	Replace
Regulator	Any form of malfunction which has been isolated to the regulator.	Replace with complete new previously tested and set up regulator assembly

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5. TROUBLE SHOOTING

5.1. General Comments

a. When any abnormal phenomenon is noticed, investigate whether it is a failure of the main pump itself or a problem in the main control valve, third pump or circuit.
For this purpose, the pilot pressure, pump discharge pressure, load pressure, etc. should be measured.
Additionally, even when partial disassembly and checking is carried out, follow the previously mentioned disassembly and assembly procedures.

b. Since dust is very harmful to hydraulic components, pay full attention to dust prevention. Even for partial disassembly dust prevention measures should be carried out.

c. Handle movable parts carefully. Even for a small damage, correction using an oilstone should be carried out.

d. Carefully carry out your investigation, paying due attention not to damage the sealing faces of O-rings. Such damage will cause both internal and external oil leakage.

e. As a general rule when any abnormalities occur the following categories should first be inspected so as to evaluate the possible causes:

i) Filter & Drain Oil Inspection
Inspect the filter element. Check to see whether there is an abnormally large amount of foreign matter. There will be a small amount of metallic powder due to wear of the shoe and cylinder, but if there is a large amount of metallic debris in the filter, it may be due to trouble with the shoe. Additionally check the drain oil in the pump casing

ii) Abnormal Vibration and Noise
Check to see if there is any abnormal vibration or noise being emitted by the pump body. Check to see if it is like the regular frequency noise of the regulator's working or attendant valve relief working. If it is an abnormal vibration or sound, it is possible that there is damage or cavitation inside the pump.

iii) Measure Pressure of each Part
When it is a control problem, do not unnecessarily open ports for inspection purposes, measure the pressure for each section and find the abnormal item.

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5. TROUBLE SHOOTING

5.2. Basic Pump Trouble Shooting

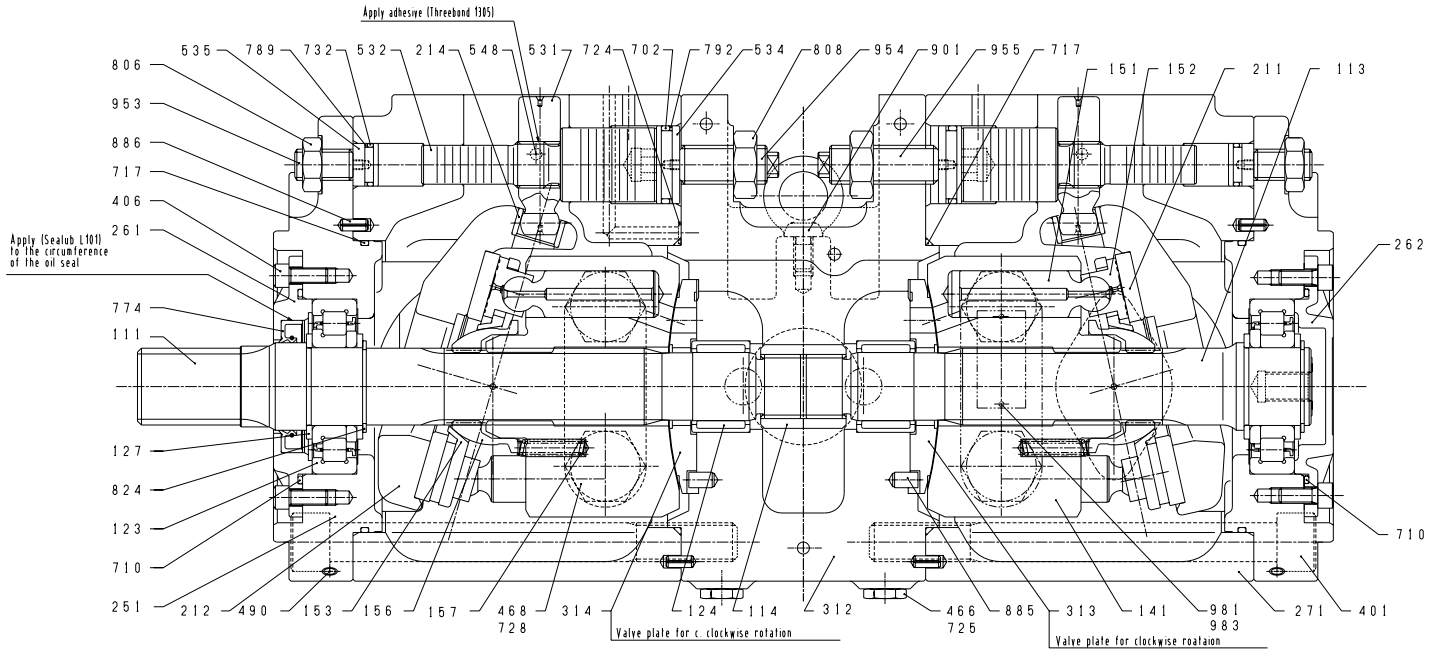
Phenomenon	Possible Cause	Remedy
1. Engine Stalls or is overloaded.	1) Engine Speed is low 2) Regulator Torque Setting is set high 3) Seizure or damage of pumps internal parts. 4) Incorrect regulator hose connection	1) Recheck engine speed and reset if necessary 2) Replace regulator 3) Replace damaged parts 4) Correct hose connections
2. Pump output flow is extremely low and decreases rapidly with increasing pressure.	1) Regulator breakdown 2) Seizure or damage of pump internal parts. 3) Pump Breakdown 4) Attendant Valve Breakdown. 5) Incorrect regulator hose connection	1) Replace regulator 2) Replace damaged parts 3) Replace damaged parts 4) Inspect attendant valve 5) Correct hose connections
3. Pump is creating an abnormal sound or vibration.	1) Cavitation 2) Shoe caulking damage 3) Crack in Cylinder 4) Bad installation of pump 5) Relief Valve bouncing	1) Eliminate cavitation by checking and correcting suction line. Replace all damaged parts 2) Replace rotating group 3) Replace rotating group 4) Correct installation 5) Repair or replace suspect relief valve

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6. SPARE PARTS

6.1. Cross Sectional Drawings

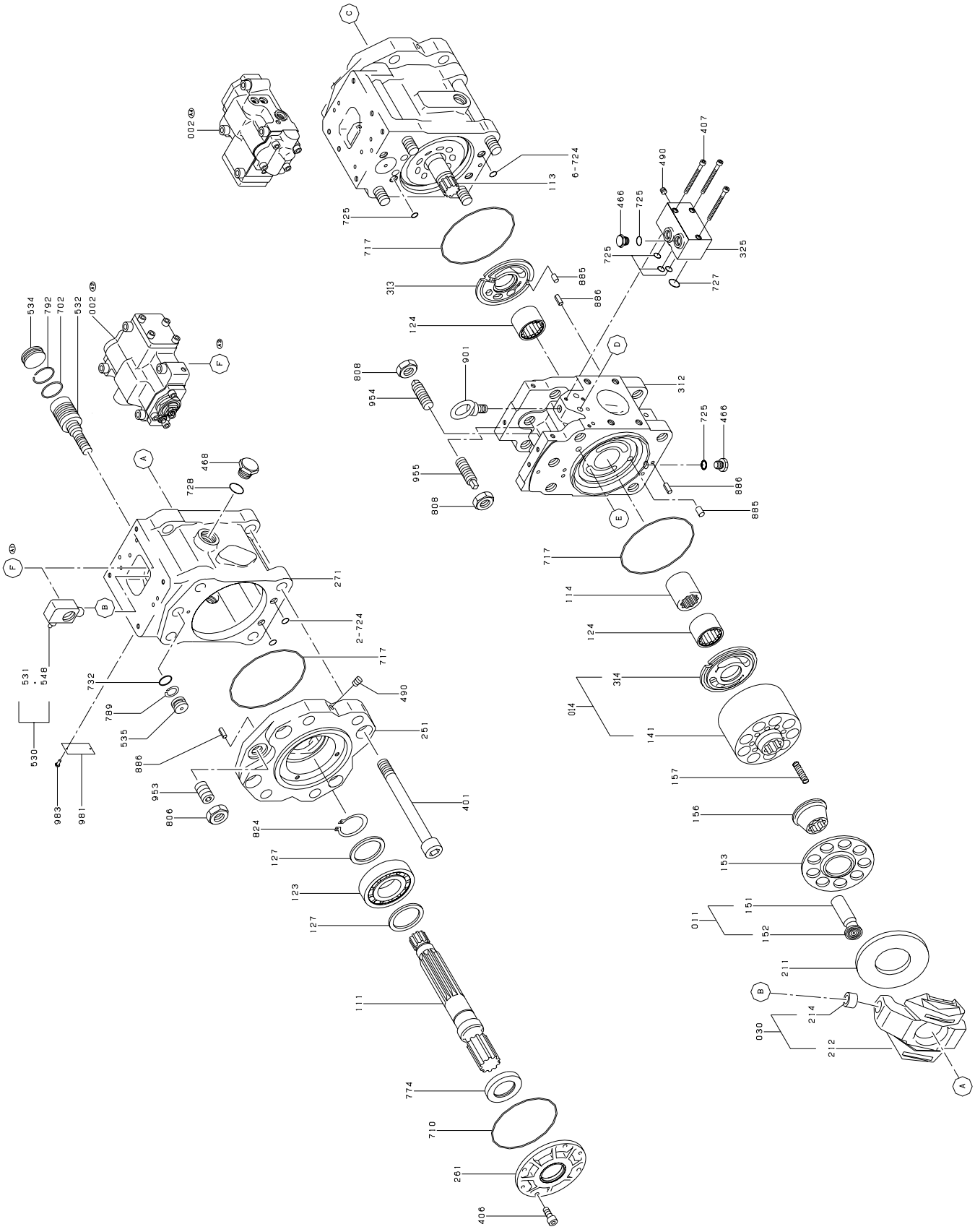
a. Main Pump



TIGHTENING TORQUE

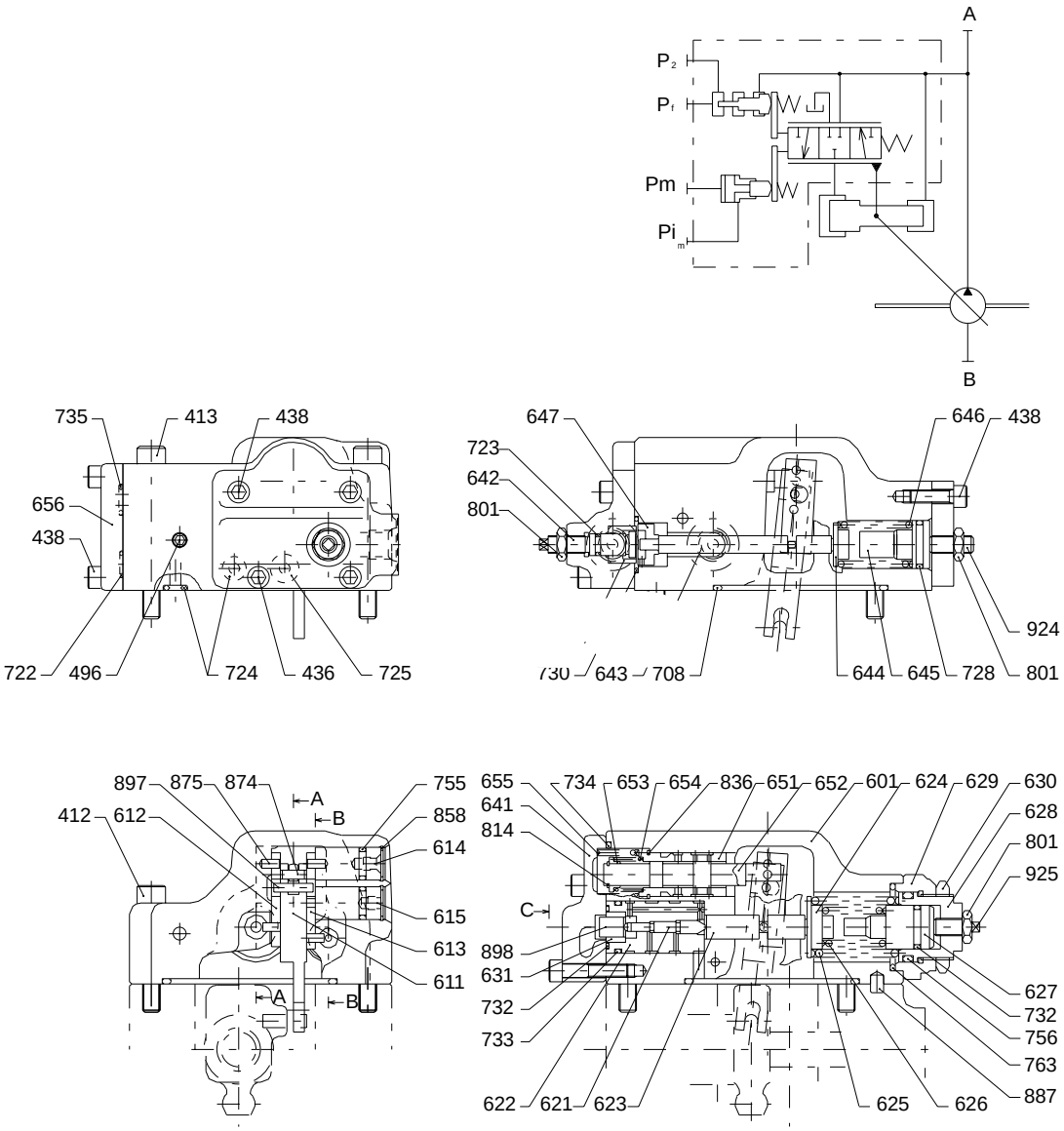
NO.	NOMINAL DESIGNATION OF SCREW THREAD	TIGHTENING TORQUE Nm
401	M16	235.4
406	M6	11.8
466	G 1/4	36.3
467	G 1/2	107.9
490	NPTF 1/16	8.8
531,532	M20 x 1.5	235.4
808	M16	127.5

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b. Regulator



TIGHTENING TORQUE

NO.	NOMINAL DESIGNATION OF SCREW THREAD	TIGHTENING TORQUE Nm
436, 438	M6	11.8
412, 413	M8	29.4
496	NPTF 1/16	8.8
630	M30 x 1.5	156.9
801	M8	15.7

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6.2 Part Listings

No.	Part Name	Part Number	Q'ty	Class
111	Shaft(F)	P- 2933800982	1	C
113	Shaft(R)	P- 2933800884	1	C
114	Coupling	P- 2953801763	1	C
123	Bearing; roller	P- PNUP308R1CS50	2	C
124	Bearing; needle	P- PAJ503518	2	C
127	Spacer; bearing	P- 38800127	4	C
141	Cylinder	P- 2933800787	2	/
151	Piston	P- 38901151	18	/
152	Shoe	P- 38900152	18	/
153	Set plate	P- 2943800463	2	C
156	Spherical bush	P- 29246100030	2	C
157	Spring; cylinder	P- 2953801769	18	C
211	Shoe plate	P- 6871000211	2	C
212	Swash plate	P- 2933800813	2	/
214	Tilting bush	P- P1R2025125	2	/
251	S.P. support	P- 2923800809	2	C
261	Seal cover(F)	P- 2943800572	1	C
263	Seal cover(R)	P- 2943800465	1	C
271	Casing	P- 2923800807	2	C
312	Valve block	P- 2923801021	1	C
313	Valve plate(R)	P- 3890R313N	1	/
314	Valve plate(L)	P- 3890L314N	1	/
325	Assist casing	P- 2933800944	1	C
401	Screw	P- 2953801767	8	C
406	Socket screw	P- 0SBM820	8	D
407	Socket screw	P- 0SBM655	3	D
466	Plug	P- 0VP14	3	D
468	Plug	P- 0VP34	4	C
490	Plug	P- PBP1162403	21	C
531	Pin; tilting	P- 2943800517	2	/
532	Servo piston	P- 2943800462	2	C
534	Stopper(L)	P- 2953801761	2	C
535	Stopper(S)	P- 2953801762	2	C
541	Seat	P- 29331800414	4	/
543	Stopper 1	P- 29332600311	2	/
544	Stopper 2	P- 29332600312	2	/
545	Ball; steel	P- 0DW732	4	/
548	Pin; feed back	P- 2953802202	2	/
702	O-ring	P- 00RBG35W	2	D
710	O-ring	P- 00RBG95	2	D

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717	O-ring	P- 00RBG145	4	D
724	O-ring	P- 00RBP8	16	D
725	O-ring	P- 00RBP11	8	D
727	O-ring	P- 00RBP14	1	D
728	O-ring	P- 00RBP24	4	D
732	O-ring	P- 00RBP18W	2	D
774	Oil seal	P- P15Z456812F	1	C
789	Back up ring	P- 0T2BP18	2	D
792	Back up ring	P- 0T2BG35	2	D
806	Nut	P- 0RNM16	2	D
808	Nut	P- 0RNM20	2	D
824	Snap ring	P- 0SR40	2	D
885	Pin	P- PJR812	2	C
886	Pin; spring	P- 0SPV614	4	D
901	Bolt; eye	P- 0EBM10	2	C
953	Set screw	P- PSSSM1630	2	C
954	Screw	P- 2953801768	1	C
955	Screw	P- 2953801866	1	C
981	Name plate	P- PNPA2550B	1	/
983	Pin	P- 0SK2548	1	/

011	Ass'y piston	P- 3853802464	2	B	151 (9pc), 152 (9pc)
013	Ass'y Cylinder -Valve plate(R)	P- 2953801893	1	B	141 (1pc), 313 (1pc)
014	Ass'y Cylinder -Valve plate(L)	P- 2953801894	1	B	141 (1pc), 314 (1pc)
030	Ass'y swash plate	P- 2953801990	2	B	212 (1pc), 214 (1pc)
041	Ass'y check valve	P- 2953802048	2	B	541,543,545 (all 1pc)
042	Ass'y check valve	P- 2953802049	2	B	541,544,545 (all 1pc)
530	Ass'y tilting pin	P- 2953801989	2	B	531 (1pc), 548 (1pc)
	Ass'y seal kit for pump	P- 2953802903	1	A	
	Ass'y regulator	P- 293G2NF9	2	B	
	Ass'y seal kit for regulator	P- 2953802084	2	A	

Class Code	Meaning
B	Parts supplied sub-assembled
C	Parts individually supplied
/	Parts not supplied
D	Standardised parts commonly available

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