DOUBLE SWASH PLATE PUMP WITH ADJUSTABLE VALVE RING CONCEPT

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ABSTRACT

Large size pumps have limited dynamics as compared to small pumps. The use of large size pumps is restricted by relatively low working pressure and low driving speed. A large size pump has large bearing and frictional surfaces, so the increased working pressure reduces the service life of the pump. A large size pump comprises large pistons, so with the high driving speed, pistons may detach from the piston shoes due to its inertia.

The present invention is contrived to overcome the main limitation on the conventional design of swash plate pumps, particularly large size pumps. The present invention will benefit the swash plate pump designs of different style, fixed and variable displacement types, small and large size pumps.

The present invention is a double swash plate pump comprises one housing, one cylinder block, two groups of swash plate-pistons assembly and, more particularly, an adjustable valve ring concept.
Fig. 1 - Shaft (Part #1, Quantity = 1)
Fig. 2 - Cylinder Block (Part# 2, Quantity = 1)
Fig. 3A - Pressure Valve Ring (Part# 3, Quantity = 1)
Fig. 3B - Suction Valve Ring (Part #3, Quantity = 1)
Fig. 4- Swash Plate (Part #4, Quantity = 2)
Fig. 5B- Piston (Part# 5B, Quantity = 18)

Fig. 6- Retaining Plate (Part# 6, Quantity = 2)
Fig. 7- Bushing (Part #7, Quantity = 2)

Fig. 8- Spring (Part #8, Quantity = 2)

Fig. 9- Bearing (Part #9, Quantity = 1)
Fig. 10 - Housing (Part #10, Quantity = 1)
Fig. 11 - Rear Cover (Part # 11, Quantity = 1)
Fig. 15 - Assembly 03
Fig. 26 - Assembly 14
DOUBLE SWASH PLATE PUMP WITH ADJUSTABLE VALVE RING CONCEPT

1—BACKGROUND OF THE INVENTION

[0001] The present invention intended to increase the specific power of the current design of swash-plate positive-displacement fixed-displacement axial-piston hydraulic pumps, particularly the large size ones. The present invention shows the design of a Double Swash Plate Pump with Adjustable Valve Ring Concept that contains the following parts:

<table>
<thead>
<tr>
<th>TABLE 1</th>
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<tbody>
<tr>
<td><strong>Components</strong></td>
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<tr>
<td><strong>Part #</strong></td>
</tr>
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<td>1</td>
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<tr>
<td>2</td>
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<tr>
<td>3A</td>
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<tr>
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<td>12</td>
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2—BRIEF SUMMARY OF THE INVENTION

[0002] The present invention is to provide a double swash-plate positive-displacement fixed-displacement axial-piston hydraulic pump with valve ring concept to satisfy the following absolute “novel” advantages compared to the swash plate pump current conventional design:


[0004] Ability to control the internal sealing clearances of the pump.

The present invention satisfies the following relative advantages, as compared to a conventional pump of the same size:

[0005] Increases working pressure due to the ability to control the sealing clearances by the pressure valve ring.

[0006] Increases the driving speed without the fear of the detaching force generated between the piston and piston shoes since smaller pistons are used.

[0007] Increases the overall pump specific power since both the working pressure and the driving speed will be increased as well as decreases the pump volume and weight.

[0008] The present invention comprises the components shown above in Table 1.

3—BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The above object and other characteristics and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings, in which:

[0010] FIG. 1 is the shaft.
[0011] FIG. 2 is the cylinder block.
[0012] FIG. 3A is the pressure valve ring.
[0013] FIG. 3B is the suction valve ring.

[0014] FIG. 4 is the swash plate.
[0015] FIG. 5A is the piston shoe.
[0016] FIG. 5B is the piston.
[0017] FIG. 6 is the retaining plate.
[0018] FIG. 7 is the bushing.
[0019] FIG. 8 is the spring.
[0020] FIG. 9 is the bearing.
[0021] FIG. 10 is the housing.
[0022] FIG. 11 is the rear cover.
[0023] FIG. 12 is the locking nut.

[0024] FIG. 13 is Assembly 01 that shows the bearing-shaft assembly.

[0025] FIG. 14 is Assembly 02 that shows assembly 01 after adding the first swash plate (4) and the first piston group (5A and 5B).

[0026] FIG. 15 is Assembly 03 that shows assembly 02 after adding the first retaining plate (6), the first bushing (7) and the first spring (8).

[0027] FIG. 16 is Assembly 04 that shows assembly 03 after adding the cylinder block (2).

[0028] FIG. 17 is Assembly 05 that shows assembly 04 after adding the second bushing (7) and the second spring (8).

[0029] FIG. 18 is Assembly 06 that shows assembly 05 after adding after adding the second retaining plate (6).

[0030] FIG. 19 is Assembly 07 that shows assembly 06 after adding the second piston group (5A and 5B).

[0031] FIG. 20 is Assembly 08 that shows assembly 07 after adding the second swash plate (4).

[0032] FIG. 21 is Assembly 09 that shows assembly 08 after adding the pressure valve ring (3A).

[0033] FIG. 22 is Assembly 10 that shows assembly 09 after adding the suction valve ring (3A).

[0034] FIG. 23 is Assembly 11 that shows assembly 10 after adding the housing (2) in transparent form and

[0035] FIG. 24 is Assembly 12 that shows assembly 10 after adding the housing (2) in solid form and the locking nut (12).

[0036] FIG. 25 is Assembly 13 that shows assembly 12 after adding the rear cover (11) in transparent form.

[0037] FIG. 26 is Assembly 14 that shows assembly 12 after adding the rear cover (11) in solid form.

[0038] FIG. 27 is Assembly 15 that shows assembly of housing (2) in transparent form, the pressure valve ring (3A and 3B).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTs

[0039] Hereinafter, a preferred embodiment of the present invention will be explained in more detail with reference to the accompanying drawings. In the preferred embodiment of the present invention, as shown in FIG. 1, a driving shaft 1. The driving shaft is mechanically integrated with the bearing 9 as shown in FIG. 13. As shown in FIG. 15, the following pieces should be assembled in the following order, the first swash plate 4 the first piston group 5A and 5B, the first retaining plate 6, the bushing 7 and the spring 8.

[0040] As shown in FIG. 2, the cylinder block 2 is axesymmetrical components in which a central drill is made to assemble the cylinder block 2 with the drive shaft 1. On each side of the cylinder block 2, an odd number, of piston chambers are drilled and distributed in a circular array with a phase angle equal (360/number of pistons) in degrees. Number of piston chambers could be 7, 9 or 11, similar to the conventional pumps. The inventor assumed the cylinder block has 9
piston chambers distributed in a circular array with a phase angle equal 40 degrees. Each two facing piston chambers are connected internally via a cylindrical opening drilled perpendicular to the axes of the piston chambers. The shaft 1 is now can be assembled into the cylinder block 2 as shown in FIG. 16. On top of the cylinder block 2, as shown in FIG. 17, the second bushing 7 and the second spring 8 were assembled.

As shown in FIG. 19, the second piston group 5A and 5B, the second retaining plate 6 are then assembled in order. FIG. 20 shows the previous assembly after adding the second swash plate 4. So far the aforementioned assembly, shown in FIG. 20, is ready to be placed inside the housing 10.

Prior to that, the pressure valve ring 3A and the suction valve ring 3B must be place inside the housing 10 as shown in FIG. 27. As shown in FIG. 3A the pressure valve rings 3A has a cavity to collect the displaced oil by the pistons during the discharge stroke. Silencing grooves have been engraved at the beginning and end of that cavity to ease the communication between the pressure inside the piston chambers and the pressure at pump delivery port. This groove will help reduce the pump noise, vibration and shave the pressure ripples. As shown in FIG. 3B the suction valve rings 3B has a cavity to collect the sucked oil by the pistons during the suction stroke. Silencing grooves have been engraved at the beginning and end of that cavity to avoid generating sever negative pressure and avoid pump cavitation. The reason two grooves has been engraved inside each valve ring is to make the convertible in terms of the direction of rotation. As shown in FIG. 3A and FIG. 3B, tow holes in the pressure valve ring 3A and two pins in the pressure valve ring 3B are made to assure the perfect assembly of the two valve rings with respect to each other. The pressure valve ring 3A has been dimensioned so that it can be placed inside the housing 10, rotates and fit its neck in the pressure opening then left up. Similarly the suction valve ring 3B will be assembled inside the housing. After assembling both valve rings, they will be pushed against each other towards the central line of the cylinder block so that the pins on the suction ring fit in the holes in the pressure ring. Pump case drain is collected via a small opening in the housing 10 as shown in FIG. 10.

Now the assembly shown in FIG. 20 can be placed inside the housing assembly shown in FIG. 27. The result will be the full pump assembly shown in FIG. 23 with the housing in transparent form and FIG. 24 with the housing in solid form. As shown in FIG. 24, a locking nut 12 is used to tight the pressure valve ring 3A against the cylinder block 2. The locking nut 12 requires standard Allen key with a pentagon head to be tightened.

FIG. 25 and FIG. 26 show the full pump assembly after assembling the rear cover 11 in transparent and solid form; respectively. The rear cover supports the other end of the shaft with some sort of thrust bearing. By adding the rear cover, with the proper dimensioning of the whole parts, the two springs 8 will push the two bushings 7, which will push the two retaining plates 6 in opposite directions against the two swash plates 4. Retaining plates are then keeping the piston shoes 5A held against the swash plates 4.

The housing 10 has a flange in order to couple the pump to a drive motor. Once the pump shaft 1 rotates, cylinder block 2 will rotate and consequently the piston groups so that suction and delivery process starts.

By using such invention of the valve ring concept, instead of the valve (kidney) plate in the conventional swash plate pump design, the inventor anticipate to have the pump works at higher pressure since it the sealing clearance between the pressure ring and the cylinder block is controlled. Additionally, by increasing the driving speed, the overall specific power of the pump will be increased.

While the present invention has been particularly shown and described with reference to a particular embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

1. A double swash plate pump assembly, comprising one housing, one cylinder block and two piston groups.
2. The concept of using valve rings (pressure and suction) instead of using the conventional valve plate disc.
3. A mechanism to control the sealing clearance between the cylinder block and the valve rings.
4. Possibility of generating the variable-displacement variable version of the shown above invention.

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