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Spence

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[54] **HYDRAULIC APPARATUS**

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[52] **U.S. Cl.** **417/203**

[51] **Int. Cl.** **F04b 23/14**

[58] **Field of Search** 417/201–203; 91/472, 485, 499, 507

[56] **References Cited**

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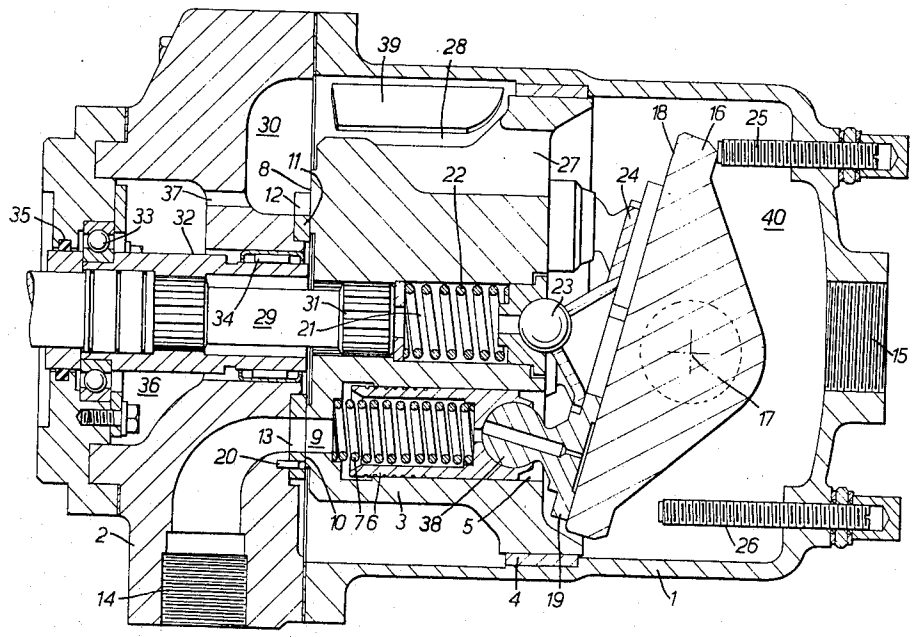
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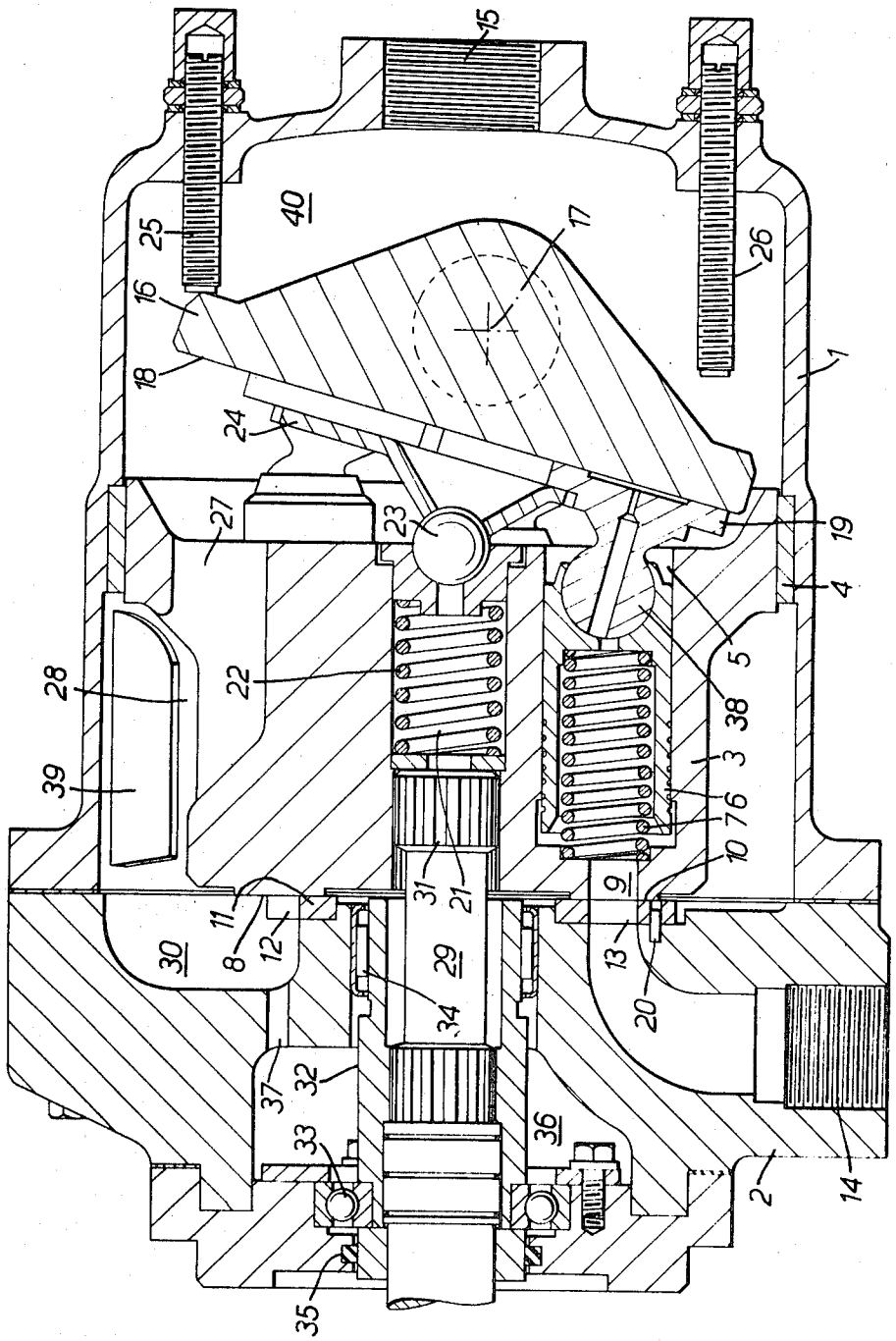
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[57] **ABSTRACT**

A swash plate pump or motor comprising a rotary cylinder block having cylinders either parallel to or inclined to the rotation axis, a valve on which the block is arranged to rotate, an inclined or inclinable swash plate located adjacent to one end of the cylinder block engageable by cylinders either directly or through the medium of slippers whereby the pistons are reciprocated as the block rotates, a casing enclosing the valve cylinder block and swash plate, the end portion of the cylinder block adjacent to the swash plate having a cylindrical journal bearing surface engaging within a complementary cylindrical bearing surface within the casing to divide the casing into two chambers and passages extending through the cylinder block in close proximity to the cylindrical bearing surfaces and connecting the two chambers for the flow of liquid therethrough during operation of the pump or motor.

5 Claims, 1 Drawing Figure





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HYDRAULIC APPARATUS

This is a division of application Ser. No. 690,369 filed Dec. 8, 1967 now U.S. Pat. No. 3,612,725.

FIELD OF THE INVENTION

A reciprocating piston pump or motor having multiple pistons located in cylinders in a rotary cylinder block, the cylinders being either parallel to or inclined to the rotation axis.

DESCRIPTION OF PRIOR ART

In a swash plate device it is known to mount the rotary cylinder block on a valve surface and to provide a cylindrical bearing around the cylinder block to locate it for rotation.

SUMMARY OF THE INVENTION

In accordance with the present invention a swash plate device comprises a rotary cylinder block having cylinders disposed parallel to or inclined to the rotation axis, valve means co-operating with the cylinder block during rotation to connect the cylinders to a fixed high pressure port cyclically during rotation of the cylinder block, a swash plate adjacent one end of the cylinder block, pistons in the cylinders co-operating with the swash plate whereby the pistons will reciprocate during cylinder block rotation, a casing enclosing the cylinder block and swash plate, the end portion of the cylinder block adjacent the swash plate having a cylindrical journal bearing surface engaging within a complementary cylindrical bearing surface within the casing to divide the casing into two chambers, and passages extending through the cylinder block in close proximity to the cylindrical bearing surfaces and connecting the two chambers for the flow of liquid therethrough during operation of the device.

The invention provides cooling for the bearing surfaces by virtue of liquid flow through the passages.

Liquid within the casing preferably flows from the chamber including the swash plate to the chamber enclosing the periphery of the cylinder block.

BRIEF DESCRIPTION OF THE DRAWING

One embodiment of the invention will be described with reference to the accompanying cross-sectional drawing.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In this drawing the casing **1** is conveniently secured by bolt or other means to a valve block **2**. The casing surrounds a rotary cylinder block **3** which is mounted for rotation by means of a large diameter plain bearing **4** which comprises a cylindrical journal bearing surface formed around the cylinder block engaging in a complementary cylindrical bearing surface formed within the casing. The bearing **4** and the cylinder block **3** divide the casing into two chambers **28** and **40**. The location of the bearing **4** is at the end of the cylinder block remote from the valve block **2**. Within the cylinder block **3** a number of cylinders **5** are provided each parallel to the axis of block rotation and equally spaced around the rotation axis. In the illustrated embodiment there are five cylinders but in practice any number

greater than three may be used. Each cylinder **5** contains a piston **6** and spring **7** which acts on the piston to urge it outwardly from the cylinder. The surface **8** of the cylinder block is a plane surface set at right angles to the block rotation axis and it includes a port **9** for each of the cylinders **5**. The surface **8** co-operates with a flat surface **10** of a valve plate **11** mounted on the valve block **2**. The valve plate **11** includes a pair of kidney shaped ports **12** and **13** with which the cylinder ports **9** co-operate during cylinder block rotation. The port **12** is the inlet port and the port **13** is the pressure delivery port. Port **13** is connected within the valve block **2** to a screw connection **14** by which pressure liquid leaves the pump. The port **12** is formed by a cut away portion of the valve plate extending inwardly from its periphery, this cut away portion being located over a recess **30** in the valve block which opens to the interior of the casing **1**. The valve plate **11** may be retained in its operative position by a plurality of dowel pins **20**.

The inlet **15** for the pump is formed in the casing at the end thereof remote from the valve block **2**. This may be a screw connection or the whole end of the casing may be open where the pump is intended for operation submerged in liquid in a reservoir.

The casing **1** also surrounds a swash plate **16** which is mounted on suitable trunnions for adjustment about an axis **17** which extends perpendicularly to the plane of the drawing. Angular adjustment of the swash plate may be effected by any conventional means. The swash plate **16** has a plane swash surface **18** facing the cylinder block. A slipper **19** is fitted by a ball joint **38** to the end of each piston **6** for engagement with the swash surface **18**. The slippers **19** may be fed with hydraulic liquid in conventional manner from the associated cylinders in order to provide a hydrostatic bearing between the slipper and the swash surface. Within a central bore **21** in the cylinder block a spring **22** is located which presses outwardly through a ball **23** on to a retainer plate **24** suitably recessed to engage against the slippers **19** to hold them in contact with the swash surface **18**. The principal function served by spring **22** and retainer plate **24** is to urge the pistons outwardly from their cylinders during one half of each cylinder block revolution. The spring within each cylinder will also help to urge the pistons outwardly.

A pair of adjustable stops **25** and **26** within the casing **1** are provided to engage the swash plate **16** to determine its limits of angular adjustment about the axis **17**.

A plurality of passages **27** are provided within the cylinder block, one between each adjacent pair of cylinders and in close proximity to bearing **4**. These passages open into the chamber **40** of the casing **1** enclosing the swash plate **18** and extend back to open to the side of the cylinder block into an annular chamber **28** defined between the casing, the cylinder block, the bearing **4** and the valve block. This chamber is the delivery region. A vane **39** formed on the interior surface of the casing projects in the chamber **28** to reduce rotary flow of liquid around the chamber **28**. The walls of the passages **27** form kinetic pumping surfaces which have radial portions to pump liquid by centrifugal action from the inlet **15** over the swash plate **16** and into the chamber **28**. It is equally within the scope of this invention that the passages **27** could be skewed relatively

to the axis of block rotation to effect axial flow kinetic pumping.

Rotational drive is supplied to the cylinder block **3** through the medium of a drive shaft **29** having a splined connection **31** within the block **3**. The shaft **29** is supported within a sleeve **32** carried within bearings **33** and **34** in the valve block **2**. A seal **35** co-operates with the sleeve **32** to prevent escape of liquid. A hollow space **36** is formed around the sleeve **32** and this is connected by a passage **37** with the recess **30**. The passage **37** will ensure that high pressure liquid escaping from the inner edge of the surfaces **8** and **11** is fed back to the inlet port **12** thus preventing any substantial pressure from acting on the seal **35**. Such liquid will also have access to the bearings **33** and **34** and ensure that they are adequately lubricated.

In operation of the described embodiment rotary driving power is supplied to the shaft **29** to rotate the cylinder block **3**. During such rotation the slippers will be held in contact with the swash plate **18** and thus the pistons will be forced to reciprocate within their cylinders. The driving direction is such that when the pistons are moving out of their cylinders the associated cylinder ports **9** are in connection with the inlet port **12**. When the pistons are moving into their cylinders the associated cylinder ports **9** are in connection with the delivery port **13**. The cross-section through the valve block **2** has been deliberately taken on a plane at right angles to the cross-section through the cylinder block and swash plate in order that the ports **12** and **13** may be shown in the drawings. Liquid enters the pump through the inlet **15** into chamber **40** and rotation of the cylinder block and the passages **27** gives a small pressure rise from the inlet **15** into the delivery chamber **28**. The vane **39** reduces flow of liquid around the delivery chamber and will help to increase the small pressure rise generated within the chamber **28**. From the chamber **28** liquid has direct access into the inlet port **12** both through its opening in the edge of plate **11** and through the recess **30** and thus to flow into the cylinders whose pistons are moving outwardly. The flow of liquid induced by the passages **27** will pass over the swash plate at the temperature at which it enters the inlet **15** and will ensure adequate lubrication and cooling of the slippers and swash plate. The bearing **4** around the end of the cylinder block **3** remote from the valve block **2** is so positioned that the side thrust exerted by the slippers on the pistons will pass substantially directly through the bearing **4** and thus will not generate any substantial tipping moment on the cylinder block **3**. The bearing **4** forms a seal between the chamber **40** and the chamber **28**. The flow of liquid through passages **27** in close proximity to bearing **4** ensures adequate cooling of bearing **4**.

I claim:

1. A swash plate device comprising a rotary cylinder block having cylinders disposed parallel to or inclined to the rotation axis, valve means cooperating with the cylinder block during rotation to connect the cylinders to the fixed high pressure port cyclically during rotation of the cylinder block, a swash plate adjacent one end of the cylinder block, pistons in the cylinders cooperating with the swash plate whereby the pistons will reciprocate during cylinder block rotation, a casing enclosing the cylinder block and swash plate, the end portion of the cylinder block adjacent to the swash plate having a cylindrical journal bearing surface engaging within a complementary cylindrical bearing surface within the casing to divide the casing into two chambers, and passages extending through the cylinder block in close proximity to the cylindrical bearing surfaces whereby the flow of liquid through said passages cools said surfaces, said passages connecting the two chambers for the flow of liquid therethrough during operation of the device.

2. A swash plate device as claimed in claim **1** including a liquid inlet connection into the chamber enclosing the swash plate, a fixed low pressure port within the valve means for connection cyclically to the cylinders during rotation of the cylinder block and a liquid flow connection from the chamber located between the cylindrical bearing surfaces and the valve means and the said fixed low pressure port whereby liquid flowing through the chambers and the passages may enter the said low pressure port.

3. A swash plate device as claimed in claim **2** wherein the said passages are arranged to provide a hydrokinetic pumping effect between one chamber and the other.

4. A swash plate device as claimed in claim **3** wherein a substantial part of each passage in the cylinder block extends parallel to the rotation axis of the cylinder block.

5. A swash plate device as claimed in claim **4** wherein the number of passages is equal to the number of cylinders in the block and a passage is located between each adjacent pair of cylinders.

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