United States Patent

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[54] **HYDRAULIC APPARATUS**
6 Claims, 1 Drawing Fig.

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[50] **Field of Search** 230/208, 186; 103/5, 162; 417/203; 91/504–506, 499

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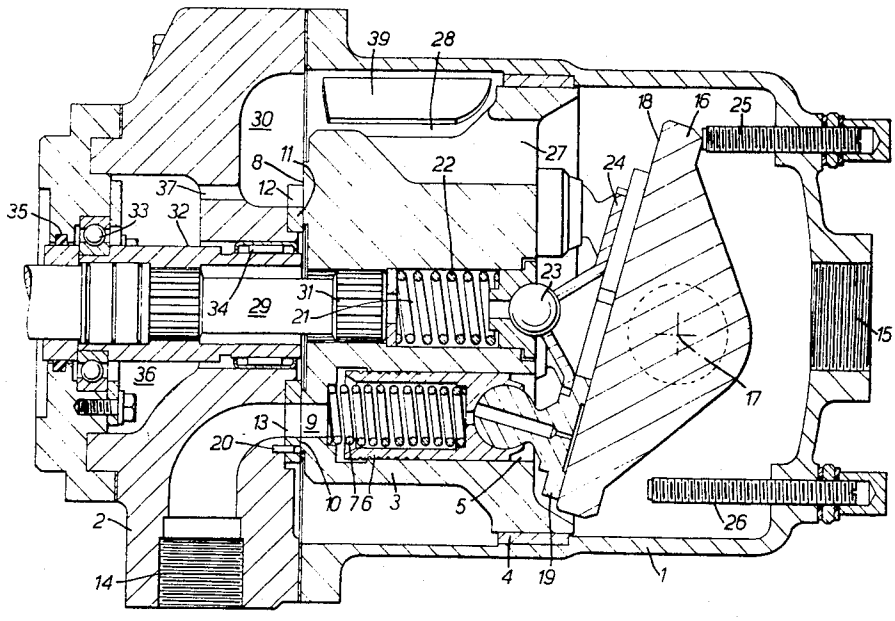
ABSTRACT: A swashplate pump comprising a rotary cylinder block having cylinders disposed parallel or inclined to the rotation axis, valve means cooperating with the cylinder block during rotation, swashplate means located adjacent to one end of the cylinder block for causing reciprocation of pistons in the cylinders during block rotation, passages or vanes or other hydrokinetic pumping means formed in or on the cylinder block, a casing surrounding the swashplate means and the cylinder block at least in part and a hydraulic inlet to the casing such that during rotation of the cylinder block liquid is kinetically pumped by the kinetic pumping means on the cylinder block to pass initially over the swashplate and then to and through the kinetic pumping means for delivery to the valve inlet for pumping by the pistons in the cylinder block.



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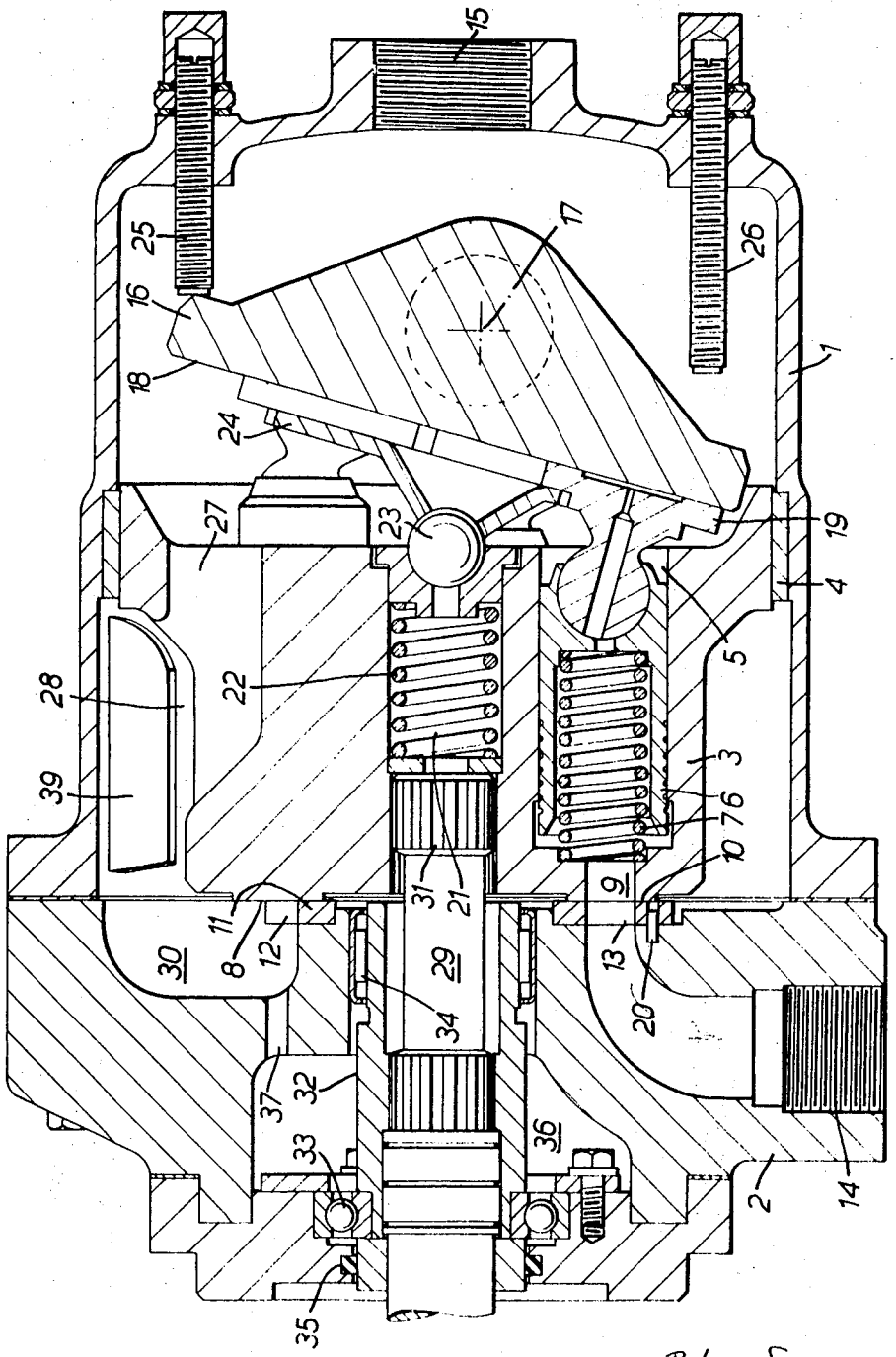

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HYDRAULIC APPARATUS

FIELD OF THE INVENTION

This invention relates to hydraulic pumps of the kind comprising a rotary cylinder block having cylinders disposed parallel or inclined to the rotation axis, valve means cooperating with the cylinder block during rotation, and swashplate means located adjacent to one end of the cylinder block for causing reciprocation of pistons in the cylinders during block rotation. This kind of pump will hereinafter be referred to as a swashplate pump.

DESCRIPTION OF THE PRIOR ART

It has been proposed in swashplate pumps to arrange that the cylinder block includes kinetic pumping passages to give kinetic pumping to some or all of the liquid entering the cylinders in the cylinder block. However in these prior art proposals the kinetic pumping effected by the cylinder block operates on the liquid before the liquid makes contact with the swashplate. The kinetic pumping action causes temperature rise of the pumped liquid which then may not effect efficient cooling and lubrication of the swashplate.

SUMMARY OF THE INVENTION

In accordance with the present invention a swashplate pump includes a casing surrounding the swashplate means and the cylinder block, hydrokinetic pumping means formed on or in the cylinder block, a liquid inlet to the casing arranged so that liquid entering through the inlet will flow over the swashplate means to and through the said hydrokinetic pumping means into a delivery region from which liquid enters the said valve means.

The hydrokinetic pumping means may comprise passages formed within the cylinder block.

The passages may include radial and/or skewed surfaces so that hydrokinetic pumping is either by centrifugal flow or axial flow or a combination of both.

A bearing around the block may locate the block for rotation in the casing and the bearing may conveniently form a seal acting to isolate at least in part the delivery region from the inlet.

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 engages between the block and the interior of the casing **1**. 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** cooperates 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** cooperate 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 cutaway portion of the valve plate extending inwardly from its periphery, this cutaway 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 swashplate **16** which is mounted in an open chamber in the remote end portion of the casing, on suitable trunnions for adjustment about an axis **17** which extends perpendicularly to the plane of the drawing. Angular adjustment of the swashplate may be effected by any conventional means. The swashplate **16** has a plane swash surface **18** facing the cylinder block. A slipper **19** is fitted by a ball joint **21** 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** onto 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 swashplate **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. These passages open into the end of the cylinder block adjacent the swashplate **18** and extend back to open at the side of the cylinder block, into an annular space **28** defined between the casing, the cylinder block, the bearing **4** and the valve block. This space is the delivery region. A vane **39** formed on the interior surface of the casing projects in the space **28** to reduce rotary flow of liquid around the space **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 swashplate **16** and into the space **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** cooperates 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 swashplate **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 swashplate in order that the ports **12** and **13** may be shown in the drawings. Liquid enters the pump through the inlet **15** and rotation of the cylinder block and the passages **27** gives a small pressure rise from the inlet **15** into the delivery space **28**. The vane **39** reduces flow

of liquid around the delivery space and will help to increase the small pressure rise generated within the space **28**. From the space **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 swashplate at the temperature at which it enters the inlet **15** and will ensure adequate lubrication and cooling of the slippers and swashplate. 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 inlet **15** and the space **28**.

It will be appreciated that many other constructions are possible within the scope of the present invention. For example it is possible for the cylinder barrel to be completely supported for rotation by a shaft extending through the barrel and located in bearings at either end of the barrel. In such a case appropriate sealing means would be provided around the periphery of the cylinder block to isolate the space from the inlet **15**. In the described embodiment the pumping surfaces are formed by the walls of passages **27** passing through the cylinder block. It is within the scope of the invention for example that such pumping surfaces should be formed as the surfaces of vanes located around the periphery of the cylinder block. In the previously mentioned modification in which the cylinder block is completely supported on a shaft such vanes could rotate in closely spaced relation with the interior of the casing **1** to form effectively a seal with the casing to isolate the delivery space from the inlet **15**. Where vanes are provided around the cylinder block they will preferably be skewed relative to the block rotation axis so that kinetic pumping is axial flow pumping rather than centrifugal pumping.

I claim:

1. In a swashplate pump comprising a rotary cylinder block having cylinders disposed parallel or inclined to the rotation axis, pistons in the cylinders, valve means cooperating with the cylinder block during rotation, and swashplate means located adjacent to one end of the cylinder block for causing reciprocation of the pistons in the cylinders during block rotation, the improvement comprising a casing surrounding the swashplate means and the cylinder block, and means for supplying liquid to the valve means including hydrokinetic pumping means formed on or in the cylinder block, and a liquid inlet into the casing arranged so that liquid entering through the inlet flows over the swashplate means en route to and through the said hydrokinetic pumping means, into a delivery region from which liquid enters the said valve means.

2. A swashplate pump as claimed in claim **1** including a bearing around the cylinder block to locate the cylinder block for rotation in the casing, the said bearing acting to isolate at least in part the delivery region from the inlet.

3. A swashplate pump as claimed in claim **2** wherein the bearing is located to resist substantially all side thrust exerted on the cylinder block by the swashplate means.

4. A swashplate pump as claimed in claim **2** wherein the delivery region is defined between the interior of the casing, the periphery of the cylinder block, and the bearing around the cylinder block.

5. The swashplate pump according to claim **1** wherein the casing has a chamber in one end portion thereof, which is in open communication with the liquid inlet, and the swashplate means is mounted in the chamber so as to be directly exposed to the liquid flowing into the chamber from the inlet.

6. The swashplate pump according to claim **5** wherein the valve means has a port therein for supplying liquid to the cylinders during block rotation, and the hydrokinetic pumping means includes a passage which interconnects the aforesaid liquid supply port with the chamber, at a point on the opposite side of the swashplate means from the liquid inlet, so that the liquid from the inlet flows directly into the passage, and thence to the supply port, after flowing over the swashplate means.