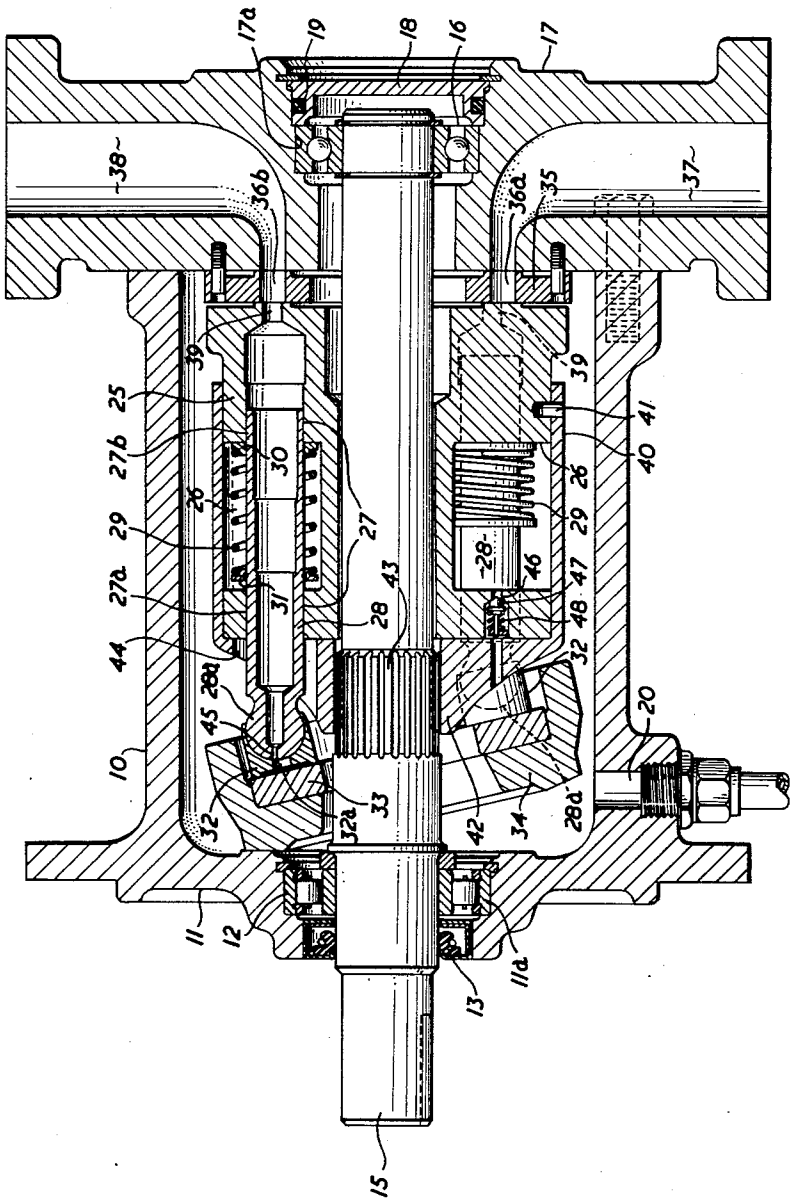
Oct. 31, 1961 A. PITT ET AL 3,006,284

SWASH-PLATE PUMP

Filed March 21, 1960



INVENTORS
ARNOLD PITT
TADEUSZ BUDZICH
BY: Maybee & Legris
ATTORNEYS

United States Patent Office

3,006,284
Patented Oct. 31, 1961

3,006,284
SWASH-PLATE PUMP

Arnold Pitt, 5 Hillgarden Road, Weston, Ontario, Canada, and Tadeusz Budzich, 3344 Colwyn Road, Cleveland, Ohio

Filed Mar. 21, 1960, Ser. No. 16,502
9 Claims. (Cl. 103—162)

This invention relates to improvements in "swash-plate pumps," by which term is meant pumps of the kind including a driven shaft on which is mounted a cylinder block having bores which are each arranged with their longitudinal axis extending in the same general direction as the longitudinal axis of the shaft, the cylinder block being secured to the shaft for rotation in unison therewith. Each of the bores contains a piston which extends from one end of the cylinder block, the pistons being biased outwardly of the bores and away from an opposite end of the cylinder block by any convenient means.

The pump also includes a plate valve which is common to each of the bores and which is arranged at the opposite end of the cylinder block, the plate valve connecting each bore in sequence to a supply of hydraulic fluid and then to a pressure line as the shaft and cylinder block is rotated through one complete revolution, and also includes an annular cam plate which is arranged adjacent the outwardly-extending ends of the pistons, the cam plate having a working face which is traversed by said ends of the pistons as the cylinder block is rotated and which is arranged at an angle to the axis of the shaft.

In such pump constructions the annular plate is commonly mounted on trunnions for adjustment about an axis transverse to the axis of the shaft in order that the inclination of the plate may be varied, and thus the length of travel of the pistons within their bores and the quantity of hydraulic fluid displaced on each reciprocation be varied, the axis of adjustment of the annular plate being arranged such that each piston is sequentially moved inwardly of its bore to a maximum extent immediately before the respective bores are disconnected from the pressure line.

Pumps of this type are generally referred to as "swash-plate pumps," and throughout the following specification and the appended claims this terminology is used to identify the above described particular type of pump.

It is an object of this invention to provide an improved swash plate pump assembly in which the usual springs employed for biasing the pistons outwardly of their bores are so positioned that they are ineffective to cause foaming of the liquid being pumped.

Another object of the invention is to provide a swash-plate pump assembly in which the "overhang" of the pistons may be kept to a minimum. The "overhang" of the pistons refers to that portion of the pistons which extends from the one end of the cylinder block and which is subjected to lateral forces arising from various factors during the operation of the pump.

A further object of the invention is to reduce the total leakage within the pump.

A still further object of the invention is to provide a swash-plate pump assembly in which the rotatable cylinder block is free to move relatively to the drive shaft for the juxtaposed faces of the cylinder block and plate valve to be self-aligning.

Another object of the invention is to provide a swash-plate pump assembly in which the requirement for precision machining is minimized, and which will operate at high pressures and high speeds for prolonged periods of time with a minimum of servicing.

According to one feature of the invention, the cylinder block is provided with an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block, the gallery intersecting the bores to divide each bore into two axially spaced portions between which the pistons extend, the pistons each terminating in one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, each piston having an abutment at a position intermediate said bore portions between which and an opposed end wall of the gallery biasing means react to bias the pistons in one axial direction. In this way the biasing means, which usually are in the form of springs, are located outside the working cylinder in a position where they are ineffective to cause foaming of the liquid being pumped.

According to another feature of the invention, a sleeve is provided extending between the ends of the cylinder block in sealing relation therewith, the sleeve closing the open side of the gallery to form a closed annular space through which the pistons extend. The closed annular space provides a reservoir for fluid which leaks past the sliding surfaces of each piston and its associated working cylinder, and eventually becomes pressurized, thus providing a back pressure operating in opposition to the pressure in the working cylinders and which is effective to reduce leakage along said sliding surfaces.

Additionally, the pressurized fluid in said space is effective to provide a lubricating supply of fluid to the sliding surfaces of the pistons and said other bore portions.

Preferably, a relief valve is provided for the space in order that the pressure therein may be maintained below a determined maximum.

According to a further feature of the invention, the cylinder block is ring-shaped and surrounds the drive shaft with an appreciable clearance, the drive between the cylinder block and drive shaft being through an extension of the sleeve which is drivingly connected to the shaft in a manner permitting relative movement between the cylinder block and drive shaft. The cylinder block is thus permitted to float between the plate valve and the annular cam plate for it to be self-aligning with the plate valve, thus mitigating the need for precision machining of certain surfaces of the cylinder block.

Preferably, a positive driving connection between the sleeve and the cylinder block is provided at that end of the cylinder block which is adjacent the plate valve, the drive to said sleeve being provided through an extension of the opposite end of said sleeve which is keyed to the drive shaft in a manner permitting limited relative movement of the sleeve in a direction lateral to the axis of the drive shaft.

Further objects and advantages of the invention will become apparent from a study of the following specification when taken in conjunction with the single figure of the accompanying drawing, which drawing is a diagrammatic sectional elevation taken longitudinally of the axis of the pump.

Referring to the drawing, the pump includes a body **10** in the form of a hollow cylinder, the body having a radially inwardly directed wall **11** at one of its ends, which wall has a stepped bore **11***a* in which a bearing **12** and oil seal **13** are supported.

The bearing **12** is a roller bearing, and supports one end of a shaft **15**, the other end of the shaft **15** being supported by a thrust bearing **16** carried in a stepped bore **17***a* of an end closure member **17** of the body **10**. The closure member **17** is secured to the body in any convenient manner, for example, by means of bolts which

extend through the member **17** in a direction axially of the body **10**, and which are threaded into the body **10**. The bearing **16** is secured in position by a cap **18** which carries an O-type sealing ring **19**.

The structure so far described defines a closed hollow chamber through which the shaft **15** extends, and in which the shaft **15** is journalled for rotation. To accommodate leakage of hydraulic fluid which may occur in the mechanism hereinafter described, the body **10** is preferably provided with an outlet **20** which is threaded so that it may be connected to an appropriate scavenge conduit by a standard union.

The pumping mechanism includes an annular cylinder block **25** which is positioned over the shaft **15** with clearance therefrom so that the cylinder block is free to move to a limited extent in a direction transverse to the axis of the shaft **15**, or may be skewed slightly for its axis to be inclined to a minor extent laterally of the axis of the shaft **15**.

The cylinder block has an annular gallery **26** which extends inwardly of the cylinder block from its outer periphery, the gallery intersecting a plurality of bores **27** in the cylinder block to divided those bores into two axially spaced bore portions **27***a*, **27***b*. The bores **27** are arranged with their longitudinal axis extending parallel to the axis of the cylinder block, but, as readily will be apparent to one skilled in the art, the bores **27** may be arranged with their longitudinal axis converging towards the axis of the cylinder block, and also, the longitudinal axis of the bores may be inclined to a radial plane which contains the axis of the cylinder block. Preferably, the bores are spaced equidistantly around the cylinder block.

Extending through the bore portion **27***a* and into the bore portion **27***b* of each bore **27** is a piston **28**, the piston being hollowed out for the sake of lightness. That end of the piston which lies within the bore portion **27***b* provides the working end of the piston.

Surrounding that portion of the piston **28** which extends between the bore portions **27***a*, **27***b* is a helical spring **29**. The spring **29** at its end adjacent the bore portion **27***b* seats on a collar **30** which abuts the adjacent radial face of the gallery, the other end of the spring abutting against a collar **31** which is secured to the piston **28** by means of a split ring or similar device. The action of the spring **29** is to bias the pistons **28** to the left in the drawings for their working ends to be withdrawn from the interior of the bore portions **27***b* to a maximum extent permitted by the structure hereinafter described.

The ends of the pistons remote from the bore portion **27***b* are formed to be spherical as indicated at **28***a*, the spherical ends **28***a* seating in semi-spherical recesses in shoes **32** which are in rubbing contact with a cam plate **33**. The cam plate **33** is carried by a yoke **34**, the yoke being mounted in any conventional and convenient manner for swinging movement about an axis which is transverse to the axis of the shaft and which lies in a plane containing the centres of the spherical ends **28***a* of the piston **28**. A common method of mounting the yoke is to provide it with a pair of opposed trunnions which are carried in bearings supported by the body **10**, the trunnions being connected to a suitable mechanism whereby the inclination of the yoke can be varied as desired.

The springs **29** act to force the pistons in a direction for their spherical ends **28***a* to press the shoes **32** onto the sliding surface of the cam plate **33**, the reaction of the springs against the cylinder block **25** acting to force the cylinder block in an opposite direction for its end adjacent the end closure member to be forced into intimate contact with a plate valve **35**.

The plate valve **35** is of the conventional type which incorporates two kidney-shaped slots **36***a*, **36***b*, which slots respectively extend in an arc around the axis of the shaft **15** to an extent which is slightly less than 180°. The slot **36***a* is in direct communication with an outlet passage **37** of the pump, and the slot **36***b* is in direct communication with an inlet passage **38** of the pump.

The bores **27***b* sequentially are placed in communication with the slots **36***a*, **36***b* as the cylinder block is rotated by means of ports **39** in the cylinder block, so that the bore portions **27***b* are alternately connected to the inlet and the outlet of the pump.

The valving structure employed is that commonly known, and it is therefore believed that the above description will be found adequate to those skilled in the art.

A drive between the cylinder block **25** and the shaft **15** is provided by a sleeve **40** which extends across the annular gallery **26** to close-off the open side of the gallery, the sleeve **40** at one of its ends being drivingly connected to the cylinder block **25** by shear pins **41**, and at its other end extending radially inwardly of the cylinder block to a portion **42** defining a bore of slightly larger diameter than the diameter of the adjacent portion of the shaft **25**. The radially inwardly extending portion **42** of the sleeve **40** is provided with apertures **44** through which the pistons **28** extend.

A driving connection is established between the portion **42** of the sleeve and the adjacent portion of the shaft by interfitting splines **43** of the shaft **15** and of the portion **42**, the splines being arranged for them to transmit a positive drive while at the same time permitting limited movement of the sleeve into a position in which it is other than concentric with the axis of the shaft **15**.

The axial forces acting on the shoes **32** are pressure balanced by providing apertures **45** in the spherical ends of the pistons and recesses **32***a* in the rubbing faces of the shoes. In this way the hydraulic fluid under pressure in the bores **27***b* during the pressure stroke is fed into the recesses and acts in opposition to the axial force acting on the working end of the pistons.

The mode of operation of the pump is as follows:

As the shaft **15** is rotated, the sleeve **40** and cylinder block **25** are also rotated causing the shoes **32** to traverse the working faces of the cam plate **33**. As the cam is inclined to the axis of the shaft **15**, the shoes sequentially ride up the incline at one side of the plate to force the pistons **28** to the right in the drawing, and then ride down the incline at the opposite side of the plate under the influence of the springs **29** acting on the pistons, the pistons at this time moving to the left in the drawing.

As the pistons are moved to the right, the volume of the cavity provided by the bore portions **27***b* and the hollow interior of the pistons **28** is decreased, and hydraulic fluid is expressed through the associated ports **39** into the kidney-shaped slot **36***a* and thus into the outlet passage **37**. Movement of the pistons to the left results in an increase in the volume of that cavity, and hydraulic fluid is drawn into the cavity from the inlet passage **38** through the associated ports **39**.

It is arranged that the pistons reach their maximum extent of travel to the right in the drawing immediately prior to their associated ports **39** passing over from the end of the kidney-shaped slot **36***a* to the adjacent end of the kidney-shaped slot **36***b*. Movement of the pistons to the right constitutes the pressure stroke, during which time fluid is expressed from the bore portions **27***a* into the outlet passage **37**, and movement of the piston to the left under the influence of the springs **29** constitutes the priming stroke, during which time fluid is drawn into the cylinder portions **27***b* from the inlet passage **38**.

By varying the inclination of the cam plate **33** to the axis of the shaft **15** the length of travel of the pistons **28** axially of the cylinder block can be varied, and thus the output of the pump can be varied, the output of the pump reaching zero when the working face of the cam plate **33** is perpendicular to the axis of the shaft **15**.

While the pump of the invention employs the same basic principles of operation as those of known swash-

plate pumps, it embodies many advantages which are not to be found in known structures. These advantages will now be discussed in detail.

Considering first the piston and cylinder block assembly, the pistons are supported over a major portion of their length in a manner greatly reducing piston overhang, thus minimizing the effects of the lateral pressures exerted on the pistons.

Those lateral pressures are due to centrifugal action, and also to forces exerted on the shoes **32** by springs **29** as the shoes traverse the working face of the cam **33**. The residual force remaining after pressure balancing of the axial forces acting on the shoes **32** also produces some lateral loading of the pistons **28**.

The reduction of piston overhang results in an overall reduction in wear, thus resulting in an appreciable increase in the expected life of the pump.

It will be noted that there are no springs or other members within the interior of the bore **27***b* which can cause foaming of the liquid as it is being pumped, and thus, the pump satisfactorily may be operated at a much higher speed than is permissible with conventional pumps where the springs are positioned within the bore and piston cavities. In the pump of the present invention, the springs **29** are positioned exteriorily of the working cylinder in a position where they are ineffective to cause foaming of the liquid being pumped. Also, by constructing a pump in the manner of the present invention, the springs are supported exclusively at their ends, and are thus maintained out of rubbing contact with adjacent surfaces of the pump assembly. This results in a prolongation of the life of the springs **29**, for the springs are in no way subjected to abrasion, and their rate remains substantially constant throughout their useful life.

Any seepage of fluid which may occur between the sliding surfaces of the bore portions **27***b* and the pistons **28** acts as a lubricant supply for those surfaces and is collected in the gallery **26**. The fluid in the gallery usefully provides a lubricant supply for the springs, and under operating conditions eventually floods the gallery and then seeps along the sliding surfaces of the bore portions **27***a* and the pistons **28**, thus providing a lubricant supply for those surfaces.

Once the gallery has become flooded, a back pressure is developed in the gallery which acts in opposition to the pressure causing seepage between the sliding surfaces of the bore portions **27***b* and the portions **28**. In this way the total seepage past those sliding surfaces is greatly reduced, resulting in an increase in the operating efficiency of the pump.

To mitigate the possibility of damage to the sleeve **40** occurring due to the pressure in the chamber rising to an excessive extent, preferably a pressure relief valve **46** is provided in the cylinder block **25**, that valve being of the type include a valve member **47** which is pressed onto a seating by a spring **48**. By selecting the spring **48** to be of a determined rate, the pressure in the chamber may be held at a selected maximum.

Fluid which leaks past the sliding surfaces of the pistons **28** and the bore portion **27***a*, together with any fluid which is exhausted through the pressure relief valve **46** and fluid from any other source of leakage collects within the interior of the body **10** and is drained through the outlet **20**.

As the driving torque is transmitted from the sleeve **40** to the cylinder block **25** exclusively through the shear pins **41**, those pins can be of a calculated shear strength such that they will shear when a torque is reached which corresponds to a maximum permissible pressure in the outlet passage **47**. Thus, in the event of faulty operation of relief valves or other equipment associated with the outlet passage **37**, continued operation of the pump cannot result in dangerous blowouts of the hydraulic conduits, and also the structure of the pump will be undamaged with the sole exception of the shear pins **41** which can easily and quickly be replaced.

The cylinder block **25** not only is free to float axially of the shaft **15** between the valve plate **35** and the cam plate **33**, but it is also free to move to a small extent transversely and laterally of the shaft for its end face to seat accurately on the juxtaposed sliding surface of the valve plate **35**. This movement is accommodated by the interfitting splines **43**, and in this way expensive and complicated machining techniques assuring accurate alignment of the sliding faces of the cylinder block and valve plate **35** are obviated, it merely being necessary to form each of the faces as truly planar faces.

It will be understood that the structure of pump described with reference to the accompanying drawings is to be taken by way of example only of one of the forms which the pump of the invention may take, and that various modifications of that structure described above are possible without departing from the scope of the appended claims.

What we claim as our invention is:

1. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, and a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend.

2. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the outer bore portion at the other end of the cylinder block, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, and a relief valve associated with the closed annular space.

3. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between the sleeve and the

cylinder block, and a driving connection between the sleeve and the drive shaft permitting relative movement between the shaft and the cylinder block.

4. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cyilnder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between one end of the sleeve and the cylinder block in the vicinity of that end of the cylinder block which provides said working cylinders, and a driving connection between the other end of the sleeve and the drive shaft permitting relative movement between the axes of said shaft and cylinder block.

5. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, an abutment on each piston at a position intermediate said bore portions of each bore, spring means reacting between the abutments and an opposed end wall of the gallery, said means biasing the pistons in one axial direction, and a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend.

6. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, an abutment on each piston at a position intermediate said bore portions of each bore, spring means reacting between the abutments and an opposed end wall of the gallery, said means biasing the pistons in one axial direction, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between the sleeve and the cylinder block, and a driving connection between the sleeve and the drive shaft permitting relative movement between the shaft and the cylinder block.

7. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, an abutment on each piston at a position intermediate said bore portions of each bore, spring means reacting between the abutments and an opposed end wall of the gallery, said means biasing the pistons in one axial direction, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between one end of the sleeve and the cylinder block in the vicinity of that end of the cylinder block which provides said working cylinder, and a driving connection between the other end of the sleeve and the drive shaft permitting relative movement between the axes of said shaft and cylinder block.

8. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, an abutment on each piston at a position intermediate said bore portions of each bore, spring means reacting between the abutments and an opposed end wall of the gallery, said means biasing the pistons in one axial direction, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a relief valve associated with the closed annular space, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between the sleeve and the cylinder block, and a driving connection between the sleeve and the drive shaft permitting relative movement between the shaft and cylinder block.

9. In a swash plate pump, a ring-shaped cylinder block having a plurality of bores, each bore being arranged with its longitudinal axis extending in the same general direction as the longitudinal axis of the cylinder block, the cylinder block having an annular gallery which extends into the cylinder block from a peripheral surface of the cylinder block intermediate its ends, and which intersects each of the bores to divide each bore into two axially spaced portions, a piston within each bore and having a sliding fit therein, the pistons each terminating within one of the bore portions at one end of the cylinder block for that bore portion to provide a working cylinder for the piston, and each extending through the other bore portion at the other end of the cylinder block, an abutment on each piston at a position intermediate said bore portions of each bore, a spring surrounding that portion of each piston which extends between the abutment and an op-

posed end wall of the gallery, the springs reacting between the abutment and the wall to bias the pistons in one axial direction, a sleeve extending between the ends of the cylinder block in sealing relationship therewith for it to define with the gallery a closed annular space through which the pistons extend, a relief valve associated with the closed annular space, a drive shaft of the pump extending with clearance through the aperture defined by the inner periphery of the cylinder block, a driving connection between one end of the sleeve and the cylinder block in the vicinity of that end of the cylinder block

which provides said working cylinders, and a driving connection between the other end of the sleeve and the drive shaft permitting relative movement between the axes of said shaft and cylinder block.

References Cited in the file of this patent

UNITED STATES PATENTS

2,299,235	Snader et al.	Oct. 20, 1942
2,498,451	Ruben	Feb. 21, 1950
2,915,985	Budzich	Dec. 8, 1959