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VARIABLE DELIVERY MULTI-LIQUID PUMP

Filed March 17, 1964

2 Sheets-Sheet 1

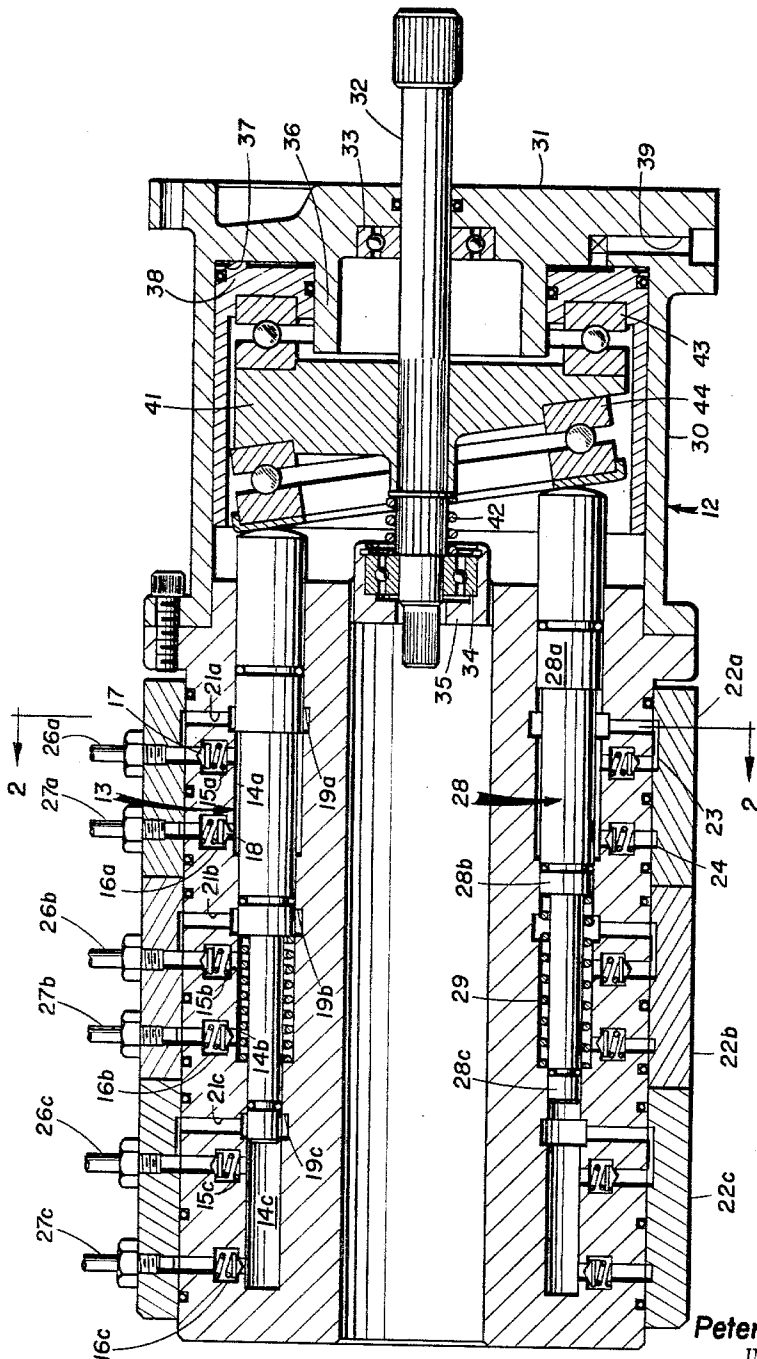


FIG. 1

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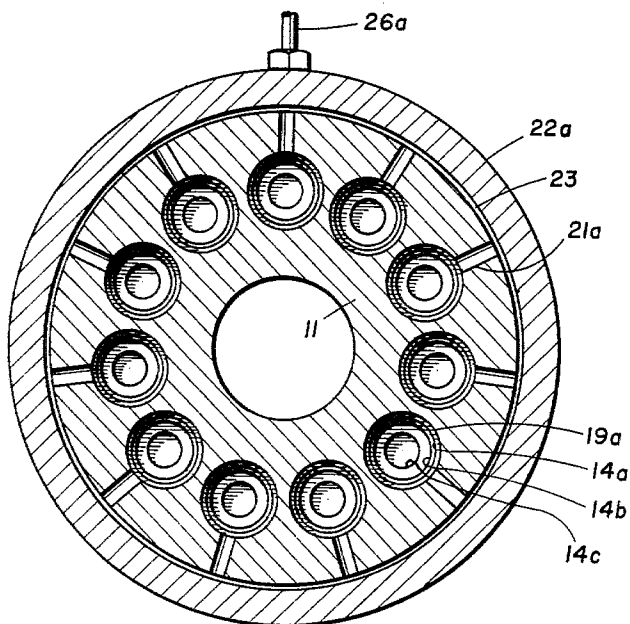


FIG. 2

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VARIABLE DELIVERY MULTI-LIQUID PUMP

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4 Claims. (Cl. 103-9)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to hydraulic pumps and more particularly to a swash plate type pump which is capable of pumping several fluids simultaneously and which may be easily adjusted to control the volume of fluid delivered by said pump.

In the past, multiple fluids have been pumped with one of two systems, the first being a single pump which does not have means to provide a variable flow control and the second being a plurality of individual pumps coupled to variable speed transmissions, but neither system has proven to be entirely satisfactory.

The general purpose of the present invention is to provide a multiple fluid pump which possesses all of the advantages of similarly employed pumps and which overcomes the disadvantages characteristic of those pumps. The present invention achieves this goal through the use of a multiple cylinder swash plate pump having connections for multiple fluid couplings and further comprising an improved means for varying the delivery of the pump by changing the effective stroke of the pistons.

It is, therefore, an object of this invention to provide a hydraulic pump having a new and improved means to vary the delivery thereof.

Another object is to provide a single pump for the delivery of multiple fluids with means to vary the volume of the fluids delivered.

A further object of the invention is the provision of a variable flow multiple fluid pump wherein the ratio of the fluids pumped may be preselected.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 illustrates a longitudinal sectional view of the preferred embodiment of this invention; and

FIG. 2 illustrates a cross-sectional view taken on line 2-2 of FIG. 1.

Referring to FIG. 1, there is shown a variable delivery pump having an elongated cylinder block 11 and a drive assembly 12 attached to one end thereof. The cylinder block is shown as a cylindrical body having a plurality of bores 13 formed therein parallel to the principal axis of said block and being symmetrically spaced around said axis, each bore having first and second counter-bores to define first, second, and third cylinders, as shown at 14a, 14b, and 14c, respectively. The cylinder block further defines a fluid inlet port 15a and a fluid outlet port 16a for each of said first cylinders 14a extending radially from the cylinders to the exterior of the block. Inlet and outlet ports 15b and 16b for the second set of cylinders are formed in the cylinder block, which further defines inlet and outlet ports 15c and 16c for the third set of cylinders. Inlet check valves 17 and outlet check valves 18 are provided in all of the inlet and outlet ports to control the direction of fluid flow therethrough. Cylinders 14a, 14b, and 14c each have an annular groove 19a, 19b, and 19c, respectively, formed in one end thereof to define a fluid by-pass port in each cylinder, while the cylinder block has a plurality of radial apertures 21a, 21b, and 21c formed therein to provide fluid communication between their re-

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spective by-pass ports and the exterior of the cylinder block.

Surrounding the first set of cylinders 14a and being in sealing contact with the exterior of the cylinder block 11 is a first annular coupling ring 22a. Similarly mounted upon the cylinder block are second and third annular coupling rings 22b and 22c surrounding the second and third sets of cylinders 14b and 14c respectively. A first annular groove 23 is formed in the inner peripheral surface of each ring 22 and is of sufficient width to provide fluid communication between all of the inlet ports 15 and by-pass apertures 21 which are surrounded by that ring. In the same manner, a second annular groove 24 is formed in the inner peripheral surface of each ring 22 to provide fluid communication between all of the outlet ports 16 which are surrounded by that ring. Threaded into through openings in annular coupling ring 22a is a fluid supply conduit 26a and a fluid discharge conduit 27a for conducting fluid into cylinders 15a and conveying pumped fluid from said cylinders. Annular coupling rings 22b and 22c have similar supply conduits 26b and 26c and fluid discharge conduits 27b and 27c connected thereto. From the foregoing, it may be seen that inlet conduits 26a, 26b, and 26c to the three separate sets of cylinders 14a, 14b, and 14c may be used in a manner such that each set of cylinders will pump a fluid which is distinct from the fluid in each of the other sets of cylinders, thus permitting three fluids to be pumped simultaneously.

Positioned within each bore 13 is a piston assembly 28 which has three portions of different diameters, the diameters being substantially equal to the inner diameters of cylinders 14a, 14b, and 14c, said three portions forming first, second, and third pistons 28a, 28b, and 28c. A helical spring 29 is positioned within each bore to resiliently bias the piston assembly outwardly of the bore.

The drive assembly 12 for the pump is of the conventional swash plate type but having certain improvements to provide control means for varying the discharge of the pump. A cylindrical drive shaft housing 30, which is closed at one end by a wall 31, has its open end secured to the end of the cylinder block 11 by means of bolts, the housing 30 being coaxially aligned with the cylinder block. A drive shaft 32 is mounted within housing 30 coaxially with the housing and the cylinder block and extends through an aperture in wall 31. The drive shaft is journaled at one end in a first roller bearing 33 and at its other end in a second roller bearing 34 which is mounted on the cylinder block by means of a bearing support 35. Integrally formed with end wall 31 is an annular hub 36 which is concentrically aligned with the drive shaft. Hub 36 cooperates with end wall 31 and the cylindrical housing wall 30 to define an annular actuator chamber or cylinder 37 which receives an annular actuator piston 38. An actuator fluid passageway 39 is formed in the end wall 31 to provide fluid communication between the cylinder 37 and the exterior of the drive assembly. A swash plate 41 is mounted upon the drive shaft by means of a spline connection which permits the swash plate to be shifted longitudinally along the shaft but prevents relative rotational movement between the swash plate and the shaft. A helical spring 42 is positioned concentrically about the drive shaft and abuts the inner race of bearing 34 at one end and the swash plate at its other end to thereby resiliently bias the swash plate against a roller bearing 43 which is interposed between the swash plate and the annular actuator piston 38. Under the influence of springs 29, the piston assemblies 28 are biased outwardly of bores 13 into contact with a roller bearing 44 which is interposed between the swash plate and the ends of the piston assemblies.

By way of operation, it is seen that rotation of the drive shaft by a suitable prime mover causes rotation of the swash plate which results in longitudinal reciprocation of the piston assemblies 28 in a well known manner. The amount of longitudinal reciprocation of the pistons is dependent upon the angular inclination of the swash plate. As the piston assemblies are moved from a top dead center position, as seen in the upper portion of FIG. 1, to a bottom dead center position, as seen in the lower portion of FIG. 1, fluid flows past the inlet check valves 17 and into the cylinders 14a-c. As the piston assemblies are moved from their bottom dead center position to top dead center, the leading edges of each piston 28a-c displaces the fluid in its respective cylinders, closing the inlet check valves and opening the outlet check valves 18 to permit the fluid to be conveyed away from the pump through conduits 27a-c. During the initial portion of the discharge stroke, the bypass ports 19a-c are open to the cylinders and permit the fluid displaced by the pistons to flow into by-pass apertures 21a-c and grooves 23 until the piston travels a distance sufficient to close the by-pass ports, at which time further piston travel causes the outlet check valves to open and the fluid to be delivered through hydraulic lines 27a-c. The amount of displaced fluid permitted to flow through the by-pass means is dependent upon the relative positions of the leading edges of the pistons with respect to the by-pass ports at the beginning of the stroke. The relative position of the pistons may be selectively controlled by the introduction of fluid into annular cylinder 37 which then forces piston 38, swash plate 41, and piston assemblies 28 to the left as viewed in FIG. 1, thereby changing the effective stroke of the pistons. With the annular actuator piston 38 abutting against end wall 31, as shown in FIG. 1, the by-pass ports remain open during the complete stroke of the pistons, under which conditions there is no discharge of fluid through lines 27a-c. When piston 38 is actuated to its left-most position, the by-pass ports remain closed during the entire stroke of the pistons, thus producing maximum flow through hydraulic lines 27a-c. By selectively positioning the annular actuator piston between its two extreme positions, the effective stroke of the pistons and therefore the percent of discharge flow of fluids may be carefully regulated.

It can be seen, therefore, that an improved hydraulic pump has been described wherein several fluids may be pumped simultaneously and which has a new and improved control means for varying the delivery rate of those fluids. The ratio of the volumes of the various fluids delivered by the described pump may be changed by either varying the lengths of the pistons or by extending the widths of the grooves which define the by-pass ports, or both.

Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A variable delivery pump comprising
 - an elongated cylinder block having a plurality of parallel bores formed therein which are radially spaced symmetrically around the principal axis of the block, each bore having a first and second counter-bore to define first, second, and third cylinders in each bore,
 - said block having a first set of radial passages formed therein to define an inlet passage and an outlet passage for each of the cylinders,
 - said block having a second set of radial passages formed therein to define a by-pass means for each cylinder which provides fluid communication between a portion of each cylinder and its respective inlet passage, check valves positioned in each inlet and outlet passage, a piston assembly positioned within each bore and having one end extending outwardly of the bore,

each piston assembly comprising first, second, and third pistons connected together and having diameters substantially equal to the internal diameters of said first, second, and third cylinders respectively,

a spring positioned within each bore to resiliently bias the piston assemblies outwardly of the bores,

a drive shaft mounted for rotation about the axis of said block,

a drive shaft housing connected to the end of said block from which said piston assemblies extend,

a swash plate mounted upon said drive shaft with one side thereof in abutting relationship with the ends of said piston assemblies and being keyed to said shaft to permit rotation therewith as well as longitudinal sliding movement along said shaft,

an annular actuator piston concentrically positioned around a portion of said drive shaft in abutting relationship with the other side of said swash plate, and fluid passage means in the end of said drive shaft housing on the side of said actuator piston remote from said swash plate for receiving therein a control fluid for moving said actuator piston inward and thereby adjustably positioning said swash plate longitudinally along said shaft,

whereby rotation of the drive shaft rotates the swash plate to reciprocate the pistons while actuation of the actuator piston means changes the effective stroke of the pistons.

2. The device of claim 1 further comprising a first inlet and outlet fluid coupling means common to all of said first cylinders,

a second inlet and outlet fluid coupling means common to all of said second cylinders, and

a third inlet and outlet fluid coupling means common to all of said third cylinders,

said coupling means being mounted upon the exterior surface of said cylinder block and being in fluid communication with respective radial inlet and outlet passages in said cylinder block.

3. The device of claim 2 wherein each of said coupling means comprises an annular ring sealingly fitted over the exterior surface of said cylinder block,

each of said rings having first and second annular grooves formed in the inner peripheral surface thereof,

each of said rings further having first and second through openings formed therein to provide fluid communication between the first and second grooves and the exterior of said rings.

4. A multi-fluid swash plate pump comprising a cylinder block defining a plurality of parallel bores formed therein about the principal axis of said block and having at least one counter-bore in each bore, pistons positioned within each bore and counter-bore, a drive shaft rotatably mounted on said block coaxially therewith,

a swash plate locked onto said shaft for rotation therewith,

said swash plate having an inclined surface on one side thereof in contact with said pistons,

said cylinder block having radial passages formed therein to define separate inlet, outlet, and by-pass ports for each bore and counter-bore and being longitudinally spaced apart therein,

coupling means including annular rings having annular grooves formed in the inner peripheral surface thereof to define separate inlet and outlet chambers common to all of the inlet and outlet ports for said bores and further defining separate inlet and outlet chambers for all of the inlet and outlet ports for said counter-bores for introducing one fluid to said bores and a separate fluid to said counter-bores, and

hydraulically operated actuator piston means on the other side of said swash plate for shifting said swash plate longitudinally on said drive shaft to thereby

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change the effective stroke of the pistons in said bores
and counter-bores,
whereby multiple liquids may be pumped simultaneous-
ly at a controlled rate of delivery.

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