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PISTON PUMP

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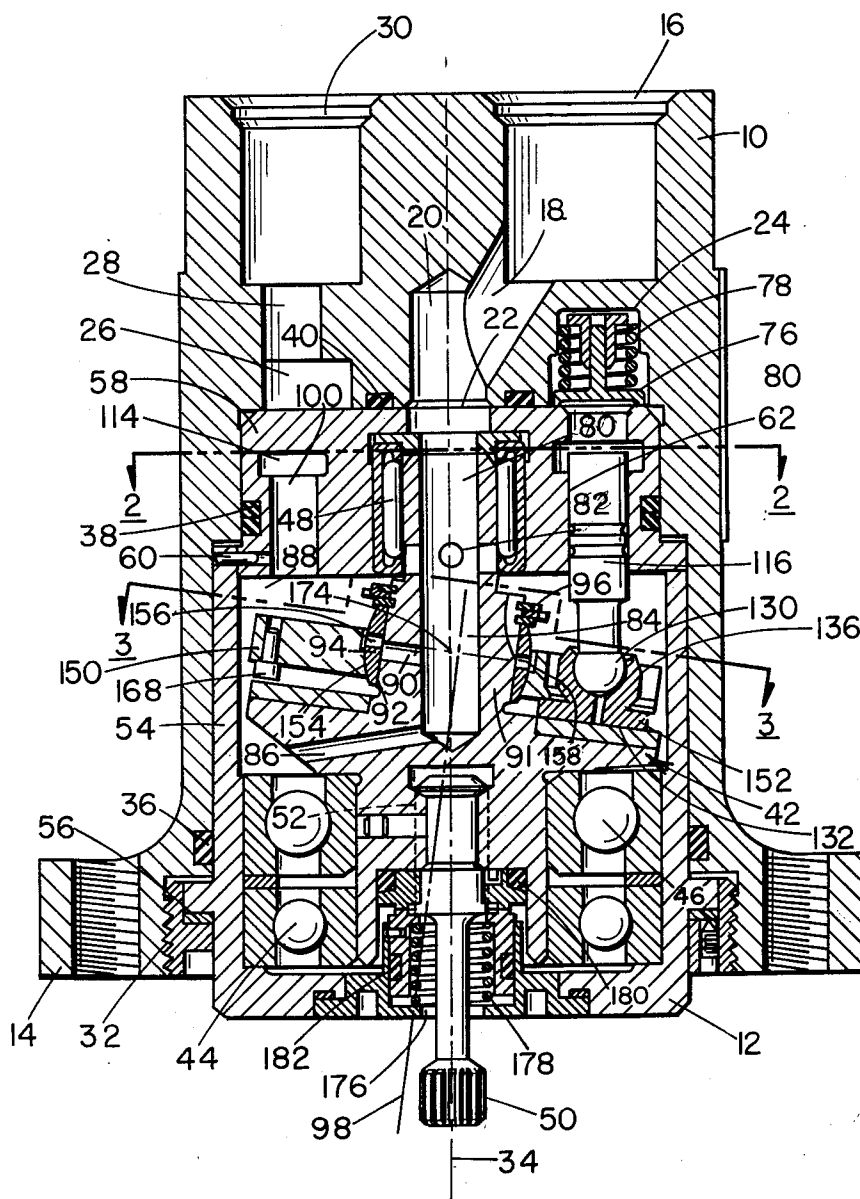


FIG. 1

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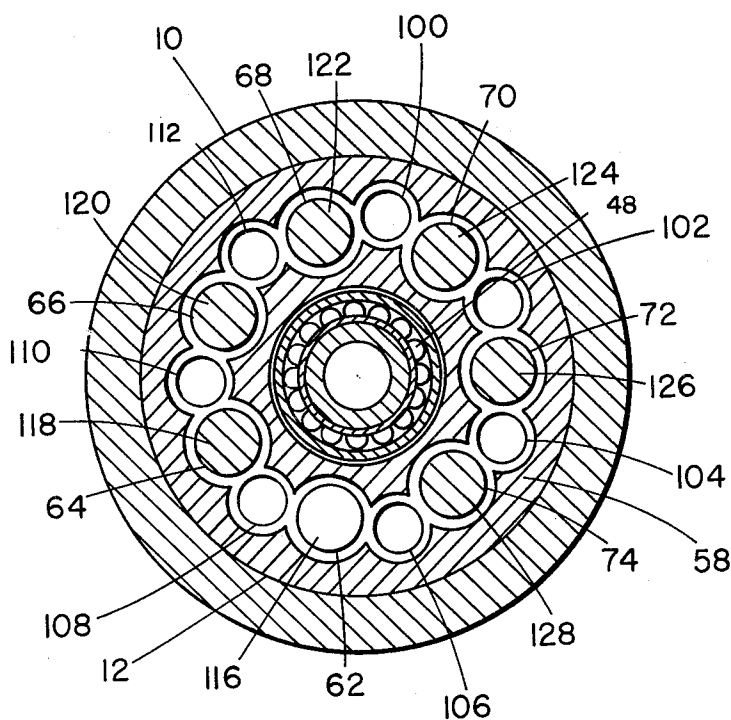


FIG. 2

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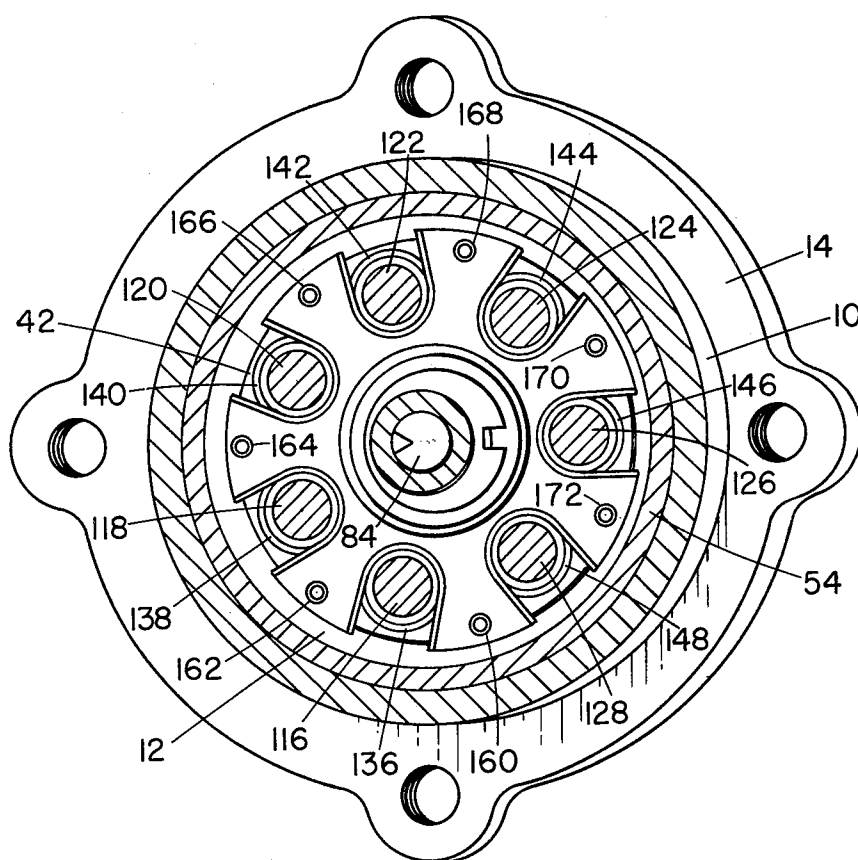


FIG. 3

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PISTON PUMP

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7 Claims. (Cl. 103-173)

This invention pertains to a piston pump, and more particularly, to a piston pump which achieves higher efficiencies than the heretofore known piston pumps.

Prior known piston pumps utilize a plurality of pistons which are driven by socketed shoes which slide over the surface of an inclined thrust plate and which are bearing-supported upon a collar-like element for universal action. Such pumps frequently have a large amount of friction which lowers their efficiency.

In the interest of efficiency, the device contemplated by this invention utilizes a floating collar which is lubricated at the bearing surfaces where the collar is supported and where the collar contacts a spider element which is adapted to retract the pistons. Because the collar of the device of this invention is floating, the relative velocities between the collar and its adjacent members are decreased which thereby decreases the friction loss, decreases the amount of heat generated at the collar surface, and therefore, decreases the amount of heat which must be removed from the interior of the pump.

It is, therefore an object of this invention to provide a new and improved piston pump.

It is another object of this invention, and a more specific one, to provide a novel piston pump which is adapted to pump liquids and gases with a decrease in friction and a consequent higher efficiency.

It is another object of this invention to provide a fluid piston pump which utilizes a floating collar as a bearing member for supporting the spider used for retaining and retracting the piston slipper shoes.

It is yet another object of this invention to provide a novel piston pump which has a unique piston retaining and retracting member which utilizes a floating collar and, a novel spacing element.

More specifically, it is an object of this invention to provide a piston pump which is driven by a rotatable shaft, wherein a plurality of pistons are symmetrically distributed about the axis of said shaft and are axially aligned for reciprocating motion relative to said shaft, and further, wherein said pistons are reciprocated by a plurality of socketed shoes which are adapted to engage spherical-shaped ends of said pistons and which are mounted to slide over a thrust surface of a swash plate to provide piston action due to the eccentricity of said swash plate, and which has a retracting spider bearing-mounted upon a floating collar for radial support.

Other objects will become apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a longitudinal view, partially in section, of a typical piston pump which is constructed in accordance with this invention;

FIG. 2 is a view, partially in section, taken at 2-2 in FIG. 1; and

FIG. 3 is a view, partially in section, taken at 3-3 in FIG. 1.

In the figures, pump housing 10 is adapted to receive pump sub-assembly 12, which is of the general shape of a circular cylinder adapted to fit concentrically into housing 10. Pump housing 10 has a flange 14 which is adapted to be connected to the frame of a prime mover, such as, for example, an electric motor (not shown). In the end of housing 10, opposite flange 14, conduit means 16 is

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adapted to receive low pressure fluid. Conduit means 18 and 20 are connected to conduit means 16 and are adapted to carry low pressure fluid to fluid joint 22 between housing 10 and pump sub-assembly 12. A plurality of recesses or chambers, such as chamber 24, are symmetrically spaced about the axis of conduit 20 and are adapted to inclose a plurality of check valves (such as check valve 76). Each check valve is spring loaded into its closed position by means of a coil spring (such as spring 78). Each of the check valve chambers (such as chamber 24) are connected together by an annular space 26 which is connected through conduit 28 to a high pressure fluid connecting member 30.

Pump sub-assembly 12 is adapted to slide into pump housing 10 and is retained by means of screw 32. The axis of symmetry of housing 10 and the axis of symmetry of pump sub-assembly 12 are co-axial. This axis is shown at 34. Sealing means between pump sub-assembly 12 and housing 10 are provided by O rings 36, 38 and 40.

Circumferential positioning of sub-assembly 12 relative to housing 10 is accomplished by means of a positioning pin (not shown) projecting from sub-assembly 12 into a pre-positioned socket (not shown) in housing 10. Housing 12 must be circumferentially aligned so that the piston cylinders of assembly 12 are coaxial with their associated check valves in housing 10.

Pump sub-assembly 12 has a swash plate assembly 42 which is mounted upon bearings 44, 46 and 48 for rotation about axis 34. Shaft 50 is splined to swash plate assembly 42 at 52.

A generally cylindrically-shaped bearing retainer 54 is adapted to hold bearings 44 and 46 in position and is held in place by back-up washer 56 and threaded locking ring 32.

Piston block 58 is pinned to bearing retainer 54 by means of pin 60. Piston block 58 has a plurality of piston cylinders symmetrically circumferentially disposed relative to axis 34, equal in number to the number of recessed chambers (such as chamber 24) in pump housing 10, as shown more particularly in FIG. 2 at 62, 64, 66, 68, 70, 72 and 74.

Each of the cylinders in piston block 58 extends there-through and communicates with annular conduit 26 through its respective check valve.

Conduit 80 is connected to receive low pressure fluid from conduit 20 and has auxiliary conduits (such as conduit 82) which are adapted to deliver oil to bearing 48 and to deliver fluid to chamber 88. Conduit 80 connects with conduit 84 in swash plate assembly 42 which in turn connects to conduit 86 to deliver fluid into chamber 88. Auxiliary conduits (such as conduit 90) deliver lubricating fluid from conduit 84 to the inner surface 92 of collar 94. Thus collar 94 is caused to float upon inclined bearing surface 92 relative to right circular cylindrical shank 91 of swash plate assembly 42 and does not turn therewith. Retaining ring 96 retains collar 94 on the cylindrical bearing surface 92 of swash plate assembly 42.

The center of curvature 174 of spherical zonal bearing surface 154 is located at the intersection of the axis of rotation 34 and the axis of shank 91. This causes the cylinder 91, which defines the bearing surface 92, to be eccentric to the swash plate center line 98. The center of the hub diameter of bearing surface 92 is axially centered with respect to the pistons at all times during their oscillatory motion.

A plurality of cylindrical conduits 100, 102, 104, 106, 108, 110, and 112 are drilled in piston block 58 between chamber 88 and connecting conduit 114 (shown more particularly in FIG. 2). Conduit 114 connects to supply low pressure fluid to piston cylinders 62, 64, 66, 68, 70, 72 and 74.

Associated with each of the piston cylinders 62, 64, 66, 68, 70, 72 and 74 is one of a plurality of piston members 116, 118, 120, 122, 124, 126 and 128. The driving end of each piston has a ball, such as ball 130, shown in FIG. 1, which is adapted to be grasped by a shoe. A plurality of shoes are disposed about the axis of shank 91, supported upon the slipper thrust bearing surface 132 of swash plate assembly 42. There is a shoe, such as shoe 134, associated with each piston 116, 118, 120, 122, 124, 126 and 128, as shown more particularly in FIG. 3. In FIG. 3, shoes 136, 138, 140, 142, 144, 146 and 148 engage the ball ends of pistons 116, 118, 120, 122, 124, 126 and 128 respectively. A plane which passes through the center of the balls on all of the pistons, and hence through the center of force applied to each piston, passes through point 174 to force-balance the moving parts.

Spider 150 engages the shoulder (such as shoulder 152 of shoe 136) of each of shoes 136, 138, 140, 142, 144, 146 and 148 to retain and to retract them during the return stroke of the pistons. Spider 150 floats freely upon spherical bearing surface 154, which is lubricated through a plurality of channels circumferentially disposed relative to the axis of shank 91 about the periphery of collar 94. Two of these channels 156 and 158 are shown in FIG. 1. Thus the surface 154 is also a floating one. The difference in velocity between spider 150 and shank 91 is divided between surfaces 92 and 154. A plurality of spacing buttons 160, 162, 164, 166, 168, 170 and 172 are symmetrically disposed about the axis of shank 91, and are adapted to fit between spider 150 and bearing surface 132 of swash plate assembly 42 to maintain proper clearance therebetween.

The spacing, which is adjusted by the buttons (such as spacing button 168), is of a predetermined dimension to cause spider 150 to clear those piston shoes that are starting or performing the pumping function and to prevent spider 150 from tipping or cocking to pinch the piston shoe when the piston shoe is retracted. Further, the clearance provided by the buttons prevents spider 150 from transmitting a binding or braking reaction force to swash plate 42.

In operation, low fluid pressure which appears at conduit 16 communicates through conduits 18, 20, 80, 84 and 86 to chamber 88. Chamber 88 communicates through conduit 100 and annular chamber 114 to pistons 116, 118, 120, 122, 124, 126 and 128. Rotation of shaft 50 rotates swash plate assembly 42 which in turn causes pistons 116, 118, 120, 122, 124, 126 and 128 to consecutively move from one end to the other of their stroke by means of forces which are exerted through the centers of their ball ends by shoes 136, 138, 140, 142, 144, 146 and 148, respectively, and by spider 150.

The manner of operation of a piston may be described in connection with the operation of piston 116 in FIG. 1. In FIG. 1 when piston 116 moves to the right it picks up a certain amount of fluid from chamber 114 and compresses it thereby opening check valve 76 to deliver high pressure fluid into annular chamber 26. From annular chamber 26, the fluid then passes through conduit 28 to high pressure fitting 30.

Because collar 94 is floating, the linear velocity across the surface of bearing surface 154 and bearing surface 92 is relatively small compared to what it would be if only one surface were floating. Thus the floating collar device 94 cuts down the friction effect in the pump to thereby increase the efficiency thereof and decrease the amount of heat which must be removed from the interior of the pump.

There has thus been provided a novel piston pump which has certain new and useful features for balancing forces, and the like, and for reducing friction to thereby increase the efficiency of the pump.

Although the pump of this invention has been particularly described, it is not intended that the description

should be limiting, but that the invention should only be limited by the following claims.

I claim:

1. A piston pump comprising: a rotatable shaft; a swash plate assembly attached to rotate with said shaft; a stationary piston block including a plurality of piston cylinders uniformly and symmetrically circumferentially disposed about the axis of said shaft; a plurality of pistons equal in number to said cylinders, connected to reciprocate in said cylinders in a direction parallel with the axis of said shaft; conduit means positioned to supply fluid to be compressed to said pistons; second conduit means positioned and adapted to receive high pressure fluid from said pistons; a plurality of slipper shoes equal in number to said pistons, positioned to slide relative to said tilted swash plate, and adapted to reciprocate said pistons through universal joint-type connections thereto; a spider member, spaced from said swash plate, positioned and adapted to retract said shoes and said pistons; a plurality of spacers located on said spider member spaced between said shoes and extending from said spider member so as to prevent said spider member from pinching said shoes when said shoes are retracted; a circular cylindrical shank attached to said swash plate with its axis normal to the surface of said swash plate and at an angle relative to the axis of said shaft; a lubricated floating collar positioned between said spider member and said shank, having a right circular cylindrical lubricated inner surface adapted slidably to engage said shank and a spherical zonal outer surface which is lubricated by centrifugal action through passages extending radially through said collar and which is adapted slidably to engage said spider member, the center of curvature of said spherical zonal surface being at the point of intersection between the axis of said shaft and a plane passing through the centers of force application between said slipper members and said pistons, and wherein said spider member contacts said collar at an area wherein the cross-sectional distance is less than the maximum diameter of said collar, said area of contact being adjacent said plane, and a collar retaining means positioned on said shank.

2. In a piston pump having a rotatable shaft and a plurality of reciprocating pistons, and further including fluid conduit means adapted to cooperate with said pistons to generate a high pressure fluid, the improvement comprising: a swash plate having a right circular cylindrical shank whose axis intersects the axis of rotation of said shaft at a point which coincides with a plane which passes through the centers of force application to said pistons; means for applying force to said pistons, adapted to slide on a thrust surface of said swash plate which is in a plane normal to the axis of said shank; spider means spaced from said thrust surface, adapted to retract said pistons; a plurality of spacers located on said spider member and spaced between said means for applying force to said pistons and extending from said spider member so as to prevent said spider member from pinching said means for applying force to said pistons; and a floating lubricated collar having a lubricated right circular cylindrical inner surface positioned and adapted slidably to engage the surface of said shank and having a spherical zonal outer surface which is lubricated by centrifugal action through passages extending radially through said collar, the center of curvature of said zonal surface coinciding with the intersection of the axis of said shank and the axis of said shaft, and wherein said spider means contacts said collar at an area wherein the cross-sectional distance is less than the maximum diameter of said collar, said area of contact being adjacent said plane, and a collar retaining means positioned on said shank.

3. In a piston pump adapted to be driven by a rotatable shaft and having fluid conduits operatively associated with the pistons of said pump to compress fluid, the improvement therein comprising: an eccentric swash plate having a thrust surface operatively connected through a

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plurality of sliding shoes to provide compressive forces to the pistons of said pump, the thrust surface of said swash plate being inclined relative to the axis of said shaft of said pump to provide a timed sequence of motion of said pistons, said swash plate having a shank whose axis is normal to said thrust surface and whose axis intersects the axis of said shaft at the point of intersection between the axis of said shaft and a plane which passes through the centers of force applied to each piston; spider means adapted to retract said shoes and spaced apart from said thrust surface; a plurality of spacers located on said spider member spaced between said shoes and extending from said spider member so as to prevent said spider member from pinching said shoes when said shoes are retracted; and floating collar means having a lubricated right circular cylindrical inner surface adapted to engage said shank and a spherical zonal surface on the exterior thereof adapted to engage said spider; and means for centrifugally lubricating the spherical surfaces of said collar, and wherein said spider means contacts said collar at an area wherein the cross-sectional distance is less than the maximum diameter of said collar, said area of contact being adjacent said plane, and a collar-retaining means positioned on said shank.

4. In combination: a pump housing; a shaft rotatably supported relative to said housing upon a first end of said housing; first conduit means upon the second end of said housing adapted to receive low pressure fluid and to channel said fluid along the axis of said shaft, thence into an interior chamber formed by said housing; a piston block, stationary with respect to said housing and having a plurality of piston cylinders uniformly and symmetrically circumferentially distributed about the axis of said shaft; at least one communicating conduit between said chamber and said piston cylinders; a plurality of pistons positioned within said piston cylinders for reciprocating action parallel to the axis of said shaft and positioned to receive fluid through said communicating conduit when in their retracted position, said pistons having a universal ball joint on their ends directed toward said shaft; a plurality of check valves equal in number to said pistons and positioned to engage the discharge end of said piston cylinders; a high pressure conduit connected between said check valves and the exterior of said pump housing to supply high pressure fluid; a swash plate connected eccentrically to rotate with said shaft and having a thrust surface which is inclined relative to the axis of said shaft, said swash plate having a right circular cylindrical shank extending normal to said thrust surface with its axis intersecting the axis of rotation of said shaft at the point of intersection between the axis of rotation of said shaft and a plane which passes through the center of curvature of said ball universal joints; a plurality of slipper shoe members adapted to slide over said thrust surface and to universally engage said universal ball joints to supply thrust to said piston members; a spider member spaced relative to said thrust surface, adapted to engage said shoes to retract said shoes and said pistons; a plurality of spacers

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located on said spider member spaced between said shoes and extending from said spider member so as to prevent said spider member from pinching said shoes when said shoes are retracted; and a lubricated collar having a lubricated right circular cylindrical surface on the interior thereof slidably engaging the outer surface of said shank and a lubricated spherical zonal outer surface which is lubricated by centrifugal action through passages extending radially through said collar and which is adapted to slidably support said spider and having its center of curvature at the point of intersection between the axis of said shank and the axis of rotation of said shaft, and wherein said spider member contacts said collar at an area wherein the cross-sectional distance is less than the maximum diameter of said collar, said area of contact being adjacent said plane, and a collar-retaining means positioned on said shank.

5. A device as recited in claim 4 and further comprising means for lubricating all moving parts of said pump.

6. A device as recited in claim 5 in which said means for lubricating moving parts of said pump comprises conduit means connected to said first conduit.

7. In a piston pump adapted to be driven by a rotatable shaft and having fluid conduits operatively associated with the pistons of said pump to compress fluid, and having an eccentric swash plate adapted to operatively engage the pistons of said pump through a plurality of sliding shoes, said swash plate having a cylindrical shank at right angles to the surface of said swash plate and a spider adapted to retract said pistons, the improvement comprising: a floating collar having a lubricated right circular cylindrical inner surface adapted to engage said shank and a centrifugally lubricated spherical zonal surface on the exterior thereof adapted to engage said spider; a plurality of spacers located on said spider member spaced between said shoes and extending from said spider member so as to prevent said spider member from pinching said shoes when said shoes are retracted; and means for lubricating the surfaces between said collar and said shank and between said collar and said spider.

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