Sept. 2, 1947. E. K. BENEDEK 2,426,588

PUMP OR MOTOR

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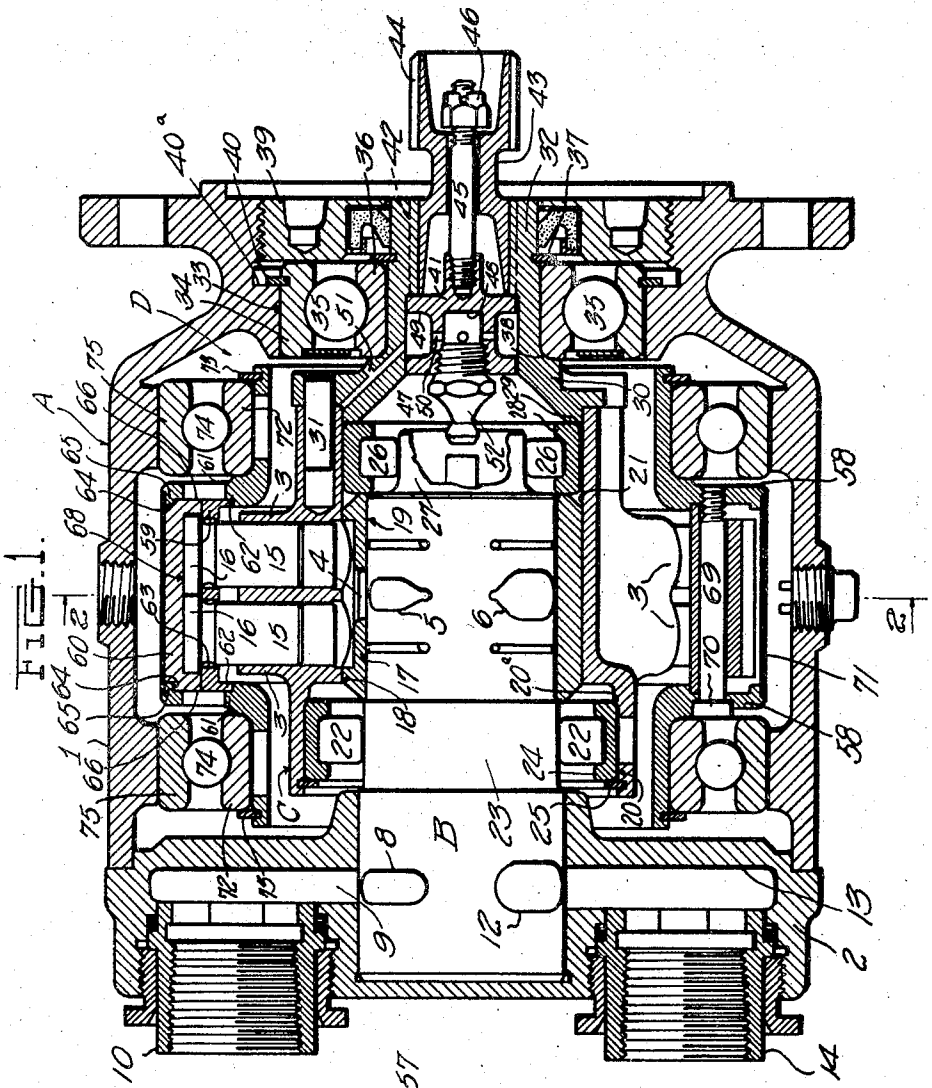


FIG. 1.

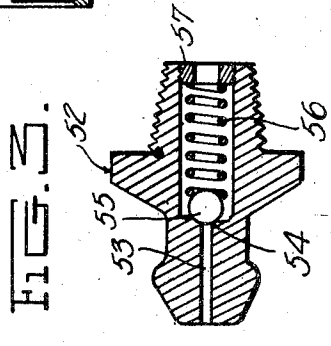


FIG. 3.

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PUMP OR MOTOR

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FIG. 2.

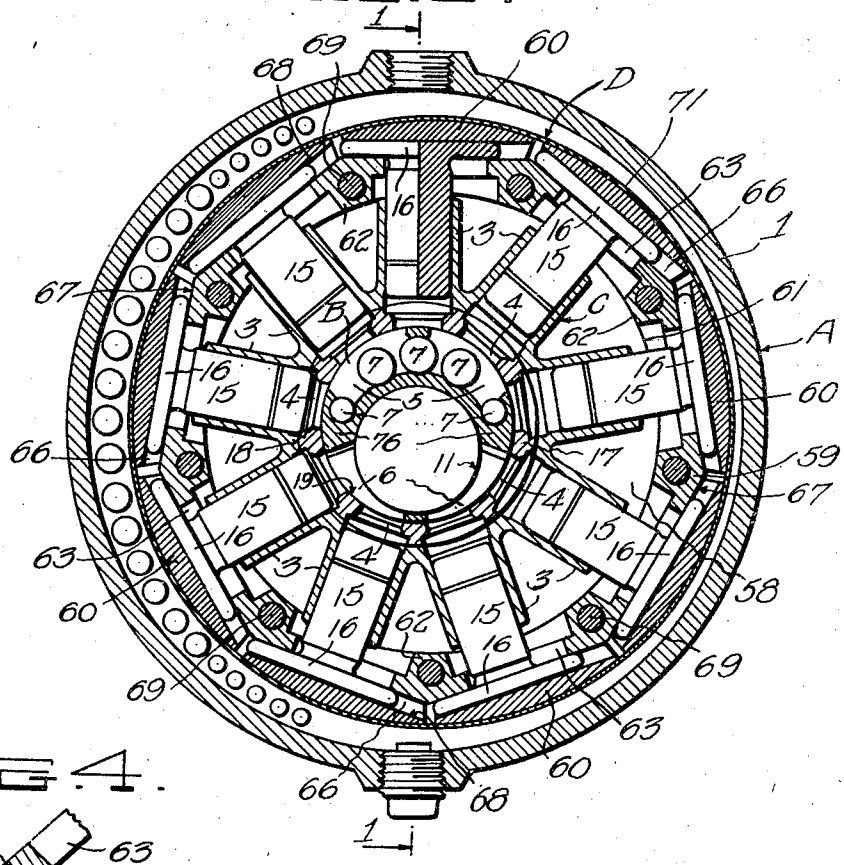


FIG. 4.

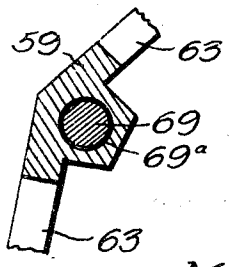
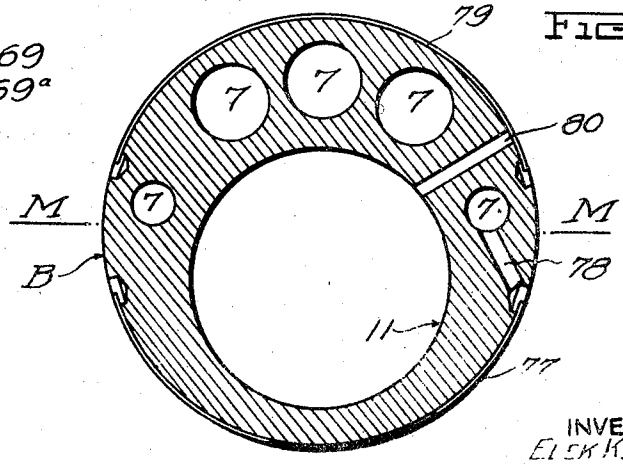


FIG. 12.



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PUMP OR MOTOR

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FIG. 5.

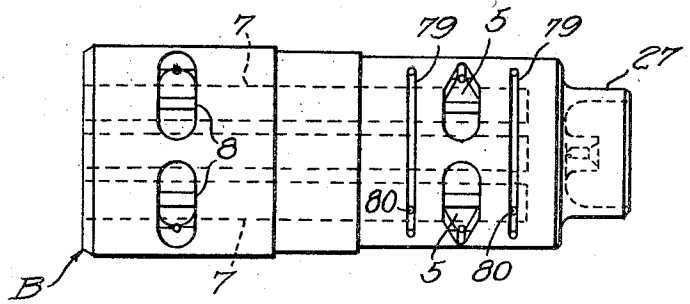


FIG. 6.

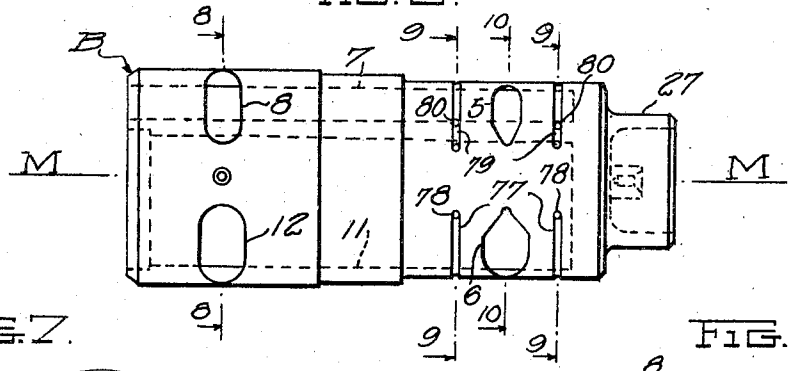


FIG. 7.

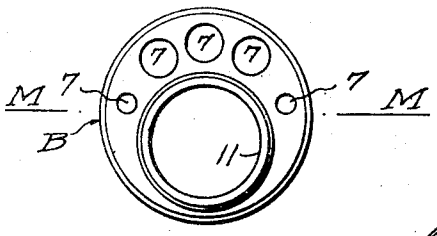
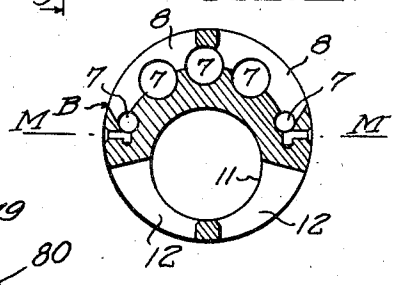


FIG. 8.



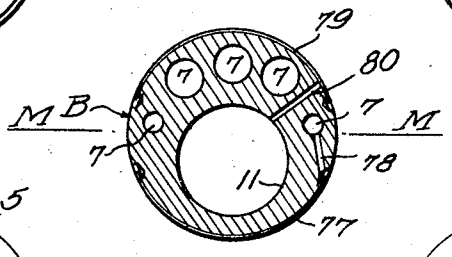


FIG. 9.

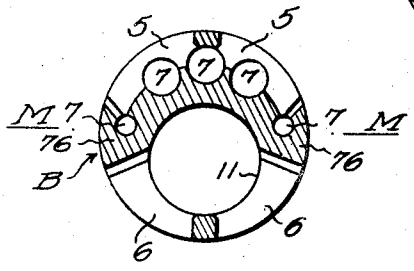


FIG. 10.

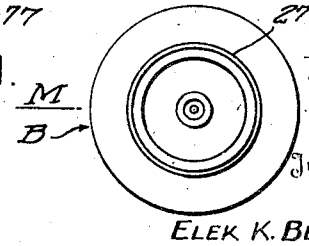


FIG. 11.

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PUMP OR MOTOR

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FIG. 13.

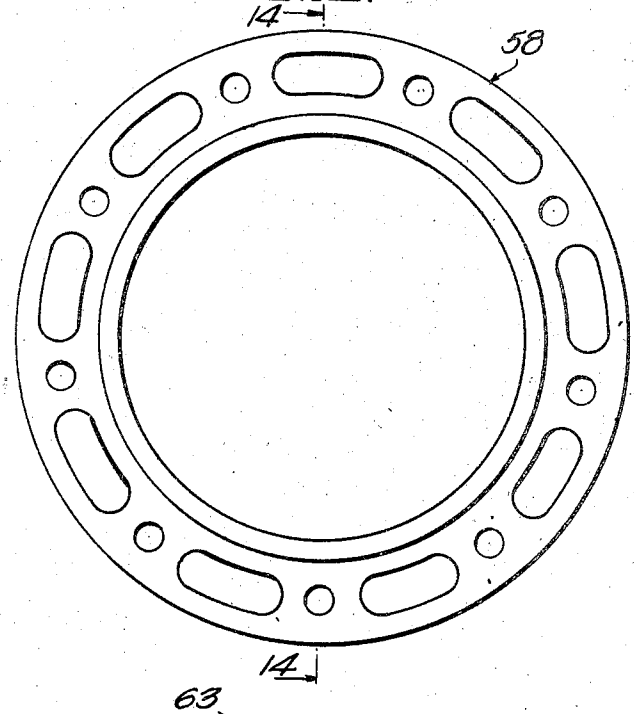
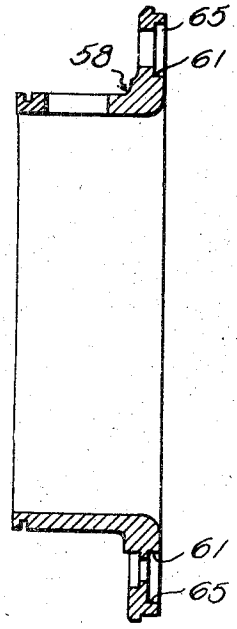


FIG. 14



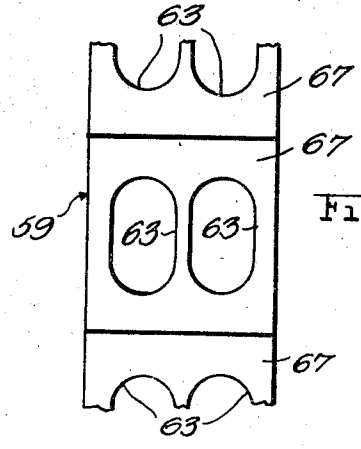


FIG. 15.

FIG. 18

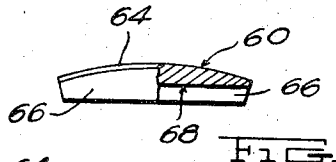


FIG. 19

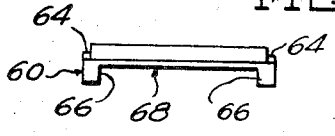
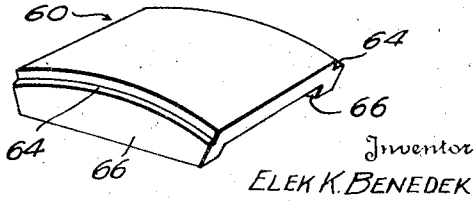


FIG. 20



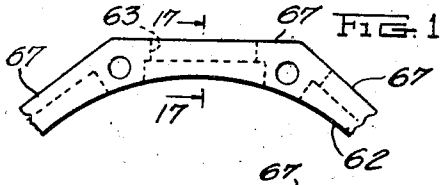


FIG. 16

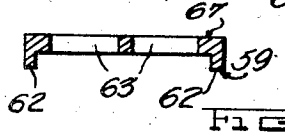


FIG. 17

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Patented Sept. 2, 1947

2,426,588

UNITED STATES PATENT OFFICE

2,426,588

PUMP OR MOTOR

Elek K. Benedek, Chicago, Ill.

Application February 6, 1945, Serial No. 576,408

26 Claims. (Cl. 103—161)

1

This invention relates to pumps or motors and more particularly to hydraulic pumps of motors of the kind including a cylinder barrel rotatable about a fixed pintle and in which pistons reciprocable in circumferentially spaced radial cylinders on the barrel are operated by thrust-transmitting means engageable with a reactance member or assembly eccentric to the pintle axis.

An object of the invention is to provide structural improvements in a pump or motor of the class referred to by which the machine is made capable of operating with increased reliability and efficiency and at very high working pressures.

Another object of the invention is to provide a pump or motor having these desirable characteristics and which is of light, compact construction.

Another object of the invention is to provide a pump or motor of the character referred to including new and improved means for lubricating a bearing interposed between the cylinder barrel and the casing for journaling the cylinder barrel and anchoring it against axial shifting.

Another object of the invention is to provide an improved reactance member which can easily be assembled to provide perfect alignment of the component parts.

Another object is to provide such a reactance member or assembly in which new, simple, and effective means is employed for preventing the unscrewing of bolts, or screws, which fasten the parts together.

Another object of the invention is to provide a pump or motor of the character stated in which the cylinder barrel may be driven or may drive through a detachable cap adapted to be removed endwise or axially through an opening in the casing end wall to permit inspection of internal parts.

A further object of the invention is to provide a new and improved arrangement of intercommunicating ducts, passages, grooves or the like for maintaining the fluid pressure acting on the pintle surface substantially in balance around the pintle so as to avoid deflection or straining of the pintle by unbalanced fluid pressure such as usually acts on different parts of pintles of pumps or motors of the kind in which the invention may be embodied.

Other objects of the invention will become apparent from a reading of the following detailed description, the appended claims, and the accompany drawings, in which:

Figure 1 is a longitudinal section of a hydraulic pump or motor embodying the invention,

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the section being taken on the line 1—1 of Figure 2;

Figure 2 is a transverse section on the line 2—2 of Figure 1;

Figure 3 is a longitudinal section of a check valve drawn on an enlarged scale;

Figure 4 is a fragmentary detail section of a part of a reactance motor assembly showing particularly the relation of a clamping bolt to polygonal reactance ring.

Figure 5 is a plan view of a pintle as viewed from above in both of Figures 1 and 2;

Figure 6 is a front elevation of the pintle as viewed from the left in Figure 2;

Figure 7 is an end elevation of the pintle as viewed from the left in Figure 6;

Figure 8 is a transverse section of the pintle on the line 8—8 of Figure 6;

Figure 9 is a transverse section of the pintle on either of the lines 9—9 in Figure 6, the pintle section being the same in the planes denoted by both of the lines 9—9;

Figure 10 is a section of the pintle on the line 10—10 of Figure 6;

Figure 11 is an end elevation of the pintle as viewed from the right of Figure 6;

Figure 12 is a view the same as Figure 9 but drawn on an enlarged scale;

Figure 13 is an elevation of a reactance end plate;

Figure 14 is a section on the line 14—14 of Figure 13;

Figure 15 is a fragmentary elevation of a polygonal inner reactance ring as viewed when looking directly upon one of a plurality of flat thrust-transmitting surfaces;

Figure 16 is an edge view of the structure shown in Figure 15;

Figure 17 is a section on the line 17—17 of Figure 16;

Figure 18 is a detail view showing an outer thrust-transmitting block; partly in section and partly in elevation;

Figure 19 is a view of the thrust block looking from one end of Figure 18; and

Figure 20 is a perspective view of the thrust block shown in Figures 18 and 19.

The embodiment shown in the drawings comprises a pump casing generally designated A and including a cylindrical body portion 1 and a manifold cover plate 2 mounted at the open end of the body 1 and clamped and held in assembled relation to the body 1 by bolts or other suitable means (not shown). The end cover 2 supports one end of a pintle B which extends into the cas-

ing and is surrounded by a rotatable cylinder barrel member C provided with two sets of circumferentially spaced radial cylinders 3. Cylinder ports 4 communicating with the cylinders 3 are adapted to cooperate in a known manner with pintle discharge ports 5 and intake ports 6. The pintle discharge ports 5 communicate with discharge passages 7 extending longitudinally within the pintle to radial discharge passages 8 in constant communication with a chamber 9 in the manifold plate 2, the chamber 9 being adapted to communicate with exterior piping fitted to a connection 10. Similarly, the pintle intake ports 6 communicate with a large intake passage 11 extending longitudinally through the pintle and being connected to radial passages 12 which communicate with a manifold intake chamber 13 adapted to communicate with outside piping through a connection 14.

Pistons 15 mounted for reciprocation in the cylinders 3 respectively are formed or equipped with tangential cross heads or thrust-transmitting connections 16 adapted to have rotary drive and thrust-transmitting connection with a reactance ring member or assembly D, the construction of which will be explained later. For the present it is sufficient to state that the reactance ring assembly D is mounted for rotation about an axis eccentric to the common axis of the pintle and cylinder barrel.

In operation, the cylinder barrel C is rotated about the pintle B whereby the pistons 15 and the cross heads 16 impart rotary drive to the reactance ring assembly D and, due to the eccentricity of the assembly D, the pistons are reciprocated. The registration of the cylinder ports 4 with the pintle ports 5 and 6 is so timed with respect to the in-and-out travel of the pistons that fluid is drawn in to the cylinders during outward strokes of the pistons and is forced from the cylinders when the pistons move in. This mode of operation as generally described thus far is well known to those familiar with pumps or motors of the rotary, radial cylinder, eccentric reactance class.

The cylinder barrel C is provided with a sleeve or bushing 17 which is press fitted into a central bore 18 in the cylinder barrel and preferably is formed of the same material, e. g., steel, as the cylinder barrel so as to provide for equal expansion and contraction in response to temperature changes. A bore 19 in the sleeve 17 and counterbores 20 and 21 at the ends of the cylinder barrel C preferably are finished machined after the sleeve 17 has been fitted into the bore 18. The bore 19 in the sleeve 17 is of such diameter as to provide a close operating clearance space between the wall of the bore and the pintle B.

The cylinder barrel C is antifrictionally mounted on the pintle B for rotation about the pintle axis. At the left hand end of the cylinder barrel C, as viewed in Figure 1, the barrel is mounted by a roller bearing assembly including a set of rollers 22 directly engaging a pintle race section 23, and an outer race 24 press fitted into the barrel counterbore 20. A snap ring 25 abutting the outer end face of the race 24 holds the opposite end face against a shoulder 20a at the inner end of the counterbore 20.

At its right hand end the cylinder barrel C is mounted on the pintle by a roller bearing assembly including a set of rollers 26 directly engaging a reduced diameter pintle race section 27, and an outer race 28 press fitted in the counterbore 21. The right hand end of the cylinder barrel sleeve 17 provides a radial shoulder projecting inwardly towards the axis of the bore 19 and facing towards the right hand end of the cylinder barrel C. The inner bearing race 28 is held in abutment with this shoulder by a shoulder 29 on a barrel end cap 30 detachably secured to the cylinder barrel C by screws or suitable fastenings (not shown) and located with respect to the cylinder barrel by means of a pin 31.

The barrel end cap 30 is formed with a journal extension 32 which projects in axial alignment with the pintle and extends through an opening 33 in the adjacent end of the casing. The wall of the opening 33 is larger in diameter than the barrel end cap 30 so as to permit the cap to be inserted into the casing axially with respect to the pintle in assembling, and to be removed from the casing for inspection of bearings or other internal parts.

Although the cylinder barrel C is mounted for rotation by bearings interposed between the barrel and the pintle, it is desirable also to provide bearings between a part of the cylinder barrel, for example the end cap 30, and the casing. In the form shown, a ball bearing assembly interposed between the journal extension 32 and the casing body 1 includes an outer race 34 surrounding and fitting the journal 32, a set of balls 35, and an inner race 36 fitted within the wall of the casing opening 33. A snap ring 37 attached to the journal extension 32 abuts the inner race 36 and holds it against a shoulder 38 on the end cap 30. The outer race 34 is held against axial movement by a ring nut closure 39 screwed into the end of the casing body 1 so as to press a snap ring 40 attached to the outer race 34 into mutual engagement with a shoulder 40a formed in the casing body 1.

The journal extension 32 is hollow and is closed adjacent its inner end by a plug 41. The outer end of the journal extension 32 is splined as at 42 to receive the splined inner end of a coupling 43, the outer end of which is splined as at 44 for engagement with an internally splined coupling part of a prime mover (not shown). A screw 45 anchored in the plug 41 extends through the coupling 43 and is provided with a nut 46 for preventing separation of the coupling 43 from the journal extension 32.

In operation, fluid is forced under high pressure from the cylinders 3, constituting a source of lubricant, through the cylinder ports 4 and thence out through the pintle discharge ports 5 and passages 7. Some of the high pressure fluid will be forced into the clearance space between the pintle B and the bore 19 and will work its way along the pintle in both directions so as to lubricate the antifriction bearings 22, 24 and 26, 28. Slip fluid which has worked toward the right past the bearing 26, 28 will collect in an inner lubricant chamber 47 defined by the free end of the pintle B and the wall provided by the end cap 30 and the plug 41. In accordance with the invention means are provided for maintaining a supply of lubricating fluid in the chamber 47 and for delivering lubricant from this chamber directly to the bearing assembly 34, 35, 36. In the illustrative embodiment this is accomplished by providing the plug 41 with a hollow portion or recess 48 communicating with an outer circumferential plug groove 49 by way of a plurality of radial passages 50, the barrel groove 49 being arranged to deliver lubricant through a lubricant passage 51 which discharges lubricant directly on the bearing assembly 34, 35, 36.

Preferably, communication between the inner

lubricant chamber 47 and the outer lubricant chamber constituted by the plug recess 48 and groove 49 is controlled by a valve 52 adapted to permit lubricant to flow from the inner chamber 47 to the outer chamber 48, 39 but not reversely. During pressure strokes, slip fluid from the barrel-pintle clearance will work into the chamber 47 and build up a supply of lubricant under pressure regulated and maintained by the relief valve 52 which opens automatically when a predetermined pressure is reached. During suction strokes, when there is no pressure slip from the cylinders through the barrel-pintle clearance, the fluid under pressure in the chamber 47 is available for lubrication. The valve shown is of conventional construction and includes a passage 53 terminating in a valve seat 54 adapted to be closed by a ball valve 55 urged toward the seat by a spring 56 held in place by an apertured nut 57.

When the pump is running the pressure of the slip fluid contained in the inner chamber 47 will build up so as to open the valve 52, whereupon fluid will flow into the outer chamber 48, 49 and thence through the passage 51 so as to be discharged directly upon the bearing assembly 34, 35, 36. The fluid contained in the outer chambers 48, 49 is whirled around rapidly so as to be under centrifugally created pressure resulting in its being delivered effectively upon the bearing assembly. When the pump stops the valve 52 closes so as to prevent back draining of the lubricant from the outer chamber 48, 49 thus assuring that the bearing assembly 34, 35, 36 will be lubricated effectively immediately upon starting of the pump.

The reactance assembly D comprises two similar spaced end plates 58, an integral polygonal inner reactance ring member 59, and a plurality of individual outer thrust transmitting blocks 60, all of which parts are held together securely to form a solid sub-assembly. The end plates 58 are formed with inner circumferential seats 61 surrounded and engaged respectively by axially spaced circumferential portions 62 on the inner ring 59. Openings 63 in the ring 59 freely accommodate the end portions of the pistons 15 which project beyond and clear of the cylinders 3.

The outer thrust transmission blocks 60 are formed with axially spaced arcuate portions 64 which are located radially within and which are engaged by outer circumferential seats 65 on the respective end plates 58. Radial spacing flanges 66 on the blocks 60 engage inner tangential thrust transmitting surfaces 67 on the polygonal ring 59 so that the blocks 60 are held between the flat surfaces 67 on the ring 59 and the outer circumferential seats 65 on the end plates 58. This provides perfect parallel alignment between tangential outer thrust transmitting surfaces 68 on the blocks 60 and the respectively associated inner thrust transmitting surfaces 67 on the ring 59.

The end plates 58, the ring 59 and the blocks 60 are held in secure assembly by a plurality of circumferentially deployed bolts or screws 69 having threaded engagement with the right hand end plate 58 and having their heads 70 exposed at a radial surface at the left hand end plate as shown in Figure 1. The screws 69 draw the end plates 58 towards each other to clamp the polygonal ring 59 and the thrust blocks frictionally. A shroud ring 71 extends around the blocks 60 and overlaps the adjacent portions of the end plates 58 so as to provide a continuous outer enclosing wall for the assembly D.

Substantial clearance 69a is provided between

the bolts 69 and the accommodating holes through the polygonal ring 59 so as to provide for flexibility and ease of assembling. This is permissible because the outer thrust transmitting surfaces 68 of the blocks 60 are maintained in perfect parallelism with the respectively associated inner thrust transmitting surfaces 67 by means of the spacing flanges 66 on the blocks 60 which directly engage the inner thrust transmitting surfaces 67. The outer thrust transmitting surfaces on the blocks 60 and the inner thrust transmitting surfaces 67 on the ring 59 respectively engage the outer and inner thrust transmitting faces of the cross heads.

The reactance assembly D is journaled for rotation about an axis eccentric to the common axis of the pintle B and cylinder barrel C. In the construction illustrated the assembly D is journaled in the casing by antifriction bearings interposed between the two ends of the assembly D and the casing body 1. Each of these antifriction bearings includes an inner race 72 held on the associated end plate 58 by a snap ring 73, a set of balls 74, and an outer race 75 fitted into the casing itself. The inner race 72 of the left hand bearing 72, 74, 75 abuts the heads 70 of the bolts or screws 69 so as to prevent them from working loose by unscrewing.

It will be seen that the bearing assembly 34, 35, 36 previously described anchors the cylinder barrel C against axial shifting. Consequently the manifold cover 2 and pintle B may be removed as a unit endwise and to the left from the casing body 1 when it is desired to inspect the pintle. Removal of the cover 2 and pintle B also will permit inspection of the left hand pintle bearing 22—24. The pintle bearing 26, 28 may be exposed for inspection by removing the ring nut 39, bearing assembly 34, 35, 36 and cylinder barrel end cap 30 axially toward the right. Thus the pintle and the pintle bearings, which are subjected to the hard service, may be inspected quite easily without any major disassembling of the pump.

In order to remove the bearing assembly 26, 28, the ring nut 39 is removed, the snap ring 37 taken off, and the entire rotatable assembly is removed from the casing endwise toward the left as viewed in Figure 1, together with the pintle B and end cover 2. The bearing 26, 28 is then radially accessible.

When the pump is operating to deliver under high pressure, the cylinder and piston assemblies 3—15 which communicate with the discharge ports 5 exert very high fluid pressure on one side of the pintle B (the top side as viewed in Figure 2) whereas the other side of the pintle (the bottom side as viewed in Figure 2) is under low or negative pressure. In Figures 6 to 12 the top and bottom sides of the pintle are shown divided by a median plane M—M which passes through bridge portions 76, 76 located on opposite sides of the pintle between the high pressure ports 5 and the low pressure ports 6. Heretofore the high pressure fluid acting above the plane M—M has been an unbalanced positive pressure tending to deflect the cantilever pintle downwardly. Although, in the pump shown in the drawings, the free end of the pintle is supported through the bearing assembly 26—28, the cylinder barrel and the bearing assembly 34, 35, 36, such an unbalanced fluid pressure could cause a small amount of pintle deflection which would increase the clearance between the pintle and the sleeve bore 19 on the high pressure side of the plane M—M and decrease the clearance on

the low pressure side of the plane M—M. In accordance with the invention this tendency of the pintle to deflect so as to form unequal operating clearances on the high and low pressure sides, and to subject the pintle to strain is eliminated or minimized by balancing or substantially equalizing the fluid pressure exerted on the pintle above and below the median plane M—M. Generally stated, this is accomplished by providing means for subjecting a surface portion of the pintle B on the bottom or low pressure side of the plane M—M to pressure of the order of the pressure in the high pressure passages 7. Preferably also means is provided for subjecting a surface portion of the pintle B on the top or high pressure side of the plane M—M to pressure of the order of the pressure in the low pressure passage 11. The pressure balancing is provided by leading high pressure fluid to the clearance space between the pintle and the bore 19 below the plane M—M, and by placing the low pressure ports 6 in communication with the clearance space above the plane M—M.

In the illustrative embodiment two balancing grooves 77 are formed on the pintle surface on the low pressure side of the pintle below the plane M—M, the grooves being spaced axially from and respectively on opposite sides of the low pressure ports 6. The grooves 77, which extend circumferentially less than 180°, are in constant communication with a high pressure pintle discharge passage 7 by means of balancing passages 78 extending through the pintle structure. High pressure fluid in the pintle passages 7 will act through the balancing passages 78 to maintain high pressure fluid in the balancing grooves 77 on the low pressure side of the pintle. The pressure fluid in the grooves 77 will spread axially from both sides of the grooves so as to compensate for the low pressure of the fluid in contact with the pintle immediately adjacent the pintle ports 6.

On the top or high pressure side of the plane M—M the pintle is formed with two balancing grooves 79 which are connected by balancing passages 80 extending through the pintle structure to the suction or low pressure passage 11. The zone of low pressure fluid thus created at and adjacent the grooves 79 tends to balance the high pressure acting on the pintle immediately adjacent the discharge ports 5. I have found that this fluid balancing of the pintle not only results in less wear on the pintle bearings but makes it possible to operate the pump with less clearance between the pintle and the cylinder barrel bore 19 than heretofore has been advisable.

I claim:

1. In a pump or motor, a casing; a pintle mounted at one of its ends in the casing; a cylinder barrel rotatable about said pintle and having means providing an end wall spaced from the opposite end of said pintle to provide a lubricant chamber for receiving slip fluid discharged from the barrel-pintle clearance; a passage through said end wall communicating at one end with said chamber and at its other end being adapted to discharge beyond said wall; and a relief valve assembly removably mounted as a unit in said wall and being responsive to pressure for permitting fluid to flow from said chamber outwardly through said passage, but not reversely.

2. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two axially spaced end plates, an integral inner reactance ring formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust-transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks formed with tangential outer thrust-transmitting surfaces respectively engaging the outer faces of said crossheads, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions.

3. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust-transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two axially spaced end plates each formed with inner and outer circumferential seats, an integral inner reactance ring axially spaced portions of which respectively surround and engage said inner circumferential seats and said ring being formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust-transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks engaging said reactance ring and having axially spaced portions respectively radially within and engaged by said outer circumferential seats, said blocks being formed with tangential outer thrust-transmitting surfaces respectively engaging the outer faces of said crossheads, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions.

4. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust-transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two

axially spaced end plates, an integral inner reactance ring formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust-transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks formed with tangential outer thrust-transmitting surfaces respectively engaging the outer faces of said crossheads, and a plurality of circumferentially deployed clamping bolts for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions, said inner reactance ring being formed with a plurality of holes through which said bolts extend with substantial radial clearance.

5. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust-transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two axially spaced end plates each formed with inner and outer circumferential seats, an integral inner reactance ring axially spaced portions of which respectively surround and engage said inner circumferential seats and said ring being formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust-transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks engaging said reactance ring and having axially spaced portions respectively radially within and engaged by said outer circumferential seats, said blocks being formed with tangential outer thrust-transmitting surfaces respectively engaging the outer faces of said crossheads, and a plurality of circumferentially deployed clamping bolts for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions, said inner reactance ring being formed with a plurality of holes through which said bolts extend with substantial radial clearance.

6. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two axially spaced end plates, an integral inner reactance ring formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust-transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks formed with tangential outer thrust-transmitting surfaces respectively engaging the outer faces of said crossheads and being formed also with radial spacing means engaging said inner reactance ring for maintaining said outer thrust-transmitting surfaces radially spaced from and parallel to the respective inner thrust-transmitting surfaces, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions.

7. In a pump or motor, a casing; a pintle mounted in the casing; a cylinder barrel rotatable relatively to said pintle; radial cylinders in said cylinder barrel; valve means for controlling flow to and from said cylinders; pistons reciprocable in said cylinders respectively; thrust transmitting crossheads respectively on the ends of said pistons projecting clear of said cylinder barrel; and a reactance assembly mounted to rotate about an axis eccentric to the cylinder barrel axis and being cooperable with said crossheads for reciprocating said pistons when said cylinder barrel and said reactance assembly rotate, said reactance assembly comprising two axially spaced end plates each formed with inner and outer circumferential seats, an integral inner reactance ring axially spaced portions of which respectively surround and engage said inner circumferential seats and said ring being formed with openings through which said piston projecting ends respectively extend and also being formed with tangential inner thrust transmitting surfaces respectively engaging the inner faces of said crossheads, a plurality of individual outer thrust transmitting blocks engaging said reactance ring and having axially spaced portions respectively radially within and engaged by said outer circumferential seats, said blocks being formed with tangential outer thrust transmitting surfaces respectively engaging the outer faces of said crossheads and being formed also with radial spacing means engaging said inner reactance ring for maintaining said outer thrust transmitting surfaces radially spaced from and parallel to the respective inner thrust transmitting surfaces, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust blocks between said end plates and hold said reactance ring and said thrust blocks frictionally in circumferentially adjusted positions.

8. An annular reactance assembly for cooperation with the piston crossheads of a rotary cylinder barrel, radial cylinder and piston pump or motor, said assembly comprising two axially spaced end plates; an integral inner reactance ring formed with openings through which the pistons are adapted to project and also being formed with tangential inner thrust-transmitting surfaces adapted respectively to engage the inner faces of said crossheads, a plurality of individual outer thrust transmitting blocks formed with tangential outer thrust-transmitting surfaces adapted respectively to engage the outer faces of said crossheads, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust-transmitting block between said end plates and hold said reactance ring and said thrust-transmitting blocks

frictionally in circumferentially adjusted positions.

9. An annular reactance assembly for cooperation with the piston crossheads of a rotary cylinder barrel, radial cylinder and piston pump or motor, said assembly comprising two axially spaced end plates; an integral inner reactance ring formed with openings through which the pistons are adapted to project and also being formed with tangential inner thrust-transmitting surfaces adapted respectively to engage the inner faces of said crossheads, a plurality of individual outer thrust-transmitting blocks engaging said reactance ring and having axially spaced portions respectively radially within and engaged by said outer circumferential seats, said blocks being formed with tangential outer thrust-transmitting surfaces adapted respectively to engage the outer faces of said crossheads, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust-transmitting blocks between said end plates and hold said reactance ring and said thrust-transmitting blocks frictionally in circumferentially adjusted positions.

10. An annular reactance assembly for cooperation with the piston crossheads of a rotary cylinder barrel, radial cylinder and piston pump or motor, said assembly comprising two axially spaced end plates; an integral inner reactance ring formed with openings through which the pistons are adapted to project and also being formed with tangential inner thrust-transmitting surfaces respectively adapted to engage the inner faces of said cross-heads, a plurality of individual outer thrust-transmitting blocks formed with tangential outer thrust-transmitting surfaces respectively adapted to engage the outer faces of said crossheads and being formed also with radial spacing means engaging said inner reactance ring for maintaining said outer thrust-transmitting surfaces radially spaced from and parallel to the respective inner thrust-transmitting surfaces, and means for drawing said end plates axially towards each other to clamp said reactance ring and said thrust-transmitting blocks between said end plates and hold said reactance ring and said thrust-transmitting blocks frictionally in circumferentially adjusted positions.

11. In a rotary pump or motor, a casing; a rotatable cylinder barrel; a plurality of radial, circumferentially spaced cylinders; pistons reciprocable respectively in said cylinders; thrust-transmitting means on said pistons; a reactance assembly cooperable with said thrust-transmitting means and comprising axially spaced members and bolts passing through one of said members and being screwed to the other of said members, the bolt heads being exposed at a radial surface of said one of said members; means mounting said reactance assembly to rotate in said casing eccentrically to said cylinder barrel including an antifriction bearing comprising roller elements and a race fitted to said reactance assembly; and means for holding said race in abutting engagement with said exposed bolt heads for preventing said bolts from accidentally unscrewing.

12. In a rotary pump or motor, a casing; a pintle mounted at one of its ends in one end of said casing and projecting toward the other end of said casing; a cylinder barrel; means mounting said cylinder barrel for rotation about said pintle including a bearing interposed radially between the projecting end of said pintle and

the adjacent end portion of said cylinder barrel; an end cap detachably secured to said cylinder barrel end portion and engaging said bearing for holding it against axial displacement from between said pintle projecting end and said barrel end portion; an opening through said casing aligned with said end cap and being larger than said end cap whereby the latter may be removed from within said casing to provide access to said bearing; a journal extending axially from said end cap and through said casing opening; an antifriction bearing assembly in said opening and including an inner race surrounding and fitted to said journal and held against axial movement thereon in either direction, and an outer race fitted within the wall of said casing opening; mutually engaging means on the casing and the outer race for limiting movement of said outer race axially toward said one end of said casing; and a ring detachably secured to said casing and abutting said outer race for holding said outer race against movement axially away from said one end of said casing.

13. In a rotary pump or motor, a pintle; a cylinder barrel mounted for rotation relatively about the pintle axis and formed with a bore receiving said pintle with a close operating clearance between the pintle and the bore wall; radial cylinders in said barrel; high pressure port means in said pintle on one side of a median plane of said pintle; low pressure port means in said pintle on the opposite side of said median plane; pintle bridge portions located in said median plane and separating said high pressure port means from said low pressure port means; cylinder ports opening inwardly from the respective cylinders to said bore and being cooperable with said high and low pressure port means for valving flow to and from said cylinders; pistons reciprocable respectively in said cylinders; means for reciprocating said pistons in response to rotation of said cylinder barrel relatively to said pintle; a balancing passage providing communication between said low pressure port means and said operating clearance space on said one side of said median plane; and another balancing passage providing communication between said high pressure port means and said operating clearance space on said opposite side of said median plane.

14. In a rotary pump or motor, a pintle; a cylinder barrel mounted for rotation relatively about the pintle axis and formed with a bore receiving said pintle with a close operating clearance between the pintle and the bore wall; radial cylinders in said barrel; high pressure port means in said pintle on one side of a median plane of said pintle; low pressure port means in said pintle on the opposite side of said median plane; pintle bridge portions located in said median plane and separating said high pressure port means from said low pressure port means; cylinder ports opening inwardly from the respective cylinders to said bore and being cooperable with said high and low pressure port means for valving flow to and from said cylinders; pistons reciprocable respectively in said cylinders; means for reciprocating said pistons in response to rotation of said cylinder barrel relatively to said pintle; a first groove in the pintle surface between said bridge portions and on said one side of said median plane; a balancing passage providing communication between said first groove and said low pressure port means; a second groove in the pintle surface between said bridge portions and on said opposite side of said median plane; and a bal-

ancing passage providing communication between said second groove and said high pressure port means.

15. In a rotary pump or motor, a pintle; a cylinder barrel mounted for rotation relatively about the pintle axis and formed with a bore receiving said pintle with a close operating clearance between the pintle and the bore wall; radial cylinders in said barrel; high pressure port means in said pintle on one side of a median plane of said pintle; low pressure port means in said pintle on the opposite side of said median plane; pintle bridge portions located in said median plane and separating said high pressure port means from said low pressure port means; cylinder ports opening inwardly from the respective cylinders to said bore and being cooperable with said high and low pressure port means for valving flow to and from said cylinders; pistons reciprocable respectively in said cylinders; means for reciprocating said pistons in response to rotation of said cylinder barrel relatively to said pintle; and means for subjecting a surface portion of said pintle on said one side of said median plane to pressure of the order of the pressure in the low pressure port means, and for subjecting a surface portion of said pintle on said opposite side of said median plane to pressure of the order of the pressure in the high pressure port means.

16. In a rotary pump or motor, a pintle; a cylinder barrel mounted for rotation relatively about the pintle axis and formed with a bore receiving said pintle with a close operating clearance between the pintle and the bore wall; radial cylinders in said barrel; high pressure port means in said pintle on one side of a median plane of said pintle; low pressure port means in said pintle on the opposite side of said median plane; pintle bridge portions located in said median plane and separating said high pressure port means from said low pressure port means; cylinder ports opening inwardly from the respective cylinders to said bore and being cooperable with said high and low pressure port means for valving flow to and from said cylinders; a high pressure passage extending internally in said pintle and communicating with said high pressure port means; a low pressure passage extending internally in said pintle and communicating with said low pressure port means; pistons reciprocable respectively in said cylinders; means for reciprocating said pistons in response to rotation of said cylinder barrel relatively to said pintle; a balancing passage extending through the pintle structure between said low pressure passage and said clearance space on said one side of said median plane; and another balancing passage extending through the pintle structure between said high pressure passage and said clearance space on said opposite side of said median plane.

17. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle; an end wall structure removably secured to said cylinder barrel and being spaced from the opposite end of the pintle and forming with said pintle opposite end a chamber for receiving slip fluid discharged from the barrel-pintle clearance; a passage through said end wall communicating at one end with said chamber and at its other end being adapted to discharge beyond said end wall structure; and a relief valve assembly removably screw-threaded as a unit into said end wall structure and being responsive to pressure of fluid in said chamber for permitting fluid to flow from said chamber outwardly through said passage, but not reversely, for thus maintaining a supply of fluid under predetermined pressure in said chamber.

18. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle; an end wall removably secured to said cylinder barrel and being spaced from the opposite end of the pintle; a hollow journal extension on said end cover having an internally splined outer end; a hollow plug inserted in the inner end portion of said journal extension for closing the end thereof adjacent said opposite end of the pintle; said pintle opposite end, said end wall and said plug providing a chamber; a source of fluid under pressure communicating with said chamber; a passage communicating with said chamber and extending through said plug; a relief valve assembly removably mounted as a unit in said plug and being responsive to pressure for permitting fluid to flow from said chamber outwardly through said passage, but not reversely; an externally splined drive coupling fitted in the outer end of said journal extension; and means for connecting said coupling to said plug for retaining the coupling in the journal extension.

19. In a rotary pump or motor, a casing; a pintle mounted at one of its ends in one end of said casing and projecting toward the other end of the casing, said other end of the casing having an end wall and a mounting flange in a plane substantially perpendicular to the pintle axis, and said end wall being formed with an opening; a cylinder barrel journalled to rotate about said pintle within said casing; journal means drivingly associated with said cylinder barrel and extending through said end wall opening; an antifriction bearing assembly in said end wall opening and including an outer race fitted within the wall of said opening and an inner race on said journal means; a shoulder on said casing; means on said outer race engaging said shoulder for limiting movement of said race axially toward said one end of said casing; and a retainer detachably secured in said end wall opening and bearing against said outer race for holding said outer race against movement toward the opposite end of said casing.

20. In a rotary pump or motor, a casing; a pintle mounted at one of its ends in one end of said casing and projecting toward the other end of the casing, said other end of the casing having an end wall and a mounting flange in a plane substantially perpendicular to the pintle axis, and said end wall being formed with an opening; a cylinder barrel journalled to rotate about said pintle within said casing; journal means drivingly associated with said cylinder barrel and extending through said end wall opening; an antifriction bearing assembly in said end wall opening and including an outer race fitted within the wall of said opening and an inner race on said journal means; a shoulder on said casing; a snap ring on said outer race engageable with said shoulder for limiting movement of said race axially toward said one end of the casing; and a retainer ring screw-threaded into said end wall opening and bearing against said outer race for pressing said snap ring against said shoulder to lock said outer race against movement in said casing.

21. In a rotary pump or motor, a casing; a pintle mounted at one of its ends in one end of

said casing and projecting toward the other end of the casing, said other end of the casing having an end wall and a mounting flange in a plane substantially perpendicular to the pintle axis, and said end wall being formed with an opening; a cylinder barrel journalled to rotate about said pintle within said casing; journal means drivingly associated with said cylinder barrel and extending through said end wall opening; an antifriction bearing assembly in said end wall opening and including an outer race fitted within the wall of said opening and an inner race on said journal means; a shoulder on said casing; means on said outer race engaging said shoulder for limiting movement of said race axially toward said one end of said casing; a seal surrounding said journal means; and a retainer ring detachably secured in said end wall opening for holding said seal in operative position, and bearing against said outer race for holding said outer race against movement toward the opposite end of said casing.

22. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle and having a bore; an end wall structure on said barrel and having a bell shaped section and being spaced axially from the other end of said pintle, said other end of said pintle constituting a fixed wall portion of a fluid chamber and said end wall structure constituting a rotary wall portion of said chamber; a self-contained relief valve associated with one of said wall portions; and discharge passage means cooperable with said relief valve to relieve the pressure in said chamber to reduce the hydrostatic pressure on the other of said wall portions of said chamber.

23. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle and having a bore; a bearing journalling said cylinder barrel in said casing and restraining axial movement of said cylinder barrel; an end wall structure on said barrel and having a bell shaped section and being spaced axially from the other end of said pintle, said other end of said pintle constituting a fixed wall portion of a fluid chamber and said end wall structure constituting a rotary wall portion of said chamber; a self-contained relief valve associated with one of said wall portions; and discharge passage means cooperable with said relief valve to relieve the pressure in said chamber to thereby reduce the axial component of hydrostatic pressure on said rotary wall portion and reduce the axial load on said bearing.

24. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing and having ports; a cylinder barrel rotatable about said pintle and having a bore in which said pintle is received with close operating clearance; an end wall structure on said barrel and having a bell shaped section and being spaced axially from the other end of said pintle, said other end of said pintle constituting a fixed wall portion of a fluid chamber and said end wall structure constituting a rotary wall portion of said chamber; a self-contained relief valve associated with one of said wall portions; and discharge passage means cooperable with said relief valve to relieve the pressure in said chamber to reduce the hydrostatic pressure on the other of said wall portions of said chamber, said relief valve being capable of maintaining sufficient pressure in said chamber to effect flow of fluid from said chamber into said clearance to envelope said pintle and exert a radial pressure on the pintle surface opposite to the port of the instantaneous working pressure.

25. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle and having a bore; an end wall structure on said barrel and having a bell shaped section and being spaced axially from the other end of said pintle, said other end of said pintle constituting a fixed wall portion of a fluid chamber and said end wall structure constituting a rotary wall portion of said chamber; a self-contained relief valve associated with one of said wall portions; and discharge passage means cooperable with said relief valve to relieve the pressure in said chamber to reduce the hydrostatic pressure on the other of said wall portions of said chamber, said relief valve constituting a load transformer between said fixed wall portion and said rotary wall portion, whereby part of the radial load on said fixed wall portion will be transformed into axial load on said rotary wall portion.

26. In a pump or motor, a casing; a pintle mounted at one of its ends in said casing; a cylinder barrel rotatable about said pintle and having a bore; an end wall structure on said barrel and having a bell shaped section and being spaced axially from the other end of said pintle, said other end of said pintle constituting a fixed wall portion of a fluid chamber and said end wall structure constituting a rotary wall portion of said chamber; a self-contained relief valve associated with one of said wall portions; and discharge passage means cooperable with said relief valve to relieve the pressure in said chamber to reduce the hydrostatic pressure on the other of said wall portions of said chamber, said relief valve constituting a load transformer between said fixed wall portion and said rotary wall portion, whereby part of the radial load on said fixed wall portion will be transformed into axial load on said rotary wall portion to thereby adjust the load on the respective bearings of said wall members.

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