

Jan. 31, 1961

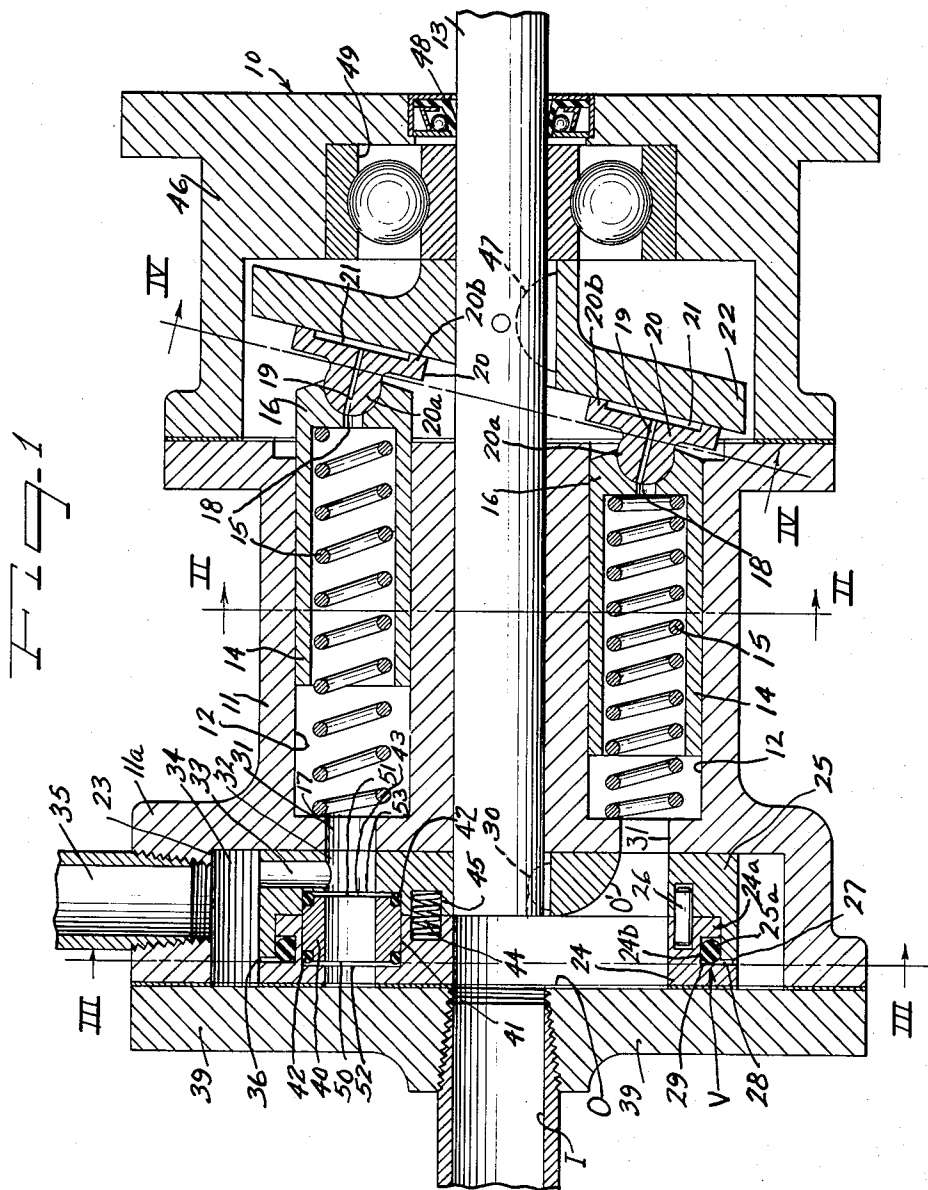
E. C. DUDLEY

2,969,810

WOBBLE PLATE PUMP

Filed Dec. 27, 1955

4 Sheets-Sheet 1



Inventor
Edward C. Dudley

Wiley Sherman, Meritt, Gross & Lingner Attys

Jan. 31, 1961

E. C. DUDLEY
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Fig. 2

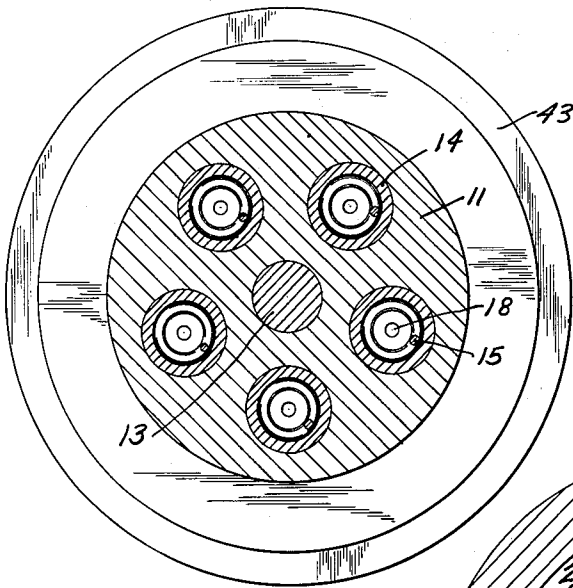


Fig. 3

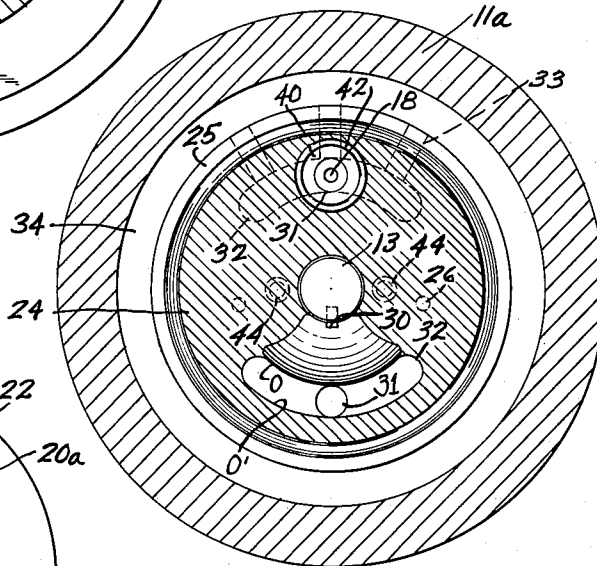
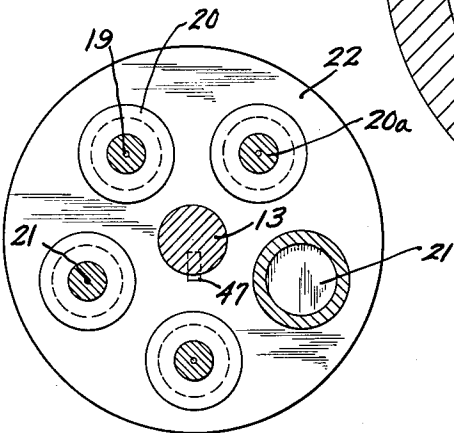


Fig. 4



Inventor
Edward C. Dudley

Attorneys
Hill, Sherman, Munro, Goss & Simpson

Jan. 31, 1961

E. C. DUDLEY
WOBBLE PLATE PUMP

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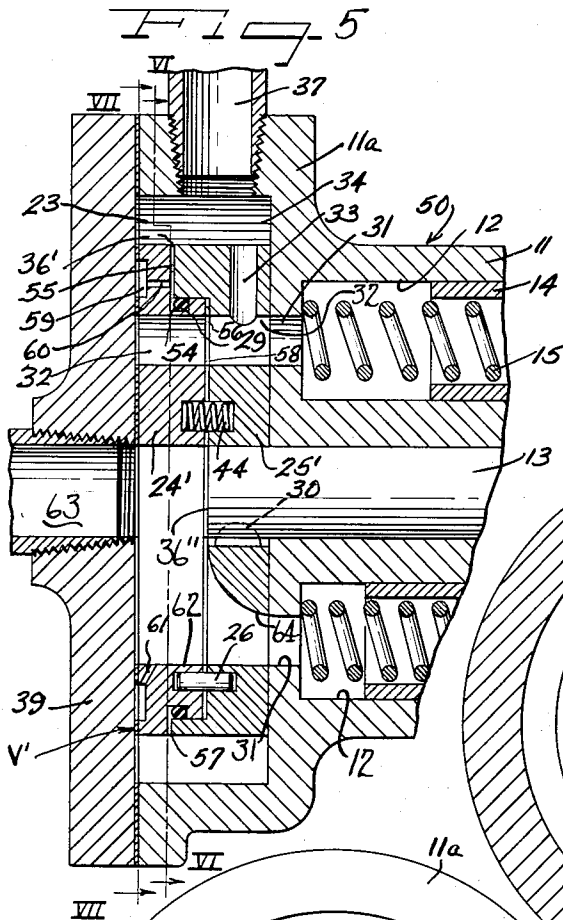


Fig. 6

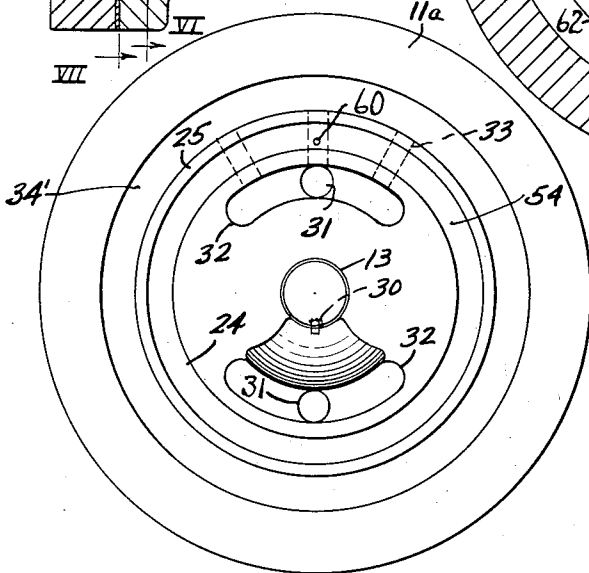
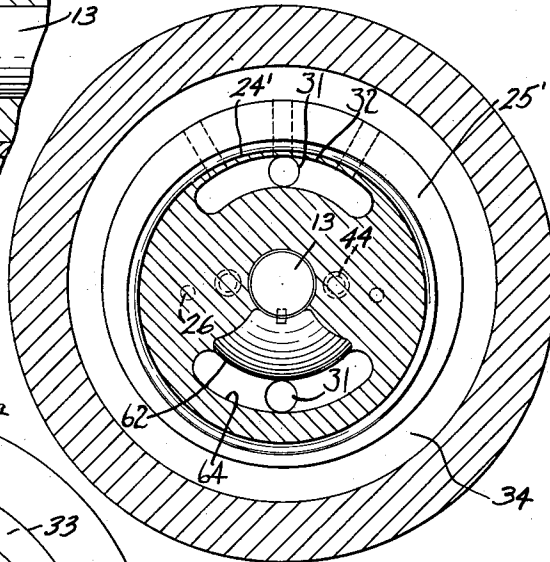


Fig. 7

Inventor
Edward C. Dudley

By *Kell, Herman, Moran, Gross & Knight* Attorneys

Jan. 31, 1961

E. C. DUDLEY

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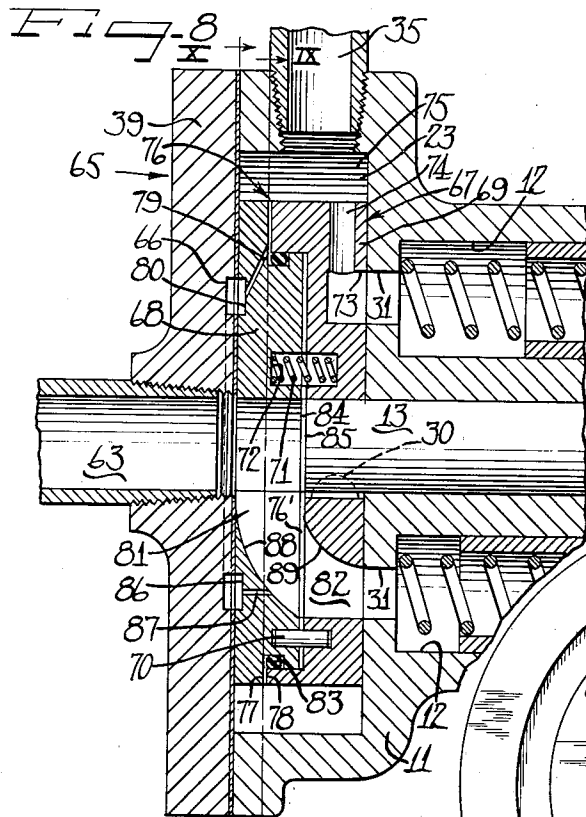


FIG. 10

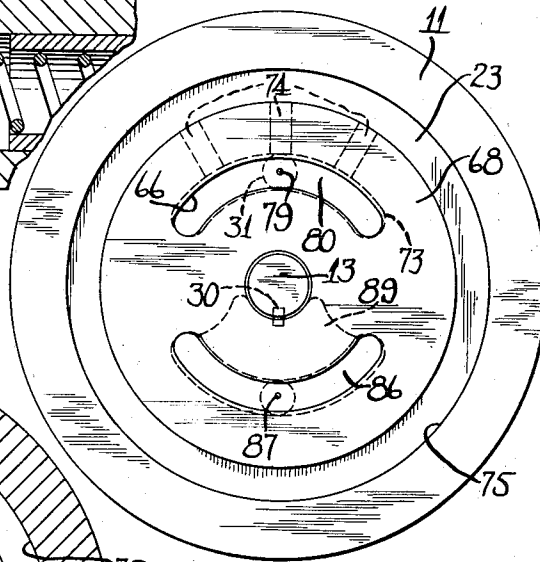
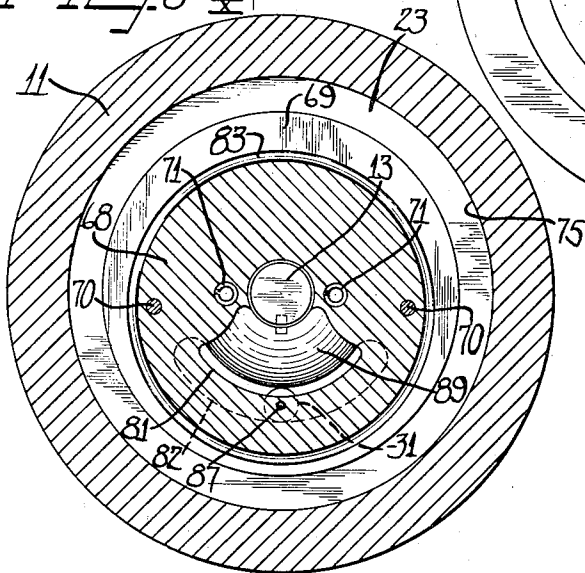


FIG. 9



Inventor
Edward C. Dudley

Will Sherman Merri, Charles Scripps Attys

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2,969,810

WOBBLE PLATE PUMP

Edward C. Dudley, 23630 Lake Shore Blvd.,
Cleveland 23, Ohio

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5 Claims. (Cl. 137—625.15)

This invention relates to pressure balanced wobble plate type piston pumps equipped with efficient valves and slippers eliminating heretofore required close machining tolerances and fits. Specifically this invention relates to a wobble plate pump having self-adjusting pressure balanced valve and slipper means.

According to this invention, the pump valve is formed from a plurality of plates urged apart into sealing relationship with the pump housing and end plate by pump pressure. Use of pump discharge pressure on responsive areas between the valve plates permits much wider production tolerances in valve assemblies and provides a self-adjusting valve for normal wear during pump operation.

The pump slippers also include pressure responsive areas exposed to pump pressure so that during high pump pressure operation, the slipper will tend to lift off the wobble plate, thereby reducing the frictional force and at the same time providing a centralized lubrication reservoir for the slipper and wobble plate face.

In the past, construction of rotary valves for use in hydraulic pumps required very close production tolerances in order to maintain an effective pressure seal and prevent leakage between the inlet and discharge side of the pump. Normal wear caused excessive clearances to develop between these parts with a corresponding loss in efficiency and pump output. Either a new valve assembly or dismantling for adjustment was the only alternative for returning the pump to normal operation.

The present invention greatly reduces the frequency of dismantling and repair operations in hydraulic pumps necessitated by leakage because of excessive wear of the rotary valve. The rotary valve feature of this invention is self-adjusting for normal wear and maintains a continuous fluid pressure seal between the inlet and discharge of the pump through a wide range of operating speeds and pressures. In addition, the utilization of pump discharge pressure as the means of maintaining the pumping seal, rather than a spring bias, provides a completely variable sealing force at all pump speeds and pressures thereby minimizing frictional losses and wear at low pump discharge pressures, where high seal pressure is not required.

The present invention also minimizes slipper wear by venting a centralized chamber in the slipper face engaging the face of the wobble plate with pump discharge pressure through a small bleed passageway. As pump pressure increases the chamber becomes filled with pressurized fluid which exerts a pre-determined force between the adjacent faces of the slipper and wobble plate tending to separate them. By suitable metering of the bleed passage and proportioning of chamber area, the net force between the slipper and wobble plate can be proportioned as desired, relative to the pump discharge pressure. Frictional forces may thereby be minimized at all pump running conditions and the overall efficiency of the pump increased.

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It is then an object of this invention to provide a pressure balanced wobble or swash plate pump.

Another object is to provide self-adjusting pump pressure activated valve and slipper means for wobble or swash plate pumps.

A further object of this invention is to provide a self-adjusting multi-piece rotary valve for use in maintaining variable seal pressure between the inlet and outlet of hydraulic pumps, particularly of the wobble plate type.

A specific object of this invention is to minimize frictional losses in hydraulic pumps, by providing a pressure balanced rotary valve assembly between the inlet and outlet of the pump, maintained in proportionate self-adjusting sealed relationship as a function of pump discharge pressure.

A still further object of this invention is to permit a wide range of production tolerances in the manufacture of rotary valves for use in hydraulic pumps, particularly of the wobble plate type, through the use of pump discharge pressure as the means of maintaining hydraulic seal contact.

Another object of the present invention is to provide a pressure balancing chamber in the engaging face of slippers positioned between the piston and wobble plate in wobble plate type hydraulic pumps, and selectively bleeding this chamber to pump discharge pressure, thereby reducing frictional forces between the slippers and wobble plate.

A further object of this invention is to provide a lubrication reservoir between the engaging faces of the slippers and wobble plate in wobble plate type hydraulic pumps.

Still another and further feature of this invention relates to balancing and maintaining optimum seal at both inlet and discharge sides of the pump.

Many other objects, advantages and additional features of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the preferred structural embodiments which are described therein.

On the drawings:

Figure 1 is a longitudinal cross sectional view of a wobble or swash plate pump according to this invention with parts rotated out of position.

Figure 2 is a transverse cross sectional view along the line II—II of Figure 1.

Figure 3 is a transverse cross sectional view along the line II—II of Figure 1 showing the proper location of the rotated parts in Figure 1.

Figure 4 is a transverse elevational view with parts in cross section along the line IV—IV of Figure 1.

Figure 5 is a fragmentary view similar to Figure 1, but showing a modified pressure responsive valve according to this invention with parts rotated out of position.

Figure 6 is a transverse cross sectional view along the line VI—VI of Figure 5 showing the proper location of the rotated parts in Figure 5.

Figure 7 is an end elevation along the lines VII—VII of Figure 5.

Figure 8 is a fragmentary view similar to Figure 1, showing still another modified pump and valve construction according to this invention with parts rotated out of position.

Figure 9 is a transverse cross sectional view along the line IX—IX of Figure 8 showing the proper location of the rotated parts in Figure 8.

Figure 10 is an end elevation along the lines X—X of Figure 8.

As shown on the drawings:

As shown in Figure 1, the pump 10 of this invention includes a central housing or body 11 having a plurality of springs 15 enclosed in a hollow portion of the pistons, and bearing on the heads of the pistons 16 and seating on the

shoulders 17 of the housing. The head of each piston includes a central port 18 which communicates pump discharge pressure from the interior of the piston through a bleed passageway 19 in each pump slipper 20 to a pressure balancing chamber or cavities 21 in the face of the slipper which is in sliding engagement with the pump wobble or swash plate 22.

The head 16 of each piston surrounding the exit of each port 18 is counter-bored an amount sufficient to accommodate a ball shaped head 20a of each slipper 20, thereby providing a self-centering ball and socket bearing relationship between the pistons 14 and slippers 20.

By virtue of the above interrelationship of elements, the pressure responsive areas in cavities 21 may be made so that the total force on the rubbing surfaces between the wobble plate 22 and the slippers 20 or more specifically the slipper feet 20b are equal to or less than the spring load. This is very highly advantageous since the less force between the members the less will be the wear and frictional power loss.

One end of the housing is enlarged at 11a to provide a relatively large cylindrical chamber 23 which receives in rotatable relation therein a rotary valve assembly V driven by shaft 13.

As shown in Figure 1, the rotary valve assembly V contained in chamber 23 is comprised of a pair of opposed adjacent circular metal plates or disks 24 and 25 in face to face relation to each other by pins 26, such as will accommodate relative axial movement. The plate 24 has a reduced diameter pilot portion 24a slidably seating in a cylindrical recess 25a of the plate 25. The portion 24a has an annular peripheral groove 24b therearound for receiving a rubber seal ring 29 therein. The plates 24 and 25 each have axially confronting shoulder or flange faces 27 and 28 for a purpose to be hereinafter described.

A key 30 joins the valve plate 25 with the shaft 13 and since the pins 26 couple the plates 24 and 25 the entire valve assembly will be driven.

Each bore 12 of the housing or body 11 has a circular port 31 at the end thereof selectively communicating and venting the bore through an arcuate port 32.

In communication with arcuate port 32 on the radially outer side thereof are a plurality of ports 33 leading into annular passage 34 which constitutes the radially outer portion of chamber 23. Passage 34 is in turn connected to a main discharge port 35. Thus as the fluid is urged out of the bore 12 it flows successively through ports 31, 32, ports 33, and passage 34 into the main discharge port 35.

Pump discharge pressure is communicated from the annular passageway 34 radially inwardly to an annular pressure responsive chamber 36 between radially outer peripheral faces 27 and 28 of the valve plates 24 and 25, so as to hydraulically urge the valve plates axially apart into sealing relationship with the pump body 11 and end plate 39.

In the embodiment of the present invention shown in Figure 3, a loose-fitting arcuate bushing 40 is annularly disposed between the annular valve plates 24 and 25 in recess 41 and circumscribes the discharge sector passage 32. Annular seals 42-42 prevent leakage between the valve plates and bushing. Additional pressure responsive chambers 43 are thereby created between the faces of the bushing 40 and valve plates 24 and 25 adjacent passage 32 which additionally tend to axially urge the valve plates apart when subjected to discharge pressure from the discharge port 31. A suitable number of springs 44 are each positioned in a recess 45 between the valve plates near the arcuate discharge passage 32 to provide an initial bias urging the valve plates axially apart into sealing relationship with the pump body 11 and end plate 39.

As pump discharge pressure increases the annular pressure responsive chamber 36 and the internal chamber 43 will continue to exert a proportionately increasing force

between the valve plates urging the plates into hydraulic sealed relationship with the pump body and end plate.

Similarly, as pump discharge pressure is reduced, the force urging the valve plates apart will be proportionately reduced with a corresponding reduction in frictional losses.

By utilizing pump discharge pressure, on predetermined pressure responsive areas between the axially movable plates in a rotary valve assembly to maintain a hydraulic seal between the valve assembly, pump body, and end plate, the normal wear on the valve plate surfaces is automatically compensated for without loss of pressure or pumping efficiency because of leakage past a worn valve.

An end head 46 closes the end of the housing 11 and journals the drive shaft 13. A wobble plate 22 is keyed to the drive shaft 13 by a key 47, thereby maintaining the wobble plate 22 and rotary valve assembly V in a unitary co-rotational relative position. A seal 48 prevents any leakage around the drive shaft journal and bearings 20 49.

The slippers 20 are maintained in cooperative relationship with the face of the wobble plate 22 by the spring biased action of the pistons 14.

To prevent excessive wear and friction losses between the slippers 20 and wobble plate 22 induced by the compression in springs 15, and forces caused by discharge pressure of pump discharge pressure is selectively communicated from the cylinders through the ports 18 and bleed passageway 19 to the pressure responsive chambers 21, shown in Figures 1 and 4. As discharge pressure increases, the pressure in the slipper chamber 21 will proportionately increase and tend to separate the slipper from the face of the wobble plate by an amount proportional to the area of the chamber 21 times the discharge pressure. The pressure balancing area of the chamber 21 between the slippers and the wobble plate may be so regulated as to balance the compression force of the springs 15 and face caused by discharge pressure within the pumping cylinder 12. By pressure balancing the slippers with pump discharge pressure frictional forces are reduced and a continuous lubrication system is provided by the reservoir of working fluid in the chamber 21 of the slipper.

In operation, pump discharge pressure during the discharge stroke of the pump is respectively communicated from the cylinders 12 through the port 31 to passages 32 and 34 to pressure responsive areas 36 and 43 between bushing faces 50 and 51 and inner flange faces 52 and 53. At the same time pump discharge pressure is communicated through the ports 18 in the ends of the pistons 14 through a bleed passage 19 in the slipper 20 to the pressure responsive chamber 21 between the face of the slipper and the wobble plate 22. As pump discharge pressure increases, the pressure in the various responsive areas in the rotary valve tends to urge the radially outer and inner valve plate faces 27 and 28, 52 and 53 apart, with a sufficient force to maintain a hydraulic pressure seal between the rotary valve plate faces and the pump body 11 and end plate 39. By proper selection of pressure responsive areas the forces tending to urge apart the valve plates 24 and 25 may be balanced by the forces tending to force them together and excessive frictional losses are thereby eliminated and continuous adjustment due to wear is thereby maintained without dismantling the pump.

Similarly, the pump discharge pressure in the pressure responsive chamber 21 of the slipper 20, tends to urge the slipper away from the face of the wobble plate 22 by an amount proportional to the chamber space area and pump discharge pressure. The effect is to progressively reduce the compression loading force of the springs 15 in the pistons 14 holding the slipper 20 in engagement with the face of the wobble plate 22, by a predetermined amount, so that frictional forces will be minimized and at the same time a lubrication reservoir

is provided by the chamber 21 for the engaging faces of the slipper 20 and wobble plate 22.

It will be noted that plates 24 and 25 are provided with registered openings O and O'. These openings are continually vented to pump inlet I. Thus during the inlet cycle of the pump fluid is pumped at low pressure through the port 31 into inlet bores 12 whereupon the wobble plate during the discharge cycle causes the fluid to discharge through port 31 at high speed pressure.

In Figures 5-7 a modification of my invention is shown wherein rotary valve assembly V' is mounted in a pump 50. Identical numerals have been utilized where corresponding elements are identical.

In this form of my invention, valve plates 24' and 25' are mounted in eccentric relation for a purpose hereafter revealed.

Valve plate 24' is of T-shaped cross section having an eccentric annular recess 54 therein. Valve plate 25' is of a reverse T-shaped construction and is adapted to seat upon and snugly engage with plate 24' with rubber seal 29 housed in the recess sealing the inlet side from the discharge side of the pump.

To this end, valve plate 24' has eccentric radially outer and inner surfaces 55 and 56 separated by the seal recess 54. Valve plate 25' has eccentric radially outer and inner surfaces 57 and 58. These surfaces or faces are normally axially spaced by reason of the spring bias of spring 44. Upon operation of the pump these surfaces are further axially expanded in order to insure a seal between the plates and axial surfaces, defining the valve housing in the same manner as set out before.

It will be perceived that chamber 36' and more particularly chamber 36'' defined by faces 56 and 58 receives discharge pressure from discharge passage 32 and passage 34 while being vented to low pressure at the inlet since seal 29 disassociates chambers 36' and 36''.

The above valve plate construction provides a larger pressure responsive area on the discharge side of the pump as opposed to the inlet side with the result that a stronger optimum seal is obtained at the point of greatest pressure while a corresponding weaker optimum seal is obtained at the point of least pressure all to the end of providing pressure balancing between the plates along with minimum amount of frictional horsepower loss.

This modified form also has additional means for reducing friction between the end plate 39 and the valve plate 24'.

As shown in Figure 5, the valve plate 24' abutting the end plate 39 contains an annular cavity or chamber 59 centrally spaced between the valve plate 24' and the end plate 39. Chamber 59 is in turn communicated with pump discharge pressure on the discharge side of the pump, by a series of interconnecting passages 60 and 36' to the annular discharge passage 34.

On the inlet side of the pump, it will be noted that valve plate 24' has a passage 61 venting chamber or reservoir 59 to inlet pressure in opening 62 of valve plate 24'. Opening 62 is in communication with pump inlet 63 and opening 64 in valve plate 25'. Hence as the valve V is rotated opening 62 is continually vented to inlet 63 and is at the same time in registry with opening 64 which in turn is in communication with port 31 leading to bore 12 on the inlet cycle of the pump.

The annular chamber suitably provides a reservoir of working fluid between the engaging surfaces of the rotary valve and the end plate thereby insuring continuous lubrication of the engaging parts and reduction of friction losses.

In Figures 8-10 there is shown still another form of my invention including a slightly modified pump construction 65. Where identical parts again appear as in the previous forms of my invention, the same description of elements and numerals again are applicable.

This form of the invention departs from the other embodiments in that an annular fluid reservoir portion

66 has been provided in end plate 39 which opens into the chamber 23 housing my modified rotary valve assembly 67.

In this instance, the valve assembly 67 again includes two circular generally T-shaped eccentric metal plates or disks 68 and 69 in face to face relation to one another within the chamber 23. Plate 69 is keyed at 30 to drive shaft 13 and plate 68 is connected to plate 69 by pins 70 thereby enabling co-rotation of the plates allowing relative axial movement. The plates 68 and 69 are maintained in a given position with respect to one another through the utilization of a suitable number of springs 71 each of which are positioned in a recess 72 between the valve plates near the axis of the plates to provide an initial bias urging the valve plates axially apart into sealing relationship with the pump body 11 and end plate 39.

The pumping cavities or bores 12 are in direct communication with a discharge port 31, each of which are in selective communication with discharge passage 73 in valve plate 69. Passage 73 in turn communicates with ports 74 leading into annular passage 75, the passage 75 constituting a radially outer portion of chamber 23. Passage 75 is in turn connected to a main discharge port 35. As the fluid is urged out of the bore 12 it flows successively through ports 31, 73, passage 74, and port 75 into main discharge port 35.

Plates 68 and 69, as in the last embodiment, are in eccentric relation to one another to afford a relatively large pressure responsive cavity or chamber 76 defined by annular eccentric faces 77 and 78 of varying area, with the greatest area being located opposite or adjacent the bore or bores 12 discharging during the discharge cycle of the pump.

Plate 68 has a connecting passage 79 connected at one end to chamber 76 and at the other end to an arcuate reservoir portion 80 in registry with annular reservoir portion 66 for purposes later described in more detail.

Pump inlet 63 communicates with registered openings 81 and 82 in respective valve plates 68 and 69, the openings defining a passageway in registry with ports 31 during the inlet and discharge cycles of the pump.

A second variable pressure responsive chamber 76' has been provided between the valve plates separate from chamber 76 by annular seal 83. Chamber 76' is defined by opposing faces 84 and 85 on the respective plates. Here again it will be noted that chamber 76' has a relatively large area on the discharge side of the valve assembly 67 as opposed to the inlet or intake side of the valve assembly 67.

Hence, as opposed to the first form of the invention, chamber 76 is responsive to discharge pressure while chamber 76' is principally responsive to inlet pressure, all to the end of pressure balancing the plates within the pump 65.

Plate 68 has a second arcuate reservoir portion 86 connected to a passage 87 which is vented to the inlet opening 81. It will be further noted that opening 81 has a flared surface 88 cooperating with an opposed surface 89 to define a progressively diminishing sized passageway (openings 81 and 82) whereby high pressure fluid is vented from annular reservoir portions 66 to arcuate reservoir portion 86 through passage 87 to inlet pressure and pressure drop is thereby reduced (surfaces 88-9).

Reservoir portions 66, 80 and 86 allow fluid to be dispersed over the opposed end plate 39 and valve plate 68 to lubricate same while at the same time metering some of the high pressure fluid to the low pressure inlet opening 81.

From the foregoing, it will now be appreciated that the modified pump constructions not only utilizes pump discharge pressure to hydraulically urge the plates into sealed relationship with the pump body and end plate, but in addition utilizes this pressure to provide a self-

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adjusting balance between the plates along with a lubricating fluid between the engaging surfaces of the rotary valve.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention, but it is understood that this application is to be limited only by the scope of the appended claims.

I claim as my invention:

1. A rotary valve assembly for a wobble plate pump or the like comprising a housing having a pair of axially spaced walls, one of said walls having an inlet centrally therein, a driving means extending centrally through the other of said walls, a pair of valve plates in said housing, one of said valve plates being slidably secured to said drive means in angularly fixed relationship thereto, means securing said valve plates in axially movable angularly fixed relationship, said valve plates being coaxial with said drive means and forming a peripheral annular chamber with said housing, said housing forming an outlet leading from said peripheral annular chamber, said other wall forming a pair of ports spaced radially from said drive means and angularly from one another, said valve plates cooperatively forming a passageway leading from said inlet and terminating in position for successive communication with said ports, one of said plates forming a passage leading to said peripheral annular chamber and successively communicating with said ports, each of said plates having an outer eccentric surface extending therearound in facing, registered relationship to the eccentric surface of the other of said plates and an inner eccentric surface extending therearound in facing registered relationship to the inner eccentric surface of the other of said plates to define outer and inner cavities of angularly variable surface area, said cavities being spaced axially, means sealing said cavities from one another internally of said plates, said ports being alternately fed with fluid from said inlet through said valve plates and the inlet passageway formed therein and then emitting the fluid under high pressure through the passageway in said one valve plate to said outlet, said cavities formed by said valve plate surfaces having a larger pressure responsive area which is always in closely adjacent relationship to and in communication with the high pressure fluid that is alternately and successively introduced through said ports, and said passageway in said one of said plates and said peripheral annular chamber to said outlet upon rotation of said valve plates by said drive means whereby to urge said valve plates away from one another into sealing engagement with said walls with increased sealing force at the high pressure areas in said housing.

2. A rotary valve assembly comprising a housing having an inlet and an outlet, a pair of flanged, generally circular valve plates, means for rotatably driving said valve plates, said valve plates being in axially movable and angularly fixed relationship to one another, said housing defining a pair of ports adjacent one of said valve plates and said valve plates defining a passage from said inlet successively registering with said ports, and a passage communicating with said outlet and successively registering with said ports to receive fluid emitted through said ports under high pressure for release to said outlet, the flanged portions of said valve plates being in overlapping meshing relationship and defining a pressure responsive chamber therebetween to urge the respective valve plates apart in sealing relationship with said housing, and means for transmitting fluid pressure to said chamber, said flanged portions of said valve plates having a circumferentially eccentric configuration to define eccentric pressure areas in said chamber having larger pressure area portions in closely adjacent relationship to and in communication with the high pressure fluid that is alternately and successively pumped into the said ports.

3. A rotary valve comprising a pair of valve plates, a

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drive shaft, one of said valve plates being slidably secured to said drive shaft in angularly fixed relation thereto and said valve plates being angularly fixed and axially movable relative to each other, a housing enclosing said valve plates and defining wall surfaces complementary to said valve plates, spring means biasing said plates apart into sealing relationship with said housing structure and said wall surfaces thereof, said valve plates defining an inlet sector and an outlet sector, an inlet in said housing in communication with said inlet sector, one of said plates defining a plurality of ports for introducing pressurized fluid alternately and successively into said inlet sector and said outlet sector, an outlet in said housing for receiving fluid from said outlet sector, said valve plates defining therebetween inner and outer opposed eccentric surfaces extending circumferentially therearound and forming a first pressure balancing chamber having a greater area adjacent said outlet sector defined by said plates and being always in closely adjacent relationship to and in communication with the high pressure fluid that is alternately and successively introduced into the valve through said ports and a second pressure balancing chamber having a portion of greater area afforded by said eccentric surfaces adjacent said inlet sector and in communication with said outlet sector and said inlet sector, one of said valve plates on said housing defining an annular lubricating chamber therebetween in communication with said outlet sector, and defining vent means venting said annular lubricating chamber to said inlet thereby maintaining a predetermined pressure bias between said valve plates during a wide range of operating speeds of said valve.

4. A rotary valve assembly comprising a housing having a pair of axially spaced walls, one of said walls defining a central inlet opening and the other of said walls defining a pair of ports in radially and angularly spaced relationship and a pair of valve plates in said housing having eccentric flanges forming outer eccentric opposed pressure responsive surfaces and inner eccentric opposed pressure responsive surfaces, and forming a passage leading from said inlet to register with said ports successively and a passageway registering with said ports successively and communicating with a peripheral portion of said housing surrounding said valve plates for receiving pressurized fluid introduced alternately and successively through said ports, said outer eccentric surfaces having a larger area adjacent said outlet passageway and being in communication with said peripheral portion of said housing, said inner eccentric surfaces being in communication with the inlet passageway formed by said valve plates and having a relatively large radial dimension adjacent said inlet passageway, thereby to maintain an optimum seal at all times between said valve plates and the walls of said housing.

5. A self-adjusting rotary multiple piece valve comprising first and second valve plates having eccentrically formed flanges in overlapping meshing relationship, a housing for said valve plates having wall surfaces complementary thereto, a drive shaft, one of said valve plates being keyed to said drive shaft in coaxial relationship thereto and the other of said valve plates being keyed to said one of said valve plates for unison rotation therewith while being free to move axially with respect thereto, said eccentric flanges having opposed surfaces forming cavities therebetween, one of the walls of said housing defining a central inlet, the other of said walls of said housing defining a plurality of ports, said valve plates defining an inlet passage communicating with said inlet in said one wall of said housing and successively registering with said ports, said one of said valve plates having an outlet passage for receiving fluid which may be pumped alternately and successively into said ports and transmitting the fluid to said outlet through said housing, said opposed surfaces providing cavities between said plates, and means communicating fluid to said cavities to force said valve plates apart and into sealing relationship with the respective adjoining walls of said housing, said ec-

centric surfaces providing pressure responsive areas there-between in continuously adjacent relationship to and communication with the high pressure fluid that may be alternately and successively pumped into the valve housing through said ports.

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