

Feb. 23, 1937.

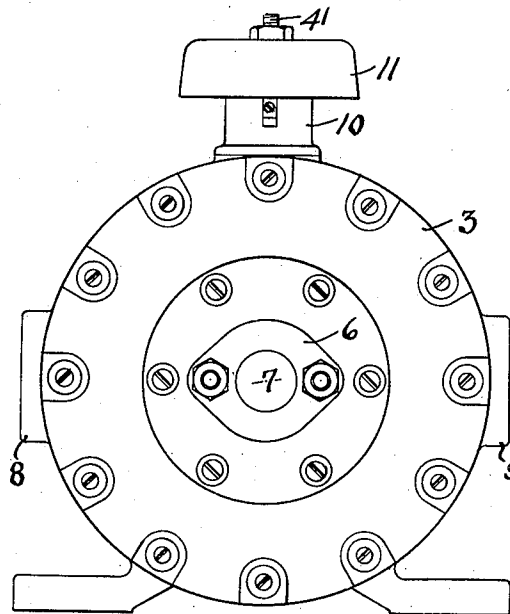
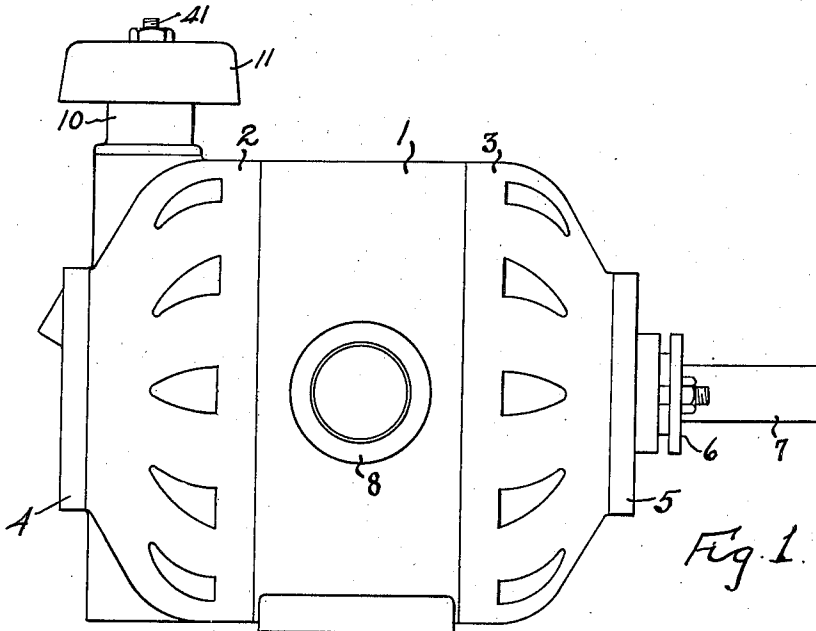
P. WHITCOMB

2,071,672

VARIABLE DELIVERY PUMP

Filed June 26, 1935

4 Sheets-Sheet 1



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Feb. 23, 1937.

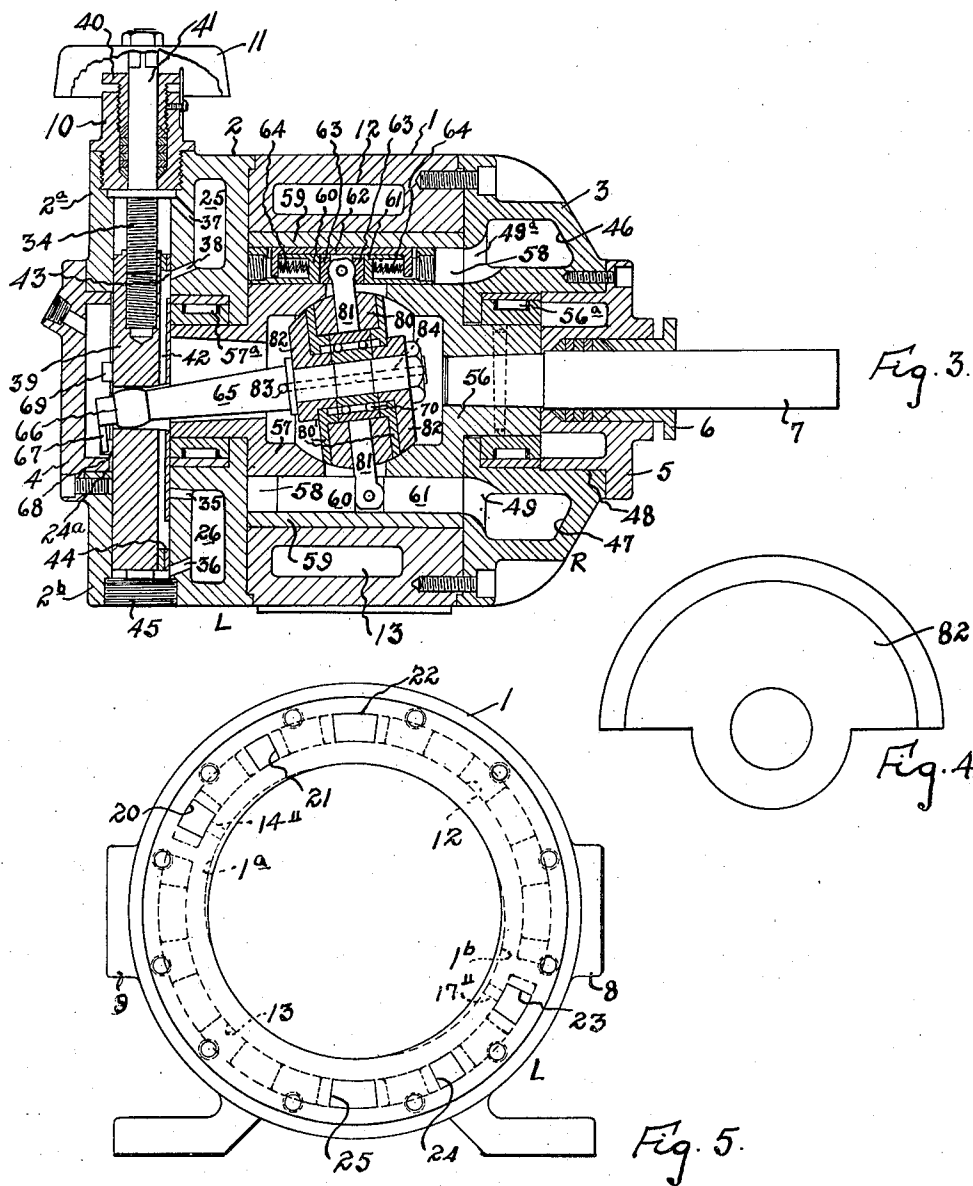
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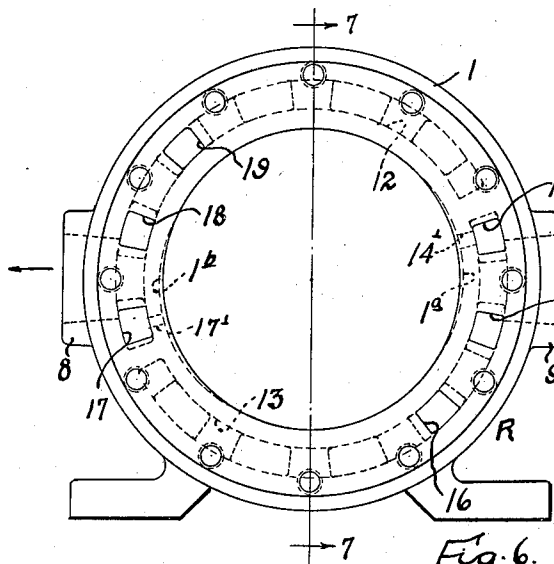


Fig. 6.

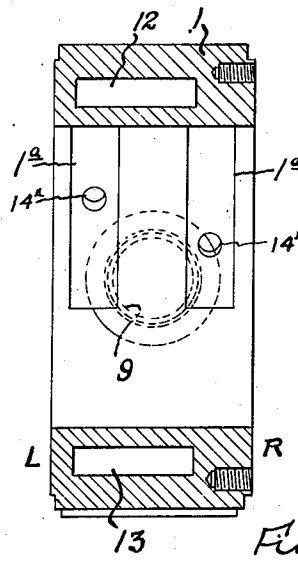


Fig. 7.

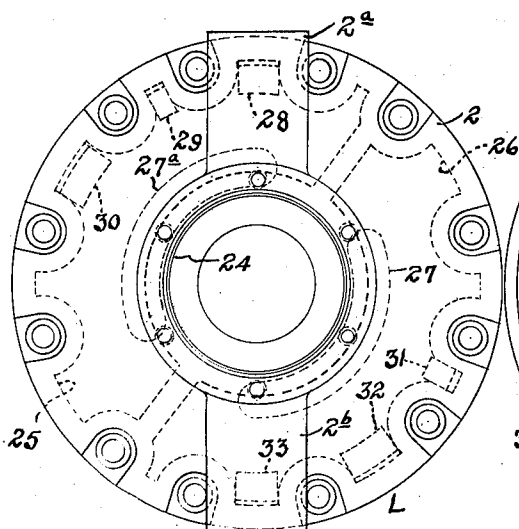


Fig. 8.

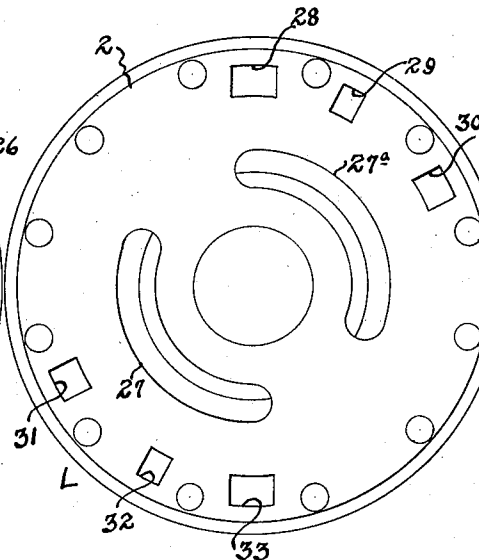


Fig. 9.

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4 Sheets-Sheet 4

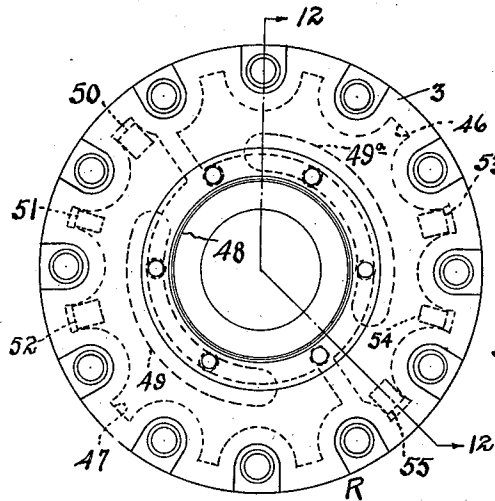


Fig. 10.

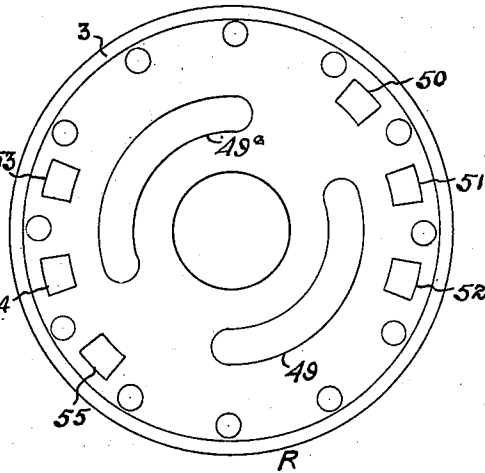


Fig. 11.

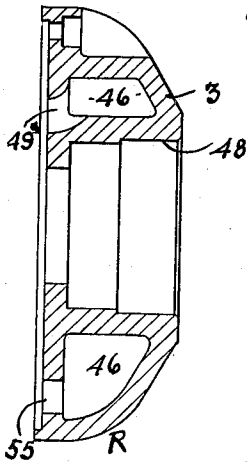


Fig. 12.

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UNITED STATES PATENT OFFICE

2,071,672

VARIABLE DELIVERY PUMP

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Application June 26, 1935, Serial No. 28,391

9 Claims. (Cl. 103—162)

This invention relates to improvements in variable delivery pumps by means of which both the pressure and direction of flow of a pressure fluid may be varied from a maximum in one direction gradually through zero to a maximum in the opposite direction while the rotor of the pump revolves at constant speed.

An important object of this invention is to provide an efficient pump of this type of rugged and yet simple construction.

A more specific object of the invention is to provide a variable delivery pump capable of a substantially constant discharge pressure for any particular speed of operation within the capabilities thereof.

A further object of this invention is to provide a variable delivery pump construction having a relative arrangement of parts whereby the pressure of the fluid internally of the pump is substantially balanced on the various operating parts and particularly upon the rotor, thereby increasing its efficiency by minimizing the frictional forces in the bearings and reducing wear on the bearings.

A still further object of this invention is to provide a manually operable means for controlling the output of the pump and means for hydraulically balancing the manually controlled means so that it may be adjusted with a minimum of effort.

These and many other objects are successfully attained by means of this invention.

This application is a continuation in part of my co-pending application Serial No. 758,790, filed December 22, 1934, for Variable delivery pump.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, as will be described in detail below.

In the drawings,

Figure 1 is a side elevational view of one form of pump construction in accordance with this invention;

Figure 2 is an end elevational view thereof from the shaft side;

Figure 3 is a longitudinal, cross-sectional view through the complete pump;

Figure 4 is a plan view of one of the segmental plates of the rotor structure;

Figure 5 is an elevational view from the left hand side of the central housing casting or stator;

Figure 6 is a similar view from the right hand side;

Figure 7 is a cross-sectional view taken on the line 7—7 of Figure 6;

Figure 8 is an outside elevational view of the left hand housing cover plate;

Figure 9 is a similar view of the other side;

Figure 10 is an outside elevational view of the right hand housing cover plate;

Figure 11 is a similar view from the other side; and

Figure 12 is a cross-sectional view taken on the line 12—12 of Figure 10.

The structure set forth in the drawings as illustrating one form which the invention may take includes a central housing casting 1. This casting is of substantially circular shape, having a large central bore therethrough and provided with a pair of separated passages 12 and 13 in the walls thereof. These passages are not in direct communication, as is clear from Figures 5 and 6. A connection port for passage 12 is provided by a passage in the cylindrical projection 8 and similarly a connection port is provided for the passage 13 by a passage in the cylindrical projection 9. The internal cylindrical opening in the casting is provided with two pairs of face grooves, indicated in Figures 5, 6 and 7. One pair of these grooves is shown at 1a and one pair is shown at 1b. As shown by Figure 7, the right hand groove 1a is connected by the passage 14' with the passage 13. The left hand groove 1a is connected by the passage 14'' with the passage 12. Similarly, looking at the other half of the stator on the plane 7—7 of Figure 6 but in the opposite direction, the left hand groove 1b is connected by the passage 17' to the passage 12 and the right hand groove 1b, Figure 5, is connected by a passage 17'' with passage 13. Opening outwardly on the left hand face of the stator casting, see Figure 5, are the ports, 20, 21 and 22, which communicate with the passage 12 in the stator wall, and the ports 23, 24 and 25, which communicate with the passage 13 in the stator wall. On the right hand face of the stator housing 1, as shown in Figure 6, there are provided the ports 14, 15 and 16 communicating with the passage 13 and the ports 17, 18 and 19 communicating with the passage 12.

As shown in Figure 1, the central stator casting or housing 1 is closed on its right hand end by means of the cover plate 3 and the packing gland disc 5 and on its left hand end by means of the cover plate 2 and the closure disc 4. The left hand cover plate 2 is shown in Figures 8 and 9. It consists of a casting having a pair of separated arcuate passages 25 and 26 formed in

the wall thereof. On the inner face these passages are connected to the arcuate ports 27a and 27, respectively. Issuing on the same face are the ports 28, 29 and 30 which communicate with the passage 25, and the ports 31, 32 and 33 which communicate with the passage 26. Opening on the outer face of this casting is an enlarged cylindrical recess 24a. Extending vertically above and below the recess are the hollow auxiliary housings 2a and 2b which open into a recess 24a, as is clear from Figure 3.

The right hand cover plate casting 3 is likewise provided with a pair of arcuate separated passages 46 and 47 in the walls thereof which communicate with the ports 49a and 49, respectively, issuing on the inside face thereof. The ports 50, 51 and 52 issue on the same face and communicate with the passage 47, and the ports 53, 54 and 55 similarly issue on the inside face of the casting and communicate with the passage 46. This casting is provided with an enlarged cylindrical recess 48, as is clear from Figures 10 and 12.

Referring to Figure 3, it will be seen that the rotor comprises a pair of cylindrical parts 56 and 57 which are formed hollow and are bolted together by means of axial bolts, not shown. The rotor part 56 is provided with a central hub which is journaled in the roller bearing 56a mounted in the recess 48. The open end of this recess is closed by the packing gland closure disc 5 in which is the adjustable packing gland 6 surrounding the drive shaft 7 which is pinned as shown to the rotor. The rotor portion 57 is provided with a hollow hub which is journaled in the roller bearing 57a mounted in the recess 24 of the left hand cover plate 2. The closure disc 4 closes the open end of the recess 24. The complete rotor is provided with a series of axial grooves opening outwardly on its periphery and of a cross-sectional form as disclosed in my co-pending application Serial No. 758,790, filed December 22, 1934, but not shown here in detail since their form constitutes no separate part of this invention. The entire rotor is encased by a cylindrical ring 59 which is secured to the rotor in any suitable manner but preferably by shrinking it thereon. This ring closes the open sides of the grooves 58 forming channels which issue at the sides of the rotor, as is clear from Figure 3.

In each groove 58 is a piston which is axially reciprocable therein. These pistons comprise the two parts 60 and 61 which are interconnected by means of a U-shaped yoke 62, the ends of which extend down into openings on the top of the sections 60 and 61. Interposed between these sections and the ends of the yokes are the springs 64. By this construction it will be seen that the piston sections 60 and 61 are urged towards each other by the springs 64. The details of construction of these pistons likewise form by themselves no part of this invention. They have been disclosed in full detail in my co-pending application above mentioned.

Within the chamber of the rotor, which chamber is of substantially spherical form at its central portion, is the connecting means or spider for supporting the connecting rods 81. This arrangement involves the shaft 65 upon which the connecting rod spider 80 is journaled for rotation on the ball bearings 70. The spider 80 consists of a ring having flat sides and being transversely curved to form a sliding fit with the chamber within the rotor. The shaft 65 does not rotate

and has secured thereon so as not to rotate a pair of segmental plates 82 of a form shown in Figure 4. These plates are displaced 180°, as indicated in Figure 3. Interposed between the plates 82 and the spider 80 are the discs 80' which rotate with the spider 80. Projecting radially from the spider 80 at properly spaced points are the connecting rods 81 which are rigidly secured therein. The outer ends of these connecting rods are ball shaped and nest between a pair of shoes 63 which in turn are engaged by the piston sections 60 and 61. These shoes are shaped on their face to fit the ball ends of the connecting rods and by the construction employed it will be apparent that modifications of the connecting rods will cause the pistons to move therewith but through a yielding connection which will permit relative movement between the piston sections and the ends of the connecting rods as is necessary for a constructions of this type.

At 39 is a reciprocable plunger which is mounted for sliding movement in the chambers formed by the auxiliary housings 2a and 2b. This plunger is provided with an opening through which the end of shaft 65 projects. Near the end of the shaft it is ball shaped, as indicated at 66. The extreme end of the shaft is provided with a projecting lug 67 positioned to engage the pins 68 and 69 mounted on the plunger 39. These pins are positioned 180° above or along a longitudinal element of the plunger. The plunger may be moved longitudinally by means of the shaft 41, the lower end 34 of which is threaded and engages a threaded passage in the upper end of the plunger. The shaft 41 projects upwardly through a bushing 10 mounted on the portion 2a and through a packing gland 40 as shown. The projecting end of the shaft is provided with a hand wheel 11, by means of which it may be turned. The plunger 39 is provided with a longitudinal passage 42 which opens at its ends on one face of the plunger, as shown in Figure 3, at the ports 43 and 44. Passages 37 and 38 are provided in the cover plate 2 and extend from the passage 25 to the wall along which the ported face of the plunger 39 slides. In a similar way passages 35 and 36 extend from the passage 26 in the cover plate 2 to the face along which the ported face of the plunger 39 slides. The lower end of the portion 2b is provided with a threaded opening in which a closure plug 45 may be mounted. This is provided so that access may be had to the parts. The shaft 65 is provided with a transverse bore 83 which opens at each end and communicates with a longitudinal bore 84 which extends through the shaft to the opposite side of the connecting rod spider assembly.

In the assembly of the machine the right hand cover plate 3 is applied to the central housing portion 1 so that the ports 50, 51 and 52 register with the ports 19, 18 and 17, respectively, and the ports 53, 54 and 55 register with the ports 14, 15 and 16, respectively. The arcuate ports 49 and 49a are positioned so as to be in the path of rotation of the right hand ends of the axial grooves 58. The left hand cover plate 2 is applied to the casting 1 so that the ports 28, 29 and 30 register with the ports 22, 21 and 20, respectively, and the ports 31, 32 and 33 register with the ports 23, 24 and 25, respectively. The arcuate ports 27 and 27a of this cover plate are likewise positioned so as to be in the path of rotation of the left hand ends of the grooves 58.

The operation of this pump will now be de-

scribed. It will first be assumed that hand wheel 11 is turned so that shaft 65 is swung upwardly so that its longitudinal axis coincides with the axis of rotation of the rotor and shaft 7. It will then be apparent that the pistons will not reciprocate regardless of the direction of rotation of shaft 7. In this position the rotor revolves, carrying the pistons around with it (since they are, of course, mounted therein) and carrying the connecting rods and connecting rod spider 80 with it. The pump will, of course, then not move any fluid. In this position the finger 67 does not engage the stops 68 and 69 so that shaft 65 is free to revolve. If the plunger 39 is longitudinally moved from this central position in either direction the pump will begin to operate and for any given speed the quantity of fluid pumped will depend upon the angular displacement of shaft 65. The angular displacement of this shaft will also cause an equal angular displacement of the connecting rods 81 with respect to the vertical. In other words, if the pump is not running and the shaft 65 is moved to either side of its central position the pistons will be initially positioned from a central position and, of course, each a different amount. For example, as shown in Figure 3, the left hand end of shaft 65 has been depressed. This causes a shifting of the connecting mechanism and the pistons. The uppermost piston is shifted to the extreme left and the lowermost piston to the extreme right. Between these two extreme positions the other pistons will be at intermediate positions.

It will be assumed that the rotor is revolved by any suitable power source, such as, for example, a constant speed electric motor, in a clockwise direction, viewing the device as in Figure 2, or from the right hand end of Figure 3. It is also assumed that the shaft 65 is depressed, as shown in Figure 3, and that the fluid supply pipe is connected to the ported projection 9 and the discharge pipe is connected to the ported projection 8. Fluid will then flow from 9 into passage 13 in the casting 1 and then into passage 46 in the cover plate 3 through the registering ports 14-53, 15-54 and 16-55. Fluid will then flow from passage 46 through port 49a into those rotor grooves which are in alignment therewith. As a rotor groove moves into alignment with port 49a it will begin to recede from the port and draw fluid thereinto. At the same time fluid will flow from passage 13 into passage 26 in the cover plate 2 through the ports 23-31, 24-32 and 25-33 which are in registry. From passage 26 the fluid will flow through port 27 into the ends of the grooves 58 as they register with that port, as previously described. In the assembled machine the ports 49a and 27 are on opposite sides of the rotor and so positioned that the grooves 58 in which the pistons are receding from those sides are in registry therewith. As the grooves 58, which are really the cylinders, fill with fluid they move out of registry with the ports 49a and 27 opposite those areas of the end plates which are not ported and hence which seal them.

The fluid is then carried by the cylinders or grooves 58 until their ends register with the ports 49 and 27a, respectively. The fluid then flows through port 49 into passage 47 in the cover plate 3. From this passage it flows into passage 12 in the casting 1 through the ports 50-19, 51-18 and 52-17 which are in registry. Likewise, on the other side of the rotor, as the

cylinders move into registry with port 27a the fluid is forced through port 27a into passage 25 in the cover plate 2. From this passage the fluid flows into passage 12 in the casting 1 through ports 28-22, 29-21 and 30-20 which are in registry. In the passage 12 the fluid combines and goes out through the passage in the ported projection 8 to the discharge pump. As will be apparent, when the cylinders 58 are in registry with the ports 49 and 27a the pistons are moving towards those ports so as to force the fluid from the cylinders.

The direction of flow of fluid through the pump is simply reversed by operating the hand wheel 11 to move the plunger upwardly so that shaft 65 moves above the horizontal. For the same direction of rotation of shaft 7 it will be apparent to those skilled in the art that the direction of fluid flow through the pump is reversed. In this case the various inlet passages as traced above simply become the outlet passages, and the outlet passages as traced above become the inlet passages.

Assuming now that the parts are in the position first assumed, namely, that of Figure 3 with plunger 39 in the position shown, it will be seen that passage 25 is a pressure passage so that the fluid will be also forced through the passage 38 into the hollow rotor issuing from the plunger around the shaft 65. Fluid can also flow through passages 83 and 84 to the other side of the spider assembly so that the same pressure that exists on the discharge side of the pump is applied to both sides of the spider assembly. The segmental plates 82 are provided and positioned so as to protect certain portions of the side faces of the spherical assembly within the rotor while leaving other portions exposed to fluid pressure so as to counteract or oppose the forces acting on the spherical member as a result of the pressures created by the pistons as they pump fluid. It is again emphasized that the segmental members 82 are rigidly fixed to the shaft 65 which shaft does not normally revolve. These segmental members are displaced 180 degrees with respect to each other, and are positioned as shown in Figure 3, so that the side faces of the central spherical member or assembly are exposed to the fluid pressure which reaches them through the passage 84 in the shaft 65, so as to apply a turning force to the spherical assembly which counteracts the pressure on the piston rods 81 acting through the pistons as they pump fluid. Briefly, this arrangement subjects the central assembly to a fluid pressure which balances the pressure exerted by the pistons on the piston rods, and therefore places this part of the assembly in balance. This balances the fluid pressure on the spider assembly, thereby eliminating any unbalanced forces thereon. While, of course, there is an oil film between the plates 82 and the rotary parts 80' for purposes of lubrication, this film does not transmit much pressure to the faces of the parts 80' because of the high pressure gradient in the film. The pressure in the space within the rotor is transmitted in a very small part through this film but this pressure rapidly dies off so that it may be readily compensated for by a slight enlargement of the 70 plates to get the full shielding effect desired. Furthermore, the tendency for any pressure to build up between the plates 82 and the rotary parts 80' is being continually prevented by reason of the relative movement between these 75

parts whereby the plates 82 are continually scraping the oil film from the parts 80'. In other words, the relative movement between the parts is continuously destroying the film that has previously formed, necessitating the continuous rebuilding of the film which cannot occur at a rapid enough rate when the mechanism is in operation to cause the building up of any substantial amount of pressure between these parts.

Fluid also flows from passage 25 through passage 37 to the space above the plunger 39. This balances the upward pressure on the plunger caused by the tendency of shaft 65 to swing back to central position. It is clear to those skilled in the art that compensation for the unbalance caused by the application of pressure to the ends of the plunger 39 is provided in determining the proper area of the segmental plates 82 for any particular structure. The relative areas of the ends of the plunger and of the segments 82 may be varied to secure balance for different designs and the additional balance provided by the plunger may be found to be particularly beneficial in those cases where the areas of the segments 82 cannot for other reasons be reduced as much as would be necessary to get a balance with the segments and without the plunger. Thus when the hand wheel 11 is turned to move the plunger to a different position, pressures thereon are substantially balanced so that the hand wheel may be easily manipulated. The reaction pressures acting through the piston rod spider and which tend to tilt the rotor and increase bearing friction, are counterbalanced by the pressures in the grooves 1a and 1b. When passage 12 in the casting 1 is a pressure passage fluid is introduced into the left hand groove 1a, Figure 7, through the passage 14'', and the right hand groove 1b through the passage 17' so as to be applied at opposite ends of the rotor and at 180° apart. The result is that the tendency of the rotor to tilt is eliminated. When the direction of fluid pressure is reversed, passage 26 in the cover plate 2 becomes a pressure passage and fluid under pressure is supplied to the bottom of the plunger 39 to counteract the tendency of the shaft 65 to react downwardly. Likewise pressure is supplied to the right hand groove 1a and the left hand groove 1b from the pressure passage 13 in the casting 1 to counteract the tendency of the rotor to tilt in the opposite direction.

When the shaft 65 is moved from the position shown to a point above the horizontal the reaction forces set up cause shaft 65 to revolve through an angle of 180° so that finger 67 engages the pin 68 to limit its rotation. This automatic rotation also re-positions the segmental plates 82 to cause a proper balance of the fluid pressure on the spider which pressure is now reversed in direction of action. When the parts are in the position shown in Figure 3 the finger 67 engages the pin 68 which holds it against any tendency to move further in a clockwise direction, when viewed from the left hand end of Figure 3. The stop pins 68 and 69 are positioned to limit the rotational movement of shaft 65 so that the segmental plates 82 will be properly positioned to effect pressure balance of the spider as described above.

From the above description it will be apparent that this invention involves certain physical embodiments, only one of which has been illustrated in the drawings. I do not, therefore, de-

sire to be strictly limited to the disclosure as given for purposes of illustration but rather to the scope of the appended claims.

What I desire to secure by Letters Patent is:

1. A variable delivery pump of the type described comprising a stator having inlet and discharge passages in the walls thereof, a rotor journaled in said stator having a plurality of axial channels intermittently communicating with said passages as the rotor revolves, pistons slidably mounted in said channels, a ring member journaled in said rotor, a piston rod extending from the ring to each of said pistons, a spindle journaled in said ring, adjustable means mounted on the stator for varying the angle between the spindle and the axis of the rotor, said adjustable means including a plunger slidably mounted in the stator and having an aperture therein into which the end of the spindle fits and means for applying fluid pressure on opposite ends of said plunger to balance it.

2. A variable delivery pump comprising a casing having an internal chamber connected to inlet and outlet ports, a rotor mounted in said chamber, a plurality of reciprocal pistons mounted in said rotor, a piston rod for each piston, means for connecting all of said piston rods together, supporting means forming a rotatable support for said connecting means, and means including segmental plates for applying fluid pressure to limited portions of opposite faces of said supporting means to counteract the forces acting thereon as the pistons pump fluid.

3. A variable delivery pump comprising a casing having an internal chamber connected to inlet and outlet ports, a rotor mounted in said chamber, a plurality of reciprocal pistons mounted in said rotor, a piston rod for each piston, means for connecting all of said piston rods together, supporting means forming a rotatable support for said connecting means, means including segmental plates for applying fluid pressure to restricted portions of said supporting means to counteract the forces acting thereon as the pistons pump fluid, and means for positioning said support and connecting member to vary the stroke of said pistons.

4. A variable delivery pump comprising a casing having an internal chamber connected to inlet and outlet ports, a rotor mounted in said chamber, a plurality of reciprocal pistons mounted in said rotor, a piston rod for each piston, means for connecting all of said piston rods together, supporting means forming a rotatable support for said connecting means, means for applying fluid pressure on restricted portions of opposite faces of said supporting means to counteract the forces acting thereon as the pistons pump fluid, means for positioning said support and connecting member to vary the stroke of said pistons, and means for applying pressure fluid in opposite directions to said last mentioned means to facilitate manipulation thereof in either direction.

5. A fluid pressure pump as described comprising a casing forming a closed chamber having inlet and outlet ports, a rotor journaled in said casing, a plurality of pistons reciprocally mounted in the rotor, means for connecting all of said pistons together, an angularly positionable shaft for rotatably supporting said means, means for shielding portions of opposite faces of said means and means for applying fluid pressure to the exposed portions of said means for connecting the

pistons together to counterbalance the reaction forces acting through the pistons as they pump fluid.

6. A variable delivery fluid pump of the type described comprising a casing having inlet and outlet ports, a hollow rotor journaled in said casing, a plurality of pistons reciprocally mounted in said rotor, means including a ring member for connecting all of said pistons together, a bearing assembly for said ring member, an angularly positionable shaft connected to said bearing member, manual means for varying the angular position of said shaft, said manual means including a reciprocal plunger connected to said shaft and slidably mounted in the casing, and means for applying a balancing fluid pressure to the opposite ends of said plunger.

7. A variable delivery pump of the type described comprising a casing having inlet and outlet ports, a hollow rotor mounted in said casing, a plurality of pistons reciprocally mounted in said rotor, a piston rod for each piston, a member for connecting all of the piston rods together, said member being mounted within the rotor, a bearing for said member, an angularly positionable shaft for supporting said bearing, means for angularly positioning the shaft, plates mounted on said shaft and movable therewith for selectively protecting portions of the side areas of said bearing, and means for supplying pressure fluid to the sides of said bearing at the exposed areas to

counteract the reaction forces acting thereon as the pistons pump fluid.

8. A variable delivery pump comprising a closed casing having inlet and outlet ports, a rotor journaled in said casing, a plurality of pistons reciprocally mounted in the rotor, each piston comprising two longitudinally spaced parts, a plurality of connecting rods for said pistons each having an end lying between the parts of the associated piston, means for resiliently pressing the piston parts against the ends of the piston rods, means for securing said connecting rods together, and means for positioning the connecting rods at an angle to the axis of the rotor whereby the pistons are caused to reciprocate when the rotor revolves.

9. A variable delivery pump comprising a stator casing having inlet and discharge passages in the wall thereof terminating in inlet and outlet ports, a rotor journaled in said casing having a plurality of axially reciprocal pistons mounted therein, means interconnecting all of said pistons including a member positionable at an angle to the axis of rotation of the rotor for adjusting the stroke of said pistons, segmental plates mounted on opposite faces of said members to cover portions thereof, and means for applying pressure fluid to the exposed portions of said member to balance it against the piston reaction forces.

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