

Feb. 18, 1958

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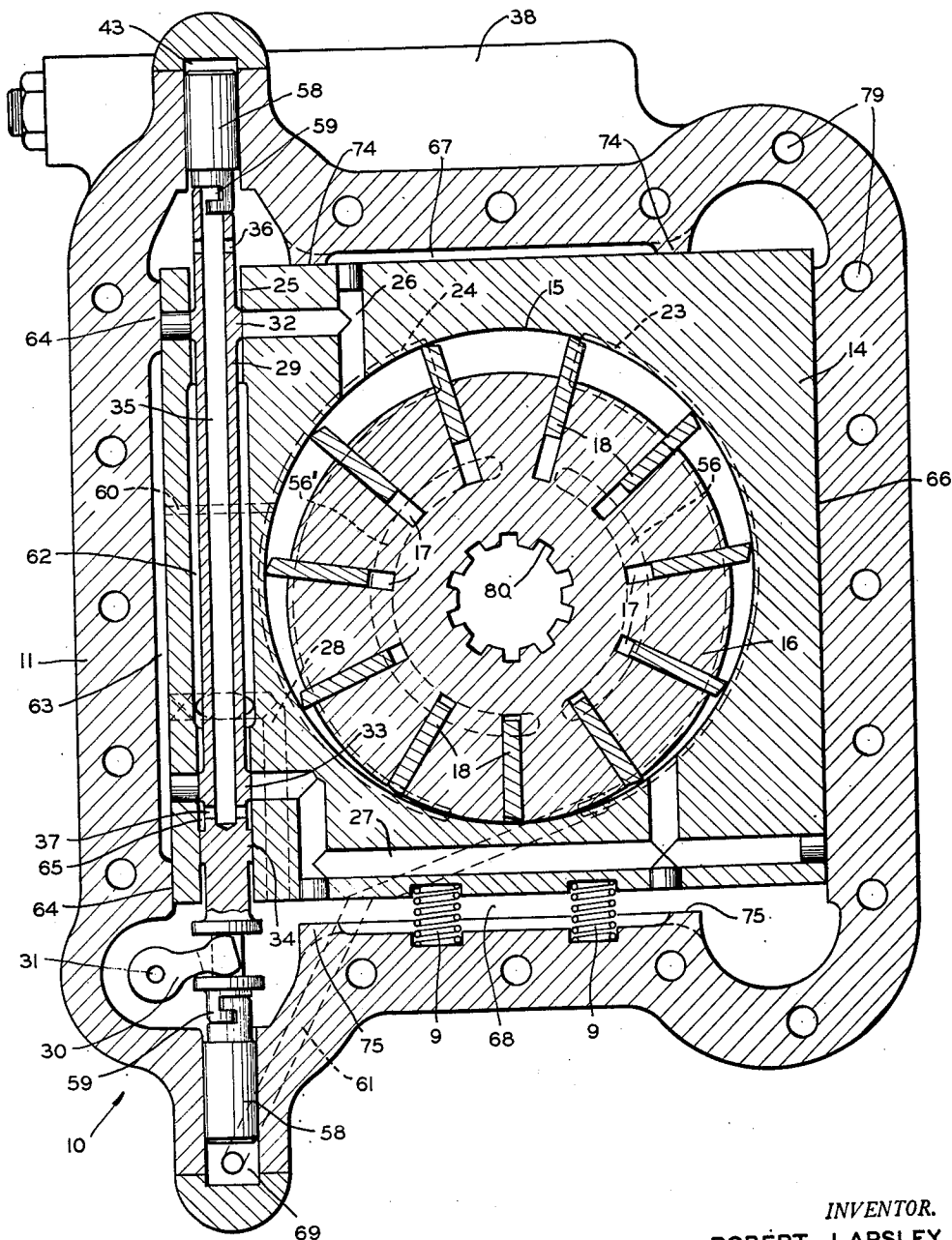
2,823,614

PUMP

Filed June 13, 1952

3 Sheets-Sheet 1

FIG. 1



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FIG. 2

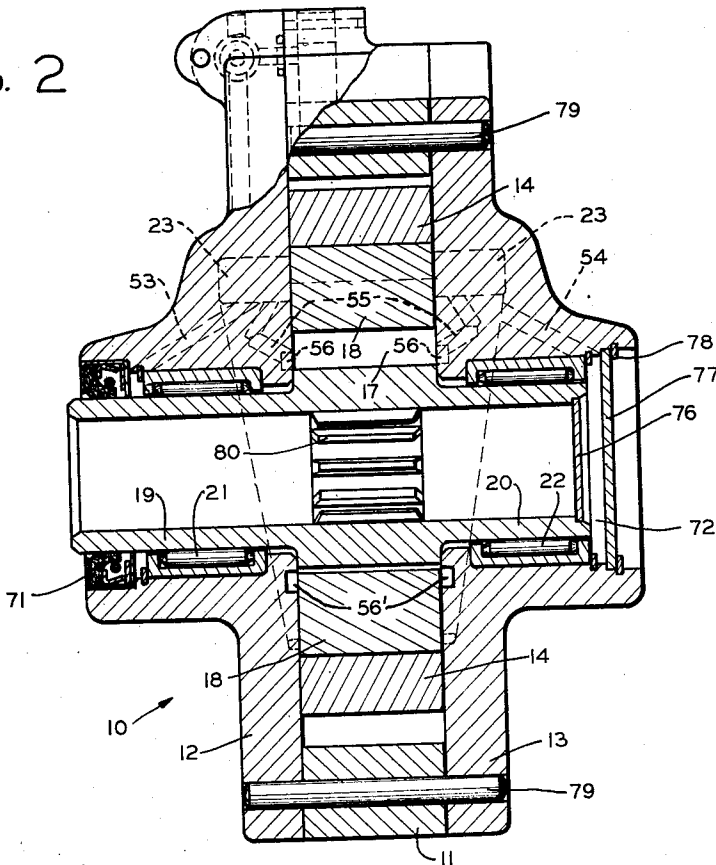
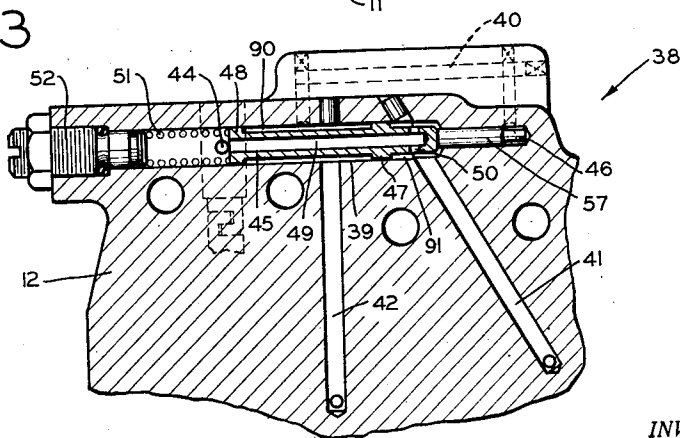


FIG. 3



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FIG. 4

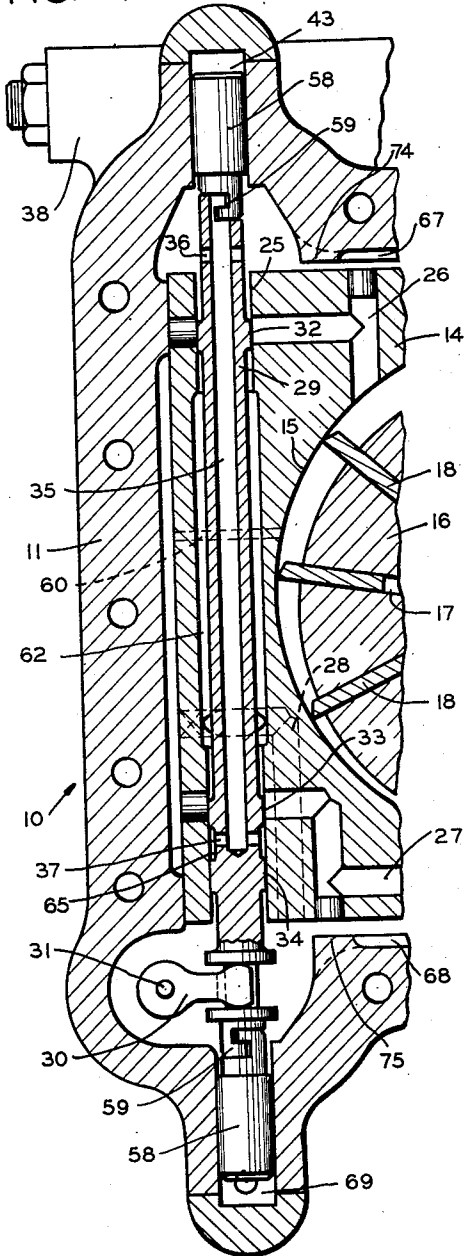
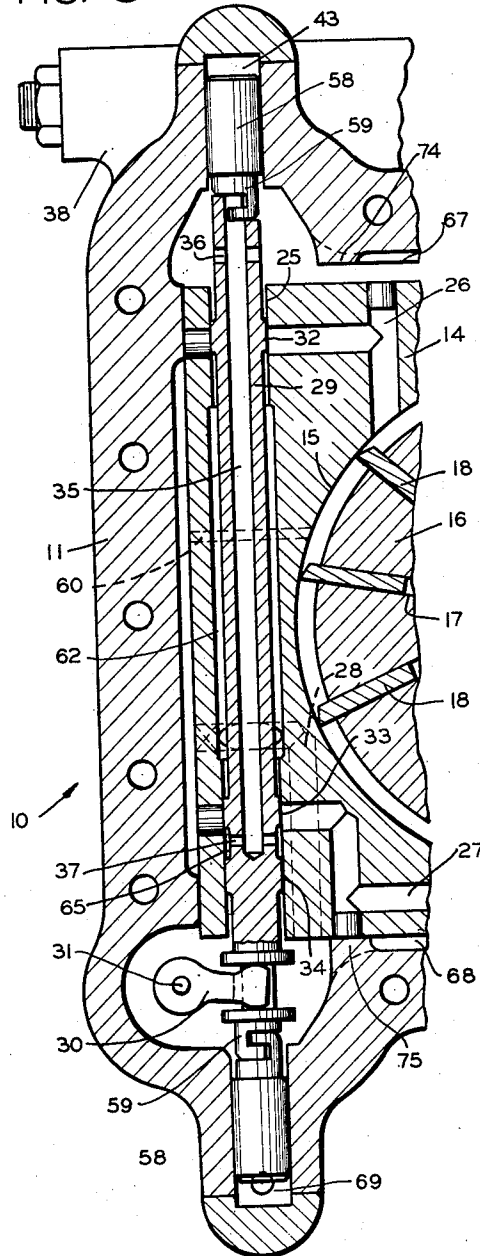


FIG. 5



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9 Claims. (Cl. 103—120)

My present invention relates generally to pumps, and, more specifically, is directed to pumps in which the volume of fluid discharged thereby may be varied.

It is an object of my present invention to provide a pump wherein the volume of the fluid discharged thereby may be varied selectively.

It is a further object of my present invention to provide a pump, as described, wherein the volume of fluid to be delivered by the pump may be preselected within the capacity of the pump.

It is a further object of my present invention to provide a pump wherein the minimum volume of fluid discharged thereby will be sufficient to maintain the pump elements properly lubricated, and prevent any considerable flow from pressure lines connected to the discharge port back to the intake port through the pump elements.

In the accomplishment of the above objects, I contemplate the provision of a pump having a housing in which is slidably mounted a casing. A chamber is formed in the casing, and disposed therein is a rotor which is adapted to be rotated. Suitable intake and discharge ports are formed in the housing and communicate with the chamber. In addition, fluid passageway means are formed in the casing which have communication with the intake and discharge ports. A slidable valve is mounted in the casing and has passageway means formed therein. The valve and passageway means are so arranged that through movement of the valve the discharge port may be placed in communication with the interior of the housing at one or the other of the ends of the casing while the intake port is placed in communication with the interior of the housing at the opposite end of the casing. As a result, the casing may be shifted relative to the housing and rotor thus permitting the eccentricity of the casing relative to the rotor to be varied. The volume of fluid delivered by the pump is dependent on the degree of eccentricity of the casing and thus by varying the latter, the volume of fluid delivered by the pump may be varied.

It is another object of my present invention to counterbalance the eccentricity adjusting means so that changes in volume of fluid pumped can be readily and smoothly accomplished at all times irrespective of the pressure of the fluid being delivered by the pump.

It is another object of my present invention to provide a pump of the character noted wherein a safety valve assembly is embodied for automatically returning the casing toward zero eccentricity, at which point no considerable volume of fluid will be discharged by the pump, when the pressure of the fluid at the discharge port exceeds a predetermined value.

In the accomplishment of the last noted object, the safety valve assembly is arranged primarily between the discharge and intake ports and the one end of the valve. Now when the pressure of the fluid at the discharge port exceeds the predetermined value, the discharge port and the one end of the valve are placed in communication. The pressure of the fluid at the one end of the valve is

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compressed and a force is exerted on the valve causing the latter to move to a position wherein the eccentricity of the casing and the volume of fluid delivered by the pump are reduced until the pressure of the fluid decreases to a safe value.

Another object of my present invention is to provide an articulated valve so as to prevent deflection thereof that would cause binding during movement of the valve.

Now, in order to acquaint those skilled in the art with the manner of constructing and using pumps in accordance with the principles of my present invention, I shall describe in connection with the accompanying drawings, a preferred embodiment of my invention.

In the drawings:

Figure 1 is a vertical sectional view of the pump of my present invention taken transversely of the drive shaft thereof with the pump elements arranged for pumping maximum volume;

Figure 2 is a substantially vertical sectional view of the pump of Figure 1 taken along the axis of the drive shaft;

Figure 3 is a vertical sectional view of the safety valve of the pump of Figure 1;

Figure 4 is a partial sectional view of the pump of Figure 1 taken transversely of the drive shaft and shows the pump elements arranged for pumping an intermediate volume of fluid while the adjusting valve is positioned to cause the pump elements to move to decrease the volume of fluid delivered; and

Figure 5 is a partial sectional view of the pump of Figure 1 taken transversely of the drive shaft and shows the pump elements arranged for pumping minimum volume while the adjusting valve is positioned to cause the pump elements to move to increase the volume of fluid delivered.

Referring now to the drawings, there is shown a pump housing 10 comprising an intermediate portion 11 and end plates 12 and 13 suitably located and secured thereto by the dowels 79. Disposed within the pump housing 10 is a generally rectangular movable vane casing 14 which is guided on one side by the two guide surfaces 64, which define a fluid chamber 63, and on the opposite side by the support surface 66. The casing 14 is normally biased to the position shown in Figure 1 by springs 9. A cylindrical chamber 15 is formed in the casing 14, and mounted for rotation therein is a rotor 16 having a plurality of circumferentially spaced radially extending grooves 17 in which are slidably mounted vanes 18. The rotor 16 is provided with axially extending tubular portions 19 and 20 which are journaled, respectively, in rollers or needle bearing assemblies 21 and 22 secured within the end plates 12 and 13 of the pump housing 10. The rotor 16 is adapted to be rotated through the splines 80 by any suitable prime mover means for effecting rotation of the vanes 18 within the chamber 15. Suitable intake and discharge ports 23 and 24 and vane control ports 56 and 56' are formed in the pump housing 10 at each side of the rotor 16 and communicate with the chamber 15 at opposite sides thereof as viewed in Figure 1.

A fluid seal 71 is mounted at the outer end of tubular portion 19 of the rotor 16 for preventing fluid from leaking therepast. Fluid collected at the fluid seal 71 is returned to the intake port 23 through the fluid passageway 53. A plug 76 is mounted in the outer end of the tubular portion 20 of the rotor 16 for preventing fluid from leaking into the drive opening of the rotor 16. A plug 77 is mounted, by means of a retainer ring 78, in the end plate 13 for preventing fluid from leaking out of the pump. The plugs 76 and 77 form a fluid chamber 72 wherefrom fluid leaking from the pump elements

is returned through fluid passageway 54 to the intake port 23.

A vertically extending opening 25 is formed in the casing 14 at the left side thereof as viewed in Figure 1. At the upper end of the casing 14, a fluid passageway 26 is formed which communicates at one end with the opening 25 and at the other end with the discharge port 24. At the lower end of the casing 14, a fluid passageway 27 is formed which communicates at one end with the opening 25 and at the other end with the suction port 23. Another fluid passageway 28, which communicates at one end with the opening 25 and at the other end with the lower interior portion of the housing 10, is formed in the casing 14.

Extending through the opening 25 is a valve member 29 which is mounted for unrestricted sliding movement. The valve 29 has secured to its ends, by means of flexible joints 59, pistons 58 which are slidably mounted in the housing 10. The articulated valve construction prevents deflection thereof that would cause binding during movement of the valve 29, and serves to balance the latter against fluid forces during normal pumping but provides for positive endwise connection.

Rectilinear movement of the valve member 29 is adapted to be effected by means of a crank arm 30 mounted on an actuating rod 31 which may be automatically or manually actuated. The valve member 29 is formed with axially spaced enlarged portions 32, 33 and 34. Also formed in the valve member 29 is a longitudinal passageway 35 intersected at its upper end by a port 36, which opens into the upper chamber 67 of the housing 10, and at its lower end by a port 37, which communicates with an annular passageway 65 intermediate of the enlarged valve portions 33 and 34. An annular fluid passageway 62 is defined by the enlarged valve portions 32 and 33.

Arranged at the upper end of the housing 10 is a safety valve assembly indicated generally by the reference numeral 38. The safety valve assembly 38 is shown in section, in Figure 3, and includes a horizontal opening 39 formed in the end plate 12. A fluid passageway 40 communicates at one end with the forward end of the opening 39, and at the other end with the intermediate portion of the opening 39. The opening 39 is also placed in communication with the intake and discharge ports 23 and 24 through passageways 41 and 42, respectively. The opening 39 further communicates with the opening 43 at the upper end of the upper piston 58 of the valve member 29 through a passageway 44.

Disposed in the opening 39 are a safety valve member 45 and an actuator piston 57 which has a forward reduced nose portion 46 defining a fluid chamber. The valve member 45 is formed with enlarged portions 47 and 48 which define annular fluid passageways 90 and 91. A longitudinal port 49 is formed in the safety valve member 45 and opens outwardly at the left end thereof as viewed in Figure 3. A port 50 intersects the valve member 45 and communicates with the chamber 91.

A coil spring 51 is disposed in the opening 39 at the left end thereof for normally biasing the safety valve member 45 to the right. The spring 51 is adjusted and maintained in position by means of a nut and screw assembly 52.

As shown in Figure 2, passageways 55 place the intake ports 23 in communication with semi-annular grooves 56 which, in turn, communicate with the grooves 17 in the rotor 16 as they move therepast. Passageways, similar to 55, place the discharge port 24 in communication with semi-annular grooves 56' which, in turn, communicate with the grooves 17 in the rotor 16 as they move therepast. A horizontal passageway 60, as shown in Figures 1, 4 and 5, places the discharge port 24 in communication with the chamber 63 at one side of the casing 14.

The pressure created by the discharge fluid in chamber 63 forces the casing 14 toward the right and thereby

slightly overpowers the pressure of the fluid in the discharge half of the chamber 15 which urges the casing 14 to the left. This counterbalancing of the sidewise pressures assures free movement of the casing 14 when being adjusted for varying the volume of fluid delivered irrespective of the fluid pressure then existing.

The above described pump of my present invention operates in the following manner: The volume of fluid discharged by the pump is controlled through movement of the valve member 29 which controls movement of the casing 14 within the housing 10. Now, looking at Figure 5, it will be observed that the casing 14 is in its lowermost position, and that the chamber 15 is very nearly concentric with the rotor 16. In this position of the casing 14, no appreciable volume of fluid is delivered by the pump. Sufficient volume of fluid does flow, however, to leak past the running clearances of the pump elements to maintain the latter properly lubricated and to prevent any considerable flow from pressure lines connected to the discharge port 24 back to the intake port 23 through the pump elements. With the valve member 29 disposed in the position shown in Figure 5, the chamber 67 above the casing 14 will be placed in communication with the intake port 23 through port 36, passageway 35, port 37 and passageway 27. At the same time, the chamber 68 below the casing 14 will be placed in communication with the discharge port 24 through the passageways 26, 62 and 28. Thus, suction and pressure force the casing 14 to move upward until the openings 26 and 27 are aligned with the enlarged portions 32 and 33 of the valve member 29 whereby communication between the chambers 67 and 68, located above and below the casing 14, and the intake and discharge ports 23 and 24, is interrupted and the fluid in the chambers 67 and 68 is trapped therein. The fluid thus trapped in the chambers 67 and 68 prevents movement of casing 14 and the eccentricity of the latter will be maintained at such location until the valve 29 is moved to another position. The springs 9 urge the casing 14 upwardly to insure that pumping action will start.

When it is desired to have the pump deliver fluid at maximum capacity, the valve 29 is moved to the position shown in Figure 1 after which the casing 14 will move upwardly, under the force of fluid under pressure in chamber 68 and under suction in chamber 67, to the position shown in Figure 1. In this position of the pump elements, fluid is delivered at maximum capacity.

The volume of fluid delivered by the pump may be decreased by moving the valve 29 downwardly, for example, to the position shown in Figure 4. As the valve 29 is moved downwardly, the chamber 68 at the lower end of the casing 14 will be placed in communication with the intake port 23. Simultaneously, the fluid will be compressed in the chamber 67 above the casing 14. As the afore-noted fluid is compressed, the casing 14 is forced downwardly thereby until the passageways 26 and 27 are closed by the valve portions 32 and 33. It is to be understood that the valve 29 may be disposed in any one of an infinite number of positions and that the casing 14 will, in the manner described hereinbefore, assume a corresponding position. As a result, the volume of fluid delivered by the pump may be varied in infinite steps within the capacity of the pump.

When the pressure of the fluid at the discharge port 24 increases beyond a safe limit, the safety valve assembly 38 becomes operative. The elements of the safety valve assembly 38 are normally in the position shown in Figure 3. In this condition of operation, the upper end chamber 43 of the valve 29 communicates with the intake port 23 through passageway 44, port 49, port 50, and passageways 91 and 41. At the same time the fluid is compressed in the passageway 42, passageway 90 intermediate the valve portions 47 and 48, passageway 40, and chamber 46, at the end of piston 57. The spring 51 is pre-tensioned so

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as to prevent movement of the valve 45 to the left when the pressure of the fluid at the discharge port 24 remains below a predetermined safe value.

Now, should the pressure of the fluid at the discharge port 24 increase beyond a safe value, the valve 45 is urged to the left by the fluid under pressure acting in chamber 46 against piston 57 to press against the valve 45. Movement of the valve 45 to the left will cause the valve portion 48 to interrupt communication between passageway 44 and port 49. At the same time the passageway 44 will be placed in communication with the passageway 90 around the valve 45. Now, the fluid in the passageway 44 will be compressed against the upper end of piston 58 thus forcing the control valve 29 downwardly until the pressure developed at the pump discharge port 24 decreases to a safe value. If the valve 29 is moved to its lowermost position, the casing 14 will be returned to its lowermost position, as shown in Figure 5, and the pump will deliver no appreciable volume of fluid at the discharge port 24.

For the successful operation of a pump of the nature described, the valve 29 must never be restricted against free movement nor biased for movement by any other force than that exerted by the actuator lever 30 or upon the functioning of the safety valve 38. To assure free movement at all times, the valve 29 is seated at the ends only by means of the pistons 58. The center of the valve 29 is relieved so that exact straightness is not required.

The end pistons 58 are of the same diameter as the enlarged portions 32, 33 and 34 of the valve 29, thus providing for exact balancing of all forces that may be created by the fluid pressure or suction. The outer end of the upper piston 58 is in communication with the intake port 23 through the safety valve 38 and the outer end of the lower piston 58 is in communication with the intake port 23 through the passageway 61. This arrangement permits free movement of the valve 29 by action of lever 30 since no fluid can be trapped in the chambers 43 or 69 except upon the functioning of the safety valve 38.

It should be readily appreciated from the foregoing description that I have provided a pump the delivery volume of which may be varied in infinite steps within the capacity of the pump. In addition, I have provided a safety valve mechanism which automatically returns the pump toward zero discharge volume when the pressure of the fluid at the discharge port exceeds a predetermined value.

Now, while I have shown and described what I believe to be a preferred embodiment of my present invention, it will be understood that various rearrangements and modifications may be made therein without departing from the spirit and scope of my invention.

I claim:

1. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted for rotation in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, fluid passageway means in said casing having connection with said intake and discharge ports, a fluid balanced valve slidably in said casing lengthwise thereof and having fluid passageway means formed therein, means actuated exteriorly of said housing for operating said valve, said valve effecting through said fluid passageway means responsive to relative movement between said valve and casing connection of said discharge port with the interior of said housing at one end of said casing and said intake port with the interior of said housing at the other end of said casing or oppositely connecting them whereby said casing is subjected to fluid pressure at one end and to suction at its other end effective for shifting said casing endwise for controlling the eccentricity of said casing relative to said rotor so as to adjust the volume of fluid discharged by said pump.

2. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted

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for rotation in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, a valve opening formed in said casing lengthwise thereof, first passageway means formed in said casing and communicating with said valve opening and said discharge port, second passageway means formed in said casing and communicating with said valve opening and said intake port, third passageway means formed in said casing and communicating with said valve opening and the interior of said housing at one end of said casing, a valve slidable in said valve opening, means operable externally of said housing for actuating said valve, fourth passageway means formed in said valve, said valve being adapted to increase the eccentricity of said casing relative to said rotor upon relative movement between said valve and said casing in one direction by placing said discharge port in communication with the interior of said housing at the said one end of said casing through said first and third passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the other end of said casing through said second and fourth passageway means, and said valve being adapted to decrease the eccentricity of said casing relative to said rotor upon relative movement between said valve and said casing in the opposite direction by placing said discharge port in communication with the interior of said housing at the said other end of said casing through said first passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the said one end of said casing through said second and third passageway means and said valve opening.

3. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted for rotation in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, a valve opening formed in said casing lengthwise thereof, first passageway means formed in said casing and communicating with said valve opening and said discharge port, second passageway means formed in said casing and communicating with said valve opening and said intake port, third passageway means formed in said casing and communicating with said valve opening and the interior of said housing at one end of said casing, a valve slidable in said valve opening, fourth passageway means formed in said valve, said valve being adapted upon relative movement between said valve and said casing in one direction to increase the eccentricity of said casing relative to said rotor by placing said discharge port in communication with the interior of said housing at the said one end of said casing through said first and third passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the other end of said casing through said second and fourth passageway means, said valve upon relative movement between said valve and said casing in the opposite direction being adapted to decrease the eccentricity of said casing relative to said rotor by placing said discharge port in communication with the interior of said housing at the said other end of said casing through said first passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the said one end of said casing through said second and third passageway means and said valve opening, and selector means adapted to position said valve in any one of a plurality of positions whereby the eccentricity of said casing relative to said rotor may be set at any predetermined degree within the capacity of the pump, and said casing moving in slave response to movement of said valve until said first and second passageway means are closed by said valve.

4. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted for rotation in said chamber, intake and discharge ports

formed in said housing and communicating with said chamber, a valve opening formed in said casing lengthwise thereof, first passageway means formed in said casing and communicating with said valve opening and said discharge port, second passageway means formed in said casing and communicating with said valve opening and said intake port, third passageway means formed in said casing and communicating with said valve opening and the interior of said housing at one end of said casing, a fluid balanced slide valve reciprocal in said valve opening, fourth passageway means formed in said valve, said valve being adapted upon selected movement thereof in one direction relative to said casing to increase the eccentricity of said casing relative to said rotor by placing said discharge port in communication with the interior of said housing at the said one end of said casing through said first and third passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the other end of said casing through said second and fourth passageway means, said valve upon movement in the opposite direction thereof relative to said casing being adapted to decrease the eccentricity of said casing relative to said rotor by placing said discharge port in communication with the interior of said housing at the said other end of said casing through said first passageway means and said valve opening while simultaneously placing said intake port in communication with the interior of said housing at the said one end of said casing through said second and third passageway means and said valve opening, a secondary safety valve opening formed in said housing, fifth passageway means formed in said housing and communicating with said secondary safety valve opening and said intake port, sixth passageway means formed in said housing and communicating with said secondary safety valve opening and said discharge port, seventh passageway means between the intermediate portion and the one end of said secondary safety valve opening, eighth passageway means formed in said housing and communicating with said secondary safety valve opening and the one end of said valve, a secondary safety valve disposed in said secondary safety valve opening, ninth passageway means formed in said secondary safety valve, said secondary valve being normally positioned to place the one end of said valve and said intake port in communication through said fifth, eighth, and ninth passageway means and the said one end of said safety valve opening and said discharge port in communication through said sixth and seventh passageway means, and said safety valve being shifted when said discharge pressure increases above a predetermined value for effecting movement of said valve to a position causing a decrease in eccentricity of said casing relative to said rotor by placing said discharge port in communication with the said one end of said valve through said sixth and eighth passageway means.

5. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted for rotation in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, and means including a fluid balanced valve and fluid passageway means for selectively connecting the interior of said housing at one end of said casing with said discharge port and the interior of said housing at the other end of said casing with said intake port or oppositely connecting them whereby said casing is subjected to fluid pressure at one end and to suction at its other end effective for shifting said casing lengthwise for varying the eccentricity of said casing in either direction relative to said rotor so as to control the volume of fluid discharged by said pump, fluid chamber means formed in said housing at the side of said casing, said chamber means communicating with said discharge port, and fluid under pressure in said chamber means serving to counteract the fluid pressure internally of said pump for

maintaining said casing balanced sidewise so as to permit free movement of the latter.

6. In a pump, a housing, a casing slidably mounted therein, a chamber formed in said casing, a rotor mounted for rotation in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, fluid passageway means formed in said casing, a valve slidably in said casing lengthwise thereof for selective positioning to effect through said fluid passageway means connection of said discharge and intake ports with the interior of said housing at opposite ends of said casing whereby pressurized discharge fluid will be caused to act on one end of said casing while the opposite end of the latter is subject to intake suction for varying the eccentricity of the latter in either direction relative to said rotor so as to control the volume of fluid discharged by said pump, means for selectively positioning said valve means, fluid chamber means formed in said housing at the side of said casing, said chamber means communicating with said discharge port, fluid under pressure in said chamber means serving to counteract the fluid pressure externally of said casing for maintaining said casing balanced sidewise so as to permit free movement of the latter, pistons rigid with the ends of said valve in lengthwise movement but flexibly connected for sidewise movement whereby misalignment of said valve is compensated for and fluid forces exerted on said valve are counterbalanced, and said pistons being guided in said housing.

7. In a rotatable vane pump, a housing, a casing slidably mounted therein, a chamber formed within said casing, a vane-type rotor rotatably mounted in said chamber, intake and discharge ports formed in said housing and communicating with said chamber, first fluid balanced valve means including fluid passageway means for selectively connecting said discharge and intake ports with sub-chambers located between opposite ends of said casing and said housing, selected movement of said valve means serving to control the admission of discharge pressures in one of said chambers and intake suction in the other thereof to cause responsive movement of said casing for controlling the eccentricity of the latter in either direction relative to said rotor thereby to adjust the volume of fluid discharged by said pump, and second valve means including fluid passageway means communicating with the said intake and discharge ports for actuating said first valve means when the pressure at the discharge port of said pump exceeds a predetermined value to cause appropriate movement of said first valve means to decrease the eccentricity of said casing relative to said rotor and thereby reduce the pressure of fluid at said discharge port.

8. In a rotatable vane pump, a housing, a casing slidably mounted within said housing for rectilinear movement, a chamber within said casing, a vane rotor within said chamber having a fluid intake and discharge means communicative therewith, a fluid balanced slide valve within said housing, fluid passageways within said casing and slide valve selectively intercommunicating to connect said intake and discharge means with two sub-chambers formed between the opposite ends of said casing and said housing, and operating means engageable exteriorly of said housing for moving said slide valve means selected amounts to place one of said sub-chambers in communication with said intake means and the other sub-chamber in communication with said discharge means and vice versa as selected, thereby to produce corresponding slave movement of said casing relative to said rotor under the influence of discharge pressure in said one sub-chamber and intake suction in said other sub-chamber, the movement of said casing being measured by said selected movement of said valve means with the eccentricity thereof relative to said rotor adjusting the output volume of said pump.

9. The combination as set forth in claim 8 including extreme relief valve means responsive to pressures at

said discharge means, whereby when discharge pressure exceeds a predetermined limit said relief valve means is operated to direct said extreme pressure against one end of slide valve to override said operating means and return said slide valve to a position dictating corresponding slave movement of said casing to a position of minimum eccentricity relative to said rotor thereby to reduce said discharge pressure.

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