

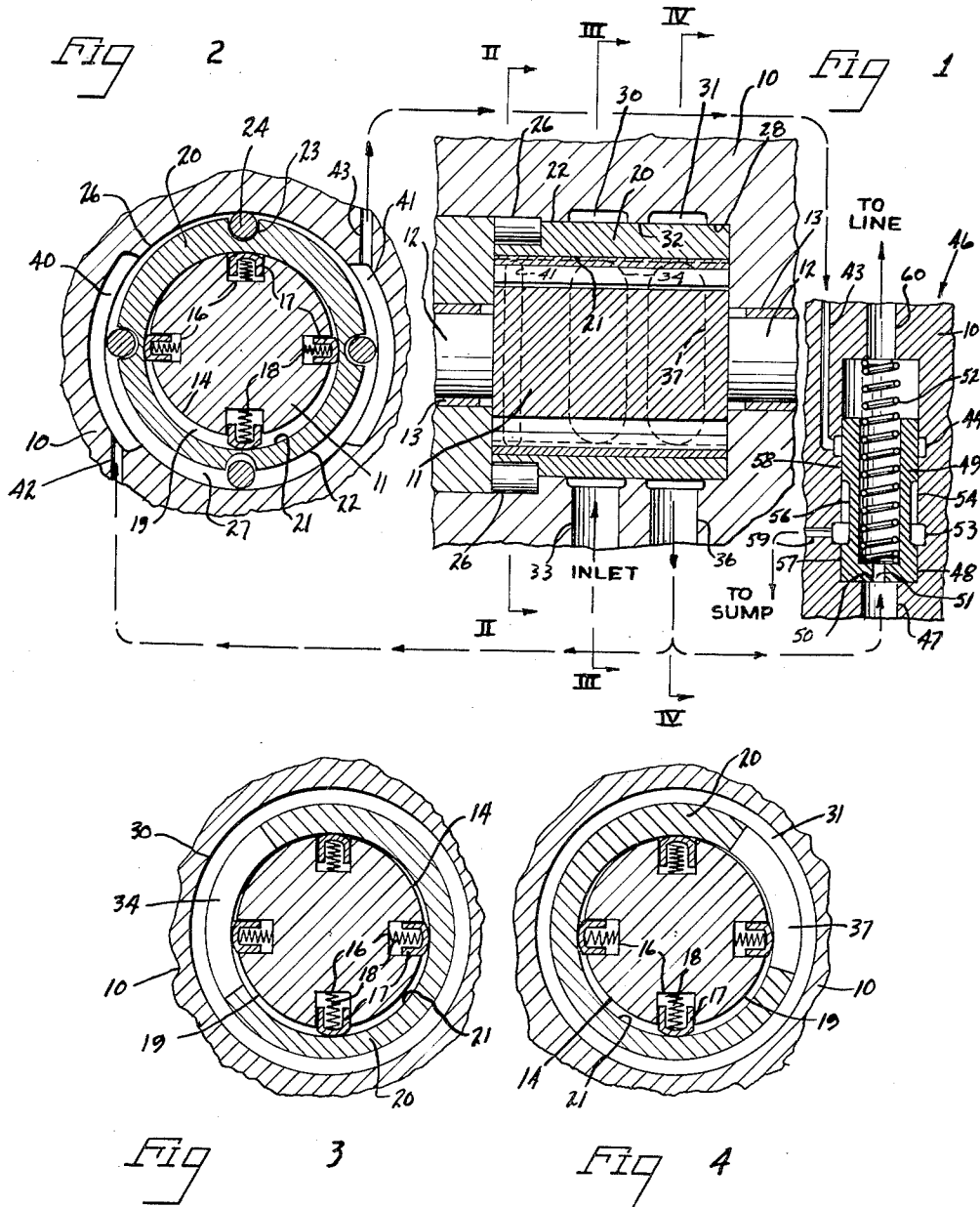
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VARIABLE DISPLACEMENT PUMP

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3,038,412

VARIABLE DISPLACEMENT PUMP

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4 Claims. (Cl. 103—120)

This invention relates generally to variable displacement pumps and more particularly relates to a method and apparatus of varying the displacement of a slipper-type pump wherein a rotatable header ring forming a working chamber for the pumping element carrying rotor is rotatably driven as a function of the flow discharge from the pump, thereby to afford a wide range of variable displacement.

It is an object of the present invention to provide an improved variable displacement pump.

Another object of the present invention is to provide a novel slipper-type pump construction.

A further object of the present invention is to provide improved variable displacement means for a slipper-piston-type pump.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheet of drawings in which a preferred structural embodiment of a pump incorporating the principles of the present invention is shown by way of illustrative example. The methods contemplated by the present invention will be clear to those versed in the art upon studying the selected structural embodiment for practicing such methods.

On the drawings:

FIGURE 1 is a somewhat schematic cross-sectional view showing a slipper-type pump incorporating the principles of the present invention and illustrating on the right-hand section thereof an orifice flow regulator control;

FIGURE 2 is a cross-sectional view taken substantially on line II—II of FIGURE 1;

FIGURE 3 is a cross-sectional view taken substantially on line III—III of FIGURE 1; and

FIGURE 4 is a cross-sectional view taken substantially on line IV—IV of FIGURE 1.

As shown on the drawings:

Although the pump of the present invention is of general utility and the methods of operation and regulation contemplated by the present invention could conceivably find other fields of application, the preferred structural embodiment described herein for purposes of illustration contemplates the utilization of a pump such as is employed for supplying pressurized fluid to a power assisted hydraulic system of a vehicle, for example, a power steering system.

There is shown, therefore, a casing 10 in which is rotatably supported a pump rotor 11 having oppositely extending shaft extensions 12 journaled in bearing sleeves 13.

As shown in FIGURE 2, the rotor 11 is particularly characterized by a peripheral surface 14 which is generally circular in cross-section and which has formed therein a plurality of peripheral recesses or notches 16 each receiving a pumping element 17.

The pumping elements 17 may conveniently comprise a so-called slipper-type pumping element which is free to move radially and to rock angularly in following the contour of an adjoining pumping chamber wall eccentrically disposed relative to the rotational axis of the

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rotor 11. In the form of the invention shown, each of the pumping elements 17 is preloaded radially outwardly by a continuous biasing means such as a coil spring 18.

A pumping chamber 19 is formed for the rotor 11 by an inner housing member also referred to herein as a header ring 20, or sometimes identified herein as an insert ring or member.

The ring 20 constitutes a generally circular ring having an inner bore surface 21 which is slightly larger in diameter than the outer peripheral surface 14 of the rotor 11. The ring 20 is further provided with an outer peripheral surface 22 spaced concentrically outwardly of the inner bore surface 21. As shown in FIGURES 1 and 2, at one end of the ring 20, the peripheral surface 22 is provided with a plurality of circumferentially spaced notches each indicated at 23 and receiving a sealing member which conveniently takes the form of a generally cylindrical pin 24 conforming in shape to the notch or recess 23 but projecting radially outwardly of the peripheral surface 22 for engagement with the adjoining wall surface of the casing 10.

In this connection, it will be noted that the casing 10 is particularly characterized by the formation therein of a bore wall 26 radially outwardly of the pins 24 which is of slightly larger diameter than the outer diameter of the peripheral surface 22 and which is eccentrically offset with respect to the rotational axis of the rotor 11 to provide around the notched portion of the ring 20 a working chamber 27 in which the pins 24 may be moved.

The casing 10 is further characterized by the formation of a bore wall 28 rotatably engaging the adjoining peripheral surface 22 of the ring 20, thereby supporting the ring 20 for rotation in the casing 10.

As will be noted on FIGURE 2, the ring 20 is also supported to be eccentrically offset relative to the rotational axis of the rotor 11, thereby providing a crescent-shaped working chamber 19. Thus, a sealing area is provided between the rotor 11 and the inner surface 21 of the ring 20 near the top of the pump using the orientation of FIGURE 2.

An inlet and an outlet for the pump unit is provided in the pump and in this connection it will be noted that the casing 10 has formed therein an annular inlet recess 30 and an annular outlet recess 31, both of which are spaced longitudinally with respect to one another and separated from one another by a land 32. The casing 10 is further shown with an inlet passage 33 communicating with the inlet recess 30.

In order to establish communication between the working chamber 19 on the inlet side of the pump and the inlet recess 30, as shown in FIGURE 3, the ring 20 is formed with an inlet port 34.

The casing 10 is also characterized by the formation of an outlet passage 36 which communicates with the outlet recess 31 for transmitting pressurized fluid to a point of utilization.

In order to communicate fluid from the working chamber 19 to the outlet recess 31, there is formed in the ring 20 an outlet port shown at 37 in FIGURE 4.

At opposite sides of the pump in the casing 10 there is formed a first recess 40 and a second recess 41, each communicating with the working chamber 27. The casing 10 is further provided with a passage 42 extending from the recess 40 to communicate with pump discharge at the passage 36, thereby communicating pump-generated pressure to one side of the working chamber 27.

The casing 10 is further provided with a passage 43 extending from the recess 41 on the opposite side of the pump and which passage 43 communicates with an

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nular valve recess 44 formed in a flow-regulating device indicated generally at 46. The flow-regulating device may comprise an integral part of the pump construction and is shown as a fragmentary sectional portion on the right-hand side of FIGURE 1. Thus, the casing 10 may have formed therein a flow passage 47 which communicates directly with the pump discharge passage 36 and is enlarged as at 48 to receive a spool-type valve member comprising a generally cylindrical sleeve 49 having an end 50 characterized by the formation of an orifice 51 therein in which is positioned in the flow passage 47. The sleeve 49 bottoms a coil spring 52 comprising a continuous biasing means for preloading the sleeve 49 in one direction. In addition to the valve recess 44, the casing 10 is further provided with a second valve recess 53 which is spaced axially from the valve recess 46, there being provided a land area 54 therebetween.

The peripheral surface of the sleeve 49 is also provided with an annular recess 56 having land areas 57 and 58 on opposite sides thereof. The valve recess 53 communicates through a passage 59 to a zone at low pressure such as the sump containing the supply of inlet fluid for the pump.

All fluid passing through the orifice 51 is directed to the line or point of utilization through the outlet passage 60.

By virtue of the arrangement thus provided, it will be appreciated that the ring 20 in addition to forming a working chamber for the pump rotor, also comprises part of an hydraulic motor in that fluid pressure from pump discharge in the discharge outlet 36 and communicated to the working chamber 27 tends to rotate the ring in counterclockwise direction using the orientation of FIGURE 2 if the fluid is permitted to flow between the recess 40 and the recess 41. The escape of fluid from the recess 41 through the passage 43, however, is regulated by the blocking and metering action of the valve arrangement provided by the orifice-type flow regulator control 46. By metering or blocking the flow from the recess 41, the insert ring 20 is either held stationary or is allowed to rotate in the same direction as the rotor 11. Moreover, by controlling the rotation of the ring 20 through the orifice flow control valve, the rotation of the ring 20 is made responsive to the discharge flow of the pump.

Accordingly, the structure described achieves a variable displacement pump since full discharge will be achieved when the insert ring 20 is held stationary. Moreover, lesser discharges can be effected upon permitting the ring to rotate. For example, half discharge rate would be achieved if the ring 20 were allowed to rotate at half the speed of the rotor 11. Furthermore, when free flow from the port or recess 41 is allowed, maximum rotation of the ring 20 is had and a zero discharge from the pump is approached.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In a pump, a casing having a cylindrical bore formed therein, said casing having a pair of longitudinally spaced annular recesses formed in the wall of said bore forming an inlet recess and an outlet recess, respectively, said casing further having formed at one end of said bore an enlarged recess with an outer wall thereof eccentrically offset relative to the casing axis to form a motor working chamber, an insert ring rotatably mounted in said bore and notched at one end inwardly adjacent said motor working chamber, a rotor inside of said insert ring, means for rotating said rotor at constant speed, sealing pin means in said notched portion of said insert ring engaging and following the outer wall of said eccentrically offset recess in said casing whereupon said insert ring will be rotatably driven in response to pressure flow through said motor

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working chamber in the same direction as said rotor, said rotor and the inner peripheral surface of said insert ring being eccentrically offset with respect to one another to form a pumping working chamber, said insert ring having an inlet port formed therein in register with said inlet recess and said insert ring having an outlet port formed therein in register with said outlet recess and control means for selectively communicating pump-generated pressure from said outlet port to said motor working chamber to rotatably drive said insert ring whereby the displacement of said pump can be selectively varied by variably rotating said insert ring relative to said rotor during the operation of said pump.

2. A pump as defined in claim 1, and said control means comprising flow regulating means for regulating the flow through said motor working chamber comprising a spool-type valve having an orifice therein, valve housing means positioning said spool-type valve in the discharge passage of said pump and valve recesses and lands formed in said valve housing means and communicating with said motor working chamber, said recesses and lands controlled by said spool-type valve in response to the flow rate for venting one side of said motor working chamber to a zone at low pressure, whereby the rotation of said insert ring will be controlled as a function of the flow rate.

3. A pump comprising inner and outer housing members each having a bore formed therein, a peripherally notched rotor in said bore of said inner housing member and being rotatable on an axis eccentrically offset with respect thereto, means to rotate said rotor at constant speed, a pumping element carried by said rotor at its peripherally notched portion and being free to move radially and to rock angularly for following the contour prescribed by said inner housing member upon rotation of said rotor, means forming a pump inlet and a pump outlet in said inner and outer housing members, whereby said rotor and pumping element move fluid from the pump inlet to the pump outlet under increased pressure for discharge to a point of utilization, said outer housing and said inner housing together forming a motor chamber having a wall eccentrically offset relative to a peripheral portion of the inner housing member, sealing means carried by said inner housing member at its peripheral portion and engaging and following the eccentrically offset wall of said outer housing member upon relative rotation between said inner and outer housing members, means forming an inlet for said motor chamber in said outer housing member on one side thereof and communicating with said pump outlet, means forming an outlet for said motor chamber and said outer housing member on the diametrically opposite side thereof, said inner housing member being rotatable in response to flow through said motor chamber, and flow control means in said pump outlet regulating the flow out of said motor chamber outlet as a function of the pump discharge flow rate, whereby full discharge from said pump is achieved when said inner housing member is held stationary and diminishing rates of flow are achieved by increasing the rotational speed of the inner housing member relative to the rotational speed of the rotor.

4. In a pump, casing means having formed therein an inlet and an outlet spaced longitudinally of one another, a rotor journaled for rotation by said casing means and carrying a pumping element for movably following the eccentricity of an adjoining wall in a pumping chamber in which said rotor operates, means for rotating said rotor at constant speed, a rotatable header member forming said pumping chamber having a cylindrical wall eccentrically offset to the rotor axis and providing said adjoining wall, said header member having formed therein an inlet port and an outlet port each in register with a corresponding inlet and outlet in said casing means, and means for varying the displacement of said pump from maximum to minimum by rotatably driving said header

member in the same direction as said rotor at speeds from zero to rotational speeds approaching the rotational speed of said rotor, said means for varying the displacement of said pump comprising means in said casing forming an adjoining wall eccentrically outwardly of a peripheral portion of said header member and together therewith forming a motor chamber, sealing means in said header member engaging and movably following said eccentrically outward wall in said motor chamber, inlet and outlet means formed in said adjoining casing wall of said casing means and communicating pump-generated pressure thereto for rotatably driving said header ring in the same direction as said rotor as a function of the flow rate between said inlet and outlet means, and a flow regulating means in said pump outlet regulating the flow out of said motor chamber outlet as a function of the pump discharge flow rate, whereby full discharge from said pump is achieved when said header ring is held stationary and diminishing rates of flow are achieved by increasing the rotational speed of the header ring relative to the rotational speed of the rotor.

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