Oct. 19, 1948. W. H. DE LANCEY 2,451,666

VARIABLE CAPACITY PUMP

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Fig. 1.

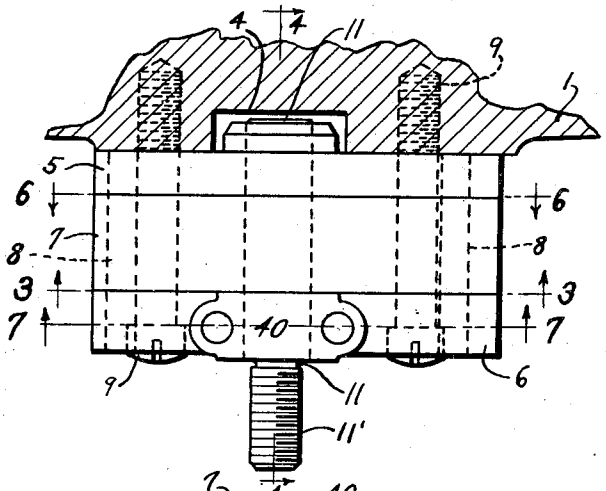


Fig. 2.

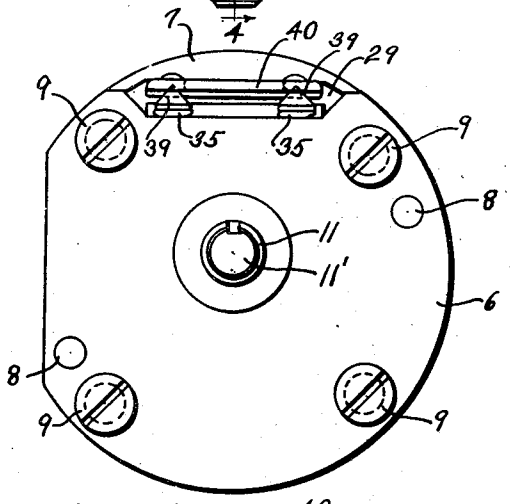
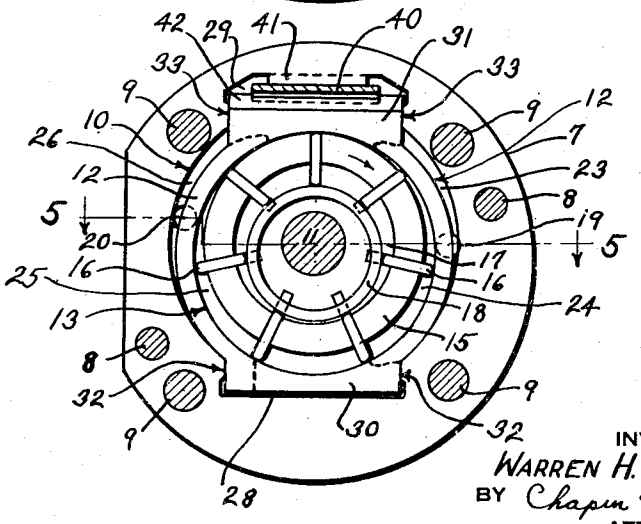


Fig. 3.



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Fig. 4.

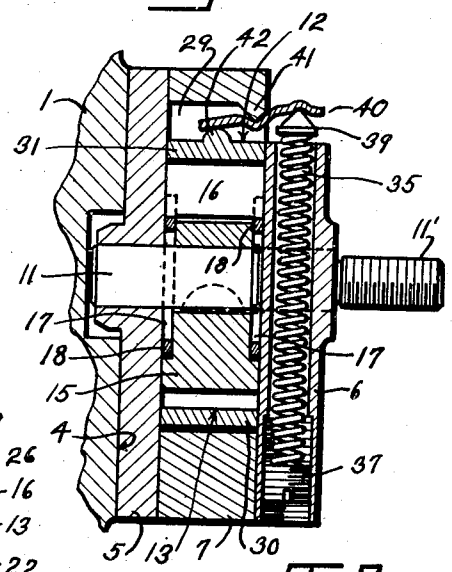


Fig. 6.

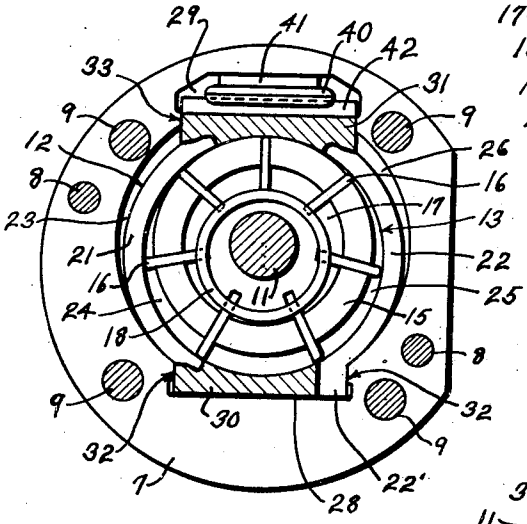


Fig. 7.

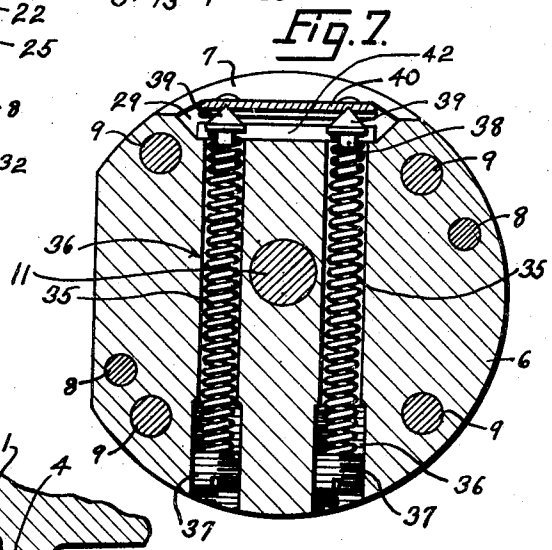
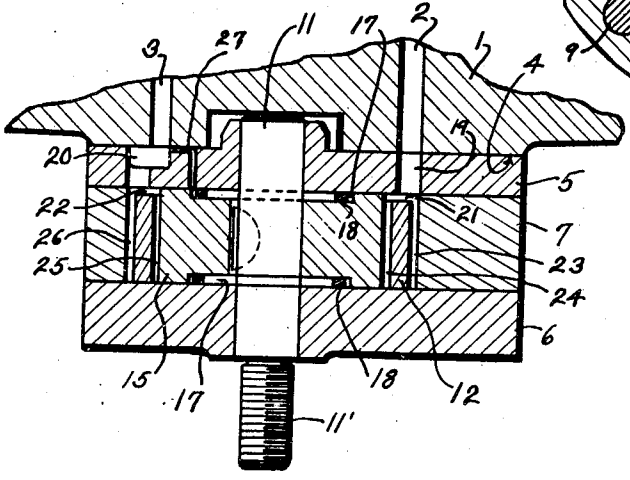


Fig. 5.



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VARIABLE CAPACITY PUMP

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Application November 1, 1945, Serial No. 626,023

5 Claims. (Cl. 103—120)

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This invention relates to improvements in variable capacity rotary pumps of the kind in which the capacity or pumping rate is varied automatically by the pressure of the fluid pumped in order to maintain the pressure of the pumped fluid constant irrespective of variations in the driving speed of the pump or in the load thereon.

An example of the prior art in this respect is the patent to Erskine No. 2,064,421 of 1936.

This application is an improvement on my application Serial No. 548,021, filed August 4, 1944.

The general object of the invention is to provide an improved pump of the class described which will cost less to make, will need less space for mounting and will be of less weight; also to make the pump more sensitive to pressure variations so that it will quickly and automatically adjust itself to maintain closer regulation and better precision in operation.

The invention is capable of general use. As one example of one specific use, the invention may be used in gasoline dispensing apparatus to vary the rate of flow from a maximum to zero accordingly as the valve of the dispensing nozzle is moved from fully open to fully closed position. As an example of another use, the pump may be used in the hydraulic system of an automobile to maintain fluid at a constant high pressure over a wide range of driving speeds. As an example of another use, the pump may be used in connection with an oil burner to supply fuel at rates of flow which vary over a wide range and to maintain the pressure of the pumped fuel constant. The invention will be disclosed herein in two illustrative examples particularly designed for the last two uses although not limited thereto.

The invention has for another object to provide in a pump of the class described a pressure-regulating valve carried by the same element which operates to shift the pump stator and vary the pumping rate,—such valve maintaining the outlet of the pump closed until the desired predetermined pressure has been established. This feature, while capable of other uses, is especially desirable where the pump is intended for use in an oil burner.

There are other objects relating to improvements in constructional features and these will best appear as the detailed description proceeds and they will be pointed out in the appended claims.

The invention will be disclosed with reference to the accompanying drawings in which—

Figs. 1 and 2 are top plan and front elevational

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views of one form of pump embodying the invention;

Figs. 3 and 4 are sectional elevational and cross sectional views taken on the lines 3—3 and 4—4, respectively, of Fig. 1;

Fig. 5 is a sectional plan view taken on the line 5—5 of Fig. 3; and

Figs. 6 and 7 are sectional elevational views taken on the lines 6—6 and 7—7, respectively, of Fig. 1.

The pump shown in Figs. 1 to 7 of these drawings is a commercial embodiment of the invention for use in the hydraulic system of an automobile. The whole system need not be described because the invention is concerned only with the pump and its mode of operation. It will suffice to state that the pump is adapted to be connected with the hydraulic transmission of an automobile and driven by the automobile engine. The driving speed of the pump may vary as much as from 80 R. P. M. to 4000 R. P. M. The purpose of the pump is to maintain a constant and steady hydraulic pressure over such a range of driving speeds. A preferred form of pump as actually designed for commercial use to accomplish the work described is shown full size in Figs. 1 to 7 of the drawings.

In Figs. 1, 4 and 5, there is shown a portion of a wall 1 which support the pump and which contains inlet and outlet passages 2 and 3 (Fig 5), respectively, extending to the finished face 4 of the wall. The pump (Fig. 1) includes a casing, comprising end plates 5 and 6 and an intervening member 7, all suitably held together. As shown, the casing parts 5, 6 and 7 are held in precise coaxial relation by a pair of dowel pins 8 (Fig. 2). The pump casing is suitably clamped to the face 4 of wall 1, as for example by a plurality of cap screws 9, which pass through the parts 5, 6 and 7 (Fig. 1) and thread into wall 1. The central member 7 has an opening (Figs. 3 and 5) extending axially there—through for housing the stator and the rotor of the pump. This opening is closed at its ends by the plates 5 and 6, except for certain passages in plate 5 to be later described, whereby a chamber 10 is formed having two flat parallel end walls, comprising the plates 5 and 6, and a peripheral wall comprising the boundary walls of said opening. The end plates 5 and 6 have bearings (Fig. 5) for rotatably supporting the pump driving shaft 11, which extends transversely through the chamber 10 and has a threated portion 11' projecting outwardly beyond end plate 6 for connection to any suitable driving element.

Referring to Fig. 3, the chamber 10 in member 7 receives a pump stator 12 which has two sub-

stantially flat parallel faces (Fig. 4) to engage one with each of the flat end walls of chamber 10 and a cylindrical opening 13 extending therethrough with its axis normal to said face and forming the pump chamber for the rotor of the pump. This rotor comprises a cylindrical barrel 15, keyed to shaft 11 and radially slotted at equal angularly-spaced intervals to receive radially slidable blades or vanes 16. The stator 12, barrel 15 and the vanes 16 are just slightly less in axial length than the casing 7 so that they slidably engage the inner faces of the end plates 5 and 6. The end faces of the rotor barrel 15 have shallow cylindrical recesses 17 therein (Figs. 3, 4 and 5) to receive, one in each, annular rings 18. Each ring engages the inner ends of all the blades 16 and holds the outer edges of all of them in engagement with the peripheral wall of the pump chamber 13. The plate 5 (Fig. 5) has inlet and outlet passages 19 and 20, respectively, which at their outer ends constantly communicate with the above-named inlet and outlet passages 2 and 3, respectively. The inner ends of the passages 19 and 20 constantly communicate with the chamber 10 on opposite sides of the pump rotor 15 (Figs. 3 and 5). The end faces of the two curved side portions of the stator 12, which faces lie adjacent plate 5, are relieved over a certain area so that they do not touch the end plate 5, whereby passages 21 and 22 are provided. These relieved portions or passages 21 and 22 are shown in complete form in Fig. 6. Fig. 6 is taken looking from the back of Fig. 5 wherefore the positions of the passages 21 and 22 in Fig. 6 are reversed from those in Fig. 5. The passage 21 enables inlet 19 to communicate with the space 23 between the outer wall of one curved portion of the stator and the adjacent inner wall of chamber 10 and also to communicate with the space 24 between the inner wall of said curved portion of the stator and the outer wall of the pump rotor. Thus, liquid under inlet pressure is admitted to opposite sides of the right hand curved portion of the stator 12, Fig. 3, whereby to balance the lateral thrusts thereon. Liquid admitted to the space 24 fills the spaces between successive pairs of vanes 16 as the rotor 15 turns in the direction of the arrow (Fig. 3) and liquid is thus carried to the outlet side of the rotor into a space 25 between the latter and the inner curved wall of the left hand curved portion of the stator. By means of recess 22, liquid may flow to outlet passage 20 and also to the space 26 between the outer wall of the left hand curved portion of the stator and the inner wall of chamber 10. It will be noted that liquid under outlet pressure acts equally on opposite sides of the last-named curved portion of the stator, whereby the lateral thrusts on such portion are balanced.

It will be noted that a passage 27 (Fig. 5) in end plate 5 allows some liquid under outlet pressure to enter the adjacent recess 17 in the rotor. Liquid entering this recess, can pass through the clearance spaces between the inner edges of vanes 16 and the bottoms of the grooves in which the vanes are mounted, and into the opposite recess 17 in the rotor. The several vanes are thus thrust outwardly by hydraulic pressure into close engagement with the peripheral wall of the pump chamber 13. Also, liquid under outlet pressure acts equally and oppositely against the ends of the rotor to balance the end thrusts on the same and prevent end thrust of the rotor on either of the end plates 5 and 6.

The chamber 10 in the casing 7 has two diametrically-opposite ends 28 and 29 (Fig. 3) to slidably receive the more or less rectangular ends 30 and 31, respectively, of the stator. The parallel sides of the ends 30 and 31 slidably engage narrow lands 32 and 33, respectively, formed on plate 7 in the peripheral wall of chamber 10. The lands 32 separate the inlet and outlet spaces 23 and 26 at one end from the space 28 and the lands 33 separate the inlet and outlet spaces at their other ends from the space 29. The passage 22 in the stator is extended, at 22' (Fig. 6), to allow liquid from the outlet side of the pump to reach the space 28. The end 30 of the stator functions as a piston and is acted on directly by hydraulic pressure, tending to move the stator 12 in a direction such as to carry the cylindrical pump chamber 13 into coaxial relation with the pump rotor 15 or in a direction such as to reduce the pumping rate.

The opposite end 31 of the stator is subjected to the pressure of suitable yieldable means, such for example, as the springs 35 (Figs. 4 and 7). These two springs are mounted, one in each of two parallel holes 36 which are provided in the end plate 6 one on each side of the shaft 11 and they extend entirely through this plate. Each hole 36, near one end, is threaded to receive a screw 37 which forms a seat for a spring 35 that is adjustable by turning the screw. The upper end of each spring has inserted therein the cylindrical stub 38 of a conical member 39. The two conical members 39 fit into depressions in the outer end of a lever 40 in the form of a pressed metal plate, which has a transverse groove fulcrumed on a knife edge 41, formed near the outer wall of chamber 29. The inner end of lower 40 bears against a rib 42 on the stator end 31. The springs 35 through the lever 40 tend to move the stator 12 in a direction such as to carry the pump chamber out of coaxial relation with the pump rotor, and such as to increase the pumping rate. It will be noted that the upper end of the outer end plate 6 is cut away so as to enable the space or chamber 29 to communicate with the atmosphere.

In operation of that form of the invention shown in Figs. 1 to 7, as the shaft 11 is driven at various speeds by the automobile engine, the stator 12 moves radially back and forth in its chamber 10 to vary the rate of pumping, as may be necessary to maintain a constant pressure at the outlet of the pump. Liquid from the discharge side 25 of the pump is introduced by way of passages 22 and 22' into a high pressure space 28 located beyond the end 30 of the stator. Such liquid acts directly on the stator to move it radially in opposition to the force of the springs 35. When these opposing forces are equal, the pump stator is balanced between them and the relative positions of the stator and rotor are such as to maintain a predetermined pressure at the pump outlet for that particular speed at which the rotor is being driven. If the rotor speed increases, then the momentary rise in pressure will move the stator to lower the pumping rate to make the outlet pressure the predetermined value. If the rotor speed decreases, then the momentary lowering of the pressure will allow the springs to move the stator in the opposite direction, to increase the pumping rate and until the outlet pressure is raised to its predetermined value. The action is a fast one, it taking but an instant of time to give the effect. Likewise, if the load on the pump changes, the stator will be automatically shifted to compensate for the change, in-

creasing or decreasing the pump rate as the load is respectively increased or decreased to maintain the outlet pressure constant at the selected valve. The particular outlet pressure desired may be obtained by adjustment of the screws 37 by means of a screw driver inserted in the holes 36. The pump will automatically maintain a constant outlet pressure irrespective of variations in speed or load. While the operation as described involves changes of pressure, they are momentary ones to cause correction by moving the stator. The effect is to give a substantially constant outlet pressure, any tendency to vary being instantly corrected by such tendency.

The pump parts are balanced to avoid any thrusts under heavy pressure of one part against another, which if permitted would result in heavy friction losses and rapid wear and would interfere with the sensitivity of movement which it is so desirable to attain. In particular the sliding member—the combined pump stator and piston—is balanced so that there is no substantial pressure of it on any of the lands 32 or 33 on which it slides. On the intake side of the pump, liquid in the spaces 23 and 24 acts equally and in opposite directions on the right hand (as viewed in Fig. 3) curved part of the stator and on the discharge side of the pump liquid in the spaces 25 and 26 acts equally and in opposite directions on the left hand curved part of the stator. By thus balancing the stator there is little pressure on the lands 32 and 33 and, by reducing the area of these lands as much as is feasible, the frictional resistance to sliding movement of the stator is kept within low limits. The relieving of one end face of the stator to form the inlet and outlet parts 21 and 22 also reduces the frictional resistance and the other face of the stator may also be relieved to still further reduce frictional resistance as will later appear. Thus, the stator is made sensitive to small variations in liquid pressure. It responds quickly to any changes in pressure with the result of closer regulation of the outlet pressure.

The pump structure is characterized by compactness. The one member serves as the stator of the pump and also as the piston, by means of which the stator is shifted to vary the capacity of the pump. Actually, this one member is little larger in size than would be necessary if it were to serve only as the pump stator. There are only the short, integral, end extensions 30 and 31 which respectively provide a piston at one end and an abutment at the other end for the spring-pressed lever to engage. The outside dimensions of the pump casing are not much greater than those of a rotary pump of similar type but of non-variable capacity. The arrangement of the springs also contributes to the desired compactness of structure. These springs are made relatively long to make the pump sensitive to pressure variations. These long springs are made to overlap the pump stator, rather than being arranged in extension thereof. Thus, the springs do not add to the radial extent of the pump structure. The springs may thus be carried by one of the end plates, and preferably housed therein as shown, so that they do not add to the axial length of the pump structure.

By the invention, a variable-capacity pump is provided which is of simple construction and may be produced in quantities at low unit cost. And the construction offers an efficient pump which will maintain the pressure of the pumped fluid constant at a selected value within close limits.

The pump is sensitive and responds quickly to small variations in pressure, thus enabling the desired close regulation of pressure. The pump has a minimum of parts and some parts serve two purposes such as the element which forms the pump stator and the piston for moving it. The construction is characterized by a very efficient utilization of the available space resulting in an extremely compact structure.

I claim:

1. A rotary pump, comprising, a casing having therein a central cylindrical chamber with two short diametrically-opposed recesses each of which has two short straight walls paralleling a diameter of said chamber, a hollow cylindrical member mounted in said chamber, the cylindrical opening in said member forming a pump chamber, said member having two diametrically-opposed ends projecting outwardly from its periphery one into each of said recesses, each such end having two straight parallel side walls engaged one with each of the first-named side walls to support said member for sliding movement radially of said cylindrical chamber, a drive shaft rotatably mounted in said casing, a bladed pump rotor fixed to the drive shaft and mounted in the pump chamber, said casing having inlet and outlet passages communicating with the pump chamber on opposite sides of the rotor, yieldable means acting on one end of said member and tending to move the pump chamber into eccentric relation with the rotor, and means connecting the discharge side of the pump to one of said recesses at a location beyond the other end of said member, whereby fluid pressure acts directly on such end as a piston and moves the member radially in opposition to said yieldable means to decrease the relative eccentricity of the pump chamber and rotor and thus the rate of pumping.

2. A rotary pump, comprising, a casing having therein a central cylindrical chamber with two short diametrically-opposed recesses each of which has two short straight walls paralleling a diameter of said chamber, a hollow cylindrical member less in outside diameter than the diameter of said chamber mounted in the latter and having two diametrically-opposed ends projecting outwardly from its periphery one into each of said recesses, each such end having two short straight parallel sides to engage one with each of said walls to slidably support said member for movement radially of said chamber, the opening through said member forming a pump chamber, a drive shaft rotatably mounted in said casing and extending transversely through said chambers, a bladed rotor fixed to said shaft, said member being movable to carry the pump chamber from a position of coaxial relation with the rotor to various other positions of non-coaxial relation, said casing having inlet and outlet passages to the pump chamber on opposite sides of the rotor, the space between one curved side of said member and the adjacent wall of the first-named chamber and the inlet space between said curved side and the rotor being interconnected and the space between the other curved side wall and the adjacent wall of the first-named chamber and the outlet space between the last-named curved wall and the rotor being interconnected, whereby to balance the member and avoid substantial side thrust on any of said walls, means connecting the outlet space of the pump to one of said recesses at a location beyond one of said ends, whereby fluid pressure acts directly on such end as a piston and moves the member radially to vary the rela-

tive eccentricity of the pump chamber and rotor and thus the rate of pumping, and yieldable means acting on said other end in opposition to such fluid pressure.

3. A rotary pump, comprising, a casing having two end plates and an intermediate member clamped between said plates, said member having an opening therethrough closed at opposite ends by said end plates and forming a chamber, a pump stator in said chamber having a cylindrical opening therethrough closed by said end plates and forming a pump chamber, said stator being slidable in a direction at right angles to the axis of the pump chamber, a pump rotor mounted in the pump chamber, a driving shaft fixed to the rotor and rotatably mounted in one of the end plates, vanes movably mounted in the rotor and contacting the periphery of the pump chamber, said casing having inlet and outlet passages communicating with the pump chamber on opposite sides of the rotor, spring means mounted in one of the end plates and acting on one end of the stator to move the pump chamber into eccentric relation with the rotor, the first-named chamber having a space beyond the other end of the stator connected to the discharge side of the pump chamber for moving the stator by hydraulic pressure in opposition to said spring to vary the relative eccentricity of the pump chamber and rotor, decreasing such eccentricity as the pressure increases.

4. A rotary pump, comprising, a casing having two end plates and an intermediate member clamped between said plates, said member having an opening therethrough closed at opposite ends by said end plates and forming a chamber, a pump stator in said chamber having a cylindrical opening therethrough closed by said end plates and forming a pump chamber, said stator being slidable in a direction at right angles to the axis of the pump chamber, a pump rotor mounted in the pump chamber, a driving shaft fixed to the rotor and rotatably mounted in one of the end plates, vanes movably mounted in the rotor and contacting the periphery of the pump chamber, said casing having inlet and outlet passages communicating with the pump chamber on opposite sides of the rotor, springs mounted in one of said end plates one on each side of said driving shaft and engaging at one end with seats in such plate, a lever pivoted in the casing and engaging the other ends of said springs and one end of said stator, said springs and lever acting on the stator with a tendency to move the pump chamber into eccentric relation with the rotor, the first-named chamber having a space beyond the other end of the stator connected to the discharge side of the pump chamber for moving the stator by hydraulic pressure in opposition to said spring to vary the relative eccentricity of the pump chamber and rotor, decreasing such eccentricity as the pressure increases.

5. A rotary pump, comprising, a casing having two end plates and an intermediate member clamped between said plates, said member having an opening therethrough closed at opposite ends by said end plates and forming a chamber, a pump stator in said chamber having a cylindrical opening therethrough closed by said end plates and forming a pump chamber, said stator being slidable in a direction at right angles to the axis of the pump chamber, a pump rotor mounted in the pump chamber, a driving shaft fixed to the rotor and rotatably mounted in one of the end plates, vanes movably mounted in the rotor and contacting the periphery of the pump chamber, said casing having inlet and outlet passages communicating with the pump chamber on opposite sides of the rotor, a lever fulcrumed intermediate its ends on said member and having one end engaging one end of said stator, spring means carried by one of the end plates and acting on the other end of said lever to move the stator to carry its pump chamber into eccentric relation with said rotor, the first-named chamber having a space beyond the other end of the stator connected to the discharge side of the pump chamber for moving the stator by hydraulic pressure in opposition to said spring to vary the relative eccentricity of the pump chamber and rotor, decreasing such eccentricity as the pressure increases.

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