Dec. 19, 1944. H. Z. GORA 2,365,263

ROTARY HYDRAULIC PRESSURE DEVICE

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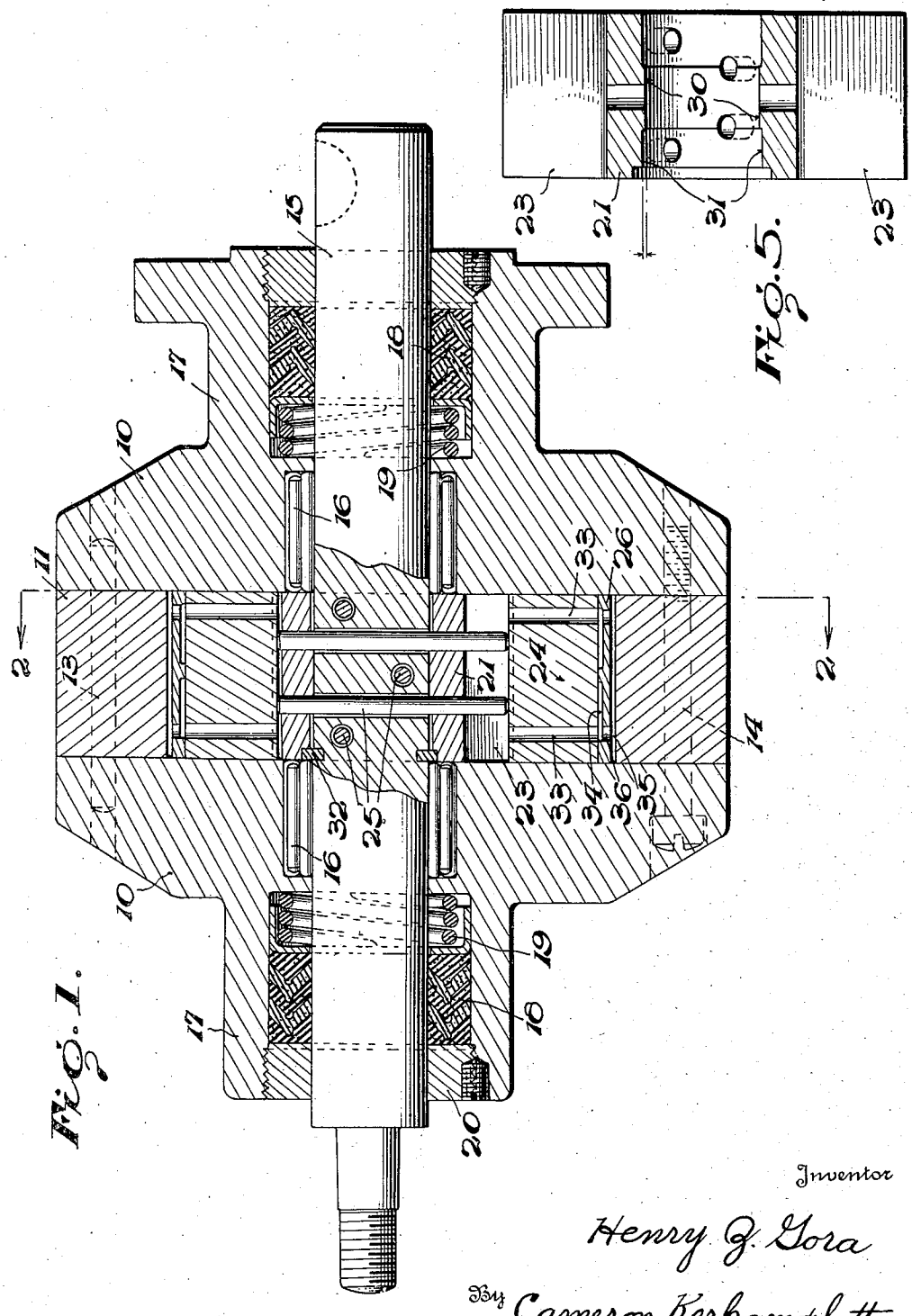

Fig. 1.

Fig. 5.

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Fig. 3.

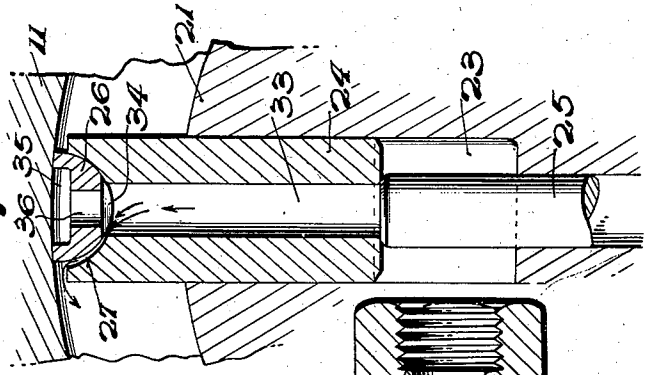


Fig. 4.

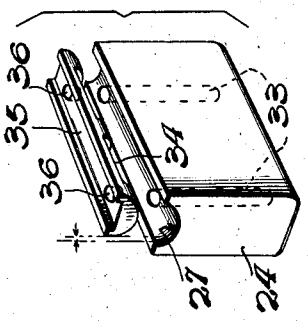
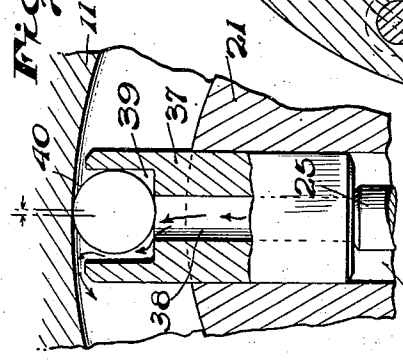


Fig. 2.

Fig. 6.



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ROTARY HYDRAULIC PRESSURE DEVICE

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10 Claims. (Cl. 103—138)

This invention relates to rotary hydraulic pumps and motors and more particularly to a rotary pump or motor in which the rotor is mounted eccentrically within a substantially cylindrical chamber and carries radially movable vanes which slidably engage the walls of the chamber.

In such devices the path of movement of the vane ends is not concentric with the casing and accordingly it has been proposed heretofore, as for example in the patents to John W. Gurley Nos. 1,472,414 and 1,658,524, to employ shoes seated in recesses in the ends of the vanes and having their outer or working faces curved in substantially the same radius as the inner surface of the casing. As the device rotates, these shoes can rock in the vane recesses and thus maintain close sliding engagement with the casing. At the same time, however, the eccentricity of the rotor results in relative radial movement of the vanes which thus have a piston-like reciprocation in their pockets in the rotor and a resultant pumping effect on any liquid in the rotor pockets beneath the vanes. Accordingly the aforesaid Gurley Patent No. 1,658,524 provides passages extending from these pockets through the vanes and shoes to recesses in the outer faces of the shoes, and passages extending from the latter to the leading sides of the moving vanes, whereby the liquid in each rotor pocket is pumped out ahead of the moving vane. Since it is necessary for efficient operation to expel the liquid to the leading side of the vane a directional limitation is thus imposed on the rotation of the device.

While satisfactory for certain purposes, the field of use of devices of the type characterized above has heretofore been limited in important respects. For instance, it has been difficult to maintain a liquid-tight sliding seal, particularly between the ends of the rotor and the radial edges of the vanes, on the one hand, and the opposed flat end surfaces of the chamber. As a result efficiency has been low even at low pressures, and high pressures cannot be developed and maintained, particularly with liquids such as oil which become thin at high operating temperatures. Hence the use of such devices as liquid pumps has been restricted, and they have not been satisfactory as hydraulic motors where positive operation is required. Another disadvantage in a device of the type shown in the Gurley Patent No. 1,658,524, for example, is that it will operate in only one direction of rotation, either as a pump or as a motor, whereas reversibility is often required in both cases as, for example, in most hydraulic remote control or remote operation systems.

One of the objects of the present invention is to provide a novel device of the type characterized above which will operate efficiently in either direction of rotation, whether as a pump or a motor.

Another object is to provide a novel device of the above character which is symmetrical in construction and operation and equally efficient in either direction of operation.

Another object is to provide novel means for controlling the flow of liquid to and from the rotor pockets beneath the vanes, which means is automatically reversible as the direction of rotation of the device is reversed.

A further object is to provide such a device which is capable of developing and maintaining or operating positively at high as well as low pressures with great efficiency and at high as well as low temperatures.

A still further object is to reduce the leakage past the vanes of such a device.

Other objects will appear hereinafter as the description of the invention proceeds.

One embodiment of the invention has been illustrated in the accompanying drawings, but it is to be expressly understood that said drawings are for purposes of illustration only and are not to be construed as a definition of the limits of the invention, reference being had to the appended claims for this purpose.

In the drawings:

Fig. 1 is a section through a device embodying the invention taken on the line 1—1 of Fig. 2;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is an enlarged sectional view showing a vane and its associated shoe;

Fig. 4 is a perspective view of the vane and shoe;

Fig. 5 is a section through the rotor; and

Fig. 6 shows a modified form of vane and shoe embodying the invention.

The casing of the device may be of any suitable type and construction. In the form shown, it comprises two casing members 10 having opposed flat surfaces which are separated by a ring member 11, these parts forming a substantially cylindrical chamber 12. The casing parts may be located with respect to one another by dowel pins 13 and held together by a suitable number of bolts 14.

The rotor shaft 15 extends eccentrically through the cylindrical chamber 12 and is suitably mounted for rotation in the casing members 10 as by means of roller bearings 16. The shaft extends through recessed bosses 17 on the casing members in which any suitable liquid-tight packing may be provided. In the form shown, the packing 18 is held in engagement with the shaft by springs 19, the recesses being closed by end plugs 20.

A rotor 21 is mounted on the shaft 15 to rotate within the chamber 12 as by means of a key 22, the ends of the rotor having a close sliding fit with the end surfaces of the chamber 12 as shown in Fig. 1. A suitable number of axial slots or pockets 23 are formed in the rotor to carry radially movable vanes 24. As herein shown, the pockets and vanes are six in number, although it will be understood that any suitable number of vanes can be employed. The vanes 24 are arranged to move in and out in their pockets 23 as the distance between the circumference of the rotor and the inner peripheral surface of the ring 11 varies due to their eccentricity. Preferably this radial movement is effected by arranging the vanes in diametrically opposed pairs, pins 25 extending through openings in the hub of the rotor and in the shaft so that they are interposed between the inner ends of each pair of vanes. Thus inward movement of one vane due to the eccentricity of the rotor causes outward movement of the diametrically opposite vane. The pins 25 are suitably arranged so that they do not conflict in passing through the axis of the rotor shaft. As shown in Fig. 1, the vanes of one pair may be connected by a single central pin 25, the vanes of a second pair by two pins passing on either side of the first pin, and the vanes of a third pair by two pins passing on either side of the first pair of pins. These pins preferably have a tight sliding fit in their openings in the rotor hub in order to minimize leakage from the bottoms of the pockets 23.

The radal edges of the vanes 24, together with the end surfaces of the rotor 21, have a tight sliding fit between the opposed end surfaces of the cylindrical chamber 12. The ends or axial edges of the vanes, however, rotate in a path which due to the eccentricity of the rotor and chamber has a different radius of curvature than the peripheral surface of the chamber 12. In order to maintain a sliding seal between the ends of the vanes and the periphery of the chamber, shoes 26 are seated in recesses 27 in the ends of the vanes, the outer working faces of these shoes having a sliding engagement with the periphery of the chamber 12 and the shoes being capable of rocking or tilting in their recesses 27 to maintain this engagement. Suitable inlet and outlet openings 28 and grooves 29 are formed in the ring 11, as shown in Fig. 2, the direction of movement of liquid through the device depending upon the direction of rotation of the shaft 15 and on whether the device is used as a pump or as a motor. In Fig. 2 the arrows indicate the direction of movement of the liquid when the device operates as a pump and the shaft 15 rotates in a counterclockwise direction. The liquid then enters the device through the right-hand opening 28 and groove 29 and is displaced through the chamber 12 by the rotating vanes 23, leaving the device through the left-hand groove 29 and opening 28.

One source of difficulty in devices of this type is to maintain a tight sliding fit between the rotor and vanes and the end surfaces of the cylindrical chamber. The rotor shaft is held in substantially rigid alignment by its bearings in the casing, so that the plane of rotation of the rotor is fixed when it is secured rigidly to the shaft. When allowance is made for this condition, the clearances which must be left between the ends of the rotor and vanes and the end surfaces of the chamber are too large to develop and maintain high pressures, particularly at high operating temperatures where the viscosity of the liquid, such as oil, decreases. Hence provision is made for relatively small inclination of the rotor axis with respect to the shaft axis and independently of the alignment of the shaft in its bearings, with the result that smaller clearances are satisfactory. Thus the device operates with greater efficiency and is also capable of developing and maintaining substantially higher pressures. In the form shown, this is accomplished by providing a loose fit between the central portion 30 of the rotor hub (Fig. 5) and the shaft 15 and by enlarging the internal diameter of the end portions 31 of the rotor bore, the shaft being held longitudinally in position with respect to the rotor hub and casing in any suitable manner as by the split ring 32. Thus tilting of the rotor axis with respect to the shaft axis is permitted by the loose fit of its bearing surface 30 and the maximum available extent of such tilting is increased by the enlarged portions 31. At the same time the shaft openings through which the pins 25 extend are of larger diameter than the pins, as shown in Fig. 1, so as not to interfere with the play of the rotor on the shaft.

Preferably also the material of the rotor and the vanes has a coefficient of expansion which is at least as great and preferably slightly greater than that of the material of the ring 11. Hence as the operating temperature increases and the ring 11 expands to separate the end surfaces of the cylindrical chamber 12, the axial extent of the rotor and vanes increases correspondingly and the tight sliding fit is thus maintained. Preferably the coefficient of expansion of the rotor and vanes is slightly greater than that of the ring, so that the clearance between the rotor and vanes and the end surfaces of the chamber will be decreased slightly as the temperature increases and the viscosity of the liquid decreases. Any suitable materials may be employed; for example, the ring 11 may be made of cast iron and the rotor and vanes of steel.

It is further desirable that such devices, whether operated as pumps or as motors, should be capable of rotation in either direction, and accordingly it is desirable to provide means for exhausting the liquid from the rotor pockets 23 to the leading sides of the vanes regardless of the direction of rotation of the device, and which are automatically reversible with reversal of the direction of rotation of the device. Preferably this is accomplished by providing passages 33 through the vanes 24 which connect the bottoms of the pockets 23 with the bottoms of the recesses 27, and by employing the shoes 26 as flow-controlling devices to direct the liquid from the passages 33 to the proper sides of the moving vanes depending on the direction of rotation of the device. To this end the seating faces of the shoes 26 are made smaller than the seating faces of the vane recesses 27 so that the shoes are capable of circumferential displacement against either side of the recesses to maintain the seal while at the same time leaving spaces at the

other sides of the recesses through which the liquid escapes from the passages 33 to the chamber 12. In the working space of the device, as shown at the top of Fig. 2, the shoes are thus maintained against the trailing sides of their recesses so that the liquid escapes from the pockets 23 to the leading sides of the vanes regardless of the direction of rotation.

Preferably, and as here shown, the seating faces of the shoes 26 and the cooperating faces of the vane recesses 27 are circular, but the radius of curvature of the shoe faces is less than that of the vane faces. Hence the shoes are free to rock or tilt in the recesses so that their working faces conform to the curvature of the periphery of the chamber 12, while at the same time the shoes are capable of circumferential displacement against either side of their recesses, as explained above, leaving spaces for the escape of liquid on the other sides thereof. To insure that the shoes will not seat sufficiently in the recesses to close off the passages 33 the bottoms of the seating faces of the shoes may be cut away adjacent the ends of the passages as shown at 34 in Figs. 3 and 4. In this way a free flow of liquid from the bottom of each pocket 23 to the proper side of its moving vane 24 is insured at all times.

If desired, longitudinal grooves 35 may be provided in the working faces of the shoes 26 to decrease the area of the shoes bearing on the periphery of the chamber 12, and at the same time passages 36 may be provided through the shoes to connect the grooves 35 with the vane recesses 27 whereby the pressure of the liquid on the seating faces is partially equalized by the equal pressure of the liquid on the bottoms of the grooves 35. By these means the friction between the shoes and the casing is minimized.

Fig. 6 illustrates a modified form of vane and associated element whereby a seal is maintained between the ends of the vanes and the peripheral surface of the casing and reversibility of rotation is obtained as described above. The vane 37 is provided with one or more passages 38 and an end recess 39 which correspond to the passages 33 and recesses 27 of the vanes 24 described above. The sealing element or shoe 40, which corresponds to the shoe 26 described above, is here shown in the form of a roller capable of rotation in the recess 39 so that it rolls in contact with the periphery of the chamber due to the rotation of the rotor and vanes. The diameter of the shoe or roller 40 is smaller than the width of the recess 39 so that it is capable of displacement against either side of the recess, having the other side open for the escape of liquid from the passages 38 to the leading side of the vane as described above. Since the shoe 40 rolls in contact with the casing, however, it is not cut away to provide relief spaces corresponding to the spaces 34 of the shoes 26, but the bottom of the recess 39 may have any suitable shape, preferably substantially rectangular, to provide such relief spaces and thus to insure the free escape of the liquid from the passages.

It will be observed that due to the close sliding fit maintained between the rotating parts and the walls of the chamber, high pressures can be developed and maintained in pumping operation and positive high pressure operation obtained as a motor. At the same time leakage past the vanes and rotor is minimized and the efficiency of operation is greatly increased over devices of this type as heretofore proposed. Moreover, the desired efficiency of operation is maintained regardless of changes in the operating temperature of the device. Whether used as a pump or as a motor, the device may rotate in either direction with equal efficiency since the construction and operation are symmetrical in either direction of rotation. These results enable the use of such devices to accomplish purposes and functions for which such devices have not been practicable heretofore. As one example, they are well adapted for use in hydraulic remote control or operating systems such as are desirable on board ship for controlling and operating remote devices such as watertight doors and the like. For such purposes reversibility is often an essential requirement, and to insure positive operation it must be possible to develop and maintain relatively high pressures and to insure positive motor operation, both at high efficiency. A device embodying the present invention fulfills all of these requirements and can be used either as a pumping unit or as a motor unit, or both. It will be understood, however, that the invention is in no way restricted to these particular uses, and that while prior devices of this type may have been acceptable for certain purposes, the present invention nevertheless enables superior results to be obtained in any use for which rotary hydraulic devices of this type have been proposed.

While only one embodiment of the invention has been described and illustrated in the drawings, it will be understood that this embodiment is for purposes of illustration only, and that various changes may be made in the design, details of construction and arrangement of parts, many of which will now be apparent to those skilled in the art, without departing from the spirit of the invention. Accordingly, reference is to be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, shoes seated in said recesses and having sealing engagement with the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, said shoes being smaller than said recesses and each displaceable circumferentially against either side of its recess whereby said passages communicate with said chamber through the other open sides of said recesses.

2. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, the ends of said vanes having arcuate recesses, shoes having arcuate faces seated in said recesses and working faces slidably engaging the peripheral surface of said chamber, the radius of curvature of the seating faces of said shoes being less than the radius of curvature of said recesses whereby said shoes are each displaceable circumferentially against either side of their recesses, and passages in said vanes

connecting said recesses with said pockets beneath the vanes.

3. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, shoes seated in said recesses and slidably engaging the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, said shoes being smaller than said recesses and each displaceable circumferentially against either side of its recess whereby said passages communicate with said chamber through the other open sides of said recesses, the seating faces of said shoes being cut away adjacent the ends of said passages to permit free escape of liquid from said passages.

4. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, the ends of said vanes having arcuate recesses, shoes having arcuate faces seated in said recesses and working faces slidably engaging the peripheral surface of said chamber, the radius of curvature of the seating faces of said shoes being less than the radius of curvature of said recesses whereby said shoes are each displaceable circumferentially against either side of their recesses, and passages in said vanes connecting said recesses with said pockets beneath the vanes, the bottom portions of the arcuate seating faces of said shoes being cut away adjacent the ends of said passages to permit free escape of liquid from said passages.

5. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, shoes seated in said recesses and slidably engaging the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, said shoes being smaller than said recesses and each displaceable circumferentially against either side of its recess whereby said passages communicate with said chamber through the other open sides of said recesses, the working faces of said shoes having grooves communicating with said recesses by passages through said shoes.

6. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, shoes seated in said recesses and slidably engaging the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, said shoes being smaller than said recesses and each displaceable circumferentially against either side of its recess whereby said passages communicate with said chamber through the other open sides of said recesses, the seating faces of said shoes being cut away adjacent the end of said passages to permit free escape of liquid from said passages, the working faces of said shoes having grooves communicating with said recesses by passages through said shoes.

7. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with sockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, rollers seated in said recesses and having rolling engagement with the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, the diameter of said rollers being less than the width of said recesses so that each roller is displaceable circumferentially against either side of its recess leaving the other side open for the escape of liquid from said passages.

8. In a device of the class described having a casing with a substantially cylindrical chamber therein, a rotor mounted eccentrically within said chamber and provided with pockets, and vanes radially movable in said pockets and rotatable therewith, the radial edges of the vanes and the ends of the rotor slidably engaging the end surfaces of said chamber, said vanes having recesses in the ends thereof, rollers seated in said recesses and having rolling engagement with the peripheral surface of said chamber, and passages in said vanes connecting said recesses with said pockets beneath the vanes, the diameter of said rollers being less than the width of said recesses and the bottoms of said recesses being shaped to provide spaces for liquid leaving said passages so that each roller is displaceable circumferentially against either side of its recess leaving the other side open for the escape of liquid from said passages and spaces.

9. A device of the class described having a casing with a substantially cylindrical chamber therein, a rotor shaft mounted in said casing eccentrically with respect to said chamber, a rotor on said shaft with its ends having sliding engagement with the end surfaces of said chamber, diametrically opposite radially movable vanes carried by said rotor with their radial edges in sliding engagement with the end surface of said chamber, said shaft and rotor having diametrically extending openings therethrough, vane-operating means extending through said openings and interposed between diametrically opposite vanes, and means on said vanes for maintaining a sliding seal between the ends of the vanes and the peripheral surface of said chamber, said rotor being mounted on said shaft for rotation therewith but adapted for inclination of its axis with respect to the shaft axis and said operating means fitting loosely in their shaft openings to permit such inclination.

10. A device of the class described having a casing with a substantially cylindrical chamber therein, a rotor shaft mounted in said casing eccentrically with respect to said chamber, a rotor on said shaft with its ends having sliding engagement with the end surfaces of said chamber, dia-

metrically opposite, radially movable vanes carried by said rotor with their radial edges in sliding engagement with said end surfaces, said shaft and rotor having diametrically extending openings therethrough, vane-operating means extending through said openings and interposed between diametrically opposite vanes, and means on said vanes for maintaining a sliding seal between the ends of the vanes and the peripheral surface of said chamber, said rotor being mounted on said shaft for rotation therewith but the central portion of the rotor bore fitting loosely on the shaft and the end portions thereof being enlarged to provide for inclination of the rotor axis relative to the shaft axis and said operating means fitting loosely in their shaft openings to permit such inclination.

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