Sept. 30, 1952 W. ERNST 2,612,114

VANE PUMP OR MOTOR

Filed April 6, 1948 4 Sheets-Sheet 1

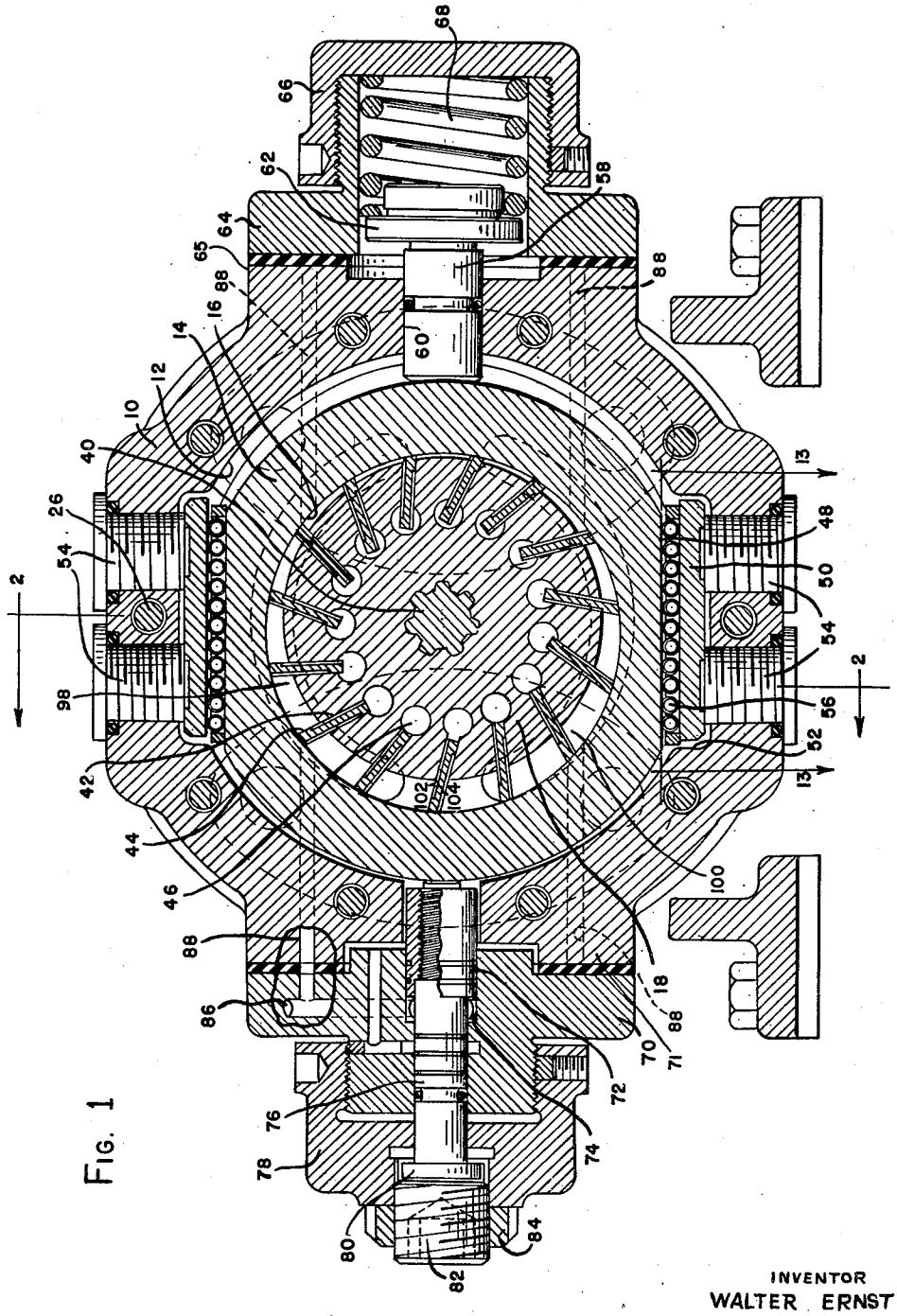


FIG. 1

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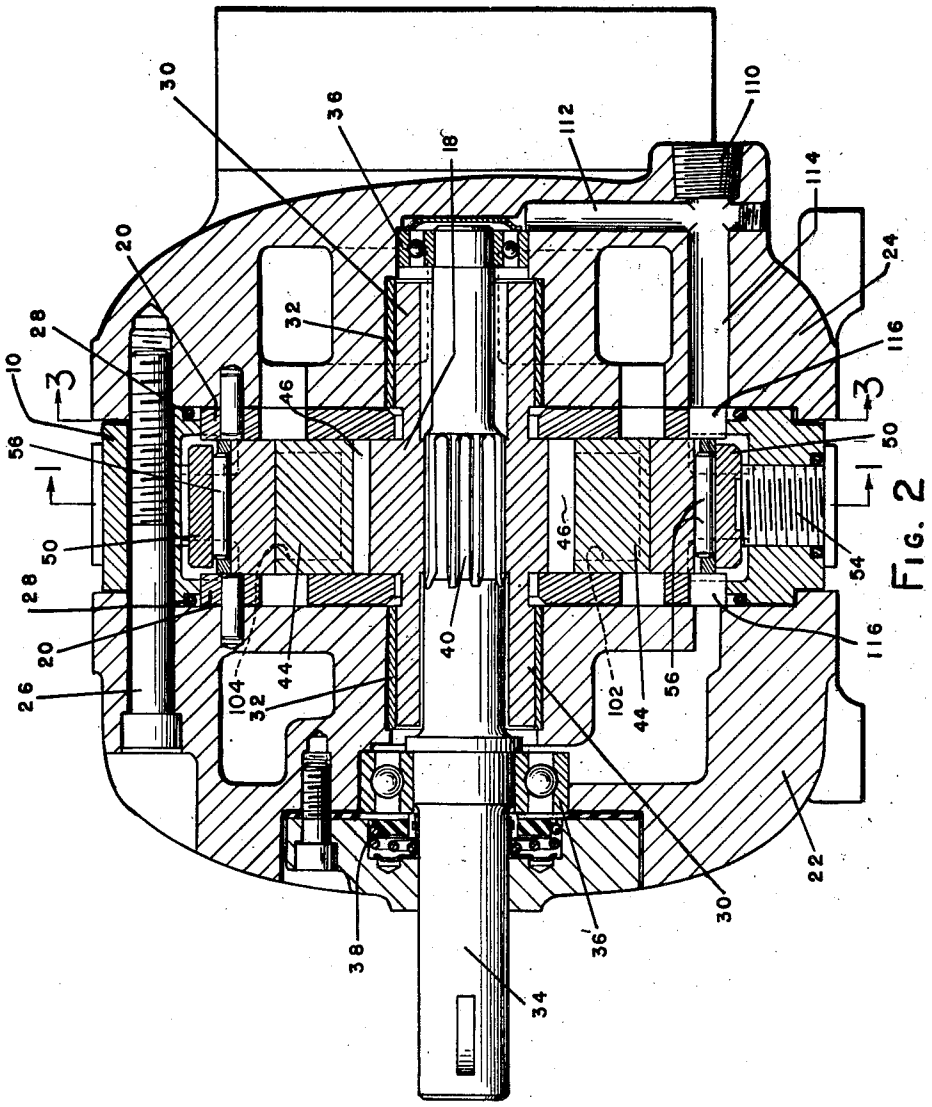


FIG. 2

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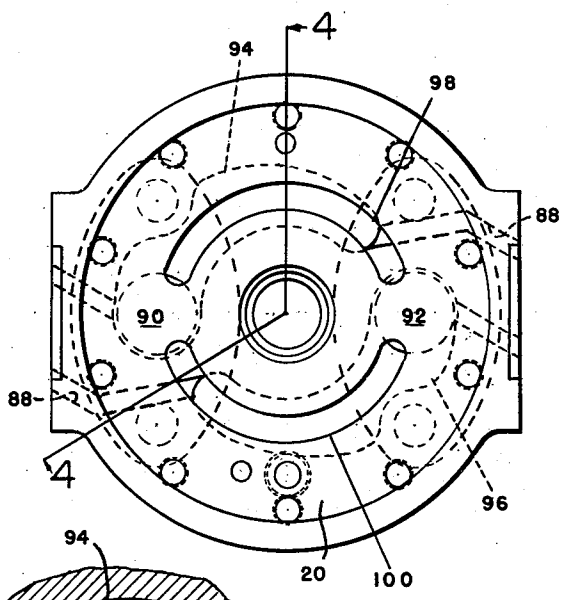
FIG. 3



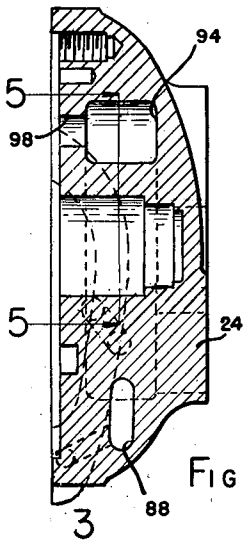




FIG. 4

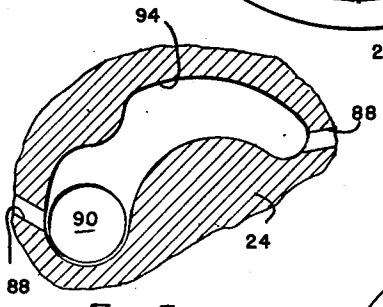



FIG. 5

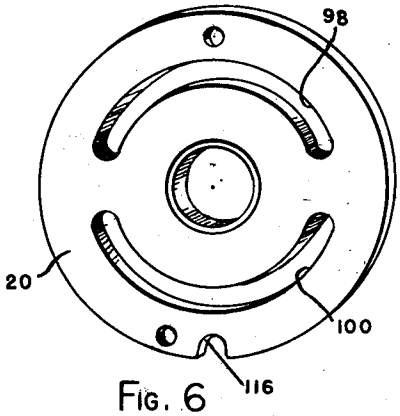



FIG. 6

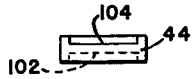



FIG. 7

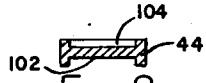



FIG. 8

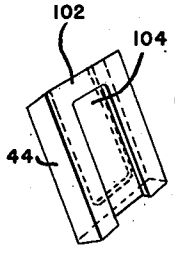



FIG. 9

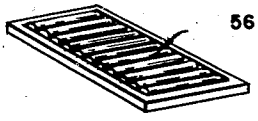



FIG. 10

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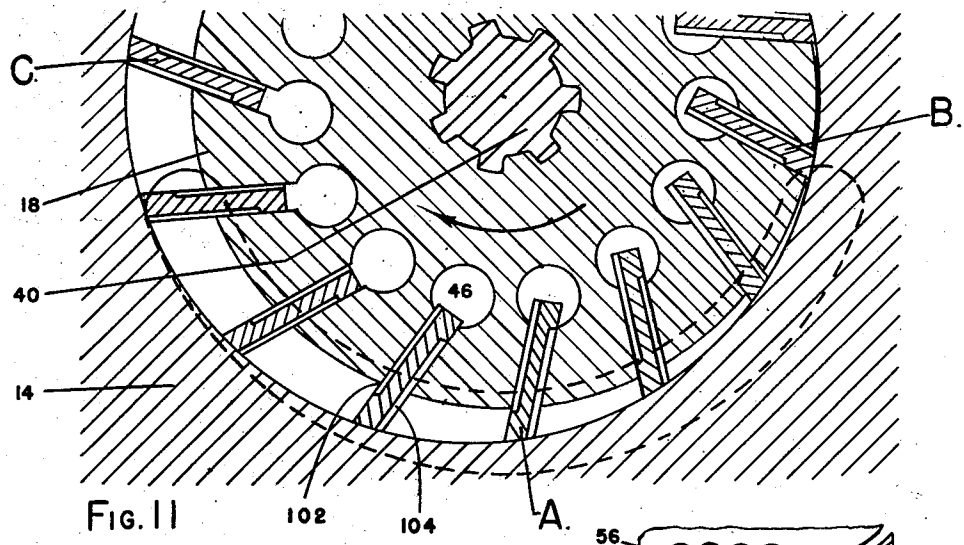


FIG. 11

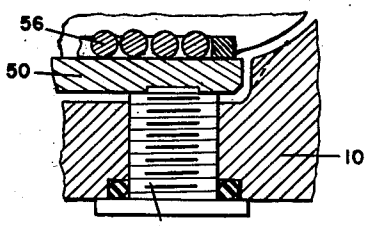


FIG. 12

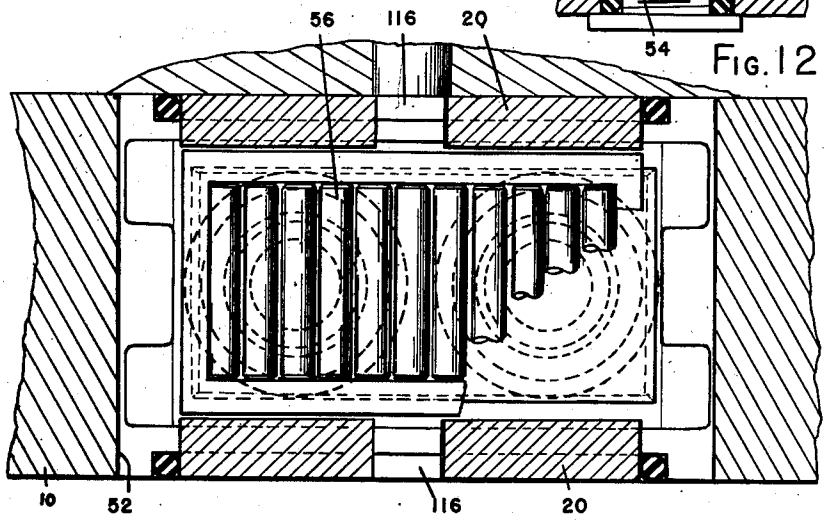


FIG. 13

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Patented Sept. 30, 1952 2,612,114

# UNITED STATES PATENT OFFICE

2,612,114

## VANE PUMP OR MOTOR

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Application April 6, 1948, Serial No. 19,410

4 Claims. (Cl. 103—120)

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This invention relates to vaned hydraulic apparatus such as vane pumps and vane motors.

The particular object of this invention is to provide an improved design of vane pump or motor having improved operating characteristics and which is relatively simple and inexpensive to manufacture.

Another object is to provide a vane pump or motor so designed that it is adapted for being manufactured in different sizes thereby to provide for different capacities.

A still further object is the provision of a vane pump or motor in which the unit is adapted for operating in either direction of rotation and with a fluid flow taking place therethrough in either direction in order that the said pump or motor can be adapted to different situations.

A still further object is the provision of a vane pump or motor which has high efficiency and in which wear on the moving parts is reduced to a minimum.

It is also an object of this invention to so arrange a vane pump or motor that the rotor thereof floats within the housing of the unit thereby eliminating high stresses ordinarily encountered in such devices.

A still further object is the provision of a vane pump or motor which is variable in delivery and in which the said delivery can be varied in response to a predetermined control pressure.

These and other objects and advantages will become more apparent upon reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a transverse section through a unit constructed according to this invention and is generally indicated by the line 1—1 on Figure 2;

Figure 2 is a transverse section through the unit as indicated by the line 2—2 on Figure 1 with portions of the unit in elevation;

Figure 3 is a view looking in at the face of the right hand end frame in Figure 2 and is indicated by the line 3—3 on Figure 2;

Figure 4 is a section through the end frame shown in Figure 3 and as indicated by the line 4—4 on Figure 3;

Figure 5 is a sectional view indicated by the line 5—5 on Figure 4 and showing the arrangement of one of the fluid flow pasasges in the end frame;

Figure 6 is a fragmentary view showing one of the wear plates which are disposed on each side of the rotor of the unit;

Figures 7, 8 and 9 are views showing one of the vanes carried by the rotor of the unit;

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Figure 10 is a perspective view showing one of the anti-friction bearings which journal the movable flow controlling member or shift ring of the unit;

Figure 11 is a somewhat enlarged view showing the arrangement of the vanes in the rotor and the manner in which the passages in the vanes cooperate to produce high efficiency of operation;

Figure 12 is a fragmentary view showing the means for supporting the anti-friction bearings between the shifting ring and the pump housing; and

Figure 13 is a plan view taken over one of the anti-friction bearings and is generally indicated by the line 13—13 on Figure 1.

Referring to the drawings, a pump or motor constructed according to this invention generally comprises an intermediate frame member 10 which is centrally bored as at 12 and within which bore there is mounted the hardened steel cylinder block or shifting ring 14.

The shifting ring 14 is similarly bored as at 16 to provide for a cylinder opening within which there is rotatably mounted the rotor 18 of the unit.

On each side of the rotor 18 there is a brass wear plate 20 and it will be noted that while the rotor and the cylinder block are of exactly the same axial length, the intermediate frame member 10 is equal in axial length to the axial length of the rotor and cylinder block taken together with the two wear plates 20.

On each side of the intermediate frame member 10 is an end frame member, the left hand one of which is indicated at 22 and the right hand one of which is indicated at 24. The intermediate frame member and the end frame members are rigidly clamped together by a plurality of through bolts 26 and there are preferably the resilient sealing rings 28 which rest between the intermediate frame member and the end frame members.

The rotor 18 has hub parts extending oppositely from each side thereof as shown at 30 in Figure 2 and these hub parts are journaled in sleeve bearings 32 which are carried in suitably machined bores in the end frame members.

It will be apparent at this time that the rotor 18 is symmetrical about a transverse plane passing through its center so that the said rotor can be turned 180 degrees if it is desired for the said unit to operate in the opposite direction of rotation.

The rotor 18 is centrally bored for receiving a drive shaft 34. This drive shaft is journaled in-

dependently of the rotor by the antifriction bearings 36, 36', one of which is mounted in each of the end frames. The left hand end frame, and through which the end of the shaft 34 extends, includes a face type sealing arrangement 38 which prevents leakage of fluid from the inside of the pump casing.

For effecting a driving connection between the shaft 34 and the rotor 18 the involute spline arrangement shown at 40 is provided. It will be noted that the shaft has clearance inside each of the hub parts 30 of the rotor and that the said spline arrangement is substantially centrally located within the rotor. Due to this fact and to the fact that the rotor and shaft are independently journaled the rotor may be said to float within the pump housing and the only forces transmitted between the shaft and the said rotor are driving torques. This eliminates high pressures of the rotor on the side plate due to slight misalignment of the shaft, and likewise prevents heavy radial loading on the shaft due to misalignment of the rotor and, in general, promotes long life of the unit by reducing all wearing stresses to the absolute minimum.

The rotor 18 has a plurality of vane receiving slots therein as shown at 42 and these slots are tilted in the direction of rotation of the rotor. This is done for the purpose of lengthening the support for the vanes thus reducing unit stress on the vanes and the walls of the slots in which they rest and inducing longer life of the unit thereby. In each of the slots 42 there is a vane 44 which is axially of the same length as the rotor and cylinder block and thus fits closely between the wear plates 20. The outer edges of the vanes 44 are inclined so that they have a substantial area of contact with the inner periphery of the cylinder block 14. For convenience of manufacture, each of the slots 42 preferably terminates at its inner end in an axial bore 46.

As mentioned before the unit of this invention is variable in displacement. To this end the cylinder block or shifting ring 14 has a flat on each side thereof at 48 and opposing these flats are the flat plates 50 which are retained in position in the recesses 52 in the intermediate frame member 10 by means of the pilot screws 54.

Between the flats 48 and the adjacent flat surfaces of the plates 50 there are the anti-friction roller bearings 56. The screws 54 and plates 50 are accurately machined so that when the said screws are tightened, the cylinder block 14 is retained between the roller bearings. This provides adequate support for the cylinder block, but at the same time permits it to be shifted in one direction very easily.

At the right side of Figure 1 there is shown a plunger 58 which extends through a bore 60 in the frame member 10 and bears against the right side of the cylinder block 14. The right end of the plunger 58 has a head 62 thereon within a sleeve member 64 that is bolted to a suitably formed pad 65 at that side of the frame member 10. The sleeve member 64 is threaded and receives a cap 66 and between the said cap and the head 62 of the plunger 58 there bears a compression spring 68. This compression spring exerts a predetermined bias on the cylinder block or shifting ring 14 urging it leftwardly toward its Figure 1 position.

At the left side of the pump as illustrated in Figure 1 there is a member 70 bolted to a pad 71 on the frame 10 which is substantially identical with the pad 65 on which the sleeve member 64 is mounted. The member 70 is a cylinder block and has therein a plunger 72 that bears on the left side of the shifting ring 14 and thus acts in opposition to the thrust of the plunger 58 thereon. The plunger 72 is reciprocable in the cylinder bore 74 and the member 70 and connected with the plunger 72 is a rod 76 which extends out the left side of the member 70 and into an adjustable cap 78 wherein the said rod has a head 80 thereon. The adjustable cap 78 is threaded to the member 70 and is thus adjustable relative thereto, so that the exact position at which the head 80 abuts the said cap member can be adjusted. The cap member also has therein the adjusting screw 82 which abuts the head 80 on its left side and thus predetermines the maximum left hand position of the shifting ring 14. The adjusting screw 82 is adapted for being locked in position by the lock nut 84.

In order to conduct pressure fluid to the cylinder 74 to actuate the plunger 72, the member 70 is bored as indicated at 86 and this bore communicates with a passage 88 extending through the end frame member 24 to a position where it will receive pressure fluid from one of the flow passages in the unit.

Fluid is supplied to and taken from the unit by means of flow passages in the end frame member 24. These flow passages are best seen in Figures 3, 4, and 5 wherein it will be seen that the said end frame member has a pair of ports 90 and 92 which communicate with the cored passages 94 and 96, respectively, in the end frame. These passages are arcuately arranged as indicated in Figures 3, 4, and 5 and open inwardly toward the rotor of the unit. The wear plates 20 are similarly provided with the arcuate slots 98 and 100 which are best illustrated in Figures 3 and 6. These arcuate slots coincide or overlap the arcuate passages of the end frame member and are positioned radially as will be seen in Figures 1 and 2 so that they provide communication of the spaces between the vanes carried by the rotor and the said arcuate passages. As will be noted in Figure 1 the upper of the arcuate slots 98 communicates with the spaces between the vanes during the time these spaces are decreasing in size and is thus the outlet passage when the device is being used as a pump. Similarly, the arcuate slot 100 communicates with the spaces between the vanes during the time they are increasing in size and thus forms the inlet passage when the device is operating as a pump. The passages 88 leading from the flow passages in the end frame 24 to the pads 65 and 71 which mount the members 64 and 70 are also illustrated in Figure 3.

It will be noted that each of the arcuate passages 94 and 96 have one of the said passages 88 extending therefrom to each of the said pads 65 and 71. In this manner the cylinder 74 can be placed in communication with either of the said passages from either end of the device.

Normally, only one of the passages 88 at any one time will be connected with the cylinder 74 and the particular one so connected will depend on which of the pads 65 and 71 the member 70 is mounted on and the manner in which it is mounted on the said pad.

Each of the vanes 44 provides for a valving action the purpose of which is to relieve the bores 46 of fluid entrapped therein and for introducing pressure into the said bores to hold the vanes outwardly against the periphery of the cylinder block.

This valving arrangement of the vanes is best illustrated in Figures 7 through 9 and 11. In these figures it will be noted that the leading side of each vane has a groove or slot 102 therein which is open at the inner edge of the vane and which is closed adjacent the outer edge thereof.

The trailing side of each vane, similarly, has a slot 104 therein, but the slot 104 opens at the outer edge of the vane and is closed adjacent the inner edge thereof.

As will be seen by the vane indicated at "A" in Figure 11 the closed ends of the slots 102 and 104 are spaced apart so that as the closed end of the slot 102 emerges from the periphery of the rotor the closed end of the slot 104 passes into the vane slot and communication thereof with the bore 46 is thus interrupted.

Referring to Figure 11 it will be noted that the vane at "B" is approaching the suction zone of the device, assuming that the device is operating as a pump. Accordingly, vane "B" has pressure conducted to the bore 46 at the inner edge thereof from the pressure zone of the pump by means of the groove 104 cut in the trailing side of the said vane. This maintains the vane outwardly during its travel across the lap between the slots 98 and 100 and thereby prevents any leakage of fluid past the vane and which leakage would contribute to inefficient operation.

During the time that the vane is passing through the suction zone it is relatively immaterial whether it is maintained outwardly against the periphery of the cylinder block or not, although, normally, the centrifugal force acting on the vane due to the rotational speed of the rotor would urge it outwardly and maintain it in sliding engagement with the cylinder block. However, when the vanes reach the position of the vane indicated at "C," it again becomes important for the vane to bear against the periphery of the cylinder block. As will be noted at this time the vanes have moved outwardly in their slots far enough to establish communication via slots 102 between the space at their leading sides and the bores 46 at their inner edges. The pressure ahead of the vanes is thus conducted down the slots 102 to the bores 46 and urges the vanes outwardly into engagement with the periphery of the cylinder block at least during the time that they are passing across the lap from the suction side of the pump to the pressure side.

It will be observed that, in addition to fulfilling the function of maintaining the vanes in sealing engagement with the cylinder block during the passage of the said vanes across the pump laps, the slots 102 and 104 also prevent any trapping of fluid in the bores 46, which trapping of fluid might lead to development of excessive pressures and induce high rates of wear between the ends of the vanes and the cylinder block, or prevent the vanes from moving outwardly against the cylinder block.

Due to the fact that there is always some slight leakage in pressure operated hydraulic devices having sliding fits, it is desirable that the inside of the pump casing be adapted for being drained periodically or for being connected with a slippage pump which will continuously remove fluid therefrom which has leaked from the normal flow passage. To this end all parts of the inside of the pump casing which do not form a portion of the flow passage through the pump are connected with a drain port 110. This



port is connected by a bore 112 with the recess receiving the anti-friction bearing 36 in the cover 24, and is also connected by a bore 114 with the bottom part of the intermediate frame member 10. In order to provide free drainage of fluid to the bore 114 each of the wear plates 20 is notched out at its bottom edge as at 116. By this arrangement all fluid which leaks into the inside of the pump will be drawn off and thus prevents a pressure building up within the pump casing which would cause leakage between the parts thereof or around the shaft 34.

The operation of the unit, when operated as a pump, may be described as follows:

Referring to Figure 1, the rotor will operate in a clockwise direction. This will cause fluid to be drawn in through the lower port and to be discharged from the upper port in a manner which is well known in the art.

The pump shifting ring will normally rest in the position shown in Figure 1, and which position is determined by the adjustment of the screw 82. However, should the discharge pressure of the pump exceed a predetermined value, the rightward thrust of that pressure on the plunger 72 will cause the shifting ring to move rightwardly to compress the spring 68. This changes the eccentricity of the cylinder block and rotor and reduces the pump discharge. The amount of shifting of the shift ring at that time will be determined by the setting of the cap 78 which provides an abutment for the head 80. Usually the cap 78 will be positioned to stop the shifting ring at about ten percent of the maximum delivery of the pump, this amount of the pump delivery being normally necessary for making up slippage.

At any time the discharge pressure of the pump is relieved after it has been shifted toward neutral, the spring 68 will again return the shifting ring to its Figure 1 position and the pump will resume full delivery. During operation of the pump the vanes, as mentioned before, are urged into sealing engagement with the cylinder block at least during the time the said vanes are passing the pump laps and accordingly, a high efficiency of operation is obtained.

Should it be desired to operate the pump in the opposite direction of rotation the rotor is removed therefrom and reversed and the pump is then reassembled. This will cause the vanes to tilt in the opposite direction and the rotor can then be driven in that direction.

In order to retain the pressure control in operation when the direction of rotation of the pump is reversed the member 70 is unbolted from the pad on which it rests and is rotated until the bore 86 therein communicates with the passage 88 extending to the lower of the ports in Figure 1, which, at this time, will now be the discharge port. Similarly, if, for some reason, it is desired for the pressure control to be mounted on the right side of the pump as viewed in Figure 1, this can readily be accomplished by interchanging the members 70 and 64 and adjusting the member 70 so that the bore 86 thereof communicates with the proper one of the passages 88.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

I claim:

1. In a vane pump or motor; a vaned rotor, a cylinder block surrounding said rotor eccentric thereto and movable in one direction transversely

of the rotor for increasing the eccentricity between the block and rotor and in the opposite direction for decreasing the said eccentricity, a spring acting on said block to urge it in said one direction, a fluid operable plunger acting on said block for urging it in the other direction, a rod connected to and extending from said plunger, a head on said rod, a first abutment adjustably mounted between said head and said plunger adapted for engaging one side of said head, and a second abutment adjustably mounted on said first abutment adapted for engaging the other side of said head whereby said head is movable between said abutments to provide for spaced stopped positions of said cylinder block.

2. In a vane pump or motor; a frame, a vaned rotor in said frame, a cylinder block surrounding said rotor in the frame eccentric to the rotor and movable in one direction in the frame transversely of the rotor for increasing the eccentricity between the block and rotor and in the opposite direction for decreasing the said eccentricity, a spring in the frame at one side acting on said block to urge it in said one direction, a cylinder on the other side of said frame, a fluid operable plunger in the cylinder acting on said block for urging it in the other direction, a rod connected to and extending from the plunger out the end of the cylinder opposite said block, a head on the outer end of the rod, a cap member threaded to said cylinder and having a shouldered bore through which said rod extends, said bore being of a size to receive said rod but smaller than the head on the end of the rod, and a stop screw threaded into said bore, whereby the shoulder in the bore is engageable with one side of said head and the stop screw is engageable with the other side thereof to predetermine limits of movement of said rod and plunger and, therefore, of said block.

3. In a vane pump or motor; a frame, a bored cylinder block in said frame movable in a direction transversely of the bore in the block, a vaned rotor eccentrically mounted in the bore in said cylinder block, ports in said frame communicating with the space between said rotor and cylinder block, mounting pads formed on opposite sides of said frame, a plurality of channels in said frame leading from said ports to spaced points on the surfaces of said pads, said points all being the same radial distance from the central axis of said pads and spaced circumferentially, means mounted on one of said pads closing the said points thereon and including spring means acting on said block to urge it in one direction, a cylinder mounted on the other pad, a plunger in the cylinder engaging the cylinder



block, and a passageway in the cylinder connecting the interior of said cylinder with a point on the surface thereof that engages the pad, said point being at a radial distance from the axis of the cylinder such that it will register with any selected one of the said points on the surface of said pad.

4. In a vane pump; a frame, a bored cylinder block in said frame movable in a direction transversely of the bore in the block, a vaned rotor eccentrically mounted in the bore in said cylinder block, a pair of mounting pads formed on opposite sides of said frame, spring means mounted on one of said pads and acting on said block to urge it in one direction in the frame, a fluid operable means adapted for acting on said block to move it in the other direction, and including a cylinder mounted on said other of said pads, said cylinder having a channel leading from the interior thereof to the surface of the cylinder abutting the said pad, inlet and outlet passageways in said frame leading to the space between said rotor and cylinder block, and channel means in the frame connecting each of said passageways with respectively different points on the surfaces of each of said pads, said points being so located that said fluid operable means can be mounted on either of said pads and be adjusted thereon to cause the said channel in the cylinder to communicate with any selected one of said channel means, the said one pad having a member mounted thereon closing the ends of the channel means terminating thereon and enclosing said spring means.

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## REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 1,035,449 | Kinney | Aug. 13, 1912 |
| 1,240,211 | Horvath | Sept. 18, 1917 |
| 1,943,929 | Rayburn | Jan. 16, 1934 |
| 2,141,170 | Centervall | Dec. 27, 1938 |
| 2,149,337 | Deming | Mar. 7, 1939 |
| 2,216,053 | Staley | Sept. 24, 1940 |
| 2,238,062 | Kendrick | Apr. 15, 1941 |
| 2,256,459 | Kendrick | Sept. 16, 1941 |
| 2,313,075 | Kendrick et al. | Mar. 9, 1943 |
| 2,313,246 | Kendrick et al. | Mar. 9, 1943 |
| 2,368,223 | Kendrick | Jan. 30, 1945 |
| 2,420,155 | Tucker | May 6, 1947 |
| 2,423,271 | Talbot | July 1, 1947 |
| 2,423,654 | Leis | July 8, 1947 |
| 2,426,361 | Lester | Aug. 26, 1947 |