Nov. 25, 1958 D. B. NEFF 2,861,517

VANE PUMP

Original Filed July 26, 1952 4 Sheets-Sheet 1

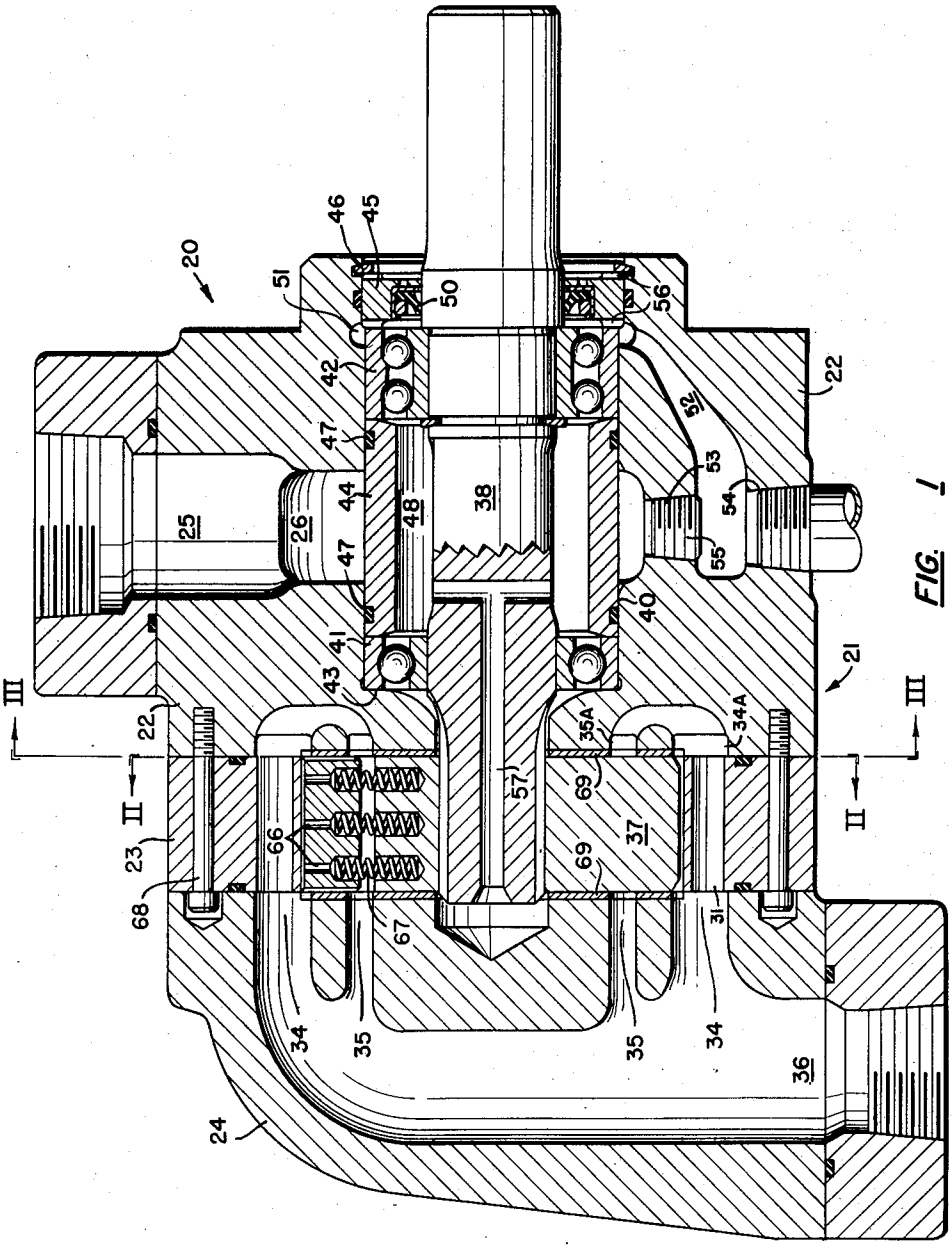


FIG. 1

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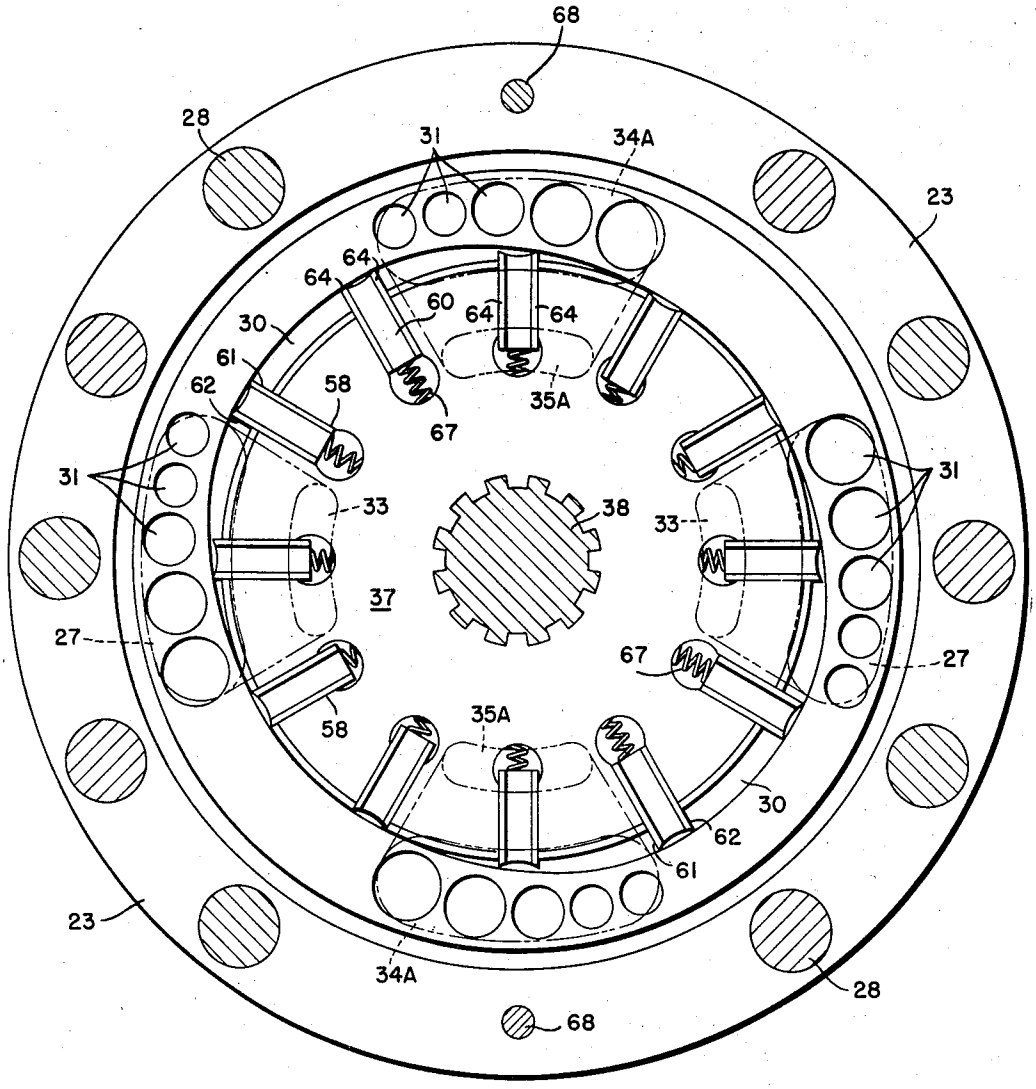


FIG. 2

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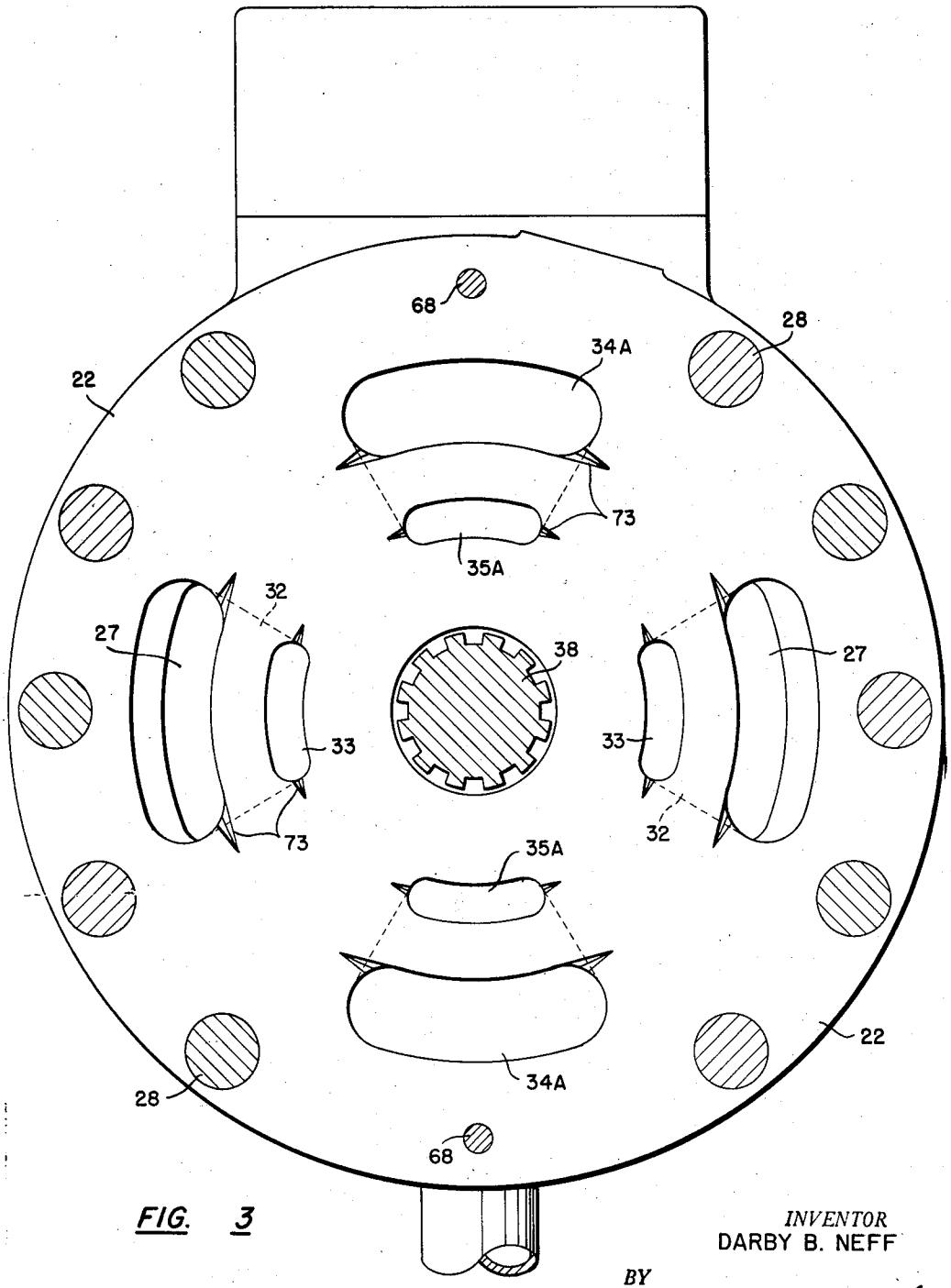


FIG. 3

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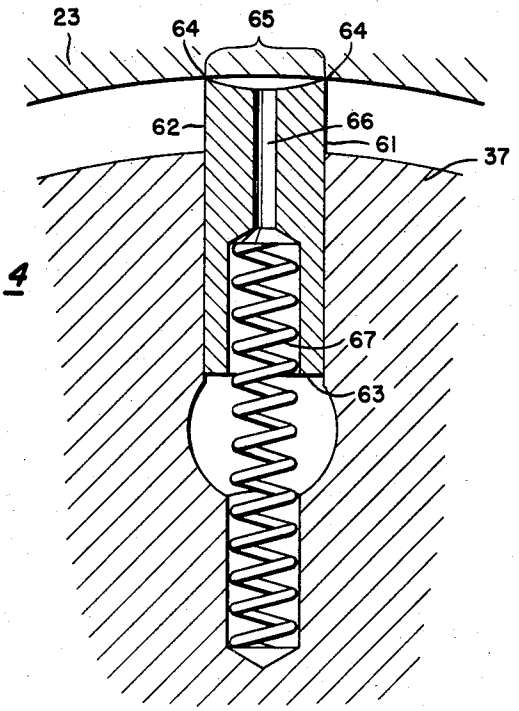


FIG. 4

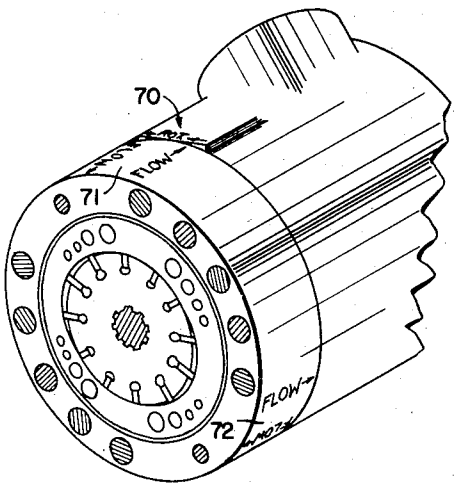


FIG. 5

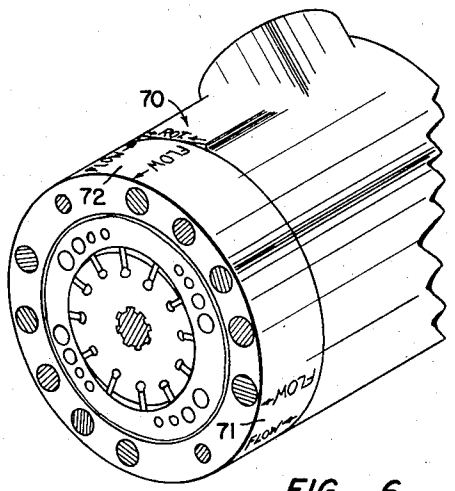


FIG. 6

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VANE PUMP

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Original application July 26, 1952, Serial No. 301,076. Divided and this application September 9, 1955, Serial No. 533,294

1 Claim. (Cl. 103—3)

This invention relates generally to hydraulics and is more particularly directed to fluid pumps or motors of the vane type.

An object of this invention is to provide a fluid pressure energy translating device which embodies a construction producing a greater overall efficiency for pumps or motors of the type mentioned above.

Another object of the invention is to provide an improved vane pump or motor which is so constructed that the rotor of the pump may be rotated in either direction without altering the pump when it is desired to reverse the direction of fluid flow through the pump casing or certain parts of the pump may be reversed or otherwise repositioned when it is desired to maintain the direction of fluid flow through the pump yet reverse the direction of rotation of the movable elements.

Another object of the invention is to provide the casing of the pump with indicia by which the direction of flow through the pump for various directions of rotation of the operating shaft may be determined without dismantling the pump or otherwise altering the same.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a vertical longitudinal sectional view taken through the fluid pressure energy translating device forming the subject matter of the invention;

Fig. 2 is a vertical transverse sectional view taken through the device on the plane indicated by the line II—II of Fig. 1;

Fig. 3 is a similar view taken on the same plane but in the direction of the arrows III—III;

Fig. 4 is a detail sectional view on an enlarged scale taken through a portion of the rotor and one of the vanes carried thereby;

Figs. 5 and 6 are perspective views of the fluid pressure energy translating device with a portion of the casing removed to show the relation of interior structure and external indicia.

This application is a division of application Serial No. 301,076, filed July 26, 1952, for a "Vane Pump" which is now abandoned.

Referring more particularly to the drawings, the pump or fluid motor, formed in accordance with the invention, is indicated generally by the numeral 20. This device, which may be used either as a pump or motor without alteration, will for convenience hereinafter be referred to as a pump. It includes a casing 21 having three main parts 22, 23 and 24. The part 22 will be hereinafter designated as the body, the part 23 will be designated as the cam ring, and the part 24 will be termed the cover. The body 22 has an inlet port 25 which communicates with a chamber 26. This chamber, in turn, communicates at diametrically opposed points with ports 27 which open to a side wall of the body 22, this side wall being

formed for engagement with the complemental side wall of the cam ring 23. The opposite side wall of this ring is formed for engagement by the complemental wall of the cover 24. These three parts are secured in assembled relation by bolts 28, the inner wall of the cam ring forming a substantially elliptical rotor chamber 30. The ports 27 are disposed on opposite sides of this rotor chamber and will be hereinafter designated as inlet ports. From Fig. 2, it will be noted that these ports are arranged adjacent one end of portions of the peripheral wall of the rotor chamber which are spaced a greater distance from the axial center of the chamber than the other portions of the peripheral wall. It will also be noted from Fig. 2 that the elliptical chamber or the peripheral wall thereof has four portions which are arcuate, the radii for these portions extending from the axial center of the chamber. One of the important features of this invention is to generate these arcuate portions from a common center. The reason for this construction will be made apparent later.

The cam ring 23 is provided with a plurality of openings 31 to connect the inlet ports 27 in the body 22 with corresponding inlet ports 27 in the cover 24. These inlet ports 27 have extensions, indicated by the numeral 32, which extend toward the cam ring and terminate in openings 33 in the opposed side walls of the body and casing. These openings 33 will be designated hereafter as port extensions. Their purpose will be apparent from the following description.

The cover 24 is provided with outlet ports 34 which are angularly displaced 90° from the inlet ports 27, ports 34 also having port extensions 35 and communicating with an outlet 36. The ports 34 and 35 are connected also by openings in the cam ring with corresponding ports 34A and 35A formed in the body 22. The rotor chamber receives a rotor for transferring fluid from the inlet ports 27 and extensions 33 to the outlet ports 34 and 34A, and extensions 35 and 35A. This rotor has a substantially circular body 37 which has a central opening formed with spline grooves for the reception of a similarly formed end of a shaft 38 which extends into the rotor chamber through a bearing chamber 40 formed in the body 22.

This bearing chamber 40 is formed for the reception of inner and outer ball bearings 41 and 42, the former being disposed in engagement with a shoulder 43 formed at the inner end of the bearing chamber. The bearing 41 is held against this shoulder 43 by a sealing sleeve 44, the bearing 42 being disposed in engagement with the outer end of the sealing sleeve. Bearing 42 is, in turn, engaged by a shaft seal assembly 45 which is held against the bearing by a tapered retaining ring 46, this member being disposed in a groove formed in the body 22, the taper serving to urge the bearings and sleeve toward the shoulder 43. The sleeve 44 is grooved to receive gaskets 47, the sleeve and the gaskets serving to separate the inlet chamber 26 from the space 48 around the shaft 38. The shaft 38 is supported for rotation by the inner races of the bearings 41 and 42, the outer end of the shaft projecting beyond the end of the body 22 and being formed for connection with a prime mover, not shown. The seal 45 is disposed between the bearing 42 and the outer surface of the body 22.

This seal has a flexible member 50 which is resiliently held against the shaft to prevent the escape of fluid around the shaft. This flexible member projects in an angular direction, being shown in Fig. 1 as projecting toward the interior of the pump. Internal pressure in the pump will force this sealing member into fluid tight engagement with the shaft. With the seal disposed in the position shown in Fig. 1, the pump must be drained

externally, that is, fluid escaping from the rotor chamber to the space around the shaft must be drained to the exterior of the pump casing. To provide for this external draining, the casing is formed, substantially in registration with the inner end of the seal **45**, with an annular groove **51** which is connected by an angular passage **52** with a pair of threaded ports **53** and **54**. The port **54** is provided with a conduit for conducting the fluid drainage to a suitable point of discharge. If it is desired to drain the leakage internally, a plug **55**, disposed in the port **53**, is removed and the conductor in port **54** is replaced by a suitable plug; fluid then may flow from the passage **52** into the inlet chamber **26** and be mingled with the fluid flowing through the inlet port to the pump. It will be noted that the body of the seal **45** has radially extending grooves **56** to establish communication between the space around the shaft and the annular groove **51**. When the pump is in operation, fluid seeping between the rotor and the chamber wall will be caused to flow along the shaft through the space between the inner end of the shaft and the casing or other ports, around the bearings **41** and **42**, past the shaft seal **50** and into the groove **51** from which it will be conducted to exhaust either internally or externally as above pointed out. It will be noted that, when the leakage is to be drained internally, the shaft seal **45** is reversed so that the flexible member **50** will extend toward the exterior of the pump and prevent the entrance of air into the casing due to the presence of subatmospheric pressure therein. The inner end portion of the shaft **38** is formed with a passage **57** so that fluid seeping into the space at the inner end of this shaft may be conducted to the space in the sleeve **44** and be drained with the rest of the leakage.

The rotor body **37** is provided with a plurality of circumferentially spaced, radially extending slots **58**. These slots receive vane means, indicated generally by the numeral **60**, the vanes closely fitting the slots so that a minimum of fluid seepage will take place between the vanes and the slot walls. The vanes are of a transverse length sufficient to have sliding engagement at both ends with the opposed faces of the rotor chamber side walls. This sliding engagement is also designed to provide a minimum of leakage between the vanes and the walls. Each vane comprises a one-piece body of plate-like form with flat front, rear and bottom surfaces, **61**, **62** and **63**, respectively, the ends and the top surface of the body being grooved to provide spaced wall-engaging edges **64**. The groove in the top surface of the body is of such dimensions that the sealing edges **64** will be located on or substantially in alignment with the front and rear surfaces **61** and **62** of the vane body. By this construction, the top surface of the vane will present a pressure receiving area substantially equal to the pressure receiving area at the bottom or inner end **63** of the vane. When these areas are exposed to equal pressures, the forces of the fluid pressures tending to move the vane radially will be balanced. The pressures on these areas are equalized by establishing communication between the spaces at the inner and outer ends of the vane. In the first place, the grooves in the end walls of the vane establish communication between the groove in the top wall and the inner portion of the slot for the vane. Additional communication is provided by forming the vane with one or more openings **66** which extend from the top or outer end to the bottom or inner end of the vane. These openings are counterbored at their inner ends to receive coil springs **67**, these springs also being disposed in sockets formed in the rotor body **37**. The springs are provided to urge the vane bodies in a radial or outward direction and maintain the sealing edges **64** at the outer ends thereof in engagement with the peripheral wall of the rotor chamber. Through the provision of the spaced sealing edges at the top and ends of each vane and the balancing of pressures at the top and bottom of the vane, leakage from the space at the front to the space at the rear of the vane is minimized. A double seal with an intermediate pressure zone therebetween is provided. It will be obvious from Figs. 2 and 4 that, if outlet port or high pressure exists in front of the vane, it will have to pass two seals before reaching the inlet or low pressure which exists in back of the vane. In so moving, there will be a pressure drop from the higher pressure zone to the space between the sealing edges **64** and a second pressure drop from this space to the lower pressure zone. The efficiency of the seals provided by the edges **64** engaging the cam ring and the end walls of the rotor chamber will determine the pressure in the intermediate pressure zone between the sealing edges **64**. During the movement of a vane along the concentric arcuate portions of the cam ring, the intermediate pressure zone will be sealed from the other pressure zones in the manner described hereafter.

The rotor chamber forming surfaces of the body **22** and cover **24** have bearing plates **69** secured thereto for engagement with the sides of the rotor body. These bearing plates are formed from a suitable bearing material to minimize wear. The cam ring, as shown in Fig. 1, is held in engagement with the body **22** by bolts **68** which are disposed on opposite sides of the cam ring. These bolts permit the bolts **28** to be removed whereby cover **24** may be separated from the casing without the cam ring being displaced. The bolts **68** may then be removed and the cam ring reversed, that is, the side formerly engaged by the cover **24** being disposed in engagement with the body **22** and vice versa. When this reversal is made, the lower portion of the cam ring is moved to the top. The purpose of this arrangement will be apparent later. When the cam ring is reversed, the longitudinal axis of the elliptical chamber will be shifted from its angular position relative to the vertical, as shown in Fig. 2, to a similar angular position on the opposite side of the vertical. The shifting of the cam ring will then dispose the pumping chambers formed by the ends of the ellipse between the inlet ports **27** and the outlet port opposite that which previously communicated with the particular pumping chambers. The rotor may then be revolved in the opposite direction to cause fluid to flow through the device in the same direction as previously.

This device, as previously mentioned, will serve both as a fluid motor and as a pump. The working parts may be revolved in either direction with the cam ring as shown or reversed without dismantling or altering the pump in any way. However, when the rotor is revolved in one direction, fluid will flow through the device in a predetermined direction. If the rotor is then revolved in the opposite direction without reversing the cam ring, the direction of fluid flow through the casing will also be reversed. If it is desired to reverse the direction of rotation without reversing the direction of fluid flow through the casing, the cam ring must be reversed as above described. The device is provided, as shown in Figs. 5 and 6, with indicia to show the direction of fluid flow for each direction of rotation of the shaft. This indicia comprises the abbreviation "Rot." with oppositely extending arrows at the ends thereof, as at **70** on the casing to show clockwise and counter-clockwise directions of rotation, and the word "Flow" with oppositely directed arrows, as at **71** and **72** at two places on the cam ring, the arrows registering with the arrows on the casing and serving to show the direction of fluid flow through the casing for each direction of rotation of the shaft. Two sets of indicia are provided on the cam ring, one set being disposed adjacent to and cooperating with the indicia on the casing in one position of the cam ring and the other set being so disposed and used when the cam ring is reversed, as described. It will be noted that the arrows are reversed in the sets. With this indicia, an observer can tell at a glance which direction fluid will flow through the casing when the shaft is revolved in a selected direction.

It will be noted from Fig. 3 that the inlet and outlet

ports and extensions are provided with bleed slots 73 extending in opposite directions from the ends thereof, the slots 73 terminating in sharp pointed extremities. These slots permit communication between the spaces between the vanes, the spaces between the sealing edges on the vanes, the vane slots and the inlet and outlet ports to be relatively gradually established to eliminate shock and noise resulting therefrom. The ends of adjacent bleed slots are spaced circumferentially to provide sealing areas 74 on the side walls of lengths at least equal to the angular distance between adjacent vanes in the rotor. These sealing areas permit the vane slots and the spaces between the sealing edges on the vanes to be sealed from the spaces at the sides of the vanes and from the inlet and outlet ports. These sealing areas provide intermediate pressure zones including the inner end portions of the vane slots, the spaces at the ends of the vanes, the passages in the vanes and the spaces between the sealing edges at the outer end of the vanes; fluid pressure will be the same in all portions of this zone. Since the outer ends of the vanes have the same area as the inner ends thereof, the vanes will be balanced by fluid pressure, a tendency to move outward being imparted by centrifugal force. This tendency is augmented by the springs 67. Due to the provision of the intermediate pressure zones, the leakage around the vanes from the space at one side of each vane to the space at the other will be minimized, the fluid having to pass two sealing edges. This construction increases the efficiency of the device both from a volumetric as well as a pressure standpoint.

It will be noted from Fig. 2 that, when the vanes move from the concentric arcuate portion of the peripheral wall having the smaller radius to the other concentric arcuate wall portion, one of the sealing edges of the vanes will be spaced from the peripheral wall. At this time, however, the vane is exposed to the pressure in the inlet or outlet port and all edges of the vane will be exposed to the same fluid pressure. It will be further apparent that a fluid pressure balance on each vane is maintained continuously throughout the rotation of the rotor. When the vane registers with the inlet port, the pressure of the inlet port will be maintained completely around the edges of the vane. When the vane moves along the pumping zone, the intermediate pressure will obtain on all the vane edges and, when the vane moves across the outlet port, all of the edges of the vane will be exposed to outlet port pressure. The vane will, therefore, be urged toward the peripheral wall only by centrifugal force plus the force of the springs 67. Through proper calculation and design, the most efficient spring force may be employed. Since only the spring force required will be used, wear on the cam ring by the vanes will be kept at a minimum and the life of the device will be increased.

The above described features of the vanes are claimed in a co-pending application Serial No. 533,304, filed September 9, 1955, for a "Vane for Use in a Rotary Fluid Apparatus," by Cecil E. Adams and John R. English.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claim which follows:

I claim:

A fluid pressure energy translating device including means forming a casing having two casing elements movable to two different positions relative to each other; a reversible rotary fluid pressure energy translating means within said casing; a shaft connected to rotate with said fluid pressure energy translating means; a pair of ports adapted to function reversely, one as an inlet, and one as an outlet port of said translating device, said casing elements being movable to said different positions to change the relative directions of fluid flow through said ports with respect to the directions of rotation of said shaft; two indicium on one of said casing elements including oppositely pointing arrows, and one indicium on the other of said casing elements including oppositely pointing arrows, the arrows on one of said elements indicating the direction of flow of fluid through said ports and the arrows on the other of said casing elements indicating the direction of rotation of said shaft to obtain either flow direction indicated by the flow direction arrows in each relative position of said casing elements.

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