Feb. 9, 1960 V. V. BLASUTTA ET AL 2,924,182

FLUID PRESSURE ENERGY TRANSLATING DEVICE

Filed Aug. 31, 1955 3 Sheets-Sheet 1

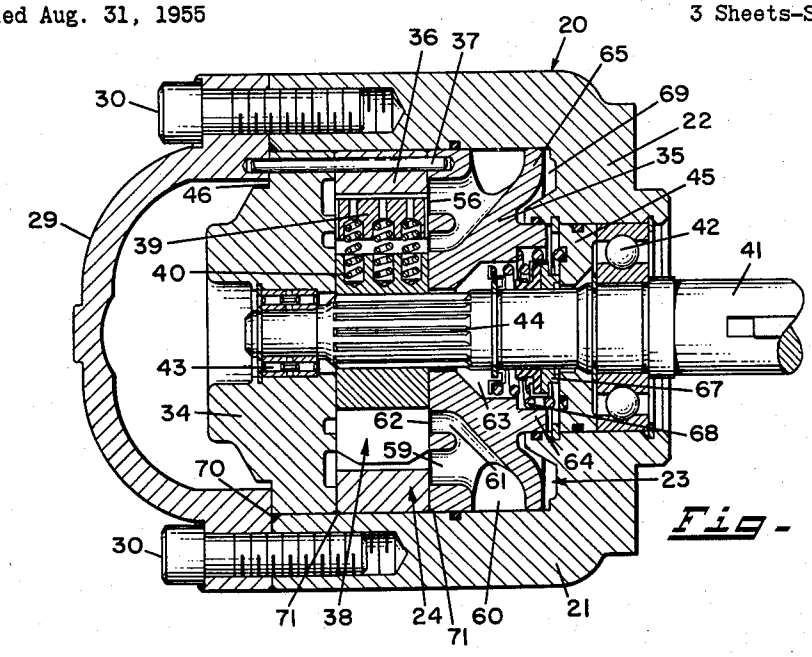

Fig. 2

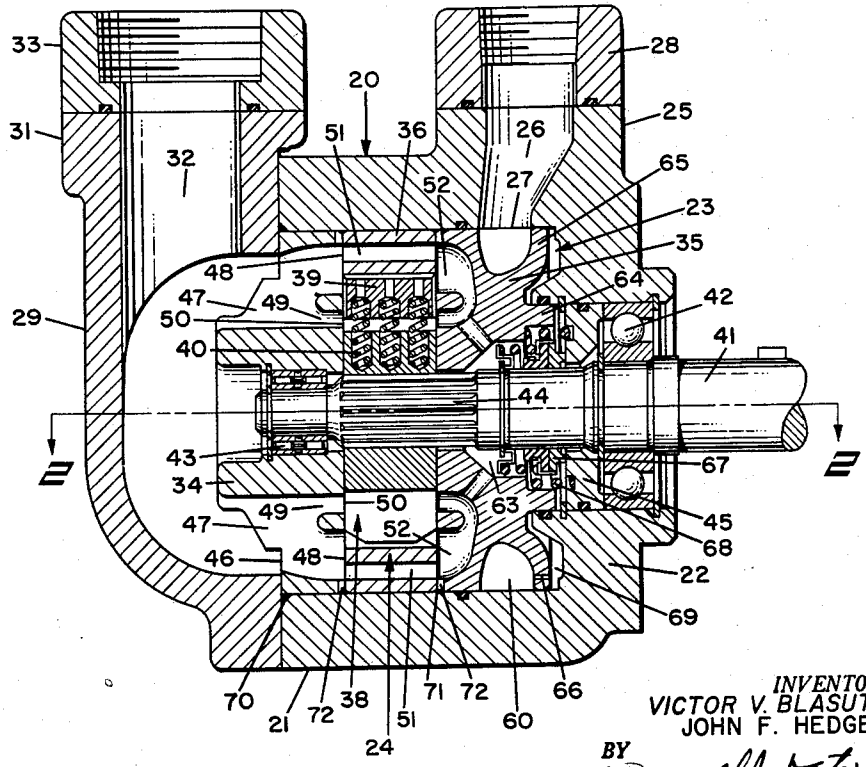

Fig. 1

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FLUID PRESSURE ENERGY TRANSLATING DEVICE

Filed Aug. 31, 1955 3 Sheets-Sheet 2

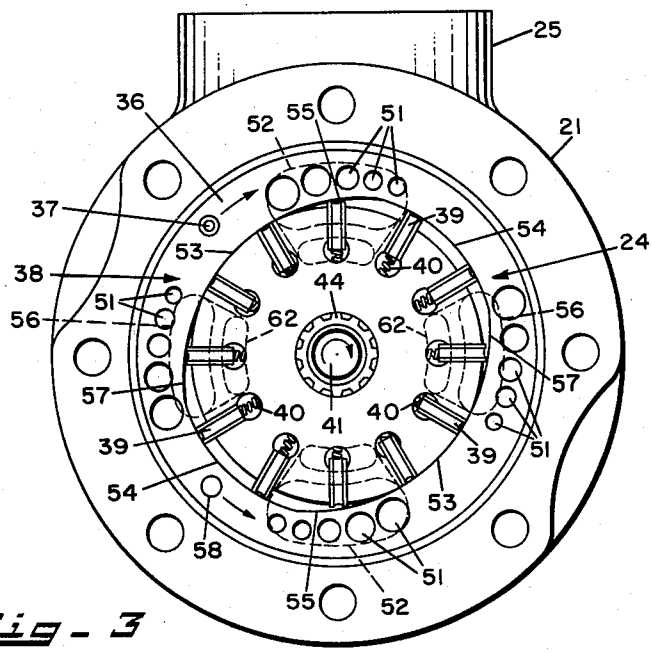

Fig - 3

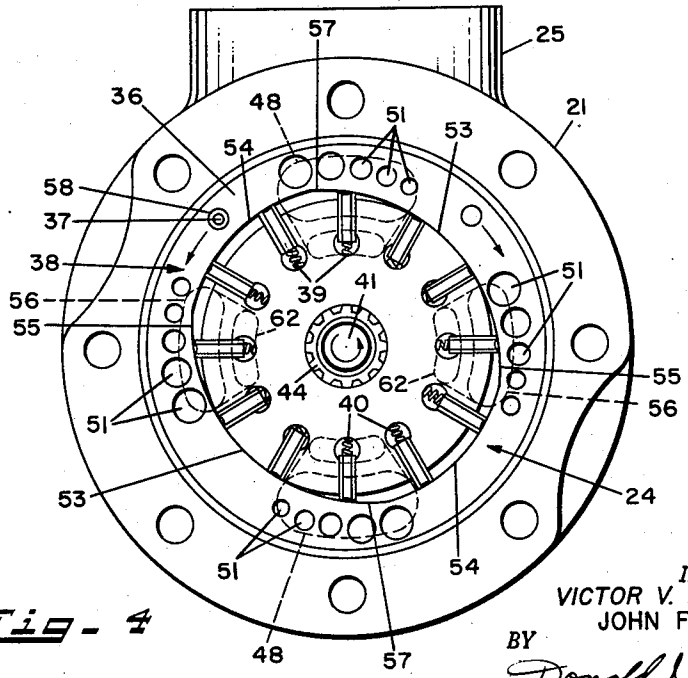

Fig - 4

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FLUID PRESSURE ENERGY TRANSLATING DEVICE

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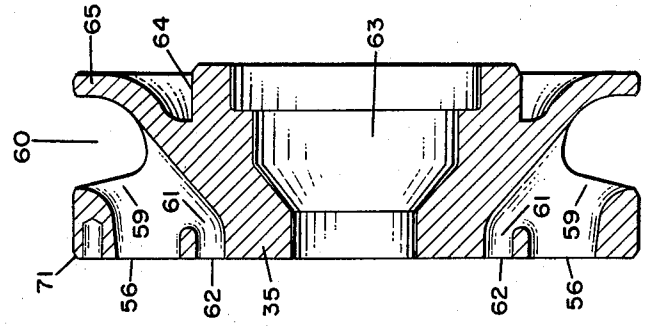

Fig. 7

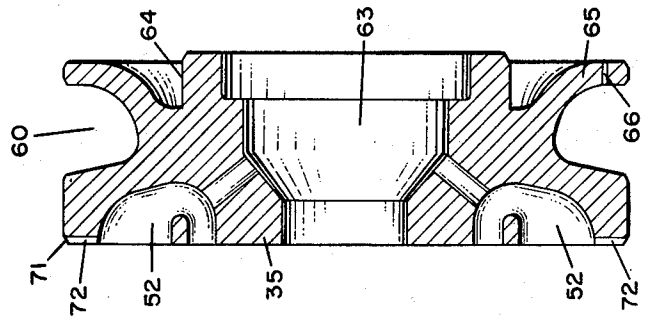

Fig. 6

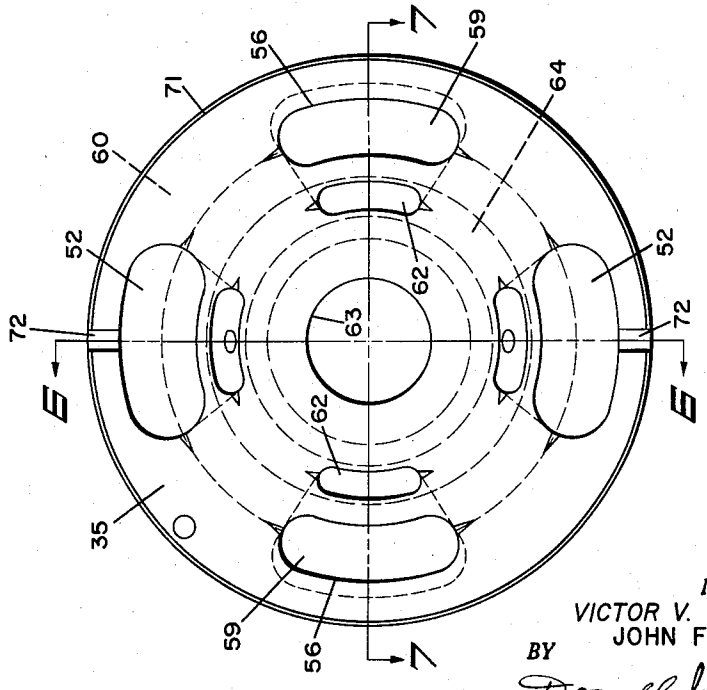

Fig. 5

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FLUID PRESSURE ENERGY TRANSLATING DEVICE

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Application August 31, 1955, Serial No. 531,807

2 Claims. (Cl. 103—136)

This invention relates to fluid pressure energy translating devices such, for example, as hydraulic pumps or motors.

The invention is described and illustrated herein in connection with a rotary type hydraulic pump or motor of the capsule type. For the sake of brevity the invention is described hereinafter as being applied to a fluid pressure energy translating device in the form of a pump but it is to be understood that the invention is not to be limited by such description to a pump.

An object of this invention is to provide improved and simplified structure in a pump.

Another object of the invention is to provide an improved pump apparatus which includes improved and simplified means for conducting fluid within the apparatus.

Another object of the invention is to provide improved and simplified construction in a capsule type pump i.e., a pump in which pump elements are inserted in a housing or casing and which housing or casing includes passage means for conducting fluid to and from the pump.

Another object of the invention is to provide improved structure in a pump of the type set forth in the foregoing object in which the pump includes improved means by which the high pressure fluid passages in the pump are formed and connected with the high pressure fluid passage means in the casing or housing and preferably, but not necessarily, wherein certain of the pump elements are held together by fluid pressure taken from said passages.

In carrying out the foregoing object, it is another object of the invention to cause a cheek plate of the pump, which may or may not function as a piston in the housing, to include all of the high pressure fluid passages of the pump and to connect the pump directly with the high pressure fluid passage means in the housing.

Still another object of the invention is to cause the cheek plate set forth in the foregoing object to cooperate with walls of the casing or housing to provide a pressure chamber and to provide a restricted passageway for conducting fluid pressure existing in the high pressure passages to said chamber whereby said cheek plate will function as a piston to urge pump elements within the casing or housing together in an axial direction.

Still another object of the invention is to provide an improved pump of the type set forth having a housing including two elements in each of which there is an inlet or outlet passage and wherein said casing or housing elements may be rotated with respect to each other to change the relative positions of said inlet or outlet passages, the internal arrangement of the pump being such that said passages are in communication with passages of the pump regardless of the relative positions occupied by the casing or housing elements.

Yet another object of the invention is to provide an improved cheek plate for use in a pump of the type described.

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:

Figs. 1 and 2 are views in section of an improved capsule type pump or motor including features of the invention, Fig. 2 being a view taken on line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a view looking at the left-hand end of the pump seen in Figs. 1 and 2 after a cover or cap and cheek plate thereof have been removed, the view showing construction and arrangement of the cam ring, rotors and vanes, etc. of the pump;

Fig. 4 is a view similar to Fig. 3, but showing the cam ring rotated 90° in a clockwise direction with respect to Fig. 3 to permit operation of the apparatus in a direction reversed from that of Fig. 3;

Fig. 5 is a view in elevation of the port side of a cheek plate employed in the pump, and

Figs. 6 and 7 are views in section, the views being taken on lines 6—6 and 7—7, respectively, of Fig. 5.

The pump shown in the drawings is of the capsule type, that is, it includes a casing or housing 20 having a cylindrical wall 21 and end wall 22 which walls cooperate to form a hollow cylindrical chamber 23 in which a rotary vane type pump 24 is contained. The casing or housing 20 also includes a boss 25 which extends radially from its cylindrical wall 21 and forms a high pressure fluid outlet or exhaust passage 26 which leads radially through the wall 21 and terminates at its itnerior cylindrical surface in opening or port 27. A readily removable internally threaded hollow flange 28 is secured by bolts, not shown, to the outer end of boss 25. Flange 28 is provided for the purpose of permitting quick and easy connection and disconnection of the pump casing or housing 20 to the high pressure side of a hydraulic system, not shown.

The end of chamber 23 opposite the end wall 22 is closed by a cap or cover 29 secured to one end of the cylindrical wall 21 by a plurality of screws 30 and this cap or cover 29 includes a radially extending boss 31 which forms a low pressure fluid inlet, conduit or passage 32 extending from its cup shaped interior to its exterior, and of course, from the outside to the inside of casing or housing 20 for admitting fluid into the housing. A flange 33 similar to flange 28 is secured to boss 31 for connection and disconnection of the pump housing or casing 20 from the low pressure side of said hydraulic system.

It may be mentioned here that one of the advantages of the pump is the fact that its cap or cover 29 may be secured to the casing or housing wall 21 in different rotated positions to change the radial relation of the inlet and outlet passages 32 and 26 thereby to render the pump more versatile to connection with the low and high pressure sides of said hydraulic system.

The pump assembly 24 includes a pair of rigid cylindrical cheek or port plates 34 and 35 between which a cam ring 36 is sandwiched. These elements 34, 35 and 36 telescope within the cylindrical chamber 23 and are interlocked against relative rotation with respect to each other and the cap or cover 29 of casing or housing 20 by a pin 37 which extends through aligned openings in the cheek plate 34 and the cam ring 36 and into sockets in the cap or cover 29 and cheek plate 35, as shown in Fig. 2 of the drawings.

The cheek plates 34 and 35 and the cam ring 36 cooperate to provide a rotor chamber in which there is a rotor assembly 38 including a rotor body provided with radially extending circumferentially spaced vane slots in each of

which there is a vane 39. Vanes 39 are urged radially outwardly by springs 40 seated in sockets formed in the rotor body at the bottom of each of said vane slots. Pump 24 also includes a shaft 41 which extends into the casing or housing 20 through a central bore in the end wall 22 thereof and through the cheek plate 35, the rotor body and into the cheek plate 34. Shaft 41 is mounted adjacent its exposed end in a ball bearing 42 in said central bore in end wall 22 and its opposite end is mounted in a roller bearing 43 carried in a central through bore in the cheek plate 34.

Because the cheek plates 34 and 35 and the cam ring 36 are telescoped with a close fit into the chamber 23 and float axially therein, it is necessary to provide for relative movement between the shaft and the cheek plate 34 as well as the rotor body and the shaft. For this reason, and to permit expansion and contraction of the elements of the apparatus, the construction at the roller bearing 43 is such that some relative axial motion between the cheek plate 34 and shaft 41 may occur and the roller bearing is connected to the shaft 41 through a motion permitting spline connection 44. Axial movement of shaft 41 is prevented by the ball bearing 42. Ball bearing 42 is secured in the central bore in end wall 22 and against an annular seal ring or plate 45 by a pair of snap rings.

The cheek plate 34 is provided with an annular shoulder 46 on its side adjacent the cap or cover 29 and this shoulder 46 abuts and is held against a shoulder on said cap or cover in a manner to be hereinafter described. One end of cheek plate 34 extends into the hollow cup-like interior of the end cap or cover 29 and it includes two diametrically positioned fluid inlet, suction or low pressure passages 47 which lead therethrough from the interior of cap or cover 29 to the interior of the rotor chamber, said passages 47 terminating in elongated inlet ports 48 formed by the face or wall of the cheek plate 34 immediately adjacent the rotor assembly 38.

As clearly shown in Fig. 1 of the drawings, the cheek plate 34 includes a pair of passages 49 which connect the inlet, suction or low pressure passages 47 with elongated ports 50 which register with the inner ends of the vane slots in the rotor body as the slots rotate past the ports 50.

From the foregoing, it will be apparent that the path of fluid to the rotor chamber of the pump 24 is through the flange 33 and passage 32 to the large reservoir-like interior of cap or cover 29 and through the passages 47 and ports 48 into the rotor chamber. It will also be apparent that fluid will be admitted to the inner and outer ends of the vanes 39 each time the vanes 39 and their slots in the rotor body pass the ports 48 and 50.

Cam ring 36 includes a plurality of axially extending through bores 51 which conduct fluid from the inlet ports 48 to ports and passages 52 formed in the face of cheek plate 35 which is adjacent the cam ring 36. These ports and passages 52 duplicate the passages 47 and 49 and the ports 48 and 50 on the opposite side of the rotor chamber.

Because of the above described arrangement of the inlet, suction or low pressure passages and ports and their connection with the passage 32 through the large interior of the cap or cover 29, the pump has excellent suction characteristics, that is, the passages offer very little resistance to the flow of fluid at low or suction pressure and, therefore, the tendency of the pump to cavitate is reduced to a minimum.

As seen in Fig. 3 of the drawings, the inner annular surface of the cam ring 36 forms the peripheral wall of the rotor chamber. This peripheral wall is generally of elliptical shape and it includes two diametrically disposed sealing portions 53 of equal radii struck from the axial center of the rotor chamber which, of course, is the axis of shaft 41, and two diametrically disposed transfer portions 54 of equal but larger radii than the sealing portions 53. The radii of the transfer portions 54 are

also struck from the axial center of the rotor chamber. All four of the arcuate portions 53 and 54 of the peripheral wall of the rotor chamber are interconnected by ramps, the intake, suction or low pressure ports 48 being positioned at diametrically positioned ramps 55 and high pressure, outlet or exhaust ports 56 formed in the cheek plate 35 being disposed adjacent diametrically disposed ramps 57.

As indicated in Fig. 3 by an arrow formed in the cam ring 36 and positioned adjacent the pin 37, the rotor assembly 38 will be rotated in a clockwise direction. The inlet ports 48, 52 and ramps 55 are each located at the end of one of the sealing sections 53 and in advance of one of the transfer sections 54 while one of the exhaust ports 56 is located at each of the ramps 57 at the end of each transfer section 54 and in advance of the next adjacent sealing section 53. As is well understood in the art, when the rotor assembly 38 is rotated in the direction of the mentioned arrow, the vanes 39 will cause fluid to be transferred from the inlet ports 48, 52 across the transfer sections 54 and to be expelled through the exhaust ports 56.

In Fig. 4 of the drawings, the cam ring 36 is shown in a position rotated 90° in a clockwise direction from that of Fig. 3 to reverse the direction of rotation of the rotor assembly 38 and shaft 41. In this position, the ramps 57 are aligned with ports 48, 52 and ramps 55 are aligned with ports 56.

The cam ring 36 may be rotated from the position shown in Fig. 3 to the position shown in Fig. 4 without removing it from the rotor assembly 38. To rotate the cam ring 36, the cap or cover 29 is removed from the cylindrical wall 21 of casing or housing 20 to expose the cheek plate 34. Cheek plate 34 is then withdrawn from the casing or housing 20 to expose one end of both the cam ring 36 and the rotor assembly 38 and, upon removal of the pin 37, the cam ring 36 may be rotated until an opening 58 therein becomes aligned with the pin socket in the cheek plate 35 whereupon the apparatus may be assembled in an order reverse to that described. A second arrow formed in the cam ring 36 adjacent the opening 58 in which the pin 37 is positioned upon rotation of the cam ring 36 indicates the new direction of rotation of the rotor assembly 38. It is to be understood that if the apparatus is to function as a motor, rather than as a pump, that the directions indicated by the arrows will be reversed.

Cheek plate 35 constitutes or makes possible important features of this invention and the structure of this cheek plate will best be understood with reference to Figs. 5, 6 and 7 of the drawings. The cheek plate is a very rigid circular disk which is preferably, but not necessarily, formed by casting and it floats within the chamber 23 in an axial direction only, its diameter being such as to provide a very close fit with the interior of the cylindrical wall 21 of the casing or housing 20. As previously mentioned, the cheek plate 35 includes in its end surface which abuts the cam ring 36 (Fig. 5) the two inlet port passages 52 and the two outlet ports 56. These passages 52 and ports 56 are spaced 90° apart and the ports 56 are connected through cored passages 59 in the cheek plate with a relatively large endless groove 60 formed in the periphery of and encircling the cheek plate 35. Passages 59 are bifurcated as at 61 and are connected with ports 62 formed in said end surface of the cheek plate. Ports 62 have a function similar to the ports 50 in cheek plate 34.

Cheek plate 35 also includes a stepped central bore 63 through which the shaft 41 extends and which, at the end of the cheek plate opposite the rotor chamber end, is encircled by an annular collar 64 the purpose of which will be set forth hereinafter. It will be seen that the end of the cheek plate 35 opposite the cam ring engaging end includes a radially extending annular flange 65 the diameter of which is also such as to provide a very close

but slidable sealing fit with the interior of the cylindrical wall 21 of casing or housing 20. As seen in Figs. 1 and 6, the flange 65 includes a small diameter bore or resistor passage 66 which extends through the flange from the groove 60 to the adjacent end of the cheek plate 35. The function of this bore or resistor passage 66 will also be set forth hereinafter.

Referring again to Figs. 1 and 2 of the drawings, the cheek or face plate 35 is positioned within the chamber 23 formed by the cylindrical and end walls 21 and 22, respectively, of the casing or housing 20 and between the cam ring 36 in said end wall 22 with its annular collar 64 telescoped into the central bore in end wall 22. A suitable O-ring seal seals the collar 64 with said bore and a suitable shaft seal 67 contained within the central bore 53 of cheek plate 35 seals the shaft 41 with the seal ring 45, the latter being sealed with the bore in end wall 22 by an O-ring. Cheek plate 35 functions as a piston and is urged away from the end wall 22 and against the cam ring 36 by coil spring 68 which surrounds the shaft seal 67 and engages the cheek plate 35 and seal plate 45 at its opposite ends. An O-ring seal contained in a groove in the cylindrical wall 21 of housing 20 surrounds the cheek plate 35 to prevent any loss of hydraulic fluid under discharge pressure from the groove 60 between the cylindrical wall 21 and the cheek plate 35.

It is to be particularly noted that the high pressure outlet opening 27 in the cylindrical wall 22 of housing 20 is aligned with or is in register with the peripheral groove 60 in the cheek or face plate 35 when the pump is assembled and that the path of fluid being discharged from the pump under high pressure is from the outlet ports 56 through the passages 59 to the peripheral groove 60 in cheek plate 35 and in circumferential directions in said groove 60 which cooperates with the cylindrical wall 21 to form a circular conduit or passage leading to the port 27 and through the port 27 to the high pressure outlet passage 26.

It is also to be noted that the end of the cheek plate 35 opposite the cam ring 36 and adjacent the casing or housing end wall 22 is spaced from the latter to provide an annular pressure chamber 69 within the casing or housing 20 and that the small diameter bore, orifice or resistor passage 66 in flange 65 of cheek plate 35 connects the groove 60 with this chamber. The bore or resistor passage 66 conducts high pressure from the groove 60 to the annular pressure chamber 69 and the pressure in this chamber aids the spring 68 in urging the cheek plate 35 against the cam ring 36. It is also important to note that there is substantially no flow of liquid from the pump through the chamber 69 to the high pressure outlet passage 26 and that pressure is transmitted to the chamber 69 from the groove 60 through the resistor passage 66. Resistor passage 66 functions as a choke to impede sudden changes in pressure in the chamber 69 thereby to minimize axial fluttering of the cheek plate in the casing or housing 20 due to sudden fluctuations of pressure in the outlet passage 26.

It will be seen that usually pressure in the chamber 69 will be equal to the discharge pressure of the pump and that therefore the pressure urging the cheek plate 35 toward the cam ring 36, the cam ring 36 toward the cheek plate 34 and the cheek plate 34 toward the cap or cover 29 will be proportionate to the output pressure of the apparatus.

In pumps of the type shown and described herein, there is a slight leakage of fluid under high pressure between the cam ring 36 and the cheek plates 34 and 35 and this fluid flows to between them and the cylindrical wall 21. This fluid, of course, finds its way between these elements and to the seals such as the O-ring seal, indicated at 70, between the cap or cover 29 and the cylindrical wall 21 of casing or housing 20 and its loss from the casing or housing 20 is prevented by such seal. Hydraulic pressure at the O-ring seal 70 would act to separate the cap 29 from the cylindrical wall 21 and, of course, apply additional loads upon the screws 30 which hold the cap 29 and wall 21 together. For obvious reasons, such a condition is to be avoided and it is avoided in the pump shown in the drawings.

The pressure of the fluid leaking from the rotor chamber between the cam ring 36 and cheek plates 34 and 35 toward the cylinder wall 21 acts to balance the force exerted on the cheek plate 35 by pressure in the chamber 69 and thereby tends to separate the cam ring and cheek plates. In the pump shown in the drawings, this action is reduced to a minimum. Provision has been made in the apparatus shown in the drawings for returning fluid which leaks or is forced to between the cylindrical wall 21 and the cheek plates and cam ring to the low pressure or suction ports of the pump. These provisions include the forming of peripheral chamfers 71 (see Figs. 5–7) on the edges of surfaces of the cheek plates 34 and 35 which abut the cam ring 36 as well as similar chamfers on the ends of the cam ring. As clearly shown in Figs. 1, 5 and 6 of the drawings, the chamfers 71 are connected with the inlet, suction or low pressure passages in the cheek plates 34 and 35 by radially extending grooves or slots 72 formed in the cheek plates 34 and 35.

Because the grooves formed by the chamfers 71 at the peripheries of the cam ring and cheek plate are connected with the inlet, suction or low pressure passages in the cheek plates 34 and 35 by the grooves or slots 72, the pressure in said grooves will be substantially equal to the pressure in the inlet, suction or low pressure passages. It will thus be seen that the pressure of the fluid which leaks from the rotor chamber between the cam ring 36 and cheek plates 34 and 35 toward the cylindrical wall 21 will be reduced to inlet or suction pressure at the grooves formed by the chamfers 71 and hydraulic pressure between the cylindrical wall 21 and the cam ring 36 and face plates 34 and 35 will at all times be substantially equal to the inlet or suction pressure existing in the passages 47.

It will also be seen that since hydraulic pressure cannot build up between the cylindrical wall 21 and the peripheral sides of the cam ring and face plates that there can be no build up of pressure between the face plates and cam ring and, therefore, that counterbalancing by such pressure of the pressure in the chamber 69 will be minimized.

By this invention, there has been provided an improved fluid pressure energy translating device which is of more simple overall construction and one in which each of the elements is simplified so as to minimize the cost of manufacture and, therefore, the cost of manufacture of the entire apparatus. The construction of the apparatus is such that its parts need only to be fitted into the casing or housing and when so fitted automatically align with each other and with the inlet and outlet passages of the casing or housing. For these reasons, the apparatus is well adapted for mass production thereby further reducing the cost of manufacture of the apparatus.

The apparatus is also more versatile to connection in a hydraulic system since its cap or cover 29 including the low pressure passage 32 and the cheek plates 34 and 35 together with the cam ring 36 attached thereto may be rotated as a unit to different positions with respect to the casing or housing wall 21 and high pressure passage 26. This is made possible because the port 27 will be aligned with the groove 60 regardless of the relative rotated positions of the inlet and outlet passages 32 and 36, respectively.

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 claims which follow.

We claim:

1. Hydraulic apparatus having housing means forming a cylindrical chamber and including a cylindrical wall, an end wall and a cap closing its other end, said cylindrical wall having means forming a high pressure passage leading radially therethrough and said cap having means forming a low pressure passage leading radially therethrough, means for attaching said cap to said cylindrical wall whereby the cap may be secured thereto in differently rotated positions; a rotary vane type fluid pressure energy translating device in said chamber including means forming a pair of cheek plates; a cam ring between said cheek plates, said cheek plates and cam ring cooperating to provide a rotor chamber; a rotor in said chamber; one of said cheek plates abutting said cap and including means forming a pair of diametrically positioned low pressure passages extending between said low pressure passage in said cap and said rotor chamber, the other of said cheek plates functioning as a piston in said chamber and including means forming a peripheral groove therein cooperating with said cylindrical wall of said chamber to provide a high pressure passage; said high pressure passage in said cylindrical housing wall registering with said peripheral groove; means forming a pair of diametrically positioned passages in said last named cheek plate extending between said rotor chamber and said groove, and means forming a restrictor passage between said groove and the side of said last mentioned cheek plate opposite said cam ring, said cheek plate and housing walls cooperating to provide a pressure chamber, said restrictor passage interconnecting said pressure chamber and said groove whereby pressure in said chamber will urge said last named face plate against said cam ring and said cam ring against said other face plate.

2. Hydraulic apparatus having housing means forming a cylindrical chamber and including a cylindrical wall, an end wall and a cap closing its other end, said cylindrical wall having means forming a high pressure passage leading radially therethrough said cap having means forming a low pressure passage leading radially therethrough; a rotary vane type fluid pressure energy translating device in said chamber including means forming a pair of cheek plates; a cam ring between said cheek plates, said cheek plates and cam ring cooperating to provide a rotor chamber; a rotor in said chamber; one of said cheek plates abutting said cap and including means forming a low pressure passage extending between said low pressure passage in said cap and said rotor chamber, the other of said cheek plates functioning as a piston in said chamber and including means forming a peripheral groove therein cooperating with said cylindrical wall of said chamber to provide a high pressure passage; said high pressure passage in said cylindrical housing wall registering with said peripheral groove; means forming a passage in said last named cheek plate extending between said rotor chamber and said groove, and means forming a restrictor passage between said groove and the side of said last mentioned cheek plate opposite said cam ring, said cheek plate and housing walls cooperating to provide a pressure chamber, said restrictor passage interconnecting said pressure chamber and said groove whereby pressure in said chamber will urge said last named face plate against said cam ring and said cam ring against said other face plate.

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