

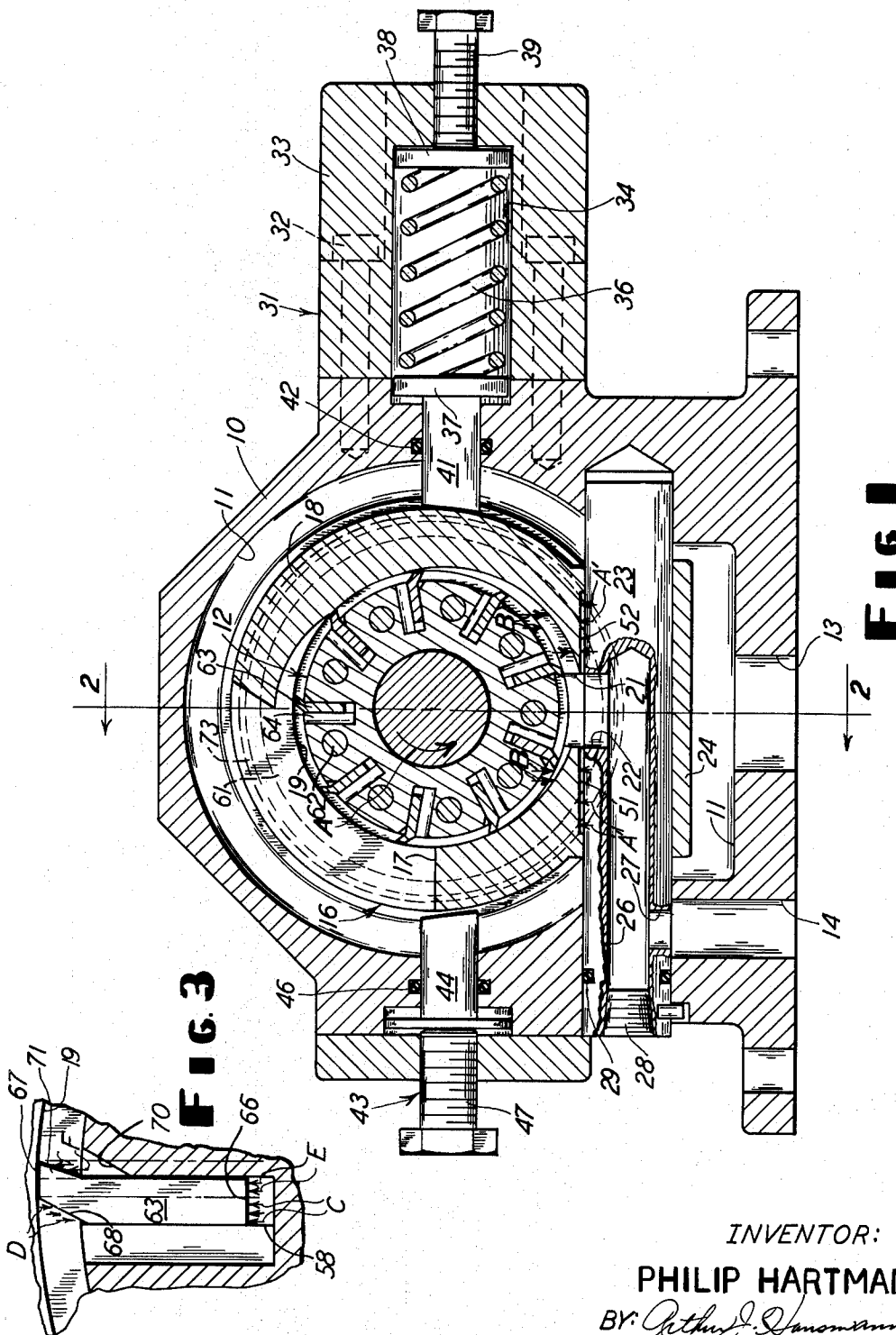
Dec. 7, 1965

P. HARTMANN
HYDRAULIC PUMP OR MOTOR WITH HYDRAULIC
PRESSURE-RESPONSIVE VANE

3,221,665

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3 Sheets-Sheet 1



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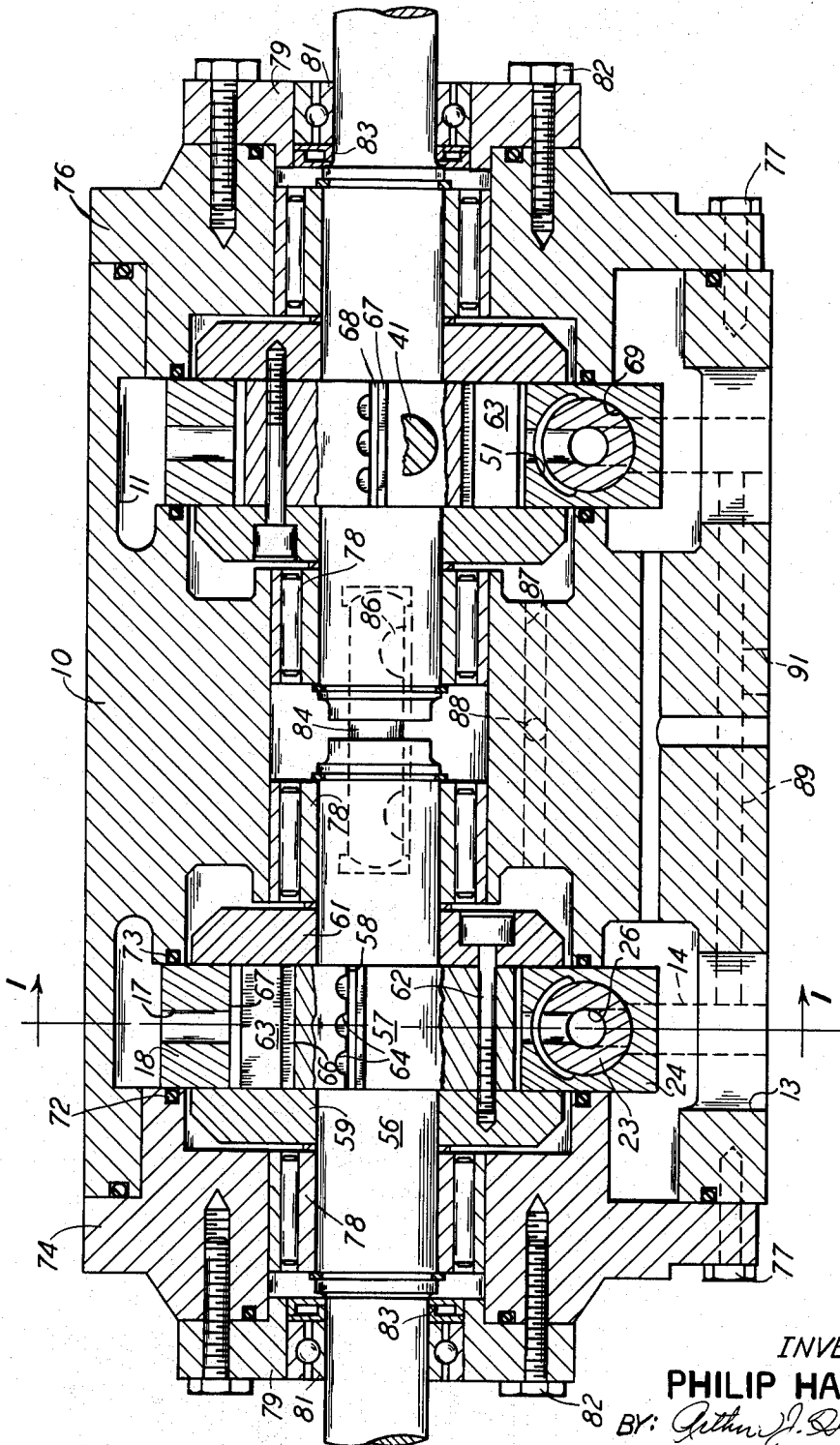


FIG. 2

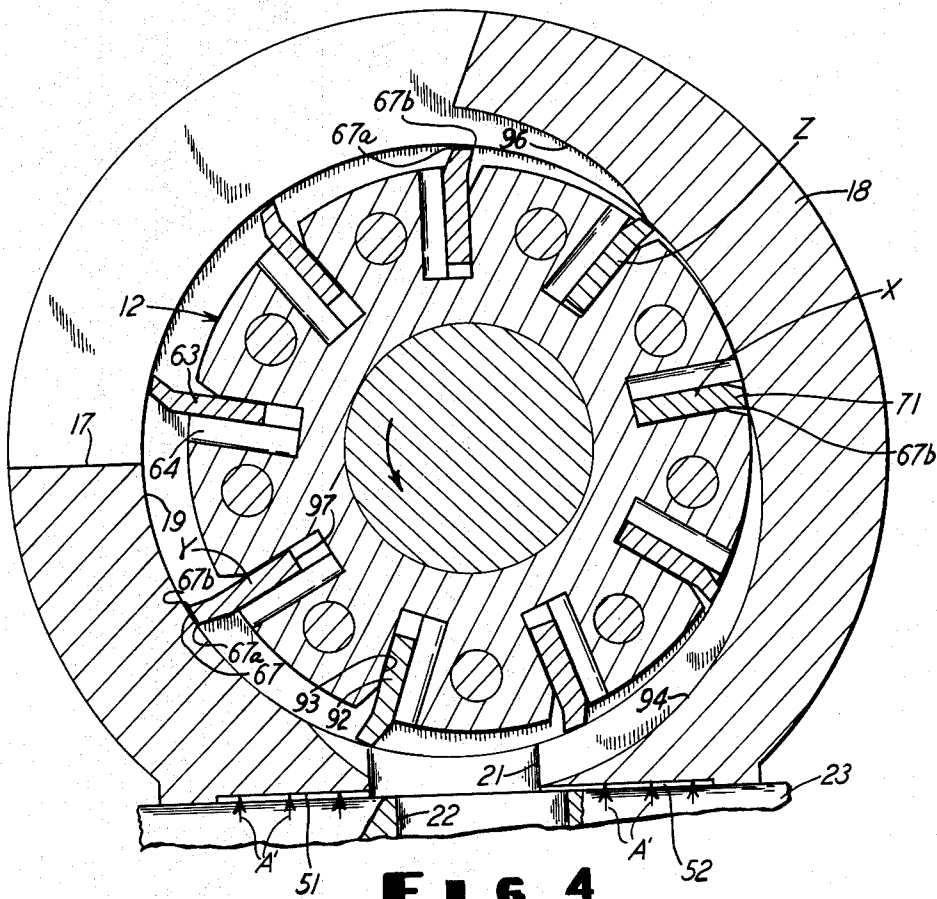
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HYDRAULIC PUMP OR MOTOR WITH HYDRAULIC PRESSURE-RESPONSIVE VANE

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Original application Jan. 11, 1962, Ser. No. 165,626, now Patent No. 3,180,271, dated Apr. 27, 1965. Divided and this application Jan. 15, 1965, Ser. No. 425,867
5 Claims. (Cl. 103-136)

This is a division of U.S. patent application Serial No. 165,626, filed January 11, 1962, now Patent No. 3,180,271.

This invention relates to a variable volume hydraulic pump and vane therefor.

It is a general object of this invention to provide an improved variable volume hydraulic pump wherein the volume of the oil or like hydraulic medium may be varied by means of adjusting the pump, but to do so without affecting the efficiency of the pump or without unduly loading various parts of the pump.

Another object of this invention is to provide a vane for a pump wherein the vane is hydraulically balanced to minimize excessive unbalancing pressures acting on the vane. Thus, in accomplishing this particular object, the vane is hydraulically balanced by the pressure of the working medium itself, to hold it out.

Other objects and advantages will become apparent upon reading the following description in light of the accompanying drawings, wherein:

FIG. 1 is a sectional view through a preferred pump of this invention and taken on the line 1-1 of FIG. 2.

FIG. 2 is a sectional view taken on the line 2-2 of FIG. 1.

FIG. 3 is an enlarged view of a fragment of that shown in FIG. 1.

FIG. 4 is an enlarged view of parts of FIG. 1, but with the parts in their adjusted positions.

The same reference numerals refer to the same parts throughout the several views.

In the preferred embodiment of this invention, there is a housing 10 having a central chamber 11 with a rotor generally designated 12 rotatably disposed therein. The housing 10 has a fluid inlet passageway 13 and a fluid outlet passageway 14, both of which are in fluid-flow communication with the chamber 11. Thus the passageway 13 is in direct fluid-flow communication with the bottom of the chamber 11, and the working parts of the pump, generally designated 16 and also referred to as a cartridge, are disposed within the chamber 11 and are of a size such that the incoming working medium or oil can flow around the cartridge 16 and come into contact with the rotor 12 through an inlet opening 17 in a port ring 18, which is a part of the cartridge designated 16. The inner bore 19 of the ring 18 thus provides the circular surface on which the rotor 12 operates in rotating in the direction shown by the arrow designated A. In this manner, the fluid enters the inlet 13 and comes into the working chamber of the pump to be engaged by the rotor 12. At this time it might also be noted that the port ring 18 has a fluid outlet opening 21 which is in fluid-flow communication with a fluid passageway 22 in a pin or guide member 23 which is stationarily mounted

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in the housing 10. The pin 23 is shown to be cylindrical and a boss or projection 24 of the ring 18 encircles the pin 23, and further the ring 18 is slidable along the pin 23 to provide the adjustment required for a variable volume pump.

The pin 23 has another fluid passageway 26 extending therethrough and communicating with a passageway 27 which in turn is in communication with the outlet passageway 14. In this manner, the fluid is exhausted from the rotor 12 through the outlet passageway 14.

A plug 28 and an O-ring 29 are employed on the pin 23 to seal at the respective points so that fluid cannot leak therepast.

A governor generally designated 31 is mounted on the housing 10 by means of the bolts 32 such that a governor body 33 is provided with a bore 34. The latter contains a compression spring 36 which has a plunger 37 and a plunger 38 on each end of the spring so that the plungers are displaceable along the axis of the bore 34 and are of course influenced by the spring 36. An adjusting bolt or control 39 is extended through the housing 33 to abut the plunger 38 and a shank 41 is extended through the pump housing 10 to abut the port ring 18. Further, an O-ring 42 is shown to seal around the plunger 41. Thus it will be understood that threading the adjustment or bolt 39 in or out with respect to the housing 33 will cause a varying pressure on the spring 36 and this will in turn influence the position of the plunger 37 and its shank 41 to in turn influence the position of the port ring 18. Therefore, the ring 18 can be displaced, for instance to the left as viewed in FIG. 1 and the ring will therefore be out of the so-called dead-heading position which it is now in, that is, its concentric position with respect to the rotor 12. Of course in the event the ring 18 is shifted to the left, a greater quantity of fluid would be moved by the pump, and conversely if the ring 18 were shifted to the right, a lesser amount would be moved and therefore the desirable, variable volume feature is achieved.

A volume limit control is generally designated 43 and is shown on the diametrically opposite side of the pump with respect to the governor 31 and it will here be noted that a plunger 44 abuts the opposite side of the ring 18 and an O-ring 46 seals around the plunger 44. Also, an adjusting member or bolt 47 is provided to give positive control over the plunger 44. Therefore, the maximum amount to which the ring 18 can shift to the left or toward the limit 43 is established by the position of the bolt 47, and this is therefore a limit control.

It will be noted that balancing pockets 51 and 52 are provided in the ring 18 at the point where the ring surrounds the upper circumferential portion of the pin 23. Thus the outlet pressure of the pump will be exerted on the ring 18 at the pockets 51 and 52 to counter-balance the downward pressure which will be exerted on the bore 19 of the ring 18 at the interior of the pump. Thus the pressure arrows designated A' show outlet fluid pressure effective in the pockets 51 and 52 acting upwardly on the ring 18 to counter-balance the pressure indicated by the arrows B on the bore 19 of the ring 18. In this pressure arrows designated A' show outlet fluid pressure it creates in pumping the fluid and thus no excessive unbalancing pressure is created, and the ring 18 is therefore free to move on the pin 23 in response to adjustment

of the governor 31. To accomplish this fluid-balancing, the upwardly projected area, on a horizontal plane, of the pockets 51 and 52 is substantially the same as the downwardly projected area, on a horizontal plane, of the bore 19 where the latter is of course subjected to the higher or outlet pressure in the lower half of the rotor 12, and the outlet opening 21 is omitted from these projected area considerations.

The rotor 12 consists of the shaft 56 and the central portion 57 which includes the vane slots 58 radially disposed around the portion 57. Side plates 59 and 61 are secured to the portion 57 by means of bolts 62, and it will be noted that the plates 59 and 61 thus flank the port ring 18 and rotate thereover upon rotation of the rotor 12.

Vanes 63 are radially slidably disposed in the vane slots 58 and it will be noted that fluid openings 64 communicate the periphery of the member 57 with the radially inner end of the slots 58 so that fluid pressure can be applied to the lower surface or base 66 of the vanes 63. In this manner, the vanes 63 are held radially outwardly so that the outer surfaces or tips 67 are held in sliding contact with the ring bore 19 to be fluid-tight therewith as desired.

An important feature of the fluid-balancing with respect to the vanes 63 is shown particularly in FIG. 3 where it will be noted that the fluid pressure applied at the base 66 of the vanes 63 is designated by the arrows C, and this pressure is radially balanced by the same fluid pressure applied on an angled or chamfered surface designated 68 on the outer end of the vane 63 and the pressure on the surface 68 is indicated by the arrows designated D. Also, pressure arrows designated E are unbalanced since the vane outer surface 67 is in contact with the bore 19 so that no pressure exists therebetween, and thus only the small force created by the pressure arrows designated E holds the vane 63 radially outwardly as desired. There would also be a small force as designated by the pressure arrows F acting radially outwardly on the offset 71 of the vane, but this would of course be only inlet pressure.

With this arrangement of a vane 63 with the chamfer 68 and the projection 71, the full outlet pressure of the fluid is not effective against the vane base 66 so that the usual excessive force is not acting on the vane to hold it outwardly and thereby create friction and wear which is unnecessary. Instead only the small area and the pressure of the arrows indicated E is effective on the vanes at the higher or outlet pressures of the pump while also only the small area and pressure indicated by the arrows F is effective on the vane at the inlet pressures which are not excessive for the vane. In this manner, both the ring 18 and the vanes 63 are hydraulically balanced so that no excessive pressures are applied thereto.

Also the rotor has a cutout 70 which receives the vane projection 71 when the vane is radially inward on the rotor. Further, the angles of the projection 71 and the cutout 70 are different so that fluid pressure can always be effective between the two and thus force the vane outwardly. Thus the force shown by the arrows C is more than the force shown by the arrows E and therefore the radially inwardly projected area on the angle or chamfer 68 is greater than the area covered by the arrows E so the outward force on the vane is not too great and thus friction between the vane and the bore 19 is not too great. Still further, the offset 71 and its underneath surface with the force designated by the arrows F hold the vane outwardly when the pump is in the dead-heading position. Thus in the variable volume pump, the vanes are always held outwardly though the ring 18 is moved back and forth.

Further, the area on which the pressure arrows A act on the ring 18 is at least one-half of the area on which

the pressure arrows B act, and, as previously described, the projections of these areas are substantially equal. Thus most of the force on the ring 18 is balanced in the pockets 51 and 52 which are therefore sufficient for substantially balancing the ring 18.

When the ring 18 is moved to the right, as shown in FIG. 4, the vane tips 67 have an important relation with the ring wall 19. It will be seen that the vane 63 is radial with the rotor 12, while the ring 16 is eccentric to the rotor 12. Thus, the vane tips 67 each have their corners or edges 67a and 67b in alternate fluid sealing relation with the wall 19. That is, on the lower half of the wall 19 the rotationally leading corner 67a is fluid tight with the wall 19, while on the upper half of the wall 19 the rotationally trailing corner 67b is fluid tight with the wall 19.

This is important in holding the vanes radially outwardly to retain the high pump pressure as long as possible, rather than release it to the suction side of the pump. Thus, the vane on the right in FIG. 4, and designated X, has its trailing corner 67b fluid tight with the wall 19, and therefore the projection 71 is effective to hold that vane radially outwardly. Of course the portion of the pump from the vane designated Y to the vane designated X is under the high pressure. Without the projection 71, the vane X would simply be radially balanced at its tip 67 and its opposite inner end so no high pressure would hold it out, and there would be a leakage of high pressure past the vane X and to the inlet opening 17. In fact, the high pressure could force the vane X radially inwardly if the projection 71 were not present. High pressure is thus effective to hold the vane outwardly to the rotated position of vane Z, since the pressure on the rotationally trailing side of the vanes is greater than that on the rotationally leading side, and projection 71 is subjected to high pressure acting radially outwardly.

Notice the arrangement of the outlet 21 and the passageway 22 communicating with the guide pin 23 so that the outlet pressure is effective around the circumference of the pin 23 and in the bore 69 of the ring 18. Thus the outlet pressure will fluid-balance and lubricate the ring 18 on the pin 23 and there will therefore be no seizing or binding of the ring 18 on the pin 23 as the ring will be free to move as desired.

Also, O-rings 72 and 73 are applied on opposite sides of the port ring 18 to seal the latter with the housing 10.

With particular reference to FIG. 2, it will also be noted that the housing 10 also has end pieces 74 and 76 secured thereto by bolts 77 and roller bearings 78 are shown along the rotor shaft 56 to rotatably mount the latter in the housing 10. Still further, it will of course be noted that two pumps having the cartridges 16 are shown in the housing 10 and these pumps are slightly out of phase so that the vanes of one pump are unloading at a time different from that of the other pump, and therefore the pulsations and vibrations are minimized. FIG. 2 therefore shows that the vanes are staggered between the two cartridges 16. It will further be noted that since the inlets and outlets of the respective pumps are substantially in the plane of the rotor 12, the bearings 78 can be as large as needed for supporting the loads on the shaft 56 since the inlets and outlets of the pump do not limit or restrict the size of the bearings 78. Still further, end caps 79 with bearings 81 are applied to the end pieces 74 and 76 and are secured thereto by bolts 82. A seal 83 is applied around the outer end of the shaft 56 to seal therewith.

With respect to the multiple or dual units of the pumps, it will therefore be understood that the cartridge units 16 can be readily inserted into and removed from the housing 10. Also, FIG. 2 shows that the shaft 56 can be connected by means of a shaft 84 being keyed thereto with the keys 86 so that the shafts 56 can rotate together if desired. Still further, fluid passageway 87 is provided

between the housing rotors 11 so that any slip oil getting beyond the plates 59 and 61 will be drained from the housing through the drain 88 so that fresh oil can replace the slip oil. With the arrangement of the passages 87 and 88, the slip oil is drained from the housing and then fresh oil will be taken in when the pumps are in the dead-heading position, and thus the pumps will run cooler with the fresh oil brought in at the lower temperature.

With the arrangement of the single housing 10, and the offset of one cartridge 16 with respect to the other cartridge 16 to minimize pulsations, the outlets 14 can be connected together through the passageway designated 89 so that a steady flow of oil under a uniform pressure is exhausted into the passageway 89 and the outlet 91. Of course, the passageway 89 may be eliminated or shut off by conventional means if it is desired that the cartridges 16 be run independent of each other without the connecting shaft 84 so that separate pressures can be exhausted by each of the pumping units.

Thus, the vanes 63 have offsets 71 for controlling the radial fluid pressures on the vanes 63, and the vanes can readily move entirely inward and outward on the rotor in response to the position of ring 18. Also, the passageways 64 are on the rotationally leading side of the vanes 63, and the radially inward planular portions or ends 92 of the vanes 63 are fluid-pressure urged against the rotor wall 93 to be fluid tight therewith.

The pump outlet 21 has the connecting passageway 94 extending therefrom and to the horizontal center line of the pump or vane X. Also the inlet 17 has the passageway 96 extending counter-clockwise from rotationally beyond the vane Z. It is therefore important to hold the high pressure in the sector of the vanes X and Z. Of course high pressure will act on the base 97 of the vane Y to hold it radially outwardly. But when the vanes get to the position of the vanes X and Z, that is when there is no high pressure on the surfaces 97 and then the projections 71 are effective to hold the vanes radially outwardly.

While a specific embodiment of this application has been shown and described, it should be obvious that certain changes could be made therein and the invention therefore should be determined only by the scope of the appended claims.

What is claimed is:

1. In a hydraulic machine of the vane type, a rotor having radially disposed vane slots and being rotatably mounted, a port ring surrounding said rotor and defining a chamber therein and being movable eccentric to said rotor and having a circular wall in contact with the radially outer edges of said vanes, a vane radially slidably disposed in each of said slots and with each of said vanes being planular in the radial inner portion thereof and with the radially outer portion of each of said vanes having a projection offset from the plane of said vane to the rotationally trailing side with respect to rotor rotation, the radially outer surface of said vane being flat and presenting one continuous outer surface with a rotationally leading edge and a rotationally trailing edge, said rotor having pockets for fully receiving said projections upon full radial retraction of said vanes, said rotor having a fluid passageway extending from the rotationally leading side of said vane with respect to rotor rotation and extending to the radially inner surface of said vane to admit fluid from said chamber to urge said vane radially outwardly, said projection and the radially outer surface of each of said vanes intersecting on said port ring wall and forming the trailing one of said outer edges of said vane along a line on a plane furthest offset from and parallel to said inner portion so that said projection has a radially projected area to present only a projected area for fluid pressurizing said vane radially outwardly only.

2. In a hydraulic machine of the vane type, a rotor

having radially disposed vane slots and being rotatably mounted, a vane radially slidably disposed in each of said slots and with each of said vanes being planular in the radial inner portion thereof and with the radially outer portion of each of said vanes having a projection offset from the plane of said vane to the rotationally trailing side with respect to rotor rotation, a port ring surrounding said rotor and being movable eccentric to said rotor and having a circular wall in contact with the radially outer edges of said vanes and with said wall defining a chamber, the entire radially outer surface of said vane being continuously flat and having a rotationally leading edge and a rotationally trailing edge, said rotor having pockets for fully receiving said projections upon full radial retraction of said vanes, said rotor having a fluid passageway extending from the rotationally leading side of said vane with respect to rotor rotation and to the radially inner surface of said vane to admit fluid from said chamber to urge said vane radially outwardly, said projection being shaped and disposed to present a projected area faced away from said circular wall and having said rotationally trailing edge in fluid-tight contact with said circular wall at the furthest limit of said projection from the plane of said planular inner portion when said port ring is eccentric to said rotor and said vane is in the pressurized portion of said chamber.

3. A rotor and vane combination for a vane-type hydraulic machine, comprising a rotor having radial vane slots, a vane disposed in each of said slots and having a radially inwardly disposed planular body portion and a radially outer end having a projection offset from the plane of said body portion to the rotationally trailing side of said vane, said outer end terminating in a radially outer flat surface transverse to said plane and presenting two corners at the rotationally opposite edges of said outer end, said outer surface extending across said projection to present the rotationally trailing one of said corners, said rotor having a fluid passageway extending along the rotationally leading side of each of said vanes from the exterior of said rotor to the radially inner end of each of said vane slots, said slots being defined on one side by a side surface on the rotationally trailing side of each of said vanes along said body portion of said vanes so that each of said vanes can be fluid-tightly urged against each of said side surfaces, and said rotor having a notch contiguous with each of said side surfaces for fully receiving said projections upon radial retraction of said vanes.

4. In a hydraulic pump of the vane type, the invention of a rotor having radially disposed vane slots and an angled corner adjacent said slots on the circumference of said rotor, a port ring surrounding said rotor, a vane slidably disposed in each of said slots and having a radially inner surface of a selected area for receiving hydraulic pressure to urge said vane radially outwardly against said port ring, and said vane having a projecting corner extending toward the rotationally trailing side of said vane at the radially outer end thereof and said projecting corner being adapted along with the adaptation of said angled corner to be fully receivable in said angled corner when said vane is radially retracted, the adjacent surfaces of said angled corner and said projecting corner being at different angles to present clearance between said surfaces in the full radially retracted position so hydraulic fluid can enter between said surfaces from said port ring.

5. A rotor and vane combination rotatable in a circular wall of a vane-type hydraulic machine, comprising a rotatably mounted rotor, a vane radially slidably disposed in said rotor and having a flat body portion and a projection offset from the plane of said body portion and disposed on the radially outer end of said vane and only to the rotationally trailing side of said vane, said outer end terminating in a flat surface disposed transverse to said plane and presenting two opposite edges

along the circular path of rotation of said vane at the opposite limits of said surface, said projection and said surface being related to join on the trailing one of said edges and with said surface terminating short of the flat plane along the leading side of said body portion, said edges being disposed to be alternately in mutually exclusive fluid-tight contact with said wall upon rotation of said rotor.

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