Dec. 27, 1949 A. H. DALL 2,492,687

HYDRAULIC PUMP

Filed April 30, 1946 3 Sheets-Sheet 1

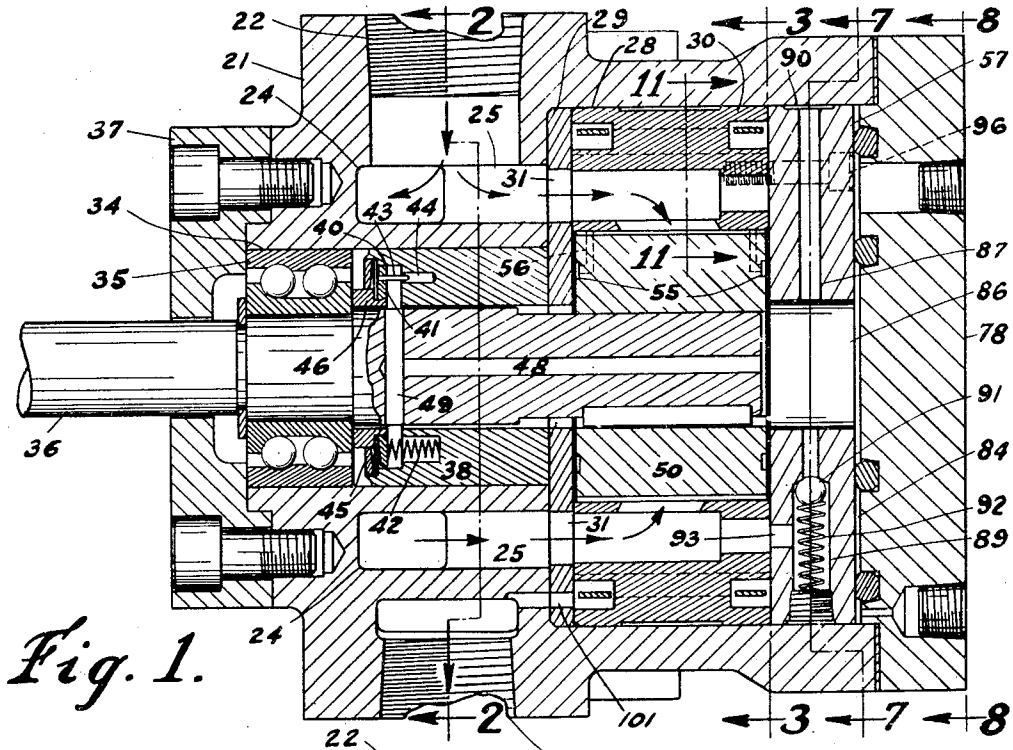


Fig. 1.

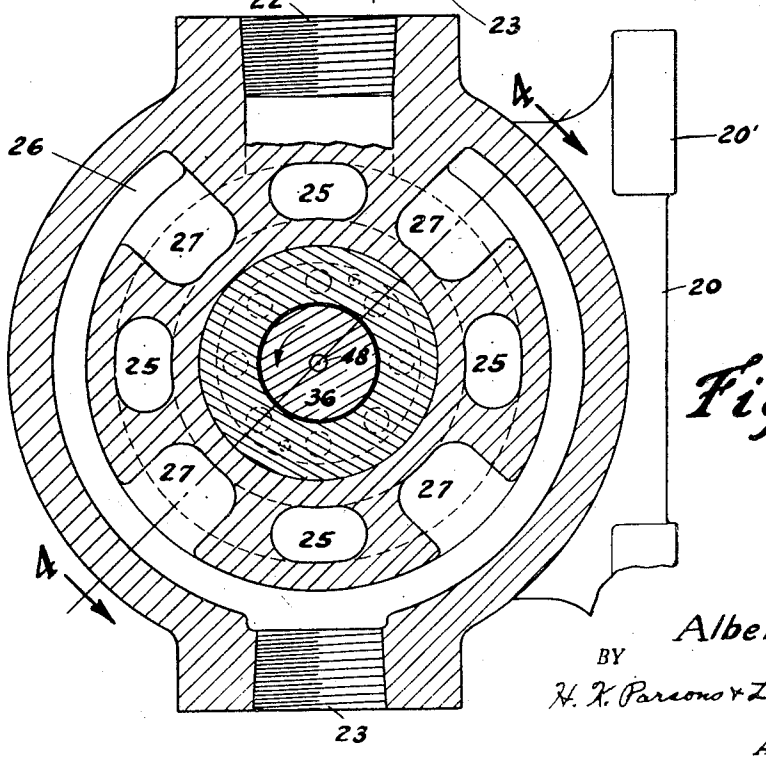


Fig. 2.

INVENTOR.
Albert H. Dall
BY
H. K. Parsons & L. W. Wright.
ATTORNEYS

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HYDRAULIC PUMP

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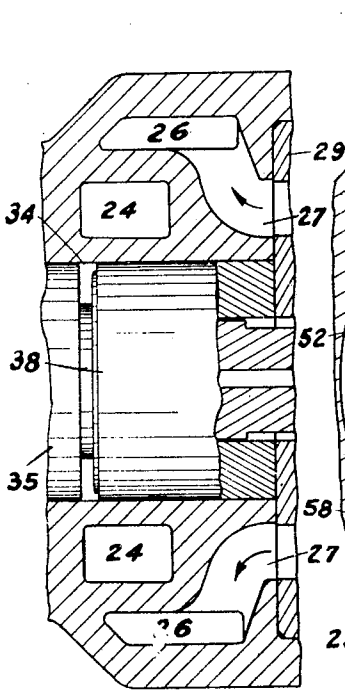


Fig. 4.

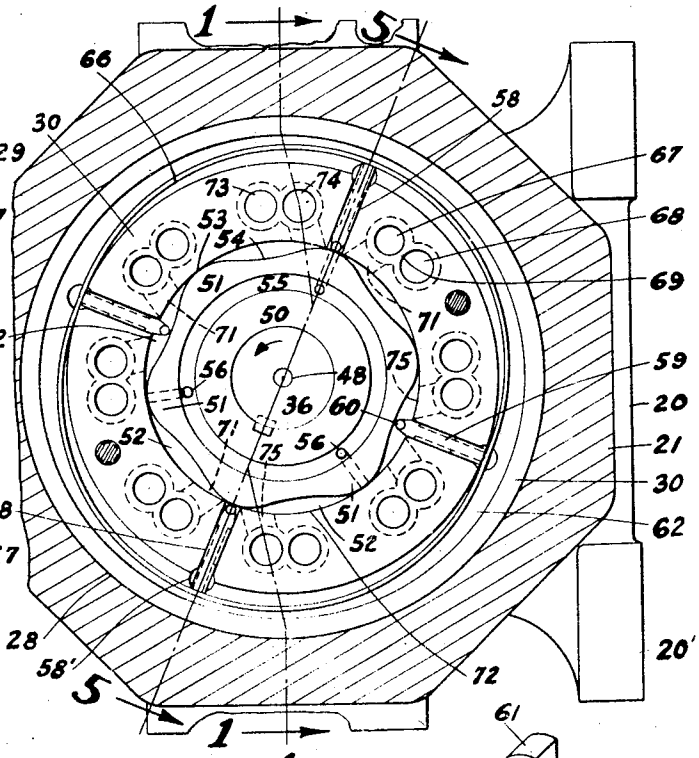


Fig. 3.

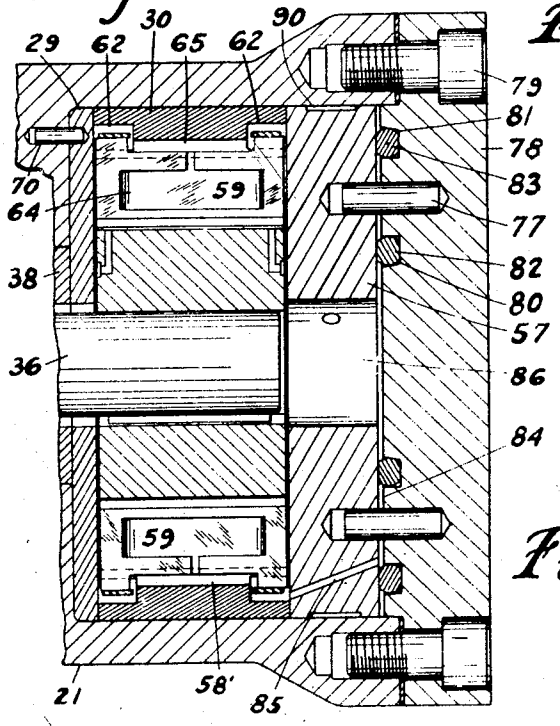


Fig. 5.

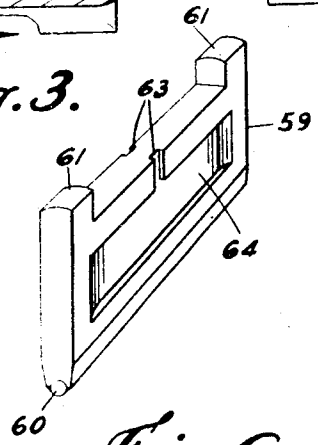


Fig. 6.

INVENTOR.
Albert H. Dall
BY
H. K. Parsons & L. W. Wright
ATTORNEYS

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HYDRAULIC PUMP

Filed April 30, 1946 3 Sheets-Sheet 3

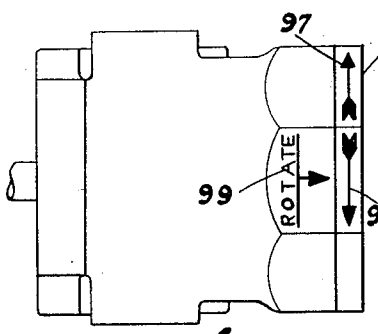


Fig. 9.

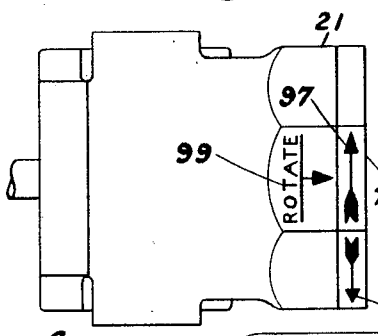


Fig. 10.

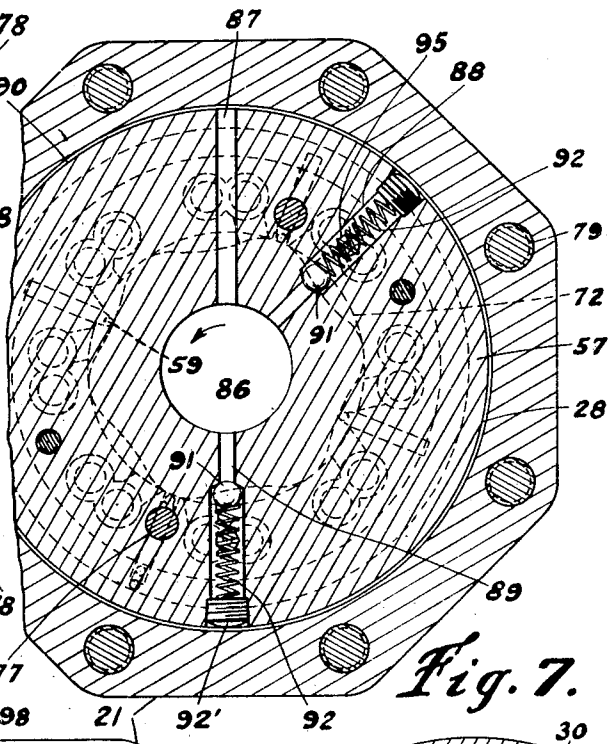


Fig. 7.

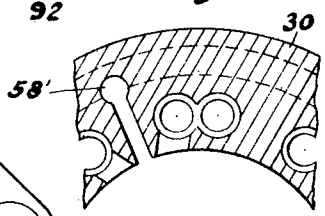


Fig. 11.

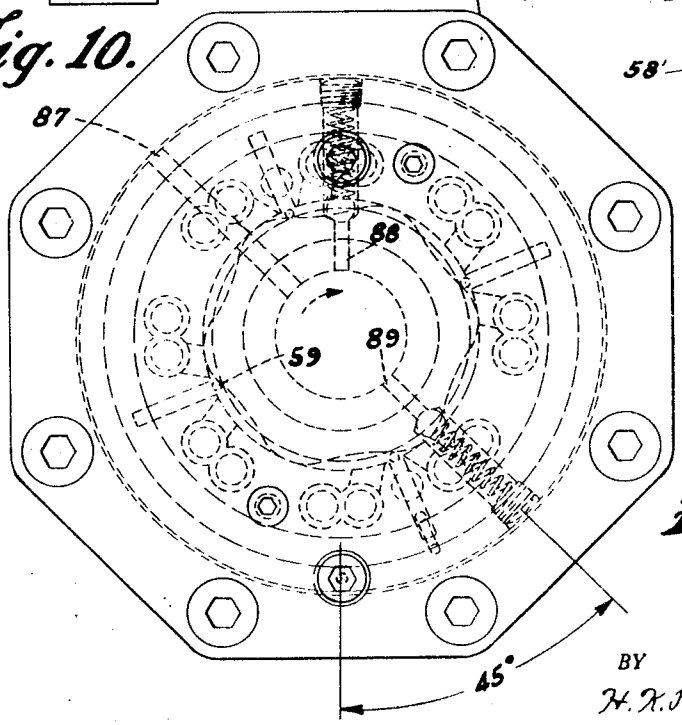


Fig. 8.

INVENTOR.
Albert H. Dall
BY
H. K. Parsons & L. W. Wright
ATTORNEYS

Patented Dec. 27, 1949 2,492,687

UNITED STATES PATENT OFFICE

2,492,687

HYDRAULIC PUMP

Albert H. Dall, Cincinnati, Ohio, assignor to The Cincinnati Milling Machine Co., Cincinnati, Ohio, a corporation of Ohio

Application April 30, 1946, Serial No. 666,133

12 Claims. (Cl. 103—123)

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This invention relates to improvements in hydraulic power units of the type adapted for high pressure actuation of machine tool units or the like.

One of the objects of the present invention is the provision of a unit particularly adapted for use as a pump for efficient production of a high actuating pressure such as 1000 pounds, or more, to the square inch, or operation of cylinders or other power elements.

A further object of the invention is the provision of an improved simplified structure in which the number of moving or shiftable elements shall be minimized, eliminating difficulties due to leakage between relatively moving parts and minimizing reduction in efficiency of the unit due to wear or improper functioning of such moving elements.

A further object of the present invention is the provision of improved means for sealing the several parts against outleakage of the pressure fluid or inleakage or entrainment of air in the system.

An additional object of the present invention is the provision of an improved structure which may be rotatively adjusted for reversal of the direction of movement of the controlling rotor thereof while maintaining unidirectional output of the power unit.

Other objects and advantages of the present invention should be readily apparent by reference to the following specification, considered in conjunction with the accompanying drawings forming a part thereof, and it is to be understood that any modifications may be made in the exact structural details there shown and described, within the scope of the appended claims, without departing from or exceeding the spirit of the invention.

Figure 1 is a vertical section of an embodiment of the invention, the exact location of the section being indicated by the line 1—1 on Figure 3.

Figure 2 is a section at right angles to Figure 1 taken as on the line 2—2 of said figure.

Figure 3 is a transverse section as on the line 3—3 of Figure 2.

Figure 4 is a fragmentary sectional view as on line 4—4 of Figure 2.

Figure 5 is a fragmentary section on line 5—5 of Figure 3.

Figure 6 is a perspective view of one of the main elements.

Figure 7 is a transverse section as on line 7—7 of Figure 1.

Figure 8 is a front view as on line 8—8 of Figure 1 with certain of the underlying elements being indicated in dotted lines.

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Figures 9 and 10 are plan views illustrating the adjustment for direction of rotation of the rotary element, and

Figure 11 is a fragmentary section on the line 11—11 of Figure 1.

In the drawings similar reference characters are employed to denote the same or similar parts.

The numeral 20 designates a supporting bracket element having the feet 20' for suitable mounting of the pump structure. Carried by said bracket 20 is the housing or casing element 21 having the inlet or intake passage as at 22 and the output passage at 23. Communicating with the intake 22 in the body of the housing is a circumferential passage or channel 24 having extending forwardly therefrom a plurality of transverse passages 25 which have here been indicated as four in number. Disposed forwardly of, and isolated from the groove 24, is a segmental groove 26 coupled with the outlet or discharge aperture 23 and provided with a plurality of inwardly extending chambers 27 disposed intermediate the passages 25. The casing 21 is provided as at 28 with a counterbore or enlarged cylindrical recess receiving the porting plate 29 and the pump body or stator 30. Plate 29 is formed from a suitable hardened wearing material and provided with a plurality of portings as at 31, for example, affording communication between the passages or pressure pockets 25 and 27 and the pump body. By employment of this construction the necessary fitting and finishing of the rear or porting plate element of the pump may be effected and the plate placed in the bore 28 in close interfitting engagement with the body portion 21 eliminating necessity for accurate finishing of the conduit elements 25 and 27 and at the same time providing a readily replaceable element in the event of wear or damage.

Formed in the casing 21 is an axial bore 34 into which is fitted a double row antifriction bearing 35 supporting the pump shaft or spindle 36. A removable plate 37 retains the bearing within the bore. Shaft 36 extends forwardly through the sealing bushing 38 in the bore which at one end abuts the porting plate 29. At its opposite end the bushing is counterbored as at 40 to slidably receive ring 41 rearwardly actuated as by springs 42 and having guide pins 43 loosely received in sockets 44. Interfitting oil seal elements 45 carried respectively by the bushing and ring 46 serve to seal the structure against leakage around the shaft. It will be noted that

the shaft has a passage as at 48 and cross-passage 49 communicating with the space intermediate the parts 38 and 41 into which latter pressure oil is introduced as hereinafter specified, maintaining the elements in expanded position and providing a fluid seal preventing leakage of air into the inlet side of the system.

Keyed on the pump shaft is the cam rotor 50 most clearly shown in Figure 3 of the drawings. This cam has been indicated as provided with a number of lobes 51 and intermediate depressions 52. Attention is invited to the fact that the central curvature as at 53 of the lobes and the central arc as at 54 of the depressions correspond in configuration. The cam has formed in its faces the grooves 55 communicating through interdrilled passages 56 with the face of the cam. During operation the fluid being pumped under pressure will be forced into the grooves 55 and react against the adjacent faces of the porting plate 29 and sealing plate 57 respectively, providing balancing pressure films centralizing the cam between said plates and preventing undue friction wear or scoring by endwise movement of the cam which by these opposed pressure films is maintained in a balanced condition, thus increasing the useful life of the elements.

By reference to Figures 3 and 5, it will be noted that the stator 30 is formed with radial slots as at 58, shown as four in number to receive the sliding vanes 59 formed on their inner surfaces with the cylindrical wear inserts 60 of tungsten carbide or other suitable wear resisting material. These vanes are additionally provided on their outer face with lugs 61 extending into the grooves 62 of the stator and having the groove 63 communicating with the recesses 64 in the faces of the vanes. Oil under pump output pressure introduced into the space 65 intermediate the outer faces of the vanes and the stator as through passage 101 will react to force the vanes inward during operation of the pump and at the same time create pressure in the pockets or recesses 64, lubricating the vanes and tending to laterally stabilize same and reduce friction wear. For pressure equalization the stator is cross drilled at the base of the vane slots, as at 58', connecting grooves 62 and insuring inward pressure on the backs of the vanes in all radial positions.

Spring rings 66 circumscribing the lugs 61 at each side of the vanes jointly react on the vanes to urge same inward against the cam 50 maintaining the parts at all times completely conditioned for use irrespective of the building up of pressure in the spaces 65. By employment of the circumscribing spring rings the reaction of the vanes is a mere flexing or distortion of the springs since, as shown in Figure 3, the relationship of the vanes to the lobes of the cam and their number are such that one opposed pair of vanes will be in its innermost position, while the opposite pair is in the outermost position so that a constant amount of displacement or distortion of the spring ring 66 is effected. At the same time due to the conditions described and the fact that the curvatures of the cam are equal but opposite at points 53 and 54 and the curvature of rise and fall of all of the lobes are alike the volume of fluid within the spaces 65 intervening the vanes and the stator will remain substantially constant, the increase in spacing between one vane and stator being compensated by corresponding decrease at the adjacent vane so that no in and out pulsations of vane actuating pressure fluid will exist. The structure described is therefore self-priming with a build-up in inward vane pressure proportionate to the pump pressure developed.

By reference particularly to Figure 3 of the drawings it will be noted that the body of the stator 30 is formed adjacent each vane slot in a clockwise direction with a pair of drilled transverse passages 67 and 68 having the major portion of the connecting wall as at 69 removed to provide a substantially oval transverse inlet passage. These correspond in number with the outlets 27 of the casing and are adapted to be disposed in aligned communication therewith by way of the porting plate 29, pins 70 serving to retain the porting plate in proper aligned position and against rotation. Each of these outlet passages has a portion 71 communicating with the interior bore 72 of the stator at a point immediately adjacent a vane slot 58. Disposed on the opposite side of the vane slots are a second series of transverse passages 73—74 adapted to be aligned with the inlet recesses 25. These likewise communicate with the bore 72 by way of the passage portions 75.

An end sealing plate 57 mounted in counterbore 28 is in close interfitting engagement with the peripheral wall of the counterbore and engages the outer face of the stator for retaining the same in position. This closure plate 57 is slidable on pins 77 carried by the plate 78 which is, in turn, secured to the casing as by bolts 79. Imbedded in grooves 80 and 81 in this plate are the resilient sealing rings 82 and 83, enclosing therebetween the thin annular space 84 communicating as through conduit 85 with the front groove 62 of the stator so that the high pressure contained within this groove will flow through the conduit to the space intermediate the sealing rings 82 and 83 creating a pressure liquid seal to insure an airtight joint between the parts.

The pressure between plate 78 rigidly secured to the casing and the outer face of the sealing plate 57 also urges and maintains the plate, stator and porting plate assembly firmly seated against the base of the counterbore.

Plate 57 is provided with a central aperture 86 constituting a low pressure fluid reservoir from which extend the radial passages such as 87, 88, and 89, particularly indicated in Figures 1, 7, and 8. The passage 87 extends without obstruction to the peripheral oil seal groove 90 of the sealing plate while the passages 88 and 89 are normally closed by pressure relief valves such as the balls 91 inwardly urged by springs 92 whose pressure may be varied as by adjustment of the plugs 92'.

When the pump shaft 36 and operating cam are rotated in a counterclockwise direction as indicated in Figure 3 as a lobe 51 moves, for example, in the direction away from the left hand vane 59, fluid will be drawn in through inlet 22 and portings 25 to the space 52 which increases in volumetric capacity as the lug recedes from the vane. At the same time entrapped fluid on the right side of the vane will be forced outwardly through the passage 69, pockets 27, groove 26 and the discharge outlet 23, a similar reaction taking place at the diametrically opposite vane whereby a balanced operating condition is attained. As pressure is built in the discharge side of the pump it will flow through 101 and force fluid under high pressure into the grooves 62 and spaces 65 urging the vanes inwardly into close interfitting engagement with the periphery

of the actuating cam and in the sealing groove 88. Also pressure films will be created between the faces of the cam and the porting and sealing plates and a lower pressure in the reservoir 86. The value of this pressure may be determined by adjustment of the ball check or release valve spring 92 shown in Figure 1 which controls flow from the reservoir 86 and connected parts through passage 93 to the low pressure or inlet side of the system so that a suitable controlled pressure is maintained. At the same time the passage 95 adjacent the other relief valve is in communication with one of the pressure chambers 27 so that this ball is kept firmly seated, preventing outflow through this line or, alternatively, ingress of the high pressure. With the parts thus operating, the several balancing grooves are maintained filled with liquid under pressure preventing any sucking in of air, insuring stabilization of the parts, and at the same time preventing development of undue internal pressure reacting at these several points due to the action of the relief valve in permitting building up of a controlled pressure only.

Particular attention is invited to the fact that in the structure as shown and described there are but five basic moving parts for effecting the complete pumping action; namely, the four sliding vane elements and the single rotating cam. Further, the capacity of the pump for a given rate of rotation may be varied by employing different cams having different depths of relief portions on its periphery, but in all instances only a limited amount of stroke movement of the individual vanes is necessary. The vanes are at all times suitably yieldingly urged inward against the actuating cam and due to their mounting in the stationary portion of the pump body they are unaffected by centrifugal action and are equally positive in operation for either high or low speed actuations of the pump drive shaft.

The physical relationship of the several parts is such that the cam may be rotated either in a counterclockwise direction, as indicated in Figure 7, or in a clockwise direction as shown in Figure 8. This would ordinarily involve reversal in direction of flow of fluid through the pump and this can be satisfactorily effected so far as the essential pump elements are concerned. When so operated, 22 becomes the high pressure outlet and the check valve shown in Figure 3 will be maintained in closed position while the upper check valve of Figure 7 will now become the relief valve into the related low pressure conduit system 26—27.

Alternatively, however, if it is desired to reverse the direction of rotation of pump shaft 36 due to operating connections or the like and at the same time maintain the same unidirectional flow of hydraulic medium through the pump this can be accomplished by loosening of the bolts 79, retaining the cover plate 78. This plate, the associated sealing plate 57 through the connecting pins 77, and stator 30 attached thereto as by bolts 96, are bodily rotated within the counterbore of the casing in a counterclockwise direction as will be understood by a comparison of Figures 7 and 8. By this rotation the passages 73—74, which in Figure 3 served for intake purposes when the cam was rotated in a counterclockwise direction would become output or pressure ports with rotation of the cam in a clockwise direction. Therefore, by counterclockwise rotation of the stator and associate parts as an entirety, these members 73—74 may be moved

through an angle of 45 degrees to the position indicated in Figure 8. In this position they have been shifted from alignment with the intake passages 25 in the pump casing to alignment with the discharge or pressure pockets 27. Corresponding interchange of relationship between the several transverse passages of the stator and the passages through the porting plate to the output conduits 27 are correspondingly effected. By tightening of bolts 79, locking the parts in their adjusted relationship a constant directional output is attained for a reversal of direction of actuation of the pump shaft and cam and consequent reversal of the functions of the stator ports adjacent the cam.

In Figures 9 and 10 the cap plate 78 has been shown as provided with arrows 97 and 98 cooperating with the fixed arrow or indication 99 on the casing. When 98 and 99 are aligned, the pump is in condition for counterclockwise operation, while when 97 and 99 are in opposition the pump is conditioned for clockwise rotation, but unidirectional output is maintained.

What is claimed is:

1. A pump structure including a casing having a counterbore chamber, a pump shaft journaled in the casing and having a portion projecting within the chamber, a multi-lobed cam secured on said projecting portion of the shaft, a stator mounted within the chamber in circumscribing relation to the cam, said stator having a plurality of radially extending slots formed centrally therein and having annular grooves formed in its faces communicating with said slots, vanes slidably mounted within the slots and projectable to maintain continuous engagement with the varying peripheral contour of the cam, said vanes having lug portions extending into said grooves, means in the grooves engaging the lugs for resiliently maintaining the vanes in engagement with the cam, means for supplying fluid under pressure against the vanes to urge said vanes against the cam, said casing having a plurality of pressure conduits formed therein and a plurality of intake conduits intermediate the pressure conduits, said stator having pairs of conduits terminating in passage portions immediately adjacent opposite sides of the vanes, and means for securing the stator with one conduit portion of each pair aligned with a pressure conduit of the casing and the other of said pair aligned with an intake conduit of the casing.

2. In a pump of the character described, the combination with a pump casing, of a pump shaft journaled therein, the casing having a chamber concentric with the shaft and a series of intake conduits and a second series of output conduits formed therein and communicating with said chamber, a porting plate mounted within said chamber having ports communicating respectively with the intake and output conduits of the casing, a stator mounted within the chamber having a plurality of passages formed therein alignable with the respective apertures in the porting plate, said stator having radial slots formed therein intermediate adjacent pairs of said passages, vane members slidable in the slots, means for exerting an inward urge against said vane members, said pairs of passages on opposite sides of a vane having converging portions terminating at the inner face of the stator adjacent opposite sides of the radial slots, the stator having a central cylindrical bore, and a multi-lobed cam mounted on the pump shaft having the outer edges of the lobes interfitting with the bore, and

its periphery disposed for continuous engagement with the termini of the inwardly urged vanes, a sealing plate secured in the chamber of the casing at the opposite side of the stator from the porting plate, means for creating hydrostatic films intervening the adjacent faces of the rotor and those of the porting and sealing plates whereby the rotor will be automatically centered and metal to metal contact of the parts prevented, said means including grooves formed in the faces of the opposed parts and pressure passages providing communication between the pressure area of the pump and said grooves, conduit means for conducting the escaping film with the pump intake conduits, and means in said conduit means for resisting the flow to cause a pressure build-up as respects the escaping film forming fluid.

3. In a pump of the character described, the combination with a pump casing, of a pump shaft journaled therein, the casing having a chamber concentric with the shaft and a series of intake conduits and a second series of output conduits formed therein and communicating with said chamber, a porting plate mounted within said chamber having ports communicating respectively with the intake and output conduits of the casing, a stator mounted within the chamber having a plurality of passages formed therein alignable with the respective apertures in the porting plate, said stator having radial slots formed therein intermediate adjacent pairs of said passages, vane members slidable in the slots, means for exerting an inward urge against said vane members, said pairs of passages on opposite sides of a vane having converging portions terminating at the inner face of the stator adjacent opposite sides of the radial slots, the stator having a central cylindrical bore, and a multi-lobed cam mounted on the pump shaft having the outer edges of the lobes interfitting with the bore, and its periphery disposed for continuous engagement with the termini of the inwardly urged vanes, a sealing plate secured in the chamber of the casing at the opposite side of the stator from the porting plate, means for maintaining a hydrostatic film intervening the adjacent faces of the cam and those of the porting and sealing plates whereby the cam will be automatically centered and metal to metal contact of the parts prevented, means for effecting a fluid pressure seal intervening the several parts and the casing to prevent ingress of air, and means for determining the effective pressure of said seal.

4. In a pump of the character described, the combination with a pump casing, of a pump shaft journaled therein, the casing having a chamber concentric with the shaft and a series of intake conduits and a second series of output conduits formed therein and communicating with said chamber, a porting plate mounted within said chamber having ports communicating respectively with the intake and output conduits of the casing, a stator mounted within the chamber having a plurality of passages formed therein alignable with the respective apertures in the porting plate, said stator having radial slots formed therein intermediate adjacent pairs of said passages, vane members slidable in the slots, means for exerting an inward urge against said vane members, said pairs of passages on opposite sides of a vane having converging portions terminating at the inner face of the stator adjacent opposite sides of the radial slots, the stator having a central cylindrical bore, and a multi-lobed cam mounted on the pump shaft having the outer edges of the lobes interfitting with the bore, and its periphery disposed for continuous engagement with the termini of the inwardly urged vanes, a sealing plate secured in the chamber of the casing at the opposite side of the stator from the porting plate, means for maintaining a hydrostatic film intervening the adjacent faces of the cam and those of the porting and sealing plates whereby the cam will be automatically centered and metal to metal contact of the parts prevented, means for effecting a fluid pressure seal intervening the several parts and the casing to prevent ingress of air, and means for determining the effective pressure of said seal, said means including a pressure chamber, a conduit intervening said chamber and the intake side of the system, and valve means in the conduit controlling the flow from the chamber to the intake side of the system.

5. In a pump of the character described, the combination with a casing having a chamber formed therein, of a pump shaft journaled in the casing having a portion projecting into the chamber, the casing having a first outlet and a plurality of conduits affording communication between said outlet and the chamber and having a second outlet and a plurality of conduits affording communication with the chamber at points intermediate the first set of conduits, a stator member mounted for rotative adjustment within the chamber having a plurality of passages corresponding in number to those of the two sets of conduits and correspondingly spaced whereby the several conduits and passages may be placed in aligned relation for various rotative adjustments of the stator, said stator having radial slots formed therein intermediate adjacent pairs of passages and said adjacent pairs having converging passages terminating adjacent said slots whereby one of said pair will always function as an intake and the other as an output passage but said functions are interchangeable, vane members slidable in the slots, means for urging said vane members inwardly in the slots, the stator having a central cylindrical bore, a multi-lobed cam secured on the pump shaft with the outer faces of the lobes in interfitting engagement with the wall of the bore, and means for securing the stator in desired rotatably adjusted position with respect to the casing whereby the direction of flow of hydraulic medium through the pump may be maintained constant dependent on the selected alignment of the casing conduits and stator passages irrespective of the direction of rotation imparted to the rotor.

6. A pump structure of the character described, including a casing having a journal portion and a concentric chamber, a pump shaft rotatably mounted in the journal portion having a portion projecting within the chamber, the casing having intake and discharge portions, a first plurality of conduits intervening the intake and a wall of the chamber, a second plurality of conduits intervening the output and the wall of the chamber, a multi-lobed rotor cam carried by the shaft and disposed within the chamber, an annular stator having a cylindrical inner surface interfitting with the points of the lobes of the rotor cam and having a plurality of passages alignable with the intake and output conduits of the casing, said stator having a plurality of radial slots formed therein intervening adjacent pairs of passages, vane members slidable in the slots for engagement with the periphery of the rotatable cam, means for maintaining the vane members in continuous contact with the periphery of the cam,

a sealing plate forming a closure for the chamber in the casing, said sealing plate having a central pressure reservoir, a circumscribing oil seal groove and a conduit extending from the reservoir to the groove and having additional conduits formed therein communicating respectively with the two sets of conduits in the casing, and unidirectional relief valves in said conduits whereby when the pressure in the chamber exceeds a prescribed amount it may exhaust to the low pressure system of the casing irrespective of reversal of direction of flow of the pressure fluid through the conduits.

7. A pump structure of the character described, including a casing having a journal portion and a concentric chamber, a pump shaft rotatably mounted in the journal portion having a portion projecting within the chamber, the casing having intake and discharge portions, a first plurality of conduits intervening the intake and a wall of the chamber, a second plurality of conduits intervening the output and the wall of the chamber, a multi-lobed rotor cam carried by the shaft and disposed within the chamber, an annular stator having a cylindrical inner surface interfitting with the points of the lobes of the rotor cam and having a plurality of passages alignable with the intake and output conduits of the casing, said stator having a plurality of radial slots formed therein intervening adjacent pairs of passages, vane members slidable in the slots for engagement with the periphery of the rotatable cam, means for maintaining the vane members in continuous contact with the periphery of the cam, a sealing plate forming a closure for the chamber in the casing, said sealing plate having a central pressure reservoir, a circumscribing oil seal groove and a conduit extending from the reservoir to the groove and having additional conduits formed therein communicating respectively with the two sets of conduits in the casing, unidirectional relief valves in said conduits whereby when the pressure in the chamber exists a prescribed amount it may exhaust to the low pressure system of the casing irrespective of reversal of direction of flow of the pressure fluid through the conduits, a closure plate for securing the parts in position within the chamber of the casing, spaced annular sealing members carried by the closure plate for engagement with the sealing plate, and means for conveying fluid under pressure into the space between said elements to effect a hydrostatic pressure seal.

8. In a device of the character described, the combination including a casing having an axial bore and an enlarged counterbore portion, a pump shaft journaled in the bore having a portion projecting centrally of the counterbore, a rotor cam carried by said projecting portion, inlet and outlet conduits formed in the casing and in communication with the counterbore, a porting plate seated in the counterbore, means for securing the porting plate against rotation relative to the casing, a stator unit fitted within the counterbore in circumscribing relation to the rotor cam and having one face thereof seated against the porting plate, the porting plate having a series of spaced inlet and a series of spaced outlet ports formed therein and the stator having two series of conduit passages formed therein terminating in the face adjacent the plate and spaced to correspond with the port spacings, whereby on rotation of the stator either series of the stator conduits may be brought into registry with the inlet ports and the other series with the outlet ports, and means for securing the stator in desired rotatively adjusted position.

9. A pump structure including a stator having a central pumping chamber formed with an even number of pairs of radially extending vane receiving slots disposed in arcuately spaced relation, vanes slidably mounted in the slots, an actuating cam rotatably mounted in the chamber having alternate high and low portions arcuately spaced to provide 180 degree opposed alternate pairs of high and low portions, said cam being disposed within the stator to engage the inner termini of the vanes and resilient retaining rings circumscribing the vanes and in joint engagement with the outer faces of the vanes whereby on rotation of the cam sliding movement will be imparted to the vanes effecting opposite flexures of the resilient rings, maintaining a uniform tension against the circumscribed vanes.

10. A pump structure including a stator having a central pumping chamber formed with an even number of pairs of radially extending vane receiving slots disposed in arcuately spaced relation, vanes slidably mounted in the slots, an actuating cam rotatably mounted in the chamber having alternate high and low portions arcuately spaced to provide 180 degree opposed alternate pairs of high and low portions, said cam being disposed within the stator to engage the inner termini of the vanes and resilient retaining rings circumscribing the vanes and in joint engagement with the outer faces of the vanes whereby on rotation of the cam sliding movement will be imparted to the vanes effecting opposite flexures of the resilient rings, maintaining a uniform tension against the circumscribed vanes, the stator having pressure chambers formed therein adjacent the outer faces of the vanes, and means for introducing pressure fluid from the pumping chamber into said pressure chambers to supplement the rings in urging the vanes in the direction of the cam.

11. A structure of the character described including an inner multiple lobe cam member and a member circumscribing the cam, said member having a plurality of vane receiving slots formed therein and pressure chambers formed adjacent the outer portions of said slots, and vane members slidably mounted within the slots and projectable therefrom into engagement with the cam, said vanes having central pockets formed in the faces thereof in opposition to the walls of the slots, and means for introducing pressure fluid into the pockets by way of the chambers to create hydraulic films intervening the vanes and the walls of the slots.

12. A structure of the character described including an inner multiple lobe cam member and a member circumscribing the cam, said member having a plurality of vane receiving slots formed therein and pressure chambers formed adjacent the outer portions of said slots, and vane members slidably mounted within the slots and projectable therefrom into engagement with the cam, said vanes having central pockets formed in the faces thereof in opposition to the walls of the slots, means for introducing pressure fluid into the pockets by way of the chambers to create hydraulic films intervening the vanes and the walls of the slots, said vanes having recessed inner faces opposing the cam, and wear resisting inserts mounted in said faces in intervening re-

lation to the body of the vanes and the surface of the cam.

ALBERT H. DALL.

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