

July 22, 1941.

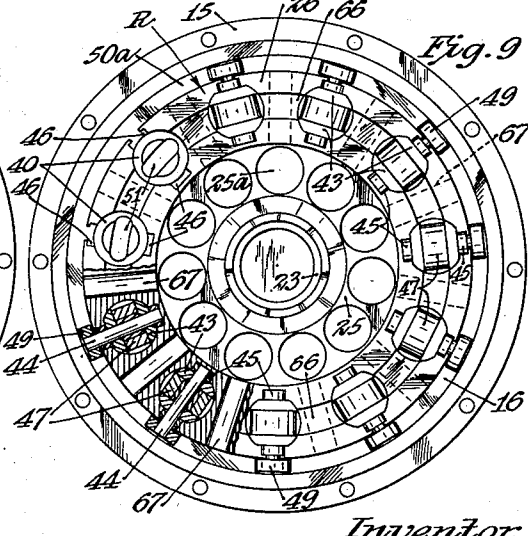
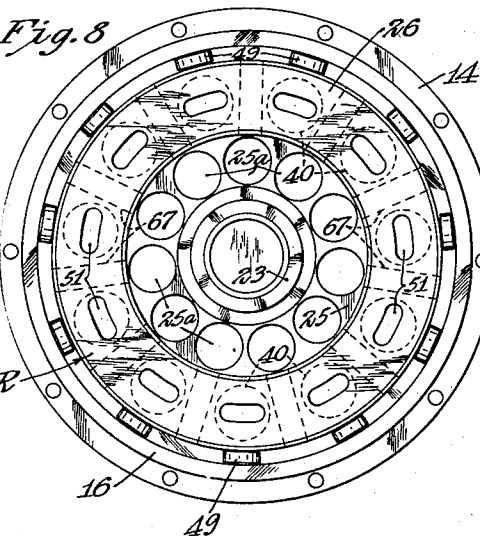
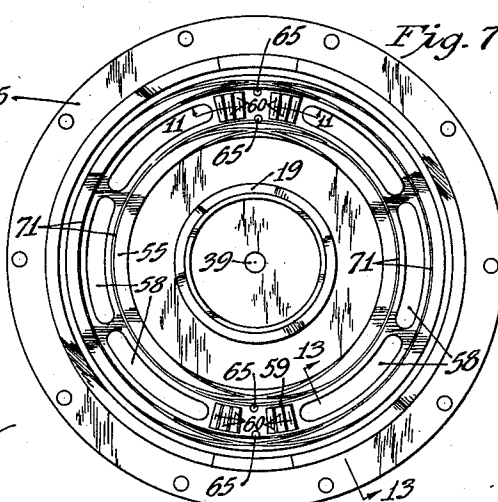
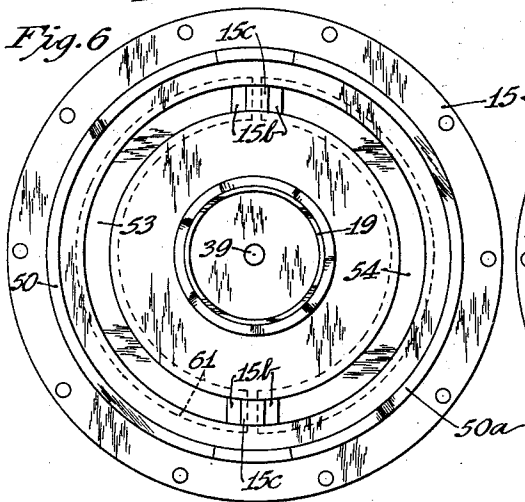
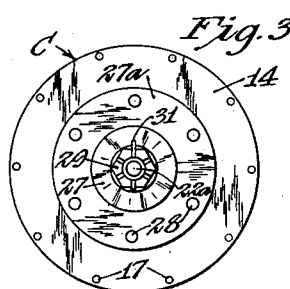
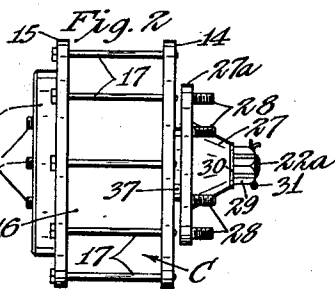
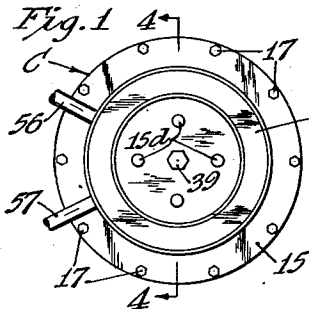
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2,250,031

HYDRAULIC MOTOR OR PUMP

Filed Nov. 13, 1939

3 Sheets-Sheet 1



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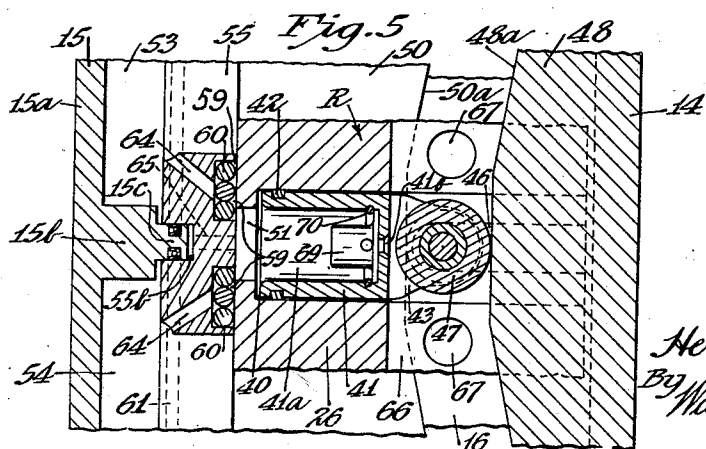
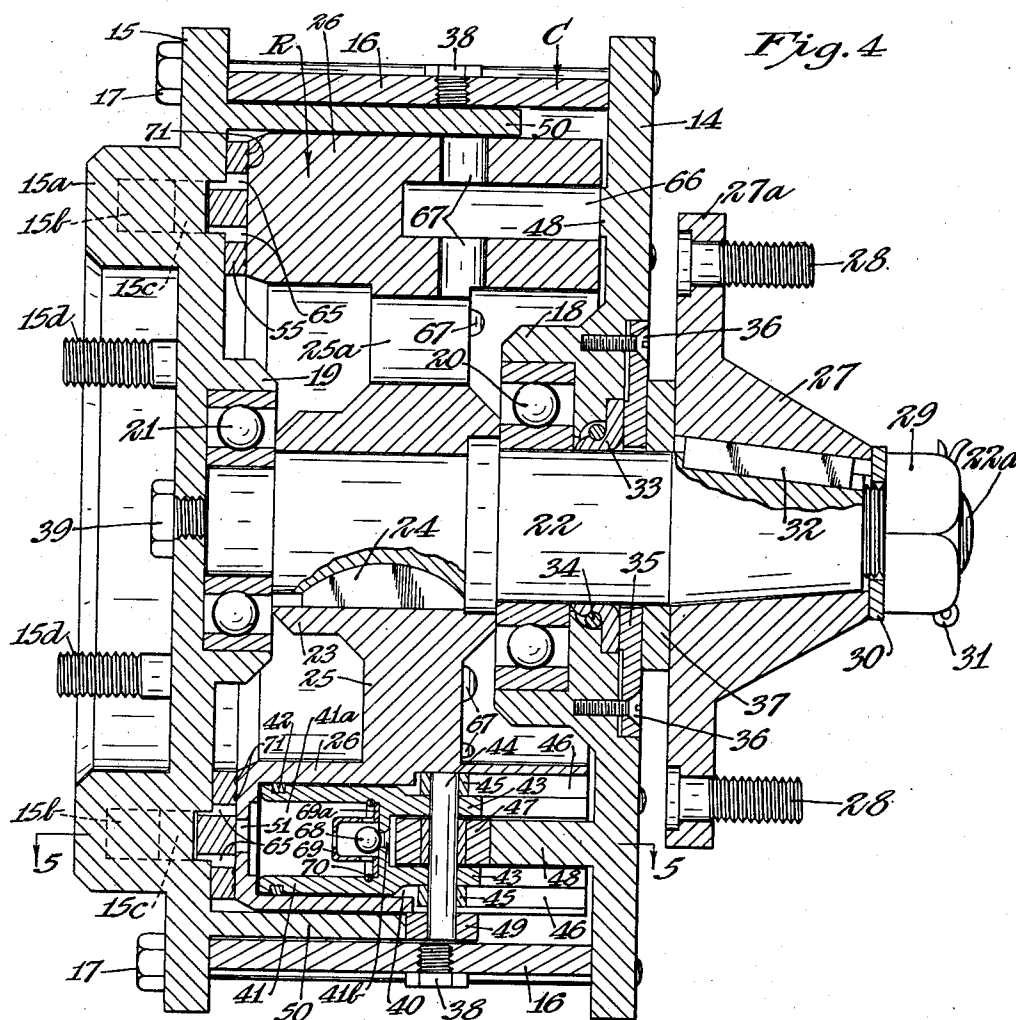
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Fig. 10

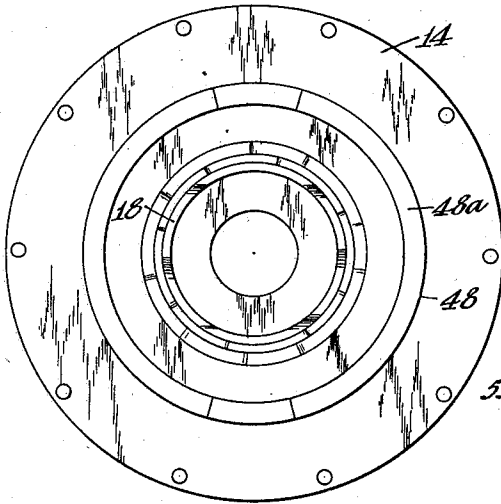


Fig. 11

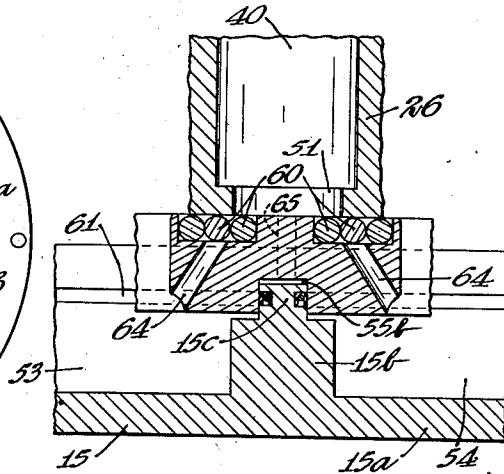


Fig. 12

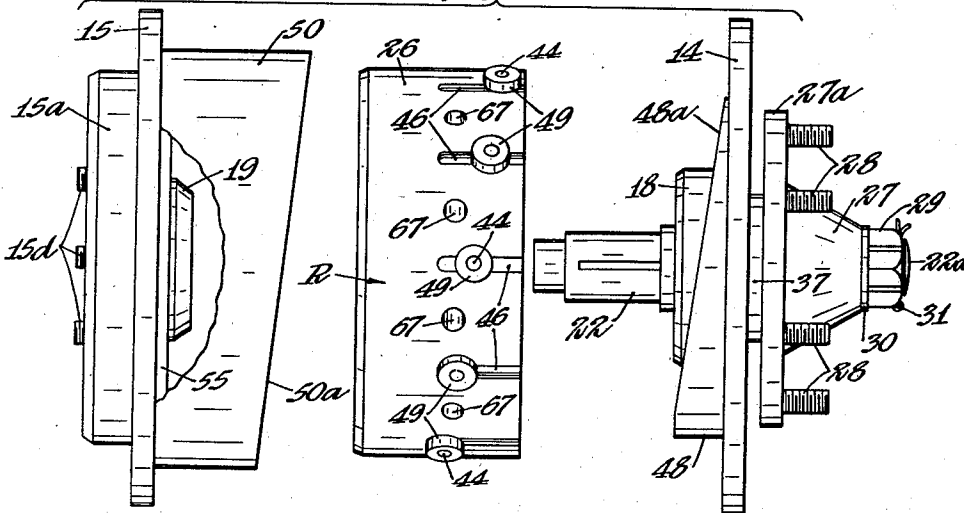
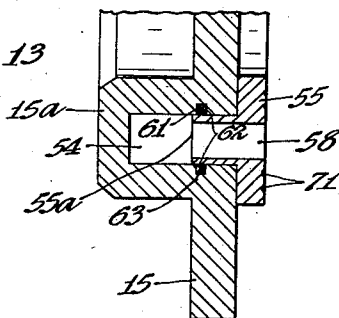


Fig. 13



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UNITED STATES PATENT OFFICE

2,250,031

HYDRAULIC MOTOR OR PUMP

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4 Claims. (Cl. 103-162)

My invention relates to hydraulic apparatus and particularly to a reversible hydraulic motor or pump device.

Many hydraulic devices have been constructed for use in hydraulic vehicle-propulsion systems for use as wheel-driving motors when propulsion is being effected and as fluid pumps when a braking operation is being performed. It is to such devices that my invention pertains and particularly to forms of such devices having reciprocable pistons working in conjunction with annular camming members.

A general object of my invention is to provide a reversible hydraulic motor or pump device having pistons carried in cylinders formed in a rotor working in conjunction with stationary annular camming means through an improved and highly efficient means of connection between the pistons and camming means.

Another object is to provide such a device wherein the camming means and the means connecting the same with the pistons is arranged to afford a positive driving connection throughout the entire cycle of reciprocation of each piston.

Still another object is to provide such a device wherein each piston is provided with a roller type cam follower and guide means for maintaining the axis of the follower roller radially disposed relative to the rotational axis of the rotor of the device.

Yet another object is to provide such a device wherein side thrust on the pistons is eliminated during the fluid pressure portions of the cycles of operation of the pistons.

A further object is to provide such a device wherein all of a series of guide and cam follower rollers associated with each of the pistons are rotatably mounted on a common pin carried by a yoke-like extension of the piston.

A still further object is to provide such a device of simple, compact, rugged and inexpensive construction.

These and other objects and advantages of the invention will more fully appear from the following description made in connection with the accompanying drawings, wherein like reference characters refer to the same parts throughout the views, and in which:

Fig. 1 is a rear view of a device incorporating an embodiment of my invention;

Fig. 2 is a side view;

Fig. 3 is a front view;

Fig. 4 is a diametrical sectional view taken on the line 4-4 of Fig. 1 as indicated by the arrows;

Fig. 5 is a sectional view taken on the line 5-5 of Fig. 4;

Fig. 6 is an interior elevational view of the rear portion of the device with the valve ring removed;

Fig. 7 is an interior elevational view of the rear portion of the device with valve ring in place;

Fig. 8 is an interior elevational view of the front portion of the device with the rotor in place;

Fig. 9 is a front elevational partially broken away view of the device with the front cover plate removed;

Fig. 10 is an interior elevational view of the front plate of the device showing a camming surface formed thereon;

Fig. 11 is a sectional view taken along the line 11-11 of Fig. 7 as indicated by the arrows;

Fig. 12 is an exploded side elevational view of the device; and

Fig. 13 is a sectional view taken on the line 13-13 of Fig. 7 as indicated by the arrows.

Referring to the drawings the embodiment of my invention illustrated includes a circular front plate 14 and a circular rear plate 15 disposed parallel to each other and separated by a substantial distance. The marginal portions of the plates 14 and 15 bear against a tubular member 16 so that the plates 14 and 15 together with the tubular member 16 constitute a casing C defining a chamber therewithin. Cap screws 17 extend through suitable apertures in the marginal portion of the plate 15 and at their free ends are screwed into apertured and internally screw-threaded portions of the marginal part of the plate 14 so as to clamp the tubular member 16 between the plates 14 and 15.

The plates 14 and 15 are provided in their central portions with inwardly projecting concentrically located bearing receiving cups 18 and 19, and the plate 14 is centrally apertured. Ball bearing assemblies 20 and 21 are mounted in the cups 18 and 19 and carry a rotor shaft 22. The hub 23 of a rotor R is mounted on portion of the shaft 22 disposed between the bearing assemblies 20 and 21 and is secured upon the shaft 22 against rotation relative thereto by means of a key 24 in a conventional manner. The hub 23 carries an annular radially projecting web 25 which at its peripheral portion carries an enlarged annular body or heavy rim portion 26 constituting part of the rotor R. The shaft 22 projects outwardly of the front plate 14 and in its projecting portion is tapered. A wheel hub 27, including a flange 27a equipped with wheel mount-

ing bolts 28, is mounted on the tapered projecting portion of the shaft 22 and is secured thereon by means of a nut 29 screw threadedly mounted on a screw threaded outer portion 22a of the shaft 22. A washer 30 is interposed between the nut 29 and the hub 27 and a cotter key 31 is utilized in the usual manner in conjunction with the nut 29 and the threaded shaft portion 22a to prevent unscrewing of the nut 29. The hub 27 is secured against rotation on the shaft 22 by means of a key 32.

The rotor web 25 is provided with an annular series of apertures 25a therethrough. The rear plate 15 is provided with an annular flange 15a projecting outwardly thereof for engagement with any member on which my device is to be mounted, and for another purpose to be described. The rear plate 15 is also provided with screw threaded studs 15d projecting outwardly for use in securing my device to any supporting structure therefor. Where the shaft 22 projects through the front plate 14 an annular sealing ring 33 of L-shaped cross section as shown is placed in snugly encircling relation with the shaft 22 and is accommodated in an annular space provided by suitably cutting away the plate 14. To insure a close fit of the sealing member 33 with the periphery of the shaft 22 an annular contractile element 34 of suitable construction is placed in encircling relation with the sealing element 33 as shown. To hold the sealing element 33 in place a circular retaining plate 35, centrally apertured to accommodate the shaft 22, is placed against the outer side of the sealing member 33 and is suitably secured to the front plate 14 as by means of screws 35. The front plate 14 is cut away in such manner that the outer surface of the retaining plate 35 is substantially flush with the outer surface of the plate 14, as shown. For further providing a seal between the shaft 22 and the front plate 14 a washer 37 is provided in encircling relation with the shaft 22. The washer 37 is interposed between the retaining plate 33 and the wheel hub 27 and is preferably formed of compressible material. Removable screw threaded plugs 38 for checking and drainage purposes are provided in the uppermost and lowermost portions of the tubular member 16, and a removable screw threaded plug 39 is provided at the center of the rear plate 15. With the plug 39 removed, a screw may be substituted therefor for use as a jack in driving the rotor out of the casing during disassembly of the device.

The enlarged rim portion 26 of the rotor has therein an annular series of piston-accommodating recesses or bores 40 having respective axes parallel to the axis of the shaft 22. Each recess 40 has therein a piston 41 which is preferably provided with a piston ring 42. Each piston 41 is extended outwardly, that is to the right as viewed in Fig. 4 to form a pair of apertured spaced parallel elements 43 constituting a yoke. A pin 44 is provided in connection with each of the yokes and is extended through the apertures of the yoke elements 43. Immediately outwardly of each of the yoke elements 43 a roller 45 is rotatably mounted on the pin 44. The rollers 45 are utilized as a portion of means for maintaining the pins 44 in radially disposed relation with the rotor and, for cooperation with the roller 45, guide grooves 46 are formed in the enlarged outer portion 26 of the rotor, the respective guide grooves 46 associated with each of the pistons 41 being aligned with each other radially of the ro-

tor R and each extending parallel to the rotational axis of the rotor R.

Each of the pins 44 is provided, in the portion thereof between the yoke elements 43 carrying the same, with a cam follower roller 47. For cooperation with the rollers 47 the front plate 14 is provided with an annular cam member 48 projecting inwardly from the inner side thereof toward the annular series of pistons 41. The dimension of the camming member 48 parallel to the axis of the shaft 22 is varied to provide, at the free edge of the camming member 48, an undulatory camming surface 48a. The above mentioned dimension of the camming member 48 is so varied as to be respectively maximum and minimum at diametrically opposite points on the member 48 and to substantially uniformly vary in the portions intermediate the minimum and maximum points as indicated in Fig. 12. Also, as indicated in Fig. 5, the dimension may be made constant for a short circumferential distance at each of the respective minimum and maximum dimensioned points on the camming member 48. It will be apparent that maintaining the rollers 47 in contact with the camming surface 48a while the rotor is being rotated will result in the respective pistons 41 being reciprocated in the corresponding ones of the recesses 40, the respective ones of the pistons 41 being at a given time in different portions of their respective cycles of reciprocation. Compression chambers 41a exist between the pistons 41 and the closed or left-hand ends of the corresponding recesses 40 and reciprocation of the pistons 41 will naturally cause variation of the volume of each compression chamber 41 in recurring cycles. To accommodate the cam member 48 the rim portion 26 of the rotor R is provided with an annular groove 66 on the side thereof toward the cam member 48 as shown in Figs. 4 and 9.

Means is provided for maintaining the rollers 47 in contact with the camming surface 48a. For this purpose additional cam follower rollers 49 are rotatably mounted on the outer ends of the respective pins 44. For cooperation with the rollers 49 the rear plate 15 is provided with an annular camming member 50 projecting toward the front plate 14 and being varied in its dimension parallel to the axis of the shaft 22 in such manner as to provide at its free edge a camming surface 50a which is complementary to the contour of the camming surface 48a as indicated in Fig. 12. The above mentioned dimension of the camming member 50 is so selected and varied that the rollers 47 and 49 will at all times be maintained in contact with the respective camming surfaces 48a and 50a so that movement of the pistons 41 in both directions during reciprocation of the pistons will be effected positively and without the need of springs for urging the pistons 41 in one of their directions of movement. From the above it should be apparent that rotation of the rotor responsive to mechanical power applied to the shaft 22 will be accompanied by forcible reciprocation of the pistons 41 and also that reciprocation of the pistons 41 responsive to application of fluid under pressure thereto will forcibly cause rotating of the rotor, whereby the pistons 41 and parts associated therewith will function for either a pump operation or a fluid motor operation of my machine.

Means is provided for enabling flow of fluid into and out of the compression chambers 41a in proper relation to the performance of the reciprocation cycle of operation of the pistons 41.

The rotor is provided with apertures 51 between the respective compression chambers 41a and the rear face of the rotor adapted to function as ports for conducting fluid into and out of the respective compression chambers 41a. The apertures or ports 51 are, as indicated in Fig. 8, arranged in an annular series wherein the respective ports 51 are all equidistant from the axis of the shaft 22. The flange 15a and rear plate 15 are provided with two circumferentially extending grooves 53 and 54 facing inwardly of the machine and each extending through slightly less than a semicircle and being separated by two ungrooved portions 15b of the flange 15a and rear plate 15. The ungrooved portions 15b constitute walls between the respective grooves 53 and 54 and are situated in axial alignment with the points of maximum and minimum dimension of the camming members 48 and 50. An annular valve ring 55 is placed immediately inwardly of the rear plate 15 to cover the grooves 53 and 54 and to form in conjunction therewith respective chambers or fluid manifolds one of which will constitute a fluid inlet manifold and the other a fluid outlet manifold. Conduits 56 and 57 are secured in suitably apertured portions of the flange 15a so as to be in communication with respective ones of the two fluid manifolds. The ungrooved portions 15b of the flange 15a and rear plate 15 constitute barriers between the respective manifolds and are provided on their sides facing toward the rotor R with tongues 15c projecting toward the rotor R. The valve member or ring 55 is provided with notches 55b into which the tongues 15c project for purposes of anchoring the valve ring 55 against rotation relative to the casing C. The valve ring 55 is provided with a circumferentially extending series of circumferentially extending ports 58 there-through situated for cooperation with the ports 51 of the rotor R and, for purposes of mechanical strength, separated by narrow unapertured portions of the valve ring 55. The ports 58 of each half of the valve ring 55 are in communication with one of the manifolds 53 and 54 and together function as a single port extending through nearly a semicircle. It should be apparent that the rotor port 51 associated with a given one of the pistons 41 will be in communication with one of the manifolds 53 and 54 through certain ones of the ports 58 while the piston is moving outwardly in its corresponding recess 40 and will be in communication through other ones of the ports 58 with a remaining one of the manifolds 54 and 55 while the piston 41 is moving inwardly in its recess 40. Thus fluid introduced into one of the manifolds 53 and 54 will be delivered into the compression chambers 41a of the rotor and will be later conducted from the compression chambers 41a into the other one of the manifolds 53 and 54. As shown in Figs. 5, 7, and 11 the valve ring 55 is provided at points thereon aligned with the maximum and minimum dimensioned portions of the camming members 48 and 50 with a pair of grooves 59, each containing several rollers 60 which are disposed with their axes normal to the rotational axis of the machine. The rollers 60 are of such diameters relative to the width of the grooves 59 that the group of rollers 60 in each groove 59 will be in substantially sealed relation with each other and the walls of the groove 59 so that the group may, as a unit, function as a piston to be pressed against the valve ring 55. Each of the roller containing grooves 59 in the valve ring 55 is provided with

a duct 64 formed in the ring 55 to establish communication between the respective grooves 59 and the manifolds 53 and 54 as indicated in Fig. 5. Fluid under pressure in the manifolds 53 and 54 will, through the ducts 64, apply fluid pressure to the rollers 60 so as to press the same against the valve ring 55 in such manner that the rollers will be in substantially sealed relation with the valve ring 55 and apply thrust thereto to reduce the degree of frictional engagement of the valve ring 55 with the rotor R.

In order to seal the valve ring 55 into the rear plate 15 and the manifold-defining portions of the flange 15a, the valve ring 55 carries a pair of arcuate circumferentially extending flanges 55a each extending throughout the circumferential length of one of the respective manifolds 53 and 54 and projecting into the manifolds 53 and 54 in close fitting relation with the surface defining the manifolds. The ports 58 extend through the flanges 55a to the respective manifolds. The portions of the rear wall 15 defining the manifolds are provided with a pair of grooves 61 extending circumferentially of the respective flanges 55a, as indicated in Figs. 6, 11 and 13, and a compressible sealing element 62 is placed in each of the grooves 61 so as to extend circumferentially of and bear against the flange 55a. The sealing members 62 are of U-shaped cross section as indicated in Fig. 13 and have therein resilient elements 63 for insuring a sealing engagement of the sealing members 62 with the flanges 55a.

In alignment with each of the tongues 15c small apertures 65 extending through the valve ring 55 in an axial direction are provided, as indicated in Figs. 4, 5, 7 and 11, to permit movement of fluid into and out of the spaces between the free ends of the portions 15c and the valve ring 55.

Intermediate between successive pistons 41 the enlarged rim portion 26 of the rotor is provided with radially extending apertures 67 there-through as shown in Figs. 4, 5, and 9, these apertures being in intersecting relation with the annular groove 66 of the rotor and functioning to permit exit of fluid accumulating in the groove 66 of the rotor.

As shown in Fig. 4 the head of each piston 41 is provided with a small port 41b to permit flow of fluid from the main interior space of the machine through the piston to one or the other of the manifolds 53 and 54 at times when a suitable pressure differential between the interior space and the manifold exists. This is for the purpose of scavenging fluid which has leaked into the main interior space of the machine. To prevent movement of fluids through the ports 41b when the compression chambers 41a have pressure therewithin, a ball 68 is provided for use as a valve for covering the inner end of the port 41b. A cage 69 is provided for keeping the ball 68 in close association with the port 41b and yet enabling slight movement of the ball 68 relative to the inner end of the port 41b. The cage 69 is provided with a flange 69a as shown in Fig. 4 and against which a resilient ring 70 carried in a suitably grooved portion of the inner periphery of the piston 41 bears so as to hold the flange 69a against the inner side of the head end of the piston 41.

As indicated in Figs. 4 and 7 the surface of the valve ring 55 facing the rotor is provided with a system of oil grooves 71 which may be

arranged in any suitable pattern such as the pattern indicated in Fig. 7.

In operation of the machine as a fluid motor, fluid under pressure will be introduced into one or the other of the manifolds 53 and 54 dependent upon which direction of rotation is desired. This fluid will be admitted to certain of the compression chambers 41a to force the pistons 41 associated therewith outwardly of the corresponding recesses 40. Through action of the cam rollers 47 against one of the inclined portions of the camming member 48, rotation will be imparted to the rotor and the shaft 22 responsive to pressure applied to the certain ones of the pistons 41. As rotation continues and the pistons to which pressure has been applied reach the outer limit of their movement in the recesses 40 these pistons will next be driven inwardly by the remaining inclined portion of the camming member 48. By this time the rotor ports 51 associated with these particular pistons will have been placed in communication through the proper ports 58 of the valve ring 50 with the one of the manifolds 53 and 54 which does not contain fluid under pressure and which constitutes a fluid outlet manifold. The fluid thus delivered into the last mentioned one of the manifolds 53 and 54 will be exhausted through the corresponding one of the conduits 56 and 57 and then may be disposed of or delivered to the inlet of means providing fluid under pressure for use in the machine. When the machine operates as a pump, rotary mechanical power will be applied to the shaft 22 and the pistons 41 will be reciprocated through cooperation of the rollers 47 and 49 with the camming members 48 and 50. The rotor ports 51 and the valve ring ports 58 will connect the compression chambers 41 alternately to one and the other of the manifolds 53 and 54 so that fluid may be drawn into the compression chambers from one of the manifolds and delivered under pressure from the compression chambers 41 into the other manifold during respective portions of the cycles of operation of the respective pistons 41.

It is to be noted that in connection with each of the pistons 41 a single pin 44 carries the two guide rollers 45 and two cam follower rollers 47 and 49. It is to be noted also that the construction is so arranged that the rotational axis of the main cam follower roller 47 intersects the longitudinal axis of the piston 41 and hence the tendency is for transmission of pressure between the piston 41 and the camming member 48 to be principally in a straight line coinciding with the longitudinal axis of the piston 41. Thus forces working sidewardly of the piston 41 are minimized with the result that friction losses and wear are both minimized.

It is apparent that I have invented novel improvements in construction of machines interchangeably useable as fluid motors or fluid pumps and that such improvements in structure afford improvement in efficiency, operating characteristics, and durability of such machines.

It will, of course, be understood that various changes may be made in the form, details, arrangement and proportions of the various parts

without departing from the scope of my invention.

What is claimed is:

1. In a hydraulic power device having a casing with inlet and outlet ports, a rotor movably supported in the casing and having cylinders therein and with pistons movable in said cylinders; intake and exhaust manifolds in said casing and communicating with the inlet and outlet ports of said casing, a valve ring forming wall portions of said manifolds within said casing and lying adjacent the cylinders in said rotor, said ring being non-rotatable relative to said casing, rotor engaging elements interposed between said valve ring and said rotor, said valve ring being subject to fluid pressure in at least one of said manifolds tending to urge said ring toward said rotor, and said ring including conduits for admitting fluid under pressure from at least one of said manifolds to said rotor engaging elements to set up a pressure between said elements and said ring and to urge said ring away from said rotor to counteract pressure against said ring from at least one of said manifolds.
2. In a hydraulic power device having a casing with inlet and outlet ports, a rotor movably supported in the casing and having cylinders therein with pistons movable in said cylinders; intake and exhaust manifolds in said casing communicating with the inlet and outlet ports of said casing, a valve ring forming wall portions of said manifolds and lying adjacent the cylinders in said rotor, said ring being non-rotatable relative to said casing, said ring having pockets formed therein opening toward said rotor, anti-friction means lying in said pockets and movable toward and away from said rotor and said ring having conduits affording communication between at least one of said manifolds and said pockets whereby fluid pressure in at least one of said manifolds tending to urge said ring toward said rotor is counteracted by fluid pressure against said anti-friction means, the latter being movable under said pressure to a position against said rotor.
3. The structure in claim 2 and said anti-friction means comprising rollers lying closely adjacent to each other and to opposite walls of said pockets and said rollers being of sufficient length to bridge the ends of the cylinders in said rotor.
4. In a hydraulic power device having a casing with inlet and outlet ports, a rotor movably supported in the casing and having cylinders therein with pistons movable in said cylinders, valve means affording periodic communication between said inlet and outlet ports and said cylinders, said valve means preventing flow of fluids into the interior of said casing around said rotor, and check valves in communication with the interior of said casing and the interiors of said cylinders to permit the flow of fluids from the interior of said casing to the interiors of said cylinders in the event of leakage past said first mentioned valve means into the interior of said casing.

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