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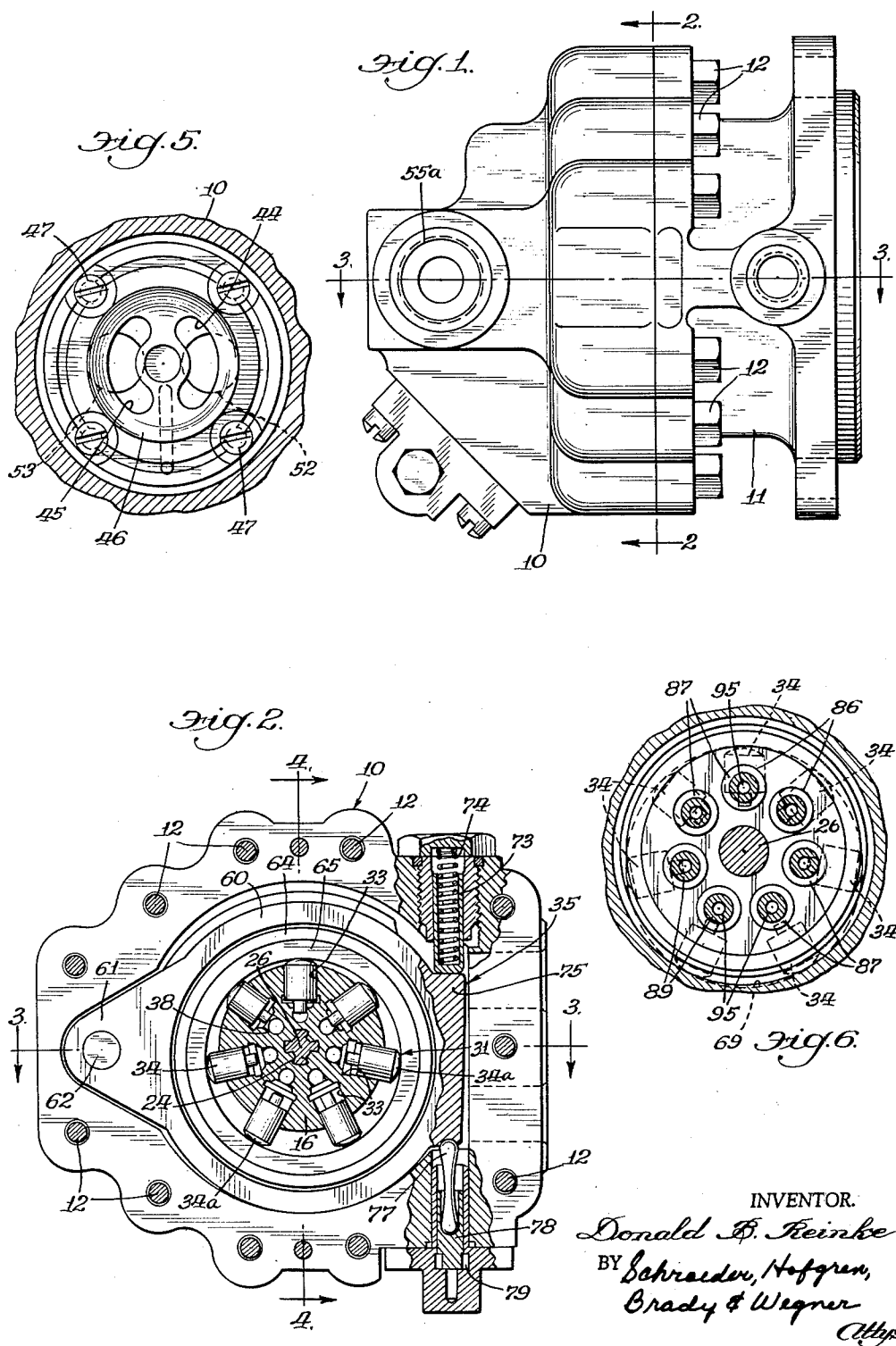
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PUMP OR MOTOR DEVICE

Filed Jan. 7, 1959

2 Sheets-Sheet 1



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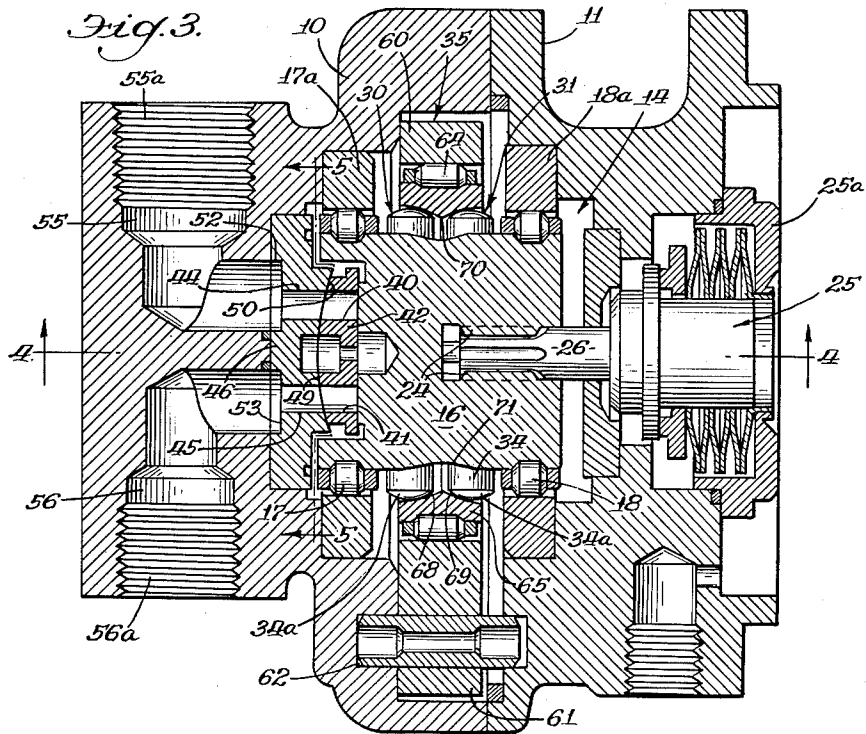
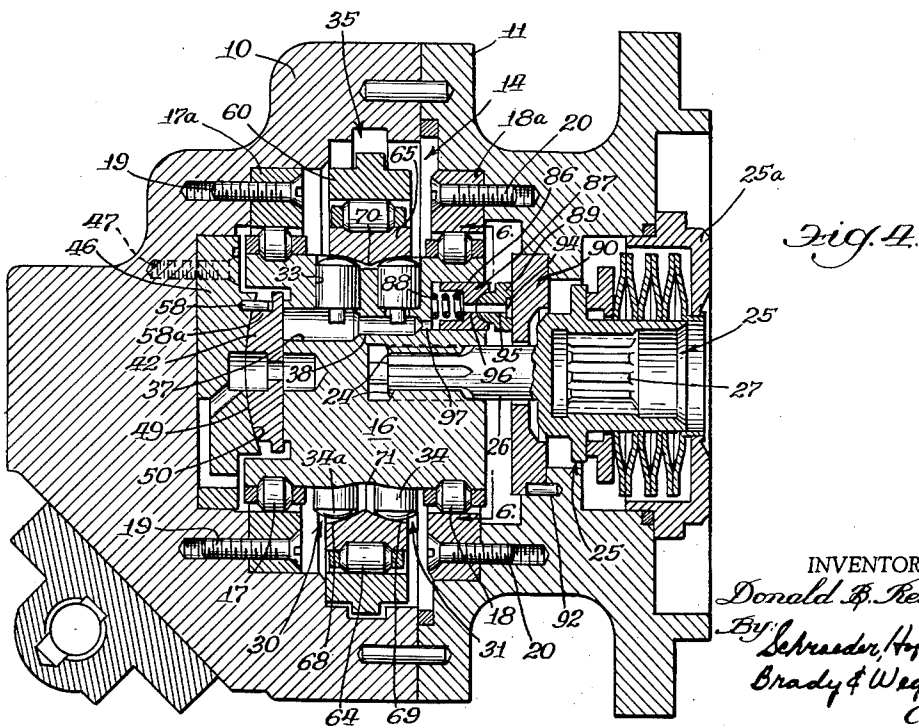
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2 Sheets-Sheet 2



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3,066,613

PUMP OR MOTOR DEVICE

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4 Claims. (Cl. 103—161)

This invention relates to hydraulic pump or motor devices, and more particularly to a radial piston pump. It is a general object of the invention to provide a new and improved radial piston pump or motor device.

A more specific object is to provide a radial piston pump having a new and improved porting arrangement.

Another object is to provide a new and improved radial piston pump having a pressure balanced cylinder block.

A further object is to provide a new and improved radial piston pump having an axially movable cylinder block, axially arranged porting leading to the radially arranged pump chambers, and means for pressure balancing the cylinder block.

Other objects and advantages will become readily apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a front elevational view of a pump embodying the principles of the present invention;

FIG. 2 is a vertical transverse sectional view taken at about the line 2—2 of FIG. 1;

FIG. 3 is a horizontal longitudinal sectional view taken at about the line 3—3 of FIGS. 1 and 2;

FIG. 4 is a vertical longitudinal sectional view taken at about the line 4—4 of FIGS. 2 and 3;

FIG. 5 is a fragmentary sectional view taken at about the line 5—5 of FIG. 3; and

FIG. 6 is a fragmentary sectional view taken at about the line 6—6 of FIG. 4.

While an illustrative embodiment of the invention is shown in the drawings and will be described in detail herein, the invention is susceptible of embodiment in many different forms, and it should be understood that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiment illustrated. The scope of the invention will be pointed out in the appended claims.

Referring now to the drawings in more detail, as illustrated, the invention is embodied in a pump including a housing comprised of a pair of complementary housing members 10 and 11 adapted to be secured firmly together as by screws illustrated at 12. The interior of the housing members 10 and 11 is hollow and provides an internal cavity 14 for receiving the operating parts of the pump mechanism.

A rotatable and axially movable cylinder block 16 is mounted in the cavity 14 as by means of roller bearings 17 and 18 on the cylinder block at opposite ends thereof, the bearings being rotatable and axially slidable in outer bearing races 17a and 18a suitably secured respectively in the housing members 10 and 11 as by screws illustrated at 19 and 20. At one end, the cylinder block 16 is provided with a central bore having drive splines as at 24, and a drive member 25 rotatable in an end plate 25a has at one end a stub shaft portion 26 slidably splined in the cylinder block for rotation with the latter. The outer enlarged end of the drive member 25 is hollow and formed with internal splines as at 27 for connecting the drive member to a drive shaft or other coupling member as desired. It will be understood that when the device illustrated is utilized as a pump, the drive member 25 may be rotated by means of an independent prime mover coupled at 27, whereupon rotation of the drive member will effect rotation of the cylinder block 16. Conversely,

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when the device is utilized as a motor, it will be understood that rotation of the cylinder block will result in driving the member 25 to in turn drive a shaft or the like coupled at 27.

The cylinder block 16 is formed with two banks or rows of radial pump cylinders spaced axially along the block and designated generally by the reference numbers 30 and 31. Each row comprises a plurality (seven as illustrated) of radial cylinders 33 (FIGS. 2 and 4) extending inwardly from the outer periphery of the block along radial lines and angularly spaced equally about the block as seen best in FIG. 2. The two rows of cylinders include equal numbers of cylinders, with each of the cylinders in one row axially aligned in the block respectively with the cylinders in the other row, as best illustrated in FIG. 4.

Pumping pistons 34 are slidable in the cylinders 33, these being urged outwardly by the pressure of incoming fluid and by centrifugal force as the cylinder block rotates, and being moved inwardly during rotation of the block by an eccentric means generally designated 35, which will be described in detail presently.

Fluid passes to and from the pumping cylinders 33 through fluid intake-exhaust passages formed axially in the cylinder block and aligned respectively with the axially aligned pistons of the two rows 30 and 31. Each intake-exhaust passage is formed by means of a first relatively large bore 37 leading from one end (the left end as viewed in FIG. 4) of the cylinder block and intersecting the inner end of the associated cylinder 33 in the row of cylinders. At the end of the bore 37, a smaller bore 38 continues axially of the cylinder block to intersect the inner end of the aligned cylinder 33 in the row 31. It will be understood that bores such as that illustrated at 37 and 38 in FIG. 4 are provided for each pair of axially aligned cylinders, each of the seven bores 38 being visible in the sectional view of FIG. 2. With this arrangement, it will be understood that fluid may flow axially of the bores 37 and 38 into the cylinders 33 as the pistons 34 move outwardly, and may flow out from the cylinders through the bores 37 and 38 as the pistons 34 move inwardly of the block. The smaller bore 38 carries the flow of the single row 31, while the larger bore 37 carries the flow of both rows of pistons.

Each of the bores 37 opens to the left end face of the cylinder block 16 for cooperation with intake and exhaust kidneys 40 and 41 (FIG. 3) disposed at diametrically opposite positions in a valve disk 42 having one face engaging the end face of the cylinder block. The intake and exhaust kidneys 40 and 41 are identical in size and shape with intake and exhaust kidneys 44 and 45 (FIGS. 3 and 5) formed in a port plate 46 secured in the housing member 10 as by screws illustrated at 47 in FIG. 4. The valve disk 42 includes a convex spherical face 49 which seats in a concave complementary spherical seat 50 in the port plate 46. Opposite the concave spherical surface 50, the kidneys 44 and 45 in the port plate 46 open into enlarged chambers as at 52 and 53 formed in the opposite face of the port plate and in register respectively with intake and exhaust passages 55 and 56 in the housing member 10 each having a threaded mouth as at 55a and 56a for receiving a suitable conduit coupling. The valve disk 42 is held against rotation with the cylinder block by means of a pin 58 (FIG. 4) fixed in the port plate 46 and loosely fitted in a recess as at 58a (FIG. 4) in the valve disk 42 whereby the disk is held against rotation but is free for limited universal movement by virtue of the spherical face 49 thereof in the spherical seat 50 which enables a self-aligning movement of the valve disk to conform to the end face of the cylinder block. This self-alignment feature compensates for any eccentricities,

misalignment, or out of squareness due to temperature changes occurring under various conditions of operation or due to manufacturing imperfections in the cylinder block or valve disk or in their mounting means, and is claimed in my copending application Serial No. 785,910, filed January 9, 1959, now abandoned.

With the construction thus far described, it will be understood that as the cylinder block rotates the intake-exhaust passages 37, 38 leading to and from the pumping cylinders 33 successively communicate alternately with the intake and exhaust kidneys 40 and 41 in the valve disk 42. As these kidneys register respectively with the kidneys 44 and 45 which in turn communicate with intake and exhaust passages 55 and 56, it will be understood that when the latter passages are suitably connected with a source of fluid and a device to be supplied with pressure fluid, a complete pumping circuit is provided. While the device illustrated is usually referred to herein as a pump, it will be understood that it is also operative as a motor by supplying fluid under pressure through the intake passages for effecting rotation of the cylinder block. The passage 40, 44, 52, 55, or the passage 41, 45, 53, 56 may either be described as an intake and the other as an exhaust passage depending upon the direction of rotation imparted to or desired of the cylinder block 16.

Stroking of the pump pistons 34 inwardly of the cylinder block is effected by means of an eccentric previously designated generally by the reference number 35. As seen best in FIGS. 2, 3 and 4, the eccentric 35 comprises an outer ring or bearing race 60 having an enlargement 61 at the left side thereof (as viewed in FIG. 2), the enlargement being pivotally mounted as by a pivot pin means 62 which enables pivotal movement of the outer ring 60 about the axis of the pin 62, upwardly and downwardly as viewed in FIG. 2, from a maximum stroke position illustrated in FIG. 2 to a no-stroke position wherein the outer ring 60 would be positioned concentrically relative to the cylinder block.

The outer ring or race 60 rotatably and axially slidably supports bearings as at 64 on an inner ring or race 65. The inner ring 65 is formed with a pair of axially spaced inner surfaces 68 and 69 (FIGS. 3 and 4) which are oppositely inclined and curved axially of the ring and engage respectively the outer piston ends in the rows 30 and 31. The surfaces 68 and 69 are concavely curved, sloping from the axial center of the inner ring away from each other and radially outwardly of the ring on an arcuate curve having a radius somewhat in excess of that of the spherical outer piston ends 34a. For example, in a preferred embodiment of the pump, the surfaces 68 and 69 are formed on a radius of .750 inch, with a center located axially just beyond the ends of the eccentric, and the spherical outer piston ends have a radius of .500 inch. By this construction, it will be understood that, due to the pivotal mounting at 62, the inner eccentric ring 65 may be moved from a concentric position to eccentric positions relative to the cylinder block so that engagement of the inner eccentric surfaces 68 and 69 with the outer piston ends, will effect a stroking of the pistons inwardly of the cylinder block as the latter rotates.

Inside the inner ring 65, a peak 70 is formed where the surfaces 68 and 69 intersect, and when the eccentric is moved to a maximum displacement position, substantially as illustrated in the drawings, the peak 70 may move to a position somewhat within the general outer periphery of the cylinder block. Accordingly, in order to accommodate the peak 70, the outer surface of the cylinder block is reduced centrally of its length as at 71 in order to enable movement of the inner eccentric ring 65 and the inner peak 70 to maximum displacement positions.

The configuration of the inner eccentric surfaces 68 and 69 is utilized to maintain the inner eccentric ring or race 65 centered axially relative to the two rows of pistons 30 and 31. More particularly, so long as the ring 65 is centered axially between the two rows of pistons,

each row of pistons exerts outwardly directed forces having components both radial and axial of the eccentric ring, with the components of the two rows of pistons being equal and opposite so that the ring remains in the centered position. In the event the ring moves axially in either direction from the central position illustrated, the axial components of the two rows of pistons become unequal, the one axial component decreasing and the other increasing in directions which tend to restore the ring to the central neutral position. This feature is claimed in the copending application of Paul Tomell, filed March 19, 1959, now Patent No. 3,010,405.

The length of piston stroke, or in other words pump displacement, may be varied by varying the pivotal position of the eccentric 35 about the pivot axis 62. This pivotal adjustment may be effected automatically under control of a piston 73 urged by a spring 74 toward an abutment 75 on the outer ring 60, thereby to urge the abutment and in turn the entire eccentric structure downwardly (FIG. 2) toward a maximum stroke position. The bias of the piston and the spring 74 is opposed by means of a universal pin 77 acting against the underside of abutment 75 and urged upwardly as by means of a piston 78 slidable in a chamber 79 adapted to receive fluid under pressure through an inlet (not illustrated) whereby the position of the eccentric may be automatically controlled as, for example, in response to an output condition, such as pressure, to maintain the same constant.

The axial cylinder block porting illustrated at 37, 38, 40, 41, etc., is enabled by virtue of a pressure balancing of the cylinder block 16 which is provided by means including a plurality of axially extending cylinders 86 (FIGS. 4 and 6) opening to the right end of the cylinder block 16 as viewed in FIGS. 3 and 4, such cylinders being aligned respectively with the axially aligned pistons 34 of the two rows 30 and 31. The cylinders 86 have pistons 87 slidable therein, and urged outwardly of the cylinders as by means of individual springs 88 seated in the cylinders and bearings at opposite ends against the cylinder block and the pistons. The outer ends of the pistons 87 are provided with concave seats which pivotably receive the ball joints of bearing slippers 89 having end faces engaging a bearing plate 90 suitably secured in the housing member 11 as by means of a pin 92 (FIG. 4).

The end face of each slipper 89 engaging the bearing plate 90 is formed with a cavity providing a pressure chamber as at 94 connected by a passage 95 through the slipper, a passage 96 through the balance piston 87, the hollow interior of the balance piston, the cylinder 86, and a passage 97 in the cylinder block communicating with the bore 38 which forms the intake-exhaust passage to the cylinders in the row 31. It will be understood that the balance pistons 86 correspond in number with the seven pistons in each bank of pistons, that the balance pistons are axially aligned respectively with the pistons in the two rows, and that the chambers 94 in each of the bearing slippers 89 is connected respectively with the aligned pumping pistons. In this fashion, the pressure fluid prevailing in each of the intake-exhaust passages 37, 38 is admitted to the aligned pressure balance chamber 94 so that the pressure of fluid in the chambers 94, together with the springs 88, function to offset and counterbalance the pressure of fluid exerted on the opposite end of the cylinder block through the kidneys 40 and 41. It will be understood that the arrangement is such that high pressure fluid acting through the high pressure kidney of the two kidneys 40 and 41 against the left end of the cylinder block is opposed by high pressure fluid in chambers 94 of one or more balance slippers 89 which happen to be aligned with the high pressure kidney at the time, while in similar fashion the pressure of low pressure fluid in the low pressure kidney at the left end of the cylinder block 16 is opposed by low pressure fluid in one or more of the chambers 94 which are at the time aligned with the low pressure kidney.

The counterbalanced cylinder block construction provided by the balance pistons 87 enables the use of axial porting as illustrated at 37, 38, 40, 41 rather than radial porting leading to the radial cylinders as by means of passages through a central pintle or hollow shaft construction, the axial porting illustrated being a preferred construction due to the simplicity and economy of manufacture, as well as the advantages of a more efficient operation.

I claim:

1. In a radial piston pump, a rotatable and axially movable cylinder block having a plurality of radial cylinders equally spaced angularly around the block, pumping pistons reciprocable in the cylinders, an eccentric ring surrounding the block and engaging the outer ends of the pistons, a valve plate engaging one end of the block and having intake and exhaust kidneys therein, axially extending intake-exhaust passages in the cylinder block communicating respectively with the cylinders and communicable successively with the intake and exhaust kidneys as the block rotates, a stationary bearing plate spaced from the opposite end of the cylinder block, a plurality of axial cylinders in said opposite end of the cylinder block at angularly spaced positions axially aligned respectively with said pumping pistons, pistons slidable in said axial cylinders, springs urging the axial pistons outwardly toward said bearing plate, bearing shoes universally mounted on said axial pistons and engaging said bearing plate, axial passages through the block connecting the radial pump cylinders respectively to the axial cylinders so that the cylinder block is urged against the valve plate, pressure chambers respectively in the faces of the bearing shoes engaging the bearing plate, and axial passages through said axial pistons, and bearing shoes, respectively connecting axial cylinders with the pressure chambers in the bearing faces of said bearing shoes, thereby to pressure balance said axial pistons.

2. In a radial piston pump, a rotatable and axially movable cylinder block having at least two banks of radial cylinders therein, said banks being axially spaced in the block and each bank having a plurality of cylinders equally spaced angularly around the block and axially aligned respectively with the cylinders of the other bank, pistons reciprocable in the cylinders, an eccentric ring surrounding the block and engaging the outer ends of the pistons, a valve plate engaging one end of the block and having intake and exhaust kidneys therein, axially extending intake-exhaust passages in the block respectively connecting aligned cylinders of the two banks and communicable successively with the intake and exhaust kidneys as the block rotates, a bearing plate spaced from the opposite end of the block, a plurality of axial cylinders in said opposite end of the block axially aligned with the pistons in said two banks, piston means in said axial cylinders including bearing shoes engaging said bearing plate, spring means acting between the cylinder block and said last recited piston means urging the latter outwardly of the block toward the bearing plate, fluid passages connecting the radial cylinders respectively with the axial cylinders so that the cylinder block is urged against the valve plate, each bearing shoe having a fluid chamber in the face thereof engaging said bearing plate, and axially extending fluid passages in said axial piston means respectively connecting each axial cylinder and the axially aligned fluid chamber, thereby to pressure balance the axial piston means.

3. In a radial piston pump or motor device, a rotatable pump block having a plurality of radial pump chambers, pump pistons reciprocable in said chambers, means for sliding the pistons in the chambers as the block rotates, a valve plate engaging one end of the pump block and having intake and exhaust ports therethrough, axially extend-

ing intake and exhaust passages in the block communicating respectively with said chambers and communicable successively with said intake and exhaust ports as the block rotates thereby to admit fluid to and exhaust fluid from the pump chambers, means mounting the pump block for limited axial movement relative to the valve plate, a bearing block spaced from the opposite end of said pump block, a plurality of axial cylinders in the block having pistons reciprocable therein and having universal bearing shoes thereon engaging said bearing block to slide thereon as the pump block rotates, fluid passages through said pump block connecting the pump chambers respectively to the axial cylinders so that the block is urged against the valve plate means providing a fluid pressure chamber at the interengaged faces of each bearing shoe with the bearing plate, and passages through said axial pistons and said bearing shoes respectively connecting said axial cylinders to the pressure chambers at the faces of said bearing shoes engaging said bearing plate thereby to pressure balance the axial pistons.

4. In a radial piston pump or motor device, a pump housing, a rotatable pump block in the housing having a plurality of radially arranged pump cylinders, pump pistons reciprocable in the cylinders, an eccentric ring in the housing surrounding the cylinder block and engageable with the outer ends of the pistons as the block rotates, a valve plate engaging one end of the block and having intake and exhaust kidneys, intake and exhaust ports in the housing communicating respectively with the intake and exhaust kidneys, axially extending intake and exhaust passages in the block communicating respectively with the pump cylinders and communicable successively with the intake and exhaust kidneys as the block rotates thereby to admit fluid to and exhaust fluid from said cylinders, means mounting the cylinder block for limited axial movement relative to the valve plate, a bearing plate in the housing spaced from the opposite end of said cylinder block, a plurality of axial cylinders in the block having pistons slidable therein and engaging said bearing plate, spring means acting between said axial pistons and said cylinder block to urge the pistons toward the bearing plate, a bearing shoe universally mounted on each axial piston and slidable on the bearing plate as the cylinder block rotates, fluid passages through said cylinder block connecting the pump cylinders respectively to the axial cylinders, means providing a fluid pressure chamber at the interengaged faces of each bearing shoe with the bearing plate, and passages through said axially slidable pistons and said bearing shoes respectively connecting said axial cylinders to the pressure chamber at the face of said bearing plate, thereby to pressure balance the axial pistons.

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