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GYRATORY VALVE FOR HYDRAULIC PUMPS OR MOTORS

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3 Sheets-Sheet 1

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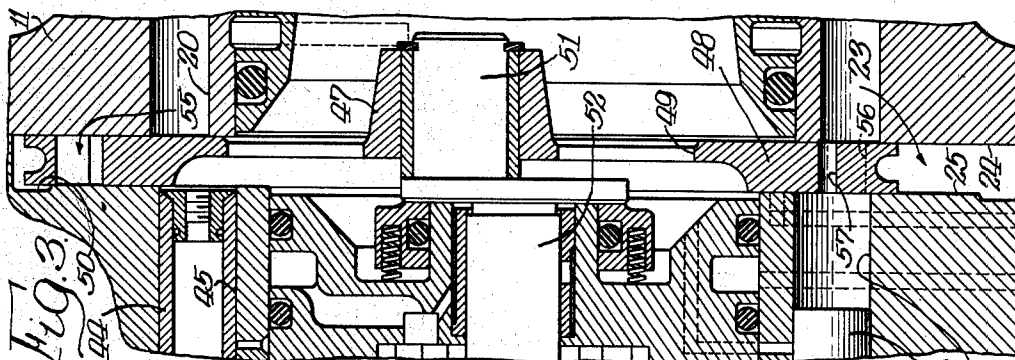
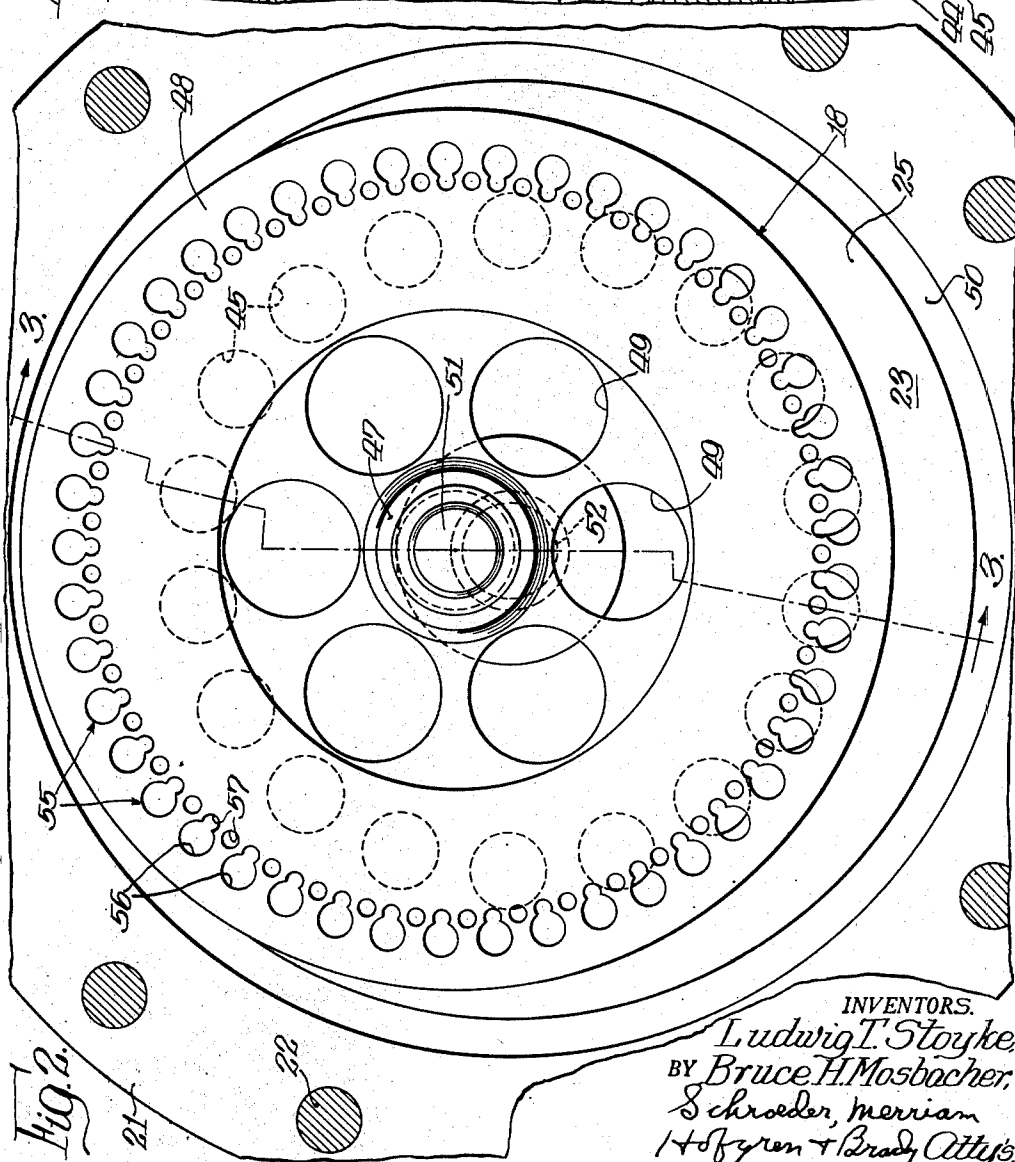
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

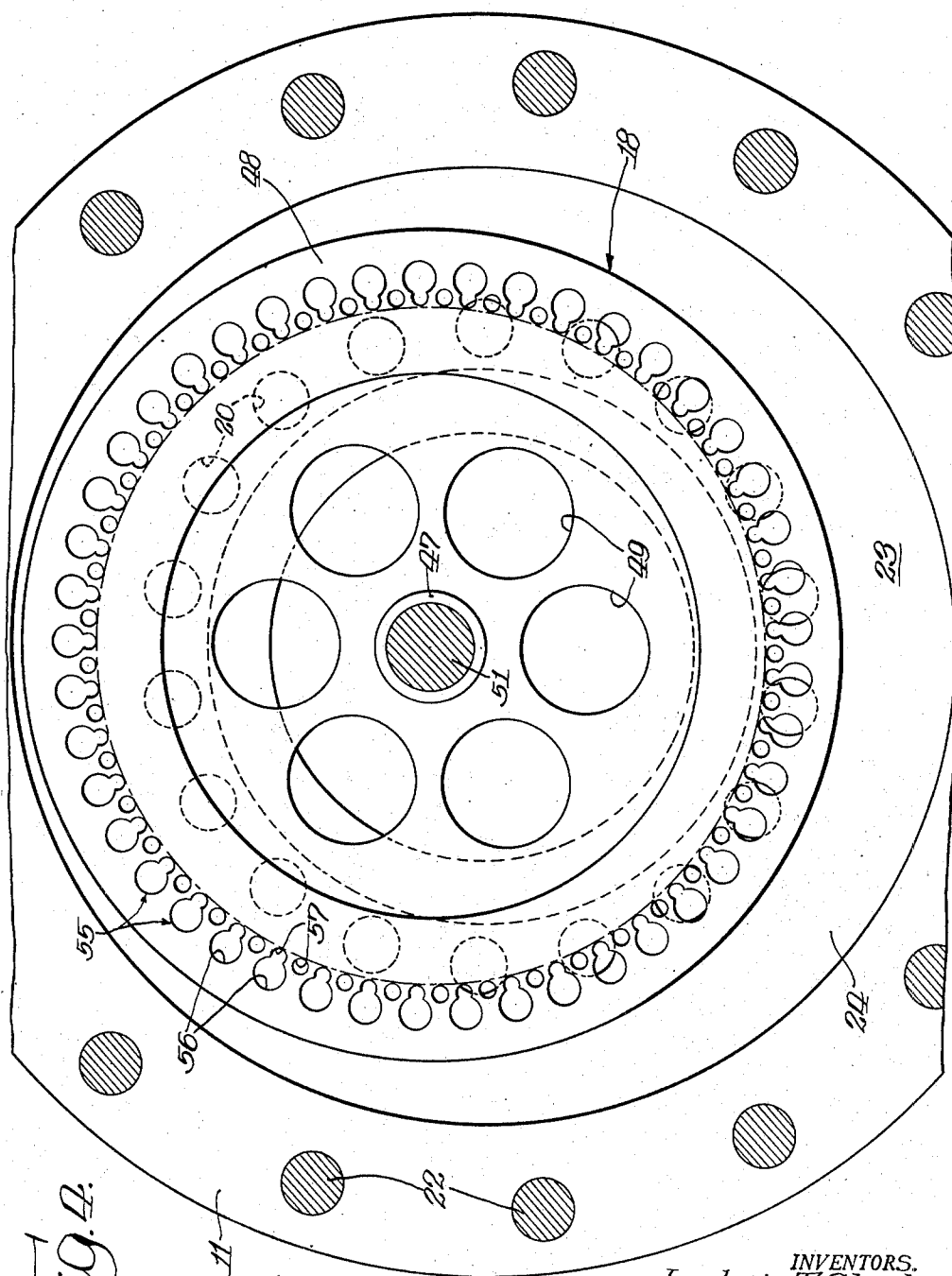


Fig. 2.

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UNITED STATES PATENT OFFICE

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GYRATORY VALVE FOR HYDRAULIC
PUMPS OR MOTORSLudwig T. Stoyke and Bruce H. Mosbacher, Rock-
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9 Claims. (Cl. 103—173)

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This invention relates to improvements in fluid pumps or motors and more particularly to a gyratory type valve for use in multiple outlet fluid pumps or multiple inlet fluid motors.

It is the general object of this invention to produce a gyratory type valve for use in a fluid pump or motor of improved construction and performance.

It is a more specific object of this invention to produce a permissibly rotatable gyratory type valve, for use in a fluid motor or in a multiple outlet fluid pump having a plurality of annularly arranged cylinder ports and discharge ports, in which the valve is adapted sequentially and separately to connect the cylinder ports with a predetermined different one of the discharge ports.

A further object of this invention is to produce a valve of the type described in the preceding paragraph having a perforated valving rim, that is, to provide a plurality of openings through the rim and located along the valving line, the openings being so proportioned as to effectively prevent cross-porting.

Another object of the invention is to provide a valve as just described with a plurality of openings so shaped and proportioned as to obtain maximum flow area and so located as to prevent cross-porting.

Other and further objects of the invention will be apparent from the following description and accompanying drawings in which:

Fig. 1 is a longitudinal section through a fluid pump housing and discharge manifold embodying the invention;

Fig. 2 is an enlarged section along line 2—2 of Fig. 1;

Fig. 3 is a section taken along line 3—3 of Fig. 2;

Fig. 4 is a section taken along line 4—4 of Fig. 1; and

Fig. 5 is a fragmentary view of a valving rim embodying the optimum shape of openings there-through.

While the invention is susceptible of various modifications and alternative constructions, it is herein shown and will hereinafter be described in a preferred embodiment. It is not intended, however, that the invention is to be limited thereby to the specific construction disclosed. On the contrary, it is intended to cover all modifications and alternative constructions falling within the spirit and scope of the invention as defined in the appended claims.

As illustrated in the drawings, the pump com-

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prises a hollow casing having a somewhat tubular section 10 and an end section 11. Located within the casing is a cylinder block 12 having a plurality of cylinder bores 13 in which pistons 14 are reciprocable. A drive shaft 16 is rotatably mounted in the casing and carries a wobbler device 17 for converting rotary motion of the shaft into reciprocatory movement of the pistons. A valve device 18 is provided for controlling the flow of fluid to the cylinders from an inlet port 19 and from the cylinders to a plurality of discharge ports 20, one of which latter ports is provided for each of the cylinders 13.

The cylinder block 12 is generally annular in form and has an integral flange 21 positioned between the casing sections 10 and 11, the casing sections and flange being secured together by a plurality of bolts 22. The cylinder block is provided with a cylindrical recess in its right hand end (as shown in Fig. 1) to form a cylindrical valve chamber 23 having opposed parallel end faces 24 and 25. In this chamber and against these faces, the valve device 18 is located.

The shaft 16 is rotatably mounted within the casing and to this end there are provided a roller bearing 26 and a ball bearing 27 at the left hand end of the casing and a roller bearing 28 supported in the cylinder block 12, which bearings carry the shaft. The wobbler device 17 comprises an inner ring member 29 which is pivotally mounted on the shaft 16 by means of a pin 30 extending therethrough. The wobbler includes an outer ring 31 carried on the inner ring by means of roller bearings 32 and thrust bearing 32a and is arranged with a flat end face 33 in position to engage the adjacent convex ends of the pistons 14. As will be noted from the drawings, the pin 30 about which the wobbler pivots is off center with respect to the central longitudinal axis of the shaft 30 and with respect to the wobbler face. Thus, as shaft 16 is rotated an inertia load is applied to the wobbler tending to rotate it about the pivot to a position imparting maximum stroke to the pistons. This inertia load is augmented by the hydraulic load applied to the pistons as will be hereinafter described and thus the wobbler tends to assume a position causing maximum stroke with rotation of the shaft 16.

Springs 34 are located in an annular recess 35 between the cylinder block and the casing 10 and are secured to an annular collar 36 which in turn is adapted to contact the ring 33 to urge the wobbler to neutral position. By compressing the springs and thus moving the collar 36 to the right, the wobbler assumes a stroke imparting

position as described. The springs may be compressed manually or, as in the embodiment shown, hydraulically. To this end I mount the springs in a sleeve 37 slidable in the recess 35. The sleeve is provided with a shoulder 38 located in a chamber 39 formed between the sleeve and an annular member 40 secured to the casing 10. A fluid passage 41 is connected to the chamber 39 and to a main relay control valve 42 which is adapted to supply control fluid under pressure thereto to move the sleeve to the right to compress the springs. The control valve 42 forms no part of this invention and hence is not further described herein.

Each of the pistons 14 has a relatively larger portion 43 adjacent its left hand end (as seen in Fig. 1) and a relatively smaller portion 44 adjacent its right hand end. The cylinders 13 are so proportioned as to engage each of the sections of the piston and accordingly the right hand section 45 of each cylinder has a somewhat smaller diameter than the left hand end. The proportioning of the pistons provides an annular shoulder surface 46 on each piston to which oil pressure is applied to urge the pistons to the left on their intake strokes as hereinafter described.

The flow of fluid to and from the cylinders 13 is controlled by the valve device 18 which, as illustrated in the drawings, comprises a wheel-like member having a hub portion 47, an annular valving rim 48, and a plurality of openings 49 between the hub and the rim. The valve is positioned with its annular rim portion 48 in the valve chamber 23 between the cylinder ports and the radially aligned discharge ports 20 opposite thereto. In order to reduce friction and wear on the valve 18 we prefer to pressurize the valve so as to cause it to bear against the discharge port face of the valve chamber 23. To this end the cylinder port face of the chamber is provided with a groove 50, which groove is in communication with high pressure oil from the piston ports. Oil pressure within the groove 50 serves to urge the valve against the discharge port face of the chamber, which face may be of bronze or other friction-reducing metal. The valve is given a gyratory movement by means of an eccentric pin 51 which is carried on a rotatable shaft 52 positioned in axial alignment with the shaft 16 and connected thereto by a spline arrangement 53.

The valve 18 is freely rotatable about the eccentric pin 51 and is provided with a perforated valving rim, the perforations taking the form of a plurality of openings 55 therethrough adapted to interconnect each of the cylinder ports with a predetermined different one of the discharge ports 20. In order to prevent cross-porting with rotation of the valve, the openings 55 through the rim are so proportioned as to have a diameter, measured circumferentially of the valving rim, less than the shortest distance between cylinder ports. The openings are located substantially on the circumference of a circle tangent to the cylinder ports at the valving line to high pressure, the valving line being determined by the eccentricity of movement of the valve and the piston circle in relation to the position of the wobbler pivot. The optimum shape of the openings 55 is trapezoidal, as shown in Fig. 5, with the sides 55a and 55b of the trapezoid lying on radii of the valve. This is a difficult shape to machine and for purposes of economy of manufacture we prefer to approach a trapezoidal shape through the medium of a plurality of circular

holes. Thus, the openings 55 comprise a first plurality of circular openings 56 arranged on the circumference of a circle concentric with the hub and a second plurality of smaller circular openings 57 lying on the circumference of a circle of smaller diameter than that of the openings 56. Two of the larger openings 56 are provided for each cylinder port and two of the smaller openings 57 are provided for each larger opening with alternate smaller openings intersecting and opening into a larger opening. Thus, the composite opening is somewhat trapezoidal in shape. In order to avoid trapping of fluid when one of the smaller openings 57 straddles a piston port, the circle on which the openings are located is approximately .010 inch smaller in diameter than the theoretical tangency to the cylinder port circle. The discharge ports 20 are located on a diameter so that a through passageway is obtained at the seal point. This arrangement eliminates the necessity of accurately aligning the discharge ports with the cylinder ports. To prevent leakage from the discharge ports to the inlet, the inner diameter of the valve plate on the discharge port face is made to provide a minimum of .060 seal. The discharge ports, therefore, are never exposed to the inlet. By the arrangement disclosed, rotation of the valve on its bearing pin 51 affects the discharge port area only slightly and the change in discharge velocity due to rotation of the valve is limited to approximately 5 to 10%.

The openings 49 permit flow of fluid from the inlet 19 to the cylinder ports on the suction stroke of the pistons in the usual manner.

In the particular embodiment shown eighteen pistons are provided in the pump which discharge into an equal number of discharge ports 20. The end cap 11 is provided with a manifold arrangement 59 designed to combine the eighteen discharge ports into six separate outlets by joining three ports equally spaced in the discharge port circle to form six groups of three discharge ports each. To this end the manifold is provided with six annular grooves 60 separated by O rings 61. Slots 62 are milled in the manifold to connect each discharge port 20 to one of the six annular grooves 60.

Movement of the pistons on their return or suction stroke is accomplished by means of a gear pump 63 mounted upon the shaft 52 and connected by means of a passage 64 to a groove 65 in each of the cylinders 13. The groove 65 is located at the mean position of the shoulder portion 45 and thus the pressure generated by the charge pump 63 serves constantly to urge the pistons to the left, that is, on their suction or return strokes.

We claim:

1. In a variable displacement hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a plurality of fluid ports opening to one end face of the valve chamber in an annular row, a second plurality of fluid ports opening to the other end face of the valve chamber in an annular row, and a fluid passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the ports in the first mentioned end face alternately to the passage and to the other ports comprising a wheel-like member having a hub, a substantially circular valving rim and an opening between the hub and the rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means

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engaging the hub for driving said valve through an eccentric movement with respect to said ports with the valve being permissibly rotatable in the chamber, and a plurality of openings extending through the valving rim and serving as the only means of communication between the ports in one end face and the ports in the other end face, the width of each of said openings measured circumferentially of the rim being less than the shortest distance between the ports in the first mentioned plurality.

2. In a wobbler type hydraulic pump or motor, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged ports opening to the other end face of the valve chamber with each of the last mentioned ports being radially aligned with a cylinder port, and a fluid passage opening to said valve chamber radially of said ports, a valve operable successively to connect the cylinder ports alternately to the passage and to the other ports comprising a wheel-like member having a hub, a valving rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means engaging the hub for driving said valve through an eccentric movement with respect to said ports with the valve being permissibly rotatable in the chamber, and a plurality of openings extending through the valving rim and acting as passages for the flow of fluid between ports, said openings having a width at the valving line measured circumferentially of the rim less than the shortest circumferential distance between cylinder ports and being adapted to confine fluid flow between said ports to radially aligned ports with eccentric movement of the valve.

3. In a wobbler type hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged discharge ports opening to the other end face of the valve chamber, and a fluid passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the cylinder ports alternately to the passage and to the discharge ports comprising a wheel-like member having a hub, a substantially circular valving rim and an opening between the hub and the rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means engaging the hub for driving said valve through an eccentric movement with respect to said ports, a first plurality of circular openings through the rim and lying on a circle centered at the center of the hub, a second plurality of openings through the rim and smaller in diameter than the openings of the first plurality, said second plurality of openings lying on a circle concentric to and having a smaller diameter than the first circle, there being two large openings for each of the cylinder ports and there being two openings in the second plurality for each opening in the first plurality, with a small opening intersecting each large opening to form a composite opening, the diameter measured circumferentially of the rim of any of said

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openings being less than the shortest distance between cylinder ports.

4. In a wobbler type hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged discharge ports opening to the other end face of the valve chamber with each discharge port being radially aligned with a cylinder port and a fluid passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the cylinder ports alternately to the passage and to the discharge ports comprising a wheel-like member having a hub, a valving rim and an opening between the hub and the rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means engaging the hub for driving said valve through an eccentric movement with respect to said ports and a plurality of openings through the valving rim and adapted to confine fluid flow from each of said cylinder ports to its associated discharge port with eccentric movement of the valve, said openings lying on the circumference of a circle tangent to said cylinder ports at the valving point to high pressure, there being at least two openings for each of said cylinder ports.

5. In a wobbler type hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a plurality of cylinder ports opening to one end face of the valve chamber in an annular row, an equal number of discharge ports opening to the other end face of the valve chamber in an annular row, and a fluid passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the cylinder ports alternately to the passage and to the discharge ports comprising a wheel-like member having a hub, a substantially circular valving rim and an opening between the hub and the rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means engaging the hub for driving said valve through an eccentric movement with respect to said ports, a first plurality of circular openings through the rim and lying on a circle centered at the center of the hub, a second plurality of openings through the rim and smaller in diameter than the openings of the first plurality, said second plurality of openings lying on a circle concentric to and having a smaller diameter than the first circle, there being two larger openings for each of said cylinder ports and there being two smaller openings for each larger opening with a small opening intersecting each large opening to form a composite single opening, the diameter measured circumferentially of the rim of any of said openings being less than the shortest distance between ports.

6. In a wobbler type pump having a casing, a cylindrical valve chamber in the casing having parallel end faces, a plurality of annularly arranged cylinders, a plurality of cylinder ports opening to the cylinders and to one end face of the valve chamber in an annular row, a plurality of fluid ports opening to the other end face of the chamber in an annular row, a fluid passage opening to said valve chamber radially inwardly of said ports, and a rotatable shaft for driving the wobbler relative to the cylinders, a

valve operable successively to connect the cylinder ports alternately to the passage and to the other ports comprising an eccentric on the shaft and extending into said chamber, a wheel-like member having a hub and mounted on the eccentric, said member being permissibly rotatable in the chamber and having a substantially circular valving rim and an opening between the hub and the rim, and a plurality of substantially trapezoidal shaped openings through the valving rim, the width of said openings measured circumferentially of the rim being less than the shortest distance between the cylinder ports.

7. In a wobbler type hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged discharge ports opening to the other end face of the valve chamber, and a fluid inlet passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the cylinder ports alternately to the inlet passage and to the discharge ports comprising a wheel-like member having a hub, a substantially circular valving rim and an opening between the hub and the rim to connect the cylinder ports to the inlet, means engaging the hub for driving said valve through an eccentric movement with respect to the ports to move the valving rim radially outward sequentially to uncover the cylinder ports to permit fluid flow thereinto from the inlet passage, and a number of openings through the valving rim substantially in excess of the number of cylinders, said openings lying on a circle centered at the center of the hub, the width of each of said openings measured circumferentially of the rim being less than the shortest distance between cylinder ports and said openings being adapted to connect each of said cylinder ports separately and sequentially with a predetermined different one of said discharge ports with eccentric movement of the valve.

8. In a wobbler type hydraulic pump or motor, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged ports opening to the other end face of the valve chamber, and a fluid passage opening to said valve chamber radially inwardly of said ports, a valve operable successively to connect the cylinder ports alternately to the passage and to the other ports comprising a wheel-like member having a hub, a substantially circular valving rim and an opening between the hub and the rim

to connect the cylinder ports to the passage, means engaging the hub for driving said valve through an eccentric movement with respect to the ports to move the valving rim radially outward sequentially to uncover the cylinder ports to permit fluid flow between the cylinder ports and the passage, and a number of openings through the valving rim substantially in excess of the number of cylinders, said openings lying on a circle centered at the center of the hub, the width of each of said openings measured circumferentially of the rim being less than the shortest distance between cylinder ports and said openings being adapted to connect each of said cylinder ports separately and sequentially with a predetermined different one of said other ports with eccentric movement of the valve.

9. In a multiple outlet hydraulic pump, a casing, a cylindrical valve chamber in the casing having parallel end faces, a number of annularly arranged cylinders in the casing with each cylinder having a port opening to one end face of the valve chamber to form an annular row of cylinder ports, an equal number of annularly arranged discharge ports opening to the other end face of the valve chamber with each of the discharge ports being positioned opposite a different one of the cylinder ports and a fluid inlet passage opening to said valve chamber radially of said ports, a valve operable successively to connect the cylinder ports alternately to the inlet passage and to the discharge ports comprising a wheel-like member having a hub and a perforated valving rim, said rim having end faces in fluid-tight sliding engagement with the end faces of the valve chamber, means engaging the hub for driving said valve through an eccentric movement with respect to said ports with the valve permissibly rotatable in the valve chamber and with the perforations in the valving rim comprising a plurality of openings extending therethrough and acting as passages for longitudinal flow of fluid between each of said cylinder ports and its opposed discharge port, said openings having a width at the valving line measured circumferentially of the rim less than the shortest circumferential distance between cylinder ports whereby to prevent annular flow of fluid between the ports.

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