

Sept. 13, 1932.

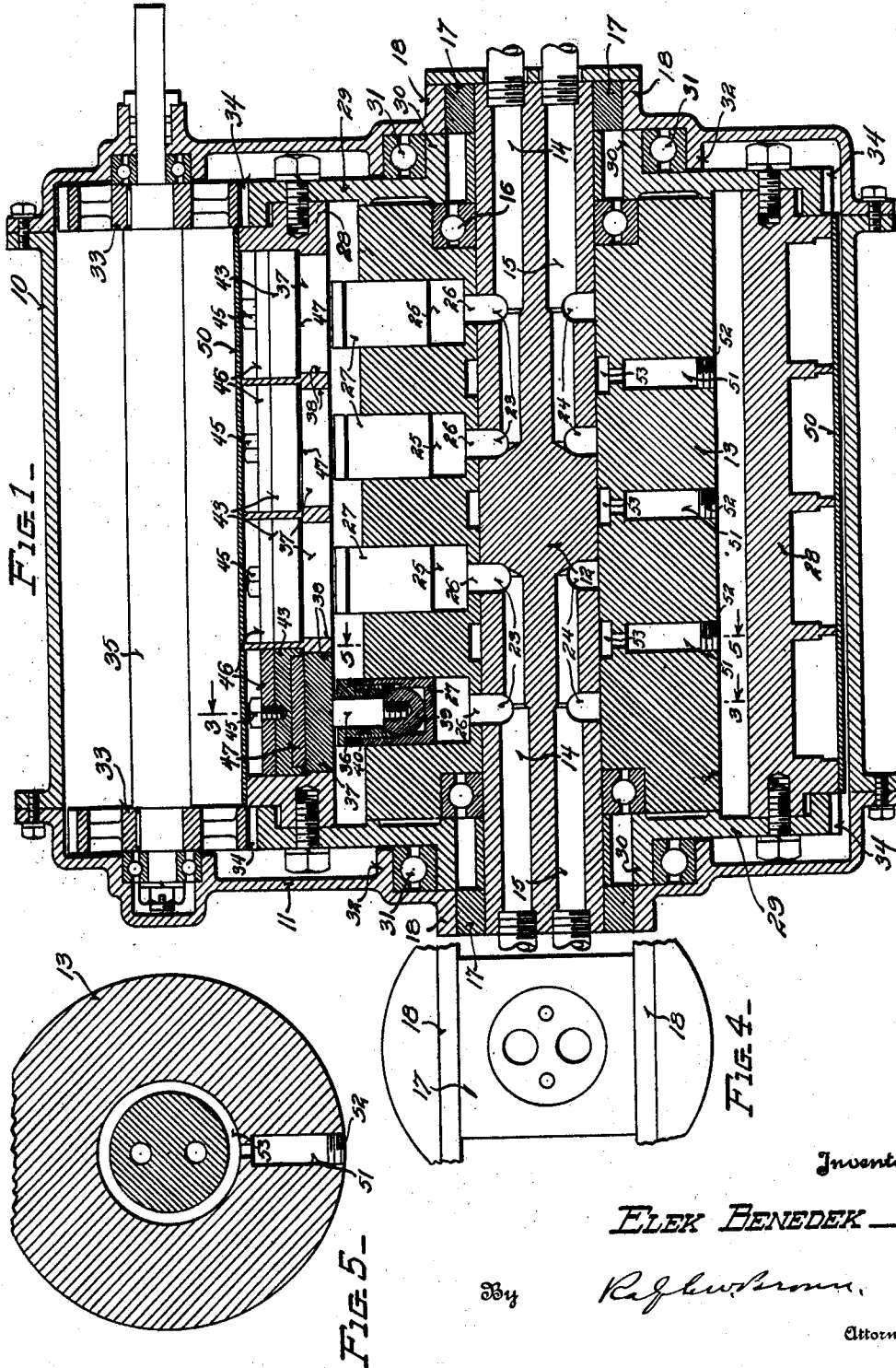
E. BENEDEK

1,876,833

PUMP

Filed Jan. 28, 1931

4 Sheets-Sheet 1



Inventor

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Ref. to prior art.

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Sept. 13, 1932.

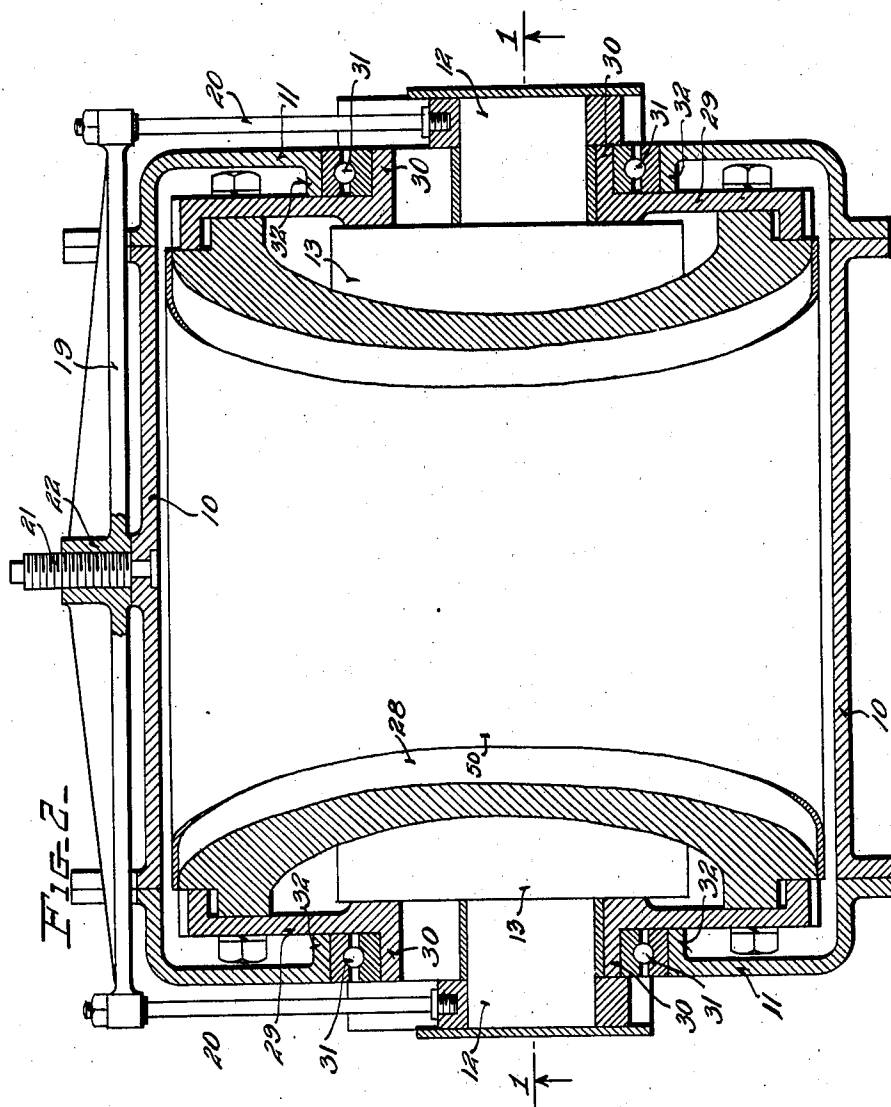
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4 Sheets-Sheet 2



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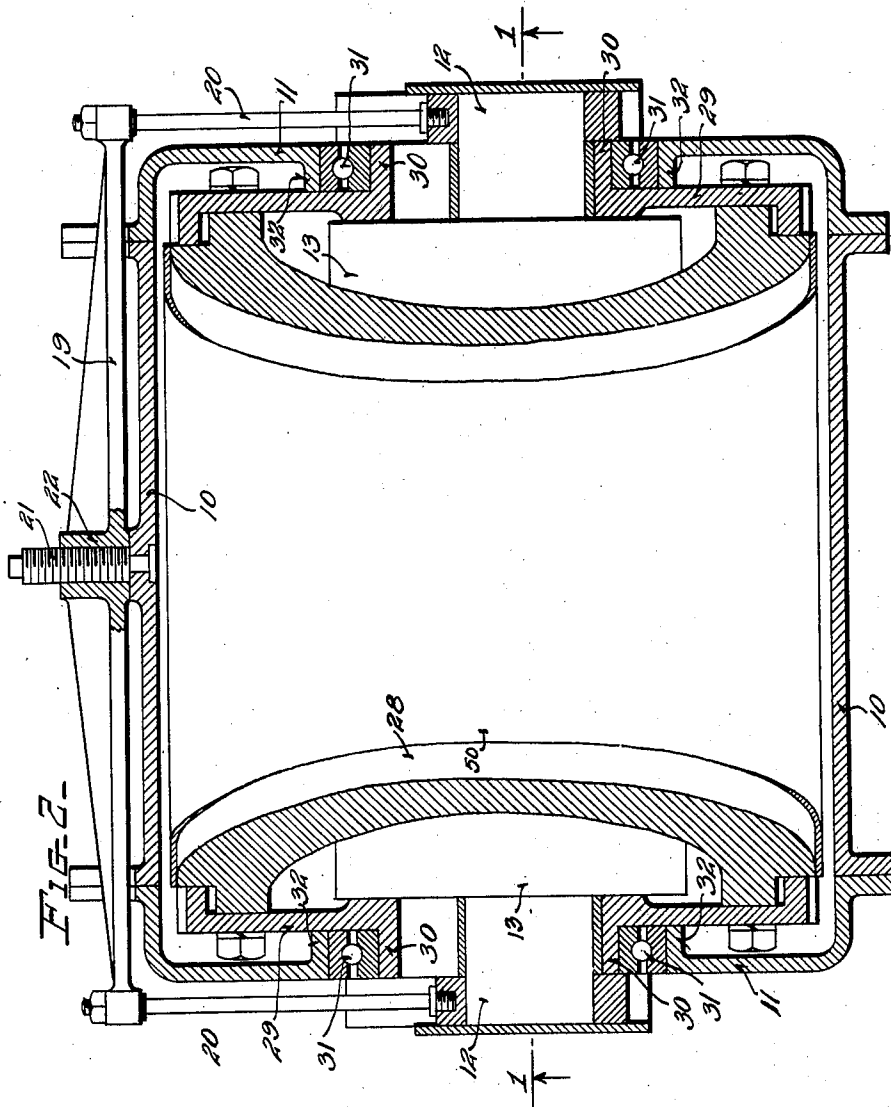
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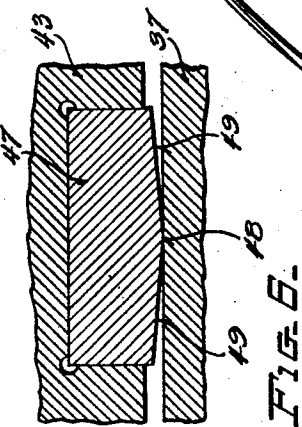
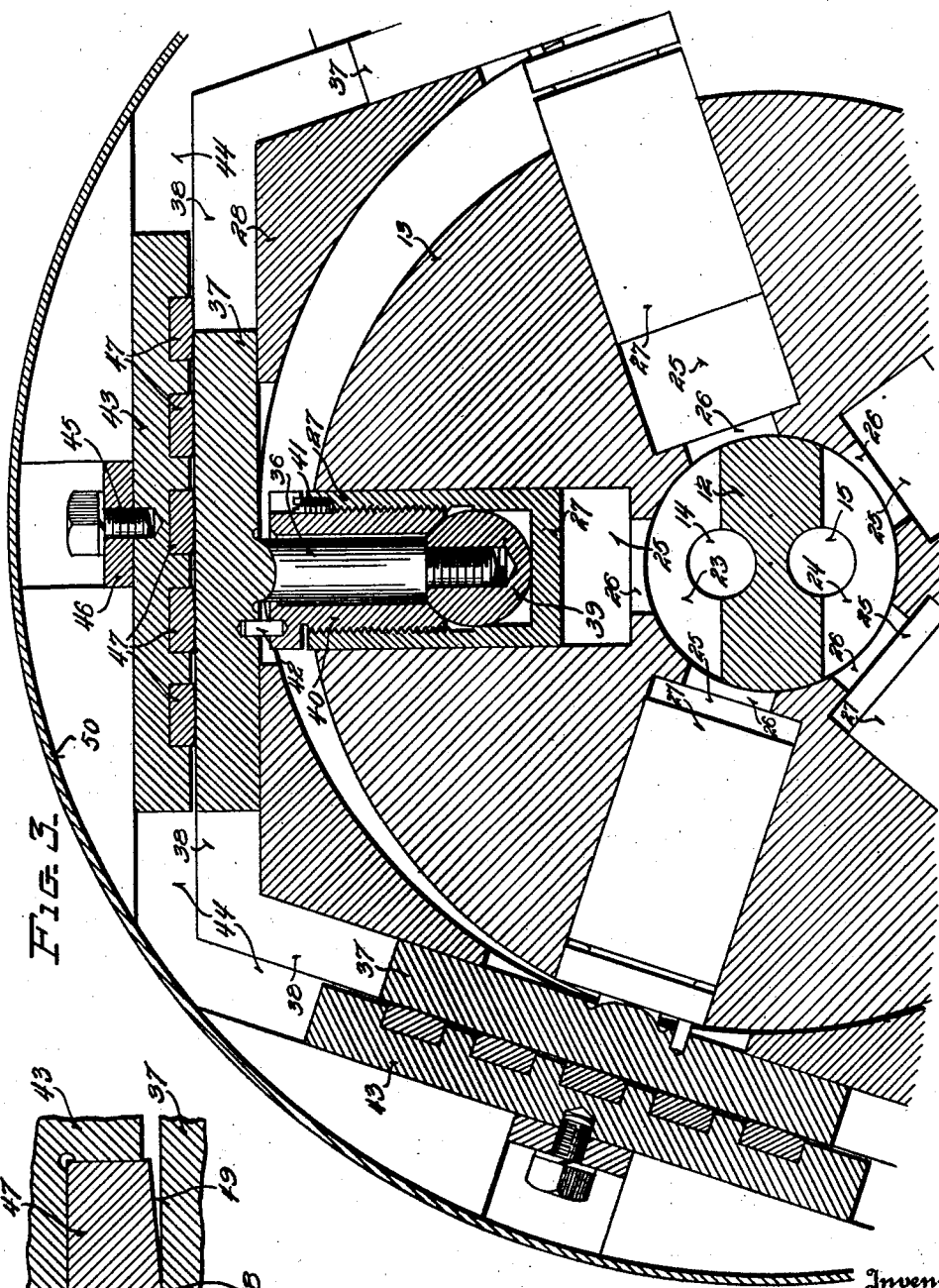
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

FIG. 7.

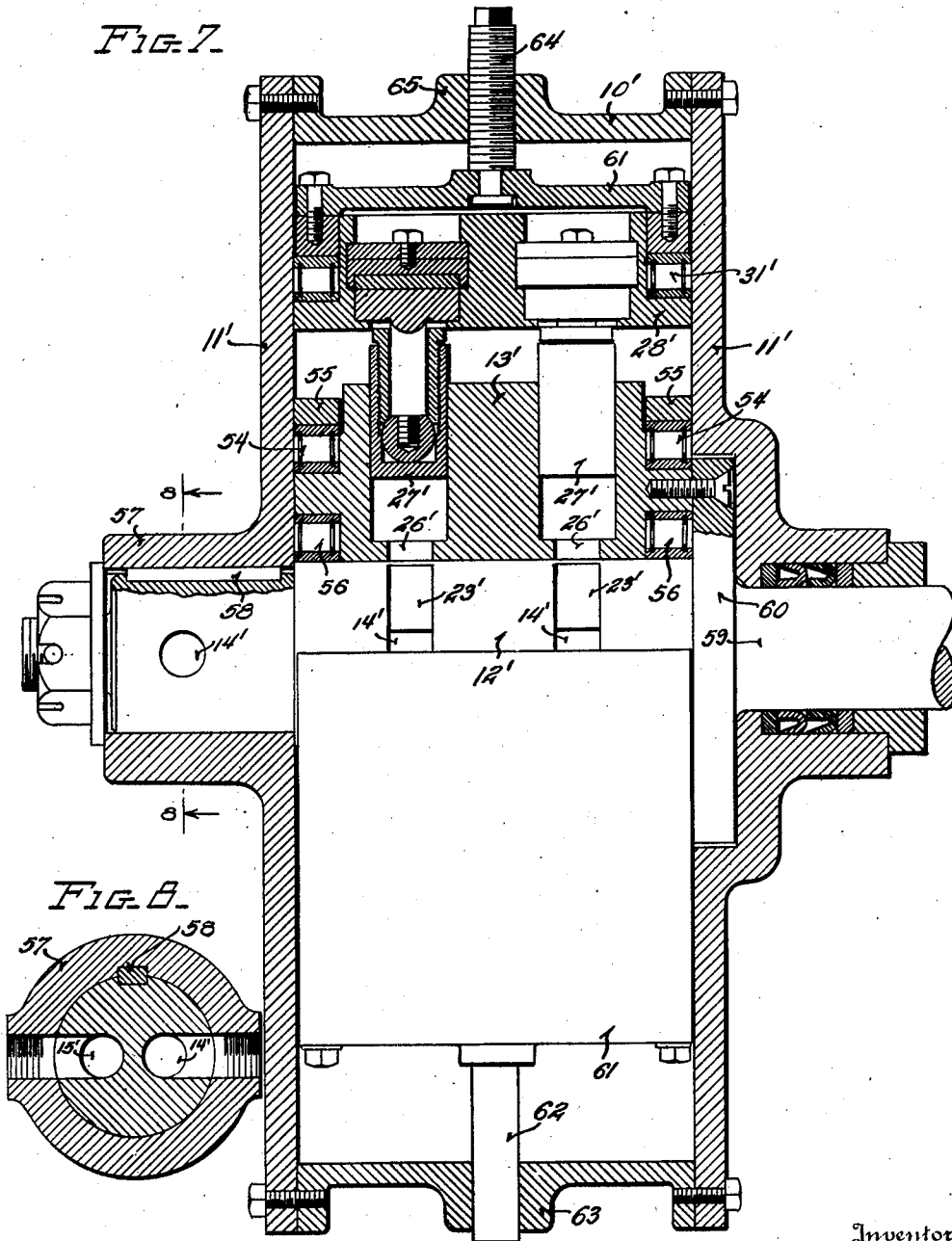


FIG. 8.

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UNITED STATES PATENT OFFICE

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PUMP

Application filed January 28, 1931. Serial No. 511,684.

This invention relates to rotary multiple piston pumps.

Pumps of the type to which the present invention applies include a cylinder barrel rotatable about a pintle and containing a series of radial cylinder bores each of which communicates alternately with inlet and outlet passages in the pintle, together with a series of pistons reciprocating in said bores and driven by a surrounding impeller which rotates with the cylinder barrel. In pumps of the type referred to each piston is connected to the impeller through a load transmitting T-shaped structure freely reciprocable in the impeller in a direction normal to the axis of reciprocation of its connected piston; and, as heretofore constructed, each T-shaped structure bore against a set of anti-friction rollers provided in the impeller to sustain the transmitted piston load and to insure freedom of reciprocation of the T-shaped structure.

One object of the present invention is to maintain an effective oil film between each T-shaped structure and impeller capable of sustaining the heavy loads involved and to thus provide and maintain a substantially frictionless bearing therebetween, to thereby make possible the elimination of the sets of anti-friction rollers heretofore required.

Another object is to insure an ample supply of lubricant to the coating surfaces of the T-shaped structures and impeller.

Another object is to provide a positive, double-acting, driving connection between each T-shaped structure and its coating piston, which will afford sufficient flexibility to permit self-alignment of each piston in its coating bore, and which at the same time will insure against eccentric loading of the piston under all conditions of operation.

Another object of the invention is to provide a novel construction and cooperative arrangement of pintle and cylinder barrel in which the pintle is supported at its respective ends in the pump casing and the relatively long cylinder barrel, which surrounds and has oil film bearing on the intervening portion of the pintle, has anti-friction bear-

ing at its ends alone on the pintle adjacent the secured ends thereof and is of very rigid non-yielding construction to adapt it for centrally supporting, and for overcoming tendencies of the hydraulic action to distort, said pintle.

Another object is to improve pintle lubrication.

Other objects and advantages will appear from the following description of two illustrative embodiments of the present invention

In the accompanying drawings:—

Figure 1 is a vertical sectional view of a pump constructed in accordance with the present invention, the section being taken along the line 1—1 of Fig. 2.

Fig. 2 is a horizontal sectional view partly in elevation.

Fig. 3 is a fragmentary sectional view, on a larger scale, taken substantially along the line 3—3 of Fig. 1.

Fig. 4 is an end view of the pintle and end support.

Fig. 5 is a sectional view on the line 5—5 of Fig. 1.

Fig. 6 is an enlarged detail view of one of the bearing blocks shown in Fig. 3.

Fig. 7 is a horizontal sectional view, partly in elevation, of a modified form of pump embodying the present invention.

Fig. 8 is a sectional view on the line 8—8 of Fig. 7.

The pump shown in Figs. 1 to 6 is enclosed within an appropriate housing 10 having a pair of end heads 11 removably secured thereto. A pintle 12, extended through the housing, constitutes a support for an inner rotary member or cylinder barrel 13 and also contains two pairs of passages 14 and 15 through which liquid is supplied to and discharged from the pump. A close running fit is provided between the cylinder barrel and pintle, the cylinder barrel being supported primarily by a pair of anti-friction bearings 16 mounted on the pintle.

The pintle is rigidly but adjustably supported at its opposite ends in a pair of slide blocks 17 guided between pairs of horizontal flanges 18 preferably formed integral with

the end heads 11 of the housing. The slide blocks 17 are simultaneously actuated and controlled through appropriate means such as a frame 19 having links 20 connected to the respective blocks (see Fig. 2). An adjusting screw 21, journaled in the housing and threaded through a boss 22 on the frame 19, serves to actuate and control the frame and to thereby advance or retract the pintle 12 and thus shift the axis of rotation of the cylinder barrel 13.

Each pair of pintle passages 14 and 15 extends lengthwise of the pintle from an intermediate portion to the end thereof, each of the upper passages 14 communicating with a pair of ports 23, and each of the lower passages communicating with a pair of ports 24. The cylinder barrel contains four sets of radial bores 25, the bores of each set having end ports 26 which communicate alternately with an upper port 23 and lower port 24 in the pintle during rotation of the cylinder barrel about the pintle. Each bore 25 contains a hollow piston 27 which is actuated by an outer rotary member or impeller 28 through connections which will be later described.

The impeller 28 is in the form of a cylindrical drum secured to and supported by end disks 29. The end disks are provided with central hub portions 30 journaled in surrounding anti-friction bearings 31 fixed within circular flanges 32 formed in the end heads 11. The impeller 28 is driven by a pair of pinions 33 which mesh with teeth 34 formed upon the periphery of the end disks 29, the pinions being fixed to a drive shaft 35 journaled in the end heads 11.

Each piston 27 is connected to the impeller 28 through a T-shaped structure comprising a shank 36 rigidly connected to and projecting inwardly from a cross-head 37 of plate like form. Each cross-head 37 extends at right angles to its connected shank 36 and is guided within a slot 38 formed in the impeller substantially tangential to the inner periphery thereof.

The shank 36 projects into its associated piston 27 and is provided at its inner end with a ball 39 which is snugly fitted within the piston and bears centrally against the base thereof, the ball being positively retained in this position by a sleeve 40 screwed into the outer open end of the piston and bearing against the ball. A key 41 prevents accidental displacement of the sleeve 40 and a key 42, loosely engaged with the cross-head 37 and with the sleeve 40, prevents rotation of the sleeve and piston with respect to the cross-head and shank.

It will be noted that the internal diameter of the sleeve 40 is slightly greater than that of the shank 36, so that the piston 27 and sleeve are permitted some freedom of movement about the ball 39 sufficient to permit

self-alignment of each piston within its coacting bore. The freedom of the cross-head permitted by the ball 39 should not be confused as an operative freedom. The ball equipment does not permit any rocking movement during operation of the pump and is provided solely to permit self adjustment of the crosshead during assembly. Once set during assembly the cross-head and the piston assembly are never permitted to cock even slightly and thus eccentrically directed thrusts and tensions are entirely avoided. It will also be noted that by maintaining the ball centrally of the piston in the manner above explained the piston is never eccentrically loaded. Furthermore the positive confinement of the ball between the base of the piston and the end of the sleeve insures a positive mechanical connection between the shank 36 and a piston in both directions of reciprocation, thereby affording a positive suction stroke as well as a positive pressure stroke of the piston.

The load on each piston 27 is sustained by a reaction face on the outer rotary member in the present instance comprising the inner side of a stationary reaction plate 43 removably fixed in a slot 44 formed in the impeller adjacent and parallel to one of the cross-head guide slots 38. Each reaction plate is retained in place in a well known manner by a screw 45 in a transverse locking plate 46 and each reaction plate is provided with means interposed between the plate and the associated cross head for carrying the hydraulic piston load. Whether the interposed bearing means is connected to the reaction plate or the associated cross head is not fundamentally important. It is important in accordance with the invention that the bearing means comprise a substantially plane faced bearing element, but the number of elements interposed between each reaction plate and the associated cross head is not critical, and there may be one or more such elements for carrying the hydraulic load on each piston. In this instance each reaction plate is slotted to receive a plurality of spaced stationary bearing blocks 47 which project slightly beyond the inner face of the reaction plate. As indicated in the illustrative embodiment shown particularly in Fig. 6, the exposed face of each block 47 is slightly inclined in opposite directions, lengthwise of the reaction plate, from a central, transversely extending high portion 48, but it will be understood that the advantages resulting from my improved organization of load transmitting means may be obtained without the bearing blocks having inclined faces as shown. The space between each cross-head 37 and its coacting reaction plate 43 is flooded with lubricant in a manner to be later described. It will be understood that the reaction plates preferably are separable and removable for

convenience in machining an assembly, but that it is not necessary in obtaining the advantages of the invention that the reaction faces be formed on separate parts.

5 The arrangement is such that, during lengthwise reciprocation of each cross-head 37, lubricant is dragged thereby into the thin wedgelike gap thus formed between the cross-head and one of the inclined faces 49 of each
10 of the several bearing blocks 47, so as to form an effective oil film therebetween well able to withstand the heavy load between the cross-head and reaction plate. By this means a substantially frictionless bearing is provided
15 between each cross-head and its coacting reaction plate. It will be understood that in practice when it is desired to use a plurality of bearing blocks having inclined faces the degree of inclination of the faces 49 is quite
20 minute, the inclination portrayed in Fig. 6 being greatly exaggerated merely to facilitate illustration.

It will be observed that the pintle 12 is rigidly mounted at its ends in the blocks 17
25 and that the cylinder barrel 13 has a secondary oil film bearing throughout substantially its whole length on the pintle but has its main bearing on anti-friction bearings 16 one of which is provided adjacent each rigidly
30 supported end of the pintle. The cylinder barrel is relatively long and is heavy and rigid or non-yielding in its construction and thus acts as a central support for the portion of the pintle intermediate its rigidly mounted
35 ends. By this construction and arrangement the strains occasioned by the hydraulic action incident to operation of the pump are not permitted to deflect or distort the pintle.

In the pump shown the space between the
40 cylinder barrel 13 and impeller drum 28 is utilized as a reservoir for lubricating oil, and for that purpose an oil retainer cover 50 is applied to the external periphery of the impeller, and the supporting end disks 29 are
45 closely fitted to the ends of the cylinder barrel, as indicated in Figs. 1 and 2. Sufficient oil is maintained in this space to flood all of the slots 38 and 44 and other spaces within the impeller, during rotation of the cylinder
50 barrel and impeller, so that an ample supply of lubricant to the cross-heads 37 and bearing blocks 47 is assured. It will be noted that leakage of oil past the several pistons 27 from the bores 25 discharges directly into this
55 space between the cylinder barrel and impeller to at least partially compensate for oil leakage therefrom.

In the pump shown in Figs. 1 to 6 the impeller drum 28 rotates about a fixed axis coincident with the centers of the bearings 31
60 and is driven at high speed from the shaft 35 through the pinions 33. The cylinder barrel 13 rotates about an adjustable axis coincident with the axis of the adjustable pintle 12, rotation being imparted to the cylinder bar-

rel from the impeller through the pistons and the T-shaped structures hereinabove described. By adjustment of the pintle through the control screw 21 and frame 19 the axis of rotation of the cylinder barrel may be
70 made to coincide with that of the impeller, in which position pump displacement is zero, or it may be shifted to one side or the other of the axis of rotation of the impeller to thereby cause the pump to discharge in one direction
75 or the other at a rate dependent upon the degree of eccentricity of the cylinder barrel with respect to the impeller.

In pumps of this general type the pintle is ordinarily lubricated by oil which escapes
80 from the several cylinder ports 26, during the pressure stroke of each of the several pistons 27, and which spreads to form a film over irregular areas between the pintle and cylinder barrel, but during the suction stroke
85 of each piston the negative pressure in the ports 26 tends to destroy the oil film thus produced causing wear between the pintle and cylinder barrel. To eliminate this difficulty small pressure reservoirs are provided
90 for supplying oil to the pintle during the suction strokes of the piston. Reservoirs for this purpose are shown at 51. Each is in the form of a bore, closed at one end by a plug
95 52, and open at the other end to a channel 53 which surrounds the pintle. Before putting the pump into use these bores 51 and channels 53 are filled with oil. Then during operation pressure is built up therein by oil
100 which escapes from the ports 26 during the pressure strokes of the pistons and finds its way along the pintle into the channels 53. This pressure is then available to force oil
105 along the pintle and thus maintain an oil film thereon during the suction stroke of the pistons.

It will be noted that the outer rotary member 28 is provided with a plurality of pairs of opposed faces normal to the respective
110 piston and cylinder assembly axes, the outer of which faces constitute reaction faces and the inner of which faces co-operate with the cross heads 37 for moving the latter and connected assemblies outwardly during the suction
115 strokes.

The pump shown in Figs. 7 and 8 is similar in many respects to that hereinabove described. It is enclosed within a housing 10' having removable end heads 11'. In this instance however the cylinder barrel 13' is supported in bearings 54, supported by circular
120 flanges 55 in the end heads 11' for rotation about a fixed axis. The pintle 12' does not support the cylinder barrel but is centered therein by anti-friction bearings 56 therebetween, one end of the pintle being loosely
125 fitted in a hub 57 formed integral with one of the end heads 11'. A key 58 holds the pintle against rotation. The pintle is provided with the usual discharge and return
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passages 14' and 15' and with ports 23' which cooperate with the cylinder ports 26' in the usual manner, during rotation of the cylinder barrel thereabout.

5 In this instance the cylinder barrel is driven by a shaft 59 journaled in one of the end heads 11' and having a flanged end 60 fixed to the cylinder barrel.

10 The impeller 28' is supported upon anti-friction bearings 31' carried by a ring 61, supported for lateral displacement between the end heads 11'. A trunnion 62 projecting from one side of the ring is guided within a boss 63 formed on the housing 10', and a
15 screw 64 journaled in the diametrically opposite side of the ring is threaded within a boss 65 formed in the housing. The arrangement is such that by rotating the screw 64 the ring 61 and impeller may be shifted in one
20 direction or the other with respect to the cylinder barrel to thereby reverse or vary the displacement of the pump in a well known manner.

25 The several pistons 27' are connected to the impeller 28' in exactly the same manner as hereinabove described.

Although both machines shown have been referred to as pumps, through the foregoing description, either will function, without modification, as a hydraulic motor.

30 Various changes may be made in either of the pumps hereinabove specifically described without departing from or sacrificing the advantages of the invention as defined in the
35 appended claims.

I claim:—

1. In a pump or motor the combination
40 of a pintle, a radial series of reciprocable piston and cylinder assemblies rotatable about said pintle, a rotary member surrounding said assemblies and rotatable therewith, a cross-head connected with each of said assemblies and freely reciprocable with respect to said rotary member in a direction
45 normal to the axis of reciprocation of the connected assembly, and a lubricated bearing block interposed between each of said cross-heads and said rotary member for sustaining the thrusts of said assemblies, each of said
50 blocks having a pair of substantially plane faced bearing surfaces oppositely inclined in the direction of reciprocation of its associated cross-head.

2. In a pump or motor the combination
55 of a pintle, a radial series of reciprocable piston and cylinder assemblies rotatable about said pintle, a rotary member surrounding said assemblies and rotatable therewith, a cross-head connected with each of said assemblies and guided for reciprocation in said
60 rotary member in a direction normal to the axis of reciprocation of the connected assembly, and means in said rotary member providing a plurality of bearing elements
65 formed with oppositely inclined substantial-

ly plane faced lubricating bearing surfaces engaging each of said cross-heads and slightly inclined in the directions of reciprocation thereof.

3. In a pump or motor the combination
70 of a pintle, a radial series of reciprocable piston and cylinder assemblies rotatable about said pintle, a rotary member surrounding said assemblies and rotatable therewith, a cross-head connected with each of said assemblies and guided for reciprocation in said
75 rotary member in a direction normal to the axis of reciprocation of the connected assembly, a reaction plate fixed in said rotary member opposite each of said cross-heads and paralleling the same, and a set of lubricated bearing blocks carried by each of said plates, said blocks having slightly inclined substantially plane faced bearing surfaces opposed to the associated cross-head and cooperating
80 with said cross-head in bearing relation thereto.

4. In a pump or motor the combination
90 of a pintle, a radial series of reciprocable piston and cylinder assemblies rotatable about said pintle, a rotary member comprising an oil retaining drum surrounding said assemblies and rotatable therewith, a cross-head connected with each of said assemblies and reciprocable in said drum in a direction normal to the axis of reciprocation of the connected assembly, and a set of bearing blocks carried by said drum and interposed between each of said cross-heads and said drum for
95 sustaining the thrusts of said assemblies, said blocks having substantially plane faced bearing surfaces lubricated by oil contained in said drum.

5. In a pump or motor the combination
105 of a pintle, a cylinder barrel rotatable about said pintle and having a plurality of radial cylinder bores therein, a hollow piston reciprocable in each bore, a shank projecting into each piston, a ball at the end of each shank centrally confined within each piston, a retainer sleeve coacting with each ball within which said shank is afforded freedom permitting cross-head alignment during assembly but no operative rocking freedom and adapted to form a rigid and positive driving connection between each shank and piston, a rotary element rotatable with said
110 cylinder barrel, and a cross-head rigidly connected with each shank and guided for reciprocation in said rotary element in a direction normal to the axis of reciprocation of the associated piston.

6. In a pump or motor the combination of a housing, a pintle, a separate support for each end of said pintle slidably mounted in
125 said housing, a cylinder barrel rotatable on said pintle and having a plurality of cylinder bores therein, a piston reciprocable in each bore, a rotary element, bearings fixed in said housing for supporting the opposite
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ends of said rotary element, a cross-head connected with each piston and guided for reciprocation in the rotary element in a direction normal to the axis of reciprocation of the connected piston, and means for simultaneously shifting said pintle supports to thereby shift the axis of rotation of said cylinder barrel with respect to that of said rotary element.

7. In a pump or motor the combination of a housing, a pintle supported at both ends in said housing, a long rigid nonyielding cylinder barrel having rotative lubricant film bearing on said pintle throughout substantially the length of the pintle intermediate its end bearings, a plurality of sets of radial bores formed in said cylinder barrel, inlet and outlet passages in one end of said pintle for communication with some of said bores, separate inlet and outlet passages in the other end of said pintle for communication with the other of said bores, a piston reciprocable in each bore, a rotary element surrounding said cylinder barrel and supported at opposite ends in said housing, and driving connections between said rotary element and pistons.

8. In a pump or motor the combination of a pintle, inlet and outlet passages in said pintle, ports in said pintle communicating with said passages, respectively, a cylinder barrel rotatable on said pintle, cylinder bores formed in said barrel having ports cooperating with said pintle ports, pistons reciprocable in said bores, a channel encircling said pintle and offset from said pintle ports, and a pressure chamber in said cylinder barrel communicating with said channel.

9. In a pump or motor the combination of a pintle, a cylinder barrel rotatable about said pintle and having a plurality of radial cylinder bores therein, a hollow piston reciprocable in each bore and having a solid inner end for acting on fluid in the bore, a shank projecting into each piston, a ball at the end of each shank centrally confined within each piston, a retainer sleeve coacting with each ball within which said shank is afforded freedom permitting crosshead alignment during assembly but no operative rocking freedom and adapted to form a positive driving connection between each shank and piston, a rotary element rotatable with said cylinder barrel, and a crosshead rigidly connected with each shank and guided for reciprocation in said rotary element in a direction normal to the axis of reciprocation of the associated piston.

10. In a pump or motor, the combination of a casing, a pintle having rigid supporting bearing at its respective ends in said casing, a long rigid nonyielding cylinder barrel extending substantially the length of the pintle intermediate its bearings and having main rotative bearing on said pintle in bearings

provided therefor adjacent the pintle bearings and secondary lubricant film bearing on said pintle throughout the length thereof intermediate said main bearings, said cylinder barrel also having a plurality of cylinder bores therein, pistons reciprocable in the bores, and means to impart reciprocation to said pistons.

11. In a pump or motor the combination of a casing, a pintle having rigid supporting bearing at its respective ends in said casing and inlet and outlet passages therein, ports in said pintle communicating respectively with said passages, a long rigid nonyielding cylinder barrel extending substantially the length of the pintles intermediate its bearings and having main rotative bearing on said pintle in bearings provided therefor adjacent the pintle bearings and secondary lubricant film bearing of said pintle throughout the length thereof intermediate said main bearings, said cylinder barrel also having a plurality of cylinder bores therein and ports cooperating with said pintle ports, pistons reciprocable in the bores, and means to impart reciprocation to said pistons.

12. In a pump or motor the combination of a housing, a pintle having inlet and outlet valve openings therein, a rigid cylinder barrel having pintle distortion preventing and rotative oil film bearing on said pintle and having a plurality of cylinder bores therein communicating with the valve openings, a rotary element surrounding the cylinder barrel and rotatable with said barrel about an individual axis, means affording cooperative engagement between the pistons and the rotary element, and means for bringing about a relative shifting movement between the barrel and rotary element axes along a straight line so related to the valve openings that the correlation of valve openings and barrel bores never varies regardless of the relative positions of the barrel and rotary element axes.

13. In a pump or motor, inner and outer rotary members rotatable about individual axes, radially disposed piston and cylinder assemblies connecting the elements for rotation together, said outer member having reaction faces, cross heads connected to the pistons and being mounted for reciprocation with respect to said reaction faces, substantially plane faced bearing blocks interposed between said reaction faces and said cross heads and being carried by one and slidably engaging the other, and means for retaining within said outer rotary element a body of lubricant constantly in contact with the sliding crossheads and subject to compression by centrifugal force according to the speed of rotation of said rotary members, said lubricant being unaffected by the operating pressure changes in the working fluid employed in said pump or motor.

14. In a pump or motor, inner and outer

rotary members rotatable about individual axes, radially disposed piston and cylinder assemblies connecting the members for rotation together and including crossheads slidably engaging the outer rotary member, and means for retaining within said outer rotary member the hydraulic medium leaking past the pistons whereby to provide a body of lubricant constantly in contact with the sliding crossheads and subject to compression by centrifugal force according to the speed of rotation of said rotary members, said lubricant being unaffected by the operating pressure changes in the hydraulic agent employed in said pump or motor, said outer element having tangential grooves therein for reciprocally receiving the crossheads, and said crossheads having their outer faces engaging and coacting with bearing portions on said outer rotary member slightly inclined in the directions of reciprocation of said cross heads whereby to provide high pressure oil film bearings for said crossheads which increase in efficiency as the speed of rotation of said rotary elements increases.

15. In a hydraulic pump or motor, the combination of a pintle, a radial series of reciprocable piston and cylinder assemblies rotatable about said pintle, a rotary member surrounding said assemblies and rotatable therewith and being provided with a plurality of pairs of opposed faces normal to the respective piston and cylinder assembly axes, the outer of which faces constitute reaction faces, cross heads connected with said piston and cylinder assemblies and each being guided for reciprocation between the faces of one of said pairs of opposed faces, and substantially plane faced bearing blocks interposed between said reaction faces and the associated cross heads and being carried by one and slidably engaging the other in bearing relation thereto.

In witness whereof, I hereunto subscribe my name this 9 day of January, 1931.

ELEK BENEDEK.

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