

Aug. 21, 1945.

J. F. HOFFER

2,383,059

FLUID PUMP

Filed Dec. 31, 1941

7 Sheets-Sheet 1

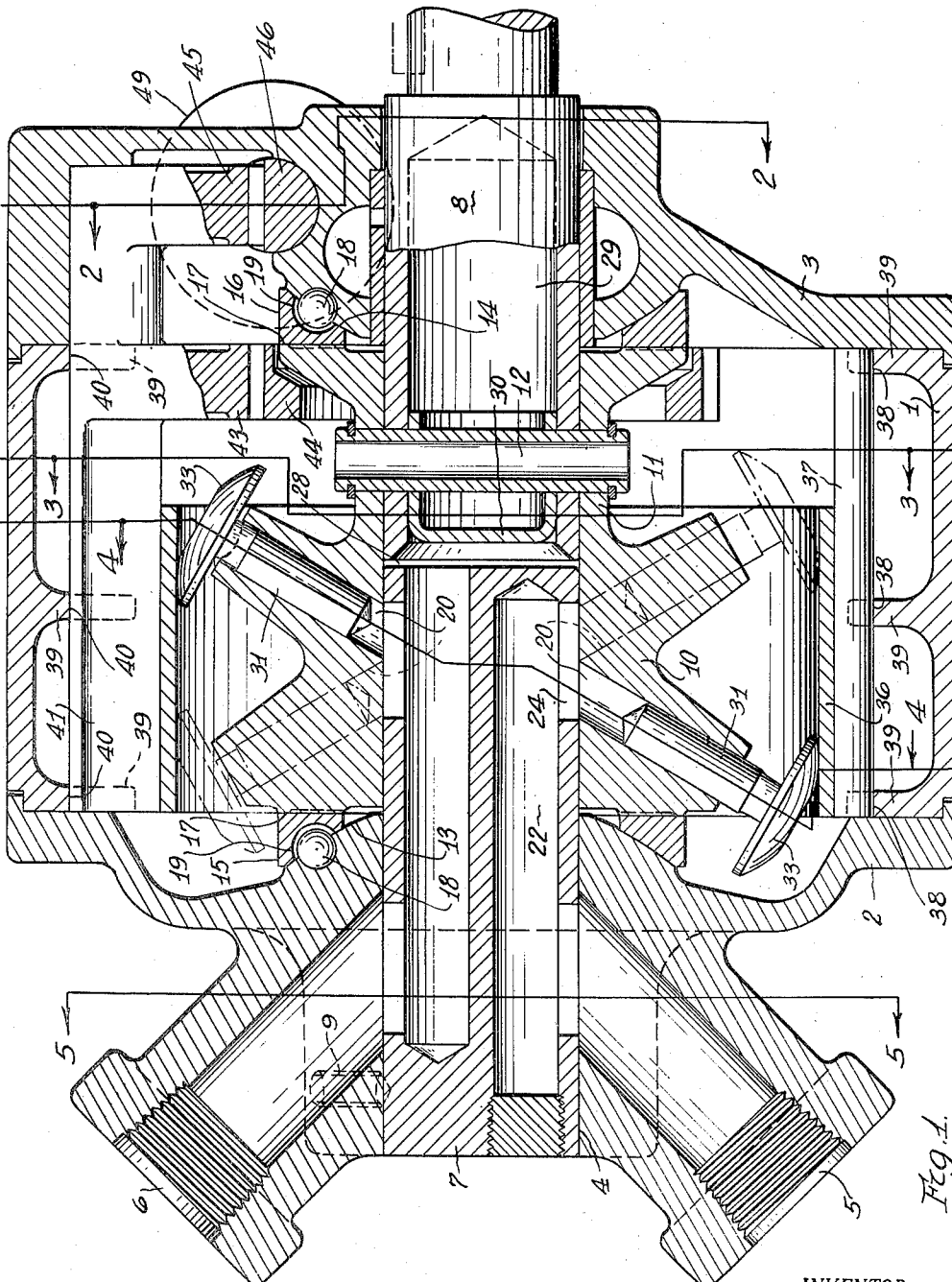


Fig. 1.

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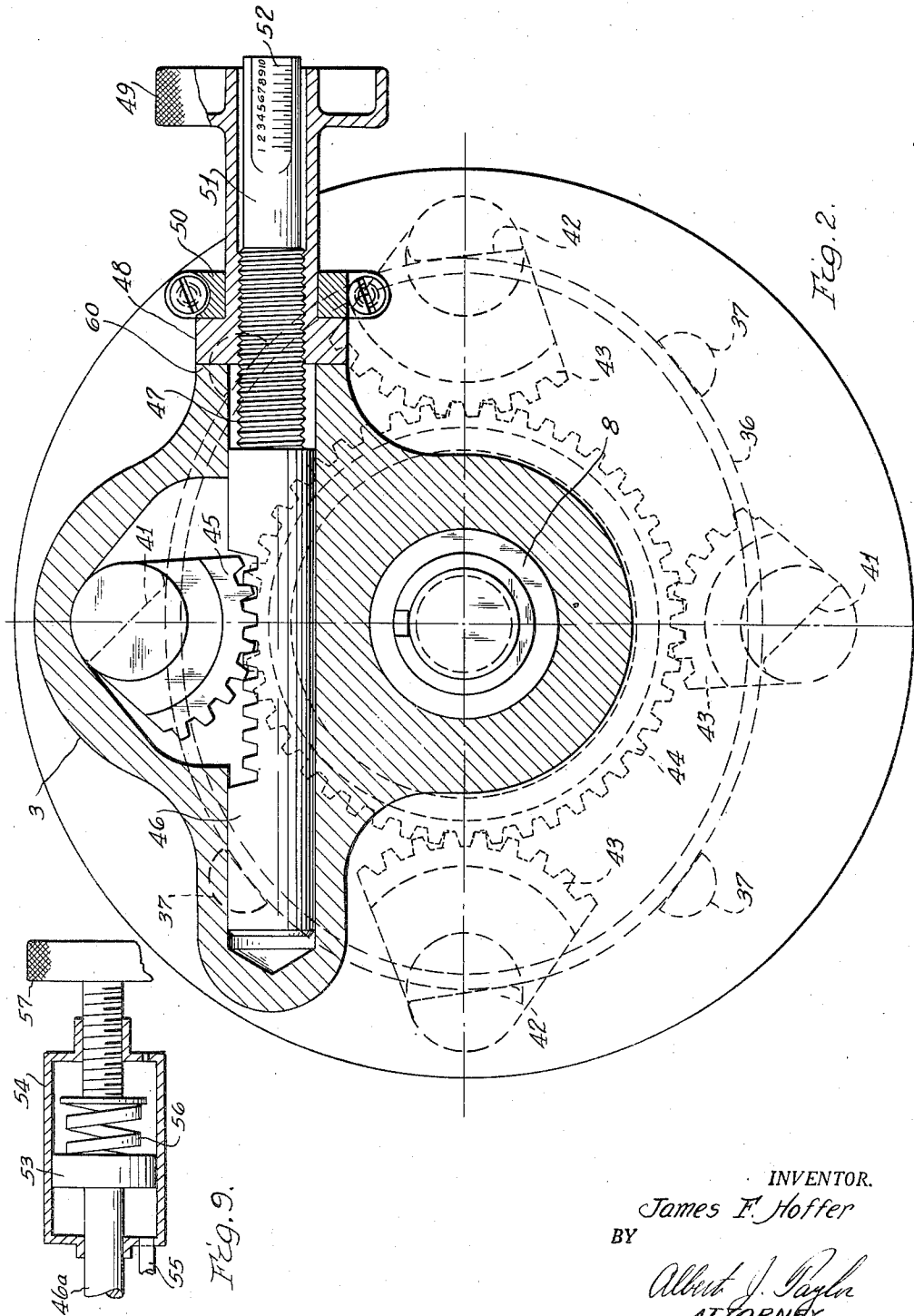
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7 Sheets-Sheet 2



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7 Sheets-Sheet 3

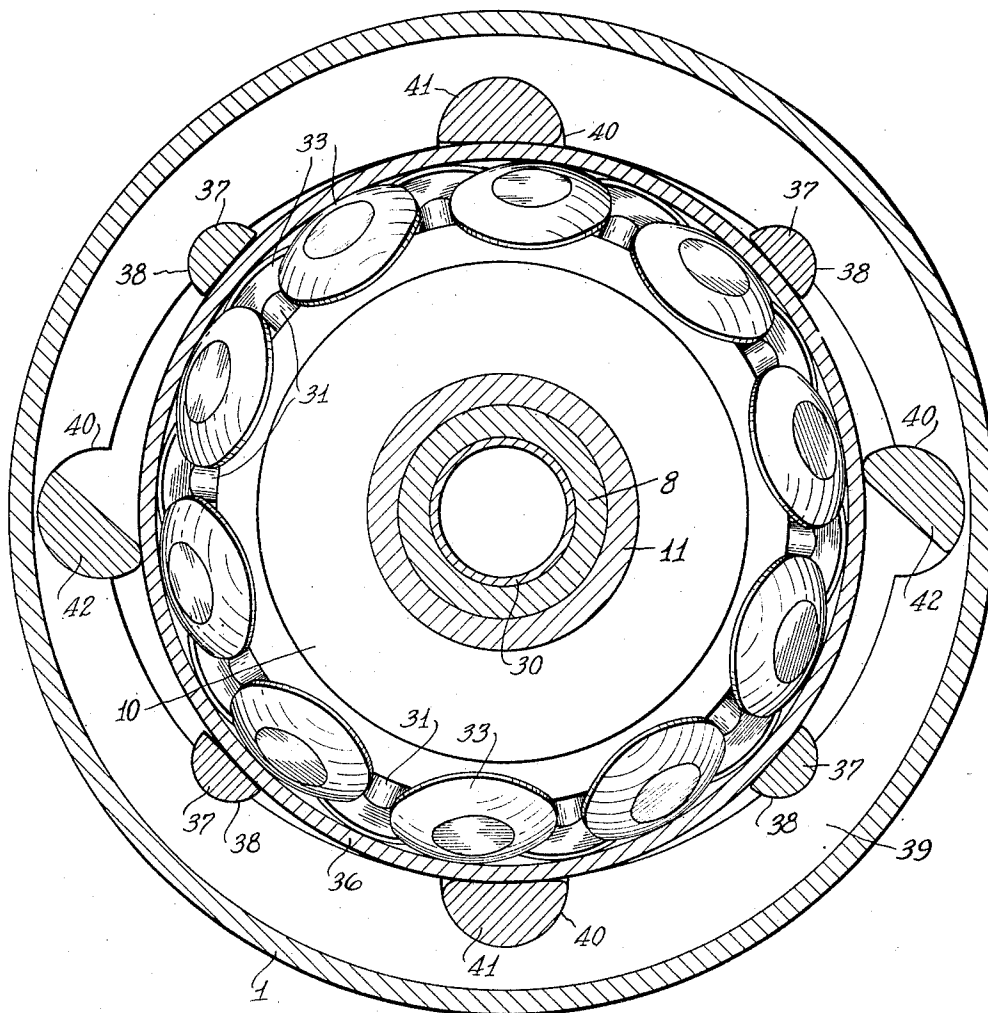


Fig. 3.

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7 Sheets-Sheet 4

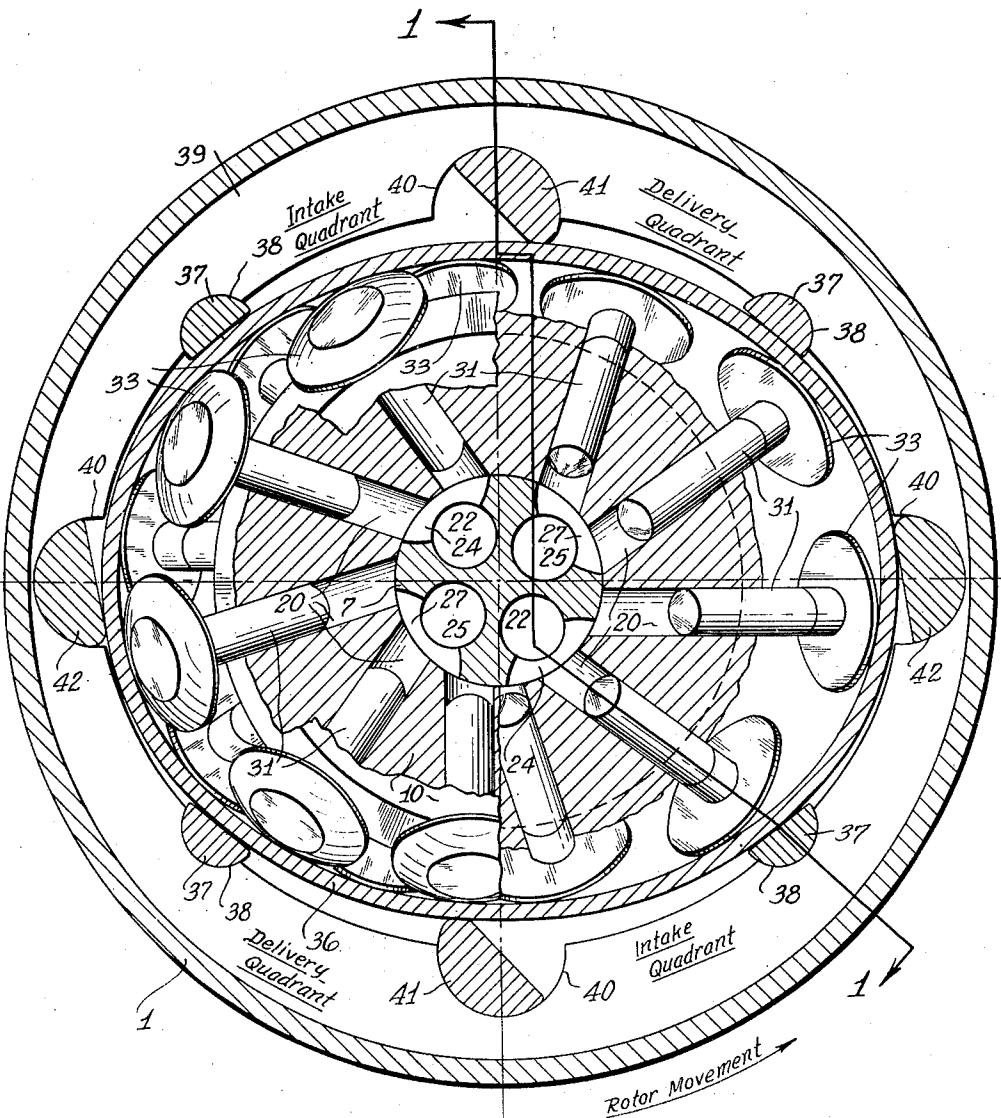


Fig. 4.

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7 Sheets-Sheet 5

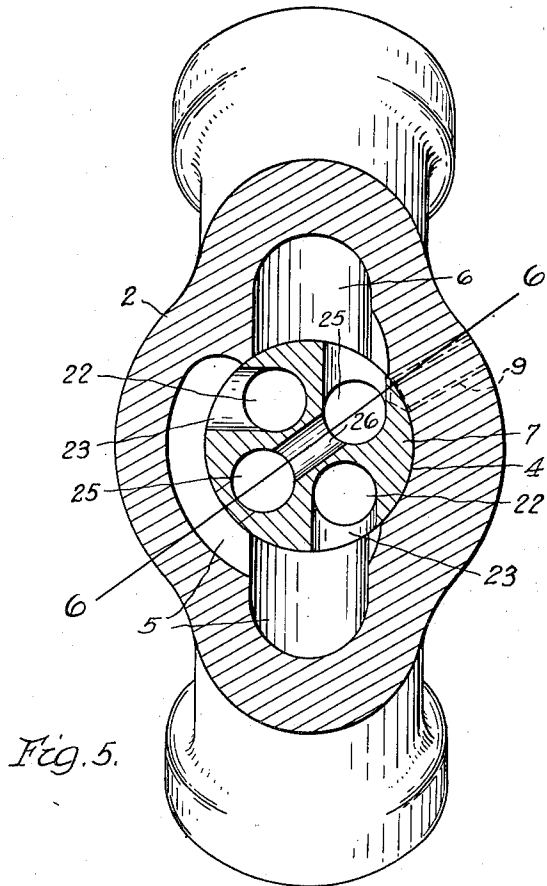


Fig. 5.

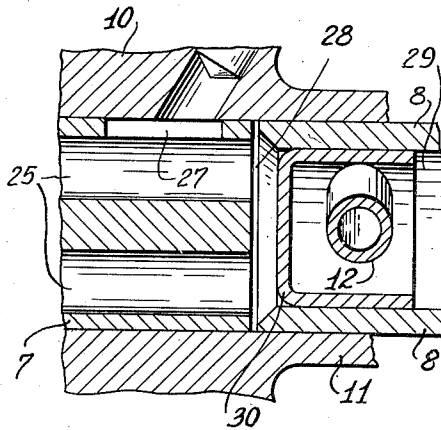


Fig. 6.

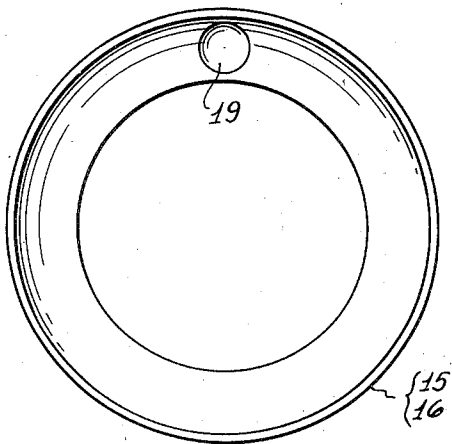


Fig. 7.

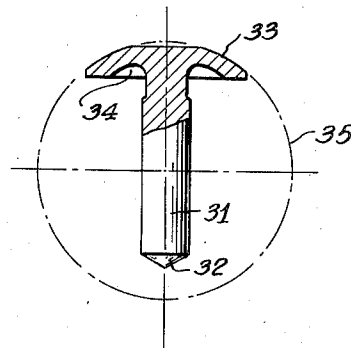


Fig. 8.

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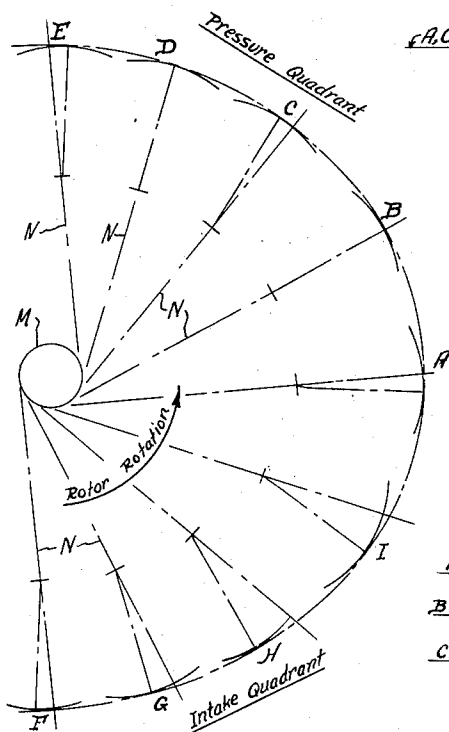


Fig. 10.

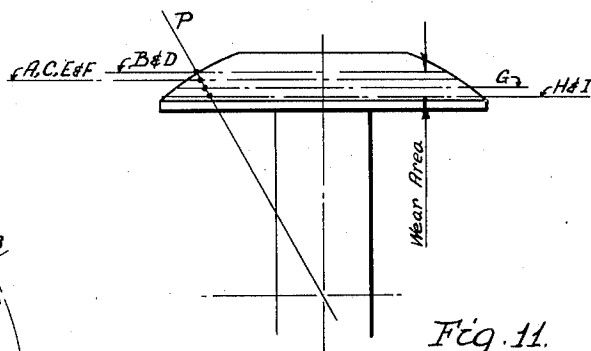


Fig. 11.

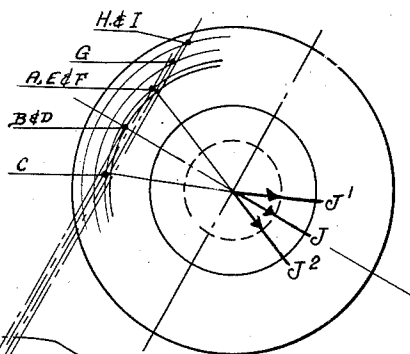


Fig. 12.

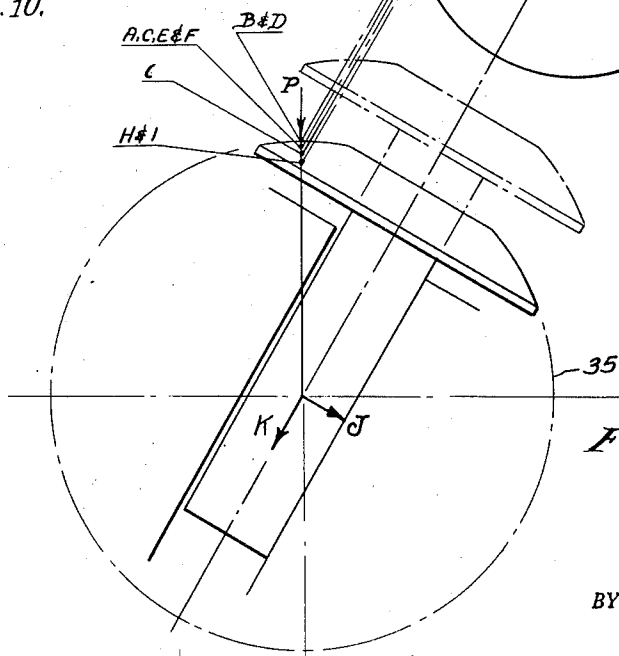


Fig. 15.

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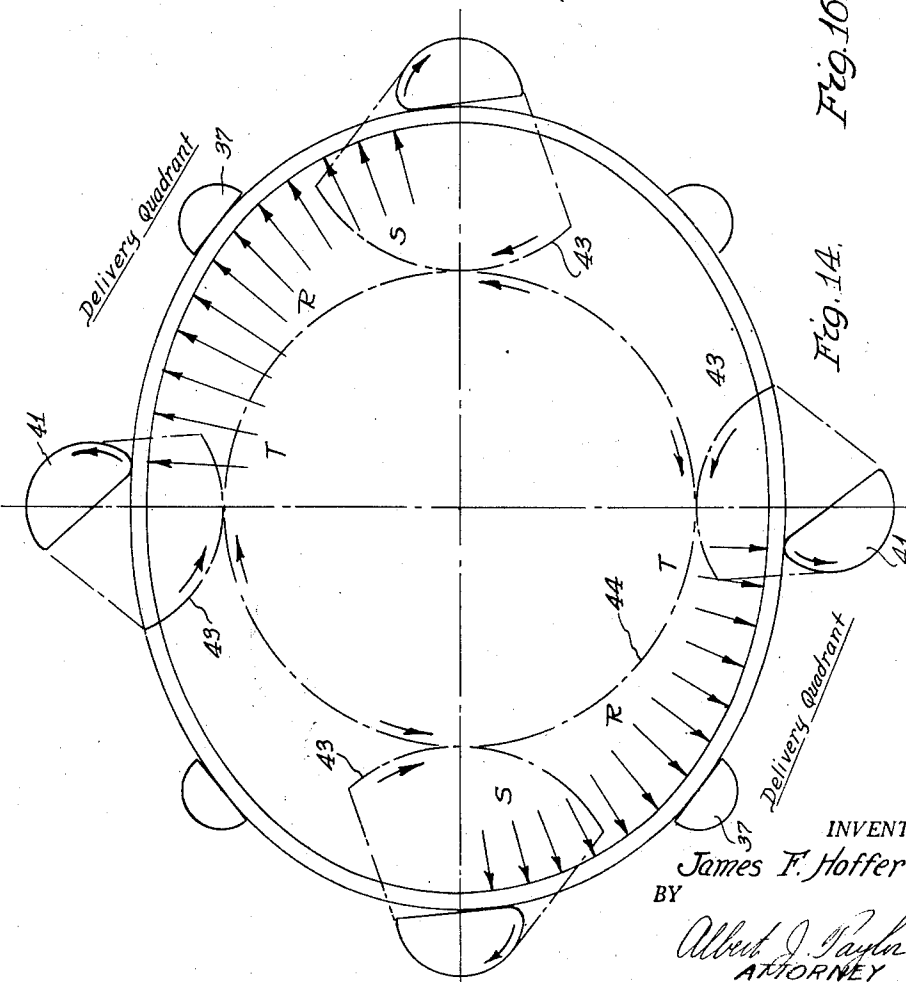
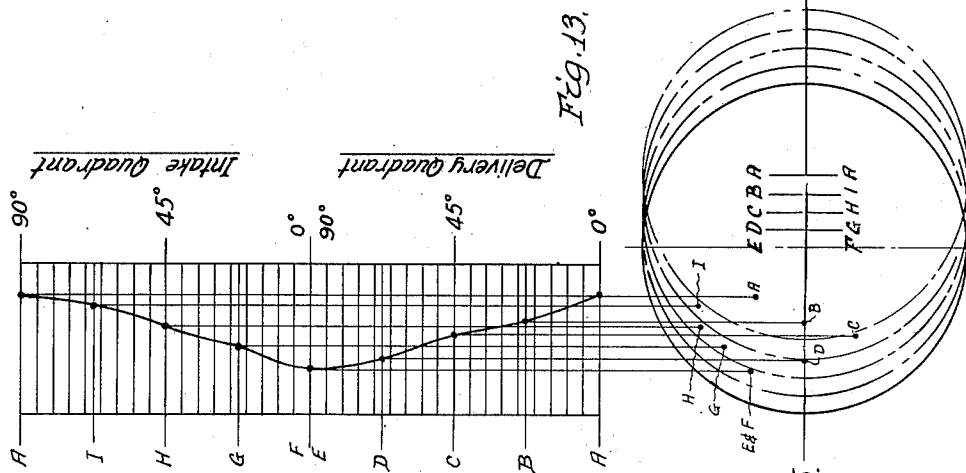
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James F. Hoffer, Detroit, Mich., assignor, by mesne assignments, to Superdrainic Corporation, Dearborn, Mich., a corporation of Michigan

Application December 31, 1941, Serial No. 425,090

9 Claims. (Cl. 103—161)

This invention relates to means for converting fluid pressure energy into work or work into fluid pressure energy. The means disclosed may be considered as being either a pump or a motor for the reason that it may be operated to pump fluids or it may be operated by a fluid under pressure to impart movement to a member. For convenience in describing the structure, its operation and its advantages, and in order to avoid confusion, the invention is referred to throughout the following description as a pump. It will be understood, however, that such reference is for descriptive purposes only and is not intended by way of limitation as to the possible uses of the device disclosed.

Generally described, the invention in the form herein disclosed provides a pump comprising a rotor, a multiplicity of substantially, but not exactly, radially extending pistons adapted to move outwardly by centrifugal force as the rotor revolves, a reaction ring for restricting outward movement of the pistons and adapted to force the pistons inwardly as the rotor carries the pistons through the intake and delivery zones, and means controlling the reaction ring in a manner such that its shape may be changed to vary the stroke of the pistons. By this reciprocating movement of the pistons fluid is taken from an inlet and delivered to an outlet. In the case of a motor, the conditions are exactly reversed, and the fluid is supplied under pressure and forces the pistons outwardly and by pressing against the reaction ring the pistons cause rotation of the rotor.

An important object of the invention is to provide a pump of the type above mentioned wherein the pistons operate somewhat on the principle of a rolling ball, so that they have rolling contact rather than sliding contact with the reaction ring. With such an action present the pistons necessarily rotate at the same time they reciprocate in their cylinders, and as is well known, such a movement is the same as that ordinarily used in lapping operations, during the "run-in" of a piston in its cylinder, for example. With such a movement present, adequate lubrication of the entire bearing surfaces of the pistons is assured, and the possibility of piston seizure or scuffing because localized generation of heat is practically eliminated. If, for example, a particle of dirt or other foreign matter became lodged between the cylinder wall and the piston, the heat generated thereby would be spread over a comparatively large area, and it could be much more readily expelled or reduced to harmless size without damage to the bearing surfaces than would be the case if such movement were not present. With respect to the rolling action, friction and wear of the pistons and reaction ring are obviously reduced to a minimum.

Another object is to provide a pump of the type above mentioned embodying a comparatively large number of relatively small diameter pump chambers and pistons. This arrangement is provided to insure a steady flow of fluid, free from objectionable pulsations and surges, both into and out of the pump. With this arrangement inlet cavitation difficulties are avoided, as well as the difficulties usually attendant where small quantities of gas out of solution are present in the liquid in the case of a liquid pump.

Another object is to provide a pump of the type above mentioned which is designed to reduce the effect of fluid compressibility to a minimum. Since even some oils are compressible to the extent of 1% for every 2800 lbs. pressure per square inch, it becomes an important consideration. In this respect a structure is provided in which the fluid volume between the plunger and the valve means is as nearly zero as practicable when the plunger is at that part of its travel nearest the valve means. At approximately this position the cylinder changes from the delivery valve means to the inlet valve means. When the piston is at that part of its travel farthest from the valve means the cylinder changes from inlet to delivery. The losses due to compressibility of the fluid are thus reduced because the fluid is substantially completely expelled from each cylinder with each delivery stroke of its piston.

Another object is to provide a pump of the character described embodying multiple banks of chambers and pistons with the banks inclined with respect to each other at angles which are equal and opposite. With this arrangement the end thrusts developed in one bank will counteract those developed in the other bank. The pistons employed have heads comprising substantially a zone of a sphere and the presence of the angularity above described has the further advantage that it places the pistons in a position such that they roll, rather than slide, over the contact surface of the reaction ring.

Another object is to provide a pump of the character described wherein the pump chambers are arranged with their axes in planes extending tangential to a reference circle having the axis of the rotor as its center. With this arrangement more favorable pressure angles are obtained than otherwise would be the case, as the pistons are forced inwardly by the reaction ring during their travel through the pressure quadrants. A further advantage in this respect is that it increases the tendency for the pistons to roll as above described rather than to slide over the contact surface of the pressure quadrant of the reaction ring.

Another object is to provide a reaction ring whose shape may be altered while the pump is in operation to regulate the stroke of the pistons in an infinitely variable manner. The reaction ring

comprises a spring of cylindrical shape, which shape is preferred because it may be finished to an extremely high degree of smoothness by conventional lapping processes. The ring shape is changed by the application of pressure on selected areas on its periphery, the preferred change being from circular to elliptical as viewed in transverse cross section because this shape provides two identical and opposite pressure quadrants, and two identical and opposite inlet quadrants. With this arrangement each plunger passes through two complete cycles for each revolution of the rotor. This arrangement obviously provides complete hydraulic and mechanical balance, both statically and dynamically.

Another object is to provide alternate means for changing the shape of the reaction ring, for regulating the stroke of the pistons. In one form the adjustment means is manually operable and has a visual indicator, whereas in the other case it is subject to control by fluid pressure, either the pressure developed in the pump or pressure from a remote source.

With the above and other objects in view the invention is more fully disclosed with reference to the accompanying drawings, in which

Fig. 1 is a longitudinal section taken substantially on the line 1-1 of Fig. 4,

Figs. 2, 3, 4 and 5 are transverse vertical sections, taken respectively on lines 2-2, 3-3, 4-4 and 5-5 of Fig. 1,

Fig. 6 is a fragmental section taken on a plane indicated by the line 6-6 of Fig. 5,

Fig. 7 is an elevation of a detail,

Fig. 8 is a view of a piston, partly in cross section,

Fig. 9 is a schematic view of a control mechanism, and

Figs. 10, 11, 12, 13, 14, 15 and 16 are diagrams used for purposes of explanation.

More specifically, 1 designates a cylindrical housing having end walls 2 and 3 secured thereto. The end wall 2 has a centrally disposed bore 4 with an inlet port 5 and an outlet port 6 communicating therewith. A stub shaft 7 is pressed into the bore 4 with a fit sufficiently tight to provide a fluid seal, as well as to prevent both rotary and lengthwise movement. The inner end of the shaft 7 projects axially into the housing 1 and constitutes a rotor support. As a safety measure against movement of the shaft 7 one or more dog point set screws may be used, as shown at 9.

A shaft 8 is rotatably mounted in the end wall 3 in coaxial relation with the shaft 7. A rotor body 10 is rotatably supported by the shaft 7 and has an extended portion 11 pressed on the shaft 8 to provide a fluid seal therewith. The rotor is secured to rotate with the shaft 8 by a pin 12, which is made hollow in order to reduce its weight, without reducing its keying surface as would be the case if it were made of smaller diameter.

As will hereinafter appear, the arrangement of the pistons is such that the end thrusts developed by their operation are entirely contained within the rotor, and the rotor does not exert any end thrusts on other parts of the structure. However, it is possible that end thrusts might come from an external source. For example, if the shaft 8 were to be driven by helical gears then an end thrust would be exerted by the rotor against the housing. The invention provides means for axially positioning the rotor with respect to the housing, which is also capable of opposing any end thrusts which might be present. This means comprises opposed, convex, spherical

bearing surfaces 13 and 14, formed on respective end walls 2 and 3. Ring shaped bearing members 15 and 16 are formed with concave surfaces for a slip-fit contact with the convex bearing surfaces 13 and 14, and also with flat bearing surfaces 17 respectively contacting flat bearing surfaces on opposite ends of the rotor 10.

The purpose of the spherical bearing surfaces is to enable the ring shaped bearings 15 and 16 to have perfect contact with both the end wall bearing surfaces and the rotor bearing surfaces. The ring shaped bearings and the rotor are formed of wear resistant metal while the housing and end walls 2 and 3 are preferably formed of a light metal such as aluminum and are, therefore, lacking in wear resistant qualities. In order to prevent the wear resistant metal rings 15 and 16 from turning in contact with the relatively soft spherical bearing surfaces 13 and 14 balls 18 are pressed into sockets in the end walls 2 and 3 and when the ring bearings 15 and 16 are assembled in place these balls project into recesses 19 in the ring bearings. The recesses 19 are larger in diameter than the diameter of the balls 18 and therefore the ring bearings may shift their position universally in an amount sufficient to enable perfect contact between their flat surfaces and the flat surfaces on the rotor.

The rotor 10 is provided with two banks of pump chambers 20, with the two banks including a like number of chambers, and with the chambers of one bank staggered circumferentially relative to those of the other bank. The chambers of one bank are inclined relative to those of the other bank, and the angles are equal and opposite. Loosely described the banks might be said to be in V relationship.

The shaft 7 is ported to provide communication between the pump chambers 20 and the inlet and outlet ports 5 and 6. The inlet means comprises two longitudinally extending bores 22 which communicate with the inlet port 5 through ports 23, shown more clearly in Fig. 5. The bores 22 also communicate with circumferentially extending inlet ports 24. As may be seen with reference to Fig. 4 the ports 24 are of a circumferential length such that all of the pump chambers located in the intake quadrant communicate therewith, while their length longitudinally of the rotor is such (see Fig. 1) that both banks of chambers communicate therewith.

The fluid outlet means comprises a pair of bores 25 which are connected by one or more transverse ports 26. The bores 25 open through the inner end of the shaft 7, into a space 28 (see Fig. 6) which is provided between the adjacent ends of the shafts 7 and 8, within the rotor 10. The two bores 25 communicate with circumferentially extending ports 27 (see Fig. 4) of a circumferential length such that all of the pump chambers located in the pressure quadrant may communicate therewith. As may be seen in Fig. 1, both banks of pressure chambers communicate with the ports 27.

The illustrated special construction of the shaft 8 is for the purpose of making the unit of as light a weight as possible. To this end the shaft 8 is bored axially at 29 to remove metal, and the bore is plugged with a sheet metal cup 30. The cup 30 has a press fit in the bore 29, which provides a fluid tight seal, and is positively held against movement by the driving pin 12.

In each pump chamber is disposed a piston. As shown in Fig. 8, each piston comprises a cylindrical shank 31 with a conically pointed end 32

and a mushroom type head 33. The head 33, as shown only in Fig. 8, is slightly hollowed at 34 so as to provide a smooth, rounded connection with the shank, the object being to avoid any sharp corners where concentration of stresses might occur. As may be seen by comparison with the reference circle 35 the piston head has the characteristics of a sphere. The piston might be imagined as being formed by removing metal from a sphere whose center falls on the axis of the shank. Were it not for the fact that the top of the head is flattened, the head could be termed the segment of a sphere. As it is, the head comprises a zone of a sphere whose center falls on the axis of the shank, at a point spaced from both of its ends.

From the description thus far, it will be apparent that as the rotor is revolved the pistons will tend to move outwardly under centrifugal force. Encircling the rotor is a reaction ring 36 with which the pistons contact as they move outwardly. The ring 36, as shown in an operative condition in Fig. 4, is of elliptical shape and therefore as the rotor revolves the pistons are alternately moved outwardly and inwardly as they move through the different quadrants of the reaction ring. These quadrants are designated intake and delivery quadrants for outward and inward movement respectively. The ports 24 and 27, as above described, are so arranged that the pump chambers communicate with the port 24 while in the intake quadrants, and the port 27 while in the delivery quadrants.

As hereinafter described, the reaction ring is of special construction, and it functions in combination with a specially constructed adjusting means to provide an infinitely variable regulation of delivery from zero to the maximum capacity of the pump. Use of this special reaction ring and its adjustment means produces advantageous results when combined with the novel pump mechanism above described, but it will be obvious to those skilled in the art that the principle upon which this reaction mechanism functions makes it adaptable for use with other special and conventional mechanisms such as vane pumps.

The reaction ring 36 is formed of spring steel, and in its original state is cylindrical as shown in Fig. 3. This shape has the advantage that the inner or contact surface of the ring may be finished to an extremely high degree of smoothness by conventional lapping methods, which is not true of an ellipse. The ring 36 is supported within the housing 1 by four bearing members 37 which comprise rods of semi-circular cross section. As may be seen from comparison of Figs. 1, 3 and 4, the round portion of the bearing members 37 rest loosely in notches 38 in internal ribs 39 in the housing 1, while their flat surfaces are contacted by the periphery of the reaction ring. The bearing members 37 are held against longitudinal displacement by the end walls 2 and 3 and are retained in their respective notches by the reaction ring. The bearing members 37 are free to move rotatively.

Four cams are rotatably mounted in notches 40 in the ribs 39. These cams are arranged in two sets of two cams, with the two cams of each set diametrically opposed with respect to the reaction ring. That is to say, two cams 41 of one set are arranged on a vertical diameter of the ring 36, and two cams 42 are arranged on a horizontal diameter. Each cam has a gear sector 43 connected thereto, and the four gear sectors thus provided all mesh with a ring gear 44, and

the cams are therefore geared together for simultaneous movement.

The cams 41 are so constructed that when they are rotated in a clockwise direction, by the means hereinafter described, they press against the periphery of the reaction ring and change its shape from circular to elliptical, as viewed in transverse section, or from the shape shown in Fig. 3 to that shown in Fig. 4. As the cams 41 are rotated as explained, the cams 42 rotate in a like direction but they are so constructed that such rotation moves them away from the reaction ring so that the ring may elongate to take an elliptical form.

The means for rotating the cams as above described comprises a gear sector 45 connected to one of the cams 41, and a transversely slidable rack 46 supported in the end wall 3 and meshing therewith. The rack 46 has a screwthreaded extension 47 engaged by a nut 48 having a hand knob 49. The nut 48 is held against lengthwise movement relative to the rack by a shoulder 60, on the end wall 3, and by a U-shaped bracket 50 secured to the end wall 3. The bracket 50 is secured to the end wall 3 by screws in order that it may be secured in place after the rack has been assembled in its support in the end wall. The rack 46 also has an extension 51 provided with graduations 52 which may be sighted over the face of the hand knob 49 to provide a visual indication of the stroke adjustment condition.

The controls above described function to regulate the rate of delivery, rather than the pressure of the fluid delivered. The stroke remains constant and at a given speed of rotation the pistons will deliver a given quantity of fluid, regardless of pressure. However the pressure is subject to regulation, if desired, by a simple mechanism schematically shown in Fig. 9. In this view the rack connector 46a corresponds to or may be considered as being connected to the rack 46, in which case the nut 48 will not be present, of course. The rack connector 46a is attached to a piston 53 which is slidably mounted in a cylinder 54. The piston 53 is adapted to be moved in one direction by fluid pressure entering the supply line 55, and such movement is opposed by a spring 56 whose pressure may be regulated by a manual regulator 47. The supply line 55 may be connected to a remote fluid pressure supply source, or it may be connected to the outlet port of the pump.

In operation, if the fluid pressure exceeds the spring pressure the spring yields and the rack is moved to shorten the pump piston strokes, and if the fluid pressure decreases the spring moves the rack and increases the stroke of the pistons. The pressure at which this action takes place may be selected by manual setting of the regulator 57.

In describing the operation, attention is first directed to the piston construction and the improved operating conditions resulting from the particular arrangement of the pistons in the rotor. The shank of each piston is comparatively small and the pump chambers are, of course, correspondingly small. The piston shanks are of a length such as to almost completely fill their respective chambers under maximum stroke conditions. They are made as long as possible without enabling them to project into and engage the lips of the inlet and outlet ports under maximum stroke conditions or when the pump is just starting to operate. By reducing unnecessary space as much as possible the tendency for loss of efficiency due to compressibility of fluids is reduced as much as possible.

The shank 31 of each piston constitutes a com-

paratively long bearing portion. As may be seen with reference to Fig. 15, contact between the head of the piston and the reaction ring exerts a force on the line P. Due to the spherical characteristics of the head of the piston, rolling contact with the reaction ring surface can only take place on a plane passing through the center of the spherical portion, which plane will always be perpendicular to the axis of the reaction ring. The force exerted on the line and in the plane P, is divided into two components K and J. Because the line P is disposed at an acute angle relative to the axis of the piston it is obvious that the component K has a much higher value than the component J. The shank is so constructed that the point of intersection of the line P with the axis of the piston is well spaced from both ends of the shank and therefore there is no tendency for the piston to cock and cause uneven wear or unfavorable operating conditions.

Another condition illustrated in Fig. 12 is that the point of contact between the piston head and the reaction ring is always spaced from the axis of the piston shank, so that such contact will cause rotation of the piston.

As may be seen in Figs. 3 and 4, the pump chambers do not extend exactly radially, or in other words, their axes do not intersect the axis of the rotor. This condition is made clearer by the diagram Fig. 10, in which it may be seen that the axes N of the several pump chambers all extend tangentially to a reference circle M having the axis of the rotor as its center. This provides more favorable operating conditions in the delivery quadrant than otherwise would be the case. If, for example, the chambers were disposed in a radial plane, the most favorable or most direct application of pressure would occur at the points A and E of the delivery quadrant, because at these two points the force exerted by the reaction ring would be in a plane containing the axis of the piston. But at the very beginning and the very end of the pressure quadrant very little pumping action takes place. The most unfavorable condition would, in that case, fall in the vicinity of a point halfway through the delivery quadrant, or at approximately the point C. By shifting the axes as here disclosed the most favorable application of pressure takes place at two points in the delivery quadrant, namely B and D. The pressure conditions are improved at the point C, where it otherwise would be poorest, while efficiency is slightly reduced at the points A and E. The overall efficiency is increased, however, because that which is gained from the points B through C to D more than offsets that which is lost at the points A and E where actually little or no work is performed.

The improvement in pressure conditions in the delivery quadrant is reflected in poorer conditions in the intake quadrant, but as no pressure is exerted inwardly by the reaction ring, other than to counteract centrifugal force, this condition actually results in an advantage in that it distributes wear over a greater area of the valve head than otherwise would be the case. This is explained with reference to the diagrams in Figs. 10, 11 and 12 wherein the points of contact referred to find their basis in Fig. 10.

As above pointed out, the contact between the valve head and the reaction ring will always be a point in the plane P. When the piston is in either the position B or D the inclination shown in Fig. 15 results in contact on the circumferential line B and D of Fig. 11. When in the posi-

tion A, C, E and F the contact is on the circumferential line A, C, E and F. When in the position G, the contact will be on the circumferential line G, and when at H and I the contact will be on the line H and I. This condition is further illustrated in Fig. 12 where the projected points of contact may be readily seen to be widely spaced so as to distribute the wear over a comparatively wide area.

Referring to Figs. 12 and 15, it will be seen that when pressure is exerted against the point B and D, A and C or F and E, the component J shifts to the point J¹ or to the point J² so that in addition to the rotary movement above described there is also a shifting of the pressure application which results in more favorable wear conditions.

As may be seen from examination of Fig. 15, the piston reciprocates inwardly and outwardly while its axis remains at an angle of approximately 30° and therefore it also shifts laterally as viewed in plan. In the diagram Fig. 16 the piston is shown in positions corresponding to points A, B, C, D and E of its travel through the pressure quadrant. In its travel through the intake quadrant the position of the piston at points F, G, H, I and A is the reverse of the positions in the order designated with respect to the delivery quadrant. Examination of Fig. 10 will reveal that an exact correspondence is not present, but it is believed to be sufficiently close for purposes of explanation.

The points of contact from A to I have been indicated on the piston according to its position in the diagram and are projected onto the developed reaction ring shown in Fig. 13 where similar divisions corresponding to the points from A to I are indicated. This serves to illustrate the path of contact between the piston and the reaction ring. It will be observed that the path shifts laterally from the vertical plane of the point A to the plane of E and F, which is a substantial width in comparison with the other parts of the structure. The importance of this characteristic is in the consideration of elimination of wear.

Figs. 3 and 4 illustrate the fact that the reaction ring is not positively connected to the housing. Actually, the structure is so designed that in the presence of sufficient forces the reaction ring may move rotatively. It does not rotate freely, however, but rather might be said to creep at a rate of say one complete revolution for several hours operation of the pump. If the reaction ring were held stationary the natural tendency would be for the piston to wear a track in the reaction ring of a form such as shown in Fig. 13. However, with creep present this "track" continually changes with respect to the reaction ring and the wear conditions are very much improved.

Fig. 14 diagrammatically illustrates the pressure conditions in the reaction ring in so far as they react against the reaction ring adjusting means, the forces being indicated by pressure arrows. It will be noted that the outward pressure of the pistons in the vicinity of the pressure arrows R press the ring against the supports 37 and such forces are directly opposed by the housing without influencing the adjustment means. In the vicinity of S the pressure tends to expand the reaction ring and to cause clockwise rotation of the cams 42, while in the vicinity of T the forces tend to cause counter-clockwise rotation of the cams 41. Inasmuch as the cams

41 and 42 are all geared together and can only rotate in unison, the forces which tend to rotate the cams oppositely are almost completely balanced in the ring gear and therefore do not tend to influence the adjustment means.

Balance is a very important factor in a pump of the character here disclosed. An examination of Figs. 1 and 3 and the description which precedes reveals that the pump is balanced both mechanically and hydraulically, and further description in this respect is deemed unnecessary.

Although a specific embodiment of the invention has been illustrated and described, it will be understood that various structural changes may be made without departing from the spirit of the invention as defined by the appended claims, and such changes are contemplated.

I claim:

1. In a device of the class described, a rotor having a chamber therein, fluid inlet and outlet means for said chamber, a piston having a shank disposed in said chamber and having an exposed bearing portion, an elliptical reaction member encircling said rotor and adapted to contact said bearing portion said member comprising a continuous spring band, and means for varying the ellipticity of said band.

2. A device of the character described comprising a rotor with a cylindrical chamber therein and having a reciprocating plunger means movable inwardly and outwardly within said chamber during operation, a reaction member encircling said rotor and with which said plunger means contact, said reaction member comprising a continuous, circular, impervious spring band of uniform and uninterrupted cross section supported concentric with said rotor, and means bearing against said band for exerting pressure at selected areas on the periphery thereof to flex said band and change its shape from circular to noncircular as viewed in transverse cross section.

3. In sub-combination, a reaction member and adjustment means therefor, said reaction member comprising a flexible cylindrical body, and means for exerting pressure at selected areas on the periphery of said cylindrical body to alter its shape from circular to non-circular as viewed in transverse cross section, said last named means comprising a multiplicity of rotatable cams adapted to contact said ring at circumferentially spaced points, a gear sector connected to each cam, a gear connecting all gear sectors, and fluid pressure actuated means for moving said gear and sectors rotatively.

4. In a device of the class described, a rotor, radially movable liquid impelling means carried by said rotor, a continuous spring band surrounding said rotor with which said liquid impelling means coact to provide a pumping action, a multiplicity of band flexing means disposed on radii of said band and each adapted to act upon the periphery of the band to change the length of the radius upon which it is disposed to thereby vary the shape of the band, and means on other radii of said band engaging the periphery of the band and maintaining the radii on which they are disposed substantially constant while the lengths of other radii are varied by said flexing means.

5. In a device of the character described, a casing, a rotor in said casing, radially movable liquid impelling means carried by said rotor, a resiliently flexible reaction ring surrounding said rotor and with which said liquid impelling means

coact to provide a pumping action, said casing having a multiplicity of arcuately shaped grooves, cam members disposed in said grooves and contacting said reaction means in such manner that the ring retains the cam members in the grooves, means for moving said cam members rotatively in said grooves to cause them to flex said ring, said casing having a second multiplicity of grooves, and bearing members in said second grooves and contacting said ring in such manner that said ring retains the bearing members in their respective grooves.

6. In a device of the class described, a rotor having a chamber therein, fluid inlet and outlet means for said chamber, a piston having a shank disposed in said chamber and having an exposed bearing portion, an annular reaction member encircling said rotor and adapted to contact said bearing portion, said member comprising a continuous spring band, and means for varying the annular contour of said band.

7. A device of the character described comprising a rotor with a cylindrical chamber therein and having a reciprocating plunger means movable inwardly and outwardly within said chamber during operation, a reaction member encircling said rotor and with which said plunger means contact, said reaction member comprising a continuous, circular, impervious spring band of uniform and uninterrupted cross section supported concentric within said rotor, and means bearing against said band for exerting pressure at selected areas on the periphery thereof to flex said band and change its shape from circular to non-circular as viewed in transverse cross section, the construction of said band and its bearing relation to said last named means being such as to permit creepage of said band about its axis.

8. In a device of the class described, a rotor, radially movable liquid impelling means carried by said rotor, a continuous spring band surrounding said rotor with which said liquid impelling means coact to provide a pumping action, a multiplicity of band flexing means disposed on radii of said band and each adapted to act upon the periphery of the band to change the length of the radius upon which it is disposed to thereby vary the shape of the band, and fixed stops on other radii of said band engaging the periphery of the band and maintaining the radii on which they are disposed substantially constant while the lengths of other radii are varied by said flexing means.

9. In a device of the class described, a rotor having a cylindrical chamber therein, a shaft upon which said rotor is rotatively mounted and having fluid inlet and outlet ports therein communicable directly with said chamber, plunger means disposed within said chamber and movable inwardly and outwardly thereof during operation, a reaction member encircling said rotor and with which said fluid displacement means contact, said reaction member comprising a continuous, circular, impervious spring band of uniform and uninterrupted cross section supported within concentric with said rotor, and means bearing against said band for exerting pressure at selected areas on the periphery thereof to flex said band and change its shape from circular to noncircular as viewed in transverse cross section.

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