

Nov. 18, 1947.

J. F. HOFFER

2,431,176

PUMP STRUCTURE

Filed Sept. 12, 1945

3 Sheets-Sheet 2

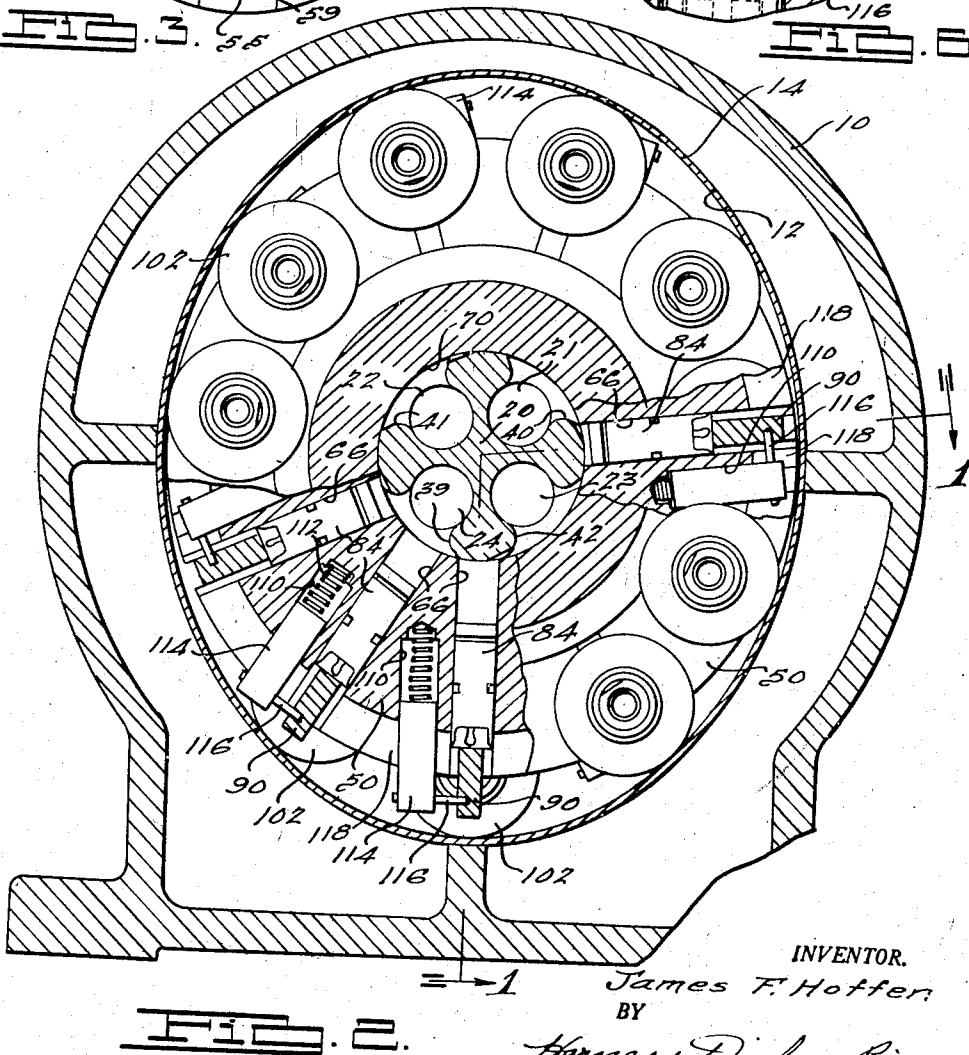
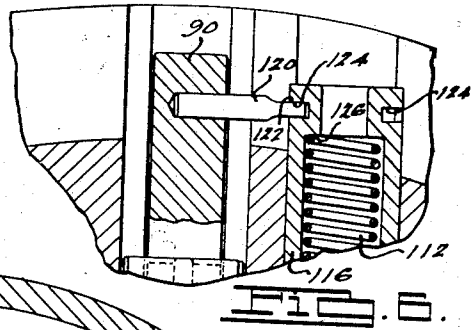
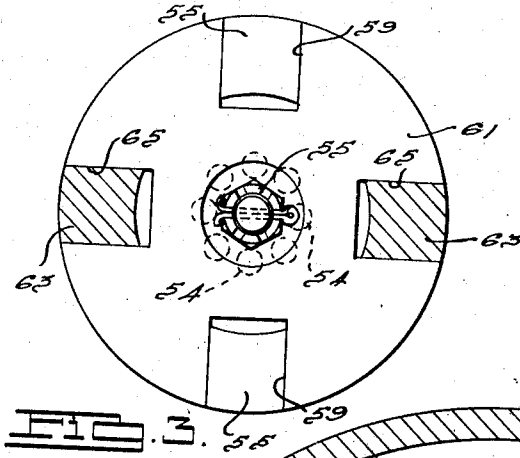


FIG. 2.

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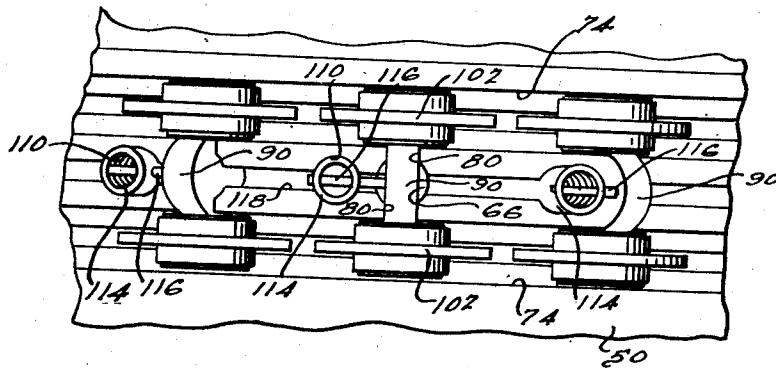


FIG. 4.

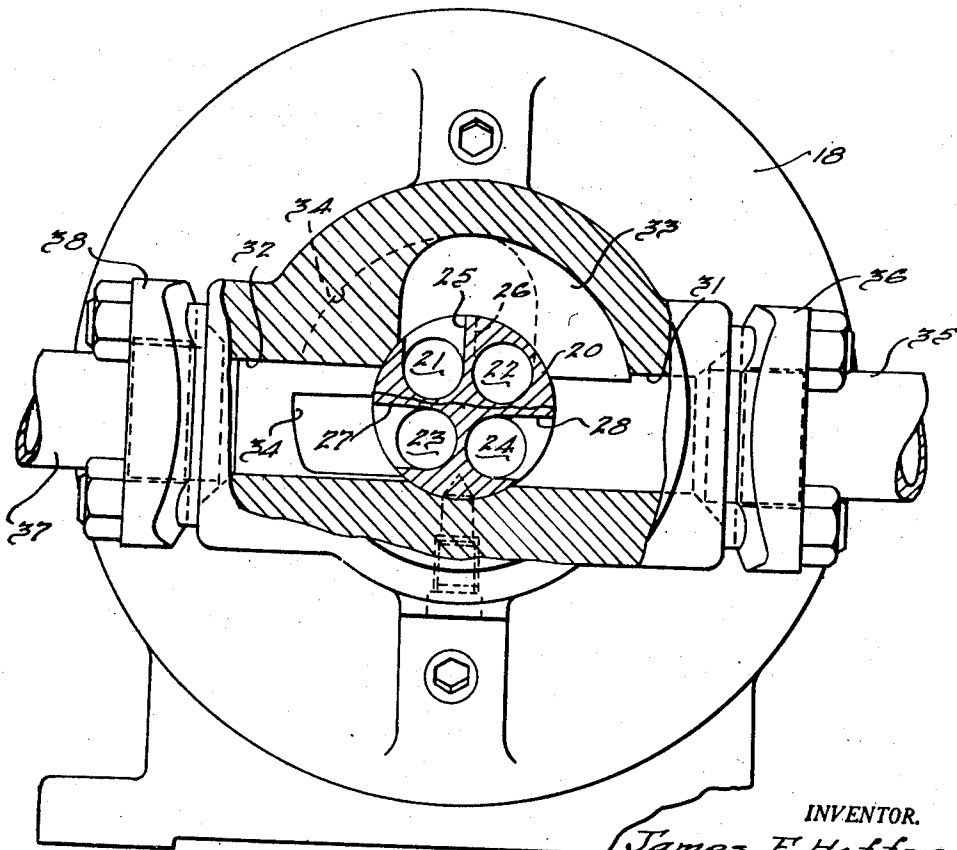


FIG. 5.

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UNITED STATES PATENT OFFICE

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PUMP STRUCTURE

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Application September 12, 1945, Serial No. 615,793

6 Claims. (Cl. 103—161)

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The present invention relates to improvements in pumps or motors, and particularly to improvements in high pressure, plunger type pumps or motors.

One of the primary objects of the present invention is to provide improvements in the plunging action of pumps or motors of the type mentioned.

A further object of the invention is to provide improvements in the means for resiliently urging the piston to its outer position of such a nature that there is no binding action on either the spring or the plunger mechanism during movement thereof.

A further object of the invention is to provide an improved construction of the type mentioned in which the spring is offset to one side of the line of action of the plunger and is arranged with respect thereto to remove surges in the spring.

A further object of the invention is to provide improvements in the connection between the spring and the means connecting the plunger to a reaction member so that the equalized loading on the means connecting the plunger to the reaction member is not disturbed and so that there is no bearing taken away, either from the plunger or the means connecting the plunger to the reaction member.

A further object of the invention is to provide improvements in the spring actuation of the plunger and its connection thereto which is of a relatively simple and economical construction, as compared to the required valving without the spring.

Other objects, advantages and features of the invention will become clearly apparent from the following specification, the drawings relating thereto, and from the claims hereinafter set forth.

In the drawings, in which like numerals refer to like parts in the different views:

Figure 1 is a side elevational view with parts broken away and parts in section, taken substantially along the line 1—1 of Fig. 2, showing a pump embodying features of the present invention;

Fig. 2 is a cross-sectional view taken substantially along the line 2—2 of Fig. 1, and having parts broken away in different longitudinal planes, and illustrating parts of the internal mechanism in elevation and section;

Fig. 3 is a cross-sectional view taken substantially along the line 3—3 of Fig. 1, on a reduced scale;

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Fig. 4 is a fragmentary, elevational view of a portion of the rotor and the plunging actuating mechanism;

Fig. 5 is an end elevational view of the structure shown in Fig. 1, taken from the left end thereof, with parts broken away and showing parts in cross-section; and

Fig. 6 is a partial cross-sectional view of a modified construction for interconnecting the axle with the spring plunger.

The present invention is here illustrated in connection with the pump disclosed in the copending application of James F. Hoffer, Serial No. 541,167, filed June 20, 1944. It is particularly applicable to the plunger actuating mechanism there disclosed and claimed. The pump there disclosed is a constant delivery pump and it will be appreciated that the structure of the present invention, including the plunger action, may also be employed in a variable delivery pump of the type disclosed in the copending application of James F. Hoffer, Serial No. 425,090, filed December 31, 1941, Patent No. 2,393,059. That is, the present invention is applicable where a flexible reaction ring is employed with means associated with the reaction ring to vary its cross-sectional contour and thereby vary the delivery rate.

Referring to the drawings, a pump embodying features of the present invention is illustrated, and such a pump includes a housing having a central section 10 having open ends and formed with inwardly directed flanges 12 having the inner surfaces thereof elliptical in shape, as best seen in Fig. 2. A reaction member 14, also elliptical in shape, is disposed within the housing 10 and bears against the inner surfaces of flanges 12. End housing members 16 and 18 are secured to opposite sides of the central section 12 by means of suitable screws or the like and serve to enclose the housing.

The housing 18 serves to provide the inlet and outlet ports for the pump and also serves as the mounting for a stationary or fixed pintle 20 which is fixedly mounted within an axial opening 19 formed in housing 18.

The pintle 20 is formed with longitudinally extending, separate passageways 21, 22, 23, and 24 therealong which terminate adjacent one end to close that end of the passage and which are plugged by means of individual plugs at the other end of the passageway, as in the Hoffer application Serial No. 541,167, above mentioned.

Inlet and outlet ports are formed through the walls of the pintle communicating with their respective passageway. Inlet ports 25 and 28 com-

municate with inlet passageways 21 and 24, respectively; and outlet ports 26 and 27 communicate with outlet or pressure passageways 22 and 23, respectively. Ports 25 and 28 are offset along and around the axis of the pintle with respect to each other; and ports 26 and 27 are offset along and around the axis of the pintle with respect to each other. Ports 27 and 28 are aligned, with respect to the longitudinal axis of the pintle and with respect to each other.

The member 18 has an axial bore 19 within which one end of the pintle 20 is received; and has a transverse bore forming an inlet passageway 31 and an outlet passageway 32 (Fig. 5). The inlet passageway 31 communicates directly with intake port 28 and communicates through an angled, cored passageway 33 with intake port 25. Pressure port 27 communicates directly with outlet passageway 32, and the passageway 32 communicates with pressure port 26 through an angled, cored passageway 34.

An inlet conduit 35 leads from a supply tank to the inlet 31 and is connected thereto by means of a coupling 36. An outlet or pressure conduit 37 communicates with outlet 32 and is connected to the housing 18 by means of a coupling 38. The conduit 37 then leads to the work mechanism (not shown).

The opposite end of the pintle 20 has a pair of ports 39 communicating with inlet passageway 24 which are longitudinally spaced with respect to each other, and has another pair of diametrically opposed, longitudinally spaced ports 40 which communicate with passageway 21. The pintle 20 also has a pair of longitudinally spaced pressure ports 41 which communicate with passage 22 and has another pair of diametrically opposed pressure ports 42 which communicate with passageway 23. One of each of the pairs of ports 39, 40, 41 and 42 lies in the same transverse position and the other of each of the pairs lies in another, same transverse position, there being one of the pairs for one of the banks of plungers and the other of the pairs for another bank. This will be more apparent from the description to follow.

Each of the pressure ports 41 and 42 is formed with a central groove or slot 43 on the leading edge, each groove being of gradually increasing depth therearound, as described in Hoffer application Serial No. 541,167.

The pintle 20 projects inwardly of the housing 10 axially thereof and serves to rotatably support a pump rotor 50. The rotor 50 is driven by a drive shaft member 52 which is connected thereto by means of a universal coupling including member 53 which is pinned to the shaft 52 by pins 54 and a lock nut 55. The face of member 53 is formed with diametrically spaced projections 55 thereon which are slidably received in diametrically opposed slots 59 formed in a coupling ring 61. The rotor 50 has diametrically opposed projections 63 formed thereon which are slidably received in diametrically opposed slots 65 in the ring 61. Slots 65 are spaced ninety degrees from slots 59.

The drive shaft 52 extends through a central axial opening in the housing member 16 and is rotatably supported therein by means of ball bearing assemblies 56. The shaft projects outwardly beyond the housing member 16 and is connected to a suitable drive means. An oil seal 57 is disposed within the opening of an end cap 58, which is secured to the housing member 16, and bears against the drive shaft in the usual way.

The rotor 50 is formed with a plurality of banks of radially disposed bores 66 and 68, the bores 66 of one bank being uniformly disposed about the rotor and the bores 68 of the other bank also being uniformly disposed about the rotor, but the bores 68 of the second bank being spaced to follow the bores 66 of the first bank a distance, for example, of about three-eighths the distance between the bores 66 of the first bank where there are eleven bores in each bank. By having the bores of one bank so offset with respect to the bores of the other bank, separate portings spaced at equal decrements results. The bores 66 overlie and communicate with one of the pairs of ports 39, 40, 41 and 42; and the bores 68 overlie and communicate with the other of the pairs of ports. It will, therefore, be understood that separate intake and pressure ports, communicating with separate inlet and outlet passageways in the pintle, are provided for each of the banks.

However, a detailed description of the construction and arrangement of the plungers and means interconnecting the plungers with the reaction member 14 of one of the banks or of one of the plungers will be sufficient for an understanding of the construction and arrangement of the other plungers and their interconnecting means. The plungers and interconnecting means are the same as those disclosed in detail in Hoffer application Serial No. 541,167, and reference may be had thereto for a detailed description. The rotor 50 has a central opening 70 therethrough which rotates on the pintle 20 with one end of the rotor running against the adjacent face of housing member 18 and the other end connected to the drive 52. The rotor 50 is formed with axially spaced, annular grooves 74 which form therebetween outwardly directed annular flanges 76 and 78, the flanges 76 having the bores 66 for one of the banks of bores formed therethrough and the flanges 78 having the bores 68 for the other bank of bores formed therethrough. The bores 66 extend completely through the rotor 50 from the outer end thereof through opening 70 and are of uniform diameter throughout their length. In the flange portions of the rotor, such as flange 76, transverse slots 80 are cut through the bores 66 in the flange portion, in a direction transverse to the direction of rotation of the rotor, providing parallel faces 82 on opposite sides of each bore. The purpose of the slot and parallel faces 82 will be more apparent from the latter description.

A cylindrical plunger 84 is disposed within each of the bores 66 (and also each of the bores 68). Such plungers 84 are adapted to reciprocate within their bores as the rotor 50 rotates and are moved outwardly by centrifugal force caused by such rotation and also by the action of the spring structure to be hereinafter described. The axial movement or position of the plungers is controlled through a connection between the outer ends of the plungers and the reaction member 14 as the rotor 50 rotates.

The plunger 84 is formed with an annular, pressure-balancing recess 86 and is flat at its inner end. At the outer end it is formed with an integral projection 88 which is generally circular in cross section and which extends completely across the top of the plunger.

Means are provided for interconnecting each plunger 84 with the reaction member 14 of such a character that there is practically no side loading of the plunger and also of such a character that it is self-aligning at all times whereby the

plunger load is equally divided on roller means which engage the reaction member.

Thus, interconnecting means include an axle or equalizing member generally indicated at 90. Such axle 90 is ruggedly constructed and includes a central portion having flat parallel sides and having the outer end crowned. The outer sides of member 90 are formed to provide bearing trunnions 94 with the inner surfaces thereof flattened for proper lubrication. The central portion 92 is formed with a transversely extending recess 98 which is complementary in transverse section to the transverse sectional shape of projection 88 and is adapted to slidably receive the projection 88 therein. The recess 98 is formed in the direction of rotation of the rotor, and when positioned in the rotor the projection 88 extends in the same direction. The flat sides of central portion 92 are adapted to bear against the parallel sides 82 of slot 80 in the rotor as the plunger reciprocates.

Rollers or wheels 102 are rotatably mounted on the trunnion portions 94 of the axle 90, through bearing sleeves when assembled. The trunnions and wheels are received within the annular groove 74 with the peripheral portions of the wheels received within annular grooves 106 formed in the bases of groove 74.

Means are provided for lubricating the wheels through the plungers, as in Hoffer application Serial No. 541,167.

In assembly, the axle 90 is slidably mounted to the projection 88 on the plunger 84. This slidable connection will permit a slight aligning movement between axle 90 and plunger 84 in the direction of rotation of the rotor. The connection between groove 98 and projection 88 will permit a slight rocking action of the axle so that the wheels 102 are self-aligning in their engagement with the reaction member 14 as the rotor rotates.

Due to the self-alignment of the axle member 90 in its interconnection between the plunger 84 and the reaction member 14, there is practically no side loading on the plunger during rotation of rotor 50. The axle 90 is free, in a limited way, to slide and rock, in planes at right angles to each other, with respect to the plunger 84 and also with respect to the engaging surfaces 82. As the plunger 84 is caused to reciprocate within its cylinder 66, the forces applied to the plunger are directly along its axis. Since the bore 66 is of uniform diameter throughout its length, the piston 84 is completely supported throughout its stroke; that is, the outer portion of bore 66 engages the piston 84 when the piston is at the outer end of its stroke and such piston is supported completely along its length throughout its stroke.

According to the present invention, spring means are employed which are connected to each of the axles 90, and through such axles connected to pistons 84, to urge the pistons outwardly. Such means includes the provision of bores 110 in the rotor 50, there being one of such bores 110 for each of the bores 66 and parallel thereto. A coil spring 112 is disposed in each of the bores 110 with the inner end of the spring abutting against the bottom of the bore and with the outer end received within a tubular member 114. Each tubular member is slidably received within its bore 110 and is urged to its outer position by its spring 112. The tube is guided by the side walls of its bore 110 so that its movement is along the axis of the bore.

The bores 110, as mentioned above, are parallel to their respective bores 66, and the center lines of bores 110 are disposed in the same plane of rotation as the center lines of bores 66. A rigid pin 116 interconnects the outer end of each sleeve 114 with its adjacent axle 90. The pin is located at the transverse center of the axle 90 and is received within a pivot opening therein. The outer end of each spring may be confined by abutment against that portion of the pin 116 which extends across the sleeve 114. An annular groove 118 is formed around the rotor 50 in the plane of the axes of bores 66 and 110 to permit the in and out movement of the pin 116.

By having the pin so connected and located with respect to the axle 90, it does not interfere at all with the rocking and aligning action of the interconnecting means for the plunger. Thus, there is equal loading on the rollers 102. The action of each spring 112 on its sleeve 114 is along a line parallel to the axis of movement of the plunger 84. The connection between the sleeve 114 and the axle 90 is such that there is no binding action on either the spring or the plunger mechanism when the axle rocks. Furthermore, with the spring offset to one side of the bore 66, surges in the spring are removed. With the spring offset from the axial bore there is a small component of the centrifugal force acting on the spring at right angles to the axis of the spring in the plane of rotation thereof causing it to bear against the guide bore, thus creating friction between the spring and its guide bore which dampens out any surges having a tendency to develop in the spring. The percentage length of the spring within its guide bore varies throughout the plunger stroke which further tends to dampen out surge.

Referring to Fig. 6, a modified interconnection between the axle 90 and its adjacent sleeve 114, a pin 120, corresponding to pin 116, is received with an opening at the transverse center of axle 90. The outer end of the pin is flattened on the top and bottom as indicated at 122 and the flat portions project within an annular groove 124 formed in the sleeve 114 adjacent the top thereof. The sleeve is also formed with an annular shoulder 126 against which the upper end of spring 12 abuts.

In the operation of the device above described, oil enters through conduit 35 into passageway 31 and into intake passageways 21 and 24. Passageway 21 communicates with bores 66 and 68 through ports 40; and passageway 26 communicates with such bores at a diametrically opposed position. Pressure passageway 22 communicates with the cylinder bore 66 and 68 through pressure ports 41; and pressure passageway 23 communicates with such cylinder bores through pressure ports 42. Pressure ports 41 and 42 are diametrically opposed. It will be understood that by the elliptical construction of the reaction member 14 with the axis of rotation of the rotor centrally disposed, there will be two intake strokes and two delivery strokes of each plunger for each rotation of the rotor. With the intake strokes occurring in opposite quadrants and the delivery strokes in opposite quadrants, the pumping forces are, therefore, balanced.

The ports are so arranged that the plungers are in their innermost positions as they approach suction ports 39 and 40 and move outwardly in passing across such ports to an outermost position prior to reaching the leading edges of pres-

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 sure ports 41 and 42. In passing across the pressure ports, the plungers are moved inwardly so that the oil collected in the bores inwardly of the plungers is discharged under pressure through such ports into the pressure passageways 22 and 23 and passes out of the pressure ports 26 and 27 through passageway 32 into conduit 37.

It will be appreciated that as the plungers 84 leave the following edges of the pressure ports that there will be a certain amount of trapped oil under pressure between the inner end of the plungers and the peripheral surface of the pintle. The lands, or spaces, on the peripheral portions of the pintle between the following edges of the pressure ports and the leading edges of the intake or suction ports are of such length as to permit enough travel of the rotor to allow the plungers to move outwardly so that the pressure of the trapped oil is reduced to a point that when the bores communicate with the intake passageways there will be an equalizing of pressure which will prevent hydraulic hammer.

The grooves 43 in the leading edges of the pressure ports are such as to provide bleeding communication between the pressure ports and the bore spaces inwardly of the plunger as the plungers move toward and across the pressure ports. These grooves serve to gradually equalize the pressure in the pressure port and that of the trapped oil in the space inwardly of the plunger at this stage to eliminate hydraulic hammer.

What is claimed is:

1. In a fluid displacement structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, means interconnecting the outer end of each plunger with the reaction member to control the axial movement of said plunger, and resilient means connected to said plunger to resiliently urge said plunger outwardly, said resilient means being offset to one side of said plunger and acting along a line offset and parallel with respect to the axis of radial movement of said plunger.

2. In a pump structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, an axle extending transverse to the direction of rotation of the rotor for each plunger, means on said axle adapted to engage said reaction member to control the axial movement of said plunger, means connecting the axle to the outer end of the plunger, said last named means being constructed to permit limited relative movement between the axle and the plunger in all directions except axially of the plunger, and resilient means connected to said axle at substantially the transverse center thereof to resiliently urge said plunger outwardly, said resilient means being positioned offset to one side of said plunger and acting along a line offset and parallel with respect to the axis of movement of said plunger.

3. In a pump structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, an axle extending transverse to the direction of rotation of the rotor for each plunger, means on said axle adapted to engage said reaction member to control the axial movement of said plunger, means connecting the

axle to the outer end of the plunger, and resilient means connected to said axle to resiliently urge said plunger outwardly, said resilient means being offset to one side of said plunger and acting along a line offset and parallel with respect to the axis of radial movement of said plunger.

4. In a pump structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, an axle extending transverse to the direction of rotation of the rotor for each plunger, means on said axle adapted to engage said reaction member to control the axial movement of said plunger, means connecting the axle to the outer end of the plunger, and resilient means connected to said axle at substantially the transverse center thereof to resiliently urge said plunger outwardly, said resilient means being offset to one side of said plunger and acting along a line offset and parallel with respect to the axis of radial movement of said plunger.

5. In a pump structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, an axle extending transverse to the direction of rotation of the rotor for each plunger, means on said axle adapted to engage said reaction member to control the axial movement of said plunger, means connecting the axle to the outer end of the plunger, another bore formed in said rotor adjacent each of said first named bores and parallel thereto, a coil spring disposed in each of said last named bores, a sleeve slidably received in each of said last named bores and embracing the outer end of each spring, said spring acting to resiliently urge said sleeve outwardly, and a pin connecting the outer end of each sleeve with said axle.

6. In a pump structure, a housing, a reaction member disposed within said housing, a rotor having radial bores disposed within said housing, a plunger in each bore, an axle extending transverse to the direction of rotation of the rotor for each plunger, means on said axle adapted to engage said reaction member to control the axial movement of said plunger, means connecting the axle to the outer end of the plunger, said last named means being constructed to permit limited relative movement between the axle and the plunger in all directions except axially of the plunger, another bore formed in said rotor adjacent each of said first named bores and parallel thereto, a coil spring disposed in each of said last named bores, a sleeve slidably received in each of said last named bores and embracing the outer end of each spring, said spring acting to resiliently urge said sleeve outwardly, and a pin connected to the outer end of each sleeve and pivotally connected to said axle at substantially the transverse center thereof.

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REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Name	Date
1,612,888	Schneggenburger	Jan. 4, 1927
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2,276,368	Benedek	Mar. 17, 1942

Certificate of Correction

Patent No. 2,431,176.

November 18, 1947.

JAMES F. HOFFER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 2, line 23, for "Patent No. 2,393,059" read *Patent No. 2,383,059*; column 5, line 6, for "ortion" read *portion*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 3rd day of February, A. D. 1948:

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.