Feb. 22, 1949. E. A. CUNY 2,462,725

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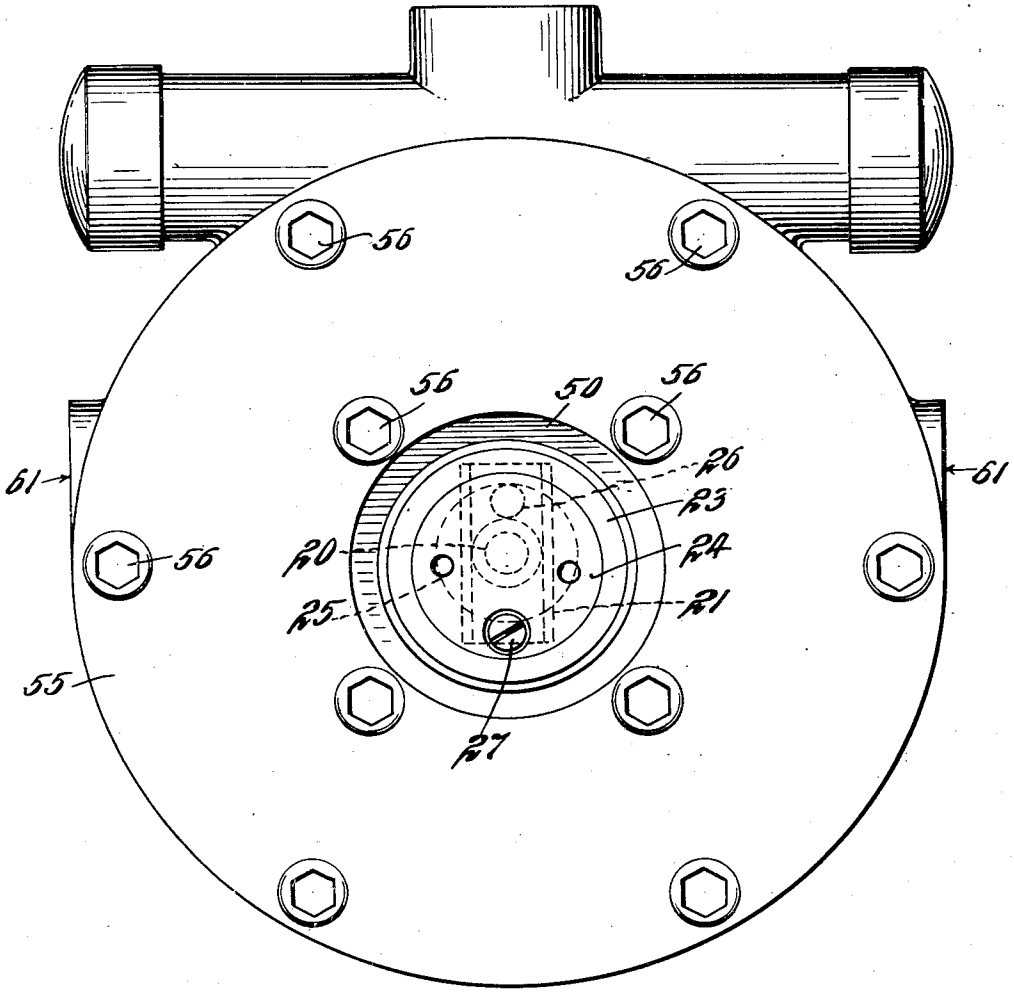


Fig. 1.

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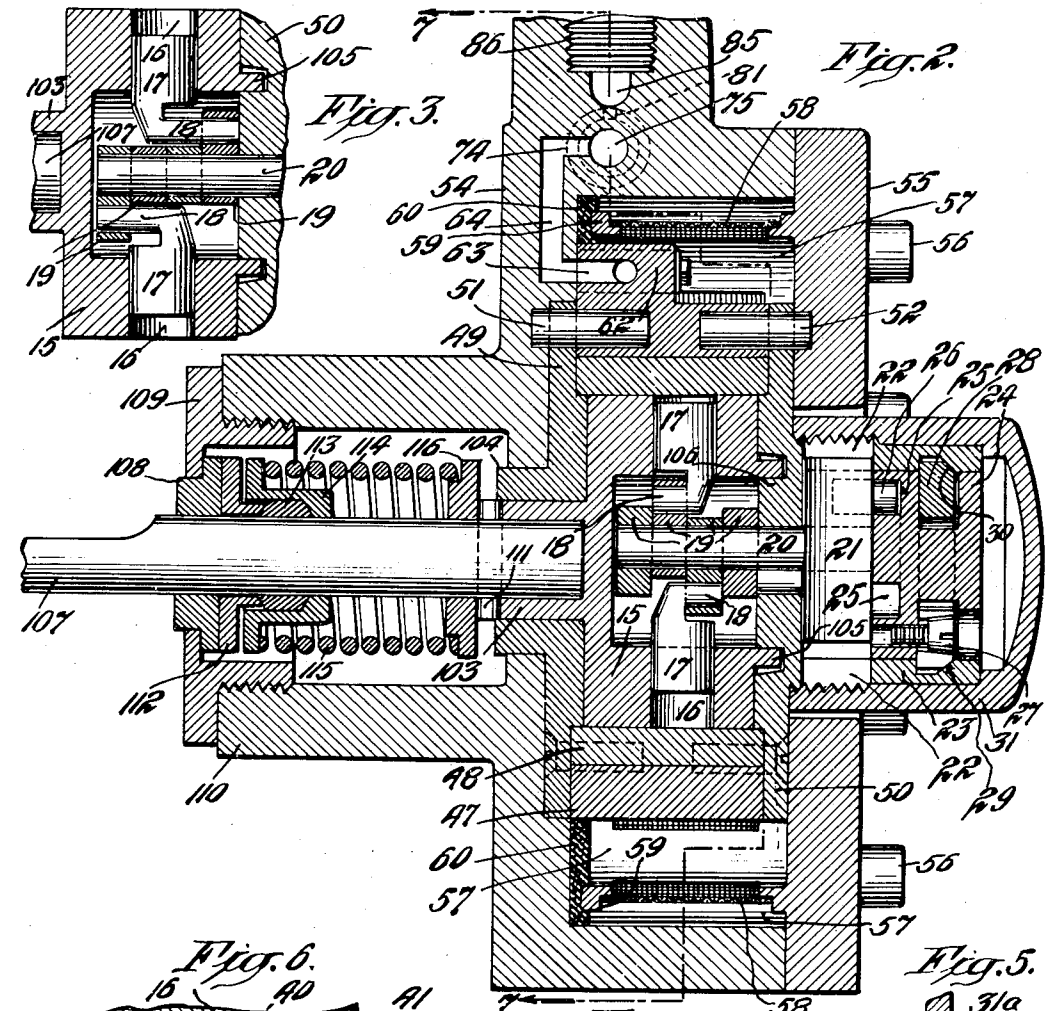


Fig. 3.

Fig. 2.

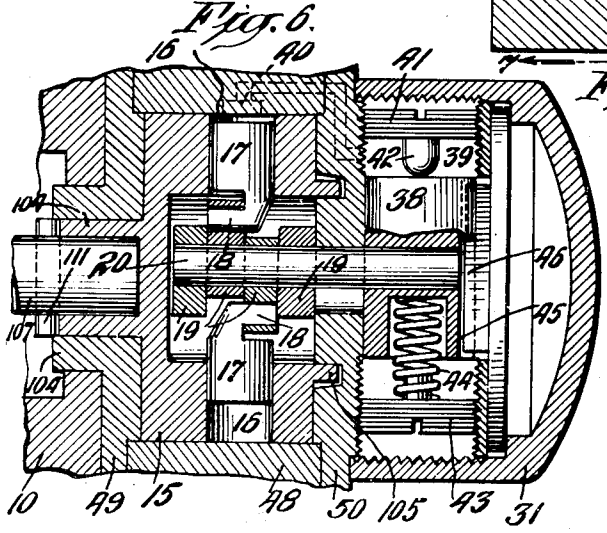


Fig. 6.

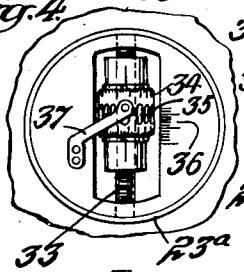


Fig. 4.

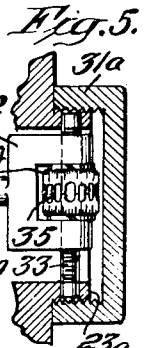


Fig. 5.

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Fig. 7.

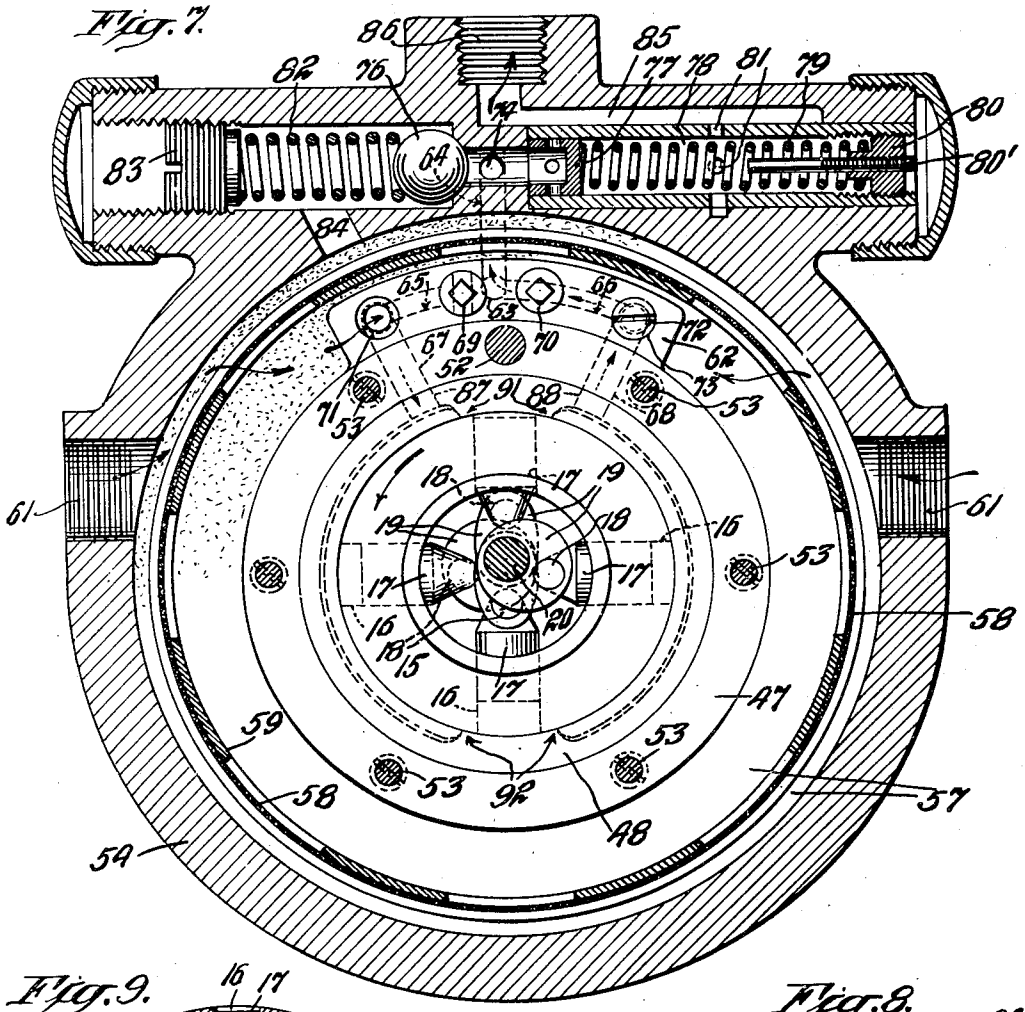


Fig. 9.

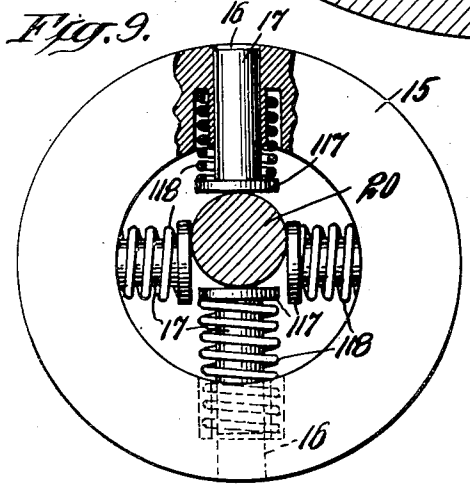
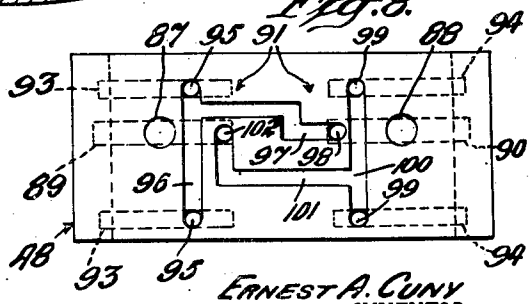


Fig. 8.



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Fig. 10.

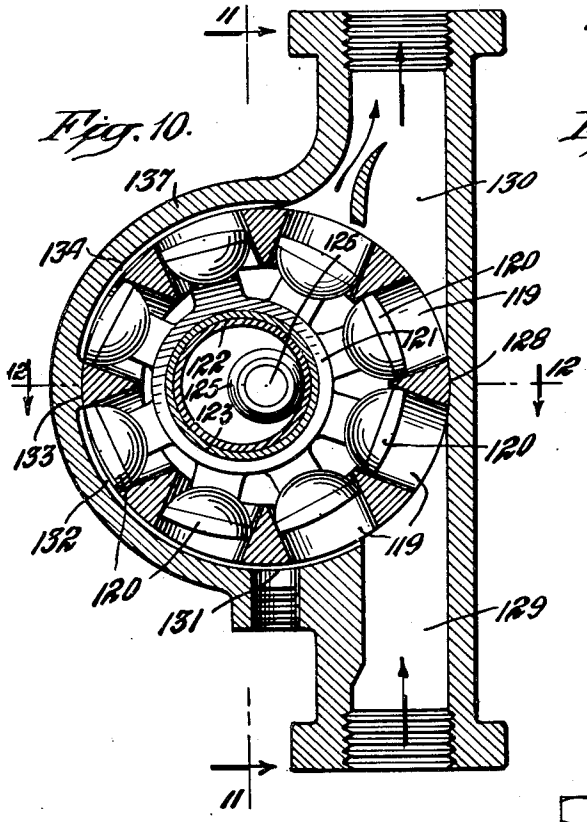


Fig. 11.

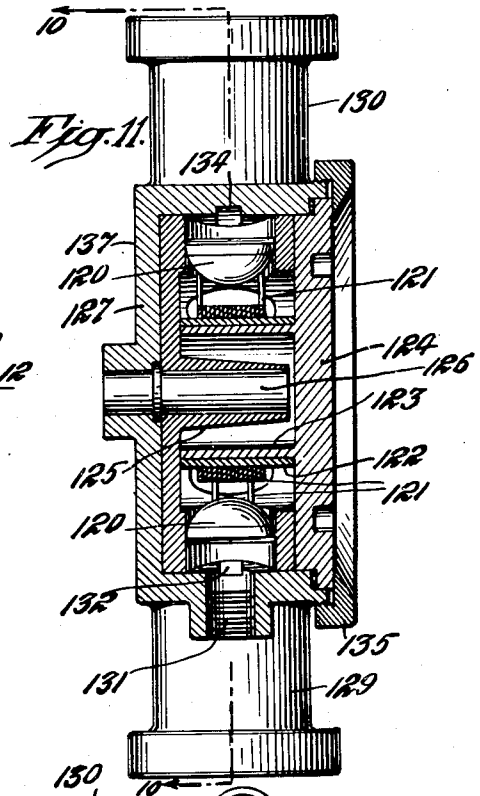


Fig. 13.

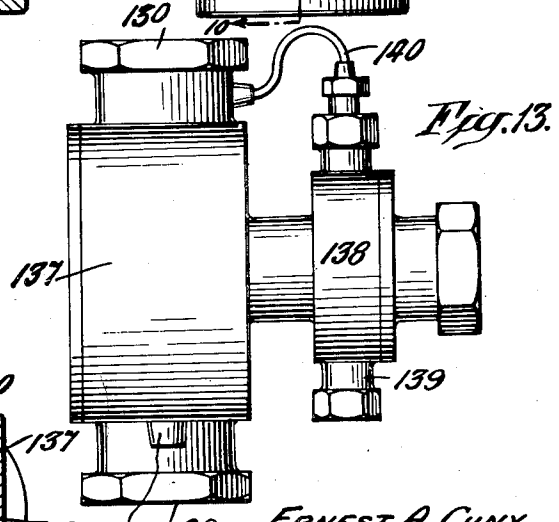
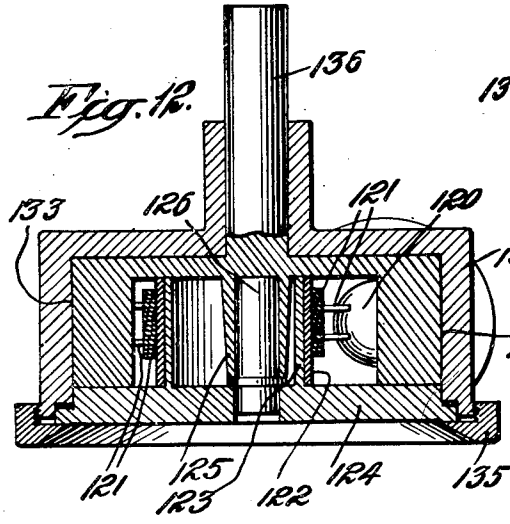


Fig. 12.



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UNITED STATES PATENT OFFICE

2,462,725

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Application December 18, 1945, Serial No. 635,645

12 Claims. (Cl. 103—161)

1

The invention here disclosed relates to fluid displacement devices in the nature of rotary pumps.

Objects of the invention are to provide a pump of this type which will be of simple, practical construction, efficient in operation for either pressure or high vacuum, consist of but few rugged parts and which with all its advantages may be produced at relatively low cost.

Special objects of the invention are to balance the operating parts to accomplish smooth, quiet, easy operation and to avoid any improper loading of the pumping elements.

A related object is to effect balance of pressures in a way to maintain a floating operation of the rotor and the full lubrication of all operating parts.

Further special objects are to provide for adjustment of both or either volume and pressure and to enable accomplishment of such adjustment or adjustments while the machine is in operation.

Another special object is to provide an automatic pressure relief and return of practical design and incorporated within the pump structure, thus avoiding use of the usual return lines or the like.

Another special object is to provide an automatic pressure relief and return of practical design and incorporated within the pump structures, thus avoiding use of the usual return lines or the like.

Other objects are to provide the pump structure in the form of a unit adapted to be operated as such or, if desired, to be incorporated in a special case and in conjunction with the latter feature, to provide ample intake and screening facilities, the possibility of operating in either direction of rotation and the provision of an effective, self-adjusting rotary seal.

Other desirable objects and the novel features through which the purposes of the invention are attained are set forth or will appear in the course of the following specification.

The drawings accompanying and forming part of the specification illustrate several of the present practical embodiments of the invention but it is to be understood that structure and operation may be modified and changed as regards the immediate disclosure, all within the true intent and broad scope of the invention as hereinafter defined and claimed.

Fig. 1 in the drawing is a front elevation of one of the pumps with the cap at the center removed to show the stroke adjusting mechanism and with certain parts broken and appearing in section;

Fig. 2 is a broken vertical sectional view on substantially the plane of line 2—2 of Fig. 1;

Fig. 3 is a broken sectional detail taken on a horizontal plane to show the other two pistons not appearing in Fig. 2;

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Figs. 4 and 5 are broken front and vertical sectional views, respectively, of another form of stroke setting mechanism;

Fig. 6 is a broken vertical sectional view of a form of automatic, pressure regulated, stroke setting mechanism;

Fig. 7 is a vertical sectional view as on substantially the plane of line 7—7 of Fig. 2;

Fig. 8 is a top plan view of the liner constituting the cylindrical pump chamber and provided with the pressure relieving and balancing passages;

Fig. 9 is a part broken sectional end elevation of a modified form of rotor and piston combination;

Fig. 10 is a vertical sectional view of another, multiple piston form of the pump, this view appearing as taken on substantially the plane of line 10—10 of Fig. 11;

Fig. 11 is a vertical sectional view as on substantially the plane of line 11—11 of Fig. 10;

Fig. 12 is a horizontal sectional view as on substantially the plane of line 12—12 of Fig. 10 but showing this form of the pump as shaft driven instead of fluid actuated as in Figs. 10 and 11;

Fig. 13 is a plan view showing the motor type of pump illustrated in Figs. 10 and 11 directly coupled to operate a smaller chemical proportioning or metering pump.

The form of the invention first illustrated comprises an annular cylindrical form of rotor 15 having four radially extending pumping cylinder passages 16 in which operate pistons 17 having rectangular extending pins 18 at the inner ends of the same pivotally engaged in short connecting links 19 which in turn are pivotally engaged over a relatively stationary crank pin 20.

As best shown in Figs. 2, 3, 6 and 7, the connecting links 19 are disposed in side-by-side relation on the crank pin 20 and the pins 18 at the inner ends of the piston are formed as integral rigid extensions of the pistons, two of them, as in Fig. 2, projecting laterally far enough to reach only the two innermost links and the other two, as in Fig. 3, reaching past the intermediate links 19 into engagement with the outermost or end links. In this manner all four pistons are freely reciprocated in the operation of the rotor and to an extent determined by the relative eccentricity of the crank pin 20.

In Figs. 1 and 2 the crank pin 20 is shown carried by and projecting from a cross slide 21 shiftable in a radial guide opening 22 in the stationary hub portion 23 of the pump.

In these views adjustment of the pin carrying slide 21 is effected by turning a disc 24 rotatably supported in the hub 23 over the slide, as by

means of a spanner wrench or like tool, said disc having in its inner face an eccentric groove 25 receiving the pin 26 on the slide.

The stroke adjusting disc 24 is secured in set position in the Figs. 1 and 2 construction by tapered screw 27 entered through the outer face of the disc between the ends of a split expansion ring 28 seated in annular groove 29 in the disc and having a conical wedging engagement in the wall of the hub at 30. This provides a simple, secure means for locking up the disc in any position of rotary adjustment between zero and maximum eccentricity of the crank pin 20.

These adjustments may be made while the machine is in operation. Normally these parts are covered and protected by screw cap 31 removably engaged over the hub 23.

Figs. 4 and 5 illustrate a modification of the stroke or volume adjusting means embodying the mounting of the crank pin 20 on a yoke 32 having its arms slidingly engaged over a diametrical screw stud 33 fixed in the hub portion 23a with a micrometer screw 34 on the stud between the arms of the yoke having an index line 35 to register on a stationary scale 36 graduated in volume or other units. This micrometer screw is shown as secured in the position of adjustment by a spring detent 37.

Automatic adjustment of the pumping stroke and hence effective displacement, is accomplished in the Fig. 6 embodiment by constructing the cross slide carrying the crank pin 20 as a piston 38 operating in a transverse cylindrical chamber 39 in the hub and subjected to the developed pumping pressure through the porting indicated in dotted lines at 40. A screw plug 41 closing the end of the pressure cylinder over the head of the piston carries a stop projection 42 limiting the out-stroke or maximum displacement position of this control piston and a screw plug 43 in the opposite end of the piston chamber provides an adjustable abutment for the spring 44 thrusting the piston toward the stop 42.

By adjustment of the stop screw plug 41 the maximum displacement position of control piston 38 may be set to determine the maximum pumping stroke of the pistons 17 and by adjustment of the other screw plug 43 the tension of spring 44 may be adjusted to determine the maximum pressure to be developed by the pump.

The control piston 38 is shown slotted in the outer side at 45 to slide over a transverse guide rib 46.

The cylindrical pumping chamber in which the rotor operates is shown as made up of outer and inner cylindrical members 47, 48, and end plates 49, 50, doweled together at 51, 52 and held by screws 53.

This, with the enclosed parts constitutes a substantially complete pump unit which may be used as such or which may be embodied within a suitable pump casing to constitute, in effect, a removable and replaceable pump unit.

In the illustration the pumping unit is shown enclosed within a pump casing made up of a body section 54 carrying the shaft bearing and necessary connections for piping and a complementary cover section 55, these receiving the ends of the dowels 51, 52, Fig. 2, and being secured together by bolts or screws 56.

This arrangement provides opportunity for a large annular intake chamber 57 completely about the enclosed pump unit and the provision of a cylindrical screen 58 carried by the perforate annular wall or flange 59 projecting inwardly

from the cover, about the pump unit and making sealing engagement at its inner edge with a gasket or packing 60 against the back of the intake chamber. This intake chamber is shown in Fig. 7 as having inlets 61 in both sides of the same, either one or both of which may be used, one being closed, as by screw plug, when only one is being used.

To provide for operation with rotation in either direction, the outer ring 47 of the pump unit is shown as equipped with an arcuate manifold extension 62 having an outlet port 63 in the back to register with an upwardly extending passage 64 in the casing, Fig. 2, and branches 65, 66, extending to said outlet port from the radial, inwardly extending passages 67, 68.

The branch passages 65, 66, have plug valves 69, 70, therein which, as shown in Fig. 7, may be set to close off one branch passage, such as 65, from the outlet 63 and to leave the other passage, such as 66, opened up to the outlet 63.

The branch passages 65, 66, further have portions 71, 72, opening through the front of the manifold into the screened inner port of the intake chamber 57 and adapted one or the other to be closed as by a screw plug 73.

In the illustration, Fig. 7, where the rotor is turning counter-clockwise as indicated by the arrow, the port 71 at the left side of the manifold is the intake port and so is left open or uncovered, while port 72 at the opposite side forms part of the outlet passage and so is closed by the plug 73.

It will be clear from Fig. 7 that for rotation in clockwise direction the parts would be reversed, that is, the port 71 would be closed by plug 73 and port 72 left open to serve as an intake and the valve 70 would be closed and the valve 69 opened to the discharge outlet 63.

To make the pump self-compensating for pressure the discharge passage 64 is shown as opening at 74 into a pressure chamber 75 closed at one end by a spring loaded ball valve 76 and at the opposite end by a piston 77 operating in cylinder 78 against the pressure of spring 79. The tension of this spring is adjustable by means of abutment screw 80 and this screw is shown as carrying a screw stud 80' adjustable to serve as a stop for the piston to prevent full collapsing of the spring 79.

The ball valve 76 is held to its seat by a spring 82, the tension of which is adjustable by means of abutment screw 83. The setting of this tension spring determines the pressure at which the ball valve will open to relieve pressure back through passage 84 back into the annular intake chamber 57.

The relief ports 81, as shown in Figs. 2 and 7, open into a surrounding space 85 connected with the discharge outlet 86 in the top of the pump casing.

The inner ring 48 is secured by a press fit or otherwise as a liner within the pump body 47, and is formed with radial ports 87, 88, in line with the radial passages 67, 68, for intake and exhaust purposes.

To avoid any locking effect at either the intake or the discharge side of the pump, segmental grooves 89, 90, are formed in the inner face of the liner extending from a relatively short change-over space 91 at the top to a relatively short change-over space 92 at the bottom. These grooves allow for full intake and discharge action of the pistons without binding or locking at any points in the cycle of operation.

To balance pressure on opposite sides of the

rotor and thus offset any binding tendency which might result from development of high pressures, narrower compensation grooves 93, 94 are provided on the inside of the liner at opposite sides of the intake and discharge grooves 89, 90, and of substantially the same full arcuate extent. These compensation grooves are cross connected with the opposed pressure grooves 89, 90. Thus the grooves 93, 94, at the left in Figs. 7 and 8, are connected together in parallel by through ports 95 and transverse groove 96 in the outer surface of the liner and by arcuate groove 97 and through port 98 with the pressure groove 90; and the compensation grooves 94 at the right are connected together by through ports 99 and transverse groove 100 with the opposed interior pressure groove 89 by exterior arcuate groove 101 and through port 102.

In the particular example illustrated, the main internal groove 89 is an intake or low pressure groove and this is connected by port 102, passages 101, 100, and ports 99 with the narrow compensating grooves 94 at opposite sides of the other main groove 90, which is the discharge or high pressure groove. In reverse effect this high pressure groove is connected by port 98, passages 97, 96 and ports 95 with the narrow compensating grooves 93, 94, at opposite sides of low pressure groove 89. Thus the low pressure groove 89 has segments of high pressure 93 at opposite sides of it and the high pressure groove 90 has segments of low pressure 94 at opposite sides of it.

The narrow compensating grooves may be substantially half the width of the wider pressure grooves with which they are associated. This accomplishes substantially even balance of pressure on opposite sides of the rotor, leading to smooth, easy, free, frictionless operation of the rotor and assuring a full, complete film of lubricant over the rotor surface. With proper close running fit of the rotor within the liner, the film of lubricant thus maintained during operation of the pump effects an efficient seal of the rotor within its working chamber.

With a further view to maintaining accurate alignment of the rotor within the pump chamber, the rotor is shown constructed with a hub 103 at the back or closed side, journaled in a bearing 104 in the end plate 49 and with a hub extension 105 at the front or open side journaled on a bearing 106 on the other or front end plate 50.

The drive of the pump is effected in the illustration by a drive shaft 107 journaled in a bearing 108 carried by a flange nut 108 screwed into the end of a bearing housing 110 on the back of the pump casing, the inner end of this shaft entering the hub 103 of the rotor and carrying a drive pin 111 entering a notch in the rotor hub.

This construction provides a readily separable drive connection or coupling between the shaft 107 and the pump unit removably seated in the pump housing.

To seal the drive shaft in its coupled engagement with the pump unit the shaft bearing 106 is finished at the inside as a lap joint with the sealing flange 112 which while loose on the shaft is sealed to the shaft by packing 113 held by a cup 114 under pressure of spring 115 backed up by abutment washer 116, the latter in abutment with the cross pin 111.

This provides a compensating, self-adjusting, spring tensioned rotary seal between the rotating shaft and the housing and bearing for the same.

The pump piston, instead of being positively connected with the actuating crank pin 20, may

be spring operated in the return or retractive movement, as illustrated in Fig. 9 where the pistons 17 are shown as having flange heads 117 at their inner ends slidingly bearing on the crank pin 20 under pressure of the springs 118 surrounding the inner ends of the pistons and bearing against flanges 117.

Figs. 10 and 11 illustrate a multiple piston form of the invention in which the radial piston chambers 119 in the rim of the rotor 120, in conjunction with the pistons 121 sliding and rocking in such cylinders, serve as the buckets of a paddle wheel to constitute the machine motor as well as a pump.

In this particular embodiment of the invention the pistons 120, as in the copending patent application Serial No. 539,345, filed June 8th, 1944, now abandoned, have connecting links or straps 121 at their inner ends pivotally engaged about a bushing 122 carried by a hollow crank pin 123 on one end plate 124 and the rotor has a hub portion 125 freely journaled on a pivot stud 126 carried by the back wall or opposed end plate 127 of the combined motor and pump housing.

In this construction the bucket forming cylinders and pistons automatically clear themselves of the water or other impelling fluid as they rotate past the point 128 separating the fluid inlet and outlet sides 129, 130, of the combined motor and pump casing.

In passing over the port 131 the pistons 120, then in their retractive movement draw in any chemical or other fluid that the pump may be intended to deliver into the discharge stream.

While the pressure balancing grooves first disclosed may be employed in this motor-pump combination, for simplicity there has been shown a single relief groove 132 extending from the point 133 to the intake passage 129, and a single relief groove 134 extending from the discharge passage 130 back to the arcuate sealing section 133.

The stroke of the pistons is adjustable in the form of the invention under consideration by rotative movement of the front cover plate 124 and which can be secured in its various positions of adjustment by the screw flange ring 135.

Fig. 12 illustrates a modification of the motor-pump combination shown in Fig. 10 by the provision of the rotor with a shaft extension 136 by which it may be driven to operate as a combination pump to draw in water or other liquid or fluid at the inlet 129 as well as chemical or other liquid or fluid at the smaller inlet 131.

Fig. 13 illustrates an adaptation of the water motor type of pump 137 shown in Fig. 10 applied to the direct driving of a smaller chemical pump 138 like that first disclosed in Figs. 1 and 2, having an inlet connection 139 and an outlet connection 140 discharging into the outlet side 130 of the combination water motor pump 137.

The balance grooves at opposite sides of each pressure groove present substantially equal area and opposite pressure to the rotor as the so-called pressure groove with which they are related and hence draw out or spread a film of the liquid being pumped, thus to float the rotor in a pressure balanced, substantially frictionless, full size bearing, where the driving force will be practically only that required to rotate it. This full sealing effect on the rotor makes the machine efficient as a high vacuum pump.

What is claimed is:

1. A pump comprising a pump cylinder, a rotor having a close running fit in said cylinder

and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having low and high pressure grooves extending arcuately around opposite sides of the same between the points of maximum and minimum displacement positions of the piston and said pump cylinder having an inlet passage opening into the low pressure groove and a discharge passage extending from the high pressure groove, and balancing grooves at the sides of and of substantially the same longitudinal extent as the pressure grooves, said balancing grooves being connected one at the low pressure side across to the high pressure groove and one at the high pressure side across to the low pressure groove, said balancing grooves being connected and arranged in pairs disposed with the grooves of each pair along opposite sides of said pressure grooves, the wall of said pump cylinder being provided by a liner, said balancing grooves being formed in the inner face of said liner and said cross connections being provided by holes through and grooves in the outer face of said liner.

2. A pump comprising a pump cylinder, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having low and high pressure grooves extending arcuately around opposite sides of the same between the points of maximum and minimum displacement positions of the piston and said pump cylinder having an inlet passage opening into the low pressure groove and a discharge passage extending from the high pressure groove, and balancing grooves at the sides of and of substantially the same longitudinal extent as the pressure grooves, said balancing grooves being connected one at the low pressure side across to the high pressure groove and one at the high pressure side across to the low pressure groove, the wall of said pump cylinder being provided by a liner, said balancing grooves being formed in the inner face of said liner and said cross connections extending through and along the outer face of said liner.

3. A pump comprising a pump cylinder, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having low and high pressure grooves extending arcuately around opposite sides of the same between the points of maximum and minimum displacement positions of the piston and said pump cylinder having an inlet passage opening into the low pressure groove and a discharge passage extending from the high pressure groove, and means for effecting reverse connection of said passages in respect to said low and high pressure grooves for enabling operation of said pump rotor in either direction.

4. A pump comprising a pump cylinder having an intake chamber, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having low and high pressure grooves extending arcuately around opposite sides of the same between the points of maximum and minimum displacement positions of the piston and said pump cylinder having an inlet passage opening into the low pressure groove and a discharge passage extending from the high pressure groove, and means for effecting reverse connection of said passages in respect to said low and high pressure grooves for enabling operation of said pump rotor in either direction and including a manifold in said intake chamber, having an outlet and branches extending from said passages to said outlet, valves to close either branch and open the other one in respect to said outlet and closures for said branches removable either one to open whichever passage is connected with the closed branch to said intake chamber.

5. A pump comprising a pump cylinder having an intake chamber, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having low and high pressure grooves extending arcuately around opposite sides of the same between the points of maximum and minimum displacement positions of the piston and said pump cylinder having an inlet passage opening into the low pressure groove and a discharge passage extending from the high pressure groove, and means for effecting reverse connection of said passages in respect to said low and high pressure grooves for enabling operation of said pump rotor in either direction and including a manifold in said intake chamber, having an outlet and branches extending from said passages to said outlet, valves to close either branch and open the other one in respect to said outlet and closures for said branches removable either one to open whichever passage is connected with the closed branch to said intake chamber, said pump casing having an outlet chamber and pressure operated valve means controlling flow from said manifold outlet to said outlet chamber.

6. A pump comprising a pump cylinder, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having inlet and outlet passages, an outlet chamber in said pump cylinder connected with the outlet passage and having a pressure operated check valve at one end and a pressure opened discharge valve at the opposite end and a pressure

return connection from the outlet side of said check valve back to said inlet passage.

7. A pump comprising a pump cylinder, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected with said piston for effecting reciprocation of said piston in the rotation of said rotor, said pump cylinder having inlet and outlet passages, an outlet chamber in said pumps cylinder connected with the outlet passage and having a pressure operated check valve at one end and a pressure opened discharge valve at the opposite end and a pressure return connection from the outlet side of said check valve back to said inlet passage, means for predetermining the opening pressure of said check valve and means for setting the relative eccentricity of said crank pin.

8. A pump comprising a pump casing having an inlet chamber and an outlet chamber, said outlet chamber having a return passage open to said inlet chamber and a spring closed check valve normally closing said passage, a pump cylinder in said casing having an inlet port open to said inlet chamber and an outlet port open to said outlet chamber, said casing having a delivery passage extending from said outlet chamber, a spring closed valve controlling flow from said outlet chamber to said delivery passage, a rotor operating in said pump cylinder and having external means for effecting rotation of the same, said rotor being provided with a radial piston cylinder open at the outer end to said pump cylinder and a crank pin eccentrically related to said rotor and connected to operate said piston in the rotation of said rotor.

9. A pump comprising a pump casing having an inlet chamber and an outlet chamber, said outlet chamber having a return passage open to said inlet chamber and a spring closed check valve normally closing said passage, a pump cylinder in said casing having an inlet port open to said inlet chamber and an outlet port open to said outlet chamber, said casing having a delivery passage extending from said outlet chamber, a spring closed valve controlling flow from said outlet chamber to said delivery passage, a rotor operating in said pump cylinder and having external means for effecting rotation of the same, said rotor being provided with a radial piston cylinder open at the outer end to said pump cylinder and a crank pin eccentrically related to said rotor and connected to operate said piston in the rotation of said rotor, said valves being located at opposite ends of said outlet chamber, the outlet passage opening into the intermediate portion of said outlet chamber between said valves and regulatable means for determining the spring closing tension on said valves.

10. A pump comprising a casing having a pump cylinder, a rotor having a close running fit in said cylinder and external means for effecting rotation of the same, said rotor having radial piston cylinders open at the outer ends to said pump cylinder, pistons operating in said piston cylinders, a crank pin at the inner ends of said piston cylinders, links pivotally connecting said pistons with said crank pin, means for supporting and setting said crank pin in eccentric relation to said rotor, said pump cylinder having inlet and outlet ports in communication with the open outer ends of the piston cylinders in the rotation of the rotor, said means for supporting and setting said crank pin including a support for said crank pin shiftable radially in respect to the center of rotation of the rotor and means for shifting and securing said support including a rotatably adjustable eccentric rotatably mounted on said casing and connected with said support and means on the pump casing for locking said eccentric in adjusted relation.

11. A pump comprising a casing having a pump cylinder, a rotor having a close running fit in said cylinder and having radial piston cylinders open at the outer ends to said pump cylinder, pistons operating in said piston cylinders, a crank pin at the inner ends of said piston cylinders, links pivotally connecting said pistons with said crank pin, means for supporting and setting said crank pin in eccentric relation to said rotor, said pump cylinder having inlet and outlet ports in communication with the open outer ends of the piston cylinders in the rotation of the rotor, said means for supporting and setting said crank pin including a support for said crank pin shiftable radially in respect to the center of rotation of the rotor and means for shifting and securing said support including an adjustably tensioned piston operable in the pump casing and a pressure connection from the pump cylinder for applying pressure to said adjustably tensioned piston.

12. A pump comprising a casing having a pump cylinder, a rotor provided with means for rotating same and having a close running fit in said cylinder, said rotor having a radial piston cylinder open at the outer end to said pump cylinder, a piston operable in said piston cylinder, a crank pin eccentrically related to said rotor and connected to said piston for effecting reciprocation of the same in the rotation of said rotor, a liner forming the wall of said pump cylinder and having high and low pressure grooves in the inner surface of the same extending arcuately around opposite sides of the cylinder between points of maximum and minimum displacement positions of the piston, passages extending through said liner into said low and high pressure grooves to form inlet and discharge passages, balancing grooves in the inner face of the liner at opposite sides of said low and high pressure grooves, a cross channel in the outer face of the liner connecting the balancing grooves at opposite sides of the low pressure groove and a channel in the outer face of the liner extending from said cross channel to the high pressure groove, a cross channel in the outer face of the liner connecting the balancing grooves at opposite sides of the high pressure groove and a channel in the outer face of the liner extending from said last mentioned cross channel to said low pressure groove.

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