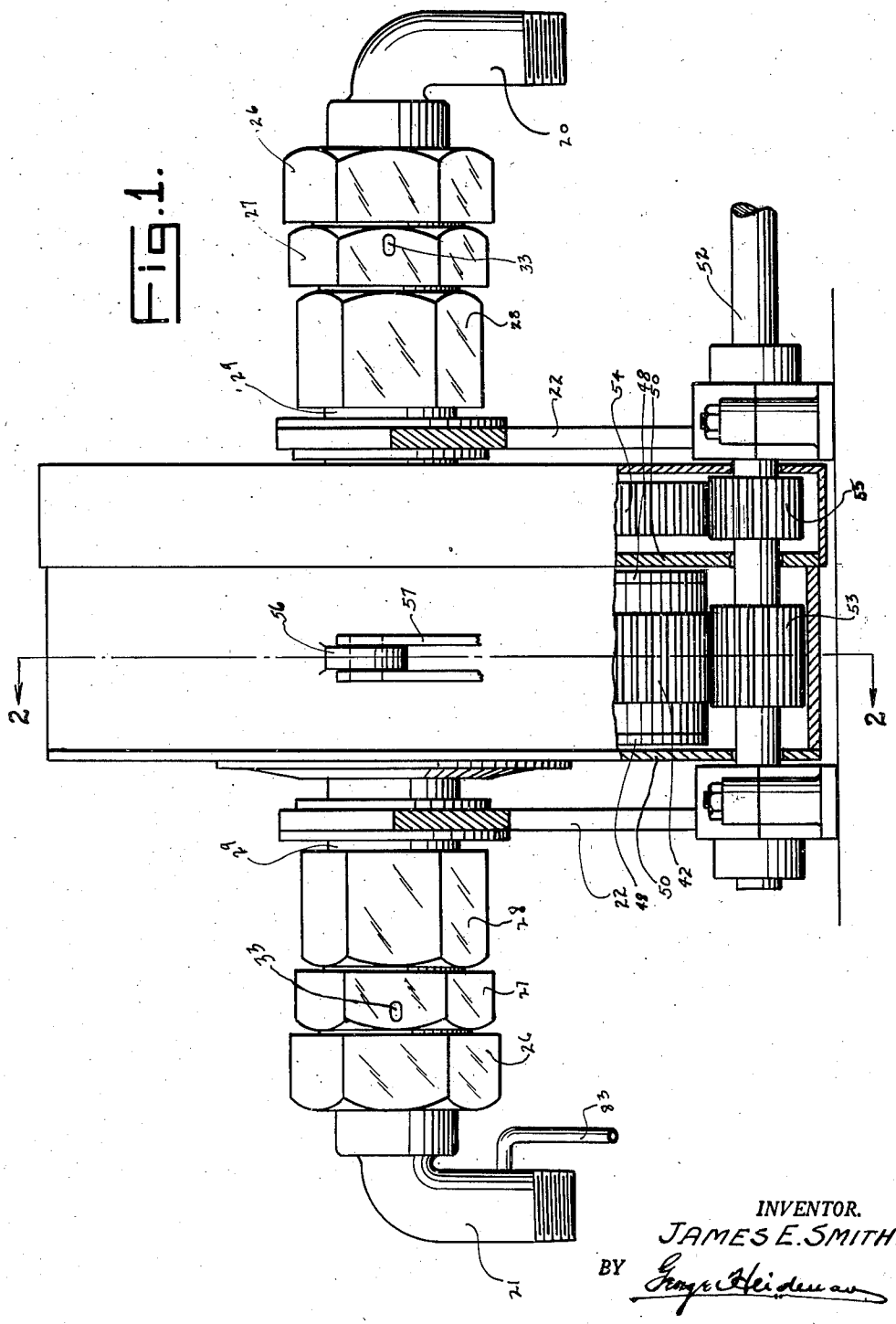
March 11, 1947. J. E. SMITH 2,417,183

VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 1

Fig. 1.



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VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 2

Fig. 2.

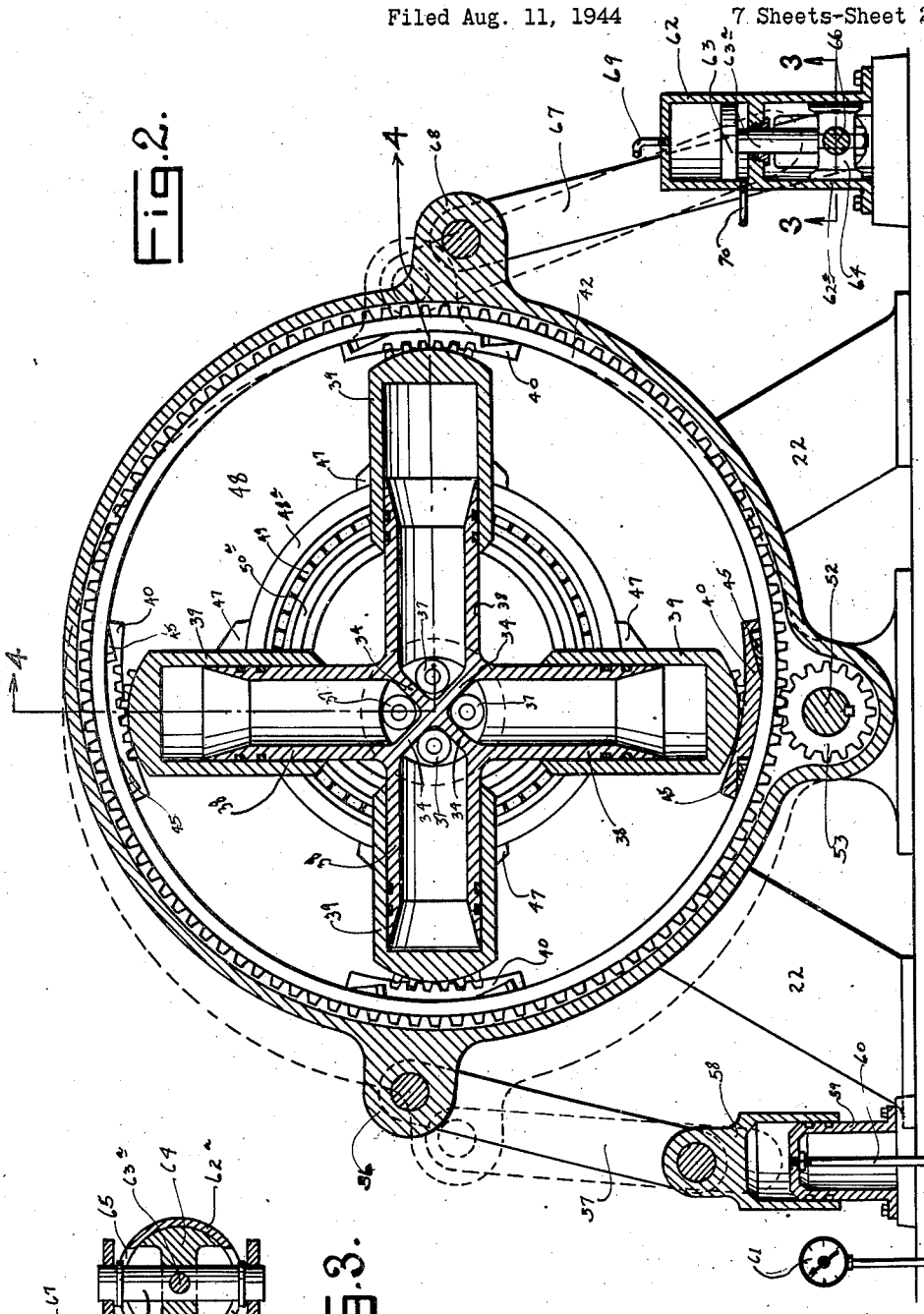


Fig. 3.

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VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 3

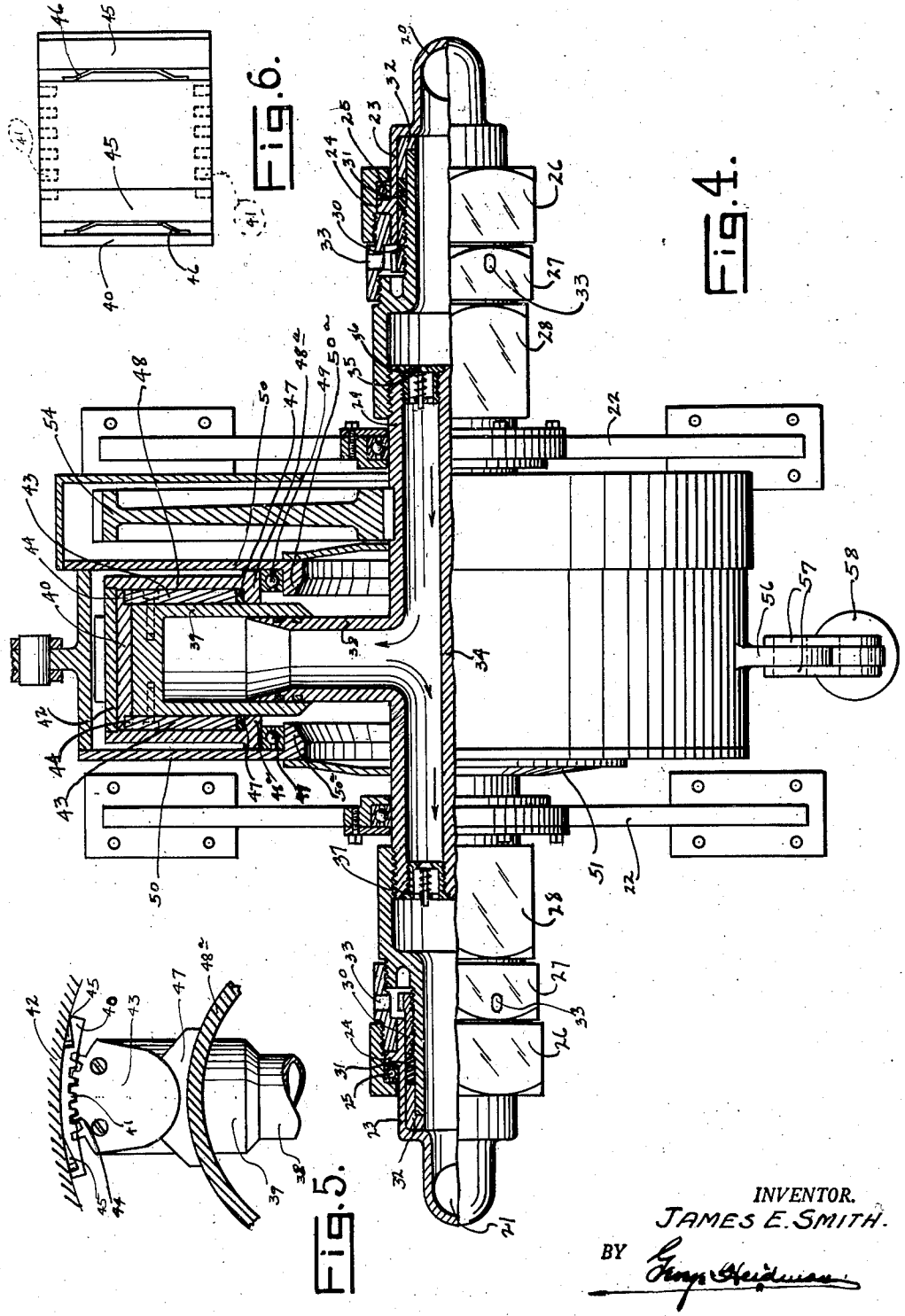


Fig. 4.

Fig. 6.

Fig. 5.

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March 11, 1947. J. E. SMITH 2,417,183

VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

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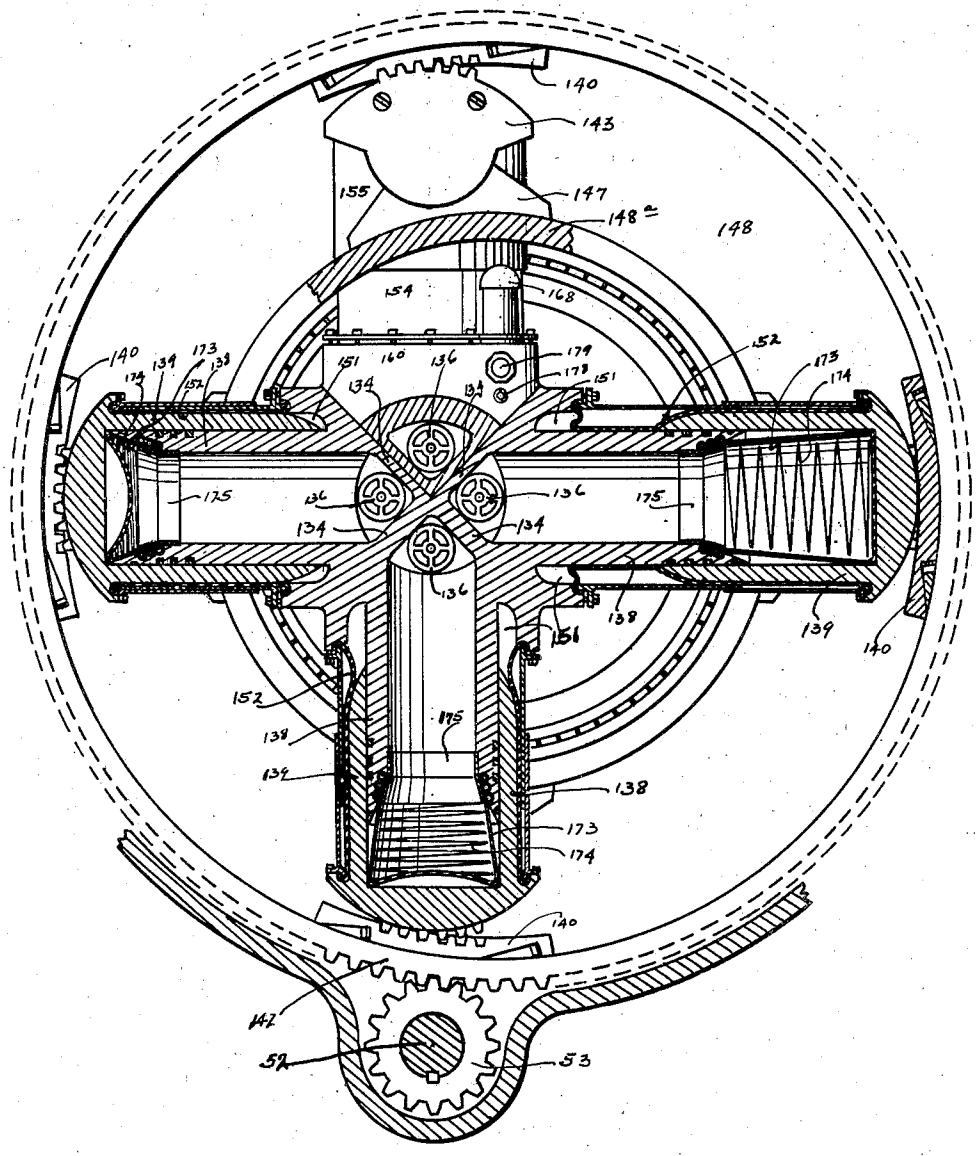


Fig. 7.

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March 11, 1947. J. E. SMITH 2,417,183

VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 5

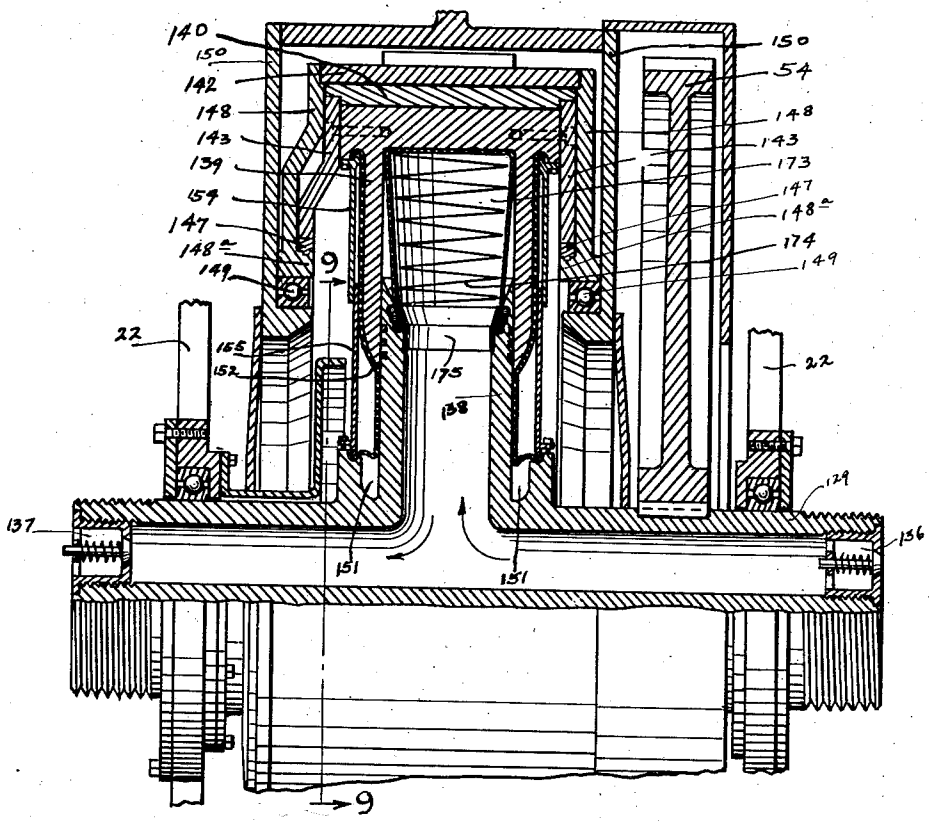


Fig. 8.

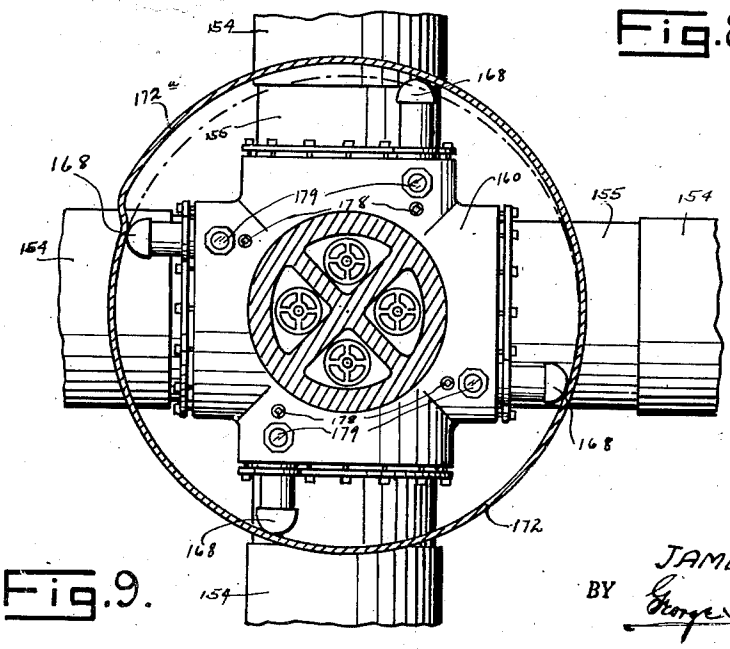


Fig. 9.

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March 11, 1947. J. E. SMITH 2,417,183

VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 6

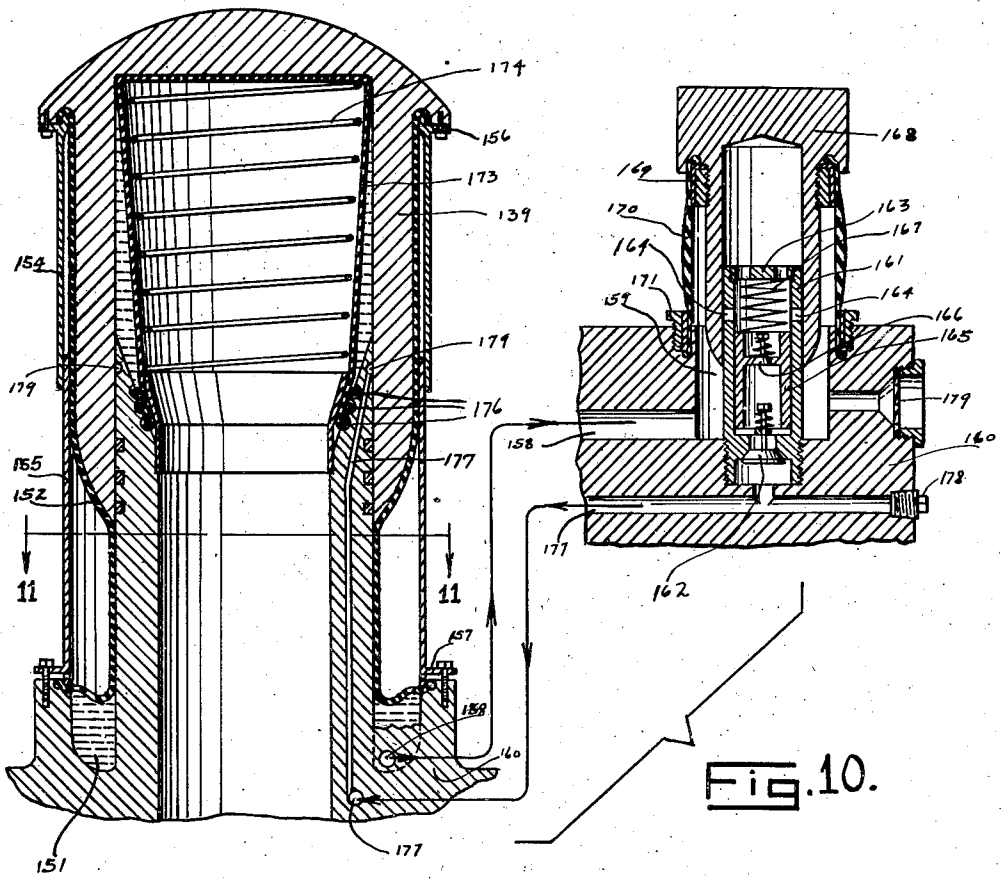


Fig. 10.

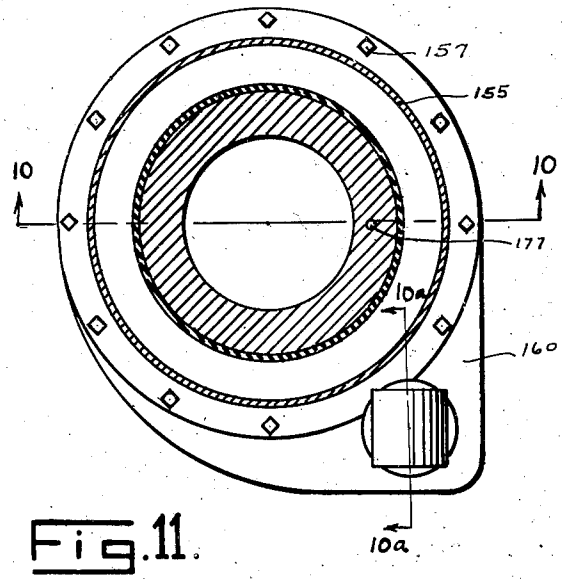


Fig. 11.

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VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

Filed Aug. 11, 1944 7 Sheets-Sheet 7

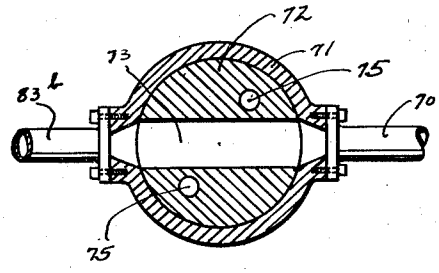


Fig. 13.

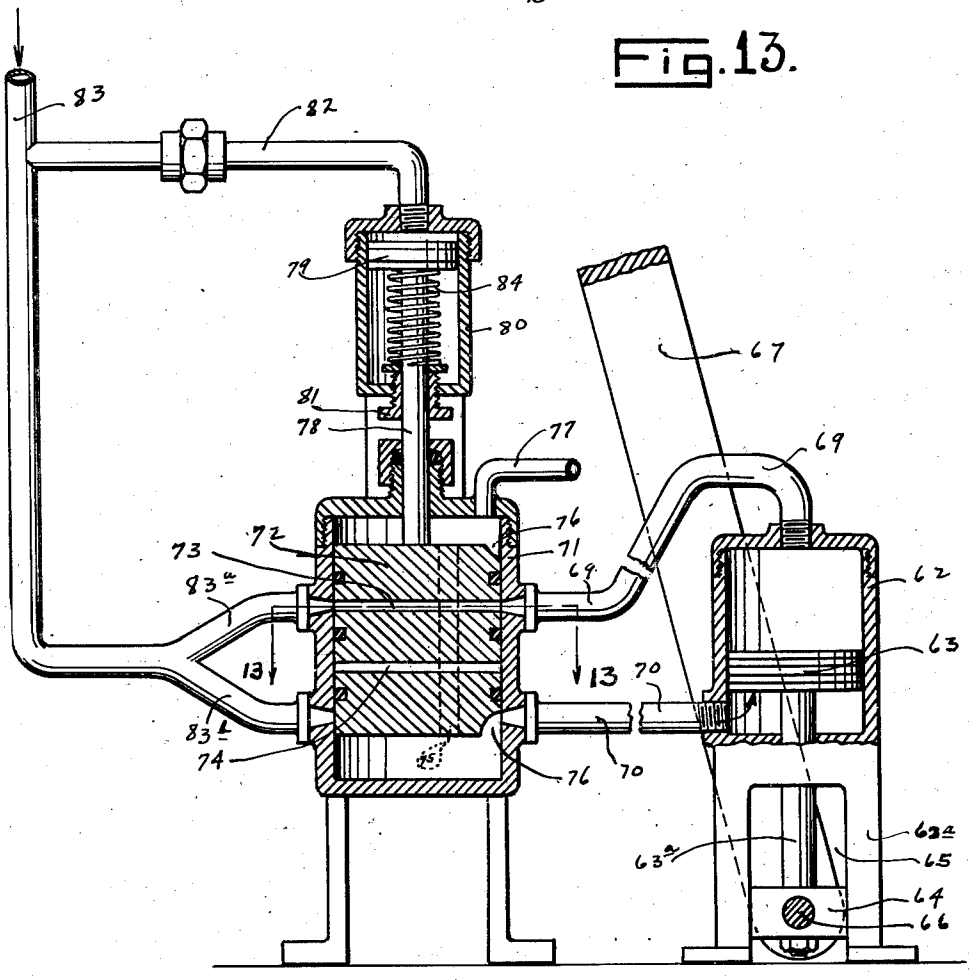


Fig. 12.

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Patented Mar. 11, 1947 2,417,183

UNITED STATES PATENT OFFICE

2,417,183

VARIABLE STROKE RADIAL CYLINDER TYPE PUMP

James E. Smith, Pittsburg, Tex.

Application August 11, 1944, Serial No. 549,025

12 Claims. (Cl. 103—161)

1

My invention relates to a radial cylinder type pump having a variable stroke involving an intake and discharge conduit forming shaft with a fixed axis and provided with a plurality of radially disposed hollow pistons associated with reciprocating cylinders actuated by rotatably mounted means whose axis is adapted to have variable eccentric relation with the fixed axis of the conduit forming shaft.

The invention has for its object the provision of means whereby the pump will automatically adjust its stroke in keeping with the pressure resistance at the discharge end so as to balance the power applied to the drive shaft with the volume and pressure at the discharge end of the pump.

The invention contemplates means adapted to control and to hold the rotatably mounted cylinder controlling means, relative to the fixed axis of the conduit shaft, at a full stroke until the pressure increases to a point where the volume of fluid discharged is to be reduced sufficiently to maintain the volume delivered balanced with the horsepower applied; that is to say, as the pressure at the delivery end increases the volume of fluid discharged correspondingly decreases; said first mentioned means involving automatically operable mechanism whereby the stroke of the pump is controlled, in conjunction with additional mechanism operable when the pressure at the discharge end of the pump reaches a predetermined degree whereby the eccentric relation between the axes of the conduit shaft and said rotatable cylinder controlling means is varied to control the volume.

My improved pump is especially designed for the pumping of fluids whose contents would normally be injurious to the movable elements of the pump, as for example the abrasive laden mud employed in well drilling, and involves means whereby the fluid pumped is maintained out of direct contact with the respective cylinders and pistons.

My invention also contemplates means whereby a constant supply of lubricant between the cylinders and pistons is provided and said lubricant maintained in separated relation with the fluid being pumped.

The objects and advantages of my invention will all be readily comprehended from the following detail description of the accompanying drawings, wherein:

Figure 1 is a side elevation of my improved pump with a portion of the outer casing, casing control mechanism and control links broken away.

Figure 2 is a vertical sectional view taken substantially on the line 2—2 of Figure 1 looking in the direction of the arrows, with a portion of the casing control mechanism in section.

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Figure 3 is a detail sectional view taken on the line 3—3 of Figure 2, as viewed by the arrows.

Figure 4 is a partial plan and sectional view, with the section being taken substantially on the line 4—4 of Figure 2 as viewed by the arrows.

Figure 5 is a detail view of the outer end of one of the cylinders and pistons illustrating the cylinder control mechanism with a portion broken away and shown in section.

Figure 6 is a top view of the detail shown in Figure 5.

Figure 7 is a sectional view, similar to Figure 2, on a somewhat larger scale illustrating a modification.

Figure 8 is a view substantially similar to Figure 4, on a larger scale, with the couplings at the ends of the conduit-shaft omitted and illustrating the modification of Figure 7.

Figure 9 is a sectional view taken on the line 9—9 of Figure 8 as viewed by the arrows.

Figure 10, at the left, is an enlarged vertical sectional view of one of the cylinders and its associated piston, taken substantially on the line 10—10 of Figure 11, with the outer casing and cylinder control mechanism omitted, illustrating my improved lubricating arrangement, with the lubricant controlling mechanism broken away and offset to the right of the figure; said portion of the figure being a sectional view taken substantially on the line 10^a—10^a of Figure 11 as viewed by the arrows.

Figure 11 is a cross sectional view taken on the line 11—11 of Figure 10 looking in the direction of the arrows.

Figure 12 is a detail vertical sectional view of the casing control mechanism partly shown at the right of the pump in Figure 2.

Figure 13 is a cross sectional view taken on the line 13—13 of Figure 12, looking in the direction of the arrows.

The particular exemplification of the invention as illustrated in the first six figures of the drawings comprises a fixedly held fluid conducting axis with an inlet coupling 20 at one end and an outlet coupling 21 at the opposite end; said hollow or fluid conducting axis being supported by suitable standards 22, 22. The fluid conducting axis at both ends is similar in construction and arrangement (see Figure 4) involving coupling 20 at the inlet end and coupling 21 at the outlet end, both couplings having a sleeve portion 23 with a flange 24 which provides a seat for the antifriction bearing shown at 25, which in turn is held in place by the inturned flange on the outer nut 26 which is threaded on the externally threaded flange of nut 27 which latter in turn is threaded on the externally threaded skirt of coupling member 28. Coupling member 28 at its inner end is internally threaded to receive the threaded end of the hollow shaft 29.

A portion of the externally threaded skirt of coupling 28 receives the packing controlling sleeve 30 and the packing 31 and the bushing 32 which is held on the outer end of the coupling member 28 by the inlet 20 at one end of the pump and by the outlet coupling 21 at the outer end of the pump; while the nut 27 is threaded on the threaded flange of coupling member 28. Nut 27 is preferably provided with a number of openings as at 33 to permit insertion of a suitable tool whereby sleeve 30 may be controlled so as to effect suitable compression of the packing 31 without the necessity of disturbing the coupled relation of the aforementioned elements.

As is apparent from the construction described and shown in Figure 4, all of the elements with the exception of the inlet and outlet elbows or couplings 26 and 21 (both ends of the pump being of similar construction) are intended to rotate with the hollow shaft 29 and are designed to maintain fluid tight connections.

The hollow shaft 29 extends transversely through the pump and is internally divided into a plurality of channels by the diagonal or crisscrossing webs 34, 34 (Figure 2); the channels extending from end to end of the hollow shaft and the inlet end of each channel (at the right in Figure 4) is provided with a spring controlled valve 35 mounted in a suitable cage 36 which screws into the channel of the hollow shaft; while the outlet end of each channel (at the left in Figure 4) is provided with a similar valve 37; the valves at both ends being adapted to open in the direction of flow of fluid through the channel. It will be understood that the ends of each channel in the hollow shaft are provided with similar valves as indicated in Figure 2 where the outlet valves 37 are shown.

The hollow shaft, coincident with each channel, is provided with the radially disposed hollow plungers or pistons 38, whose outer surfaces are preferably provided with suitable packing rings, as shown in Figure 4; and these pistons 38 receive the inner ends of the radially arranged cylinders 39 whose heads or outer ends are provided with a predetermined degree of arcuation, as shown in Figure 2. These arcuate outer ends of the cylinders bear against the arcuate plates or shoes 40; an outside plan view of one of the shoes being shown in Figure 6. The plates or shoes 40, adjacent opposite edges (namely beyond the points of contact with the arcuate heads of the cylinders) are provided with teeth, as indicated at 41 (in dotted lines in Figure 6) and in full lines in Figure 5. The shoes 40 (which are adapted to travel with the cylinders) are intended to provide greater area between the cylinders and a surrounding ring gear 42 in order to distribute the compressive force between the cylinders and the ring gear 42 and at the same time reduce wear on the inner perimeter of the ring gear that would occur if the arcuate heads of the cylinders were in direct engagement with the ring gear 42.

Opposite sides of each cylinder are provided with plates 43, 43 (shown more clearly in detail Figure 5) which preferably are removably secured to the cylinders and the outer perimeters of these plates are provided with an arcuation similar to the arcuation of the cylinder heads and provided with teeth 44 which mesh with the teeth 41 at the opposite edges of shoes 40, thereby causing the shoes to travel with the cylinders. The outer faces of the shoes 40, adjacent opposite ends, are provided with suitable angular sockets disposed in the same direction adapted to receive wedges 45, 45 (see Figures 2, 5 and 6) which are yieldingly forced into wedging position by suitable springs as at 46.

The inner perimeters of plates 43 are given a predetermined arcuation, as shown in Figure 5, and rockingly seat in the arcuate sockets formed in the blocks or saddle members 47 which are arranged in engagement with the inturned flanges 48a formed at the inner ends of the side plates 48 (see Figure 4) which are secured to the sides of the ring gear 42. The curvatures of the cylinder heads, of the toothed plates and of the saddle sockets, as previously stated, must be of a predetermined arcuation in order to maintain continuous contact or operative relation between the ends of the cylinders and the ring gear during rotation regardless of the degree of eccentricity between the axes of the hollow shaft and the ring gear.

The inner flanged perimeters of the side plates 48 are provided with or ride on anti-friction bearings 49 which are arranged on the inturned flange 50a on the side plates 50, which are secured to the circumferential wall of the outer housing; the side plates being formed with a comparatively large central opening in order to permit eccentric tilting of the housing relative to the hollow shaft; the enlarged openings in the side plates being preferably closed by the annular plates or discs 51 which are secured to the hollow shaft and have sliding engagement with the side plates.

A drive shaft 52 is disposed transversely through the bottom of the housing and provided with a pinion 53 which meshes with the ring gear 42; the drive shaft 52 being driven by any suitable power mechanism.

The outer housing at one side is shown provided with an enlarged annular chamber to receive a gear 54, properly secured on the hollow shaft 29 (see Figure 4) and meshing with pinion 55 which is secured to drive shaft 52 (see Figure 1). Ring gear 42 and gear 54 are intended to be of the same diameter and pinions 53 and 55 are of the same diameter. The housing is loosely mounted on drive shaft 52 so as to swing to and from the center or axis of the hollow shaft 29.

In order to control the eccentric relation between the axis of the housing with ring gear 42 and the axis of the hollow shaft 29, I provide the housing with lugs 56 (see Figures 1, 2 and 4) to which links 57 are pivotally secured. The lower ends of links 57 are pivotally connected to the head of the movable cylindrical air holding member 58 (see Figure 2) which is slidably mounted on the non-movable upright plunger member 59 provided with an air inlet pipe 60, leading from a suitable source of air supply; the end of the air line being shown provided with a suitable pressure gauge 61.

The cylindrical air holding member 58 is initially provided with a predetermined degree of air pressure adapted to flexibly maintain the axis of the housing and ring gear in eccentric relation with the axis of the hollow shaft in order to obtain proper operative reciprocation of the respective cylinders 39, as shown for example in full lines in Figure 2; the length of the cylinder travel or strokes decreasing as the degree of eccentricity between the axes of the housing and the hollow shaft diminishes, producing a lesser quantity of intake and exhaust, a condition which obtains when the discharge pressure or resistance increases and tends to compress the air in member 58, thus providing a variable stroke commen-

surate with the resistance on the discharge side of the pump.

As a medium of safety and to also obviate the necessity of providing an air holding member 58 of undesirable capacity or size, I prefer to employ the auxiliary control mechanism, a portion whereof is shown at the right in Figure 2, while the entire auxiliary mechanism is shown in section in Figure 12. This auxiliary control mechanism consists of a suitable cylinder 62 provided with a piston 63 whose rod 63a extends through the bottom of the cylinder and the lower end of the rod preferably provided with a cross-head 64 which is slidably mounted in the lower standard or frame portion 62a of the cylinder 62; the standard 62a at opposite sides having vertically disposed slots 65 to receive the ends of the bolt or pin 66 to which links 67, 67 are pivotally secured. The links 67, 67 at their upper ends are pivotally secured to lug 68 on the outer housing of the pump at a point diagonally opposite the lug 56.

The cylinder 62 at points above and below the piston 63 is provided with openings for pipes 69 and 70 which communicate with cylinder 71 (see Figure 12). Cylinder 71 is provided with a plug valve 72 which has transverse ports 73 and 74 and vertically disposed ports 75; and the plug valve 72 at its upper and lower perimeters adjacent the side of cylinder 71 connected with pipes 69 and 70 is provided with cut-out portions or cavities as at 76; the cavity 76 at the upper end of the plug valve 72 registering with the port in the cylinder and the pipe 69 when the plug valve is substantially seated at the bottom of the cylinders, while the lower cavity 76 in plug valve 72 will register with the cylinder port and pipe 70 when the plug valve is in its highest position, thus permitting the fluid medium in cylinder 62 above its piston 63 to escape into cylinder 71 when piston 63 moves upwardly in cylinder 62 and the medium below piston 63 to escape into cylinder 71 when piston 63 moves downwardly. During normal operation of the pump, plug valve 72 will be in elevated position with its port 73 in register with the ports in the side wall of cylinder 71 (and hence with pipe 69) at which time the opening in cylinder 71 connected with pipe 70 will be closed.

The top of the cylinder 71 is provided with a pipe 77 (portion whereof is shown in Figure 12) whereby the fluid medium in the top of cylinder 71 may escape and be led to a reserve tank (not shown). The pipes are so arranged that fluid medium will at all times remain on opposite sides of piston 63 during pump operation, in order to prevent sudden or momentary rocking movement of the pump housing immediately after the discharge of each individual cylinder of the pump; the pressure in cylinder 62 will increase or diminish in keeping with the discharge pressure of the pump; the cylinder 62, it being understood, is to be of adequate size to exert, say approximately ninety percent of the force required to maintain the desired eccentric relation in the pump, while the remaining, or say approximately ten percent of the force, is exerted by the pneumatic or air holding member 58, as the power exerted by the auxiliary or hydraulic mechanism will fluctuate with the discharge pressure of the pump.

Plug valve 72 is secured to the rod 78 of a spring controlled piston 79 located in a chamber 80 above cylinder 71; the spring pressure of piston 79 being regulated by the nut 81. The top

of chamber 80 is provided with a connection 82 leading from a pipe 83 which is connected with the outlet or discharge connection 21 of the pump (see Figure 1). Pipe 83 is also connected with cylinder 71 by the bifurcations 83a and 83b, of predetermined spacing so as to alternately establish communication with either port 73 or port 74 in plug valve 72.

The auxiliary mechanism, shown in Figure 12, acts as a safety control. During normal pumping operation, the fluid pressure will be above the piston 63, and will hold the pump housing, through the medium of link 67 in eccentric relation. In the event the pressure on the discharge end of the pump reaches an excessive point beyond the predetermined degree—or safety degree of pressure—the force exerted on piston 79 will overcome the pressure of its spring 84, causing the plug valve 72 to move down bringing its port 74 into register with bifurcation 83b and pipe 70, and allow the pressure fluid to enter the bottom of cylinder 62, causing piston 63 to move upwardly and shift the pump housing to dead center with the axis of the conduit shaft 29 substantially into the position indicated by dotted lines in Figure 2, at which time pumping action would cease regardless of the pump operation or rotation; this condition maintaining until the pressure at the discharge end of the pump diminishes to a point beneath the degree of upward pressure exerted by spring 84 on piston 79, at which time plug valve 72 will move upwardly, bringing port 73 of plug valve 72 into register with bifurcation 83a and pipe 69, allowing the pressure fluid to enter the top of cylinder 62, moving piston 63 downwardly and with it link 67, thereby moving the pump housing back to its desired or operative eccentric relation with the axis of the hollow or piston carrying shaft 29 of the pump.

The structure, as disclosed in Figures 1 and 4, is shown provided with a driving gear 54, keyed to the hollow or piston carrying shaft 29 of the pump, for the purpose of applying a portion of the power to the hollow shaft 29 instead of applying all of the power to the ring gear 42; but it will be understood that if desired, gear 54 and pinion 55 may be omitted and all of the power applied to the ring gear 42.

In Figures 7 to 11, inclusive, I illustrate a modification of the pump portion of my invention; the principle and means for providing the eccentric relation between the hollow or piston carrying shaft and the ring gear of the housing being similar to that heretofore described and shown in the preceding figures. That is to say, the modified form involves a substantially similar hollow shaft 129 provided with diagonal webs 134 whereby the shaft is divided into a plurality of channels; the shaft, coincident with each channel, being provided with the radially disposed hollow pistons 138; while the ends of each channel are provided with the valves 136 at the inlet end of the shaft and valves 137 at the outlet end of the shaft; the ends of the shaft being rotatably secured to the inlet and outlet couplings of the pump. The pistons 138 telescopically receive the cylinders 139.

In view of the fact that a lubricating system is applied to the reciprocating cylinders 139, the heads of the cylinders are somewhat enlarged to receive the arcuate side plates 143, preferably removably secured to opposite sides; the inner perimeters of the plates are rockingly seated on the blocks or saddles 147 which in turn are slidably mounted on the inturned flanges 148a of the

annular plates 148, whose outer perimeters are secured to the sides of the ring gear 142. The outer arcuate ends of the cylinders bear against the arcuate shoes 149, which, except as to size, are similar to the shoes shown in the previous figures, with their teeth meshing with the teeth on the arcuate plates 143, while the inner perimeters of plates 148 rest on the antifriction bearings 149 which rest on the inturned flange of the outer housing side walls 150.

In this lubricated modification, the junctures between the pistons 138 and the hollow shaft 129 are enlarged and provided with annular wells or sockets 151 which are intended to hold lubricating oil.

The outer sides of the pistons and cylinders are provided with yielding non-oil soluble covers 152, made, for example, of synthetic rubber, whereby the lubricant is held within the system, and through the action of mechanism to be described will be returned to its lubricating position at the upper ends of the pistons 138.

The ends of the tubular covers 152 are shown beaded and seated in suitable sockets formed in the enlarged heads of the cylinders and in the hubs or junctures between the pistons 138 and the hollow shaft 129 and are tightly held in place by projecting lips formed on the upper ends of the outer sheet metal casing or shell 154 and lips formed at the lower or inner ends of the sheet metal casing or shell 155, which are arranged in telescopic relation; the upper outer end of shell 154 being removably secured at 156 to the cylinder heads, while the lower ends of shells 155 are removably secured at 157 to the hub portion on the hollow shaft 129, as more clearly shown in Figure 10. The telescopic shells, in addition to protecting the covers 152, prevents the latter expanding and applies compressive force to the oil, within the covers, which has seeped past the rings of the pistons, causing the oil to flow through ports 158 and into the cavity 159 formed in the hub or enlarged portion 160 of the hollow shaft at the base of the respective pistons. Each of the cavities 159 (one for each cylinder and piston) is provided with a sleeve 161 whose lower end is threaded into the hub portion 160 and the lower end provided with the outwardly opening spring controlled valve 162. The upper end of the sleeve is closed by a ported plug 163, and the sides of the sleeve at a predetermined distance beneath its upper end are provided with ports 164.

The sleeve 161 is provided with a sliding valve member 165 whose upper end is provided with a spring controlled inwardly opening valve 166; and the sliding valve member 165 is normally held in its receded position by a suitable spring 167.

The sleeve 161 extends into the plunger member 168 and is shown provided with a nut 169 whereby the upper end of a non-oil soluble covering or bag 170 is firmly held in place; while the lower end of said cover or bag 170 is firmly secured to the hub portion 160 through the medium of the nut 171. The cover or bag 170 is held slightly spaced from the plunger member 168 and provides an oil receiving space which connects with the cavity 159. The cover or bag 170 preferably is made of elastic material and its intermediate portion is shown made with a heavier or thicker wall to prevent excessive lateral distention and at the same time provide sufficient contracting force whereby the plunger member 168 will be forced outwardly during a certain period in the rotation of the piston carrying hollow shaft of the pump.

Suitably secured to the pump support so as to to held against rotation, is a flanged disc 172 (see Figures 8 and 9) whose flange extends across the outer ends of the plunger members 168, as shown in Figure 9; a portion of the flange being offset or made eccentric as shown in Figure 9 at 172a, extending a predetermined distance about the disc. The purpose of this construction will later be described.

As my improved pump is especially intended for pumping mud in the drilling of oil wells, in order to prevent the abrasive lading fluid finding its way between the working cylinders and pistons, I prefer to provide each cylinder interior with a lining of yieldable material, such as synthetic rubber and the like in the form of a bag, as shown at 173, which, when the cylinder is in its complete outward position, as shown in Figures 8 and 10 and at the right in Figure 7, is in complete elongated or extended condition preferably obtained by the use of a suitable coil spring 174, which is secured to a collar 175 which is snugly seated in the outer end of the piston 136. The inner surface of the piston at its flared outer orifice is shown provided with a plurality of annular grooves and the open end of the bag is placed across these grooves, after which suitable rings are placed over the end of the bag so as to seat the end of the bag and the rings in the piston grooves, as shown at 176 (see Figure 10). The bag is then brought upwardly into the cylinder as shown and the collar 175 is forced into the piston, thereby maintaining the bag and rings in the grooves; the flared flange of the collar being located within the bag, as shown, firmly holding the rings and the lower or open end of the bag in place and thereby sealing off the interior of the cylinder. As is apparent from the construction shown, the mud or abrasive laden fluid which enters the cylinder is kept in separated relation with the lubrication and reciprocating surfaces of the pump. The bag 173 is made tapering toward its open end and the spring 174 is in the form of a spiral in keeping with the taper of the bag, so that the bag, except at its closed end, is not in contact with the walls of the cylinder, but remains in spaced relation therewith, as more clearly shown in Figure 10, thereby providing a lubricant holding space or chamber between the bag and the inner or piston contacting walls of the cylinder.

The oil for this space or chamber is introduced through the port 177, which leads to the bottom of sleeve 161; the port 177 extending beyond the bottom of sleeve 161, to the exterior of the hub portion 160 in order that the lubricant may be initially introduced; the outer end of the port being closed by a screw-plug 178.

The upper end of port 177 terminates in an annular groove 179 (see Figure 10) on the outer wall of the piston and hence in communication with the inner surface of the cylinder; the piston outer surface above the groove 179 being formed to permit the lubricant to flow into the space between the separating bag 173 and the inner wall of the cylinder. When the cylinder 139 is in its maximum outward position, the lubricant will be in the space between the separating bag or member 173 and the inner wall of the cylinder as shown in Figure 10; but during the downward or inward reciprocatory movement of the cylinder, the oil is forced upwardly by the piston and pockets above the inner closed end of the separating

bag, which will assume the inwardly dished condition shown in the lower cylinder and the cylinder at the left in Figure 7; this condition being reversed during the intake stroke or cycle of the cylinder, at which time the oil again pockets in the space at the side of the separating bag, as shown in Figure 10.

During the reciprocation of the cylinder some lubricant may seep past the piston rings and flow down within the bag 152 to the cavity 151 from whence it will flow through port 158 into the cavity 159 communicating with the interior of the pressure bag 170. Bag 170 is constructed so as to normally assume an elongated condition, causing plunger member 168 to move outwardly, thereby uncovering ports 164 in sleeve member 161. With the construction shown in Figure 10, there will be no pressure in the plunger member 168, with the result that the oil within pressure bag 170 will readily flow through ports 164, into sleeve 161, and as the plunger member 168 moves downwardly, the oil in sleeve 161 will be placed under pressure, closing ports 164, forcing the oil down through valves 166 and 162 and into port 177, leading back to the lubricant holding space intermediate separating bag 173 and the cylinder wall.

In the event of failure of valve 162 during high pressure in the pump operation, the lubricant would enter sliding valve member 165, and by reason of valve 166 cause slide valve member 165 to move upwardly against its spring 167 and thereby close off ports 164.

Circulation of the accumulated oil which escaped into cavity 151 is induced by reciprocation of plunger member 168 produced by the eccentric portion 172a of the flanged disc 172, shown in Figure 9, which point is reached by plunger member 168 when the pump cylinder begins its suction or intake stroke, which condition continues to a predetermined moment momentarily in advance of the beginning of the compression stroke of the pump cylinder 139.

It will be understood, as shown in Figure 9, that each pump piston and cylinder is provided with the oil circulating means just described.

In order that the operator may determine the condition of the oil circulating means, I provide sight openings as at 179, adjacent each cavity 159.

My improved pump is designed to be practically free of pulsations, because the cylinders travel at the same speed during the discharge period, thus consumes less power and results in less valve wear due to their softer action, plus the fact that the pump is capable of automatically regulating its stroke to balance the discharge fluid with the pressure and the horsepower.

The structure shown and described is believed to be the best embodiment of my invention, but structural modifications are possible and may be made without, however, departing from the spirit of my invention as defined in the appended claims.

What I claim is:

1. A variable stroke radial cylinder type pump comprising a tiltably mounted enclosure provided interiorly at its inner perimeter with a concentric annular trackway tiltable therewith; a non-shifting rotatable hollow shaft disposed transversely through said enclosure and normally concentric therewith for conveying fluid material into and from the pump the ends of said shaft each having a spring controlled valve; a plurality of hollow pistons radially arranged about and secured to said hollow shaft and in constant communication therewith; cylinders reciprocatingly mounted on said pistons with their outer ends arranged in operative relation with said enclosure; means secured to the sides of said cylinders arranged to ride on said trackway whereby the cylinders are moved through their intake and discharge strokes when said enclosure is tilted into eccentric relation with said hollow shaft; power operated means whereby said hollow shaft with the piston and cylinder assemblies are rotated; and yieldable automatic means connected with said enclosure and with the discharge end of the pump for yieldingly tilting the enclosure into eccentric relation with said hollow shaft whereby the pressure encountered by the pump automatically regulates the degree of eccentricity between said enclosure and said hollow shaft.

2. A variable stroke radial cylinder type pump comprising a tiltably mounted annular enclosure; a non-shifting hollow shaft disposed transversely through said enclosure and normally concentric therewith, the ends of the shaft being provided with self-closing valves operable in the direction of flow; a plurality of hollow pistons radially arranged about said shaft and in constant communication therewith; cylinders reciprocatingly mounted on said pistons with their outer ends arranged in operative relation with said enclosure; a ring member secured to the enclosure interior; secured to the sides of each cylinder and adapted to ride on said ring member whereby the cylinders are maintained in operative relation with said enclosure and made to reciprocate; power operated means whereby said hollow shaft with its associated piston and cylinder assemblies are rotated; and automatic means for moving said enclosure into eccentric relation with the hollow shaft and piston and cylinder assemblies, said automatic means having communication with the discharge end of said shaft and being adapted to automatically regulate the degree of eccentricity in keeping with the pressure encountered at the discharge end of the pump.

3. A variable stroke radial cylinder type pump comprising a tiltably mounted housing with an enlarged central opening and provided with an annular shoulder; a non-shiftable hollow shaft for conveying fluid material to and from the pump and disposed transversely through said central opening; the housing and shaft normally being in concentric relation; a plurality of hollow pistons radially secured to the hollow shaft in constant communication with the shaft interior; cylinders reciprocatingly mounted on the pistons; arcuate pressure distributing means intermediate the outer ends of the cylinders and the housing adapted to travel with the cylinders and maintain frictional relation between the cylinders and housing; means secured to each cylinder and adapted to ride on said annular shoulder whereby the cylinders are reciprocated and their outer ends maintained in contact with said pressure distributing means; power operated means whereby said hollow shaft with the piston and cylinder assemblies are rotated; and fluid pressure controlled means for automatically holding the housing in eccentric tilted relation with said hollow shaft and for regulating the degree of eccentricity in keeping with the pressure developed at the discharge end of the pump.

4. A variable stroke radial cylinder type pump comprising a tiltably mounted housing oscillative about a power imparting shaft and provided interiorly with an annular trackway arranged

intermediate the outer perimeter and the axis of the housing; a non-shifting rotatably mounted hollow shaft disposed centrally through said housing, with non-rotating inlet and outlet couplings secured to opposite ends; a plurality of hollow pistons radially arranged on said shaft in constant communication with the shaft interior; cylinders reciprocatingly mounted on the pistons; means secured to the sides of the cylinders and provided with rockable elements slidable on said trackway whereby outward reciprocation of the cylinders is induced when the housing is tilted and said trackway moved into eccentric relation with said shaft and the reciprocating strokes of the cylinders controlled by the degree of eccentricity; gear mechanism intermediate said power shaft and the hollow shaft whereby said shaft, piston and cylinder assemblies are rotated; and pressure fluid operated means arranged in communication with the discharge end of the pump and operatively connected with said housing for controlling the tilt of the housing and the eccentric relation between said trackway and the axis of said shaft and whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power shaft.

5. A variable stroke radial cylinder type pump comprising a tiltably mounted housing provided interiorly with an annular trackway; a non-shifting rotatably mounted hollow shaft disposed transversely through said housing with valved inlets and outlets at opposite ends; a plurality of hollow pistons radially disposed on said shaft with their inner ends open to the shaft interior; cylinders reciprocatingly mounted on the pistons; means associated with the trackway and connected with the sides of said cylinders whereby outward reciprocation of the latter is induced when the housing is tilted and said trackway moved into eccentric relation with said shaft and the reciprocatory strokes of the cylinders controlled by the degree of eccentricity; power operated means whereby said shaft, piston and cylinder assemblies are rotated; and automatic means having communication with the discharge end of the pump and operatively connected with said housing for controlling the tilt of the housing and the eccentric relation between said trackway and the shaft axis, whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power operated means, said means involving a fluid controlled piston having link connection with the housing and controlled by the pressure of the fluid discharging from the pump whereby pressures created during the compression strokes of the cylinders are balanced.

6. A variable stroke radial cylinder type pump comprising a tiltably mounted housing provided with an annular trackway; a non-shifting rotatable hollow shaft disposed transversely through the housing, provided with inlet and outlet openings at opposite ends; a plurality of hollow pistons radially disposed about said shaft in communication with the shaft interior; cylinders reciprocatingly mounted on the pistons and provided with outer arcuate ends; a ring gear in the housing disposed about the outer ends of the cylinders; pressure distributing arcuate shoes intermediate the arcuate ends of the cylinders and the inner perimeter of the ring gear; means associated with the trackway and with the cylinders whereby outward reciprocation of the latter is induced when eccentric relation between the trackway and the axis of said shaft is provided, said means involving extended portions at the sides of the cylinders provided with arcuate ends of predetermined degrees of arcuation to permit relative tilting movement between the cylinders, trackway and said shoes and maintain the cylinder heads and the pressure shoes in contact with said ring gear; power operated means whereby said shaft with the piston and cylinder assembles and said ring gear are rotated; and automatic means operatively connected with the housing for controlling the tilt of the latter and the eccentric relation between said trackway and the axis of said shaft and whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power operated means.

7. A variable stroke radial cylinder type pump comprising a tiltably mounted housing; a non-shifting rotatable hollow shaft disposed transversely through the housing, provided with valved inlets and outlets at opposite ends; a plurality of hollow pistons radially disposed about said shaft in communication with the shaft interior; cylinders reciprocatingly mounted on the pistons and provided with arcuate heads; a ring gear in the housing disposed about the outer ends of the cylinders; pressure distributing arcuate shoes intermediate the arcuate heads of the cylinders and the inner perimeter of the ring gear; a trackway secured to and arranged within the ring gear; saddle members arranged on the trackways; arcuate ended plates secured to the sides of the cylinders with their opposite ends in contact with said shoes and said saddle members, whereby relative tilting movement between the cylinders, saddle members and shoes is permitted and the cylinder heads and pressure shoes are maintained in contact with said ring gear, said plates and the shoes having intermeshing toothed relation with each other; power operated means whereby said shaft with the piston and cylinder assemblies and said ring gear are rotated, said means constituting the fulcrum point for the tiltable housing; and automatic means operatively connected with the housing for controlling the tilt of the housing and the eccentric relation between the ring gear and the axis of said shaft and whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power operated means.

8. A variable stroke radial cylinder type pump comprising a non-shifting rotatable hollow shaft with inlets and outlets at its opposite ends; a plurality of hollow pistons radially disposed about the shaft and in communication with the shaft interior; cylinders reciprocatingly mounted on the pistons; yielding cylinder lining elements arranged within the cylinders adapted to maintain the material being pumped out of contact with the cylinder contacting surfaces of the pistons; a housing disposed about the piston and cylinder contacting surfaces of the pistons; a housing disposed about the piston and cylinder assemblies and said hollow shaft, adapted to swing into eccentric relation with said shaft; means operatively intermediate the housing and said cylinders whereby reciprocation of the latter is induced when said housing is moved into eccentric relation with said shaft and the degree

of cylinder reciprocation controlled by the degree of eccentricity; power actuated means whereby the shaft and piston and cylinder assembles are rotated; and regulable automatic means operatively connected with said housing for controlling the tilt of the housing, whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power actuated means.

9. A variable stroke radial cylinder type pump comprising a power operated shaft; a housing tiltably mounted on said shaft and provided with an enlarged central opening; a non-shifting rotatably mounted hollow shaft disposed transversely through the central opening in the housing and having inlet and outlet openings at its opposite ends; a plurality of hollow pistons radially disposed about said hollow shaft in communication with said shaft interior; cylinders reciprocatingly mounted on said pistons; yielding cylinder lining elements arranged within the cylinders so as to provide lubricant holding cavities intermediate said elements and the cylinder interior and adapted to maintain the material being pumped out of contact with the piston contacting surfaces of the cylinders; means whereby lubricant is introduced into said cavities; means operatively intermediate the housing and said cylinders whereby reciprocation of the latter is induced when the housing is tilted into eccentric relation with said hollow shaft and the degree of cylinder reciprocation controlled by the degree of eccentricity; and regulable automatic means operatively connected with the housing for controlling the tilt of the housing, whereby the pressure against which the pump operates automatically regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power operated shaft.

10. A variable stroke radial cylinder type pump comprising a power operated shaft; a housing tiltably mounted on said shaft and provided with an enlarged central opening; a non-shifting rotatably mounted hollow shaft disposed transversely through the central opening in the housing and having inlet and outlet openings at its opposite ends; a plurality of hollow pistons radially disposed about said hollow shaft in communication with said shaft interior; cylinders reciprocatingly mounted on said pistons; yieldable cylinder lining elements arranged within the cylinders so as to provide lubricant holding cavities intermediate the elements and cylinder inner walls and adapted to maintain the material being pumped out of contact with the lubricant and the piston contacting surfaces of the cylinders; plunger mechanisms whereby lubricant is introduced into said cavities and the lubricant escaping from said cavities is automatically returned thereto; means whereby said plunger mechanisms are actuated during rotation of said hollow shaft when the escaped lubricant reaches a predetermined amount; means operatively intermediate the housing and said cylinders whereby reciprocation of the latter is induced when the housing is tilted into eccentric relation with said hollow shaft and the degree of reciprocation controlled by the degree of eccentricity; and regulable automatic means operatively connected with the housing for controlling the tilt of the housing, whereby the pressure against which the pump operates automatically

regulates the cylinder stroke to provide the maximum volume commensurate with the horsepower applied to said power operated shaft.

11. In a variable stroke radial cylinder type pump of the character described involving cylinders reciprocatingly mounted on hollow pistons radially disposed about a rotatably mounted hollow shaft with which the pistons communicate, a lubricating system for the reciprocating cylinders comprising yieldable lining elements arranged within the cylinders adapted to provide lubricant holding cavities at the outer ends of the pistons and to maintain the material being pumped out of contact with the lubricant and the piston contacting surfaces of the cylinders; distensible envelopes disposed about the sides of the cylinders, secured adjacent the outer ends of the cylinders and at the bases of the pistons for pocketing lubricant escaping from said cavities; telescopic shells secured to the outer ends of the cylinders and to the bases of the pistons whereby said envelopes are maintained adjacent the cylinder walls and the pocketed lubricant placed under pressure by the compression strokes of the cylinders; plunger mechanisms adapted to receive the pocketed lubricant expressed during the compression strokes of the cylinders whereby said lubricant is automatically returned to said first mentioned lubricant holding cavities during the suction strokes of the cylinders; and means arranged in the paths of the plunger mechanisms whereby the latter are actuated during rotation of the hollow shaft when the escaped lubricant reaches a predetermined amount.

12. In a variable stroke radial cylinder type pump of the character described having cylinders reciprocatingly mounted on hollow pistons radially arranged about a rotatably mounted hollow shaft with the pistons communicating with the shaft interior, said hollow shaft being provided with a plurality of fluid conveying channels with a seperate channel communicating with each piston and each channel extending to opposite ends of the shaft; spring controlled valves at both ends of each channel with the valves at the inlet ends of the channels adapted to open during the suction strokes of the cylinders while the valves at the outlet ends of the channels are adapted to open during the compression strokes of the cylinders; an outer housing whose side walls are provided with inwardly disposed annular flanges having anti-friction bearings; a ring gear with annular side walls arranged on said antifriction bearings, the inner perimeters of said side walls having inwardly disposed annular flanges; extensions on the sides of the cylinders adapted to ride on said last mentioned annular flanges whereby the cylinders are moved through their suction strokes; and power operated means whereby the ring gear, the piston and cylinder assembles and the hollow shaft are rotated in unison.

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