Sept. 26, 1950 J. E. SMITH 2,523,543

VARIABLE STROKE RADIAL PUMP

Filed April 29, 1946 5 Sheets-Sheet 1

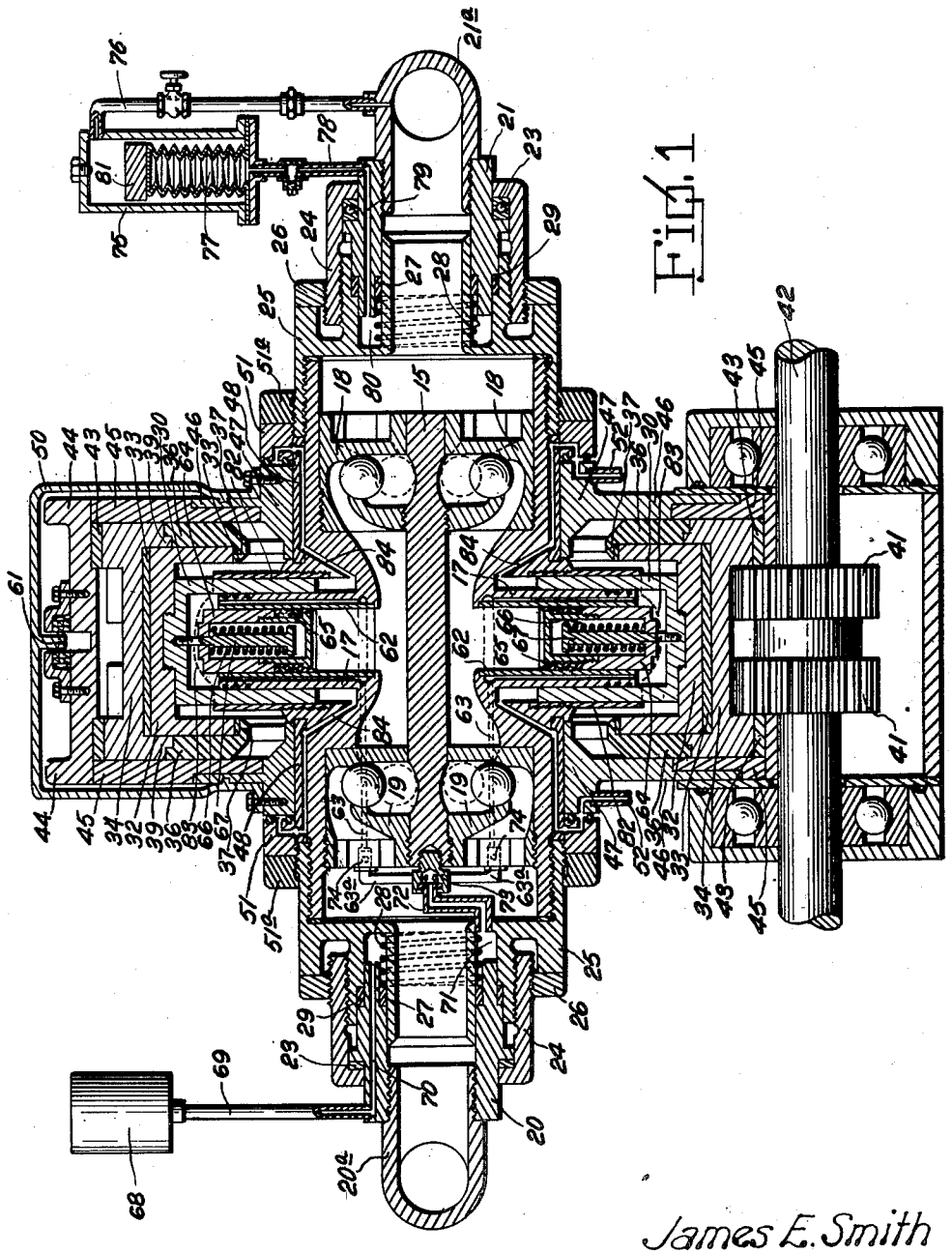


Fig. 1

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VARIABLE STROKE RADIAL PUMP

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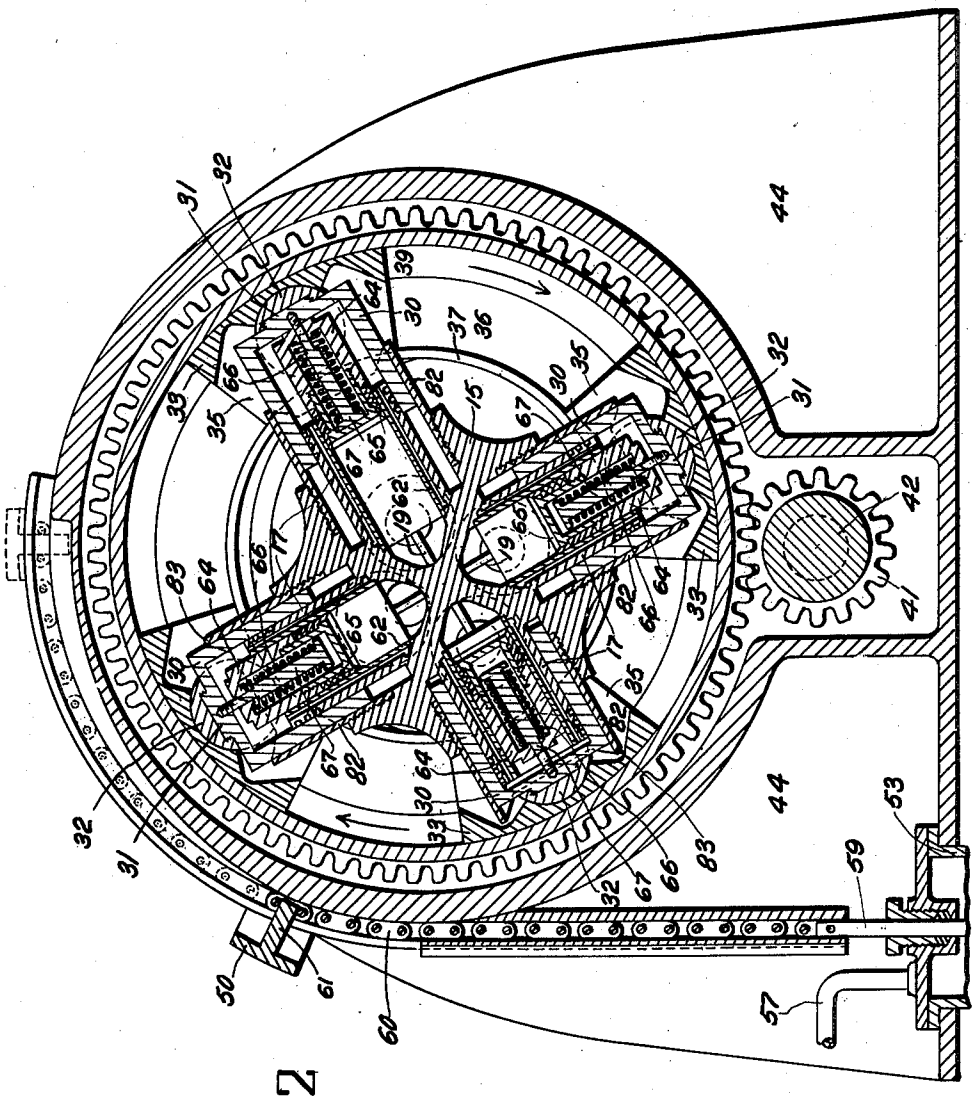


Fig. 2

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Sept. 26, 1950 J. E. SMITH 2,523,543

VARIABLE STROKE RADIAL PUMP

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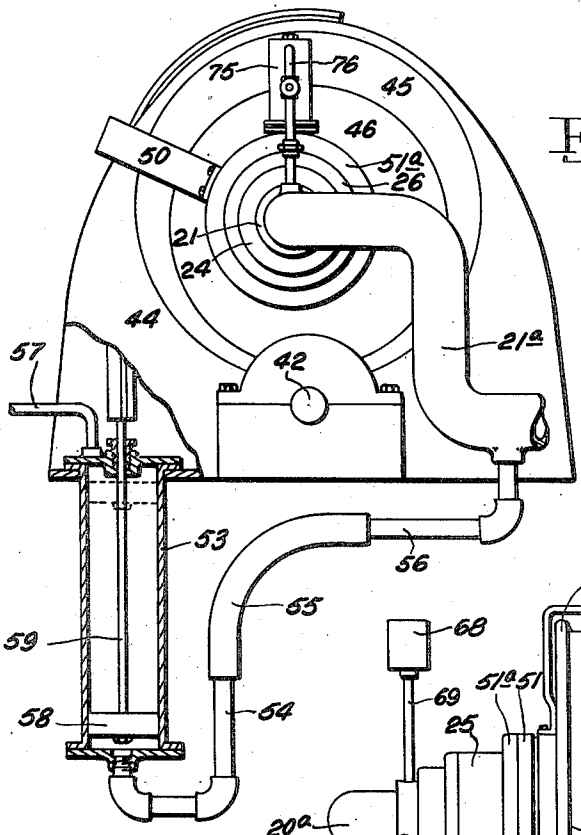


Fig. 3

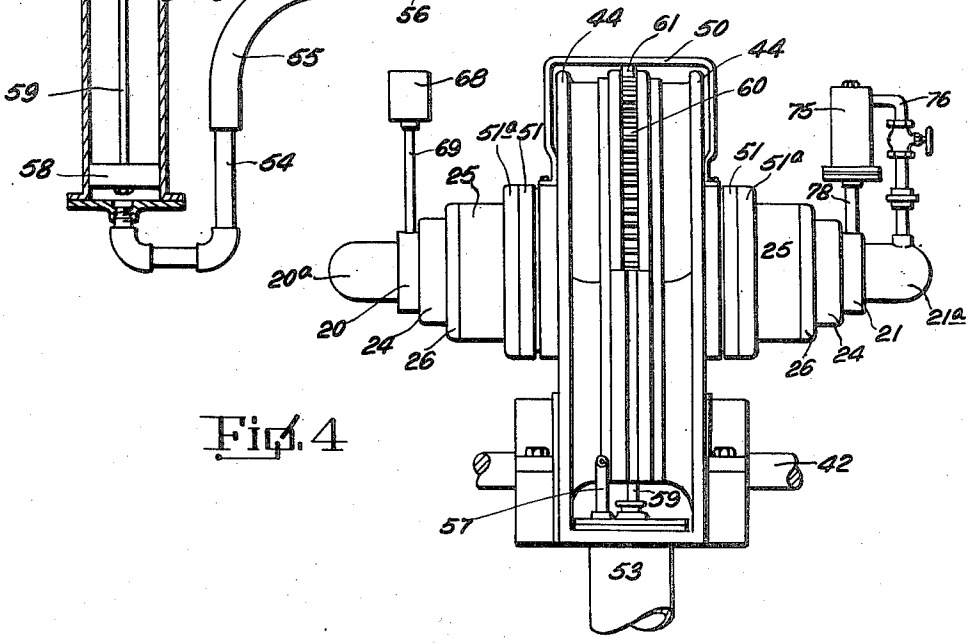


Fig. 4

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VARIABLE STROKE RADIAL PUMP

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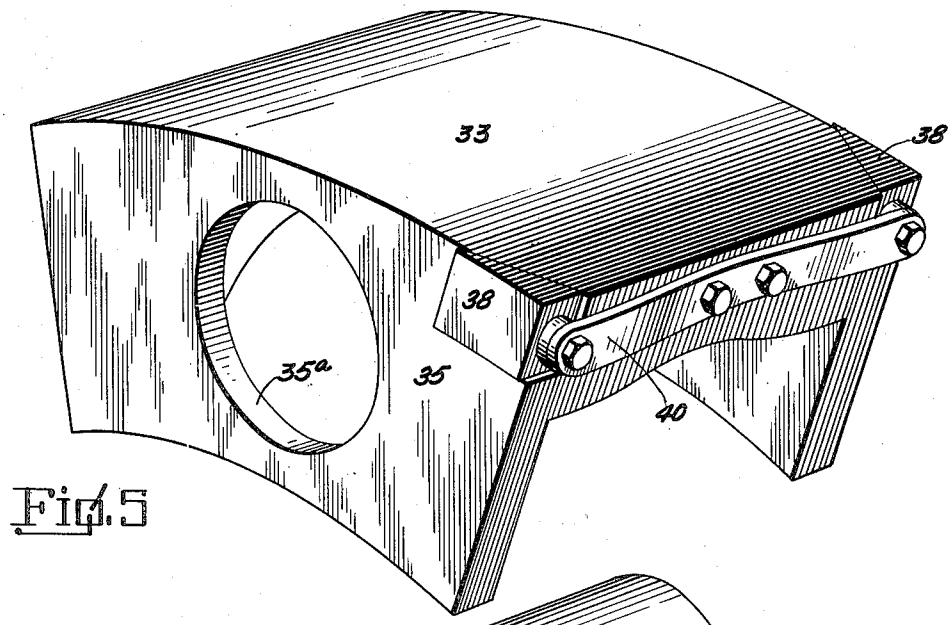


Fig. 5

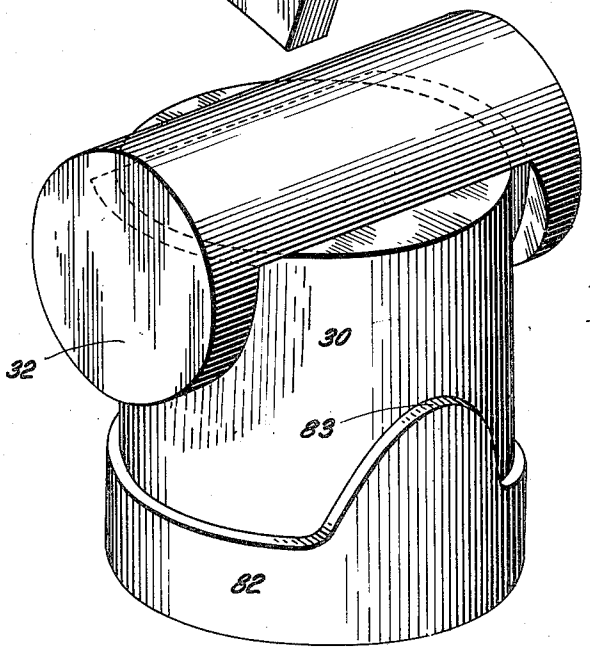


Fig. 6

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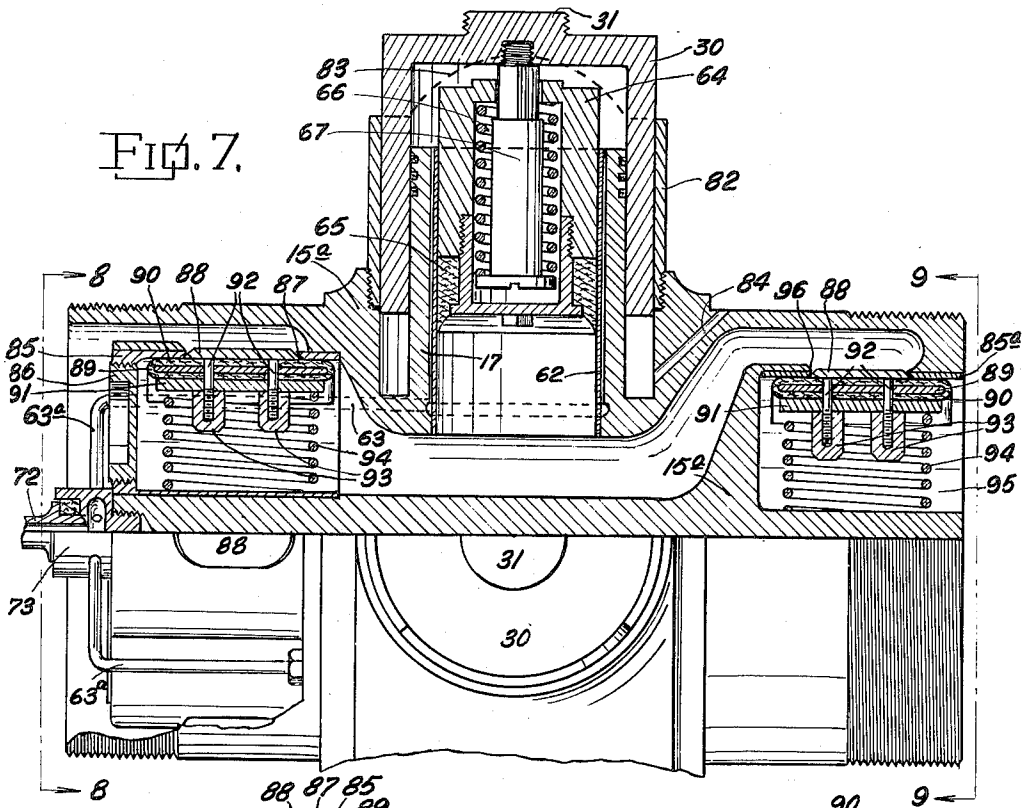
ATTORNEY

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VARIABLE STROKE RADIAL PUMP

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Fig. 7.



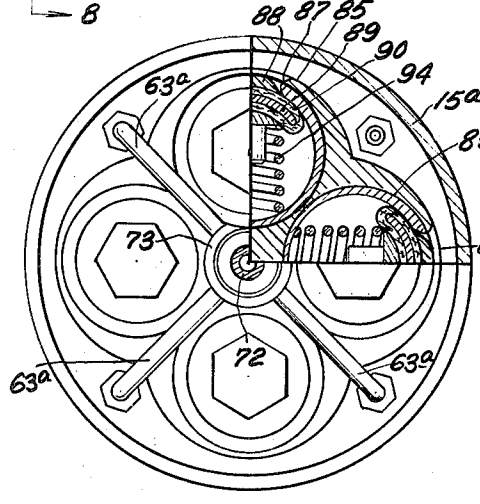


Fig. 8.

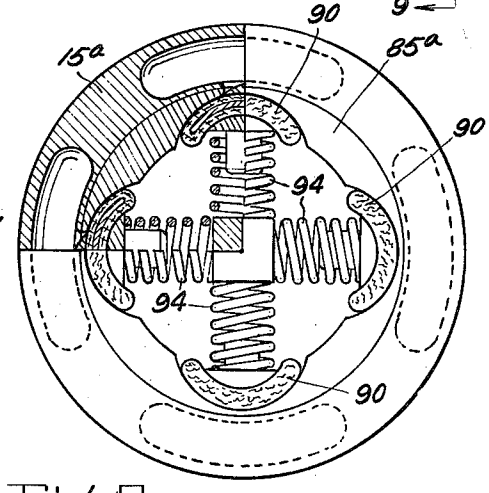


Fig. 9.

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Patented Sept. 26, 1950 2,523,543

UNITED STATES PATENT OFFICE

2,523,543

VARIABLE STROKE RADIAL PUMP

James E. Smith, Pittsburg, Tex.

Application April 29, 1946, Serial No. 665,723

11 Claims. (Cl. 103—161)

1

My invention relates to a radial pump with a variable stroke having a fixed axis or hollow shaft provided with radially disposed hollow pistons and associated reciprocatory cylinders controlled by means arranged to have variable eccentric relation with the hollow shaft; the relation between the means and shaft being automatically regulated in keeping with the pressure resistance at the discharge of the pump.

My improved pump is especially intended for pumping fluids of a type normally injurious to the movable elements, namely the telescopic surfaces of the pistons and cylinders; the invention, more specifically stated, contemplating means whereby the fluid which passes through the pump is maintained out of direct contact with the slidingly opposed surfaces of the pistons and cylinders and separation between the lubricating oil and the mud or fluid will be maintained.

The invention has for one of its objects the provision of an efficiently operable structure wherein excessive wear will be eliminated and so constructed that accessibility to the various moving parts may be readily had.

The objects and advantages of the invention will be readily comprehended from the following detailed description of the accompanying drawings wherein:

Figure 1 is a longitudinal sectional view of my improved pump with one element in elevation.

Figure 2 is a transverse sectional view through the main portion of the pump.

Figure 3 is a view showing the discharge end of the pump, with a partial section showing the cylinder which regulates the stroke, in full stroke position.

Figure 4 is a side view of Figure 3 showing piston of stroke control cylinder at top, at which position center shaft of the pump is in center of housing, or, non-pumping position.

Figure 5 is a detail perspective of one of the cylinder control shoes.

Figure 6 is a detail perspective of the upper end of a cylinder and its guide sleeve, with a cylinder rocker pin.

Figure 7 is a partial longitudinal sectional view and side elevation of the hollow shaft with one of the integral pistons and associated cylinder and inlet and outlet valves in cross-section and illustrating a modified form.

Figure 8 is a partial end and sectional view of the modified hollow shaft as viewed along the line 8—8 of Figure 7.

Figure 9 is a view, partly in section, as viewed at the line 9—9 of Figure 7.

2

The invention relates to the type of variable stroke radial pump shown and described in my pending application Serial Number 549,025, now Patent 2,417,183, issued March 11, 1947; with the pumping action preferably automatically controlled by the degree of eccentric relation between the cylinder controlling and encompassing shell or means and the axis of the piston carrying hollow shaft; the shifting of the encompassing shell or means being effected by means actuated by the pressure resistance at the discharge of the pump.

The pump involves a rotatable suitably mounted hollow shaft 15, which is internally provided with diagonal or criss-cross webs 16 (see Figure 2) whereby the shaft is provided with a plurality of channels in keeping with the number of pistons 17 which preferably are formed integral with the shaft—each piston communicating with a different channel. The hollow shaft 15 extends transversely through the pump, with the outlet end of each channel preferably provided with a removable ball valve containing shell 18 (at the right in Figure 1), while the inlet end of each channel is provided with a removable ball valve containing shell 19 (at the left in Figure 1); the valves at both ends being adapted to open in the direction of the flow.

The left hand end of shaft 15 is shown provided with an inlet coupling 20 for the inlet pipe elbow 20a; and the other end of the shaft is provided with an outlet coupling 21 for the outlet pipe elbow 21a. The couplings are of similar construction and each provided with a flange 22 to provide a seat for the anti-friction bearings 23, held in place by the inturned flange on each outer nut member 24 which is threaded on the externally threaded skirt of coupling member 25, and is held in locked position by nut 26, on its externally threaded inner end. Coupling members 25 at the inner ends are internally threaded to receive the threaded enlarged ends of the hollow shaft 15 in which the inlet and outlet valves are removably located. The outer ends of coupling members 25 receive the inner packing 27 and the circumventing springs 28 for maintaining the packing 27 under continuous pressure, as well as the inner sleeve portions of couplings 20, 21; the inner ends of the sleeve portions having reduced extensions to receive the outer packing 29. Compression of the outer packing is obtained by screwing up nuts 24, and held securely by lock nuts 26 which are threaded to receive the outer threaded inner ends of nuts 24.

All of the elements with the exception of the

inlet and outlet couplings 20 and 21 are intended to rotate with the hollow shaft 15; these elements being designed to maintain fluid tight connections.

The hollow pistons 17 are open ended and of predetermined size and length with their outer surfaces preferably provided with suitable packing rings to effect fluid-tight relation with the open-ended cylinders 30. The outer ends or heads of the cylinders 30 each are shown formed with an externally threaded boss 31 which is threaded into a tapped hole in a rocker pin or arcuate member 32 (see Figures 1 and 2) to provide the heads or outer ends of the cylinders 30 with a predetermined degree of arcuation or rounded surfaces which bear against similar arcuated inner sides of shoes 33; the rocker pins 32 each having a cut-out segment to receive the upper end of its respective cylinder as shown in Figure 6.

The rocker pin 32, at the outer end of each cylinder, fits into and has bearing contact in a concavity formed in a slidably mounted shoe 33. The shoes 33 are adapted to travel with the cylinders and provide greater bearing area between the cylinders 30 and the surrounding ring gear 34, in order to distribute the compressive force between the cylinders and the ring gear 34. The arcuation of members 32, which swivel or rock in similarly arcuated sockets on the inner sides of the shoes 33, are intended to constantly maintain the compressive force against cylinders 30, during rotation of the pump, toward the center of the line of travel, telescopically on the plungers or hollow pistons 17, to eliminate binding or friction.

Opposite sides of the shoe 33 are provided with inturned flanges 35, 35, which are provided with holes 35a (see Figure 5) to receive the annular ends of the rocker pin 32.

The sides of the ring gear 34 are provided with closure plates 36 which are provided with inturned arcuate flanges 37, which constitute trackways for the flanges 35 of the shoes 33.

It is essential that the shoes 33 have free rotative relation with the respective rocker 32 and that the shoes 33 be of predetermined arcuation to maintain continuous contact or operative relation between the ends of the cylinders 30 and with the inner circumference of the ring gear 34 during rotation, regardless of the degree of eccentricity between the axes of the hollow shaft and the ring gear.

The shoe members 33 on their outer perimeters, adjacent their rear ends, are provided with tapering wedges 38, 38 which are located opposite each other so as to effect binding relation between the shoes 33 and the inner sides of flanges 39, 39 of ring gear 34 (see Figures 1 and 2) when the cylinders 30 have reached their maximum cycle of elongation (see upper right hand side Figure 2) namely after it has completed its suction cycle and begins its compressive or discharge cycle.

The wedges 38, 38 (on each shoe) are yieldingly maintained in operative position by a flat or leaf spring 40 (see Figure 5) which is secured to the rear end of the shoe with its ends secured to the wedges 38, 38. These spring held wedges 38, 38 will sufficiently release their binding effect or relation with the ring gear flanges 39, 39 when the maximum compressive or discharge cycle of the combined cyclinder-piston unit has been reached and the suction cycle begins, thus permitting the shoe (which travels in a greater arc than its radius from the center of the piston shaft 15) to somewhat advance in its rotative path—that is to say that the shoe may travel at a greater rate of speed than the forward movement of the ring gear and thus permit the shoe to maintain its proper alignment with the combined cylinder-piston unit.

The ring gear 34 is driven by pinion gears 41 mounted on a power driven shaft 42, driven from a suitable source of power not shown.

The outer perimeters of ring 34 ride on antifriction or bronze bearings 43 (see Figure 1). The opening through the ring gear 34 is closed by plates 36 which are provided with comparatively large central openings to permit eccentric movement of the ring gear 34 relative to the central shaft assembly.

The elements heretofore described are enclosed in an outer casing or housing consisting of the outside annular shell 44 with large openings through its sides and the ends of the openings are preferably provided with eccentric non-rotating plates 45 whose inner perimeters are flanged to receive the outer flanged portion of central eccentric plates 46 which may have partial rotation to control the degree of eccentric relation between the piston carrying shaft 15 and the ring gear 34. The inner openings in plates 46 have enlarged portions or hubs 47 which receive bearings 48 attached to the outside of hollow shaft 15 by which means the central shaft assembly rotates. Adjacent to the outer ends of hubs 47 are packing rings 51 which are threaded on their inner sides to receive the outer threads on the inner ends of coupling members 25. Lock rings 51a are provided with threads on their inner sides to receive the outer threads of the inner ends of coupling members 25. The hubs 47 of eccentric plates 46 are provided with drain tubes 52, see Figure 1.

Means are provided preferably in the form of a U-shaped strap or member 50 whose inner ends are attached to each hub 47 of the eccentric plates 46 and to the outer faces of the eccentric plates 46 to hold hub members 47 in working alignment as well as provide means for the shifting of the center of ring gear 34 into eccentric relation with the central shaft assembly, which action regulates the length of the stroke at which the pump will operate.

The length of the pumping stroke is intended to be automatically regulated by the pressure or resistance against the discharge end of the pump. Means are provided preferably by a pressure cylinder 53 (shown at the left in Figure 3), which is connected to the discharge end of the pump through a pipe 54, a flexible coupling 55 and a pipe 56, which latter is connected to the discharge end of the pump, namely to outlet 21a.

Entering into the upper end of cylinder 53 is a pipe connection 57, which connects with a suitable air pressure control chamber (not shown); the size of which will vary according to the cubic content of air which may be necessary to the demands of the pressures desired, to suit the operational needs.

Working within cylinder 53 is piston head 58 attached to the lower end of piston rod 59. The upper or opposite end of rod 59 is in turn attached to the lower end of flexible chain 60. The upper or opposite end of chain 60 is slidably connected to a pin 61 carried by the U-shaped strap or member 50 which is operatively connected with and controls eccentric plates 46—46 from the position shown in Figure 3—which is full stroke po-

sition with the piston **58** as shown to the extreme neutral or dead center position of shaft **15** with the associated cylinder-piston units, namely with the U-shape strap in the dotted line position shown at the top in Figure 2 and also in Figure 4, at which time piston **58** will be at the dotted line position shown in Figure 3.

The amount of air pressure and the size of air chamber used will be of such size to force piston **58** downwardly against the pressure at the discharge end of the pump with sufficient predetermined force to maintain full stroke pumping action.

As my improved pump is especially intended for pumping mud used in the drilling of wells, I provide means for preventing the intermingling of the pump fluid and the lubricant. This means consists of an open-ended sleeve **62** in each hollow piston **17** and extends throughout the length of the piston; the outside diameter of the sleeve being somewhat smaller than the inside diameter of the hollow piston so as to provide space therebetween for passage of lubricant. Communicating with the bottom of this space between each sleeve and piston is a port **63** which communicates with a pipe **63a** for supplying lubricant which flows from a supply source through the intake end of the pump, thereby maintaining a lubricant supply within each cylinder. Slidably mounted within each sleeve **62** is a floating or separating auxiliary or diaphragm cylinder **64**, whose outer side walls are preferably provided with wiper rings **65**, as shown in Figures 1 and 2, which may be of synthetic rubber or other suitable material. These wiper rings function to keep the pump-mud or fluid from mingling with the working fluid or lubricant intermediate the auxiliary or diaphragm cylinder **64** and the main cylinder **30**. The quantity of working fluid or lubricant required in each cylinder **30** would normally be the amount required to fill the cavity between the auxiliary or diaphragm cylinder **64** and the main cylinder **30** when the former is at its greatest extended position, as shown at the upper right hand side in Figure 2. A coil spring **66** is arranged in each diaphragm cylinder **64** with its lower end pressing against the enlarged head or inner end of a bolt **67** (mounted in each diaphragm cylinder **64**) and its opposite end pressing against the inside head of the diaphragm cylinder **64**.

Connected with the intake end of the pump (see left hand side Figure 1) is a lubricant supply chamber **68**, the bottom of which has a pipe **69** connected with a port **70** in coupling member **20**. This permits the passage of the lubricant or working fluid into an inner chamber **71** in coupling member **25**. A pipe **72** is attached to the coupling member **25** and provides means of passage for the lubricant or working fluid from inner chamber **71** to a plug **73** fitted into the center of the intake end of the hollow shaft **15** and rotates therewith. The plug **73** is provided with the pipes **63a** which provide passage for lubricant through check valves **74** communicating with the drilled ports **63** which lead to the inner spaces between the outside of inner sleeves **62** and the inner sides of pistons **17**. The check valves **74** permit passage of the lubricant from supply chamber **68** to the interior of the cylinders **30**, but prevent return or backward passage of the lubricant. The supply chamber **68** is preferably arranged in elevated position to provide gravity flow of lubricant or working fluid to the inner chamber **71** within member **25** which chamber is closed to outer escape of the lubricant by outer packing **29** and to its inward escape by inner packing **27**. Inner packing **27** is held compressed from within by spring **28** while the outer packing is compressed by nut **24**.

At the discharge end of the pump (see right hand side of Figure 1) I provide a chamber **75** having a pipe **76** which extends into the discharge end of the pump. Within the chamber **75** is a fluid tight bellows **77** whose lower end communicates with a pipe **78** which communicates with a drilled hole **79** in coupling member **21**, thereby providing means of passage for lubricant into lubricant-holding cavity **80** formed within member **25**. Pressing against the top of bellows **77** is a weight **81** which provides sufficient pressure against the lubricant in bellows **77** to force lubricant to the moving or swiveling bearings at the discharge end of the pump. As the lubricant from bellows **77** diminishes, an equal amount of the pump fluid passes through pipe **76** to chamber **75** which functions to equalize the pressure in chamber **75**, plus the added pressure provided by weight **81**.

During revolution of the pump, inducing reciprocation of the cylinders **30**, diaphragm or auxiliary cylinder **64** is placed into compressive action against the incoming fluid or mud, and due to the fact that the cubic area on the inside of the cylinder **30** is greater than the cubic area of the outside of diaphragm or auxiliary cylinder **64**, the working fluid or lubricant within cylinder **30** will cause auxiliary cylinder **64** to move inwardly at a slightly greater rate of speed than cylinder **30**.

The diaphragm or auxiliary cylinder springs **66** are intended to maintain an expanding action or compressive force against the lubricant or working fluid within the main cylinders **30**. The purpose of this action is to maintain pressure on the lubricant at a slightly higher degree than that attained by the mud or fluid pumped, with the result that if there is any leakage between diaphragm cylinder **64** and the sleeve **62** it would be lubricant leaking into the mud and not mud passing the wiper rings **65** on the lower end of the diaphragm cylinder **64**. As the lubricant or working fluid within cylinder **30** may be used or diminished during operation of the pump it will be replaced during the suction or intake cycle produced by elongation of cylinder **30** over piston **17** induced by rotation of the pump. When the cavity or space between the inside of cylinder **30** and the outside of diaphragm cylinder **64** is properly filled with the correct amount of lubricant or working fluid, the diaphragm cylinder **64** will bottom, or be forced by the action of spring **66** against the inside of the closed end of cylinder **30** at the moment the compression or discharge cycle begins (see upper right hand side Figure 2). Should a portion of the lubricant leak into the mud or pumped fluid during the rotation through the compression or discharge cycle, diaphragm cylinder **64** would bottom, or contact the inside end of the cylinder **30**, before the compression cycle begins. At such time the compressive action of spring **66** cannot be effective against the lubricant surrounding diaphragm cylinder **64**, and the suction or intake action from that point of the cycle to where compression begins will draw from the lubricant supply in chamber **68** an amount required to correctly refill the cavity within cylinder **30** and the outside of diaphragm cylinder **64**.

Fitted into the enlarged base portion or hub of

shaft 15 are guide shells 82 of sufficient length to surround the lower or inner ends of the pump cylinders when the latter are in maximum extended condition; the shells being intended to snugly encircle the cylinders 30 to act as guides, maintaining the proper aligned telescopic relation between the cylinders and their pistons or plungers 17 and also to catch any leakage of working fluid or lubricant that may escape past the piston rings on each of the plungers or pistons 17. The outer ends of the guide shells 82 preferably are provided with extended sides or lips 83 (see Figure 6 and in dotted lines in Figure 1) which extend past the outer end of the cylinders 30 when at maximum compressed position (see lower left side Figure 2, also Figure 6). These lips or extended portions 83 give greater support for the cylinder 30 when the latter is at its maximum extended position (see upper right hand side Figure 2).

The annular chamber formed intermediate each guide shell 82 and plunger or piston 17 is provided with a breather opening 84 which drains the cavity or chamber to the pump exterior, as shown in Figure 1.

In Figures 7, 8 and 9, I illustrate a modification more especially of the valve construction; namely a valve construction adapted to greater pressures on abrasive fluids; this modification also providing valve cases or seats that may be readily removed and easily replaced.

Figure 7 is a sectional view similar to the upper half of Figure 1, with the outer casing and cylinder reciprocating mechanism omitted as well as the inlet and outlet couplings and associated elements, shown in Figure 1 omitted, as these elements may be the same as heretofore described and illustrated. Figure 7 is on a somewhat larger scale than that of Figure 1, but insofar as piston and cylinder arrangement, cylinder operation and lubricant distribution it is substantially similar to the construction shown in Figure 1 and heretofore described.

In these figures I illustrate a different type of valve mechanism consisting of valve shells 85 removably secured in the cored ends of the hollow rotating shaft 15a; the central portion of the shaft, especially at the inlet end being cored somewhat in a four leaf clover shape, see Figure 8, and constituting the ends of the four passages in the shaft. Each inlet orifice is provided with a similar and removably mounted valve shell 85. The outlet or discharge end of the shaft may be provided with a single shell 85a, open at the ends and provided on its perimeter with four equi-spaced ports arranged in communication with the respective channels in the shaft. The respective shells 85 at their outer ends are closed by suitable closure members 86 shown screwed into the outer ends of the shells while the perimeter of each shell is provided with an inlet port 87 communicating with the common or general inlet end of the shaft. The outlet ends of the shells communicate with the respective channels in the body of the shaft.

Each inlet shell 85 contains a composite valve composed of an outer port seating metal member 88, a metal core or plate 89 which is entirely covered with rubber, as at 90 and a clamping plate 91. The port seating outer member 88 is provided with inwardly disposed threaded pins 92, which extends through the rubber pad, core plate and clamping plate, with the inner ends of the pins receiving the cap nuts 93, whereby the respective members are removably secured together.

The various members of the composite valves are given transverse arcuation as shown in Figure 8, corresponding to the inner circumference of the shells; and the rubber pad portion and its core are of larger dimensions than the outer port seating member 88 to permit the rubber pad to seat or fit snugly against the inner side of the shell around the inlet port 87, to compensate for the wearing effect of the abrasives encountered in oil well mud pumping.

Each shell 85 is provided with a suitable coil spring 94 of sufficient strength to normally hold the composite valve on its seat but not to interfere with the suction force of the reciprocating cylinder.

At the discharge end, namely at the right in Figure 7, the hub or central portion of the main shaft 15a has an annular cavity 95, at the outer end of the shaft, which is provided with the single valve cage or shell 85a provided with four ports coincident with the ports in the shaft core, as shown at 96 in Figure 7, which are coincident with the respective channels in the shaft.

The interior of the shell 85a, coincident with its ports, is convexed to receive and provide sockets for the composite valves similar to the valves at the inlet end of the shaft, except for the independent valve cages, consisting of the metallic seating member 88, core plate 89, rubber pad 90, and clamping plate 91, all secured together by means of the pins 92 and cap nuts 93; and the respective valves normally maintained on their seats by their coil springs 94 which are maintained in place by the cap nuts while their inner ends seat on a squared portion of the central hub of the shaft.

The modification shown in Figures 7, 8 and 9 is especially intended for greater pressures on abrasive fluids and at the same time provide replaceable valves, valve cages and valve seats.

I have shown and described what I believe to be the best adaptations of my invention which I have described in terms of description and not as terms of limitation as 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 pump comprising a rotatable hollow shaft adapted for fluid passage therethrough, the ends of said shaft having self-seating valves with the valves at one end of said shaft adapted to open during the suction stroke of the pump while the valves at the other end of the shaft are adapted to open during the exhaust stroke of the pump, said shaft being provided with radially disposed hollow piston members communicating with the shaft interior; cylinders reciprocatingly mounted on the piston members; a ring gear disposed about the outer ends of the cylinders in operative relation therewith; hollow plunger members slidably arranged in the outer ends of the piston members in fluid sealing relation therewith whereby the pumped fluid is maintained out of contact with the upper ends of the cylinder interiors and lubricant receiving chambers intermediate the plunger members and cylinder interiors provided; lubricant feeding means communicating with said chambers and the lubricant in the chambers during outward movement of the plunger members maintained under greater pressure than the fluid pumped; and power means whereby said ring

gear and hollow shaft with associated piston-and-cylinder assemblies are rotated.

2. A variable stroke radial pump comprising a rotatable hollow shaft with a plurality of inlet and outlet channels extending from both ends of the shaft and the ends of the shaft provided with self-closing valves at each end of the channels and operable by the pressures created in each channel, the intermediate portion of the shaft being provided with radially disposed hollow piston members, each communicating with a separate inlet and outlet channel; a cylinder reciprocatingly mounted on each piston member; a plunger member reciprocatingly mounted in each piston member and adapted to maintain the pumped fluid out of contact with the cylinder interior and to provide a lubricant receiving chamber within the outer end of the cylinder; means whereby the plunger member is placed under outwardly moving pressure; lubricating feeding means communicating with each of said chambers, said feeding means in conjunction with said plunger members being adapted to place the lubricant in said chambers under pressure; a ring gear disposed about the outer ends of the cylinders in operative relation therewith; and power means for rotating said ring gear whereby the hollow shaft with its associated piston-and-cylinder assemblies is rotated.

3. A variable stroke radial pump comprising a rotatable hollow shaft with a plurality of inlet and outlet channels extending from opposite ends toward the center of the shaft and provided with radially disposed hollow piston members, each in communication with a separate inlet and outlet channel; self-closing valves arranged at the ends of said channels with the valves at the inlet ends of the channels operable during the suction phase of the pump and the valves at the outlet ends of said channels operable during the exhaust phase of the pump; a cylinder reciprocatingly mounted on each piston member; a hollow plunger member reciprocatingly mounted in each piston member and within the associated cylinder whereby the pumped fluid is maintained out of contact with the cylinder interior and a lubricant receiving chamber within the cylinder provided; lubricant feeding means communicating with each of said chambers and the lubricant within said chambers placed under pressure; an annular member disposed about the outer ends of the cylinders; means operatively associated with the ends of the cylinders and slidingly engaging the inner perimeter of the annular member; means whereby a binding frictional relation between said last mentioned means and the annular member is effected during predetermined periods of pump rotation; and power means for rotating said annular member whereby the hollow shaft with its associated piston-and-cylinder assemblies is rotated.

4. A variable stroke radial pump comprising a rotatably mounted hollow shaft with a plurality of separate longitudinal channels extending from both ends of the shaft, the channels from one end constituting intake channels and the channels from the other end of the shaft constituting discharge channels, all of the channels having self-closing valves with those of the intake channels operable during intake suction of the pump and the valves of the discharge channels operable during the discharge phase of the pump, said shaft having a radially disposed hollow piston member communicating with a channel from each end of the shaft; a cylinder reciprocatingly mounted on each piston member; a guide shell for each cylinder secured to the rotatable shaft; an annular driving member provided with side flanges disposed about the ends and sides of the cylinders; means provided with correlated predetermined degrees of arcuations arranged intermediate the annular member and the outer end of each cylinder in free bearing relation with the inner perimeter of the annular member; yielding means operatively intermediate said last means whereby a driving frictional engagement between said last mentioned means and the driving member is effected; means reciprocatingly mounted in each piston member and associated cylinder whereby the fluid pumped is maintained out of contact with the cylinder interiors and lubricant receiving chambers within the cylinders provided; lubricant feeding means communicating with said chambers whereby the lubricant in the chambers is maintained under pressure; and power means for rotating said annular driving member.

5. A variable stroke radial pump comprising a rotatable hollow shaft with a plurality of valve controlled channels extending from both ends of the shaft to constitute inlet channels and outlet channels; a plurality of radially disposed hollow pistons, each communicating with an inlet channel and an outlet channel; a discharge pipe having a swiveled connection with the discharge end of said hollow shaft; a cylinder reciprocatingly mounted on each piston; means movably mounted in each piston and operatively connected with the associated cylinder whereby the fluid pumped is maintained out of contact with the cylinder interior, a lubricant receiving chamber in the cylinder provided and yielding pressure on the lubricant exerted; a source of lubricant supply having communication with said swiveled connection and with said lubricant chamber and the lubricant maintained under pressure greater than that of the discharging fluid; an annular driving member disposed about the outer ends of the cylinders whereby the hollow shaft and associated pistons and cylinders are rotated; an eccentrically mounted annular member intermediate the ends of the hollow shaft and said driving member whereby an eccentric operative relation between the driving member and the hollow shaft with its associated piston-cylinder assemblies is provided; pressure distributing means intermediate the closed ends of the cylinders and the inner perimeter of the driving member and adapted to effect binding relation with the latter; and power means for rotating said annular driving member.

6. In a variable stroke radial pump provided with a rotatable hollow shaft formed to provide inlet and outlet channels extending from the ends with self seating valves at the ends of the channels; a plurality of radially disposed hollow pistons secured to said shaft and communicating with the channels in the shaft and cylinders reciprocatingly mounted on the pistons; a driving ring gear disposed about the outer ends of the cylinders in operative relation therewith; side plates at opposite sides of the gear with eccentric openings therein; eccentric plates rotatable in said eccentric openings and having controlling relation with said reciprocating cylinders and ring gear for shifting the latter into eccentric relation with said hollow shaft and thereby control the reciprocating strokes of the cylinders; and pneumatically operated means for rotating

said eccentric plates to provide the desired cylinder stroke.

7. In a variable stroke radial pump provided with a rotatable hollow shaft having a plurality of channels therein extending from the ends of the shaft to constitute inlets and outlets, a plurality of hollow pistons each communicating with a separate channel, cylinders reciprocatingly mounted on the pistons; annular means whereby the cylinders are reciprocated; driving means encircling the outer ends of the cylinders and having frictional engagement therewith for rotating said cylinders and shaft; a plurality of removably mounted valves in the inlet end of the shaft each consisting of a cylindrical open ended shell provided with a port in its peripheral wall, a removable closure cap for the outer end of the shell for securing the valve shells to the shaft while the inner end of the shell is open to the channel within the shaft, a spring actuated valve within the shell consisting of a port seating metal plate and cushion means secured to the inner side of the metal plate and in overlapping relation with the inner side of the shell, said valves being adapted to open inwardly with the suction force of the pump.

8. In a variable stroke radial pump provided with a hollow rotatable shaft provided with inlet and outlet valve controlled channels extending from opposite ends of the shaft and having a plurality of radially disposed hollow pistons communicating with the shaft interior; cylinders reciprocatingly mounted on the pistons; plunger members reciprocatingly mounted in the pistons with their outwardly presented ends yieldingly connected with the cylinder-heads and formed to provide a lubricant holding chamber in each cylinder and to maintain the pumped fluid entering the piston out of contact with the cylinder interior, said plunger members being reciprocable by the fluid in the piston the reciprocating plunger members placing the lubricant under pressure; and rotatable cylinder actuating means disposed about the cylinders.

9. In a variable stroke radial pump provided with a rotatable hollow shaft having inlet and outlet channels extending from opposite ends adapted to receive the pumped fluid at one end and to discharge the fluid at the other end, self-closing valves at the outer ends of the channels, intake and discharge conduits at the shaft ends, swiveled couplings at the ends of the shaft for connecting said conduits to the shaft ends; hollow pistons radially secured to said shaft in communication with the channels on the shaft interior; cylinders reciprocatingly mounted on the pistons; and lubricating means for the couplings at the discharge end of the pump comprising a retainer provided with a lubricant holding weighted bellows whose open end has communication with said swiveled coupling for lubricating the latter, while the retainer has communication with the discharge end of the pump so as to equalize the pressure in said retainer.

10. In a variable stroke radial pump having an outer immovable casing with side wall openings; rotatable eccentric plates arranged in the casing sides and having enlarged openings to permit an eccentric relation with the axis of the pump to be obtained; a rotatable hollow shaft extending from side to side of the casing and held against longitudinal movement; valve controlled inlet and outlet openings at opposite ends of the shaft; a plurality of radially disposed hollow pistons secured to and communicating with the shaft interior; cylinders reciprocatingly mounted on the pistons in fluid sealing relation therewith and having outer closed ends and rocker pins secured on the outer closed ends of the cylinders and disposed transversely thereof; an arcuate shoe for each cylinder provided with depending apertured sides adapted to receive the ends of the rocker pins, whereby the shoe is operatively secured to the cylinder; a flanged ring gear disposed about the radially disposed cylinders and the arcuate shoes with the latter in bearing relation with the inner perimeter of the ring gear; friction providing members yieldingly secured to the shoes adapted to effect frictional engagement with the side flanges of said ring gear and induce rotary movement of the cylinder-and-piston assemblies and rotation of said shaft; means associated with said eccentric plates and the ring gear whereby the latter may be moved into eccentric relation with the rotatable shaft and the degree of cylinder reciprocation controlled; power means for driving the ring gear; and means for rotating and controlling said eccentric plates.

11. In a variable stroke radial pump provided with a hollow rotatable shaft having channels extending from opposite ends, self closing valves at the outer ends of the channels; a plurality of radially disposed hollow pistons secured to the shaft and communicating with the shaft channels; cylinders reciprocatingly mounted on the pistons and provided with trunnion members at the outer ends; guide shells fixedly secured to said shaft and disposed about the inner ends of the cylinders to maintain proper alignment of the latter with the pistons during cylinder reciprocation; an annular drive member disposed about the outer ends of the cylinders and provided with side flanges; arcuate shoes mounted on said trunnion members adapted to engage the inner perimeter of the drive member, the shoes being provided with spring controlled wedge members adapted to effect frictional binding relation with the side flanges of said drive member; and power means for rotating said drive member.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,647,873	Lockwood	Nov. 1, 1927
1,696,139	Ferris	Dec. 18, 1928
2,293,692	Wylie	Aug. 18, 1942
2,417,183	Smith	Mar. 11, 1947