

Nov. 24, 1936.

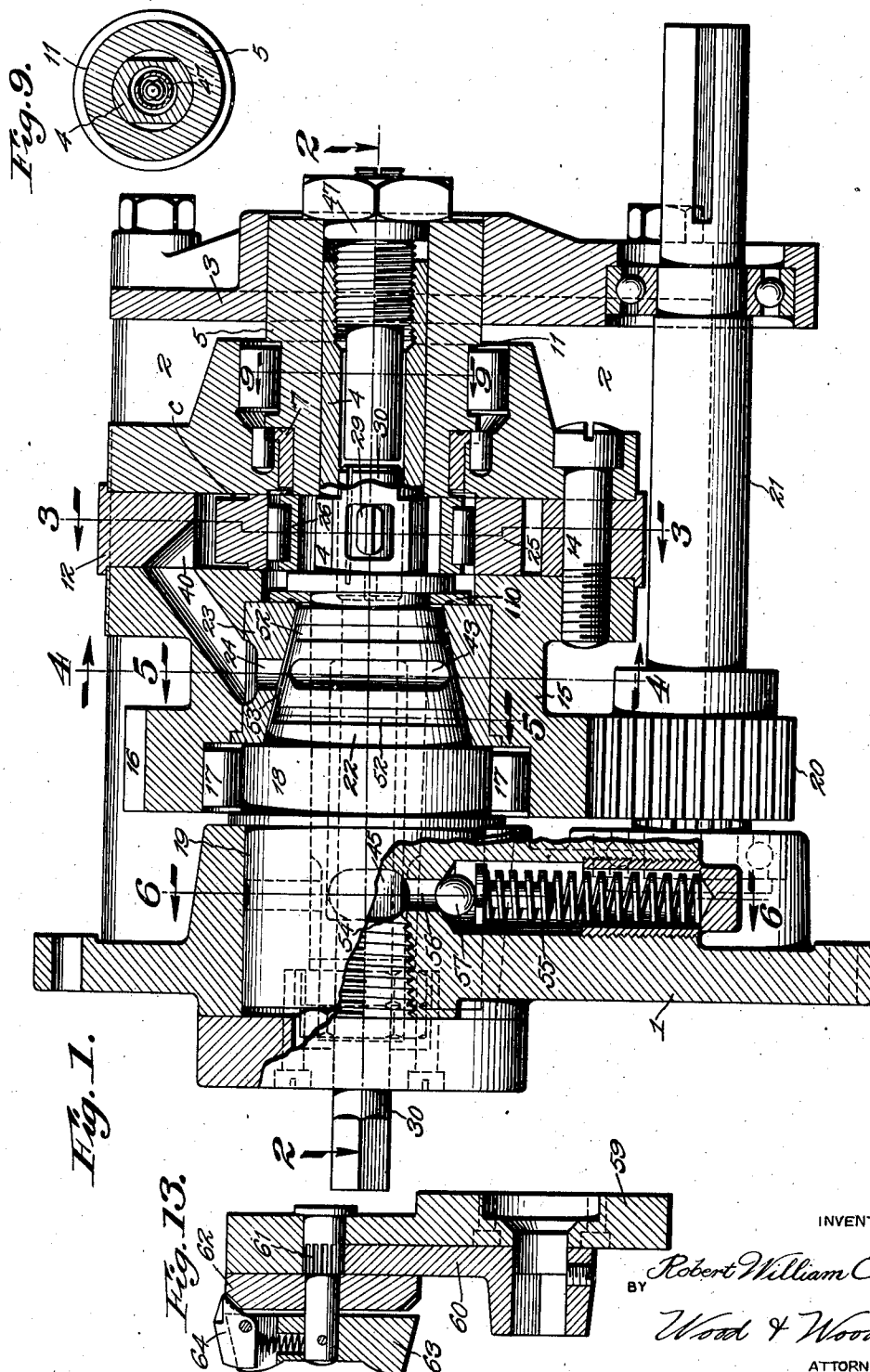
R. W. OTT

2,061,950

ROTARY PUMP

Original Filed July 12, 1932

6 Sheets-Sheet 1



Nov. 24, 1936.

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ROTARY PUMP

Original Filed July 12, 1932

6 Sheets-Sheet 2

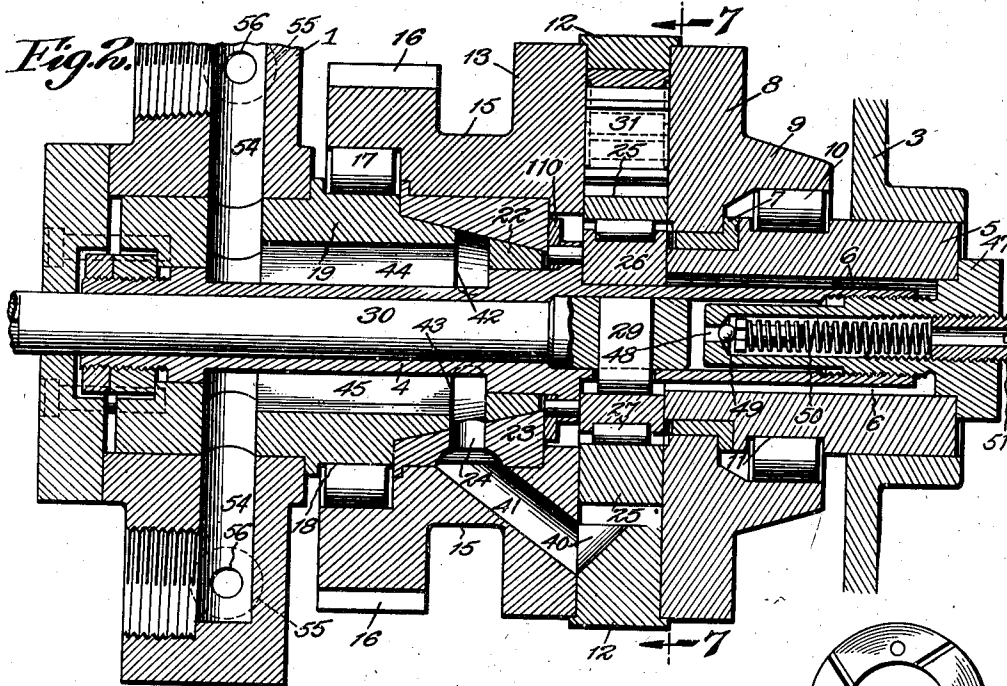


Fig. 12.

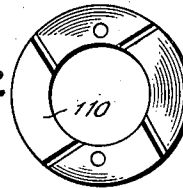


Fig. 7.

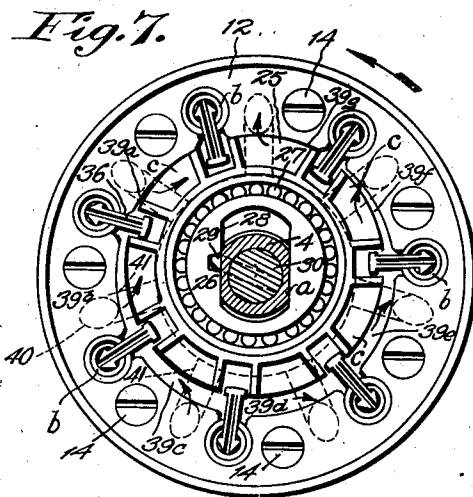
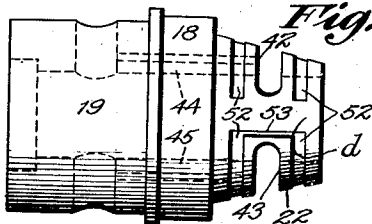


Fig. 8.



Fig. 10.



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6 Sheets-Sheet 3

Fig. 3.

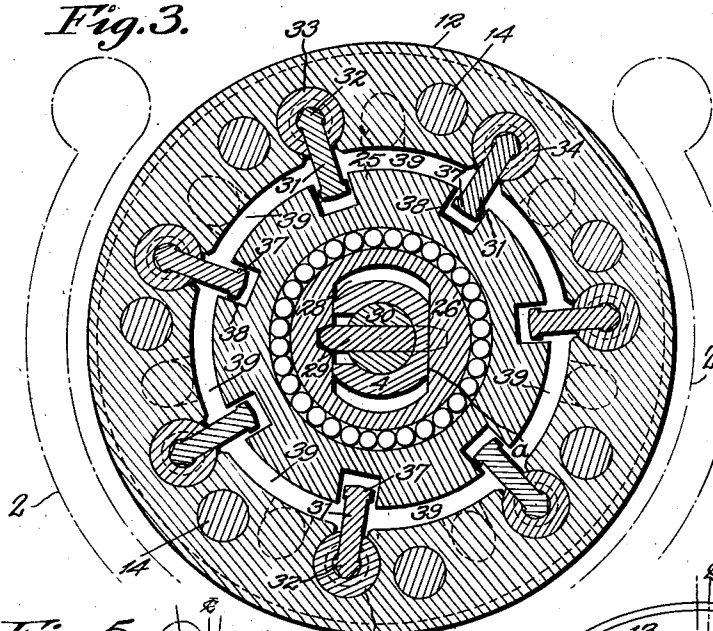


Fig. 11

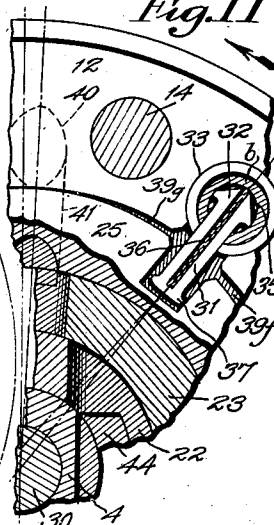


Fig. 4.

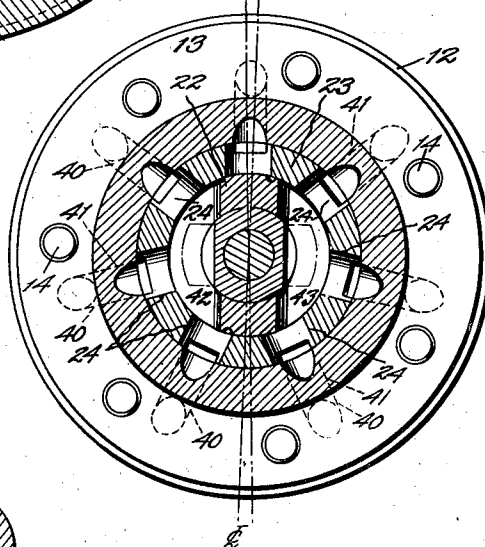


Fig. 5.

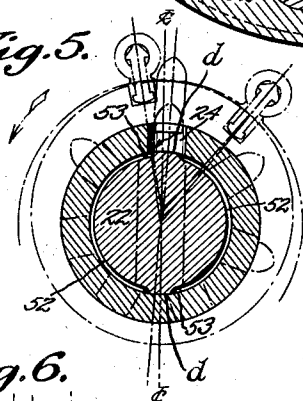
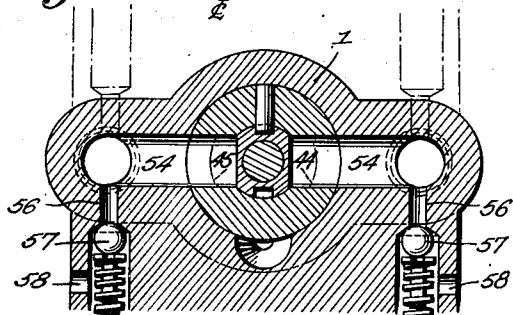


Fig. 6.



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Fig. 15.

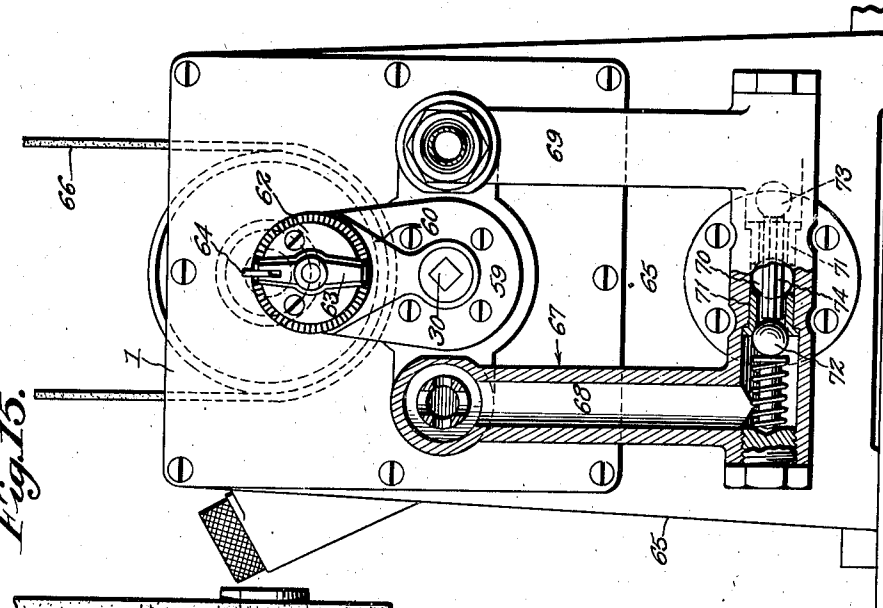
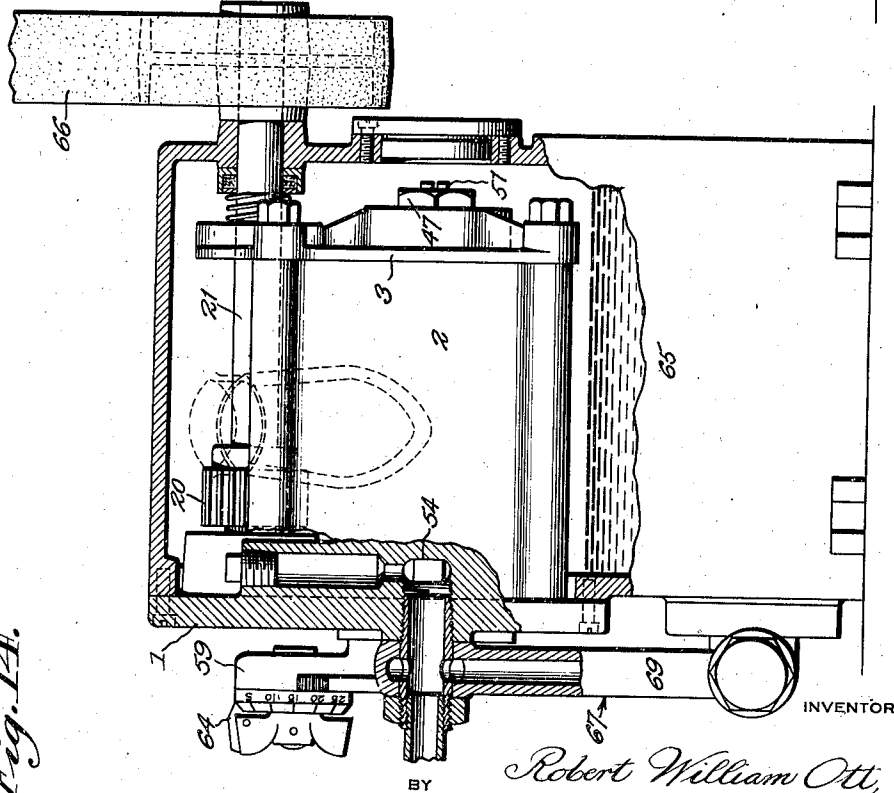


Fig. 14.



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Fig. 16.

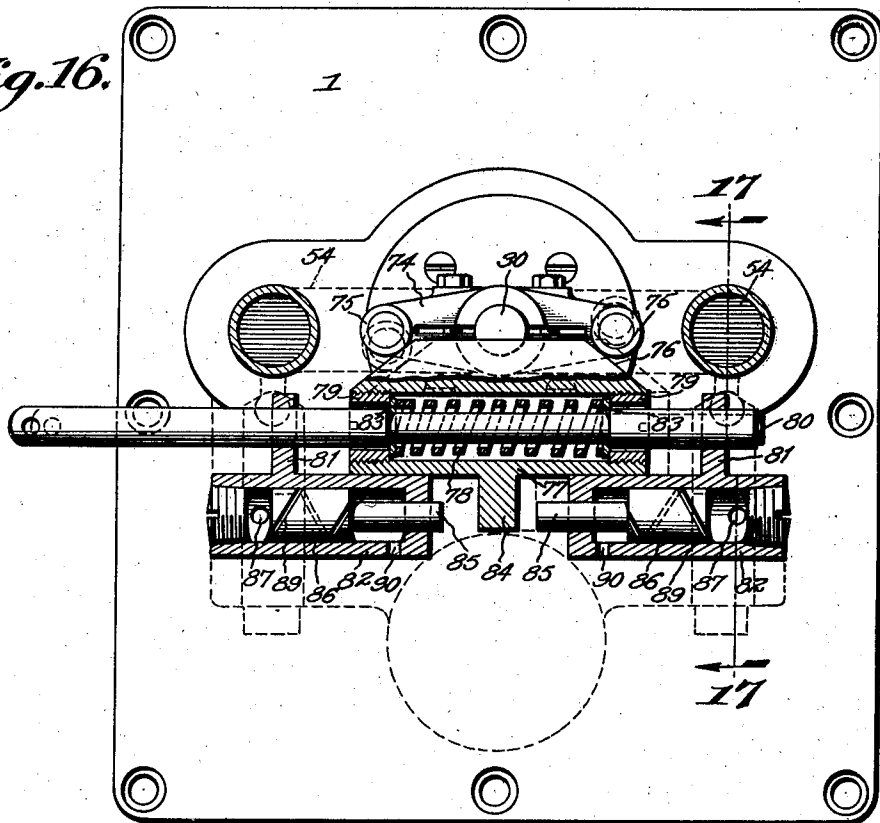
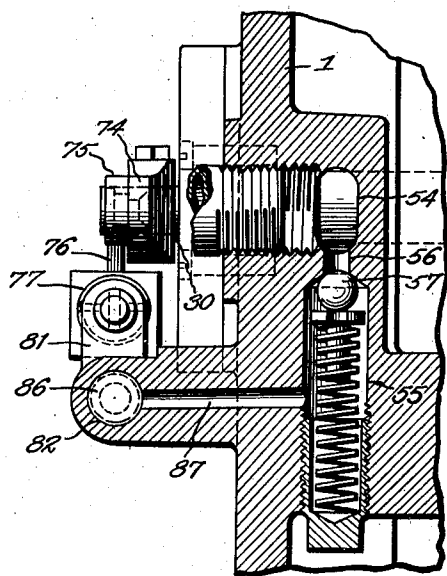


Fig. 17.



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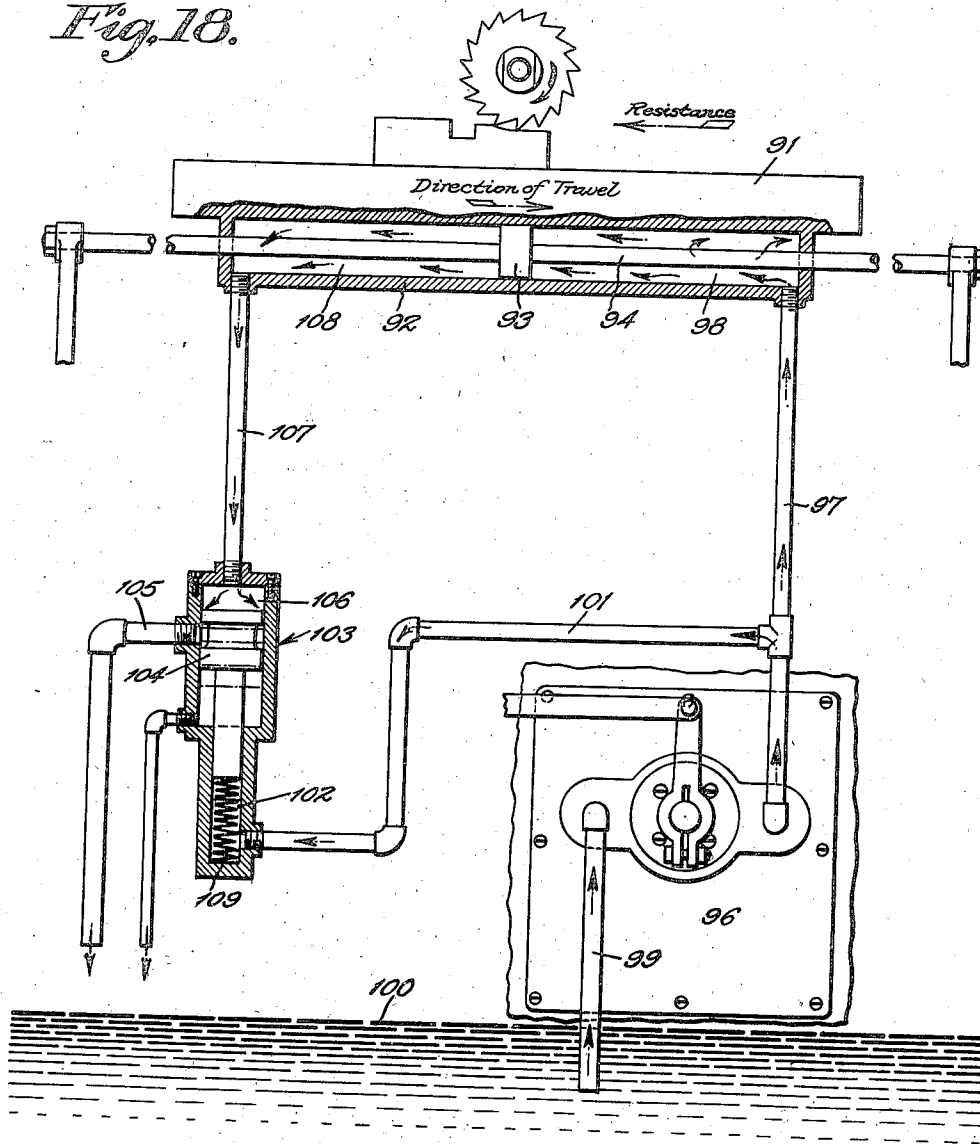
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Fig. 18.



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UNITED STATES PATENT OFFICE

2,061,950

ROTARY PUMP

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Robert Wm. Ott and Charles H. C. Van Pelt,
trustees, Cincinnati, Ohio

Application July 12, 1932, Serial No. 622,097.

Renewed April 14, 1936

9 Claims. (Cl. 103—120)

This invention relates to a rotary pump having centrifugal and eccentric pump characteristics with reciprocating multi-piston action, for drawing in and forcibly expelling or delivering fluid in continuous flow, constant or variable in volume and reversible as to direction of flow without change in the motive direction of the pump.

An object of the invention is to provide a rotary pump with a plurality of chambers arranged in a circumferential order constituting the spacing between two cylinders divided by a series of radial vanes connecting said cylinders, one cylinder normally tangentially within the other, and connected for a unitary rotation by radial vanes, the vanes pivoted to one of the cylinders and slidable within the other, forming side walls for the chambers, the inner cylinder rotatable with the outer cylinder either eccentric or concentric thereto and when eccentric increases and diminishes the chamber or chambers or spacing at relatively opposite sides of a central or diametric line from the axes of the cylinders, whereby fluid can be taken into the chamber or chambers on one side and forcibly displaced or compressibly discharged from the chamber or chambers on the opposite sides, effecting a continuous flow of fluid.

Another object of the invention is to provide a rotary pump having a rotor composed of outer and inner unitary rotatable cylinders connected by radial vanes with the inner cylinder rotating eccentrically to the other, a rotor journaled upon anti-friction bearings intermediate the rotor and an annular stationary support adapting the rotor to be run at high velocities.

Another object of the invention is to provide a rotary pump having a rotor composed of a pair of cylinders, one within the other, rotating as a unit with the spacing between the cylinders subdivided by radial vanes rotatably connecting the cylinders, and providing a plurality of chambers, the inner cylinder rotating either eccentric or concentric of or with the other upon an annular track or stator shiftable to varying the degrees of eccentricity of the inner cylinder for varying the volumetric displacement of the pump and for reversing the direction of fluid flow.

Another object of the invention is to provide a rotary pump in which the volumetric displacement or delivery can be promiscuously increased or decreased while in operation either under manual or automatic control as well as a reversal in direction of fluid flow.

Another object of the invention is to provide a rotary pump having a rotor constituting a pair

of cylinders, one within the other, the inner rotatable with the outer tangentially with fluid leads to and from compression compartments or chambers between the cylinders arranged to afford a gyroscopic action to the fluid for better filling of the compartments.

Another object of the invention is to provide a rotary pump having a rotor providing a series of compression compartments or chambers circumferentially arranged with the joints of the relative moving parts relieved for reducing friction and providing fluid sealing pockets or channels, and to stabilize certain of the parts under fluid pressure at relative opposite sides thereof and for a blending of the compartments or chambers into one perpetual chamber.

Another object of the invention is to provide a rotary pump with a rotor revolving about a valve, the valve balanced by fluid pressure in circumferential channels about the valve and for maintaining fluid sealing joints.

Various other features and advantages which relate to details of construction, compactness and symmetric arrangement of parts, facilities and ease of control, and the methods employed for reducing the friction of the slippage, all of which will be more fully set forth in the description of the accompanying drawings in which:

Figure 1 is a longitudinal section through the pump with the centermost stationary parts in elevation. The casing structure for the pump is of a character adapting the pump to be installed or built into the housing of the machine, the pump to serve for compressing fluids, air, gases, utilized in circuits applicable to machine tools, refrigerators, etc.

Figure 2 is a horizontal section on line 2—2, Figure 1, showing more completely the passages through the pump.

Figure 3 is a section on line 3—3, Figure 1, through the rotor and adjustable stator within the rotor.

Figure 4 is a section on line 4—4, Figure 1, showing the valve and associated parts.

Figure 5 is a section on line 5—5, Figure 1, illustrating grooves or passages for balancing purposes and for lubricating face of valve, with portions of rotor and passages shown in dot and dash lines for high pressure supply, to the grooves or passages for balancing, for eliminating the force resulting into radial loads by the exposed port areas, so that the valve substantially floats on a film of fluid.

Figure 6 is a vertical section on line 6—6, Figure 1, illustrating passages to relief valve with dot and

dash lines indicating the position of passages when the casing is of a type for non-built-in service.

Figure 7 is a section on line 7—7, Figure 2, illustrating the stator adjusted to a position for full delivery in one direction of rotation of the rotor.

Figure 8 is a section similar to Figure 7, showing the stator adjusted to an opposite position for full delivery in opposite direction of rotation of the stator.

Figure 9 is a section on line 9—9, Figure 1.

Figure 10 is a detail elevation of the balanced and self-adjusting valve member which also serves as a journal for the rotor.

Figure 11 is an enlarged detail section through the rotor with the parts in position as shown in Figure 7.

Figure 12 is a side elevation of a washer or valve adjusting diaphragm on the stationary rotor supporting shaft abutting the upper end of a rotatable valve member in the head of the outer cylinder.

Figure 13 is a central vertical section, through manual control devices connecting one end of the stator shaft for definite volumetric displacement.

Figure 14 is a side elevation of the control mechanism shown in Figure 9 and a partial section through a casing for a pumping unit not adapted for built-in installation.

Figure 15 is a front elevation of the pump of the type shown in Figures 1 to 5, with portions shown in section to illustrate the relieving and balancing valve for pump control.

Figure 16 is a front elevation of a pump equipped with automatic control devices, these control devices being shown in section.

Figure 17 is a section on line 13—13, Figure 12.

Figure 18 is a diagrammatic view illustrating the pump as a part of a hydraulic system for operating the carriage of a milling machine.

The pump primarily is intended for a variable transmission applicable to machine tools and the like for either speed or feed transmission constant or variable, is capable of being directly incorporated with a hydraulic speed variator, providing a very compact structure occupying considerably less space than that of any of the commercial types of variable delivery pumps, so that it can be installed as a unitary component or built-in feature of the machine. The pump is applicable to higher pressures with unusually low power input, with a better sealing under a higher pressure duty reducing slippage. The operation is comparatively noiseless and air and foreign gases are positively dispensed prior to entering the compression chambers. The rotor parts are journaled in anti-friction bearings providing smooth running and long life.

The pump is operative for providing a constant pressure with a variable volume or a constant volume with variable pressures. An infinite range of volumetric displacement can be provided between minimum and maximum capacity adequately affording a predetermined constant volumetric displacement within its range and with variable pressures adequate to resist a head pressure of the pressure line, due to resistance built up at the delivery end to a predetermined maximum safety point.

The pump is of a cylindrical rotative type having a rotor revolving about a stationary shaft or journal.

The rotor is composed of a pair of cylinders as rings one within the other with the inner of

smaller diameter than the bore of the outer, to provide an intervening compression space divided into a plurality of chambers by radial vanes or blades hingedly mounted in one of the rings and slidably engaged into the periphery of the other ring. The blades in a consecutive order for each cycle or revolution of the rotor, serve as a key for rotatively connecting the rings.

The inner ring journals upon a stator, shiftable laterally upon the central shaft for positioning the inner ring either concentric or eccentric to the bore of the outer ring, and the degree of eccentricity may be varied at will. Each chamber is provided with a port alternately serving as an intake and discharge with each revolution of the rotor. The inner ring functions as a piston for either admitting or displacing the fluid to and from the chambers and according to the present arrangement provision is made for several chambers to be open to intake while several are discharging, so that the displacement is continuous, either constantly or variable in volume and/or pressure, depending upon the adjustment control of the degree of eccentricity of the inner ring and idling when the inner ring is concentric with the outer ring.

Referring to the drawings, Figures 1 to 8 inclusive, the pump or generator is mounted within a casing or support and preferably in skeleton form, primarily for installing the unit within the framing of, say, a machine tool, as a built-in feature thereof, the casing constituting a face plate 1 having a pair of relatively spaced and curved or semi-cylindrical side walls 2—2, extending from the rear side thereof. The rear end of the side walls are connected by a back plate 3.

A central stationary hollow or tubular shaft 4 as a primary journal shaft extends between the face and back plates and supported therein. The rear end of the shaft carries a bushing or journal sleeve 5 concentric thereon; the sleeve at its rear end is supported in a bore, in the back plate. The shaft is milled or faced at relatively opposite sides for a portion of the length giving the same a polygonal contour to provide ducts or channels 6—6 intermediate of the shaft and sleeve and to permit assembling and laterally adjusting a stator ring upon the shaft within the rotor. The stator is supported or slides upon the flat surfaces or ways a—a of the sleeve shaft 4. The inner end of the journal sleeve is counter-turned for supporting a sealing ring or gland 7 concentrically thereon. The sealing ring engages into a central bore of a head plate 8 of the pump or generator, forming an element of the rotor, and is provided with a hub extension 9 journaled upon rollers 10 traveling in a race-way or track as an annular groove 11 in the periphery of the journal sleeve 5. The inner face of the head plate 8 is recessed into one side of a cylinder or ring 12 and the opposite side of the ring 12 is closed by a head plate or disc 13 likewise recessed in the ring 12. The head plates 8 and 13 with the ring are secured together as a unit by a series of bolts 14. The head 13 at its outer side has a central hub 15 extending therefrom with a gear 16 integral or combined therewith. The gear is counterbored for journaling upon rollers 17, tracking upon the periphery of an annular way 18 as a portion of a sleeve 19, the sleeve serving as a stationary valve member and is provided with longitudinal passages for inlet and discharge of the pump.

The gear 16 is in mesh with a pinion 20 mounted upon and rotatably connecting with a shaft 21 journaled in antifriction bearings mounted in the

base as back plates of the pump casing or housing. The shaft 21 extends through and beyond the back plate of the casing for connecting with any suitable drive or transmission gearing of a motive power. Any source of power or method of revolving the rotor may be utilized. The method employed for mounting the rotor provides for extremely smooth running, permitting the motor to run at high velocities under a minimum amount of friction and wear and allows for floating motion of the rotor, axially. The valve portion 22 of the sleeve 19 is of conical form, as a plug valve, seating within an annular valve member 23 permanently mounted within the hub of the head 13 to revolve integrally therewith as a unit. The rotatable valve member 23 is provided with radial ports or ducts 24 of a number equal to the number of compression chambers of the pump.

A cylinder or ring 25, functioning as a multiple piston, is disposed within the cylinder ring 12 and journaled upon an annular stator 26. The periphery of the stator is grooved to provide a race or races for a series of rollers 27 interposed between the ring 25 and stator 26, providing an anti-friction bearing for the revolving cylinder 25 of the rotor. The stator 26 has an oblong slot 28 centrally therethrough, through which the shaft 4 passes, the opposite plane surfaces of the slot slidably bearing upon the flat or plane surfaces of the shaft adapting the stator to be shifted laterally upon the shaft to a position either concentric or eccentric to the cylinders of the rotor for varying the stroke or displacement action of the rotating cylinder 25 in a cycle or revolution.

The stator is shifted laterally by a tooth 29 extending radially from the inner end of a rod 30 concentric within the shaft 4, the rod 30 extending beyond the end of the shaft 4, and having its outer end squared for socketing the handle or lever thereon for either manually or automatically revolving the rod to shift the stator. The cylinder 25 and cylinder 12 are connected by a plurality of radial vanes 31 and for the unit illustrated, seven vanes are employed at uniform spacing apart. The vanes are of duplicate construction and interchangeable, each of I or double channel form in cross section with the outer end 32 engaged and rigidly secured within a cylinder pivoted block 33 swivelled within a cross bore 34 of the cylinder 12. The end or head 32 of the vane is of barb arrow head form presenting a flange at each of its opposite sides divergently inclined or tapered and compressed into a slotted bore of the pivot block 33. The head structure of the vane provides for a plurality of ducts 35 lengthwise through the pivot block, communicating at their opposite ends with channels b formed by counter-boring the opposite ends of the pivot block. Each end channel b is open to a channel 36 centrally and longitudinally of the end of the vane, short of the length of the vane. The opposite or inner end 37 of the vane is of T form providing a longitudinal flange at each of its opposite sides slidably engaging into a slot 38 in the periphery of the inner cylinder 25. This provides for an edge contact of the vane with the walls of the slot to reduce slippage.

The slots or notches in the outer cylinder 12 and inner cylinder 27 and the thickness of the vanes are of such proportions so as to effectively establish a driving medium that can be compared with that of a hunting tooth in a gear. The vanes, it will be observed, are arranged to contact with a side of the slot in the cylinder 25 at a relative opposite side of the slot in the cylinder 12.

The vanes in the arrangement shown in Figure

7, in passing through the arc for the endless zone of the chambers and toward the approach end thereof sequentially serve as keys, the side of the vane contacting with one side of the slot in the outer cylinder within which the vane is pivoted and the free or head end of the vane contacts with a relatively opposite wall in the slot in the inner cylinder 25 within which the vane slides, rotatively connecting the inner and outer cylinders.

The side or end faces of the inner cylinder between the vane receiving slots are recessed as at c to reduce its surface area in intimate relation with surface of the adjacent head plate with which it cooperates with the vanes in forming the pump chambers 39. This clearance or relief provides a lubricant or liquid holding pocket for maintaining a sealing film between the joint surfaces of the adjoining parts and to reduce friction and wear and also for stabilizing the ring between the heads of the outer cylinder by the pressures within the chambers.

Each chamber or compartment 39 respectively connects with a port 40 in the cylinder ring 12, and each port connects with a passage 41 in the head plate 13. The passage 41 communicates with a relative port or duct 24 in the rotatable valve member 23 governed by the stationary valve member 22. The stationary valve member 22 is provided with a pair of elongated ducts 42, 43 circumferentially at relative opposite sides of its axis, and each duct respectively communicates with a passage 44, 45, formed by longitudinal grooves in the bore of the journal sleeve 19 and by recessing or squaring relative opposite sides of the shaft 4. The passages 44, 45 respectively serve as inlet or outlet passages for the pump or generator. The valve ducts 42 and 43 are of a dimension as shown in Figure 4 each to uncover approximately three of the ports 40 of the rotatable valve member 40 with the intervening surface of the valve closing one of the ports 40 of the rotatable valve member and sealing between the two sets of uncovered ports of the rotatable valve member.

In Figure 3 the setting of the stator is in its central or neutral position concentric within the cylinders of the rotor and of the stationary shaft constituting an idling position with all of the parts concentric.

Figures 7 and 8 show the stator shifted to relative opposite positions, at the extremes from the central or neutral position effecting a relative alternate or reverse flow of the pump, and without change of direction of rotor rotation. In these extreme positions the stator is set for pumping the maximum volume and the shifting accomplished for its extreme or intermediate positions by means of the rod 30 and its key or tooth 29. A change of setting can be made at will and the flow of the fluids reversed during the rotation of the rotor and without change of direction of the rotor. The stator being slidably mounted upon the guide or plane surfaces of the shaft 4 prevents the stator from rotating although freely slidable laterally upon the shaft and the slightest variations of the stator from its central or neutral position changes the volumetric displacement of the chambers pump. Any load or pressures set up by shifting the stator to an offset or eccentric position are taken on the guiding surfaces of the shaft, leaving the adjusting key or tooth 29 free of any excessive torque strains, allowing for easy or fine adjusting facilities and overcoming the need of having an adjusting mechanism that would normally shoulder the force and not deflect

under heavy pressures and interfere with sensitivity. The forces are confined between the stator and the shaft which are of the required stability and with the adjusting mechanism relieved of any undue strains. Very exacting and geometric increase or decrease of volumetric displacement setting or adjustment is available throughout the entire range.

The stator 26 is adjusted upon the flat ways of the shaft for maintaining proper timing irrespective of volumetric displacement. Adequate timing insures uniformity between the intake portion of the arc and the associated portion of the arc for a definite regulation of the fluid delivery. A variation in volumetric displacement under quick and definite control is of particular value when the device provides the power medium for the tool or work feeding instrumentalities of a machine tool, being flexible to instantly develop the increase or decrease in pressure and volume governing the traversing rate and maintain the same constantly under varying loads imposed.

Referring to Figure 7 which illustrates the stator shifted to an extreme eccentric or offset position for one direction of flow, the cylinder 25, in each revolution, due to revolving about an axis eccentric to the axis of the bore of the cylinder ring produce the equivalent of a rolling, or reciprocating action of one surface toward and from another diminishing the space between the opposing cylinder surfaces of the rings and likewise increasing the same at relative opposite sides of a diametric line or zone at which the two surfaces are closely together. With the circumferential space divided into separate compartments or chambers 39 by the radial vanes 31 connecting the two rings, the portion of the periphery of the ring 25 between each pair of vanes forming end walls for the chamber functions as a piston for said chamber or vanes compensating for the radial motion in the ring through their pivotal and sliding connection with the rings.

With the parts adjusted as shown in Figure 7, assuming passage 45 as an inlet, fluid will be admitted simultaneously by the compartments or chambers which are on the side in which the opposing surfaces of the rings move apart from each other increasing the area of the chambers conforming to a suction stroke, each action sets up a vacuum resulting in an influx of fluid into the chambers.

Under the present arrangement the valve ports 42 and 43 provide each for uncovering these chambers, three to the inlet side and three to the discharge side. The throttle opening and closing for the chambers is progressive for the sequence of the valve ports for each cycle of the rotor.

In Figure 7 arrows are shown directed inward to the chambers 39^a, 39^b, 39^c, passing through a chamber increasing zone. As shown, as a valve port 24 for a respective chamber moves beyond communication with the port 43 of the stationary valve member, it passes through a sealing zone, the port being closed by the circumferential portion of the stationary valve intermediate of the ports 42 and 43, and thence into the diminishing zone opening to the port 42 of the stationary valve, and the fluid discharged under the compressing motion of the inner ring. Therefore, the chambers 39^d, 39^e, and 39^f are in the diminishing zone from which the fluid is being forced out discharging through the outlet passage 44 in the stationary valve, whereupon the chambers are again cut off before repeating the operation for a second cycle.

While reference is made to a plurality of compartments or chambers for the rotor, it would be justified in assuming that the several chambers when in either the intake or discharge zones are in effect for each zone as a single chamber. This may be exemplified by reference to Figure 7 starting with the blade at the left side of the chamber 39^d, which is passing the radial center line as the port for the rotary valve member for the chamber 39^d is passing over the land *d* of the valve member 22 and resisting or carrying such fluid as is entrapped in the chamber by virtue of the pressure against the surface of the vane carrying the vane into contact with a wall of the slot in the notch in the inner cylinder 25. As soon as the valve port for the chamber has passed across the land *d* of the valve opening the chamber to the discharge passages, the vane at the right side becomes dormant in so far as performing any duty as is the case for the vane for one side of the chamber ahead.

This also follows for certain of the vanes of the chambers in the intake zone. Therefore several chambers in effect are merged or blended establishing a perpetual chamber. Any particular vane in the design illustrated only performs an acted part within limited degrees of the cycle or on either side of the radial center line.

The unit being of reversible type, for reversing direction of fluid flow under a continued direction of rotation, it is optional which of the passages 44 or 45 serve as supply or discharge, the direction of fluid flow being governed by shifting the stator to relative opposite sides of the axis of the outer cylinder. With stator 26 shifted to the side as shown in Figure 7, passage 45 of the stationary valve member is an intake passage and passage 44 an outlet passage, and with the parts adjusted as shown in Figure 8, the reverse follows.

The inner and outer rings 12 and 25 and end or head plates 8 and 13, with the ring intervening vanes connected as a unit and rotatably mounted on anti-friction bearings are transmitted by the gearing 16 and 20 driven from any source of power with the direction of rotation constant. The head plates and outer ring always rotate concentric upon the central stationary shaft 4 while the inner ring may rotate either concentric or eccentric thereto. The relative eccentricity between the periphery of the inner ring 25 and the peripheral bore of the outer ring 12 establishes a contraction and expansion of the areas of the chambers or compartments 39 of the series. While the vacuum is created in the chambers when traversing through the expansion zone filling the chambers as their areas are increasing, vacuum, however, is not solely relied upon as the means for filling the compartment.

The incoming fluid is forcibly moved into the compartment by means of the centrifugal and gyroscopic action of the fluid due to the velocity of the rotor or head containing annular ducts 41, one for each chamber, leading from the inner supply point to a radial extremity of the chamber with which the duct connects. The chambers therefore are filled under vacuum, and centrifugal action which practically insures that the chamber is fully filled as it is cut off from the supply. Each chamber is open to the outlet for a duration of approximately 160° of a cycle. This, of course, can be varied and depends primarily upon the circumferential dimension of the elongated valve openings in the stationary valve member, the arrangement herein employed being such as would practically deliver a constant discharge.

For the purpose of reducing undue friction and a better sealing of the fluid, all moving parts forming chambers are relieved or provided with interstices as the channels 36 in the opposite ends of the vanes and the clearance in the opposite ends of the inner displacement cylinder to provide spaces or channels for the reception of oil or lubricant, or the fluid within the chambers which conditions plus the combination of proper metals permits extremely close running tolerances desirable for reducing slippage. The ring 25, vanes 31, and pivot blocks 33 are preferably made of high grade steel, since it has, after a heat treatment, a finer texture and less expansion when subjected to frictional heat.

The outer cylinder ring and head plates are preferably made of metal alloy providing extremely hard surfaces for the moving parts to operate therebetween with very little, if any, wear over long periods. This permits making anti-friction bearing races within the pump parts reducing the number of parts, facilitating assembling, offering compactness and avoids increasing the size of the unit in general.

The pivot block 33 rotatably mounted in the cylinder ring supporting one end of the vane 31 is provided to accommodate for all variations between the cylinder ring 12 and displacement ring 25. The slot 38 in the displacement ring facilitates necessary accommodation for the oscillating motion of the vanes due to the retarding and advance motions of the cylinder ring and displacement ring relative to each other.

The compartments are securely sealed and separable. The cylinder ring and head plates are securely clamped together permitting no passage of fluid between the connecting joints thereof. The vanes 31 each at its inner end sliding within the slot 38 of the displacement ring, is slightly narrower than the slot permitting a rocking motion within the slot, and the necessary passage of fluid utilized for sealing.

Referring to compartment 39^a, since the forward vane has passed over center, there being no pressure against the vane on its forward side, however, an effective pressure due to resistance within the pressure channel on the entire area of the rear side of the vane, the effects of the pressure reflects a sealing action between the side wall of the slot in the displacement ring into which the vane is engaged and the narrow edge of the forward flange on the inner end of the vane in ratio to the ratio of the pressure within compartment 39^a, making it impossible for the fluid to pass this joint, although the pivot block is closely fitted within the bore in the cylinder ring 12, the effect of the pressure against the inner end area of the vane forces the vane against the wall of the bore, further preventing slippage and better sealing the pivotal end of the vane. An identical condition prevails as the vane passes the opposite center when leaving the intake zone and entering the displacement zone. Between the intake and displacement zones the vanes are more or less balanced. Any fluid entering the left channel in the opposite ends of the vane serves to balance the vane between the opposite faces of the head plates thereby reducing friction.

Any fluid passing through the joints between the ring 25 and faces of the head plates, is used for sealing and lubricating purposes, for sealing the joint of the sealing ring or gland 7, on one side lubricating the roller bearing between the displacement ring and stator, and for the valve seat or joint between the rotatable and stationary

valve members. The valve being of tapered form, the pressure will force the rotatable valve member in a direction outwardly and prevent any leakage between the valve seating surfaces. The rotatable valve being rigidly connected with the head plate or rotor, the entire unit is forced in a direction against the stationary valve. The unit contains a combination of automatic and manual take-up of the valve compensating for wear and obviating undue slippage. The rotary is journaled to permit axial movement.

The amount of pressure may be limited by means of a by-pass or relief valve engaged into the end of the stationary shaft consisting of a lock stud 47, screw-threaded and engaged into the end of the stationary shaft 4, the head of the lock stud engaging with the outer end of the bearing sleeve 5. The lock stud 47 is of tubular or hollow form having a port 48 through its inner end controlled by a spring-pressed ball check valve 49, the spring 50 of the check valve at its outer end abutting against a hollow adjusting screw 51 screw-threaded into the outer end of the lock stud 47.

The stationary valve member 22 in its periphery, at each of the opposite sides of the elongated ports 42 and 43, respectively, has a pair of channels 52—52 cut therein having an effective area equal to that of the ports and each pair respectively is connected by a cross-channel 53 adapted to receive the remaining discharge of fluid in the compartment 39^a, as the compartment passes over the cut off zone providing a balancing pressure about the valve to avoid undue wear and excessive radial loads on the bearings journalling one end of the rotor. A balanced valve eliminates radial leads due to the variation of pressures existing between the male and female members in view of the exposed port areas, at the same time self-adjusting for the purpose of reducing slippage across the valve face.

In the preferred arrangement, fluid passages 44, 45 in the stationary valve member 22, each respectively connect with passages 54, 54 in the face plate of the casing (see Figure 6), to which the piping connections to and from the pumps are made. Each passage 54 connects with a relief chamber 55 through a port 56 controlled by a spring-pressed check valve 57 within the relief chamber. The relief chamber is provided with an escape port 58. This protects against overloading the unit as the valve will automatically unseat under excessive pressures, the relief mechanism being in duplicate, and designed for reversal flow, when the passages are alternately used as intake and outlet.

In Figures 13, 14 and 15, mechanism is provided for manually adjusting and setting the stator to graduated degrees to change the volumetric displacement of the pump or generator and enabling a definite and accurate setting to be made. A bracket 59 is rigidly fixed to the front side of the stationary valve member 22 through which the square end of the stator adjusting rod 30 is projected.

The adjusting rod has a rack segment socketed upon its end, the segment having a tooth mesh with a pinion 61, journaled in the bracket 59. The pinion has a stud projecting from one end thereof loosely engaged through an index disc or plate 62, fixed to the bracket 59. The stud carries a knob 63 fixed thereon for manually rotating the pinion and thereby swinging the segment in a direction for appropriately shifting and setting the stator. The knob 63 is notched to receive a spring pressed thumb latch 64, pivotally

supported upon the knob and engages with the near notching upon the periphery of the index plate.

In Figures 14 and 15, the pump or generator is illustrated as housed within a casing 65 and the rotor of the pump driven by a belt 66 engaged over a pulley on the end of the rotor driving shaft 21. The fluid passages to and from the pump connect with a reversing and surplus fluid relieving manifold 67, the manifold providing branch conduits 68, 69 respectively in connection with the passages 54—54 in the face plate of the pump housing. The branch conduits 68, 69 connect with an outlet 70 through valve control ports in the cross head of the manifold. The cross head of the manifold is provided with valve seat sleeves 71—71 at relative opposite sides of the outlet 70 each seat engaged by a respective spring pressed ball valve 72, 73 with an interposed separator or push bar 74. The fluid forced out of the delivery side of the pump, for exemplification, say, from the passage 54, in communication with the branch conduit 68 of the manifold which will cause the valve 72 to seat forcing valve 73 open and closing the branch conduit 68 to the fluid outlet 70.

The outlet 70 leads into a reservoir in the face of the casing 65. The intake side of the pump when the pump is utilized as a power medium for operating a feeding element or the like of a machine tool connects with a return line from the machine driven thus connects with the second branch conduit 69 of the manifold which is open to the reservoir allowing any surplus supply to be drained into the reservoir. The reservoir also serves for supplying the inlet side of the pump under such conditions as a reserve should the return supply be inadequate. When the direction of flow is reversed, the entire circuit automatically changes.

In the event that the control rod 30 is mechanically or automatically operated, the oscillation of the rod may be synchronized with the oscillation or rotation of a transmitting element, having a determined direction of motion, thus optionally selecting between conduits 68 and 69 as being the intake and discharge. This is a rather significant advantage in that often the controls tying in with the pump from the devices, as applied to, have a very definite direction of motion and it becomes rather difficult to alter them to accommodate motions necessary for adjusting the pump. By removing shaft 4 and turning it 180° and replacing the same, the control direction can be reversed. The shaft 4 can be set for variously altering the position of the parts for making tying connections with the control rod.

When the pump is controlled by manual means for adjusting or setting the stator for a definite volumetric displacement, a relief valve is provided for escaping the fluid when the resistance opposing the fluid is excessive or above that for which the relief valves have been set, the fluid escaping, to relieve the overloading conditions. This is extremely hard on the fluid as well as consuming power, and energy, the relief mechanism only provides a safety factor.

In Figures 16 and 17 means are provided for automatically shutting off the pump and maintaining the maximum pressure for any period, pumping only such fluid as may be necessary to compensate for slippage which is automatic controlled thus reducing power consumption to a very minimum. The control rod 30 for shifting the stator is provided with a rocker arm 74 having rollers 75—75 respectively journaled in its

opposite ends and engaging or riding upon a reciprocating cam 76 for rocking the control rod in relative alternate directions. The cam is provided with a tubular body 77 housing a compression spring 78 held within the bore by nuts 79—79 within the body at opposite ends of the compression spring.

A control rod 80 is engaged through the tubular body and compression spring, and slidably supported within bracket extensions 81—81 extending from the cylinders 82—82 fixed to the face plate of the pump housing. The intermediate portion of the rod is reduced in size to provide shoulders for the washers 83—83, engaging respectively with the opposite ends of the compression spring. The rod 80 when shifted in either direction compresses the spring to a determined degree appropriately rocking the rocker arm 74 in a predetermined direction for carrying a load of predetermined value. The device is similarly affected in either of reverse directions. The tubular cam body at its lower side is provided with a centrally projecting lug 84 for contacting with a piston rod 85 of either one of a pair of pistons 86 disposed at relative opposite sides of the lug 84.

The cylinders 82 respectively communicate with the relief duct 87 of the relief chamber 55 and should the pressure in the delivery passage of the pump exceed the pressure for which the relief valve is set or adjusted to carry, the relief valve will open and pass the fluid through the escape duct 87 into the cylinder chamber in rear of the piston 86, moving the piston outwardly against the lug 84 and against the tension of the compression spring 78, operating or moving the cam neutralizing the pump. The combined resistance of the control lever setting and compression spring 78, makes it possible to retain a given pressure over an indefinite period of time by merely pumping such fluid as will escape the small passages 89, spirally around the piston as exhaust passages for the fluid, the exhaust fluid draining through a duct or channel 90 for return to the pump supply. The entire control functions and responds regardless of the direction of fluid flow. By this medium, it is possible to confine the fluid activities to that which is actually needed to perform a given duty and not pump any excess and by-pass the overage. It further obviates the difficulties of getting fluid of uniform viscosity and permits uniform performance by virtue of not heating the fluid.

In Figure 18, one of the uses of the pump is disclosed, diagrammatically, a method of feeding a carriage of a machine tool. 91 indicates the carriage having a cylinder 92 as a part of its organization. Within the cylinder is a piston 93 fixed upon a stationary piston rod 94 suitably supported at its opposite ends exteriorly of the cylinder.

96 indicates the pump having a fluid delivery connection through a conduit or pipe 97 with the cylinder chamber 98 at one side of the piston 93. The pump has an intake conduit or pipe 99 leading to a source of supply 100. A branch passage or pipe 101 at one end connects with the delivery or pressure line 97 and its opposite end connects with a chamber 102 of a back pressure valve device 103.

The fluid pressure in the chamber 102 acts upon a high pressure end of a differential piston or slide valve 104. The opposite end of the valve 104 is of increased diameter moving to throttle an outlet port connecting with a discharge line 105

leading to the fluid supply source. A piston chamber 106 at the upper end of the valve 104 is in connection to a pipe 107 with a chamber 108 of the cylinder 92 at the opposite side of the piston 98. The upper or larger diameter of the piston valve when raised cuts off communication between the discharge lines 105 and 107, maintaining the back pressure within the cylinder chamber 108 during the movement of the carriage.

A spring 109 exerts its pressure against the lower or reduced diameter end of the valve normally maintaining the valve in a position closing the port for the discharge line 105 to prevent the fluid from draining from the cylinder chamber 108 during idle periods. As the fluid enters the cylinder chamber 98 it will move the carriage to the right in the direction of travel being indicated by the arrow diminishing chamber 108 building up the pressure for the exhaust fluid sufficient to depress the valve opening the port to the discharge line 105 for exhausting the fluid from the chamber 98.

The larger end of the valve having an area greater than the smaller end will depress the valve with less pressure per square inch than is imposed on the small end maintaining the valve in a position to keep the control port open under a graduated degree governed by the counter influence at the opposite end of the valve. This provides a means for maintaining a back pressure in the cylinder chamber 108 to resist recalling of a moving passage or carriage under intermittent loads.

To simplify the diagram Figure 18, the piping is illustrated for carriage movement in one direction only, it being obvious to include simple valves and piping in the system for reversing the operation either under automatic or manual control.

Having described my invention, I claim:

1. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation tangential to the bore of the outer cylinder, a plurality of radial vanes rotatably connecting said cylinders, each vane having pivotal connection with one cylinder and a sliding connection with the other, said vanes dividing the circumferential space between the cylinders into a plurality of chambers, and for an arc of rotation with each revolution of said cylinders providing a key for rotatively connecting said cylinders, a head of the outer cylinder provided with passages one for each chamber for supplying and discharging the fluid to and from the chamber and a stationary valve concentrically engaged and fitting within a recess in said outer cylinder head, the valve having independent inlet and outlet ports and passages respectively cooperating with said passages in said head for simultaneous intake and discharge control respectively for a corresponding number of said chambers for continuous and uniform volumetric intake and discharge.

2. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation tangential to the bore of the outer cylinder, a plurality of radial vanes rotatably connecting said cylinders, each vane having pivotal connection with one cylinder and a sliding connection with the other, said vanes dividing the circumferential space between the cylinders into a plurality of chambers, a head of the outer cylinder provided with passages, one for each chamber for supplying and discharging the fluid to and from the chamber, and a stationary valve fitting

within a recess in said outer cylinder head coaxially with the outer cylinder and cooperative therewith for controlling said passages, said passages disposed in diverting directions from the valve to the chamber to communicate with the spacing between the cylinders at the inner periphery of the outer cylinder.

3. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation with the outer cylinder with its periphery in tangential relation to the bore of the outer cylinder, a plurality of radial vanes rotatably connecting said cylinders, each vane having pivotal connection with one cylinder and a sliding connection with the other, said vanes dividing the circumferential space between the cylinders into a plurality of chambers each chamber having a fluid conveying duct communicating therewith for supplying and discharging the fluid to and from the chamber, and an eccentric journal for said inner cylinder, the opposing faces between the inner cylinder and heads of the outer cylinder arranged to provide cavities communicating with respective chambers for stabilizing the inner cylinder between the heads of the outer cylinder by the fluid pressure within the chamber.

4. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation with the outer cylinder with its periphery in tangential relation to the bore of the outer cylinder, and a plurality of radial vanes rotatably connecting said cylinders, each vane having pivotal connection with one cylinder and a sliding connection with the other, said vanes dividing the circumferential space between the cylinders into a plurality of chambers each chamber having a fluid conveying duct communicating therewith for supplying and discharging the fluid to and from the chamber, and the joint faces at the opposite ends of the vanes, adjacent the heads of the outer cylinder, having channels longitudinally therein, and intercommunicating through the pivot of the vanes, for stabilizing the vanes between the heads, by the pressure of the fluid in said channels.

5. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation tangential to the bore of the outer cylinder, a plurality of radial vanes rotatably connecting said cylinders, each vane having pivotal connection with one cylinder and a sliding connection with the other, dividing the circumferential space between the cylinders into a plurality of chambers, each chamber having a passage for alternately supplying and discharging fluid therefrom in each rotating cycle, valve means for controlling said passages, the sliding ends of the vanes each are flanged to provide edges at opposite sides of the vane for contact with the walls of the slot of the cylinder into which the vane is slidably engaged and an increased side area for exposure to the pressure in the chamber for which the said vane provides a wall to hold the vane in a sealing contact with the wall surface of the slot.

6. In a rotary pump, a rotor as a unit, comprising, an outer cylinder and an inner cylinder normally in tangential relation with radial vanes connecting said cylinders and forming a plurality of compression chambers between the cylinders, and a stationary valve member, concentrically fitting within a recess in a head of outer cylinder and cooperating therewith for controlling a fluid passage within the outer cylinder one to each of said chambers for supply and discharge, the

valve having a pair of ports for supply and delivery of fluid, each port of an area for opening to the fluid passage of a plurality of said chambers for maintaining a constant flow.

- 5 7. In a rotary pump, a rotor as a unit, comprising, an outer cylinder and an inner cylinder normally in tangential relation with radial vanes connecting said cylinders forming a plurality of compression chambers between the cylinders, a
10 central tubular journal shaft for said rotor, stationary journals on said shaft, anti-friction bearings for journalling said rotor at opposite sides with the rotor capable of floating motion axially, a conical valve seat concentric with the axis of the
15 rotor and fixed within the head of the outer cylinder, the cylinder having ports each respectively communicating with a passage to each of the said chambers alternately for supply and discharge, and a stationary conical valve engaged
20 with said rotatable seat for controlling said ports, said valve and seats maintained in joint sealing engagement and the valve stabilized within the seats by pressure imparted from one of the chambers.
- 25 8. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation with the outer cylinder having its periphery in tangential relation to the interior periphery of the outer cylinder, a plurality of radial vanes connecting said cylinders and providing intervening
30 chambers between said cylinders, each vane having a pivotal connection with one cylinder and a sliding connection with the other, and each chamber respectively communicating with a fluid conveying duct within the outer cylinder, for fluid
35 supply or discharge to and from the chamber, a stator journalling the inner cylinder, slidably mounted upon a stationary axis and shiftable radially to alter cylinder rotation from a concen-

tric to various degrees of eccentricity relative to the outer cylinder for volumetric fluid control to and from said chambers, the stator radially adjustable to position its axis to either of opposite
5 sides of the stationary axis for a fluid reversal control, a shaft providing a stationary axis for the stator and slidingly supporting the same, and a stationary valve having separate intake and exhaust ports and passages, the valve coaxial with
10 the outer cylinder and fitting within a recess in a head end thereof for cooperation therewith controlling the fluid to and from said chambers and passages therefor, the intake and discharge ports of the valve respectively continuously open to a
15 corresponding number of chambers for continuous and uniform volumetric inlet and discharge.

9. In a rotary pump, a rotatable outer cylinder, an inner cylinder within and journaled for rotation with the outer cylinder having its periphery
20 in tangential relation to the interior periphery of the outer cylinder, a plurality of radial vanes connecting said cylinders and providing intervening chambers between said cylinders, each vane having a pivotal connection with one cylinder
25 and a sliding connection with the other and each chamber respectively communicating with a fluid conveying duct within the outer cylinder for fluid supply or discharge to and from the chamber, and a stationary valve having separate intake
30 and exhaust ports and passages coaxial with the outer cylinder and fitting within a recess in a head end thereof for cooperation therewith controlling the fluid to and from said chambers and passages therefor, the intake and discharge ports
35 of the valve respectively continuously open to a corresponding number of chambers for continuous and uniform volumetric inlet and discharge.

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