

Feb. 2, 1937.

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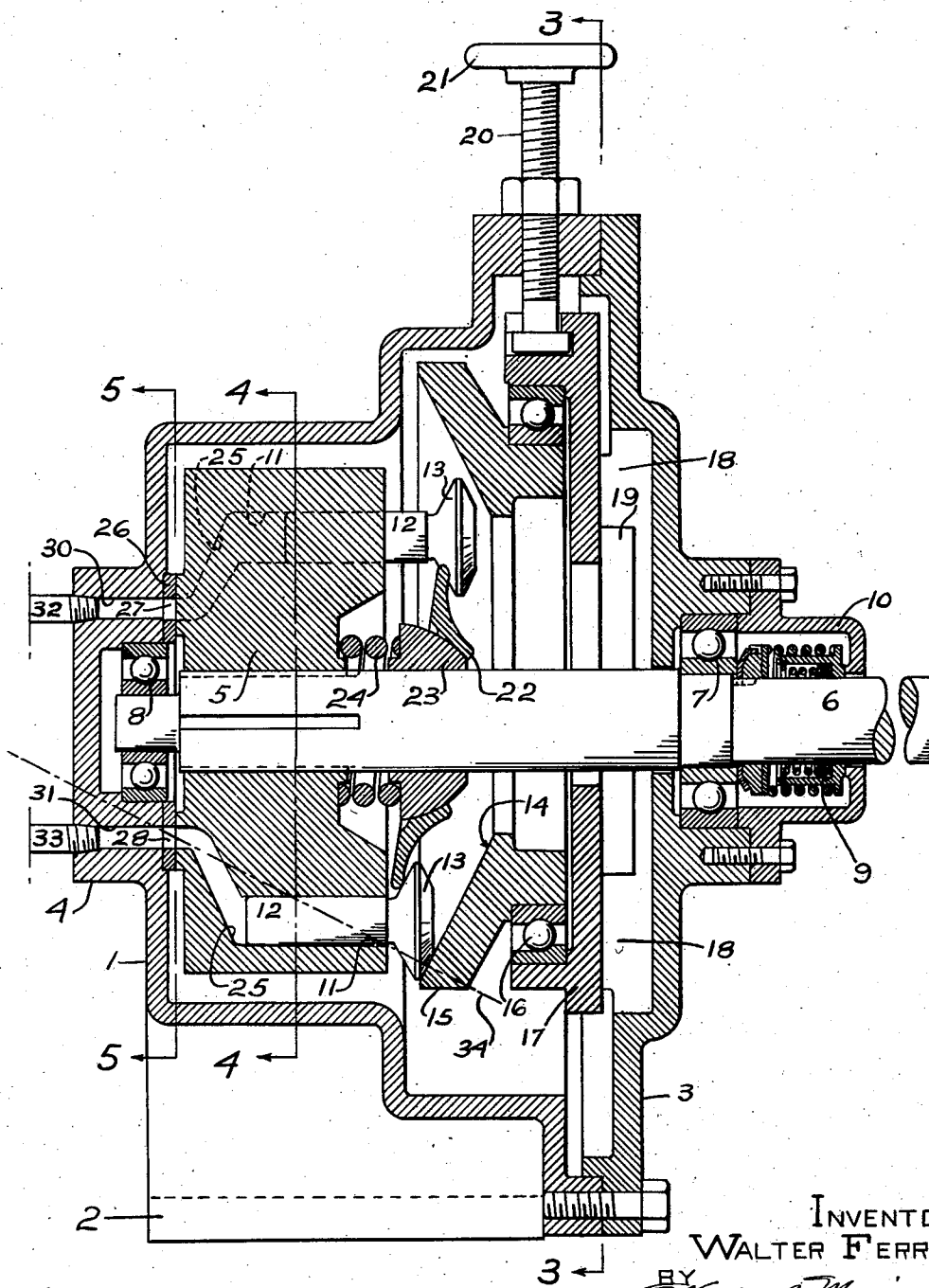
2,069,651

PUMP OR MOTOR

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Fig. 1.



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Fig. 2.

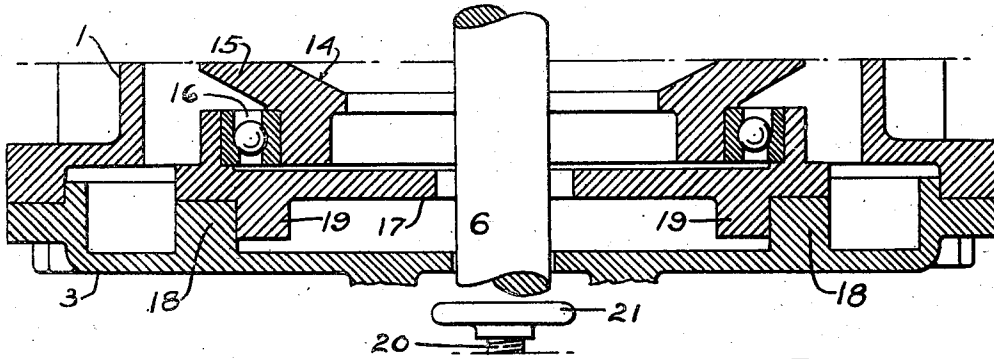
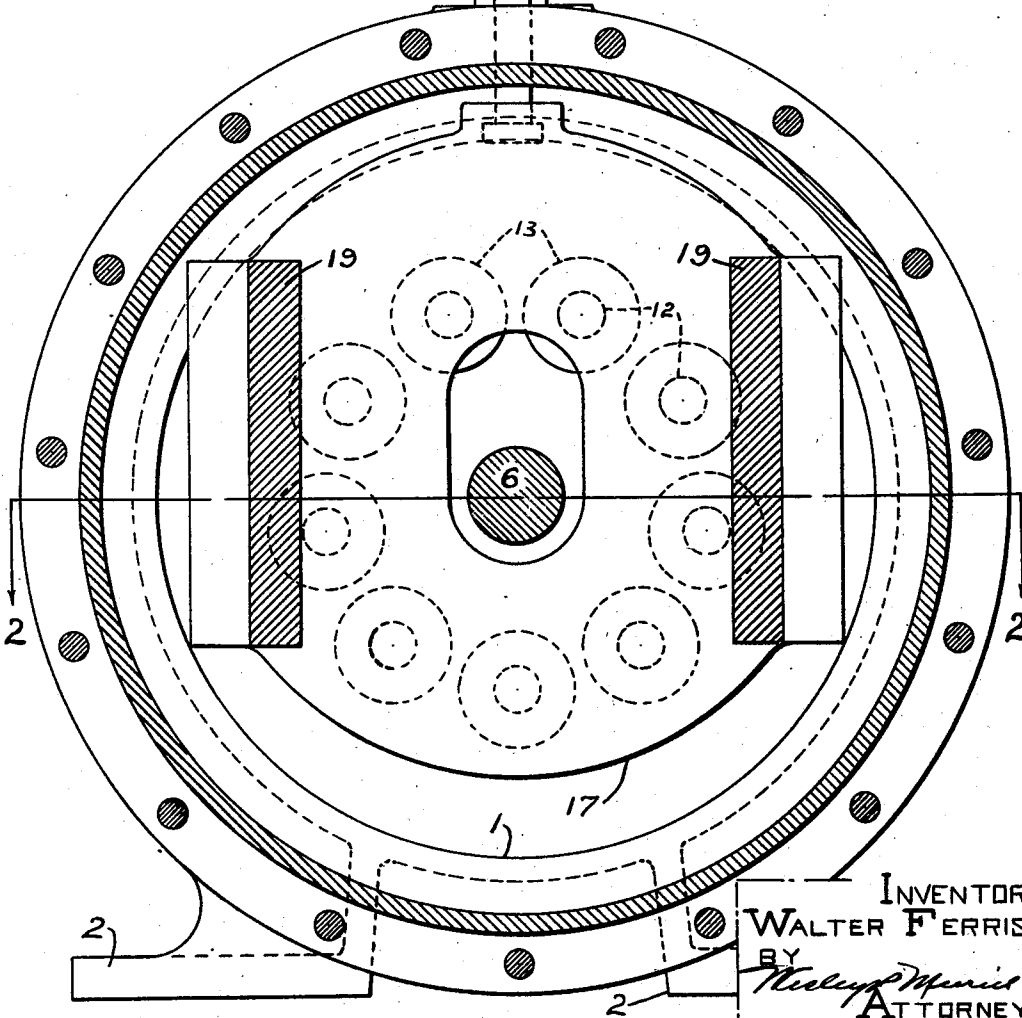


Fig. 3.



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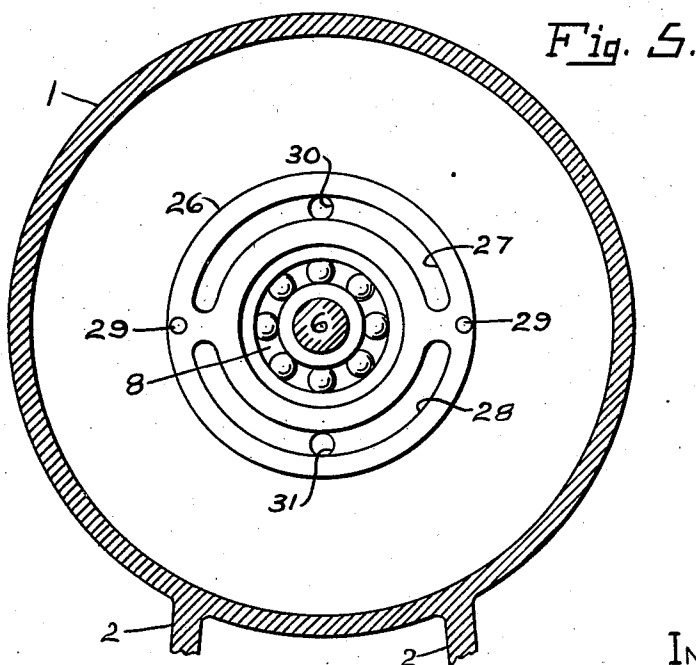
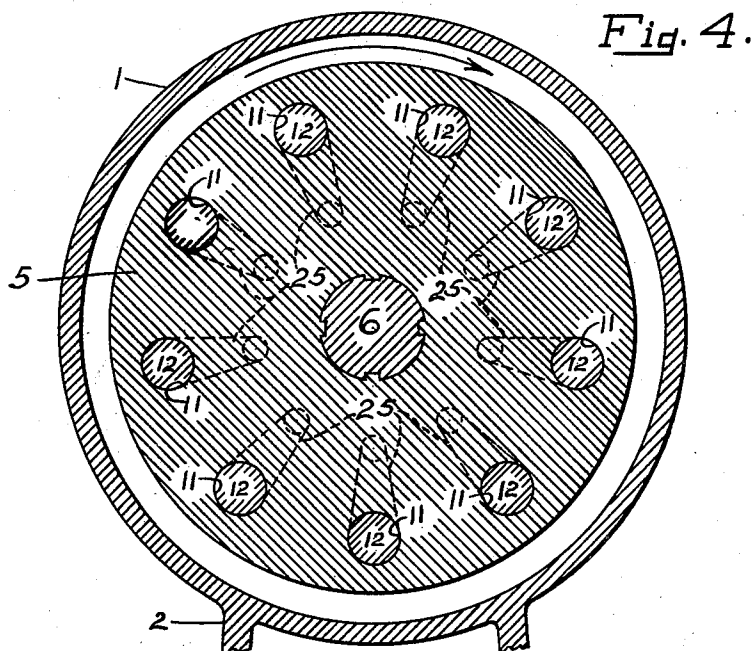
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,069,651

PUMP OR MOTOR

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Application February 18, 1935, Serial No. 6,967

19 Claims. (Cl. 103—162)

This invention relates to pumps or motors of the type in which a plurality of cylinders are arranged in a rotatable cylinder barrel and provided with pistons which have the outer ends thereof in engagement with a thrust member and are reciprocated thereby as the cylinder barrel rotates. A machine of this type will function as a pump when it is driven mechanically and will function as a motor when driving liquid is supplied to its cylinders. For the purpose of illustration, the machine will be referred to herein as a pump and the invention will be explained as applied to a pump, but it is to be understood that the invention is equally applicable to a motor of the same type.

The pump to which the invention applies in particular is provided with a thrust member which engages the outer end or head of each piston upon a single spot offset from the piston axis whereby the outer end or head of each piston will roll along the thrust member and each piston will rotate in its cylinder as it reciprocates therein, such as the pump described and claimed in Patent No. 1,998,984, issued April 23, 1935 on my copending application, Serial No. 699,847 filed November 27, 1933 and in application, Serial No. 662,219 filed March 23, 1933 of which this application is a continuation as to matters common to both applications.

The present invention has as an object to provide a rolling piston pump of the axial type.

Another object is to provide an axial type of pump which is capable of developing high pressures.

Another object is to provide an axial type of pump which is highly efficient.

Other objects and advantages will appear from the following description of the pump illustrated in the accompanying drawings in which the views are as follows:

Fig. 1 is a central longitudinal section through a pump in which the invention is embodied.

Fig. 2 is a fragmentary longitudinal section taken at right angles to the plane of Fig. 1, as indicated by the line 2—2 of Fig. 1.

Fig. 3 is a transverse vertical section taken on the line 3—3 of Fig. 1.

Fig. 4 is a transverse vertical section taken on the line 4—4 of Fig. 1.

Fig. 5 is a transverse vertical section taken on the line 5—5 of Fig. 1.

The pump chosen for illustration is provided with a casing 1 having feet or bases 2 fixed thereto for supporting the same.

The casing is closed at its front end by remov-

able front plate or head 3 and at its rear end by an end wall or head which is shown as being integral with the side walls of the casing and provided with a boss 4.

The casing has a cylinder barrel 5 arranged therein and adapted to be rotated by a drive shaft 6 with which it is fixed for rotation as by being splined thereon. The shaft 6 extends through the front plate 3 for connection to a prime mover and is journaled in antifriction bearings 7 and 8 carried, respectively, by the front plate 3 and the boss 4. Leakage of liquid through the front plate 3 is prevented by a packing or gland 9 arranged upon the shaft 6 and retained in position outward of the bearing 7 by a cap 10 fastened to the front plate 3.

The cylinder barrel 5 has formed therein a plurality of cylinders 11 which are arranged parallel to the axis thereof and equally spaced around the shaft 6, nine cylinders being shown.

Each cylinder 11 has a cylindrical piston 12 closely fitted for reciprocation therein and provided upon its outer end with a nonspherical contact surface to engage a reaction surface which is formed upon a thrust member and inclined to the cylinder barrel axis.

As shown, each piston 12 is provided upon its outer end with an enlarged head 13 having upon its outer face an inclined contact surface to engage an internal conical reaction surface 14 which is formed upon a thrust member 15 and has its axis parallel to the cylinder barrel axis. The reaction surface 14 engages each piston head upon a single spot which remains upon the outside of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of the cylinder barrel.

However, the thrust member 15 may be provided with an external conical reaction surface which engages each piston head at a point inside the piston axis. This construction has not been illustrated as it is simply the reverse of the construction shown. Also, under certain conditions, each piston may be provided with a head which is no larger than the piston body, that is, the contact surface may be formed on the end of the piston body, but in practice it is ordinarily found to be advantageous to provide each piston with an enlarged head. The contact surface on the outer end or head of each piston is arcuate but nonspherical and is ordinarily formed by shaping the outer end or head into the form of a truncated cone and then generating the contact surface by holding it in contact with a grinding surface corresponding to the reaction surface 14.

revolving the piston about an axis corresponding to the axis of the cylinder barrel 5, and causing or permitting the grinding surface to rotate upon an axis which is parallel to but offset from the axis about which the piston revolves.

The generated surface thus produced provides the largest possible bearing spot in any position of the piston.

The thrust member 15 is restrained from axial movement but, if it were restrained from rotation, the rotative speed of the cylinder barrel would be limited by the rotative speed which could be imparted to the pistons, thereby limiting the volumetric delivery of the pump. For this reason, the thrust member 15 is rotatably supported as by means of an antifriction bearing 16 the axis of which coincides with the axis of the conical reaction surface 14.

The bearing 16 is carried by a reaction member or support 17 which is restrained from axial or rotative movement but which, in a variable displacement pump, is adjustable transversely of the cylinder barrel axis to change the stroke of the pistons.

As best shown in Fig. 2, the support 17 is restrained from movement away from the cylinder barrel 5 by two abutments 18 which are carried by the front plate 3 upon opposite sides of the shaft 6 and engage the front face of the support 17 near each of its lateral sides.

As best shown in Figs. 2 and 3, the support 17 is restrained from lateral movement by two guides 19 which are fixed upon the front face thereof with the outer edge of each guide in contact with the inner edge of an abutment 18.

The abutments 18 and the guides 19 prevent the support 17 from moving in two directions but permit it to be moved vertically either by hydraulic or mechanical means both of which are in common use. As shown in Fig. 1, a screw 20 is threaded through the top of the casing 1 and attached to the support 17 by a connection which permits it to rotate independent thereof.

The screw 20 is provided upon its upper end with a hand wheel 21 by means of which it may be rotated to raise or lower the support 17 and the thrust member 15 to thereby vary the stroke of the pump.

When the axis of the reaction surface 14 coincides with the cylinder barrel axis, the point of contact between each piston head and the reaction surface remains at the same distance from the cylinder barrel throughout a complete revolution of the cylinder barrel. Consequently, the pistons are not reciprocated and no liquid will be delivered by the pump.

When the axis of the reaction surface 14 is offset from the cylinder barrel axis, the point of contact between each piston head and the reaction surface moves toward the cylinder barrel during one half-revolution of the cylinder barrel and recedes from the cylinder barrel during the other half-revolution, thereby forcing each piston rearward into its cylinder to expel liquid therefrom during one half-revolution and permitting each piston to move forward and liquid to enter its cylinder during the other half-revolution.

The piston may be moved forward or outward and the head thereof retained in contact with the reaction surface 14 in any suitable manner, such as by supplying the cylinders on the intake side of the pump with liquid at a low pressure from a gear pump as disclosed in application, Serial No. 699,847, referred to above.

As shown, an annular wobbler plate 22 en-

gages the under sides of all of the piston heads 13 and is mounted upon a collar 23 which is fitted upon the shaft 6 to slide thereon. The inner surface of the wobbler plate 22 and the outer surface of the collar 23 are spherical and complementary to each other to permit the plate 22 to tilt on the collar 23 as the cylinder barrel rotates. The plate 22 and the collar 23 are urged forward to hold the piston heads 13 in contact with the reaction surface 14 by a helical compression spring 24 which encircles the shaft 6, engages the rear face of the collar 23, and reacts against the cylinder barrel.

As the cylinder barrel rotates and the thrust member forces the pistons on the discharge side of the pump inward to expel liquid from their cylinders, the wobbler plate 22 will tilt upon the collar 23 and move the pistons on the intake side of the pump outward and enable them to draw liquid into their cylinders.

Liquid flows to and from each cylinder through a passage 25 which is formed in the cylinder barrel and has its inner end in communication with the cylinder and its outer end functioning as a port to communicate with opposite sides of an external hydraulic circuit alternately as the cylinder barrel rotates.

Liquid may flow to and from the cylinders through a central valve shaft or pintle as shown in my copending applications referred to above, in which case the port ends of the passages 25 will open into the bore of the cylinder barrel and communicate alternately with two ports formed in the pintle.

However, the passages 25 are shown as terminating upon the rear end of the cylinder barrel which bears against a flat valve plate 26 having formed therein two arcuate ports 27 and 28 with which each passage 25 communicates alternately as the cylinder barrel rotates.

The valve plate 26 bears against the boss 4 or it may be formed integral therewith. If made separate as shown, it is secured in position upon the boss as by being fitted within a shallow recess and restrained from rotation by pins or screws 29 the heads of which do not extend beyond the bearing face of the plate.

The ports 27 and 28 communicate, respectively, with two passages 30 and 31 which are formed in the boss 4 for connecting the pump to an external circuit as by means of pipes 32 and 33 fastened to the boss 4 in communication, respectively, with the passages 30 and 31.

If the thrust member 15 is raised above its central or neutral position, as shown in Fig. 1, and the cylinder barrel 5 is rotated in the direction of the arrow shown in Fig. 4, the pistons in the lower half of the cylinder barrel will be progressively urged inward by the reaction surface 14 and expel liquid from their cylinders through the passages 28, the port 28, and the passage 31 into the pipe 33, and the pistons in the upper half of the cylinder barrel will be progressively drawn outward by the wobbler plate 22 and draw liquid into their cylinders from the pipe 32 through the passage 30, the port 27 and the passages 25.

If the thrust member is moved downward until its axis is below the axis of the cylinder barrel, the pump will deliver liquid into the pipe 32 and draw liquid into its cylinder from the pipe 33. In each instance, the rate at which the pump delivers liquid will depend upon the distance the axis of the reaction surface 14 is offset from the cylinder barrel axis. Also, rotation of the cyl-

inder barrel in the opposite direction will cause the pump to deliver liquid in the opposite direction.

As previously pointed out, the thrust member 15 engages each piston upon a single spot which is offset from the piston axis. Consequently, all pumping forces are transmitted from the thrust member to the piston at an angle to the piston axis. This spot is so positioned that the line of force, indicated by the line 34 in Fig. 1, passes through the valve plate 26 and preferably passes through the valve plate port in order that the pumping forces may not tend to tilt the cylinder barrel and thereby cause excessive leakage from 15 between the end of the cylinder barrel and the face of the valve plate.

A film of liquid is maintained between the end of the cylinder barrel and the face of the valve plate, and pressure created by the pump extends into this film and tends to separate the cylinder barrel from the valve plate. In order to overcome this tendency, the port end of each passage 25 is made smaller than the cylinder 11 and the contact width between cylinder barrel 5 and valve plate 26 is made narrow so that the pumping forces may hold the cylinder barrel firmly in engagement with the valve plate.

The invention herein set forth is susceptible of various modifications without departing from the scope thereof as hereafter claimed.

The invention is hereby claimed as follows:

1. A pump, comprising a stationary valve member having intake and exhaust ports, a rotatable cylinder barrel having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis and fixed for rotation with its inner part, and a rotatable thrust member restrained from movement along the axis of said cylinder barrel and provided with an internal substantially conical reaction surface engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel, said thrust member causing said pistons to reciprocate and rotate in said cylinders and said contact surfaces to roll along said reaction surface during rotation of said cylinder barrel.

2. A pump, comprising a stationary valve member having intake and exhaust ports, a rotatable cylinder barrel having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the con-

tact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, and means for adjusting said pump to vary the distance between the axis of said cylinder barrel and the axis of said thrust member to thereby vary the stroke of said pistons.

3. A pump, comprising a stationary valve member having intake and exhaust ports, a rotatable cylinder barrel having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis and fixed for rotation with its inner part, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the contact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, said thrust member causing said pistons to reciprocate and rotate in said cylinders and said contact surfaces to roll along said reaction surface during rotation of said cylinder barrel, and means for adjusting said pump to vary the distance between the axis of said cylinder barrel and the axis of said thrust member to thereby vary the stroke of said pistons.

4. A pump, comprising a stationary valve member having intake and exhaust ports, a rotatable cylinder barrel having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the contact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, and means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel.

5. A pump, comprising a stationary valve member having intake and exhaust ports, a rotatable cylinder barrel having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis, a thrust member re-

strained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the contact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means for adjusting said pump to vary the distance between the axis of said thrust member and the axis of said cylinder barrel to thereby vary the stroke of said pistons.

6. A pump, comprising a stationary valve plate having intake and exhaust ports, a cylinder barrel rotatable upon a stationary axis in contact with said valve plate and having cylinders arranged therein parallel to its axis and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis and fixed for rotation with its inner part, and a rotatable thrust member restrained from movement along the axis of said cylinder barrel and provided with an internal substantially conical reaction surface engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel, said thrust member causing said pistons to reciprocate and rotate in said cylinders and said contact surfaces to roll along said reaction surface during rotation of said cylinder barrel.

7. A pump, comprising a stationary valve plate having intake and exhaust ports, a cylinder barrel rotatable upon a stationary axis in contact with said valve plate and having cylinders arranged therein parallel to its axis and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis and fixed for rotation with its inner part, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the contact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, said thrust member causing said pistons to reciprocate and rotate in said cylinders and said contact surfaces to roll along said reaction surface during rotation of said cylinder barrel, and means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel.

8. A pump, comprising a stationary valve plate having intake and exhaust ports, a cylinder barrel rotatable upon a stationary axis in contact with said valve plate and having cylinders arranged therein parallel to its axis and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and having a contact surface arranged upon its outer end at an angle to its axis and fixed for rotation with its inner part, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis offset from the axis of said cylinder barrel when the pump is delivering liquid, said thrust member being provided with a reaction surface inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel and engaging the contact surface on each piston upon a single spot which remains upon the same side of the piston axis in respect to the cylinder barrel axis throughout a complete revolution of said cylinder barrel and which is offset far enough from the piston axis to cause the contact surface on that piston to roll along said reaction surface during rotation of said cylinder barrel, said thrust member causing said pistons to reciprocate and rotate in said cylinders and said contact surfaces to roll along said reaction surface during rotation of said cylinder barrel, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means for moving said supporting means and said thrust member transverse to the axis of said cylinder barrel to thereby vary the stroke of said pistons.

9. A pump, comprising a stationary valve plate having intake and exhaust ports, a cylinder barrel rotatable upon a stationary axis in contact with said valve plate and having cylinders arranged therein parallel to its axis and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder, an enlarged head fixed upon the outer end of each piston and having a contact surface arranged upon its outer face at an angle to its axis, and a rotatable thrust member restrained from movement along the axis of said cylinder barrel and provided with a substantially conical reaction surface and engaging the contact surface on each piston head upon a single spot which is offset far enough from the piston axis to cause said piston head to roll along said reaction surface during rotation of said cylinder barrel, the contact spot on the head of each piston being so positioned in respect to the piston axis that the line of the pumping force transmitted through that spot passes through said valve plate at a point near enough to said exhaust port to prevent said cylinder barrel from tilting in respect to said valve plate.

10. In a pump, the combination of a stationary valve member having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the

cylinder barrel axis when the pump is delivering liquid, a reaction surface arranged upon said thrust member and inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel, said reaction surface engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, and an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said inclined reaction surface.

11. In a pump, the combination of a stationary valve member having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a reaction surface arranged upon said thrust member and inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel, said reaction surface engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said inclined reaction surface, and means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel.

12. In a pump, the combination of a stationary valve member having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a reaction surface arranged upon said thrust member and inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel, said reaction surface engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said inclined reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means for adjusting said pump to vary the distance between the axis of said thrust member and the axis of said cylinder barrel to thereby vary the stroke of said pistons.

13. In a pump, the combination of a stationary

valve member having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with an enlarged head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a reaction surface arranged upon said thrust member and inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel, said reaction surface engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, and an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said inclined reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means engaging the undersides of said piston heads for retaining said contact surfaces in contact with said reaction surface.

14. In a pump, the combination of a stationary valve member having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with an enlarged head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a reaction surface arranged upon said thrust member and inclined to the axis of each piston in the same direction in respect to the axis of said cylinder barrel, said reaction surface engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said inclined reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, means for adjusting said pump to vary the distance between the axis of said thrust member and the axis of said cylinder barrel to thereby vary the stroke of said pistons, and means engaging the undersides of said piston heads for retaining said contact surfaces in contact with said reaction surface.

15. A pump, comprising a stationary flat valve plate having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a

thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a substantially conical reaction surface arranged upon said thrust member and engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, and an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said conical reaction surface.

16. A pump, comprising a stationary flat valve plate having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a substantially conical reaction surface arranged upon said thrust member and engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said conical reaction surface, and means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel.

17. A pump, comprising a stationary flat valve plate having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with a head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a substantially conical reaction surface arranged upon said thrust member and engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said conical reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means for mov-

ing said supporting means and said thrust member transverse to the axis of said cylinder barrel to thereby vary the stroke of said pistons.

18. A pump, comprising a stationary flat valve plate having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with an enlarged head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a substantially conical reaction surface arranged upon said thrust member and engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said conical reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, and means engaging the undersides of said piston heads for retaining said contact surfaces in contact with said reaction surfaces.

19. A pump, comprising a stationary flat valve plate having intake and exhaust ports, a cylinder barrel rotatable in contact with said valve member and having cylinders arranged therein parallel to its axis of rotation and provided with ports to communicate with said intake and exhaust ports alternately as said cylinder barrel rotates, a cylindrical piston fitted in each cylinder and provided at its outer end with an enlarged head fixed for rotation with its inner end, a thrust member restrained from movement along the axis of said cylinder barrel and having its axis arranged parallel to and offset from the cylinder barrel axis when the pump is delivering liquid, a substantially conical reaction surface arranged upon said thrust member and engaging each piston head upon a single spot which is offset far enough from the piston axis to cause the piston head to roll along said reaction surface during rotation of said cylinder barrel, and an arcuate contact surface generated upon each piston head and of a form corresponding to the surface produced by said head rolling upon said conical reaction surface, means for rotatably supporting said thrust member to permit it to rotate in unison with said cylinder barrel, means for moving said supporting means and said thrust member transverse to the axis of said cylinder barrel to thereby vary the stroke of said pistons, and means engaging the undersides of said piston heads for retaining said piston heads for retaining said contact surfaces in contact with said reaction surface.

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