March 4, 1941. R. W. OTT 2,233,551

FLUID PUMP

Filed Oct. 20, 1938 2 Sheets-Sheet 1

Fig. 1.

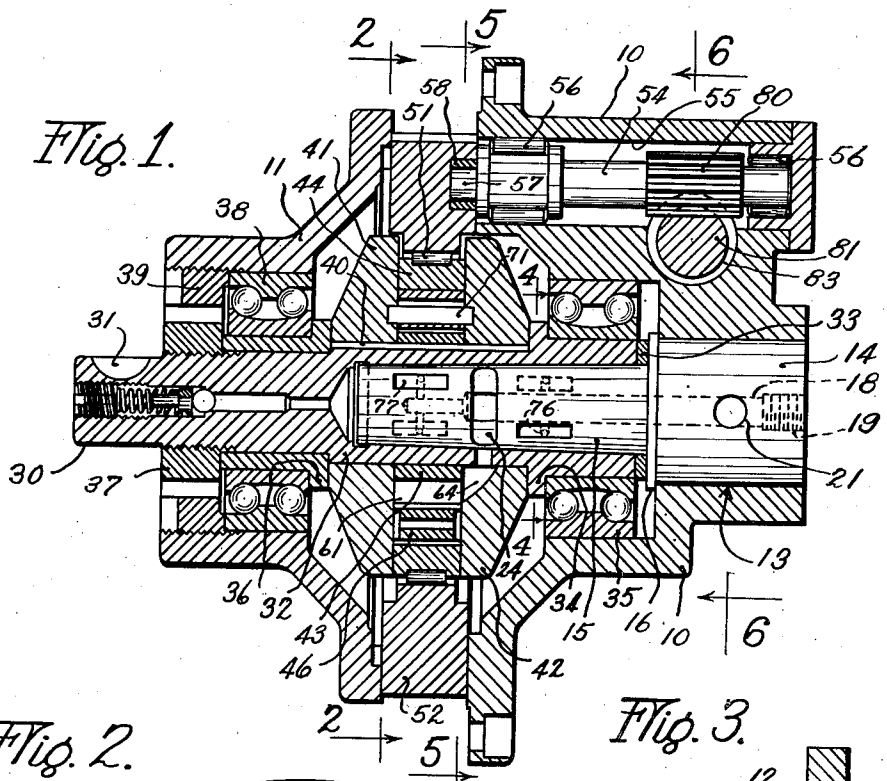


Fig. 2.

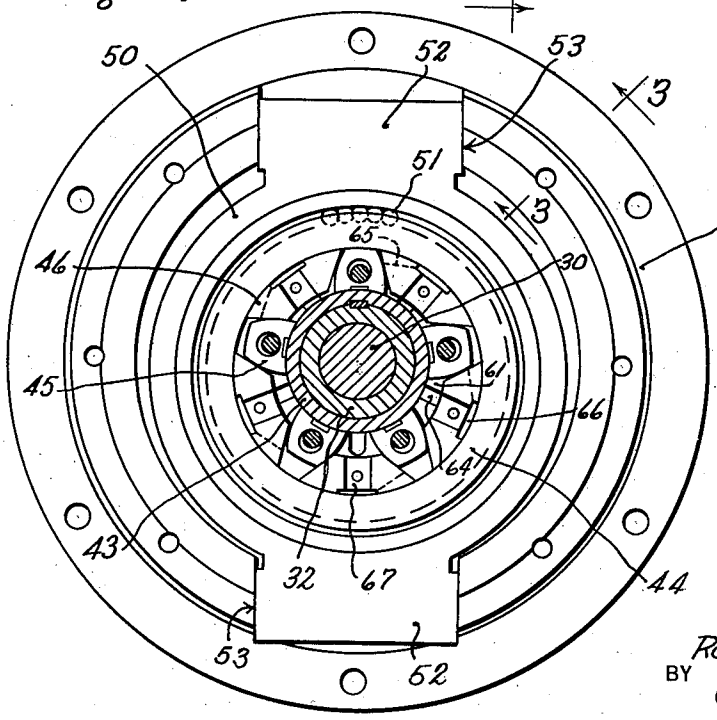


Fig. 3.

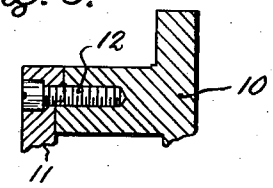
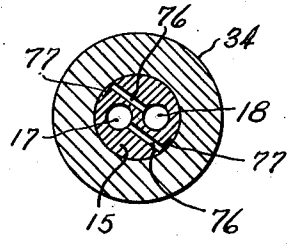


Fig. 4.



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Fig. 5.

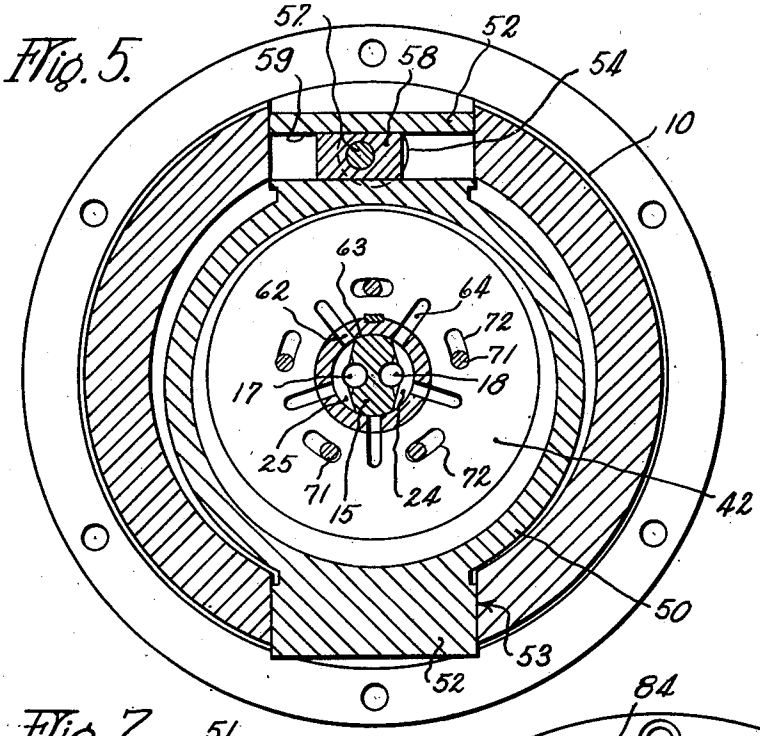


Fig. 8.

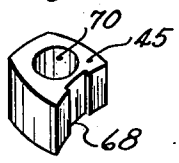


Fig. 7.

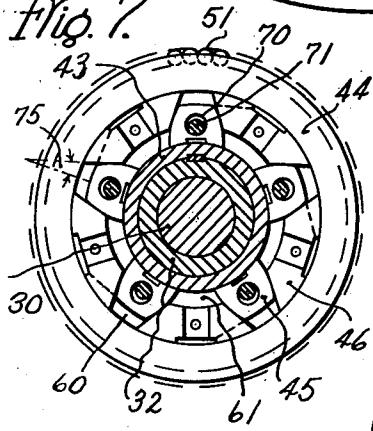


Fig. 6.

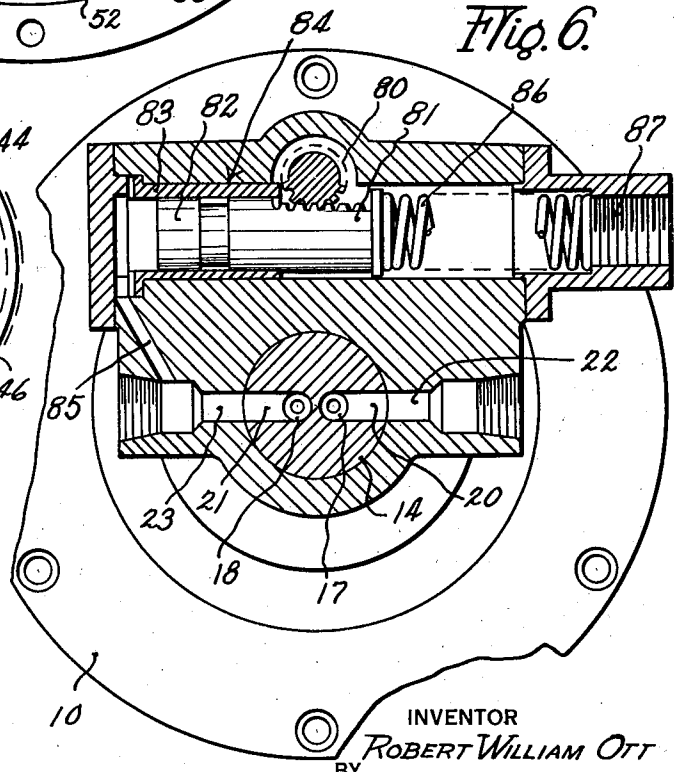
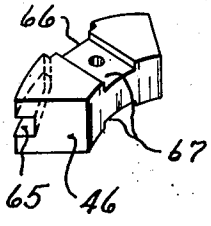


Fig. 9.



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UNITED STATES PATENT OFFICE

2,233,551

FLUID PUMP

Robert W. Ott, Stratford, Conn., assignor to Van Norman Machine Tool Company, Springfield, Mass., a corporation of Massachusetts

Application October 20, 1938, Serial No. 236,047

20 Claims. (Cl. 103—117)

This invention relates to a rotary, variable displacement, hydraulic pump.

One object of the invention is to provide a pump of this character which will be unusually compact in proportion to its performance. A further object is to provide such a pump which will practically eliminate what is known as "slippage," or leakage of the liquid being pumped past the pumping elements. A further object is to provide such a pump which will be very quiet in operation. A further object is to provide a pump of this character which will improve its tightness by use. A further object is to provide a pump in which the valve mechanism will be balanced so that binding and wearing will be eliminated and a tight seal produced. A further object is to provide a mechanism by which the output pressure of the pump may be regulated, automatically if desired, throughout its complete range without stopping the power means; or by which the pump may be used at a constant but adjustable volume output. Additional advantages and objects will appear from the following description and claims.

Referring to the drawings:

Fig. 1 is a central longitudinal section through the pump, showing the parts positioned for producing maximum volume output;

Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is a detail section on line 3—3 of Fig. 2;

Fig. 4 is a detail section on line 4—4 of Fig. 1;

Fig. 5 is a section on line 5—5 of Fig. 1;

Fig. 6 is a section on line 6—6 of Fig. 1;

Fig. 7 is a fragmentary section corresponding to a portion of Fig. 1 but with the parts in neutral position; and

Figs. 8 and 9 are perspective details of certain pump parts.

The pump mechanism is carried by a housing or frame constructed in two parts 10 and 11 secured together as by screws 12 (Fig. 3). The frame part 10 is apertured at 13 to receive with a press fit the body 14 of a tapered valve member 15. A flange 16 on the valve member abuts the frame part 10 to give a definite location to the valve member. The valve member is provided with a pair of parallel passages 17, 18 (Fig. 4), drilled in from the end of the member and closed by plugs 19. Passages 20, 21 (Fig. 6) extend laterally from the passages 17, 18, and merge into similar passages 22, 23 in the frame member which may be connected to the hydraulic circuit in which the pump is to be located. At an intermediate point the opposite sides of the valve member are grooved as at 24, 25 deeply enough to enter the passages 17, 18 and thus form ports serving respectively as inlets or outlets depending upon the setting of the pump.

A drive shaft 30, keyed at 31 to any source of power, is provided with a tapered socket 32 fitting snugly over the valve member 15 and provided with ports as will be described below so that it acts as a cooperating valve element. The drive shaft abuts a washer 33 which bears against the flange 16, so that by choosing a washer of correct thickness the tightness of fit of the drive shaft socket upon the member 15 can be regulated. A positioning flange 34 on the drive shaft bears against the end of the inner race of a ball bearing 35, the outer race of which fits in a cylindrical bore in the frame part 10 so that it will not interfere with the positioning of the shaft by the washer 33. The opposite end of the shaft is shouldered to receive a flanged spacing collar 36 held in place by a jam nut 37. A radial-thrust ball bearing 38 has its inner race carried by the spacing collar, and has its outer race forced axially by a jam nut 39 threaded into the end of the frame part 11. By tightening the latter jam nut the bearing 38 can be preloaded to hold the shaft firmly against the washer 33 and prevent any end play in the parts.

Keyed at 40 to the shaft 30 are a pair of end closure disks 41, 42 and an intermediate ring 43, all of course rotating with the shaft. The ring 43 serves to keep the disks a definite distance apart, and forms the inner wall of the pump chamber, of which the disks form the end walls. The outer wall of the chamber is formed by a second ring 44, ground to a length that will just permit it to slide between the disks while preserving fluid-tight contact with them. In the chamber thus formed are located a circumferential series of blocks arranged in two alternating and staggered series 45 and 46. The blocks of the former set are shaped generally like a gear tooth with sides in the form of circular arcs, while the blocks of the latter set have straight sides converging towards each other and making contact with the curved sides of blocks 45. The ends of the blocks of both sets are ground so as to permit them to move snugly in contact with the closure disks 41, 42 in the same manner as the ring 44, and their peripheral surfaces are ground to make tight but sliding contact with rings 43 and 44, respectively.

The ring 44 can be shifted from a position concentric with the shaft as in Fig. 7 to an eccentric position on either side thereof, one of which is shown in Figs. 1 and 2, by a shifting

member 50 having a series of rollers 51 in contact with a channeled race in the ring. The shifting member has block-like extensions 52 slidable in cut-away portions 53 of the frame part 10 and held in place by the frame part 11. A shaft 54 is journaled in a recess 55 in the frame part 11 by roller bearings 56, and has an eccentric pin 57 engaging a block 58 (Fig. 5) slidable in a slot 59 in one of the extensions 52. By rotating the shaft 54, either by hand or by some automatic mechanism like that to be described below, the shifting member may be raised or lowered, carrying the outer ring 44 to a more or less eccentric position on either side of the axis. Before considering the details of the automatic control, however, the operation of the pumping mechanism itself will be described.

The alternating blocks form pumping chambers 60 externally of the blocks 45 and chambers 61 internally of the blocks 46, as is best shown in Fig. 7. If the ring 44 is shifted to an eccentric position, as in Fig. 2, the block or blocks 45 on the side from which the ring is moved are forced between the wedge blocks 46, causing the latter to slide slightly on the outer ring. A complete readjustment of the blocks throughout the chamber follows, as is clearly indicated by a comparison between Figs. 7 and 2. The pumping chambers 60 and 61 adjacent the point where the rings approach each other most closely become smaller, and those on the opposite side larger. As the chambers enlarge they draw in a supply of fluid, and as they contract they force it out. This action is permitted by the coaction of certain valve ports with the ports 24 and 25.

As is best shown in Fig. 5, the tubular portion of the drive shaft is provided with a series of ports 62 passing through it and coming into registry alternately with the ports 24 and 25 as the shaft rotates. Intermediate its passage from registration with one port to registration with the other of the pair 24, 25, each port 62 passes across a portion 63 of the drive shaft which seals it off. With the number of blocks shown there are always two ports 62 in contact with each of the ports 24, 25. The ports 62 connect with passages 64 formed in the closure plate 42. Since this plate is keyed to the shaft, the passages always remain in registration with the ports. Each passage 64 communicates with the chamber 61 between one of the wedge blocks 46 and the ring 43. While the wedge blocks move circumferentially with respect to the ring during the pumping action, they are restricted in this motion so that the pumping chambers 61 never depart from communication with the passages 64 (see Fig. 2).

The chambers 60 are each in communication with one adjacent chamber 61. For this purpose each block 46 has a passage 65 extending from one side into a central outer recess 66. This latter recess communicates with the chamber 61 between the block and ring 43 by channels 67 extending down the side of the block. Besides the described function of connecting the chambers 60 and 61, the recess 66 performs another purpose by balancing, to the extent of the pressure of liquid acting on it, the outward pressure on the block and, therefore, decreasing the frictional resistance between the block 46 and the outer ring 44.

It was stated above that the blocks 45 have a loose connection with the disks 41, 42 and hence with the two rings. During the pumping operation the force of the liquid pressure developed and the wedging action of the two sets of blocks will cause the blocks to grip the rings firmly enough to cause rotation with no other aid, but in starting the pump it is necessary to hold the blocks temporarily in place to avoid slippage. For this purpose each block 45 is provided with a through hole 70 receiving a pin 71 of somewhat smaller diameter and received in arcuate slots 72 (Fig. 5) in the disks 41, 42. Free motion of the blocks is thus permitted within limits. If a block forces its pin to the end of its slot, however, further pressure on the block makes the bottom of the hole 70 (which is preferably eccentric with the pin for this purpose) ride on the pin and cams the block against ring 43. With one block thus held, the wedging action of the pairs of blocks causes the remainder to grip the rings tightly.

One aspect of the pumping action deserves special mention, because of its important relation to the fluid tightness of the pump. It might appear at first that each chamber 60 and 61, or at least each pair of chambers connected by passages 65, function separately and that it must for that reason be necessary to maintain fluid-tight contact between adjacent blocks 45 and 46 in all positions. It is desirable to design the wedge surfaces of blocks 46 and the curved surfaces of blocks 45 so that the two sets of blocks always fill snugly the annular chamber between the rings 43 and 44, irrespective of the position of the latter with regard to eccentricity, in order to reduce lost motion and thus the noise of the pump. In actual practice, however, the blocks do not fill the chamber tightly, either because of manufacturing tolerances (which must be chosen so that on the high side the blocks do not quite fill the chamber) or because of wear. When this occurs the blocks at the high pressure side of the pump will be forced apart by the fluid pressure and the blocks on the opposite side of the pump forced together by their resulting shifting.

No leakage is introduced by the action just described since the chambers 60, 61 through the high pressure zone are all connected together through two of the passages 64 and the common port 24 or 25, whichever may be acting as the high pressure side. The important place for the blocks to be in tight contact is at the transition points between the ports, and the separation of the blocks at the high pressure side insures this by crowding the blocks together throughout the remainder of the chamber. The tightness thus secured becomes more pronounced after the pump has been in operation, for the rubbing of the parts smooths off any tiny inequalities left by the surface finishing operation. A further feature of importance in making a fluid-tight pump is the line contact between blocks 45 and 46 due to one of them being curved and the other straight. No film of liquid is permitted to form between the blocks, as would occur were both surfaces flat, and flow between the blocks is thus prevented.

The angle 75 (Fig. 7) between a radial line through blocks 45 and the adjacent tangent surfaces of blocks 46 is of importance in securing proper operation of the pump. This angle should be large enough for a given size of pump so that a positive wedging action between the two sets of blocks will occur. On the other hand it should not be so large that the angle of contact between adjacent blocks is steep enough to cause locking by either radial or circumferential pressure, or to cause the corners of any block to bind on an adjacent block. A further consideration is that the size of the blocks and the angle 75 are prefer-

ably so coordinated that the chambers **60** and **61** will be of approximately equal volume. In general this angle may be in the range of 10° to 25°, depending upon the pump size.

It is desirable, in order to reduce the friction and wear of the parts, and to prevent leakage, that all parts be balanced hydrostatically in order to avoid excessive pressures. The manner in which this is accomplished for blocks **45** and **46** has already been considered. Aside from the blocks the only part of the present pump which requires hydrostatic balancing is the bearing of the taper socket **32** on the valve plug **15**. While the plug is held in the frame and the shaft is journaled in ball bearings slight deflections due to the pressure adjacent the high pressure port could still cause wear and leakage were not precautions taken to balance the pressure conditions. In the present case this balance is achieved by passages **76** (Figs. 1 and 4) leading from each duct **17**, **18** to a port **77** on the opposite side of the plug **15**. There are four ports **77**, two on each side, each being connected to the duct **17** or **18** on the opposite side; and the area of the two ports **77** on one side is made equal to that of the port **24** or **25** on the other side. The hydrostatic pressure tending to cause lateral relative displacement of the members **15** and **32** is thus balanced. If oil is the liquid being pumped these ports **77** may also serve as lubricating means.

The pump described lends itself readily to automatic control of its displacement, so that it may be used to deliver fluid under constant pressure. One such arrangement is shown in Figs. 1 and 6. Fixed to the shaft **54** is a gear **80** meshing with a rack **81** formed integral with a piston **82** sliding in a cylinder **83**. To provide for accurate adjustment of the mesh between the gear and rack the cylinder **83** is preferably formed as an eccentric sleeve rotatable in a bore **84**. A passage **85** extends from one end of the cylinder to the passage **23**, which in this case is connected as the high pressure side of the pump. The piston is held against the fluid pressure in the cylinder by a spring **86** backed up by an adjustable plug **87**. The pressure on the head of the piston will shift the piston, and thus change the position of the member **50** to vary the output of the pump, until the total pressure on the piston head is equal to that of the spring. Since this can be varied the pressure can be maintained at any predetermined level. If, for example, the output of the pump is completely shut off the member **50** will be shifted to a position in which the rings **43** and **44** are coaxial, in which case the output will be zero. By placing a second piston in tandem with piston **82** and connecting its cylinder periodically with a second point in the hydraulic system which is under different pressure conditions the pressure output of the pump may be varied automatically.

It may be pointed out again that the chambers **60**, **61** on the high pressure side act as one large chamber due to the passages **65**, **66**, **67**, to the separation of the blocks, and to the interconnection of the exhaust passages. One result of this is that pressure is built up practically instantaneously when the pump is put into operation. The operation of the pump is also rendered exceptionally smooth.

What I claim is:

1. A variable displacement rotary pump of the type having a rotatable annular chamber with end walls and with inner and outer circumferential walls one of which is of variable eccentricity and valve means connected to said chamber; characterized by pumping mechanism within the chamber consisting of a circumferential series of blocks arranged for contact with each other in two alternating and staggered sets slidable between the end walls, the blocks of one of said sets being in slidable contact with the outer circumferential wall and having their side surfaces inwardly convergent and the blocks of the other of said sets being in slidable contact with the inner circumferential wall and having their side surfaces outwardly convergent.

2. A variable displacement rotary pump of the type having a rotatable annular chamber with end walls and with inner and outer circumferential walls one of which is of variable eccentricity and valve means connected to said chamber; characterized by pumping mechanism within the chamber consisting of a circumferential series of blocks arranged for contact with each other in two alternating and staggered sets slidable between the end walls, the blocks of one of said sets being in slidable contact with the outer circumferential wall and having their side surfaces inwardly convergent and the blocks of the other of said sets being in slidable contact with the inner circumferential wall and having their side surfaces outwardly convergent, the blocks of at least one set having their side surfaces curved to produce line contact with the blocks of the remaining set.

3. A rotary pump comprising an annular chamber, a circumferential series of blocks slidably arranged within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces inwardly convergent and the blocks of the other set having their side surfaces outwardly convergent, means for exerting a radial wedging force progressively throughout the circumferential series of blocks, and valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof.

4. A rotary pump comprising an annular chamber, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces substantially plane and inwardly convergent and the blocks of the other set having their side surfaces curved and outwardly convergent, means for exerting a radial wedging force progressively throughout the circumferential series of blocks, and valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof.

5. A rotary pump comprising an annular chamber formed by end walls and inner and outer circumferential walls one of which is slidable between the end walls, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set being in slidable contact with the end walls and with the outer circumferential wall and having their side surfaces inwardly convergent, the blocks of the second set being in slidable contact with the end walls and with the inner circumferential wall and having their side surfaces outwardly convergent, the blocks of at least one set having their side surfaces curved to produce line contact with the blocks of the remaining set, means for rotating the chamber and the blocks therein, a bearing

for one of the circumferential walls, means for shifting said bearing transversely of the axis of rotation of the chamber to vary the eccentricity of said wall with respect to the other wall and thus to exert a radial wedging force passing progressively throughout the circumferential series of blocks to cause them to approach circumferential alinement on one side of the axis and to increase their staggered relationship on the other, and valve means connecting to the pump inlet a sector of the chamber in which the staggered relationship of the blocks is increasing and connecting to the pump outlet a sector of the chamber in which the staggered relationship of the blocks is decreasing.

6. A rotary pump comprising an annular chamber formed by end walls and inner and outer circumferential walls, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces inwardly convergent and the blocks of the other set having their side surfaces outwardly convergent, means for exerting a radial force on one of said circumferential walls to produce a radial wedging force passing progressively throughout the circumferential series of blocks, and valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof.

7. A rotary pump comprising an annular chamber composed by end walls and inner and outer circumferential walls, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces substantially plane and inwardly convergent and the blocks of the other set having their side surfaces curved and outwardly convergent, means for rotating said chamber and the blocks therein, means for adjusting one of said circumferential walls along a straight line at right angles to the axis of rotation of said chamber to thereby regulate the eccentricity of said wall with respect to said axis of rotation, and to exert thereby a radial wedging force passing progressively throughout the circumferential series of blocks, and valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof.

8. A rotary pump comprising an annular chamber, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces inwardly convergent and the blocks of the other set having their side surfaces outwardly convergent, means for exerting a radial wedging force progressively throughout the circumferential series of blocks, valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof, and means automatically controlled by the pressure delivered by the pump for varying the amplitude of said radial wedging force.

9. A rotary pump comprising an annular chamber formed of end walls and inner and outer circumferential walls, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces inwardly convergent and the blocks of the other set having their side surfaces outwardly convergent, means for varying the eccentricity of one of said circumferential walls to produce a radial wedging force passing progressively throughout the circumferential series of blocks, valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof, and means automatically controlled by the pressure delivered by the pump for controlling the eccentricity varying means.

10. A rotary pump comprising an annular chamber, a circumferential series of blocks slidably arranged with respect to the chamber and within the chamber for contact with each other in two alternating and staggered sets, the blocks of one set having their side surfaces substantially plane and inwardly convergent and the blocks of the other set having their side surfaces curved and outwardly convergent, one of said sets of blocks having passages formed therein to form a communication between the space within one series of blocks and the space outside of the other series of blocks, means for exerting a radial wedging force progressively throughout the circumferential series of blocks, and valve means for admitting fluid to and discharging it from the chamber at opposite sides thereof, said valve means being formed to permit communication between at least two of said adjacent pumping chambers.

11. A rotary pump comprising wall members defining an annular chamber having closed end walls and cylindrical inner and outer walls, a guide holding one of said cylindrical walls in a position eccentric to the other cylindrical wall, valve means having ports, certain of the wall members being apertured to communicate therewith, means for causing relative rotation between the chamber on the one hand and the valve means on the other hand, and a plurality of blocks located in the chamber in two alternating sets in sliding contact with the closed ends of the chamber and in sliding contact respectively with the outer and the inner cylindrical walls, the blocks of the first set having their side surfaces inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent, and in contact with the side surfaces of the blocks of the first set.

12. A rotary pump comprising wall members defining an annular chamber having closed end walls and cylindrical inner and outer walls, a guide holding one of said cylindrical walls in a position eccentric to the other cylindrical wall, valve means having two diametrically opposed ports, certain of the wall members being apertured to communicate therewith, means for causing relative rotation between the wall members on the one hand and the guide and the valve means on the other hand, and a plurality of blocks located in the chamber in two alternating sets in sliding contact with the closed end walls of the chamber and in sliding contact respectively with these outer and inner cylindrical walls, the blocks of the first set having their side surfaces substantially plane and inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and curved to produce line contact with the blocks of the other set.

13. A rotary pump comprising wall members defining an annular chamber having closed end walls and cylindrical inner and outer walls, a guide holding one of said cylindrical walls in a position eccentric to the other cylindrical wall,

valve means having two diametrically opposed ports, certain of the wall members being apertured to communicate therewith, means for causing relative rotation between the wall members on the one hand and the guide and the valve means on the other hand, and a plurality of blocks located in the chamber in two alternating sets in sliding contact with the closed end walls of the chamber and in sliding contact respectively with the outer and the inner cylindrical walls, the blocks of the first set having their side surfaces substantially plane and inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and curved to produce line contact with the blocks of the other set, the convergence of the side surfaces of the blocks of the first set being sufficient to produce non-locking wedge contact between the blocks of the two sets.

14. A rotary pump comprising wall members defining an annular chamber having closed end walls and cylindrical inner and outer walls, a guide holding one of said cylindrical walls in a position eccentric to the other cylindrical wall, valve means having two diametrically opposed ports, certain of the wall members being apertured to communicate therewith, means for causing relative rotation between the wall members on the one hand and the guide and the valve means on the other hand, and a plurality of blocks located in the chamber in two alternating sets in sliding contact with the closed end walls of the chamber and in sliding contact respectively with the outer and the inner cylindrical walls, the blocks of the first set having their side surfaces plane and inwardly convergent so that the included angle between the adjacent side surfaces of adjacent blocks lies between 10° and 25°, and the blocks of the second set having their side surfaces formed as cylindrical segments having line contact with the plane surfaces of the blocks of the first set throughout the motion of the blocks.

15. A rotary pump comprising wall members defining an annular chamber having closed end walls and cylindrical inner and outer walls, a guide holding one of said cylindrical walls in a position eccentric to the other cylindrical wall, valve means having two diametrically opposed ports, certain of the wall members being apertured to communicate therewith, means for causing relative rotation between the wall members on the one hand and the guide and the valve means on the other hand, and a plurality of blocks located in the chamber in two alternating sets in sliding contact with the closed end walls of the chamber and in sliding contact respectively with the outer and the inner cylindrical walls, the blocks of the first set having their side surfaces inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and in contact with the side surfaces of the blocks of the first set, one set of blocks being formed with passages connecting the space outside a block of one set with the space inside an adjacent block of the other set.

16. A rotary pump comprising a stationary tapered valve plug, a socketed member revolving around the plug and fitting closely thereon, a pair of fluid conducting passages in the plug, oppositely opening ports in the plug connected to said passages, ports in the socketed member positioned to register with the ports in the plug, a pair of closure disks keyed to the socketed member, a spacing sleeve between the disks, a ring spaced outwardly from the sleeve and slidable into concentric or eccentric relation between the disks in fluid tight relation therewith, a plurality of blocks slidable between the disks between the sleeve and the ring, said blocks being arranged in two alternating sets, passages in at least one of the closure disks from the ports in the socketed member to adjacency with at least one set of blocks, the blocks of one set being in sliding contact with the ring and the blocks of the other set being in sliding contact with the sleeve, the blocks of the first set having their side surfaces inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and in contact with the side surfaces of the blocks of the first set.

17. A rotary pump comprising a stationary tapered valve plug, a socketed member revolving around the plug and fitting closely thereon, a pair of fluid conducting passages in the plug, oppositely opening ports in the plug connected to said passages, ports in the socketed member positioned to register with the ports in the plug, a pair of closure disks keyed to the socketed member, a spacing sleeve between the disks, a ring spaced outwardly from the sleeve and slidable into concentric or eccentric relation between the disks in fluid tight relation therewith, means for varying the eccentricity of the ring with respect to the sleeve, a circumferentially complete series of blocks slidable between the disks in the space between the sleeve and the ring, said blocks being arranged in two alternating sets, passages in at least one of the closure disks extending from the ports in the socketed member into adjacency with at least one set of blocks, the blocks of one set being in sliding contact with the ring and the blocks of the other set being in sliding contact with the sleeve, the blocks of the first set having their side surfaces inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and in contact with the side surfaces of the blocks of the first set.

18. A rotary pump comprising a stationary tapered valve plug, a socketed member revolving around the plug and fitting closely thereon, a pair of fluid conducting passages in the plug, oppositely opening ports in the plug connected to said passages, ports in the socketed member positioned to register with the ports in the plug, a pair of closure disks keyed to the socketed member, a spacing sleeve between the disks, a ring spaced outwardly from the sleeve and slidable into concentric or eccentric relation between the disks in fluid tight relation therewith, a plurality of blocks slidable between the disks between the sleeve and the ring, said blocks being arranged in two alternating sets, passages in at least one of the closure disks from the ports in the socketed member to adjacency with at least one set of blocks, the blocks of one set being in sliding contact with the ring and the blocks of the other set being in sliding contact with the sleeve, the blocks of the first set having their side surfaces substantially plane and inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent and curved to produce line contact with the blocks of the other set.

19. A rotary pump comprising a stationary tapered valve plug, a socketed member revolving around the plug and fitting closely thereon, a pair of fluid conducting passages in the plug, oppositely opening ports in the plug connected to said passages, ports in the socketed member positioned to register with the ports in the plug, a pair of closure disks keyed to the socketed member,

a spacing sleeve between the disks, a ring spaced outwardly from the sleeve and slidable between the disks in fluid tight relation therewith, means for varying the eccentricity of the ring with respect to the sleeve, a circumferentially complete series of blocks slidable between the disks between the sleeve and the ring, said blocks being arranged in two alternating sets, passages in at least one of the closure disks from the ports in the socketed member to adjacency with at least one set of blocks, the blocks of one set being in sliding contact with the ring and the blocks of the other set being in sliding contact with the sleeve, the blocks of the first set having their side surfaces plane and inwardly convergent so that the included angle between the adjacent side surfaces of adjacent blocks lies between 10° and 25°, and the blocks of the second set having their side surfaces formed as cylindrical segments having line contact with the plane surfaces of the blocks of the first set throughout the motion of the blocks.

20. A rotary pump comprising a stationary tapered valve plug, a socketed member revolving around the plug and fitting closely thereon, a pair of fluid conducting passages in the plug, oppositely opening ports in the plug connected to said passages, ports in the socketed member positioned to register with the ports in the plug, a pair of closure disks keyed to the socketed member, a spacing sleeve between the disks, a ring spaced outwardly from the sleeve and slidable between the disks in fluid tight relation therewith, means for varying the eccentricity of the ring with respect to the sleeve, a circumferentially complete series of blocks slidable between the disks between the sleeve and the ring, said blocks being arranged in two alternating sets, passages in at least one of the closure disks from the ports in the socketed member to adjacency with at least one set of blocks, the blocks of one set being in sliding contact with the ring and the blocks of the other set being in sliding contact with the sleeve, the blocks of the first set having their side surfaces inwardly convergent and the blocks of the second set having their side surfaces outwardly convergent, and in contact with the side surfaces of the blocks of the first set, one set of blocks being formed with passages connecting the space outside a block of one set with the space inside an adjacent block of the other set.

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