March 17, 1964 E. E. SMITH 3,125,032

ROTARY PUMP

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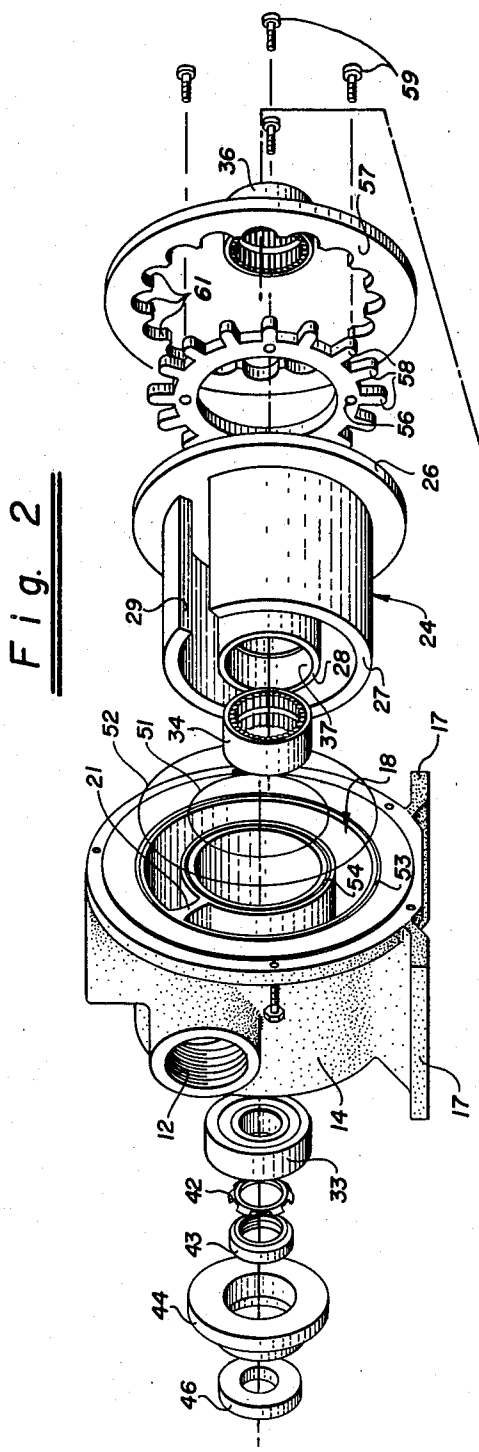


Fig. 2

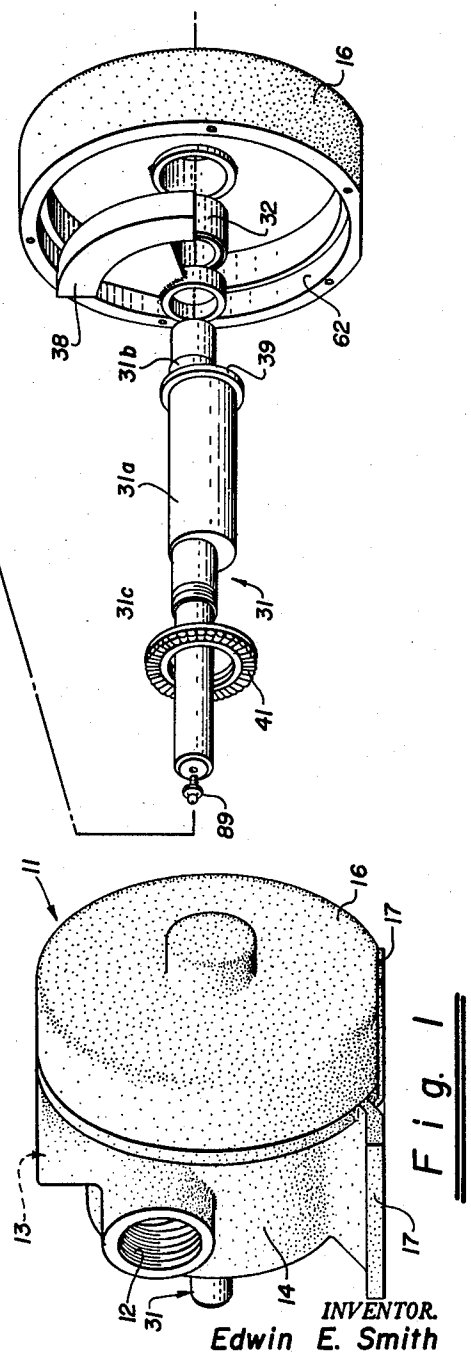


Fig. 1

INVENTOR.
Edwin E. Smith
BY Fleht and Lucas
Attorneys

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ROTARY PUMP

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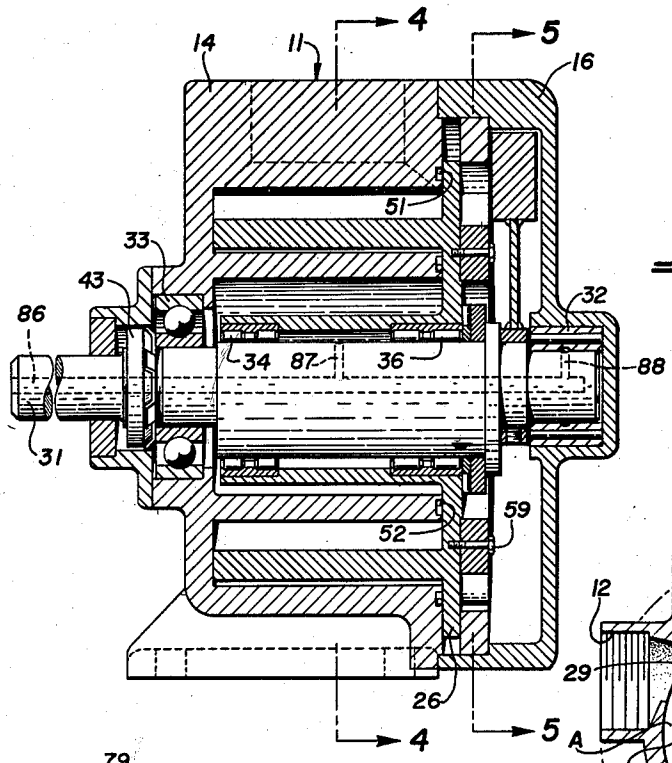


Fig. 3

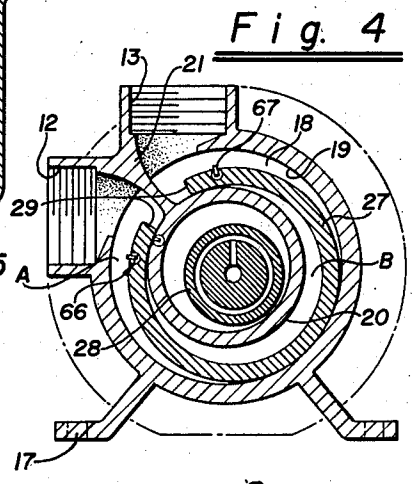


Fig. 4

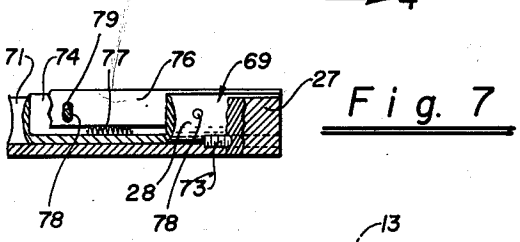


Fig. 7

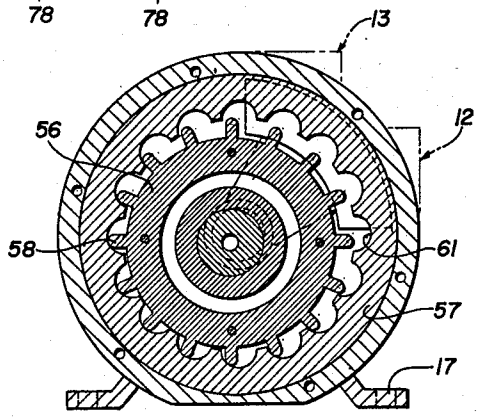


Fig. 5

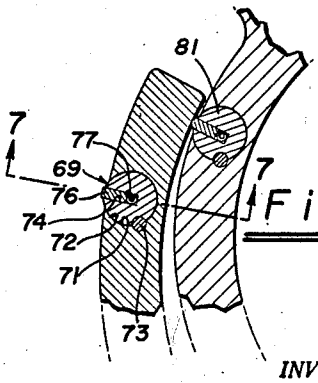


Fig. 6

INVENTOR.
Edwin E. Smith
BY
Fleht and Irwin
Attorneys

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ROTARY PUMP

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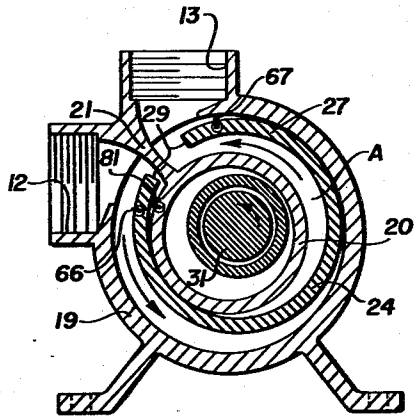


Fig. 8

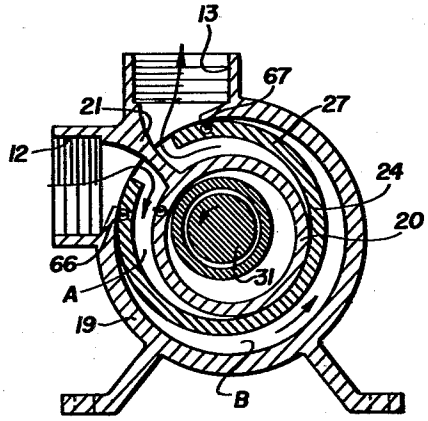


Fig. 9

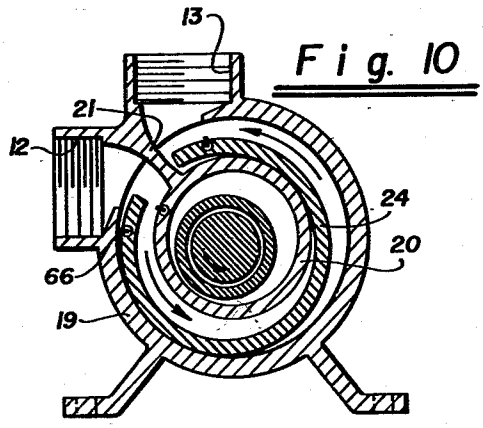


Fig. 10

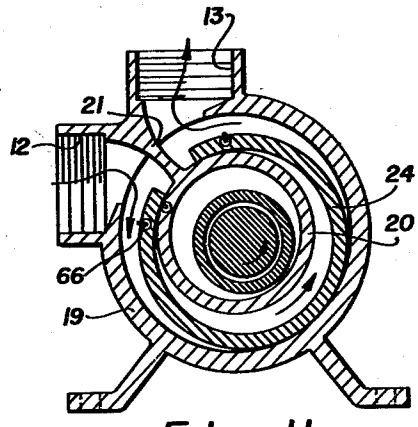


Fig. 11

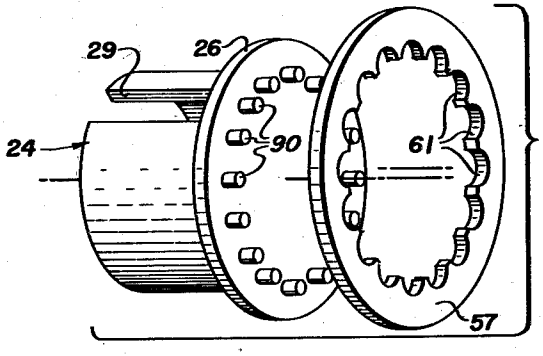


Fig. 12

INVENTOR.
Edwin E. Smith
BY Fleit & Dowd
Attorneys

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Fig. 14

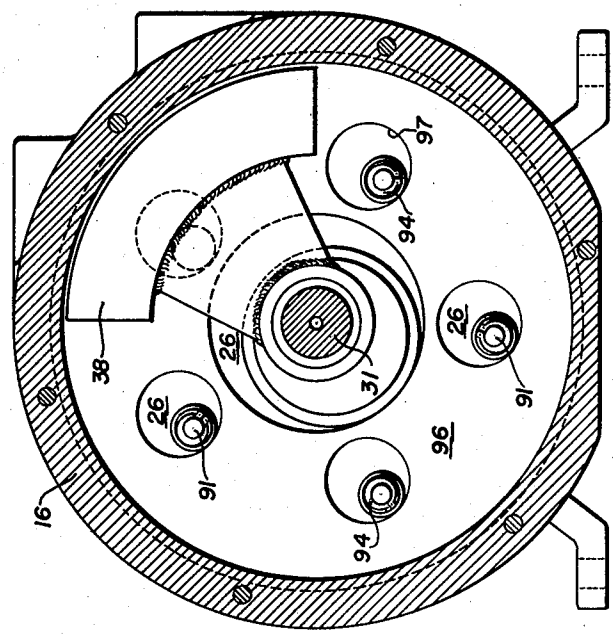


Fig. 15

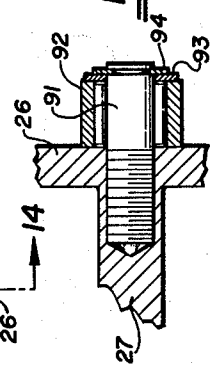
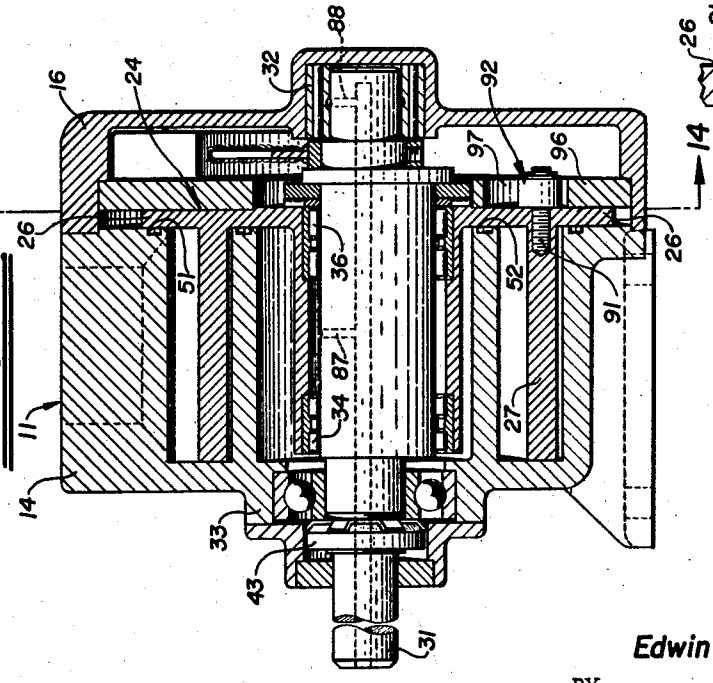


Fig. 13



INVENTOR.
Edwin E. Smith
BY Fleht and Swain
Attorneys

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ROTARY PUMP

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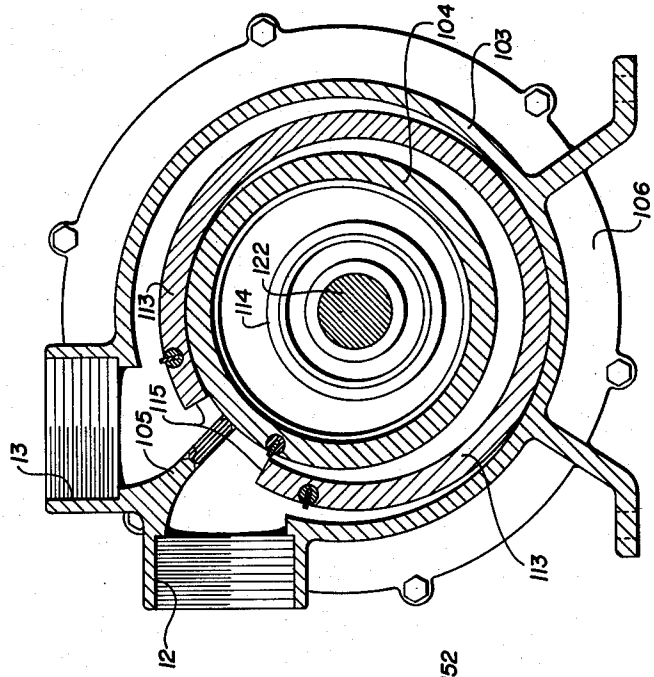


Fig. 17

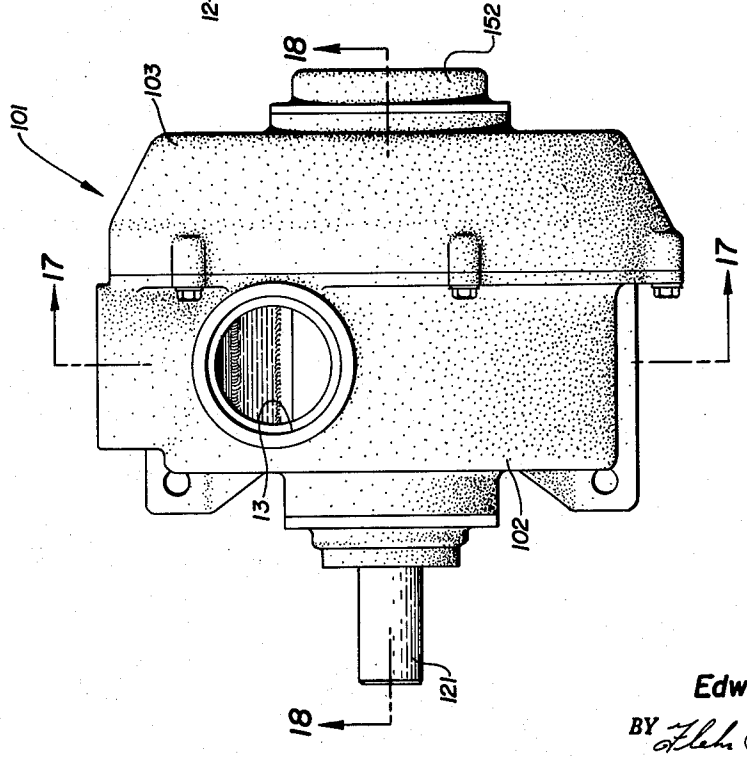


Fig. 16

INVENTOR.
Edwin E. Smith
BY Fleh & Swain
Attorneys

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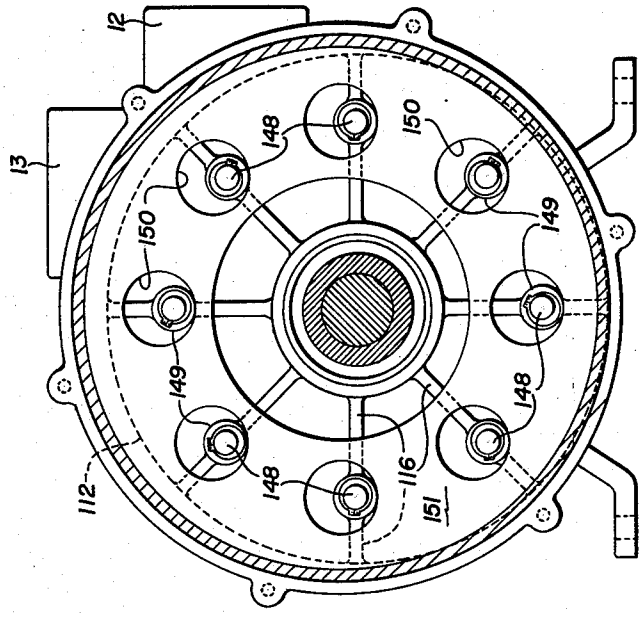


Fig. 19

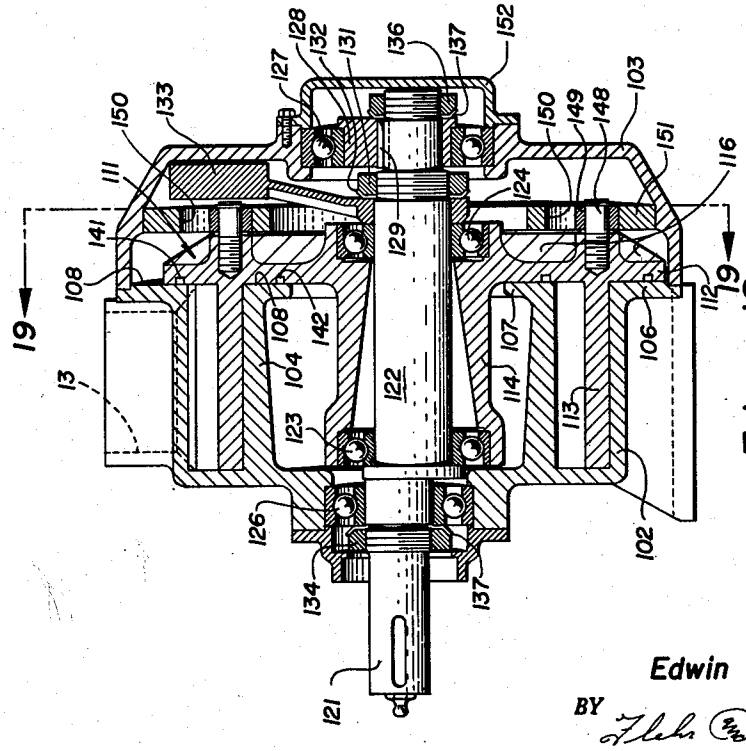


Fig. 18

INVENTOR.
Edwin E. Smith

BY Fleh & Swain

Attorneys

United States Patent Office 3,125,032 Patented Mar. 17, 1964

3,125,032

ROTARY PUMP

Edwin E. Smith, Santa Clara, Calif., assignor to Fluid Dynamics Corp., Los Altos, Calif., a corporation of California

Filed Sept. 6, 1960, Ser. No. 53,970
10 Claims. (Cl. 103—131)

This invention relaes to a rotary pump and more particularly to a rotary pump of the type having two pumping chambers.

Rotary pumps heretofore provided of the type utilizing two pumping chambers have not met with substantial commercial success. It is believed that this, in part, has been due to the fact that the designs have been such that the costs for production have been too high to be competitive with conventional pumps. In addition, it is believed that the seals provided in such pumps have not been satisfactory. There is, therefore, a need for a new and improved type of rotary pump.

In general, it is an object of the present invention to provide a rotary pump utilizing two pumping chambers which can be economically and efficiently produced.

Another object of the invention is to provide a rotary pump of the above character which is more efficient and maintains its efficiency for longer periods of time than is the case with conventional pumps.

Another object of the invention is to provide a rotary pump of the above character which is particularly adapted for pumping liquid chemicals of various types.

Another object of the invention is to provide a rotary pump of the above character in which the pumping chamber is isolated from the bearings.

Another object of the invention is to provide a rotary pump of the above character in which the pumping elements are adapted to be made of stainless steel or bronze and like materials so that it is particularly adapted for pumping corrosive and non-lubricating fluids.

Another object of the invention is to provide a rotary pump of the above character which can pump fluids of high viscosity at relatively high r.p.m.

Another object of the invention is to provide a rotary pump of the above character which has a greater capacity for a given physical size than conventional pumps.

Another object of the invention is to provide a rotary pump of the above character which operates with a high vacuum.

Another object of the invention is to provide a rotary pump of the above character in which there is no metal to metal contact in the pumping chambers.

Another object of the invention is to provide a rotary pump of the above character in which separate lubrication is provided for the bearings.

Another object of the invention is to provide a rotary pump of the above character in which a one piece case or body is utilized.

Another object of the invention is to provide a rotary pump of the above character in which wear can be taken up.

Another object of the invention is to provide a rotary pump of the above character which has a smooth flow and which is quiet running.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment have been set forth in conjunction with the accompanying drawings.

Referring to the drawings:

FIGURE 1 is an isometric view of a pump incorporating the present invention.

FIGURE 2 is an exploded view of the pump shown in FIGURE 1.

FIGURE 3 is a cross-sectional view of the pump.

FIGURE 4 is a cross-sectional view taken along the line 4—4 of FIGURE 3.

FIGURE 5 is a cross-sectional view taken along the line 5—5 of FIGURE 3.

FIGURES 6 and 7 are enlarged detail views of the seals utilized in the pump.

FIGURES 8, 9, 10 and 11 are cross-sectional views showing the mode of operation of the pump.

FIGURE 12 is an an isometric view of a portion of the pump shown in FIGURES 1–7 incorporating another embodiment of the present invention.

FIGURE 13 is a cross-sectional view of a pump incorporating another embodiment of my invention.

FIGURE 14 is a cross-sectional view taken along the line 14—14 of FIGURE 13.

FIGURE 15 is an enlarged detailed view of one of the bearing assemblies.

FIGURE 16 is a plan view of a pump incorporating still another embodiment of my invention.

FIGURE 17 is a cross-sectional view taken along the line 17—17 of FIGURE 16.

FIGURE 18 is a cross-sectional view taken along the line 18—18 of FIGURE 16.

FIGURE 19 is a cross-sectional view taken along the line 19—19 of FIGURE 18.

In general, the present invention consists of a closed casing having an opening which extends into inlet and outlet passages. The casing is provided with inner and outer concentric cylinder walls which define a working space. Partition means is provided in the working space separating the inlet passage from the outlet passage. A piston is adapted to operate in the casing and is provided with a cylinder which operates within the working space. This cylinder is slotted for movement about the partition. A drive shaft is rotatably journalled in the casing and is provided with means for transmitting working movement from the drive shaft to the piston. Control means is connected to the piston and to the casing for causing circular movement of the piston as the piston is used by rotation of the drive shaft. Particularly novel means is being utilized for controlling the circular movement of the piston. In addition, a particularly novel sealing arrangement has been provided for establishing sealing engagement between the piston and the inner and outer concentric walls during a certain portion of the pump cycle. The casing is constructed in such a manner that the inner and outer concentric cylinder walls are formed in one part. The same is true of the piston which is provided with inner and outer cylinders.

More in particular, my rotary pump shown in FIGURES 1–6 of the drawings consist of a closed casing 11 having adjacent inlet and outlet openings 12 and 13. The casing 11, as shown in the drawings, is formed in two parts, one being the main body 14 and the other being the cover 16. The main body is provided with a pair of pedestal-like feet 17 which provide means for mounting the pump in a manner well known to those skilled in the art. The inlet and outlet openings for the casing are provided in the body 14 and extend from the body at right angles with respect to each other.

The casing 11 defines a working space 18 which is limited by outer and inner curved concentric cylinder walls 19 and 20. The outer wall 19 is the outer wall of the body itself, whereas the inner wall 20 is formed by a cylinder which is an integral part of the body 14. Partition means is provided for separating the outlet side of the working space from the inlet side and, as shown particularly in FIGURE 4, it consists of a web 21 which is an integral part of the body 14 and extends diagonally between the inlet and outlet openings 12 and 13 and to the cylindrical wall 20. In other words, the web 21 ex-

tends radially of the inner and outer cylindrical walls 19 and 20 the entire length of the cylindrical walls.

A piston 24 is adapted to operate in the casing between the inner and outer cylinder walls and consists of a flat circular plate 26 having outer and inner concentric cylinders 27 and 28 extending at right angles and to one side therefrom. The inner cylinder 28 is a complete cylinder, whereas the outer cylinder 27 is provided with a slot 29 extending the length thereof which is adapted to accommodate the web 21 as shown in FIGURE 4. This slot 29 straddles the web 21 and permits the circular movement of the piston 24 as hereinafter described. The cylinder 27 divides the working space 18 into two pumping chambers, an outer chamber A and an inner chamber B.

A drive shaft 31 serves to supply working movement to the piston 24. The drive shaft 31 is rotatably journalled in the casing by a roller bearing assembly 32 mounted in the cover 16 and a ball bearing assembly 33 mounted in the body 14. The piston 24 is rotatably mounted on an eccentric portion 31*a* of the drive shaft 31 by a pair of roller bearing assemblies 34 and 36 which are seated in recesses 37 provided in the inner cylinder 28.

The drive shaft 31 is provided with a shoulder portion 31*b* which carries an arcuate shaped counterweight 38 positioned opposite the eccentric bulge on the shaft to balance the shaft and piston. A collar 39 is provided on the drive shaft 31 and engages a thrust washer 41. The thrust washer 41 engages the plate 26 of the piston 24 and urges the flat plate into sealing engagement with sealing means carried by the extremities of the inner and outer walls of the body 14. Such sealing means consists of a pair of O rings 51 and 52 or similar seals such as "Quad" rings, ceramic and metal rings, etc., seated in recesses 53 and 54 provided on the outer ends of the outer and inner walls 19 and 20 of the body. The rings may be optionally located in the piston to seat against the body. There is no direct engagement of the plate 26 with the ends of the walls 19 and 20 so that there is no metal to metal contact between the parts. A lock washer 42 is mounted on the other end of the shaft 31 adjacent the bearing 33*a* and a nut 43 is threaded onto a threaded portion 31*c* of the shaft and is adapted to be used for drawing the piston against the body so that a good seal is established. A cap 44 and a washer 46 are mounted on the ends of the shaft and enclose the nut 43 and the lock washer 42.

Means is provided for controlling movement of the piston 24 so that it moves in a true circular path. This control means consists of a pair of gear-like members with one being fixed to the piston 24 and the other being fixed to the cover 16. As shown in the drawings the gear-like member fixed to the piston is an external gear 56 which is provided with external teeth 58. It is affixed to the piston 24 by a suitable means such as bolts 59. The other gear-like member is an internal gear 57 which is provided with arcuate semi-circular recesses 61 which accommodate the teeth 58. It is affixed to the cover 16 by suitable means such as a press fit into a recess 62 provided in the cover.

Sealing means is provided for establishing sealing engaging between the cylinder 27 and the outer and inner cylindrical walls 19 and 20 during the pump cycle. The sealing means includes a pair of seals 66 and 67 which are provided in the outer wall of the cylinder 27 of the piston 24 adjacent the slot 29. Each of the seals consists of a rod 69 which is seated in a cylindrical recess 71 extending the length of the cylinder wall and cut into the cylinder wall in such a manner that a longitudinal slot 72 is provided along the length of the cylinder. A dowel or roll pin 73 is mounted in a cylindrical passage provided in the rod 71 and in the cylinder wall 28 to prevent rotation of the rod 71. The rod 71 is provided with a longitudinal straight-sided slot 74 extending the length thereof. A blade 76 of suitable material is slidably

mounted in the slot 74 and is adapted to be urged outwardly by suitable yieldable means such as three springs 77 spaced longitudinally of the slot 72 and preferably on each end of the slot and in the middle of the slot. The blade 76 and the slot 72 are positioned so that the blade is urged outwardly in a substantially radial direction from the cylinder wall 28. Pins 78 in the rod 69 are seated in slots 79 in the blade 76 and limit the outermost movement of the blades 76.

The sealing means also includes a seal 81 similar to the seals 66 and 67 which is provided on the inlet side of the inner cylindrical wall 20 of the body for a purpose hereinafter described.

Separate means is provided for lubricating the bearings in the pump and consists of a passage 86 which extends through the shaft 31. Lateral passages 87 and 88 connected to passage 86 are provided so that the grease inserted through the grease fitting 89 will be urged into the proper areas in the pump, that is, into the roller bearings 34, 36 and 32, and the ball bearing assembly 33.

Operation of my rotary pump may now be briefly described as follows. Let it be assumed that the pump is in the position shown in FIGURE 8 and that the drive shaft 31 is being rotated in the direction indicated which is towards the discharge opening 13. In this position, the inner chamber A is beginning to exhaust and the outer chamber B is completing the intake. Continued rotation of the shaft 31 in the counterclockwise direction as viewed in FIGURE 9 causes the seal 66 carried by the outer cylinder 27 to come into engagement with the outer wall 19 of the body to seal the outer chamber B from the inlet 12. At the same time that this is occurring, the inner chamber A is open to the inlet 12 so that fluid is being sucked into the inner chamber A.

Upon continued rotation of the shaft 31, the cylinder 27 is maintained in continuous contact with the outer wall 19 and continuously advances the fluid in a counter-clockwise direction as viewed in FIGURES 8–11 into the discharge opening 13. During this time, the inner chamber A continues to take in fluid. Thereafter, as shown in FIGURE 11, sealing engagement is established between the cylinder 27 and the seal 81 to prevent the escape of fluid from the inner chamber. Thereafter, the fluid in the inner chamber is discharged through the discharge passage 13 by continued rotation of the shaft 31 as shown in FIGURE 7.

Intake of fluid into the inner chamber A is commenced as shown in FIGURE 9 before all the fluid has been discharged from the inner chamber B. The same is true with respect to the outer chamber B as can be seen from FIGURE 11 in which fluid is being taken into one side of the outer chamber at the same time that fluid is being exhausted from the other side of the outer chamber.

Thus, it can be seen that as the shaft 31 rotates, there is a continuously expanding space which is created in each of the inner and outer chambers during the intake portion of the cycle for each chamber until the chamber is sealed from the intake passage 12. Thereafter, there is a continuously decreasing space in each of the chambers as the shaft is rotated to cause the fluid to be discharged out of the discharge passage 13 from the chambers.

The action of the cylinder 27 with respect to the outer cylindrical wall 19 and the inner cylindrical wall 20 is a combination sliding and rolling action. The inner and outer chambers are so arranged that they are exactly 180° out of phase at all times. The point of tangency between the cylinder 27 and the stationary cylindrical wall 20 rotates in a continuous circle because of the action of the gears 56 and 57. This point of tangency is always 180° out of phase with the eccentric on the shaft 31. As this point of tangency progresses, all fluid in front of this point of tangency is pushed toward the discharge end of the pump and fluid is sucked or pulled into the space behind the point of tangency from the intake end.

The point of tangency with respect to the movable cyl-

inder 27 and the outer stationary cylindrical wall 19 also moves in a continuous circle because of the action of the gears 56 and 57. This point of tangency is always exactly in phase with the eccentric 31*a* on the shaft 31.

Therefore, when the eccentric is in dead center, that is, at a point in line with the center of the web 21, the tangent point between the movable cylinder 27 and the stationary outer cylindrical wall 19 also is at dead center, whereas the point of tangency between the cylinder 27 and the inner stationary cylindrical wall 20 is 180° out of phase as can be seen particularly from FIGURE 9.

The seals 66 and 67 on the outer cylindrical member 27 of the piston are arranged in such a manner that sealing engagement is established between the seal 67 and the outer cylindrical wall 19 at a point before dead center of the eccentric which is at least equal to one-half the angular distance occupied by the opening in the outer cylindrical wall 19 extending into the outlet passages 12 and 13, and at this sealing engagement is maintained until the eccentric has moved past dead center. The other seal 66 is positional in such a manner that sealing engagement is established between the seal and the outer wall 19 at dead center and continued for an angle which is at least equal to one-half the angular distance occupied by the opening in the outer cylindrical wall 19 entering into the inlet passage 13. Thus, in effect, sealing engagement is maintained in the outer chamber during the time there is no pumping action by the outer chamber B. No pumping action can occur during the time that the point of tangency between the cylindrical member 27 and the outer cylindrical wall 19 is passing through the angular distance occupied by the openings in the outer cylindrical wall extending into the inlet and discharge passages 12 and 13.

It is also for this same reason that the seal 81 is provided on the stationary cylindrical member 20 to maintain sealing engagement with the cylinder 27 during the time that the point of tangency between the cylindrical member 27 and the stationary cylindrical core is moving between the opening formed by the slot 29 covers a much shorter angular distance than the angular distance covered by the openings leading into the inlet and outlet passages, it was found that the one seal 81 was satisfactory to accomplish sealing. Thus, the seal 81 establishes the sealing engagement at an angle before dead center of the eccentric equal to at least 180° minus one-half of the angle covered by the opening 29 and maintains a sealing engagement for an angle past dead center equal to at least 180° plus one-half of the angle covered by the opening 29.

It will be noted from the drawing that the seals 66 and 67 are mounted on the movable cylinder 27 for the reason that the fluid moves in the same direction in the pump as the piston moves. If the sealing rings were mounted on the outer wall 19, the seals would trap the fluid and prevent some of the fluid from moving forward at the time of engagement. In the inner chamber, since the fluid travels with the piston member 27, it is desirable that the seal be placed in the stationary cylindrical wall 20.

In one embodiment of the above invention, the openings provided into the inner and outer chambers were made as small as possible and still provide good flow. For the outer chamber, openings extended through 70°, whereas for the inner chamber, the opening 29 extended through 42°. The opening for the inner chamber can be made substantially smaller than that for the outer chamber because the inner chamber only handles half or slightly less than half the entire flow for the pump. The opening for the outer chamber, on the other hand, handles the entire flow of the pump.

The seals 66 and 67 were spaced 70° apart and had a maximum extension beyod the surface of the cylinder 27 of .060 of an inch. The seal 81 was spaced 21° from the center of the web 21 and had a maximum extension of .045 of an inch above the surface of the inner cylindrical wall 20.

With a pump having such openings and seals and with the outer cylindrical wall having an inside diameter of 6⅞ inches, the inner stationary core having an outside diameter of 4⅝ inches, and with the cylinder 27 having a wall thickness of ½ inch, it was found that the following results were obtained pumping 372 S.S.U. oil at 100° F. At 600 r.p.m., 100 gallons per minute were pumped at 25 p.s.i., and 96 gallons per minute were pumped at 100 p.s.i. It is thus apparent that a volumetric efficiency of 96% was obtained. It also was found that 82.5% mechanical efficiency was obtained at 100 p.s.i.

The pump was also found to have other outstanding performance factors. For example, it was able to draw a vacuum in excess of 29 inches of mercury. The volumetric efficiency of the pump was equal to or exceeded that of top performing pumps presently on the market. The mechanical efficiency of the pump exceeded that of other rotary pumps now on the market.

Another embodiment of the controlling means for my pump is shown in FIGURE 12. This controlling means is similar to the controlling means shown in FIGURES 1–7 except for the fact that pins 90 mounted in the flat plate have been substituted for the external gear 56. The pins 90 take the place of the teeth 58. The operation is identical to that hereinbefore described. The primary advantage of the embodiment shown in FIGURE 11 is that it simplifies the construction of the controlling means.

Another embodiment of my invention is shown in FIGURES 13–15. This embodiment is similar to the embodiment shown in FIGURES 1–7 with the exception of the means which is provided for controlling the movement of the piston 24 so that it moves in a circular path. In this embodiment, the controlling means consists of a plurality of pins 91 which are secured to the plate 26 and the outer cylinder 27, as shown in FIGURE 14. As shown in FIGURE 13, five of these equally spaced pins 91 are mounted in a circle on the plate 26. The roller bearing assemblies 92 are mounted on the pins and are held in position by washers 93 and snap rings 94. A circular plate 96 is mounted in the cover 16 in the same manner that the gear 57 is mounted in the cover. The plate 96 is provided with a plurality of equally spaced holes on a diameter equal to the diameter on which the pins 91 are mounted on the piston 24. Each of the holes 97 has a diameter which is equal to the outside diameter of the roller bearing 92 plus the amount of the eccentric stroke of the piston. This arrangement permits the roller bearings 92 to be in contact with the inside periphery of the holes 97 at all times during rotation of the shaft 31 as is shown in FIGURE 13. As the shaft 31 is rotated, the eccentric causes the piston 24 to move in the same direction as the eccentric. The roller bearings 92 in the holes 97 limit the movement of the piston to a circular movement which is equal to the "throw" of the eccentric. The pumping action of this pump is identical to that of the embodiments hereinbefore described.

Still another embodiment of my invention is shown in FIGURES 16 to 19 and consists of a casing 101. The casing 101 is very similar to the casing 11 and is comprised of a main body 102 and a cover 103. The working space within the casing is limited by outer and inner concentric cylinder walls 103 and 104. The outer wall 103 is provided with an outwardly extending flange 106, whereas the inner wall 104 is provided with inwardly extending flange 107. These annular flanges 106 and 107 are provided with annular hardened surfaces 108 which have been hardened in a suitable manner such as by chrome plating the same. These hardened surfaces are adapted to engage sealing means carried by the piston as hereinafter described.

It will be noted that the outer and inner cylinder walls 103 and 104 are similar to the cylinder walls 19 and 20 provided in the embodiment described in FIGURES 1

through 11. However, the cylinder wall 104 is gradually increased in width to the point where it is integrally connected to the body to increase the strength of the cylinder wall.

Partition means in the form of a web 105 separates the inlet and outlet sides of the working space. A piston 111 is adapted to operate in the working space in the casing between the outer and inner cylinder walls 103 and 104 and consists of a plate 112 which has an outer cylinder 113 extending at right angles therefrom and an inner substantially cylindrical member 114 also extending at right angles therefrom. The inner member 114 has an increasing wall thickness towards the hub portion of the same to increase the strength of the member. The outer cylinder is provided with a slot 115 extending the length of the cylinder which accommodates the web 105. The plate 112 is provided with radially extending reinforcing ribs 116 to strengthen the same.

A drive shaft 121 serves to supply working movement to the piston 111. The drive shaft 121 is provided with a crank portion 122 which is mounted off center from the main center line of the drive shaft 121. The piston 111 is rotatably mounted on the crank portion 122 by a pair of roller bearing assemblies 123 and 124. Bearing assembly 123 is mounted at the outer end of the substantially cylindrical member 114, whereas bearing member 124 is mounted in the hub portion of the substantially cylindrical member 114.

One end of the drive shaft 121 is rotatably mounted in the body 102 by a ball bearing assembly 126, whereas the other end of the shaft is rotatably mounted in the cover 103 by a ball bearing assembly 127 which rotatably carries a member 128 fixed to the shaft by a key 129 to accommodate the off center positioning of the crank portion 122. The piston 111 is secured to the crank portion 122 against the collar 129 provided on the drive shaft 121 by a nut 131 threaded on the shaft and engaging a lock washer 132 and a counter-weight 133 mounted on the crank portion 122. Tightening of the nut 131 urges the ball bearing assembly 124 to the left as viewed in FIGURE 18. This, in turn, urges the piston 111 to the left against the hardened surfaces 108.

The position of the piston 111 relative to the body 102 is adjusted by nuts 134 and 136 threaded on the shaft 121. Lock washers 137 are provided for both the nuts 134 and 136. It is apparent that, when desired, the position of the piston can be shifted to the left as viewed in FIGURE 18 by loosening the nut 134 and then tightening the nut 136. Conversely, it can be shifted in the opposite direction or to the right by first loosening the nut 136 and then tightening the nut 134.

Means is provided for establishing sealing engagement between the piston and the hardened surfaces 108 and consists of O-ring sealing means 141 and 142 similar to that hereinbefore described with the exception that the sealing means in this case is mounted in the plate 112 rather than in the surfaces 108 of the cylindrical members 103 and 104.

The sealing means has been positioned in the plate 112 so that if foreign material should by chance come between the plate 112 and the hardened surfaces 108, the foreign material will become embedded in the piston rather than in the body. Thus, even if the surface of the piston engaging the hardened surface 108 should be scratched, a good seal will still be maintained by the O-ring sealing means 141 and 142 engaging the hardened surfaces 108. Thus, at all times, a flat uniform surface will be provided for engagement of the O-rings.

Means is provided for controlling the path of movement of the piston 111 so that it moves in a true circular path. This means, as shown in the drawings, is similar to the controlling means shown in the embodiment in FIGURES 13 through 15. It consists of a plurality of pins 148 which have been fixed to the plate 112 by suitable means such as a press fit and which carry bearings

149. A circular plate 151 is mounted in the cover 103 and is provided with a plurality of spaced holes 150 which seat the bearings 149. A cap 152 is mounted on the cover plate 103 and encloses the bearing assembly 127. Lubrication means identical to that hereinbefore described is provided in the shaft 121 and, for that reason, it will not be described in detail.

The operation of this embodiment of the invention is similar to that of the embodiments hereinbefore described. The primary difference between this latter embodiment and the previous embodiments is in the strengthened portions which have been provided in certain of the members. A crank 122 has been provided on the shaft rather than an eccentric to make possible the manufacture of a pump with a small, overall diameter. The construction is also advantageous because it is possible to eliminate one bearing. The construction also makes it possible to adjust the position of the piston relative to the body in a different manner.

It is apparent from the foregoing that I have provided a new and improved pump which has many advantages over conventional pumps with respect to its volumetric efficiency, its mechanical efficiency, and its ability to draw a vacuum. In addition, because of the use of the two chambers and the controlling means for controlling the movement of the piston, extremely smooth action is provided by the pump. The counterweight 38 also serves to improve the smooth running action of the pump. The controlling means for controlling the circular movement of the piston is of a type which contributes to this smooth action with very little wear. Because of the O-ring seals in the recesses 53 and 54 provided, there is no metal to metal contact between the plate 26 of the piston and the ends of the inner and outer cylindrical walls 19 and 20. For that reason, liquids can be pumped which are non-lubricating. Since the pumping chambers are at all times completely isolated from the bearings, corosive fluids such as nitric acid, sulphuric acid and other materials can be pumped without difficulty. It is for this reason that the pump is also particularly adapted for use in food processing where it is necessary to keep the product out of contact with lubricating materials. The construction provided also makes it possible to provide a separate lubrication system for the bearings.

Because of the smooth flow provided by the pump, it is possible to handle fluids having higher viscosity, and at the same time to pump them at a higher r.p.m. The use of the dual chambers smooths out the pulsations to provide a more even flow from the pump. The pump, since it produces a high vacuum, also can be utilized for producing vacuums where required.

The pump is of a heavy duty type and has a substantial weight and size advantage over other types of pumps. End wear can be eliminated thereby tightening the lock nut 43. Also, if desired, adjustment can be made for pumping different types of material. For example, heavy viscous fluids may require more clearance. The same is true where fluids having a high temperature are pumped.

It is apparent from the foregoing that I have provided a new and improved pump which has many advantages over pumps heretofore on the market. Its construction is such that it can be readily fabricated. The casing provides both the inner and outer cylindrical surfaces which form the working chamber for the pump. The piston is also formed in one piece and carries an end plate upon which are mounted means for controlling the circular movement of the piston during rotation of the shaft of the pump.

I claim:

1. In a rotary pump, a closed casing comprising a body and a cover, the body having inlet and outlet passages and an opening extending into inlet and outlet passages, the body being provided with inner and outer concentric cylindrical walls defining a working space, partition means forming an integral part of said body in

said working space and separating the inlet passage from the outlet passage, and dividing the opening to provide two separate openings, a piston adapted to operate in said casing, said piston having inner and outer cylinders, said outer cylinder operating in said working space and defining inner and outer pump chambers in said working space, said piston having an end plate outside the working space, said outer cylinder being slotted for movement about the partition means, a drive shaft rotatably journalled in said casing, an eccentric mounted on said drive shaft, said eccentric being rotatably mounted in said inner cylinder of said piston and serving to transmit working movements from the drive shaft to the piston as the shaft is rotated, said shaft having a collar for engaging the plate on the piston, annularly continuous resilient sealing means disposed between the ends of the inner and outer concentric cylindrical walls and said plate for establishing a uniform pressure type seal between the same, means for applying force to said shaft to draw said plate towards the ends of the inner and outer cylindrical walls and control means mounted on said end plate of said piston and on the cover and serving to cause circular gyratory movement of said piston without axial rotation as said piston is moved by rotation of said drive shaft.

2. In a rotary pump, a closed casing with inlet and outlet openings, said casing having concentric cylinder walls defining a working space, partition means in said working space separating the inlet side from the outlet side, a piston operating in said casing, said piston having a cylinder operating in said working space and having an end plate of a diameter substantially greater than the diameter of the cylinder positioned outside the working space and engaging the ends of the concentric cylinder walls of the casing, annular continuous resilient sealing means disposed between the ends of the concentric cylinder walls and the end plate to form a uniform pressure type seal, said cylinder being slotted for movement about the partition means, a drive shaft rotatably journalled in said casing, means for transmitting working movement from the drive shaft to the piston, and control means connecting said piston to said casing for causing circular gyrating movement of said piston without axial rotation of said piston as said piston is moved by rotation of said drive shaft said control means including means for adjusting the axial position of said end plate with respect to said ends of said cylinder walls to cause the sealing means to exert a predetermined sealing pressure between said end plate and said ends of said cylinder walls.

3. In a rotary pump, a closed casing with inlet and outlet openings, said casing having concentric cylinder walls defining a working space, partition means in said working space separating the inlet side from the outlet side, a piston mounted in said casing and adapted to operate in said casing, said piston having a cylinder operating in said working space and having an end plate of a diameter substantially greater than the diameter of the cylinder and positioned outside the working space and adjacent the ends of the concentric cylinder walls of the casing, annular continuous resilient sealing means disposed between the ends of the cylinder walls and the end plate and providing a uniform pressure type seal between the same, said cylinder being slotted for movement about the partition means, a drive shaft, means rotatably journalling said drive shaft in said casing, means for transmitting working movement from the drive shaft to the piston and control means connecting said piston to said casing for causing circular gyrating motion of said piston without axial rotation as said piston is moved by rotation of said drive shaft, said control means including means for adjusting the axial position of said end plate with respect to said ends of said cylinder walls to cause said sealing means to exert a predetermined sealing pressure between said end plate and said ends of said cylinder walls said sealing means serving to prevent communication between the working space and the remainder of the casing.

4. In a rotary pump, a casing having an end wall, a pair of radially spaced concentric cylindrical walls fixed at one end to said end wall and having axially facing end edges at their other ends, the annular space between said cylindrical walls defining a working chamber closed at one end by said end wall, a generally radial partition wall extending axially of and across said working chamber, inlet and outlet ports communicating with said working chamber adjacent to but on respectively opposite sides of said partition wall, an annular cylindrical piston in said working chamber and having a radial slot therein accommodating said partition wall, said slot being substantially wider than the width of said partition wall, an end plate fixed to an end of said piston and having portions extending radially inwardly and outwardly therefrom closely adjacent and extending over said end edges of said cylindrical walls and closing the other end of said working chamber, means for driving said end plate and piston in an orbital path in contact with both said inner and outer cylindrical walls, means for holding said piston oriented in a predetermined radial direction, the orbital movement causing said piston to pump from said inlet port to said outlet port from both spaces between said piston and said cylinder walls and annularly continuous resilient sealing means disposed between said portions of said end plate and said end edges of said cylindrical walls and means for adjusting the end plate and the piston axially to cause said sealing means to exert a predetermined substantially uniform sealing pressure between said end plate and the end edges of said cylindrical walls.

5. A rotary pump as defined in claim 4 wherein said cylindrical walls and said annular piston define smooth and continuous opposed cylindrical surfaces adapted to roll and slide relative to each other, a single axially extending seal on the outer cylindrical surface of said inner cylindrical wall, projecting only slightly from the cylindrical surface thereof adjacent the inlet side of said partition and engageable with the inner surface of said piston substantially only during the time when the point of engagement between said piston and inner cylindrical wall would normally be within said slot, and a single pair of axially extending seals on the outer surface of said piston, one on each side of said slot and each projecting only a slight distance from the surface of said piston and engageable with the inner surface of said outer cylindrical wall substantially only during the time the point of engagement between said piston and outer cylindrical wall would normally be within said slot.

6. A rotary pump as defined in claim 5 wherein each of said axially extending seals comprises means defining an axial slot, a flat blade slidable edgewise in said slot, resilient means urging said blade outwardly of said slot, and stop means limiting outward movement of said blade.

7. In a rotary pump, a casing having an end wall, a pair of radially spaced inner and outer concentric cylinder walls affixed at one end to said end wall and having axially facing end edges at the other ends, the concentric cylinder walls providing an annular space between the same defining a working chamber closed at one end by said end wall, a generally radial partition wall extending axially of and across said working chamber, inlet and outlet ports communicating with said working chamber adjacent to but on respectively opposite sides of said partition wall, an annular cylindrical piston in said working chamber and having axially facing end edges and a radial slot therein, said radial slot accommodating said partition wall, an end plate affixed to an end of said piston and having portions extending radially inwardly and outwardly therefrom closely adjacent and extending over said end edges of said cylinder walls and closing the other end of the said working chamber, means for driving said end plate and piston in an orbital path in contact with

both said inner and outer cylinder walls, means for holding said piston oriented in a predetermined radial direction, the orbital movement causing said piston to pump from said inlet port to said outlet port from both spaces formed between said piston and said cylinder walls, an annularly continuous resilient sealing means exerting uniform sealing pressure disposed between said portions of said end plate and said end edges of said cylinder walls, said means for driving said end plate and piston including means for adjusting the piston and end plate axially to maintain a predetermined spacing between the end edges of the annular cylindrical piston and the end wall of the casing and a predetermined sealing pressure exerted by the resilient sealing means between said portions of the end plate and said end edges of the cylinder walls.

8. In a rotary pump, a closed casing with inlet and outlet ports, said casing having an end wall and concentric cylinder walls fixed at one end to said end wall and an annular working space and having axially facing end edges, partition means extending axially of and radially across said working space and separating the inlet port from the outlet port, an annular cylindrical piston mounted in said working space and having a slot accommodating said partition means, said piston having axially facing end edges an end plate fixed to said piston and having portions extending radially inwardly and outwardly therefrom closely adjacent and extending over said end edges of said cylinder walls, annular continuous resilient sealing means disposed between the ends of the cylinder walls and the end plate, a drive shaft, means rotatably mounting the drive shaft in the casing, means for transmiting working movements from the drive shaft to the piston and control means connecting said piston to said casing for causing circular gyrating motion of the piston without axial rotation as the piston is moved by rotation of the drive shaft, means for adjusting the shaft axially of the casing, and means mounted on the shaft and engaging the end plate so that as the shaft is moved axially the piston is moved therewith, the adjustment means making it possible to maintain a predetermined spacing between end edges of the piston and the end wall and to establish a predetermined sealing pressure with the sealing means between said end plate and said end edges of said cylinder walls.

9. In a rotary pump, a casing having an end wall, a pair of radially spaced concentric cylindrical walls fixed at one end to said end wall and having axially facing end edges at their other ends, the annular space between said cylindrical walls defining a working chamber closed at one end by said end wall, a generally radial partition wall extending axially of and across said working chamber, inlet and outlet ports communicating with said working chamber adjacent to but on respectively opposite sides of said partition wall, an annular cylindrical piston in said working chamber and having a radial slot therein accommodating said partition wall, said slot being substantially wider than the width of said partition wall, an end plate fixed to an end of said piston and having portions extending radially inwardly and outwardly therefrom closely adjacent and extending over said end edges of said cylindrical walls and closing the other end of said working chamber, means for driving said end plate and piston in an orbital path in contact with both said inner and outer cylindrical walls, means for holding said piston oriented in a predetermined radial direction, the orbital movement causing said piston to pump from said inlet port to said outlet port from both spaces between said piston and said cylinder walls, annularly continuous resilient sealing means disposed between said portions of said end plate and said end edges of said cylindrical walls, and means for adjusting the end plate and the piston axially to cause said sealing means to exert a predetermined substantially uniform sealing pressure between said end plate and the end edges of said cylindrical walls, said means for holding said piston oriented comprising an internally notched first ring fixed to said casing and an externally toothed second ring fixed to said end plate, the number of teeth on said second ring being equal to the number of notches in said first ring, said teeth being arranged to progressively engage in said notches as said end plate moves in its orbital path.

10. In a rotary pump, a casing having an end wall, a pair of radially spaced concentric cylindrical walls fixed at one end to said end wall and having axially facing end edges at their other ends, the annular space between said cylindrical walls defining a working chamber closed at one end by said end wall, a generally radial partition wall extending axially of and across said working chamber, inlet and outlet ports communicating with said working chamber adjacent to but on respectively opposite sides of said partition wall, an annular cylindrical piston in said working chamber and having a radial slot therein accommodating said partition wall, said slot being substantially wider than the width of said partition wall, an end plate fixed to an end of said piston and having portions extending radially inwardly and outwardly therefrom closely adjacent and extending over said end edges of said cylindrical walls and closing the other end of said working chamber, means for driving said end plate and piston in an orbital path in contact with both said inner and outer cylindrical walls, means for holding said piston oriented in a predetermined radial direction, the orbital movement causing said piston to pump from said inlet port to said outlet port from both spaces between said piston and said cylinder walls, annularly continuous resilient sealing means disposed between said portions of said end plate and said end edges of said cylindrical walls, and means for adjusting the end plate and the piston axially to cause said sealing means to exert a predetermined substantially uniform sealing pressure between said end plate and the end edges of said cylindrical walls, said means for holding said piston oriented comprising an internally notched ring fixed to said casing, a plurality of pins fixed to said end plate, equal in number to said notches, and extending axially of said plate in position to progressively engage in said notches as said end plate moves in its orbital path.

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