April 13, 1943. W. W. DAVIDSON 2,316,318

ROTARY LIQUID PUMP

Filed July 8, 1939 5 Sheets-Sheet 1

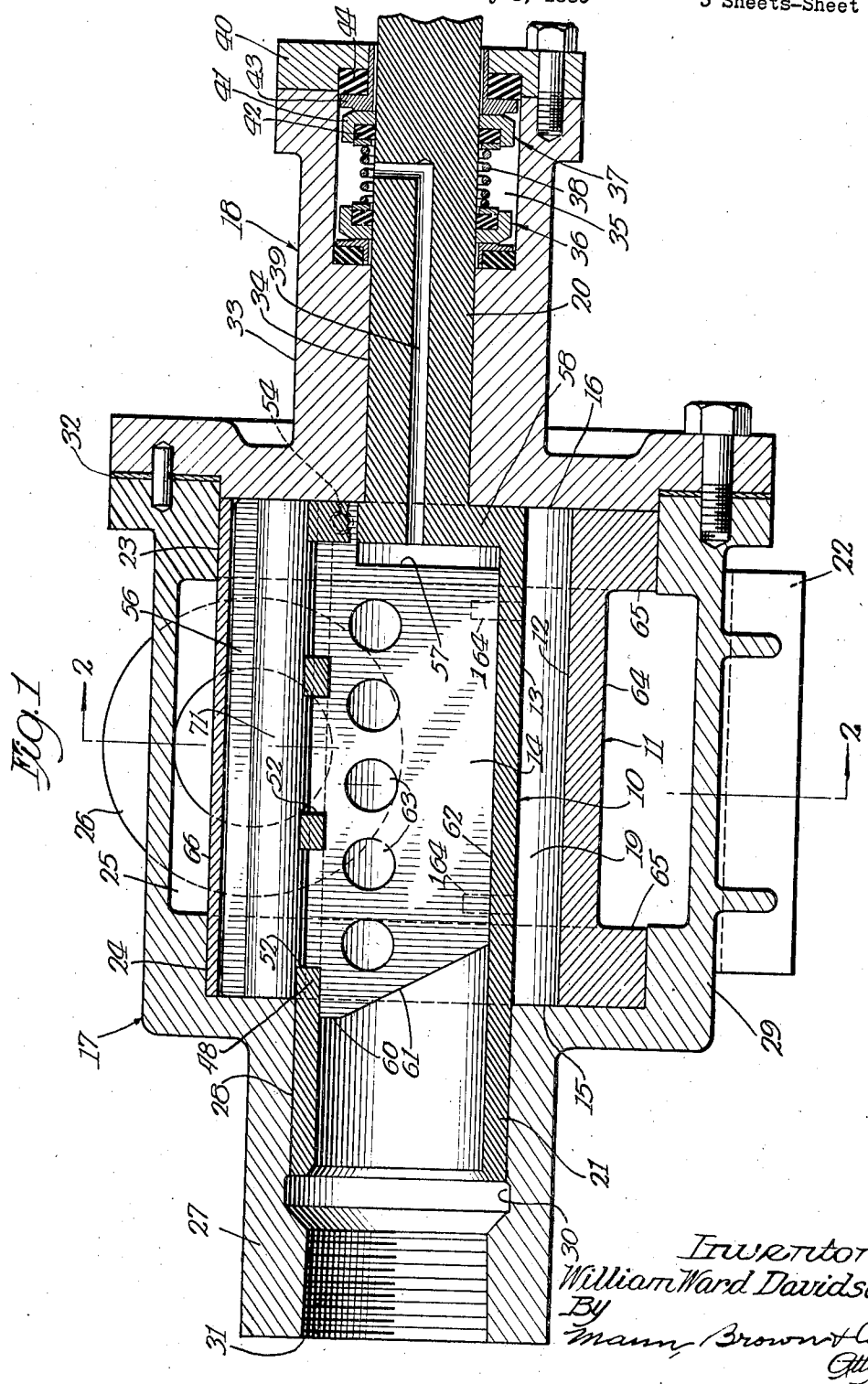


FIG. 1

Inventor:
William Ward Davidson
By
Mann, Brown & Coe
Attys.

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ROTARY LIQUID PUMP

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Fig. 2

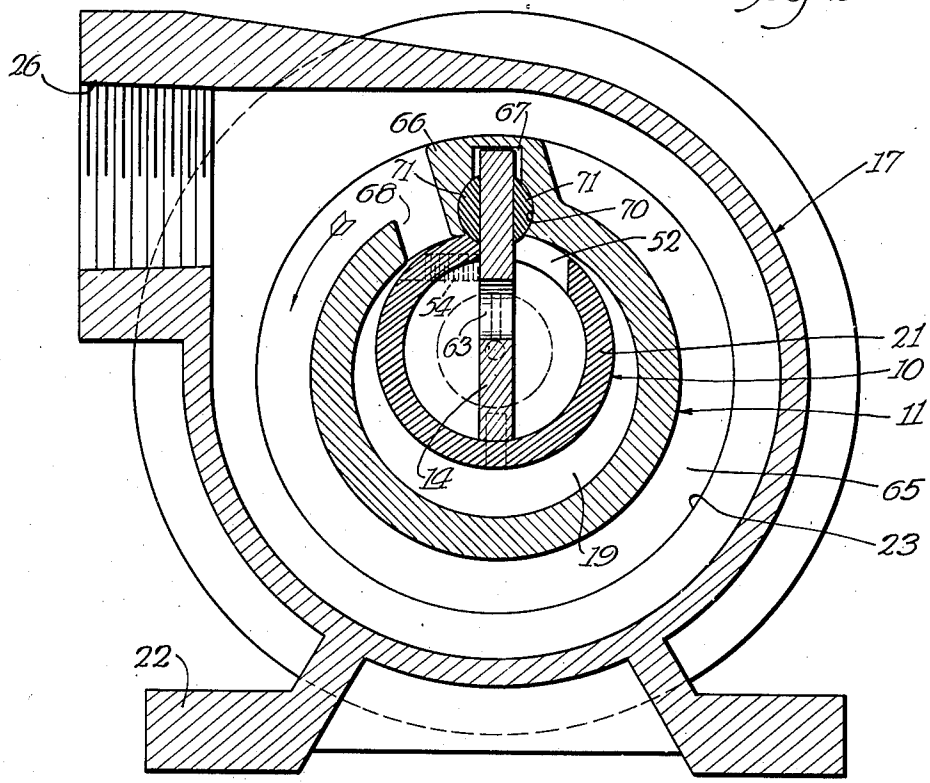


Fig. 3

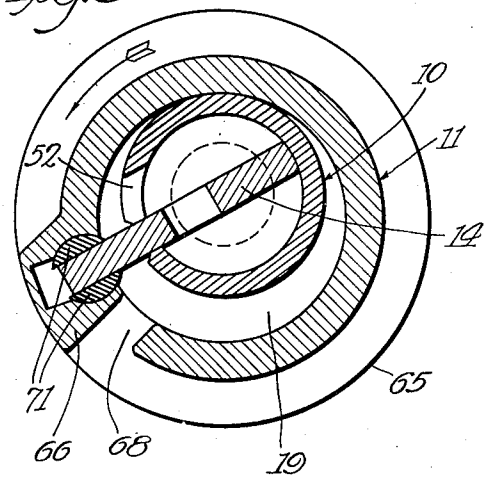
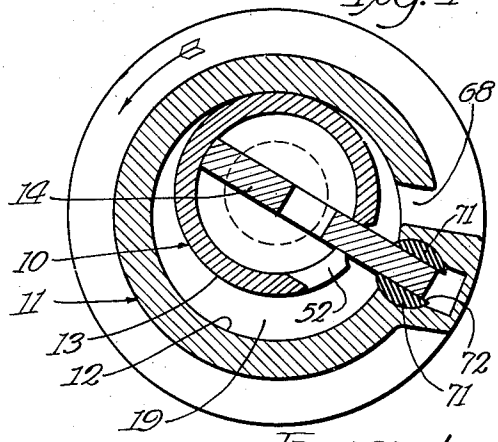


Fig. 4



Inventor
William Ward Davidson
By Munn, Brown & Co
Attys

April 13, 1943. W. W. DAVIDSON 2,316,318

ROTARY LIQUID PUMP

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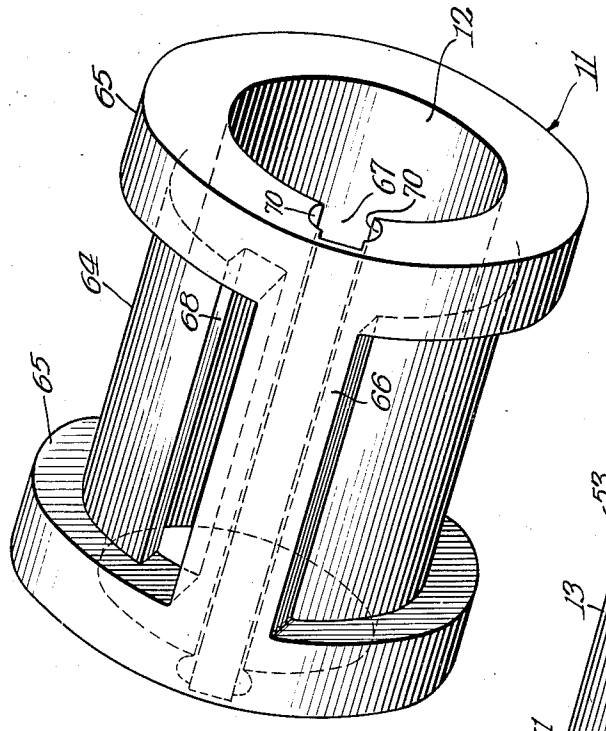


Fig. 5

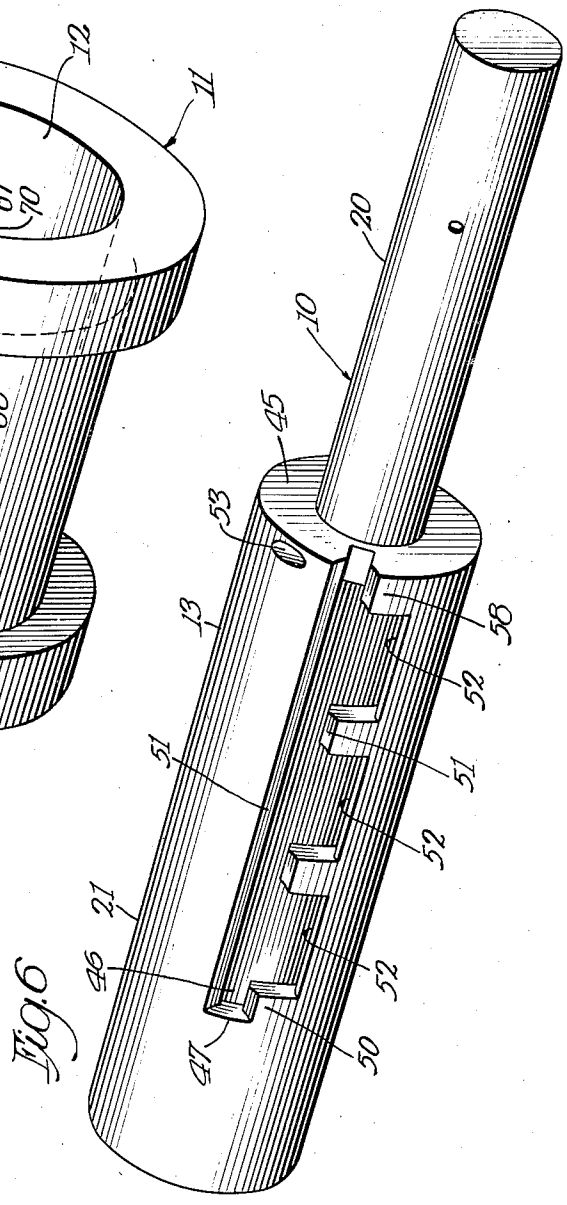


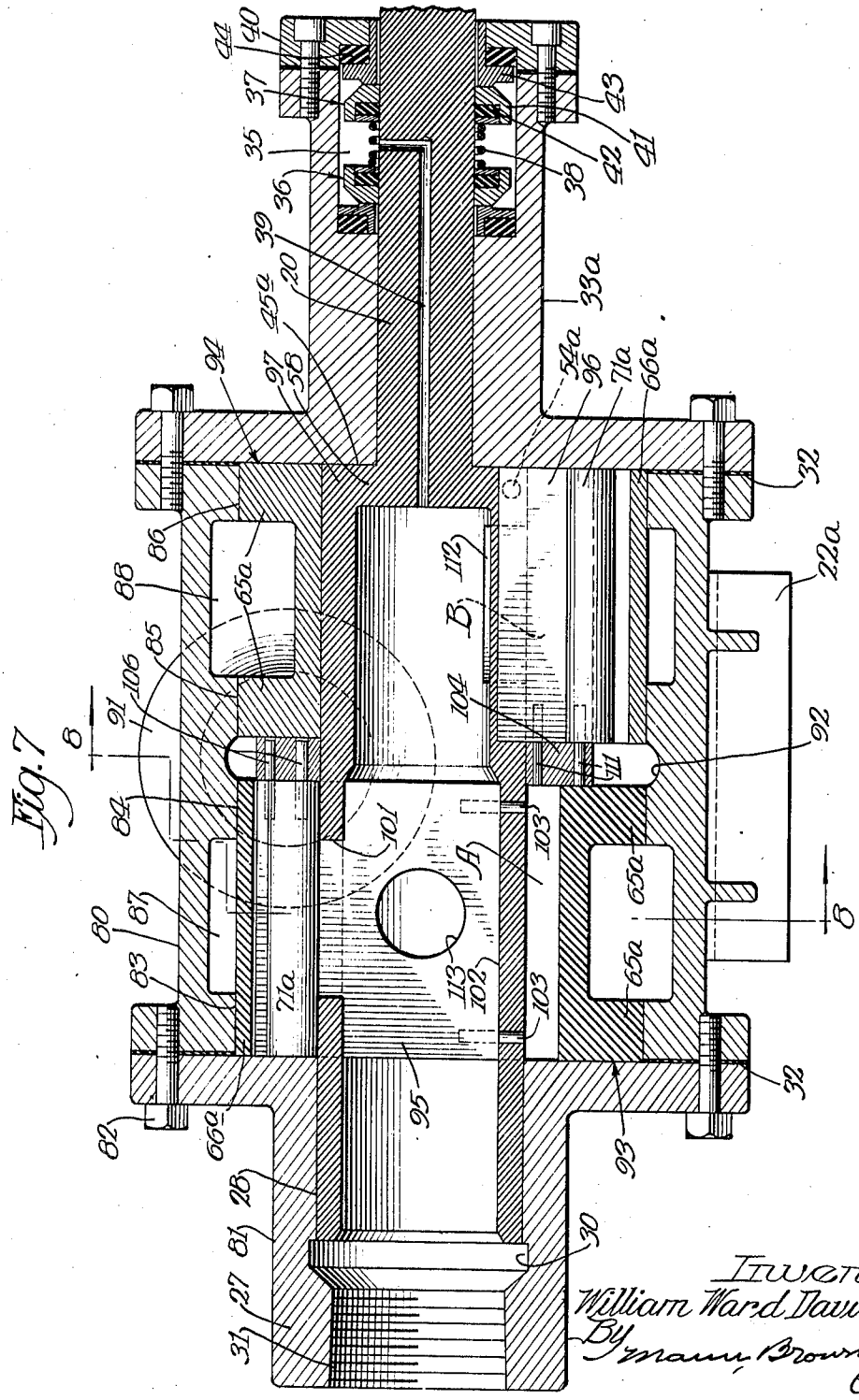
Fig. 6

Inventor
William Ward Davidson
By Mann, Brown & Co.
Attys.

April 13, 1943. W. W. DAVIDSON 2,316,318

ROTARY LIQUID PUMP

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Inventor:
William Ward Davidson
By Mann, Brown & Co
Attys.

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ROTARY LIQUID PUMP

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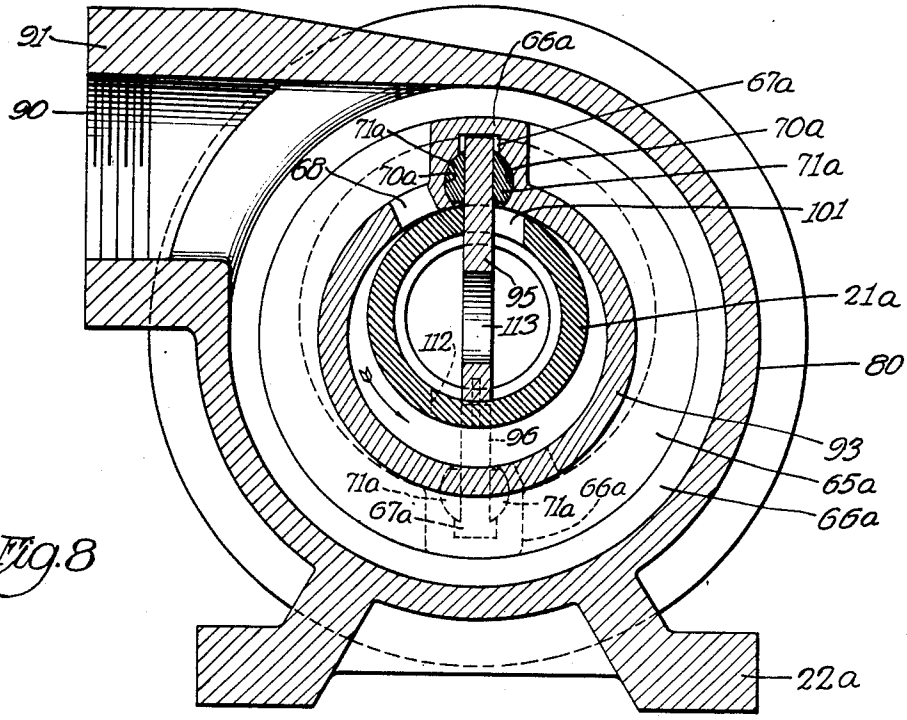


Fig. 8

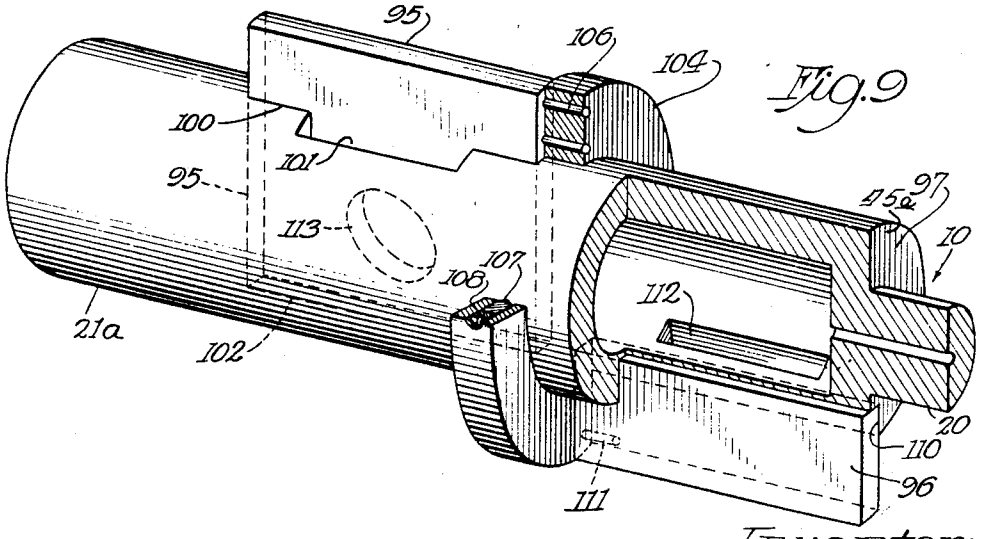


Fig. 9

Inventor:
William Ward Davidson
By Mann Brown & Co Attys.

Patented Apr. 13, 1943 2,316,318

UNITED STATES PATENT OFFICE

2,316,318

ROTARY LIQUID PUMP

William Ward Davidson, Evanston, Ill.

Application July 8, 1939, Serial No. 283,480

13 Claims. (Cl. 103—121)

The present invention relates generally to rotary pumps, and more particularly to a new and improved rotary pump of the rotary cylinder type designed to handle a large volume of liquid at full motor speed.

I provide a liquid pump which will operate at full motor speed, so that the motor shaft may be connected directly to the pump shaft. This eliminates all reduction gearing, belts and pulleys, and all bearing and seal wear which takes place in conventional pumps where belt tension is high to prevent slippage. In the present invention wear upon the seals is further minimized by subjecting them to the intake pressure instead of the head pressure developed by the pump.

Not only this, but for a given volume the pump of the invention is made smaller than those designed for slower speeds, the construction being such that perfect balance and elimination of vibration are attained by the structural features employed, including running both the rotor and the cylinder on their own true centers.

Moreover, with side thrusts removed from the bearings, improved bearing arrangements are employed where both the cylinder and the rotor are rotatably supported at spaced points, each being a single integral unit whose rotational balance is established permanently in the machining operation, with three of the four bearings employed in the invention formed at one time in one of the two members making up the sealed casing.

In providing my improved pump care has also been given to the removal of end thrusts that cause wear. The intake and exhaust are arranged to accomplish this, and the end walls of the pump compartment are rigid relative to each other so as to eliminate any possible give between them which would allow the end walls to be spread apart by compression pressures, and thereby induce heavy end thrusts.

Furthermore, one of the chief purposes of the present invention is to provide a pump of rugged simplicity having a minimum of parts and adjustments, and one which is strong enough to withstand the heaviest of work loads that can be imposed upon it by the weight and incompressibility of liquids. In this connection one of the embodiments is a comparatively constant flow pump with the pulsations sufficiently even that an expansion chamber can be eliminated.

Another object of the invention is to provide a pump which is easily and inexpensively manufactured from simple castings and parts made and finished without necessitating the use of other than elementary machine-shop practice.

These being among the objects of the invention, other and further objects, including those related to ease of assembly and adjustment, and accessibility to all parts for repairs and replacement, will become apparent from the drawings, the description relating thereto, and the appended claims.

Referring now to the drawings:

Fig. 1 is a sectional view of a preferred form of the invention, taken upon a longitudinal plane through the center of the pump;

Fig. 2 is a transverse section taken upon line 2—2 of Fig. 1;

Figs. 3 and 4 are fragmentary transverse sections similar to Fig. 2, showing the piston, cylinder and vane construction of the pump in various operating positions;

Fig. 5 is a perspective view showing the structural details of the rotatable cylindrical member of the pump as an article of manufacture;

Fig. 6 is a perspective view of the rotatable piston as an article of manufacture;

Fig. 7 is a sectional view of another form of the invention, taken upon a longitudinal plane through the center of the pump;

Fig. 8 is a transverse section taken upon line 8—8 of Fig. 7; and

Fig. 9 is a perspective view partly in section, showing a portion of the rotatable piston of Fig. 7 as assembled.

The general organization of the pump illustrated comprises an inner cylindrical member or piston 10, and an outer cylindrical member or cylinder 11, eccentrically mounted to rotate about their own true centers, with an outer cylindrical surface 13 upon the piston 10 disposed tangential to an inner cylindrical surface 12 upon the cylinder 11 to provide a crescent-shaped pump chamber 19 between them which is divided into pumping compartments by a vane 14 rigidly carried by the piston 10.

The cylinder is journaled in a casing 17 upon axially spaced bearings 23 and 24, machined on the inner walls of the casing, and the piston extends beyond both ends of the cylinder 11. At its large end 21 the piston is journaled in and terminates within the casing 17, while at its smaller end 20 the piston is journaled in the cover member 18. The ends of the pump chamber 19 are sealed by two stationary shoulders 15 and 16, machined upon the casing 17 and cover member 18, respectively. The piston 10 is directly driven by a prime mover (not shown)

through the end 20, and the cylinder 11 is driven from the piston 10 through the vane 14.

Referring now to the structural characteristics of the pump in further detail attention is directed to the casing 17, which is made of cast metal and provided with a flanged base 22 for supporting the pump as a unit. The main part of the casing is cast hollow, with a reduced portion 27 at one end and an enlarged portion 29 at the other end having a boss 26 thereon.

The two axially spaced bearings 23 and 24 are machined in the enlarged portion 29 in a way providing an enlarged compartment 25 between them, which serves as an exhaust compartment into which liquid under pressure is forced by the pumping elements. From the compartment 25 the liquid under pressure passes out through a threaded opening in the boss 26 into a conduit (not shown) threaded therein.

In the reduced portion 27 of the casing 17 a bearing 28 of lesser diameter is machined eccentric to the bearings 23 and 24. These bearings 23 and 24 support the cylinder 11 as already described, while the bearing 28 supports the end 21 of the piston. This arrangement of bearings has several advantages, where, as in this case, the pump has four bearings. Three of the four bearings are those just described, viz: 23, 24 and 28. These three bearings are located in the casing 17, and are machined all at the same time when the casing is being finished. They therefore automatically line up identically for all pumps and for each casing in their proper relation. Only one of the four bearings is in the cover member 18, and this one is concentric to one of the three. Thus the task of drilling the cover member and marking it for correct alinement is comparatively simple—only one bearing need be accounted for in the second member instead of two or more, as is the usual situation.

Beyond the end of the piston the end portion 27 is cast with an enlarged portion, as at 30, for a short distance to provide head room for longitudinal movement of the piston, so that the piston may be moved axially in the bearing 28 to take up excess clearances between moving parts, as will be more fully described later.

Beyond the enlarged portion 30 the reduced end 27 is threaded, as at 31, to receive a liquid intake conduit (not shown), and at its enlarged end 29 the casing 17 is faced to mate with the end cover 18 in partial telescoping relationship limited by a sealing shim 32, of predetermined thickness, disposed between facing shoulders upon the respective members.

The end cover 18 comprises a metal casting having an elongated central portion 33 drilled out, as at 34, to provide a bearing surface of substantial length which journals the reduced end 20 of the piston over a major portion of its length. Near the outer end the rest of the elongated portion 33 has an expanded region forming a seal chamber 35 in which are suitably mounted two spaced sealing units 36 and 37, that are held apart by a compression spring 38.

Two members of the sealing units comprise oppositely facing rings 41 that rotate with the shaft and are mounted in sealed engagement therewith upon resilient washers 42 subjected directly to the pressure of the spring 38. Stationary rings 43, supported in sealed relation to the cover 18 by means of resilient washers 44, provide the other members of the units. In this way the sealed relationship between the relative moving rings 41 and 43 is maintained in direct relation to the tension of the spring 38, a tension which may be increased or lessened by spring replacement, depending upon working pressures to which the seals are subjected. Moreover, the sealing elements are where they are readily accessible for repair and replacement at all times, it being only necessary to remove the cap 40 which holds them in place.

As more particularly shown in Fig. 6, the enlarged end portion 21 of the piston 10 is hollow, being preferably provided with a cylindrical wall of uniform thickness and a squared shoulder 45 between the enlarged portion and the reduced shaft portion 20.

A longitudinal slot 46, of predetermined width, is cut through the wall from the shoulder 45 to a point 47 spaced from the shoulder a distance approximately substantially equal to the distance between the shoulders 15 and 16 in the casing 17. The outer corners of the slot 46 are rounded concavely to provide portions 51 of a cylindrical surface along each side. With regard to the direction the piston rotates, the trailing side 50 is cut away, as at 52, to provide intake ports opening through the wall.

The outer cylindrical surface of the enlarged portion 21, including the portion journaled in the bearing 28, is of uniform diameter throughout. In this way the piston is adapted for use with cylinders of different or varying widths. If in time the shoulders 15 and 16 wear, the shim 32 may be replaced with a thinner one to take up on the wear without giving the piston any attention, the end 21 of the piston 10 merely telescoping a little further into the reduced portion 27 of the casing 17. Adjacent the shoulder 45 the enlarged end portion 21 is drilled and threaded, as at 53, along an axis chordal thereto to receive a locking screw 54 (Fig. 1) to lock the vane 14 in place.

In cooperation with the function of the seals 36 and 37 and the bearing described, I provide a drilled-out passageway 39 through the reduced end 20 of the piston leading from the enlarged space 35 between the sealing elements 36 and 37 to the hollow enlarged end portion 21 of the piston 10. This connects the seals to the intake pressure of the liquid. Any liquid under head pressure escaping other than through the exhaust port has only two ways to go, one way along the bearing 28 where it enters the column of liquid moving into the hollow portion of the piston 10 to reach ultimately the exhaust port 26, while the other direction for the liquid under pressure to escape is along the shoulder 16 through the bearing 34. This path of escape is obstructed by the seal 36, but any liquid leaking past the seal reaches the compartment 35 from which it is returned through the passageway 39 also to the liquid entering the pump chamber.

Movement of some liquid along the bearings is desirable because it acts as a lubricant for the bearing surfaces. In the present invention this is made possible without fear of leakage, and in this connection it will be appreciated that the inner bearing seal 36 merely operates to control the volumetric efficiency of the pump by preventing too much liquid escaping.

In some installations the inner seal 36 may be dispensed with where the back pressure factor upon the pump is low. On the other hand, the seal 37 prevents liquid at pump intake pressure from escaping into the atmosphere, if the pressure is higher than atmospheric pressure, and, contra, in event the intake pressure is sub-at-

mospheric the seal 37 prevents air from bleeding into the pump. In this way the purity of the liquid being pumped is maintained, the bearings lubricated, volumetric efficiency maintained, and leakage prevented.

Referring now to the structure of the vane 14, the same is pattern cut from a piece of flat stock of uniform thickness to a shape (best shown in Fig. 1) in which a substantially rectangular portion 56 is provided with an axial length the same as the length of the cylinder 16. The portion 56 is also dimensioned to extend radially a distance substantially less than the distance between the inner surface of the enlarged portion 21 of the piston and the bearings 23 and 24. At its right end (as viewed in Fig. 1) the vane is cut away, as at 57, a distance greater than the thickness of the end wall 58; while at the left end the vane extends beyond the end of the portion 56, as at 60, and subtends the ends of the wall 48 of the piston, from which point it is cut away substantially on an angle, as at 61. The bottom side of the vane may abut the side of the wall opposite the slot 46, as at 62 in a way bisecting the hollow portion of the piston 10.

Longitudinally near the center the vane is drilled out to provide openings 63, primarily designed to permit liquid in the hollow portion 21 of the piston to move freely from one side of the vane to the other in reaching the inlet ports 52, although the openings are so located as to provide a weight-balancing influence also.

With the vane bisecting the hollow compartment and rotatable with the piston, it is possible to handle more liquid effectively than would be possible otherwise. The size of the intake port through the piston is determined upon its relation to the size of the tubing to which the inlet 31 is connected, and full speed of movement of the liquid past the vane is enhanced by centrifugal forces induced by the vane.

When the liquid moves within the sweep of the vane it is immediately impelled to rotate at high speed. At this high speed the liquid has an inherent centrifugal pressure which assists in moving it intermittently from a radially static position into the pump chamber through the inlet ports upon the intake cycle of the pump members. This centrifugal action also assists in drawing the liquid into the pump casing, relieving the pump chamber of a possible vacuum load normally present with conventional arrangements.

The particular structure of the vane is such that in assembly the end 60 is inserted through the slot 46 first, and pushed rearwardly with the bottom side 62 coming into contact with the far side of the hollow portion of the piston. The vane is then pushed to the left until the right edge is flush with the shoulder 45. The locking screw 54 is then inserted and tightened to hold the vane in place. Dowels 164 are then inserted through the wall into the edge 62 of the vane, to hold the same rigidly in place.

Mounted for rotation in the bearings 23 and 24 is the cylinder 11, having a sliding and sealed relationship with the vane. The cylindrical member 11 is substantially spool-shaped, having a reduced intermediate portion or channel 64 and two rims 65, which are connected by an intermediate portion 66 running axially between them and across the reduced portion 64, with an opening 68 through the reduced portion 64 to one side of the portion 66, forming the exhaust port. The rims 65 are machined to rotate in the bearings 23 and 24, and the reduced portion 64 cooperates with the enlarged portion 25 of the casing 17 to provide an exhaust chamber for the pump.

The interconnecting portion 66 provides sufficient metal mass for a longitudinal groove 67 to be cut upon the inner cylindrical pump surface 12 of the cylinder 11 in a way affording sufficient head room for the end of the vane to move back and forth when canted relative to the cylinder, as the cylinder and the piston rotate eccentrically. The walls 70 of the groove 67 are arcuately cut away throughout their length to define sections of a surface of revolution identical with that of the cut-away portions 51 upon the piston 10.

Rocker segments 71 are provided to fit in the groove 67 between the arcuate walls 70 of the cylinder and the sides of the portion 56 of the vane 14. Thus as the elements rotate the flat faces 72 have sliding relationship with the sides of the extension 56 on the vane 14, and a rocking relation with the walls 70 on the cylinder, in a way sealing the pump compartments upon opposite sides of the vane. The face 72 of the segments 71 located upon the intake side of the vane is grooved (not shown) to liberate the groove 67 of pressure factors developed by the action of the vane between the segments 71.

In the construction described, it will be noted that as the piston and the cylinder reach a point of tangency at the vane the rocker segments 71 mate with the cylindrical surfaces 51 upon the piston. This arrangement has the advantage of a high volumetric efficiency which is not present where the segments 71 are disposed deep within the channel 67. If the segments were to be disposed deep within the channel 67 there would be a portion of the channel next to the cylinder just as wide as the channel beyond the segments, to allow for the relative canting movement of the vane. This space is dead space, and although of lesser significance where an incompressible liquid is being pumped this particular construction has a broader application in use with fluid pumps where complete displacement of a compressible substance is highly important to the pump's efficiency.

In addition, this arrangement of parts permits a greater compactness of construction, since the bearing areas between the vane and the segments 71 are never as little as half the area of the flat sides of the segments. This is important because where, as in the particular construction disclosed, the drive between the two rotating pump members is carried by the vane, the segments would be displaced or cause a binding between the segments and the vane if the area contact was half or less than half.

This development of a compact construction, as shown, brings about other advantages regarding vibration control. A lesser radius of overall weight distribution is entailed, and this permits a wider range in the apportionment of mass needed to balance centrifugal inertias. In the particular embodiment illustrated it will be noted that all rotating units of mass are dynamically balanced. The vane 14, in addition to extending beyond the outer cylindrical surface, extends in a diametrically opposite direction toward the other side of the center of rotation with substantial portions of its mass drilled away on the side of the center of rotation next to the extended portion. Thus the drilled-out portions serve, as mentioned, a double purpose in permitting free movement of liquid inside the hollow cylinder from one side of the vane to the other, and pro-

portions the metal to allow for the amount of metal which is removed from the piston portion to provide the intake ports. Since all surfaces of the piston and vane are machined, and no allowances have to be made for casting variations, it is readily apparent that the vane and piston are standardized parts that do not vary, particularly as regards rotational weight distribution.

Referring again to the cylinder on this point, all portions are machined except the reduced central portion 64, and since this entails a male coring—an operation which is easily controlled as to metal distribution—it is readily apparent that the cylindrical member can be standardized to slight variance. The stock lost in providing the exhaust ports is balanced by the inner connecting portion 66, which can be varied in mass by the width of the channel 67, it being appreciated that the mass provided by the portion 66 does not extend the full length of the cylinder as does the groove 67, thus making up for a seeming excess which might appear to be present in viewing the cylinder cross sectionally, as shown in Figs. 2, 3 and 4.

Having pointed out the structural characteristics which, to those skilled in the art, show that the parts making up the present pump can be produced and machined within elementary shop practice, it is to be noted that assemblage of the parts is also very easily had. These two factors reduce the expense materially of the invention as compared with pumps having comparable pumping capacities.

In assembling the pump the casing 17 is upended with the large end upward. The cylinder 11 is lowered into place with the exhaust port 68 on the side of the axial portion 66 next to the boss 26.

The piston and vane assembly is inserted into the casing 17, with the vane disposed in the slot 67. The segment 71 upon the side of the vane next to the intake ports is next inserted in place, a position it will readily assume since the vane has plenty of room into which to move to accommodate it. After the first segment 71 is in place, as described, the second one is tapped into place very easily, since it has a smooth continuous surface the full path of its travel, even when tangency between the pump members happens to occur at the vane.

With the pump elements asembled in place the cover portion 18, without the gasket 32, is telescoped over the reduced portion 20 of the piston until it comes to rest solidly against the ends of the cylinder, the hollow end 21 of the piston permitting this to take place by telescoping further into the bearing at 28. Preferably pressure is applied longitudinally to collapse all clearances present with the assembled parts, and the space where the gasket 32 is to be received is measured either before or after, preferably after, the pump members have been rotated a few times to seat them. The cover member is then removed and the gasket 32, of a slightly greater thickness, is located in place and the cover plate returned and fastened in place by suitable means, such as bolts (not shown)—dowels being used to locate the cover and casing in correct relationship. Thereafter the sealing members are assembled in place in their positions, as already described, with the cap 40 finally assembled to hold the sealing members in place.

Referring now to Figs. 7, 8 and 8 an embodiment of the invention is shown wherein the pump is constructed and arranged to have two pumping chambers A and B. In this embodiment I provide a pump construction which not only has substantially all the advantages and structural characteristics of the embodiment just described but also has the added advantage of providing a substantially steady output. With this particular embodiment an expansion air dome upon the exhaust line is not needed since the exhaust is substantially free from pulsation.

Although it is possible to make the main casing of a single casting similar to the casing 17 shown in Fig. 1, I prefer, in this instance, for the sake of convenience in performing the necessary machining operations, to cast the casing in two parts, a cylindrical member 80 and an end portion 81, and secure them together with bolts 82.

The cylindrical member 80 is provided with four axially spaced bearings 83, 84, 85 and 86 machined upon the inner surface thereof with compartments 87 and 88 cast in the walls thereof between the bearings 83 and 84 and between bearings 85 and 86, respectively. The compartments 87 and 88 serve as exhaust compartments in a manner similar to that shown in Fig. 1. From both compartments the liquid under pressure is exhausted through the common opening 90 cast and threaded in the boss 91.

The provision of the compartments 87 and 88 as shown not only serve as exhaust passageways but also as relief portions in the casting which reduces the amount of metal that has to be machined in order to provide the bearing surfaces required. In this connection a groove 92 is provided in the casting upon the inner surface thereof between bearings 84 and 85 for the same purpose.

The following description will be confined to the rotating cylinders 93 and 94, the vanes 95 and 96 and that portion of the piston 97 located within the confines of the cylinder 80. The construction of the pump in Fig. 7 is otherwise substantially unchanged from that shown in Fig. 1. Consequently, like numbers will be employed to identify like parts which have already been described.

The two cylinders 93 and 94 are substantially identical, being designed this way to accomplish manufacturing economies. However, they have been identified in the drawings by separate numerals to relate them to the left hand and the right hand pump compartments, respectively, as viewed in Fig. 7. These members are rotatably journaled in the bearings 83 and 84 and the bearings 85 and 86, respectively. The cylinders 93 and 94 are not as long as cylinder 11 but otherwise have substantially the same structural characteristics as the cylinder 11. Related parts of the cylinder 11 and the cylinders 93 and 94 are identified with the suffix *a* and the description already supplied concerning cylinder 11 applies here also.

As more particularly shown in Fig. 9, the piston 97 is hollow. Radially, at any given point along the axis the walls are of uniform thickness and at the end adjacent the shoulder 45*a* are of greater thickness to provide more stock to hold the vane 96 in place.

Over that portion of the piston within the boundaries of the cylinder 93 the wall of the piston is provided with a slot 100 and on its trailing side, the slot is further cut away as at 101 to provide an intake opening through the wall from the interior of the piston. In this instance, however, the outer corners of the slot 100 are not rounded concavely as in the first embodi-

ment described and the rocker segments 71*a* are cut away to clear the piston.

The vane 95 in the slot 100 is rectangular and slips radially into the slot from the outside where it comes to rest with its lower end 102 resting against the far side of the wall of the piston where it is doweled in place by dowels 103. This vane is thereby well supported to carry the load of positively driving the cylinder from the piston.

Against the right end of the vane a spacing ring 104 is telescoped over the piston and held in place against the right end of the vane 95 by dowels 106, the ring being further held in place upon the piston by set screws 107 locked in place by followers 108. The ring assembly operates to hold the vane 95 against radial displacement.

Over the remaining portion of the piston adjacent to the reduced end 20 a longitudinal groove 110 of square sides and square corners is cut into the wall of the piston without being cut all the way through the wall. The groove 110 is angularly displaced through 180° with respect to the slot 100 and receives the vane 96 therein in supported relationship by a set screw 54*a* and end dowels 111 also driven through the ring 104. The inlet opening for the second pump compartment is a slot 112 cut through the thickened part of the shaft or piston upon the trailing side of the vane 96.

It will be observed that this construction provides inherently a dynamically balanced pump. The rotating members rotate on their own true axes and each of the assemblies is dynamically balanced. In the piston, the vanes where they intersect the piston merely replace the metal cut away to receive each of them, and where they extend beyond the outer surface they extend equal distances in opposite directions, one vane balancing the other. Inside the piston the vane 95 is dynamically balanced and the inlet openings are diametrically opposed. The ring 104 is also dynamically balanced within its own weight. Consequently the opening 113 in the vane 95 that is provided to permit free passage of liquid from one side of the vane to the other may be of any size desired provided the center thereof intersects the axis of the piston. In the cylinders it will be noted that the identical cylinders 93 and 94 are displaced 180° with respect to each other so that any individual unbalance in one is counteracted by the same unbalance in the other. Need for special correction for balance is thereby eliminated.

In assembling the pump shown in Fig. 7 the piston with the vanes and ring in place is inserted inside the cylinder 80 approximately to that point which it will assume when the assembly is completed. One of the cylinders is then located in place with the segments 71*a* inserted thereafter and the cover for that end of the cylinder 80 is bolted into place with the piston received in the respective bearing. The cylinder 80 is then upended to receive the other cylinder in place after which the other cover is bolted down solid.

The procedure thereafter is substantially the same as with the first described embodiment wherein the piston is turned a couple of turns to take up all clearances between the assembled parts and the measurement is made for the insertion of the appropriate shim 32 which will determine the clearance in the moving parts desired.

Thus having described the illustrated embodiments of the invention, it will be seen a novel and improved liquid pump has been provided which eliminates, for all practical purposes, leakage and vibration encountered in pumps of conventional construction. Moreover, the parts are simple in construction, inexpensive to manufacture, assemble and maintain in operation, with many of the parts serving dual functions not heretofore accomplished in the art. Consequently, although a single preferred embodiment of the invention has been illustrated and described, it will be apparent to those skilled in the art that various modifications and changes may be made therein without departing from the spirit of the invention, the scope of which is commensurate with the appended claims.

I claim as my invention:

1. For use in a rotary pump of the type described, a hollow cylindrical piston open at one end and having a longitudinal slot having different widths and extending through the side wall intermediate the ends, a longitudinal vane extending from the internal surface of the piston diametrically opposite the slot outwardly through the slot, the thickness of the vane being substantially less than the greatest width of the slot, and means diametrically opposite the slot and rigid with the piston engaging an edge of the vane for retaining the vane and piston in fixed relation, the vane having a transverse opening within the piston.

2. In a rotary pump of the type described, a rotatable cylinder, a hollow piston rotatably mounted eccentric to the cylinder and tangential to the inner surface thereof defining therewith a pump chamber, the piston having a slot extending through a wall intermediate the ends of the piston, a longitudinal vane extending outwardly through the slot from the internal surface of the piston diametrically opposite the slot into sliding engagement with the cylinder dividing the pump chamber into intake and discharge sections each having a port therein, and dowels rigid with the piston engaging the vane within the piston and retaining the vane in rigid relation to the piston.

3. In a rotary pump of the type described, a rotatable cylinder, a hollow piston rotatably mounted eccentric to the cylinder and tangential to the inner surface thereof defining a pump chamber, the piston having a slot extending through its side wall intermediate the ends of said piston and parallel to the axis of the piston, a casing supporting the piston and cylinder and having inlet and outlet ports communicating with the pump chamber, a longitudinal vane extending diametrically outwardly through the slot from the internal surface of the piston diametrically opposite the slot into sliding engagement with the cylinder, dividing the pump chamber into intake and discharge sections, each of said sections having a port therein, and means extending through a wall of the piston intermediate the ends of said piston engaging the vane for maintaining the vane in rigid relation to the piston.

4. In a rotary pump of the type described, a rotatable cylinder, a hollow piston rotatably mounted eccentric to the cylinder and tangential to the inner surface thereof defining therewith a pump chamber, a longitudinal vane extending outwardly through a longitudinal slot in the piston from the inner surface of the piston diametrically opposite the slot into sliding engagement with the cylinder dividing the pump chamber

into intake and discharge sections, each of said sections having a port therein, and means rigid with the piston engaging the vane within the piston for retaining the vane and piston in rigid relation.

5. For use in a rotary pump of the type described, a hollow cylindrical piston open at one end only and having a longitudinal slot extending through the side wall intermediate the ends, a solid planar vane extending from within the piston diametrically outwardly through the slot, and means diametrically opposite the slot and rigid with the piston engaging the inner end of the vane for retaining the vane and piston in fixed relation, the vane extending inwardly into the piston and having a cross sectional area smaller than the area of the slot to define a piston port.

6. In a rotary pump, a casing having a conduit opening and parallel end walls, at least one of the end walls being removable, cylinder bearings in the casing intermediate the end walls, piston bearings in the end walls, an inlet in an end wall, the axis of the piston bearings being spaced from and parallel to the axis of the cylinder bearings, a hollow cylindrical piston journalled in the piston bearings, one end of the piston being reduced in diameter to form a shoulder abutting an end wall, the other end of the piston being axially movable in its bearing, a cylinder journalled in the cylinder bearings and telescoped over the piston, the inner surface of the cylinder being tangential to the piston and with it defining a pump chamber, a vane rigid with the piston slidably engaging the cylinder and dividing the pump chamber, inlet and outlet means communicating with the pump chamber, one through the hollow piston, and the other interconnecting the pump chamber and the conduit opening, and replaceable shim means interposed between the removable end wall and the casing whereby minimum clearance may be maintained between an end of the cylinder and the corresponding end wall.

7. In a rotary pump, a casing having an outlet and parallel end walls, at least one of the end walls being removable from the casing, cylinder bearings in the casing intermediate the end walls, alined piston bearings in the end walls said piston bearings having an axis spaced from and parallel to the axis of the cylinder bearings, a hollow cylindrical piston journalled in the piston bearings, one end of the piston being reduced in diameter to form a shoulder abutting an end wall, the other end of the piston being longitudinally movable in its bearing, a cylinder journalled in the cylinder bearings and telescoped over the piston, the inner surface of the cylinder being tangential to the piston and with it defining a pump chamber, one end of the chamber being substantially sealed by an end wall, a vane rigid with the piston slidably engaging the cylinder and longitudinally coextensive therewith, said vane dividing the pump chamber into intake and discharge compartments, inlet means communicating with the intake compartment through the hollow piston and a port in the cylinder interconnecting the discharge compartment and the outlet, and a shim for spacing the removable end wall from the casing thereby substantially sealing the ends of the pump chamber.

8. In a rotary pump, a casing having an outlet and end walls, at least one of the end walls being removable, cylinder bearings within the casing, alined piston bearings in the end walls said piston bearings having an axis parallel to and spaced from the axis of the cylinder bearings, a hollow piston journalled in the piston bearings and reduced at one end to form a shoulder abutting an end wall, the other end of the piston being axially movable in its bearings, cylinders telescoped over the piston and journalled in the cylinder bearings, each cylinder having its inner surface tangential to the piston and with it defining a pump chamber, an annular ring attached to the piston abutting adjacent ends of the cylinders, vanes extending outwardly from the piston equal distances in opposite directions and angularly disposed through 180° with respect to each other, each vane being longitudinally coextensive with a cylinder and having sliding engagement therewith, means for securing each vane to the ring to retain the vanes in fixed relation to the piston, inlet means communicating with the pump chambers through the piston, each cylinder having a port interconnecting each pump chamber with the outlet, and means for retaining the end walls of the casing in a running sealed relation to the opposite ends of the cylinders.

9. In a rotary pump, a casing having a conduit opening and parallel end walls, cylinder bearings within the casing intermediate the end walls, axially alined piston bearings in the end walls, the major axis of the piston bearings being spaced from, and parallel to the axis of the cylinder bearings, a hollow cylindrical piston journalled in the piston bearings, a cylinder intermediate the end walls telescoped over the piston and journalled at its periphery in the cylinder bearings, the cylinder having an internal surface of revolution tangential to the piston defining with it a pump chamber, inlet means communicating with the pump chamber and including the hollow portion of the piston, and outlet means communicating with the pump chamber and including the conduit opening in the casing, said cylinder being in rotatable and sealed relationship to the end walls, and a radial vane rigid with the piston extending outwardly therefrom, and having sliding and rocking engagement with the cylinder, the vane dividing the pumping chamber into compartments, said vane also extending inwardly into the hollow portion of the piston whereby rotary motion is imparted to the entering water within the piston.

10. In a rotary pump having a hollow rotatable cylinder, a rotatable piston mounted in tangential relation with the inner surface of the cylinder defining therewith a pump chamber, driving means rigid with the piston slidably engaging the cylinder and dividing the pump chamber, and means for driving the piston, the combination therewith of a casing telescoped over the cylinder and having end walls substantially sealing the ends of the pumping chamber, piston bearings in the end walls, an inlet in an end wall and outlet means in the side wall of the casing, the inlet and the outlet communicating with the pump chamber on opposite sides of the dividing means, and internal bearing surfaces on the casing rotatably supporting the cylinder at its periphery.

11. For use in a rotary pump of the type described, a hollow cylindrical piston having an external shoulder adjacent one end, an annular ring fixed on the piston intermediate the shoulder and the other end of the piston, longitudinal vanes extending outwardly from the piston on opposite sides of and abutting the ring and angularly displaced through 180° with respect to each other, a slot through a longitudinal wall of the piston

adjacent one side of each vane, and means rigid with the ring engaging the vanes for retaining the vanes in fixed relation to the piston.

12. For use in a rotary pump of the type rescribed, a hollow cylindrical piston having an external shoulder adjacent one end, a ring fixed on the surface piston intermediate the shoulder and the other end of the piston, planar vanes extending outwardly from the piston on opposite sides of and abutting the ring and angularly displaced through 180° with respect to each other, a transverse slot through a longitudinal wall of the piston adjacent one side of each vane, one of the vanes extending inwardly into abutment with an internal wall of the piston, means rigidly interconnecting the abutting edge of said one vane and the piston, and means rigidly connecting both vanes to the annular ring whereby said vanes are retained in fixed relation to the piston.

13. For use in a rotary pump of the type described, a hollow cyindrical piston having an external shoulder adjacent one end, a ring telescoped over the piston and attached thereto intermediate the shoulder and the other end of the piston, longitudinal vanes each extending outwardly from the piston on opposite sides of and abutting the ring and angularly displaced through 180° with respect to each other, a transverse slot through a longitudinal wall of the piston adjacent one side of each vane, one of the vanes extending inwardly into abutment with an internal wall of the piston, said one vane having a transverse opening bisected by the axis of the piston, dowels rigidly interconnecting the abutting edge of said one vane and piston, and means rigidly interconnecting both vanes to the annular ring whereby said vanes are retained in fixed relation to the piston.

WILLIAM WARD DAVIDSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,316,318. April 13, 1943.

WILLIAM WARD DAVIDSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 6, second column, line 14, for "disposed" read --displaced--; page 7, first column, line 4-5, for "rescribed" read --described--; same page, second column, line 1, for "cyindrical" read --cylindrical--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of June, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)