Nov. 3, 1953 C. L. ENGLISH 2,657,638

ROTARY PUMP

Filed April 12, 1948 3 Sheets-Sheet 1

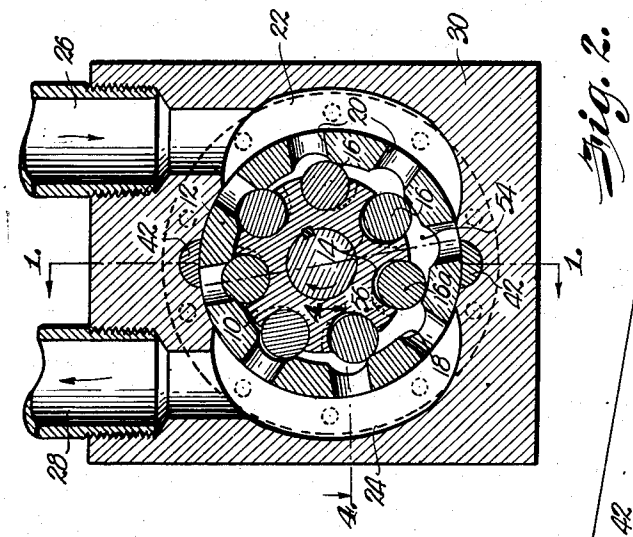


Fig. 2.

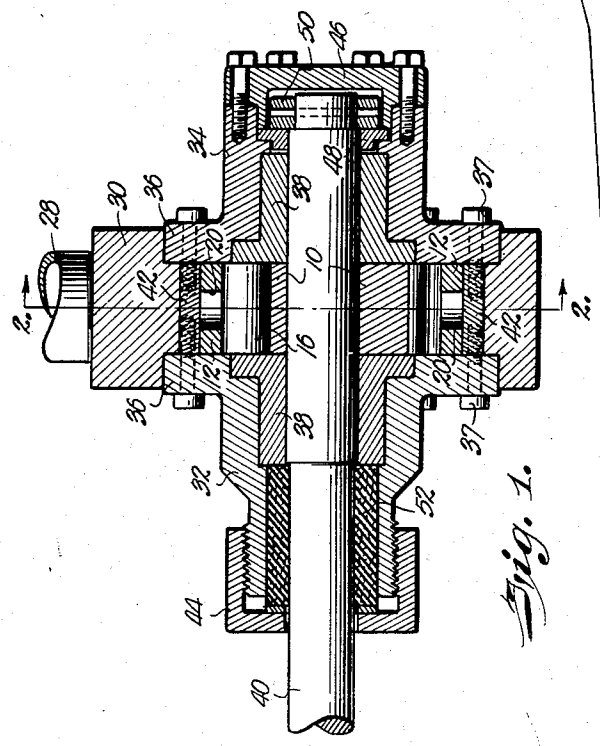


Fig. 1.

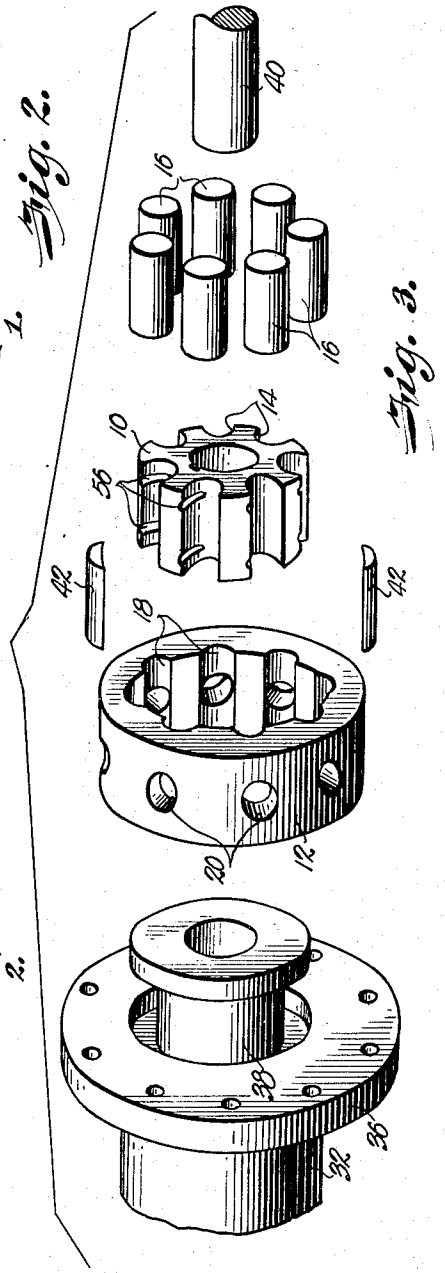


Fig. 3.

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ROTARY PUMP

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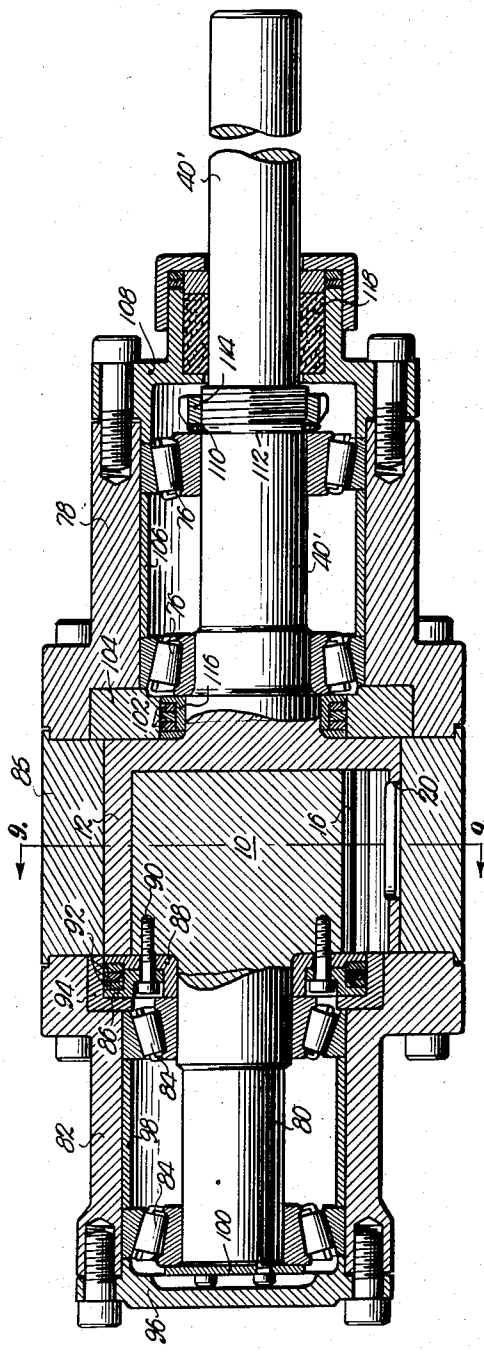


Fig. 8.

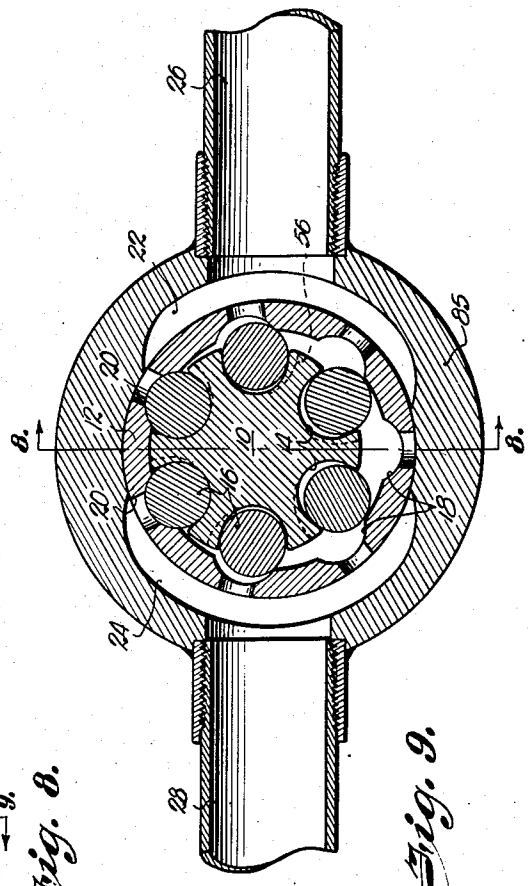


Fig. 9.

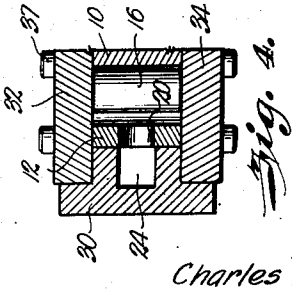


Fig. 4.

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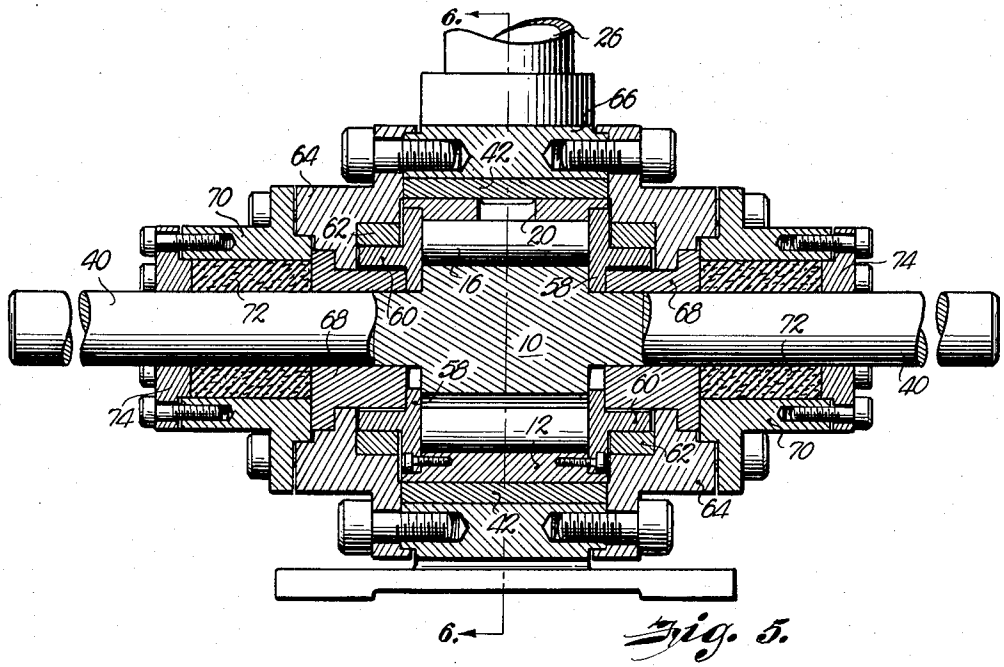


Fig. 5.

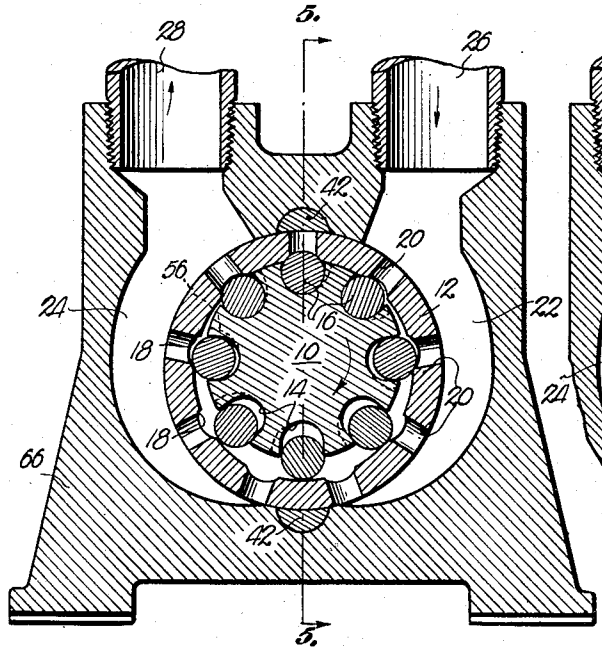


Fig. 6.

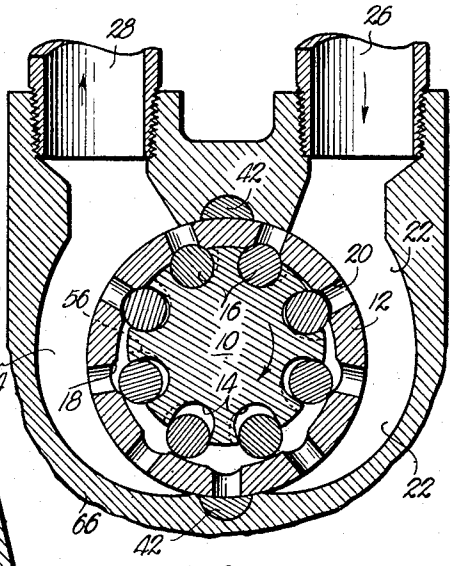


Fig. 7.

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UNITED STATES PATENT OFFICE

2,657,638

ROTARY PUMP

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Application April 12, 1948, Serial No. 20,407

25 Claims. (Cl. 103—121)

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The present invention relates in general to the pumping of fluids, and it deals more particularly with the construction of improved rotary pumping apparatus.

Broadly speaking, it is the object of the invention to provide a new type of rotary pump which is simple yet rugged in construction, which can be manufactured economically, and which is efficient and trouble-free in operation.

Another object is to provide a rotary pump mechanism having very little friction whereby it will give long service with a minimum of wear. A further object is to provide a mechanism that automatically compensates for such wear as does take place and consequently maintains its efficiency in use. Still another object is to provide a pump adapted to operate with a minimum of vibration.

A further object is to provide a pump having all the advantages of conventional ring gear-and-pinion rotary pumps, but having less friction and greater efficiency, less wear and longer life, and no inherent limitation upon capacity.

In general, my pump is of the type having an annular, ported rotor encircling a second rotor in eccentric relation thereto. An important feature of the invention resides in the provision, between the two rotors, of a series of independently movable members which serve to transmit the rotation of one rotor to the other, and which also serve as vanes or partitions subdividing the space between the rotors into a series of chambers each adapted to alternately increase and decrease in volume; according to the invention these members are cylinders having a rolling engagement with the respective rotors, whereby the friction between the parts is negligible.

Another feature lies in the structure and relationship of parts whereby the rollers or vanes are self-adjusting in position, and automatically seat themselves in the fashion best adapted to seal adjacent ones of said chambers from each other.

Other objects of the invention, together with further features of novelty, will appear in the course of the following description. In the accompanying drawings which form a part of the specification and are to be read in conjunction therewith, and in which like reference numerals are employed to indicate like parts of the various views:

Fig. 1 is an axial cross section of one form of my pump taken along line 1—1 of Fig. 2 in the direction of the arrows.

Fig. 2 is a transverse cross section of the same

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pump taken along the line 2—2 of Fig. 1 in the direction of the arrows.

Fig. 3 is an exploded perspective view of the pump mechanism.

Fig. 4 is a fragmentary cross section taken along the line 4—4 of Fig. 2.

Fig. 5 is an axial cross section of a modified form of pump taken along the line 5—5 of Fig. 6 in the direction of the arrows.

Fig. 6 is a transverse cross section taken along the line 6—6 of Fig. 5 in the direction of the arrows.

Fig. 7 is a transverse cross section also taken along the line 6—6 of Fig. 5, but showing the rotor in a slightly different position.

Fig. 8 is an axial cross section of another modified form of the pump taken along the line 8—8 of Fig. 9 in the direction of the arrows, and

Fig. 9 is a transverse cross section taken along the line 9—9 of Fig. 8 in the direction of the arrows.

Referring generally to the pumps shown in the drawings, the essential operating mechanism in all cases comprises a pair of cooperating complementary rotors 10 and 12 turning together in a common housing. Rotor 12 is annular in form and encircles rotor 10; its axis parallels the axis of the inner rotor but is spaced or offset therefrom so that the two members are in eccentric relationship.

Equally spaced around the periphery of the inner rotor are a series of axial grooves 14 occupied by cylindrical roller vanes 16. The inner periphery or bore of rotor 12 is provided with corresponding axial grooves 18, and in the region where the two rotors are closest to one another the rollers, meshing with the grooves in both the inner and outer members, insure that the two members move together. Either the inner or the outer rotor may be the driver as will be made clear presently, the rollers in either case serving to transmit the rotation of the driver to the other member.

It will be observed that the total number of grooves 18 in the outer rotor exceeds the total number of rollers 16 by one. At each groove 18 there is a radial aperture or port 20 extending through the ring so as to communicate with the suction chamber 22 and the pressure chamber 24 of the pump.

Due to the eccentricity of the rotors, the gap existing between them is generally crescent shaped, the rollers serving however to subdivide this gap into a series of compartments. As the rotors turn, the individual compartments pro-

gressively increase in volume on the side adjacent suction chamber 22 and accordingly the fluid is drawn from the latter chamber through ports 20 into the space between the rotors. On the opposite side of the pump, the compartments between the rollers decrease progressively in volume, forcing the fluid back through the same ports 20 into the pressure chamber, as will be described more in detail hereinafter. The fluid being pumped enters the suction chamber or manifold through the pump inlet 26 and leaves the pressure chamber or manifold through the pump outlet 28.

Turning to Figs. 1 to 4, the structural details of the pump there illustrated now will be considered more in detail. Its housing is made up of a central block 30 and a pair of flanged, shaft-supporting hubs 32 and 34; the annular flanges 36 on the latter members are seated in shallow circular recesses in opposite faces of the block and are secured in place by a series of bolts 37 extending through each flange into the body of the block.

In the hubs 32 and 34 are sleeve bearings 38, each having an external annular flange recessed into the end of the hub so that the flanged end of the bearing is flush with the inner face of the hub. These bearings support the shaft 40 which has rotor 10 keyed thereto.

Between the adjacent inner faces of the respective hub members, block 30 has a circular bore adapted to receive the outer rotor or ring 12. The axis of this bore (hence the axis of the ring) is spaced below the axis of shaft 40, whereby the two rotating members are in eccentric relationship as hereinbefore mentioned. The suction and pressure manifolds of the pump are formed by circumferential channels 22 and 24 in the bore of block 30, these channels registering with apertures 20 in the ring. The respective ones of the channels communicate with inlet and outlet ducts 26 and 28, as shown.

To prevent leakage of fluid from the pressure manifold to the suction manifold through the clearance around ring 12, a pair of self-adjusting sealing members 42 are provided. Disposed in semi-cylindrical grooves running parallel to the axis of the bore, these are free to swivel slightly and have concave faces adapted to seat against the periphery of the ring.

The ends of the pump housing may be closed in any suitable fashion, for example by end caps 44 and 46 as shown; the former cap, apertured to receive the shaft, has internal threads by means of which it is screwed in place while the latter is bolted to the housing. A wear plate 48 is clamped between cap 46 and an annular offset in the bore of the hub. A thrust ring 50 is pinned to the shaft to oppose the thrust of the discharge pressure reacting against the cross sectional area of the shaft diameter passing between the packing 52. At the other end of the housing there is a packing gland or rotary seal 52 of conventional form.

The direction of the pump's rotation and the direction of the fluid flow are indicated by arrows in Fig. 2. In this model of pump, the power is applied directly to the rotor 10 by means of a motor or prime mover (not shown) connected to shaft 40, and, as previously explained, the rotor in turn drives ring 12 due to the meshing of rollers 16 with grooves 14 and 18 in the respective members in the region where the ring and inner rotor are closest to one another.

Because of their intermeshed condition in this region it will immediately be apparent that the linear or circumferential speed of the inner and outer members is the same; however, having a somewhat smaller circumference than the bore of the ring 12, the rotor turns at a slightly higher angular velocity than the ring in maintaining an equal circumferential speed. Centrifugal force urges rollers 16 outwardly against the interior of the ring, and they therefore roll along the interior of the ring, advancing progressively relative to the grooves 18 due to the difference in angular velocity of rotor 10 and ring 12. This difference is such that any roller 16 will advance from one groove 18 to the next groove in the course of each complete revolution of rotor 10.

The orbit of the rollers 16 is very nearly circular, but inasmuch as each roller moves gradually away from the axis of rotor 10 during one half revolution of the rotor and then moves gradually back toward the axis during the ensuing half revolution, their orbit obviously is eccentric to the rotor. It will be evident that this near-circular orbit has its center intermediate the axes of the inner and outer rotors.

The maximum radial travel of the rollers in their individual grooves 14 is determined by the relative dimensions of the cooperating parts, and can be changed by modifications in design, as will be explained more in detail presently. However, it should be noted that the radial travel of the rollers always is somewhat less than the maximum gap between the inner and outer rotors. Considering the rollers as vanes serving to dam off the gap between the inner and outer rotors, the fact that this result can be obtained with comparatively little radial movement of the rollers 16 is important for the reason that it minimizes the vibration which otherwise might take place due to the eccentricity of the rollers' orbit relative the axis of shaft 40.

If desired, the rollers can be made of plastic or other light material rather than metal, in order to further enhance the smoothness of operation; the use of these lighter and cheaper materials also has certain commercial advantages, and inasmuch as there is little friction or abrasive action on the rollers, such alternative materials serve very satisfactorily.

The operation of the pump should be comparatively plain from the foregoing description. Referring to Fig. 2, it will be seen that the fluid entering the suction manifold 22 through inlet 26 passes through apertures 20 into the space between the inner and outer rotors as already described. As each aperture 20 in turn passes over the lowermost seal 42, the rollers 16 on either side of that aperture, together with the inner and outer rotor, form a small, completely closed cavity 54 transporting the fluid contained therein to the pressure side of the pump, the fluid then being forced out through the aperture into the manifold 24 when said aperture clears the seal and comes into register with the manifold.

Attention is directed to the fact that the roller indicated at 16*a* (Fig. 2) serves as a dam between the high pressure fluid in chamber 24 and the low pressure fluid in cavity 54. To insure that it forms a tight seal between the differing pressure zones, a pair of grooves 56 are provided in the leading wall of the roller retaining socket 14; these admit the high pressure fluid from chamber 24 to the region behind the roller, forcing it outwardly and rearwardly so that it seats firmly on the inner wall of ring 12 and the trailing edge of its retaining socket. Each roller in passing

through the critical region in which roller 16a is shown has the same important sealing function to perform, and all of them are automatically urged into the best sealing relation with the two rotors in similar fashion by pressure of the fluid behind the rollers, it being understood that this supplements the centrifugal force always acting upon the rollers.

Turning now to Figs. 5 to 7, the pump there shown embodies the basic principles explained above and the essential construction of the rotors and roller vanes is similar to that in the pump already described. Here, however, the rotary ring 12 is provided with annular end plates 58 which are bolted to the ring and form therewith a cage enclosing the inner rotor 10 and rollers 16. Integral with these plates are outwardly extending hollow trunnions 60 journalled in external sleeve bearings 62; the latter bearings are recessed in the pump housing members 64 which in turn are bolted to the central housing part 66. Thus it will be seen that instead of floating freely in the bore of the central housing part as ring 12 does in the construction illustrated in Figs. 1 and 4, the outer rotor cage in Figs. 5 to 7 is positively supported on external bearings which maintain the cage very accurately positioned relative the associated mechanism.

The shaft 40 of the inner rotor 10 is supported on flanged sleeve bearings 68, the flange on these bearings being clamped between housing parts 64 and 70. The last-mentioned parts also support packing glands or seals 72 for the rotating shaft and have annular end caps 74 bolted thereto to maintain the seals in place.

Power applied to either end of shaft 40 turns rotor 10 clock-wise (Figs. 6 and 7) and the rotor, through the medium of rollers 16 meshing with grooves 18 in ring 12, serves to drive the cage. The manner in which these cooperating rotors and roller vanes draw fluid into the suction cavity 22 through inlet 26 and expel it from pressure chamber 24 through outlet 28 will be understood from the explanation that has gone before.

Figs. 8 and 9 show a modified form of pump wherein the external prime mover is connected directly to the outer rotor and this in turn drives the inner rotor. The outer rotor 12 is a cylindrical cup integral with the drive shaft 40', the shaft being supported by two spaced sets of tapered roller bearings 76 disposed in housing member 78. The inner rotor 10 is integral with a stub shaft 80 supported in housing member 82 by spaced sets of roller bearings 84. Housing members 78 and 82 are bolted to opposite sides of the central housing section 85, as shown.

Encircling stub shaft 80 are a pair of collars 86 and 88 secured to the inner rotor by bolts 90; these extend radially outward beyond the margin of rotor 10 so that they are adjacent the edge of outer rotor 12, and they contain offsets between which are clamped sealing rings 92. The latter rings cooperate with a fixed annular seat 94 in housing 82 in order to prevent leakage into the bearing cavity of the fluid being pumped. It will be observed that the outer races of the bearings 84 are clamped between end cap 96 and an inwardly extending radial flange on seat 94, the sleeve 98 serving to maintain them properly spaced. An integral axial flange on collar 88 forms an abutment shoulder for holding one of the inner races in place, the other inner race being secured by a disk 100 bolted to the end of the stub shaft.

Around shaft 40' adjacent to rotor 12 are similar sealing rings 102, cooperating with an annular seat 104. The outer races of bearings 76, spaced apart by sleeve 106, are clamped between the seat and a shoulder on end piece 108. A split ring 110 occupying a groove 112 in the shaft and an internally threaded nut 114 maintain one of the inner races in position, while the seal-retaining member 116 holds the other. Numeral 118 identifies a packing gland around shaft 40' for further insuring against leakage.

In operation, power is applied to shaft 40' to turn the outer rotor 12 clock-wise (Fig. 9) and this, due to the meshing of rollers 16 with grooves 14 and 18 drives the inner rotor 10. The fluid is drawn into the pump through inlet 26 and discharged through outlet 28, all as described hereinbefore.

It will be observed that the pump of Figs. 8 and 9 employs six roller vanes, while the pump of Figs. 1 to 4 employs seven and the pump of Figs. 5 to 7 employs eight. In every case the total number of grooves 18 in the outer rotor or ring is one greater than the total number of rollers employed, so the angular velocities of the inner and outer rotors are in the ratio of 6:7 in the structure of Figs. 8 and 9; in the ratio of 7:8 in Figs. 1 to 4; and in the ratio of 8:9 in Figs. 5 to 7. This is intended merely to be illustrative of the variation in ratio that may be embodied in the pump mechanism, other ratios obviously being obtainable by using a larger or smaller number of rollers.

Referring to Fig. 6, it will be observed that the relative depth of grooves of 14 and 18 is such that rollers 16 at the top of their orbit are largely within the peripheral outline of the inner rotor. The total depth of the two registering grooves must, of course, be substantially equal to the diameter of the roller; however this total depth may be divided between the inner and outer grooves in other proportions than illustrated, which is to say the outer groove may be made deeper and the inner groove shallower, or vice versa. In general, the more nearly the inner and outer grooves approach being equal in depth (see for instance, Fig. 2) the less will be the radial travel of the rollers 16 relative the axis of rotor 10 in the course of the revolution of the latter.

Other possible modifications in structural details of the pump will be evident to those versed in the art; for example, either the intake manifold 22 or the discharge manifold 24 can be varied in size so as to register with a larger or smaller fraction of the outer rotor's circumference. In working with compressible fluids it ordinarily is desirable to make the discharge manifold of such size that the individual ports 20 register with it only through approximately 30 degrees of each revolution.

Pumps embodying the features set forth above can be made in an exceedingly wide range of sizes, inasmuch as the roller vane construction embodies no inherent limitation upon size. By actual test the pumps have been found to operate with a minimum of vibration.

As pointed out hereinbefore, it is practical to make the rollers 16 of metal or, alternately, of molded plastic, hard rubber or the like, the latter materials having the advantage of lightness and economy. Whatever substance is used, the rollers have an important advantage over conventional vanes in that their rolling contact with the two pump rotors very materially reduces friction and wear.

Some wearing of the rollers over a period of

time is, of course, inevitable, but even this does not impair the pump's operation for the reason that due to centrifugal force and the pressure of fluid admitted behind the rollers they automatically adjust themselves to their best seating position. Thus the pumps will maintain their efficiency and give satisfactory service over long periods of time without maintenance. The self-seating characteristic of the roller vanes also obviates maintaining close tolerances in the manufacture of the pump mechanism, a factor which is very important in reducing manufacturing costs.

From the foregoing it will be seen that this invention is one well adapted to attain all the ends and objects hereinbefore set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

Inasmuch as many possible embodiments of the invention may be made without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described the invention, I claim:

1. In a rotary pump, a pair of rotors interconnected for rotation in predetermined angular relationship, one of said rotors comprising a perforate annulus encircling the other, said rotors supported in eccentric relation whereby there is a crescent-shaped gap between them, an intake manifold and an exhaust manifold adjacent the exterior of the annulus and communicating with the perforations therein, the inner rotor having around its periphery a series of circumferentially spaced pockets, and a free-floating roller in each pocket urged outwardly by centrifugal force as the inner rotor turns whereby said rollers always ride against the interior of said annulus and subdivide said crescent-shaped gap into a plurality of separate compartments.

2. A pump as in claim 1 wherein the bore of said annulus is provided with circumferentially-spaced pockets for receiving said rollers, the depth of the latter pockets being less than the radius of the individual rollers whereby rollers seated partly in pockets in the annulus and partly in pockets in the inner rotor maintain the two rotors in predetermined angular relationship.

3. A pump as in claim 1 wherein a power driven shaft is connected directly to the inner one of said rotors, having mechanism including said rollers for transmitting the rotation of said inner rotor to said annulus.

4. A pump as in claim 1 wherein a power driven shaft is directly connected to the outer one of said rotors, having mechanism including said rollers for transmitting the rotation of said outer rotor to said inner rotor.

5. In a rotary pump, a housing having a circular bore, a rotating perforate annulus in said bore, the bore of said housing having a pair of spaced, circumferential channels registering with the perforations in the annulus, an eccentric rotor in said annulus interconnected with said annulus for rotation in predetermined angular relationship thereto, a series of circumferentially-spaced axial rollers between the rotor and annulus subdividing the space therebetween into a plurality of separate compartments, and a series of pockets in the periphery of the inner rotor each loosely confining one of said rollers for free movement independently of the other rollers toward and away from the axis of the inner rotor.

6. In a rotary pump, a housing, inner and outer rotors mounted therein, said rotors supported in eccentric relation whereby there is a crescent-shaped gap between them, said housing having an intake port and a discharge port communicating with circumferentially spaced portions of said gap, the inner rotor having in its periphery a series of circumferentially spaced pockets each extending axially of the rotor, a roller mounted in each pocket for independent movement toward and away from the axis of the inner rotor, said rollers being maintained by centrifugal force in contact with the inner surface of said outer rotor, the bore of said outer rotor being provided with circumferentially spaced pockets for receiving said rollers whereby said rotors are interconnected by said rollers for rotation in predetermined angular relationship.

7. In a rotary pump, a pair of rotors supported in eccentric relation, one comprising a perforate annulus encircling the other, the inner rotor having around its periphery a series of spaced pockets and the annulus having around its interior a different number of pockets spaced to register consecutively with pockets of said inner rotor, each pair of registering pockets containing an element disposed partly in one pocket of the pair and partly in the other, whereby the rotors are intermeshed for rotation together, said meshing elements carried by the pockets in said inner rotor and confined by said annulus for limited movement into and out of their respective pockets, and a pair of spaced-apart manifolds adjacent the exterior of the annulus each registering with the perforations in said annulus.

8. A pump as in claim 7 wherein the number of pockets in said outer rotor exceeds the number of pockets in said inner rotor by one.

9. A pump as in claim 7 wherein each of the perforations in said outer rotor extends radially outward from the bottom of one of the pockets in the outer rotor.

10. A pump as claimed in claim 7 wherein said meshing elements are rollers paralleling the axes of the rotors.

11. A pump as in claim 10 having a source of power connected to one of said rotors for turning both rotors in a particular direction, and a plurality of fluid passageways in the inner rotor each communicating at one end with the bottom of one of said pockets therein, the other end of the passageway for each pocket communicating with the peripheral space around the inner rotor at a point ahead of the roller in that pocket.

12. A pump as in claim 11 wherein each said passageway comprises a groove in the leading wall of one of said pockets.

13. A pump as claimed in claim 7 having a power driven shaft directly connected to only one of said rotors, the other rotor being driven by said one rotor through said meshing elements.

14. In a rotary pump, a pump cavity containing intermeshed ring and pinion gears, the meshing teeth of the pinion comprising independently rotatable rollers, intake and exhaust manifolds disposed adjacent the exterior of said ring, the respective manifolds being spaced apart circumferentially of the ring, and said ring having circumferentially-spaced ports each adapted

to register alternately with said intake and exhaust manifolds as the ring rotates.

15. In a rotary pump, a pump cavity containing intermeshed ring and pinion gears, said ring having one more tooth than said pinion, the teeth of the pinion comprising independently rotatable rollers, intake and exhaust manifolds disposed adjacent the exterior of said ring, the respective manifolds being spaced apart circumferentially of the ring and said ring having circumferentially-spaced ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates.

16. In a rotary pump, a pump cavity containing intermeshed ring and pinion gears, means for applying power to one of the gears thereby to cause both to rotate, intake and exhaust manifolds disposed adjacent the exterior of said ring gear, the respective manifolds being spaced apart circumferentially of the ring, said ring gear having ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates, said pinion having a circular hub with circumferentially spaced pockets in the periphery thereof, the teeth of the pinion comprising independently rotatable rollers carried in said pockets, each pocket having in its leading wall a groove for admitting fluid past the associated roller into the bottom of the pocket.

17. In a rotary pump, a pump cavity containing intermeshed ring and pinion gears, the meshing teeth of the pinion comprising radially movable rollers, intake and exhaust manifolds disposed adjacent the exterior of said ring, the respective manifolds being spaced apart circumferentially of the ring and said ring having circumferentially-spaced ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates.

18. In a rotary pump, a pump cavity containing intermeshed ring and pinion gears, said ring having one more tooth than said pinion, the teeth of the pinion comprising radially movable vanes, intake and exhaust manifolds disposed adjacent the exterior of said ring, the respective manifolds being spaced apart circumferentially of the ring, and said ring having circumferentially-spaced ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates.

19. In a rotary pump, a pump cavity containing intermeshing ring and pinion gears, said pinion including a hub having in its periphery a series of circumferentially spaced grooves each extending axially of the hub, each tooth of said pinion comprising a cylindrical roller paralleling the axis of the hub and loosely confined in one of said grooves for free movement independently of the other rollers toward and away from said axis, fluid intake and exhaust manifolds disposed adjacent the exterior of said ring gear, the respective manifolds being spaced apart circumferentially of the ring, and said ring having circumferentially spaced ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates.

20. A pump as in claim 19 wherein the maximum distance between the periphery of said hub and the addendum circle of said ring gear is less than the radius of one of said rollers.

21. In a rotary pump, a pump cavity containing inter-meshing ring and pinion gears, the ring gear having one more tooth than the pinion, said pinion including a hub having in its periphery a series of circumferentially spaced grooves each extending axially of the hub, each tooth of said pinion comprising a cylindrical roller paralleling the axis of the hub and loosely confined in one of said grooves for free movement independently of the other rollers toward and away from said axis, fluid intake and exhaust manifolds disposed adjacent the exterior of said ring gear, the respective manifolds being spaced apart circumferentially of the ring, and said ring having circumferentially spaced ports each adapted to register alternately with said intake and exhaust manifolds as the ring rotates.

22. A pump as in claim 21 wherein said rollers are of equal radius and the depth of the teeth of said ring gear is less than said radius.

23. In a rotary pump, a pair of eccentric rotors, one comprising a perforate annulus encircling the other with its bore substantially engaging the periphery of the inner rotor at one point whereby there is a crescent shaped gap between the two rotors, said gap being of maximum size at a point diametrically opposite said point of engagement, the inner rotor having in its periphery a series of circumferentially spaced grooves each extending axially of the rotor, a plurality of identical cylindrical rollers paralleling the axis of the inner rotor and each loosely confined in one of said grooves for independent movement toward and away from said axis, said rollers being free of one another and each tending to fly out of its associated groove due to centrifugal force as it travels with the rotor, said gap between the two rotors being, at said point of maximum size, less than the radius of each roller whereby the rollers always are retained in their respective grooves while bearing against the interior of said annular rotor due to centrifugal force, said annulus having in its bore a series of circumferentially spaced grooves each extending axially of the annulus for receiving said rollers, the depth of said last grooves being less than the radius of each roller, the number of said last grooves being greater than the number of grooves in said inner rotor, each of said rollers adapted as it passes said point of engagement between the two rotors to enter a groove in said annulus whereby the rotors are intermeshed for rotation together and the grooves in the annulus register consecutively with the grooves in the inner rotor as they pass said point of engagement, and a pair of spaced apart manifolds adjacent the exterior of said annulus each registering with the perforations in said annulus.

24. A rotary pump as in claim 23 wherein the diameter of each roller is substantially equal to the aggregate depth of a pair of said grooves, one groove of the pair being in the inner rotor and the other in said annulus.

25. In a rotary pump, a housing having a circular bore, a perforate annular rotor journaled in said bore with the exterior of the rotor and the wall of said bore forming complementary bearing surfaces, an inner rotor within said annular rotor mounted in eccentric relation thereto whereby there is a crescent-shaped gap between the two rotors, said housing having an intake port and a discharge port communicating via the perforations in said annular rotor with circumferentially spaced portions of said gap, said ports comprising a pair of circumferentially spaced channels in the wall of said bore each registering with the perforations in said annular rotor, the inner rotor having in its periphery a series of circumferentially spaced pockets each extending axially of the rotor, a roller mounted in each

pocket for free movement independently of the other rollers toward and away from the axis of the inner rotor, said rollers being maintained by centrifugal force in contact with the inner surface of the annular rotor thereby to subdivide said gap into a plurality of separate compartments, the width of each pocket being substantially equal to the diameter of the roller in that pocket whereby bodily movement of the rollers relative to the inner rotor is confined to inward and outward movement in said pockets and a substantially fluid-tight seal is maintained at all times between each roller and the wall of its respective pocket.

CHARLES L. ENGLISH.

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