

April 13, 1937.

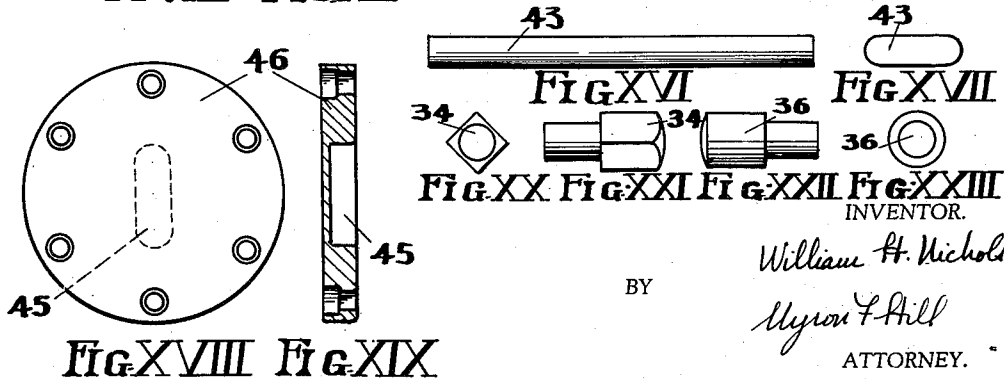
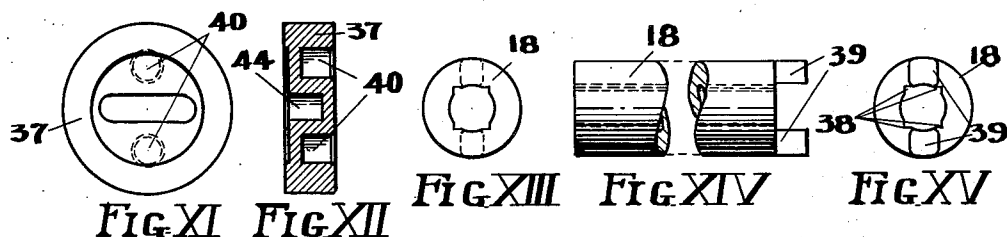
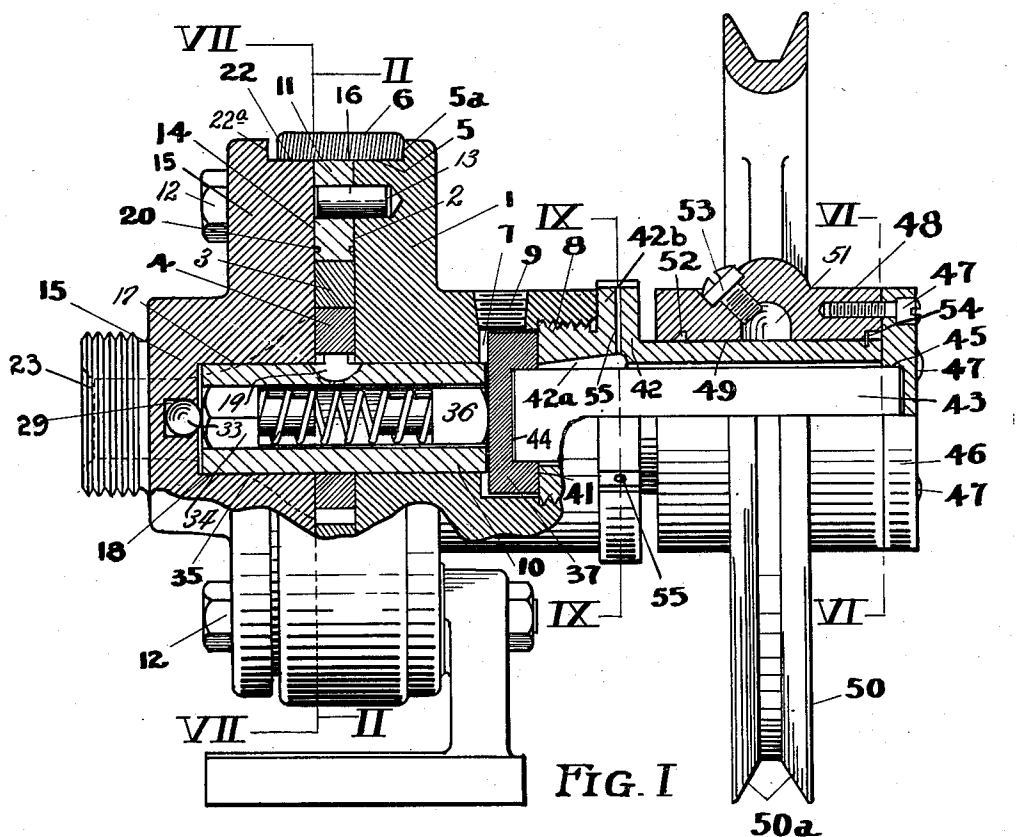
W. H. NICHOLS

2,076,664

PUMP

Filed June 4, 1932

3 Sheets-Sheet 1



BY

William H. Nichols
Myron F. Hill
ATTORNEY.

April 13, 1937.

W. H. NICHOLS

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3 Sheets-Sheet 2

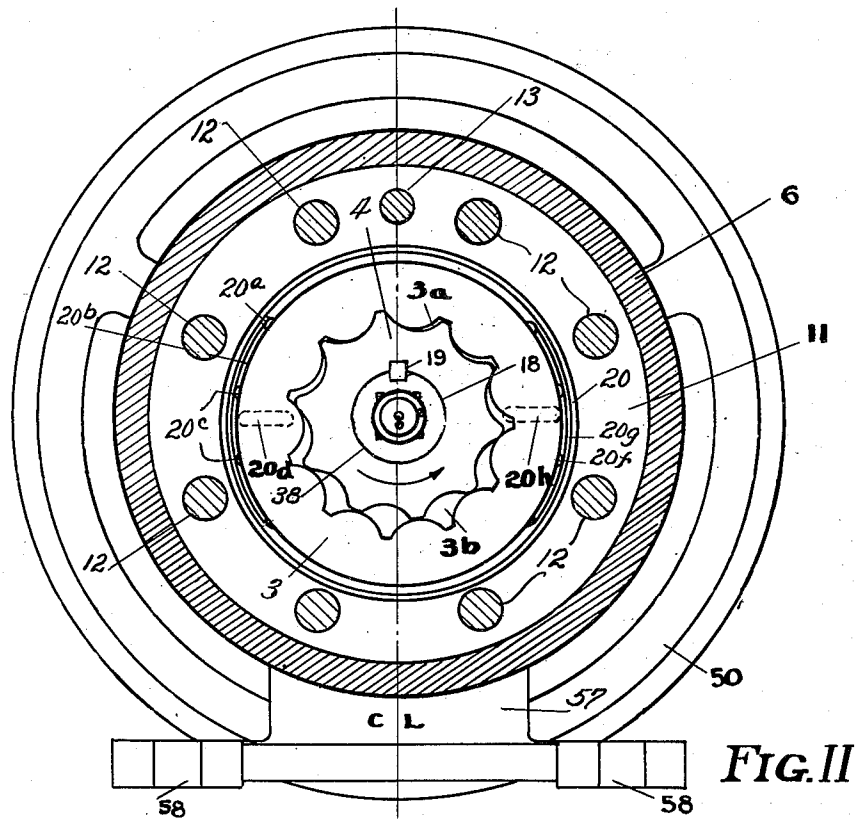


FIG. II

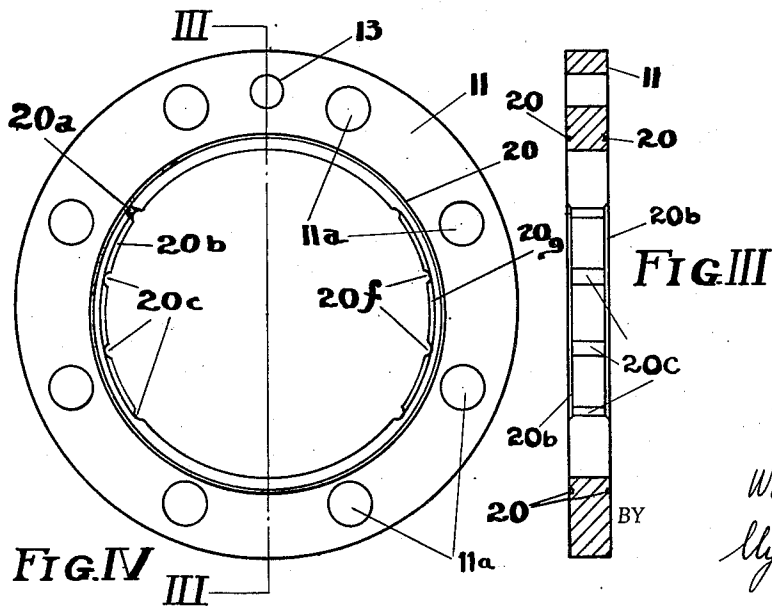


FIG. III

FIG. IV

INVENTOR.

William H. Nichols

By Myron S. Hill

ATTORNEY.

April 13, 1937.

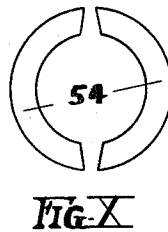
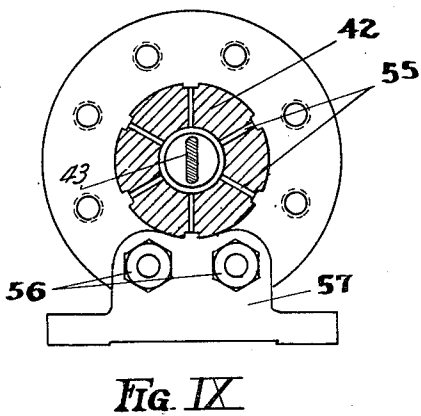
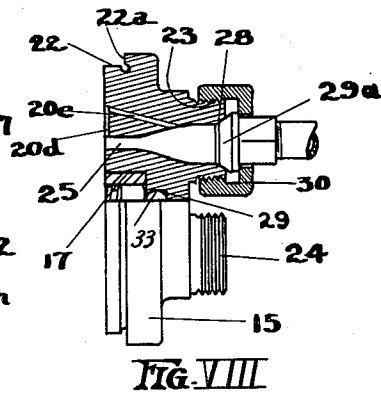
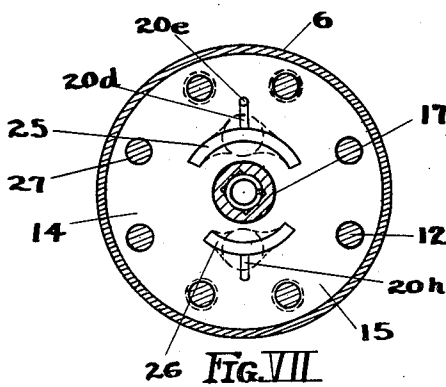
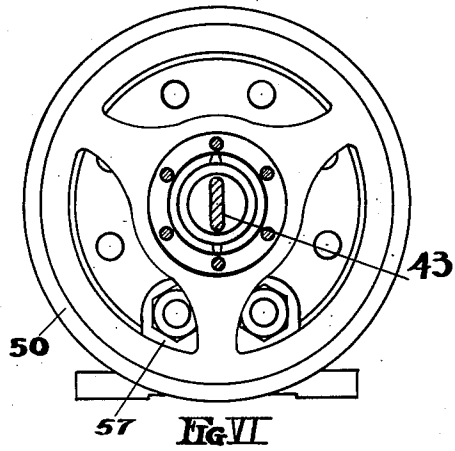
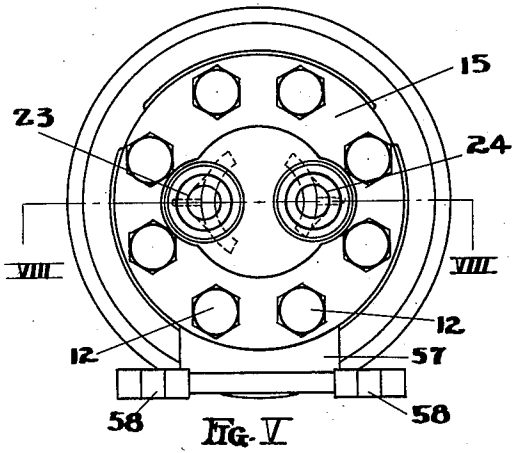
W. H. NICHOLS

2,076,664

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3 Sheets-Sheet 3



INVENTOR.

William H. Nichols

BY

Myron F. Hill

ATTORNEY.

UNITED STATES PATENT OFFICE

2,076,664

PUMP

William H. Nichols, Waltham, Mass.

Application June 4, 1932, Serial No. 615,316

16 Claims. (Cl. 103—126)

My invention relates to pumps of a rotary character and more specifically to pumps having internal rotors, such for example as those set forth in Patent to M. F. Hill, No. 1,682,563, August 28, 1928.

The object of this invention is to provide a pump for fluids in general with a minimum use of power, a minimum of leakage, with long life in operation and which works quietly.

In the drawings

Fig. I shows an elevation of a pump with parts in section.

Fig. II is a sectional elevation on line II—II, Fig. I.

Fig. III is a sectional view of the eccentric bearing plate, on line III—III, Fig. IV.

Fig. IV is a front elevation of the eccentric bearing plate.

Fig. V is a front elevation from the left-hand end of Fig. I.

Fig. VI is a sectional elevation upon the line VI—VI, Fig. I.

Fig. VII is an elevation with portions in section upon line VII—VII, Fig. I.

Fig. VIII is a plan view, partly in section, of the head on line VIII—VIII, Fig. V showing port details.

Fig. IX is a sectional elevation upon the line IX—IX, Fig. I.

Fig. X is an elevation of the split retaining washer.

Figs. XI and XII are an elevation and section view respectively of the coupling disc.

Figs. XIII, XIV and XV are respectively, a left end elevation, a side elevation and a right end elevation of the rotor drive shaft.

Figs. XVI and XVII are respectively a side elevation and an end view of the drive link or toggle.

Figs. XVIII and XIX are respectively an elevation and a section view of the hub cap.

Figs. XX, XXI, XXII and XXIII show spring buttons or plugs in side and end elevations.

In the drawings sheets 1 and 2 show in full size an operable pump and some of its details. Sheet 3 shows some views and parts to a reduced scale.

My invention is shown as embodying a rotary pump comprising a generated rotor unit comprising two rotors, one inside of and eccentric to the other, with contours whose generated curves are determined by their eccentricity, and a surrounding eccentric plate which fixes their eccentric location in a casing but it may be applied as well to other forms of rotary pumps.

The particular form of rotary pump elements proper shown in the drawings consists of an inner rotor, an outer rotor eccentric thereto and an eccentric bearing plate surrounding them and in which the outer rotor is journaled. These three elements constituting the unit are positioned within suitable casing members which enclose them. The casing members contain an integral bearing in which is journaled the shaft driving the inner rotor, to which said rotor is fastened. The axis of the outer rotor, is coincident with the axis of the bore of the eccentric bearing in the eccentric bearing plate. Thus, when assembled the eccentricity of the two rotors is the same as the eccentricity of the eccentric bearing with relation to the drive shaft axis. This unit preferably contains other features.

The clearances between the rotor side walls and the casing walls are of vital importance where high pressures are used, and where high volumetric and power efficiencies are required. These clearances are provided for by making the eccentric bearing plate wider than the rotors by the amount of clearance required at both sides, so that when the casing and rotor unit are assembled the proper side clearances are established without the use of gaskets.

The requisite clearances having been established for the particular fluid required to be pumped, which clearances will vary with the nature of said particular fluid, the loss from leakage across the end faces of the rotors at the working pressure is reduced to a minimum.

The relations of the three members of the rotor unit are shown in Fig. II, the two centers in the figure showing the eccentricity. The upper center is that of the inner rotor and of the outside of the eccentric plate. The lower center is that of the outer rotor and of the bore of the eccentric plate which is the bearing of the outer rotor. In order that the rotors upon such centers may have the contacts between all the teeth, as shown, the longest radius of each rotor curve must exceed the shortest radius of that rotor by a distance equal to twice the distance between the two centers as set forth in the patents to Myron F. Hill, 1,682,563—4—5, granted August 28, 1928, this relation of the rotor curves to the eccentricity not being my invention. My invention, however, is adapted to such rotors.

Heretofore it has been the custom for pump manufacturers to make all parts of pumps, especially rotary pumps, in a single factory, with the exception of anti-friction bearings when used, which, involving a high degree of precision in

manufacture have been made generally in specialized factories. In such pump factories loosely made parts have resulted in low volumetric efficiency at high pressures.

5 My invention aims to provide a rotor unit suitable for manufacture with the highest degree of precision possible only with specialized machinery and methods, so that it may be commercialized, much as anti-friction bearings have been
10 commercialized.

The rotors, as shown in Fig. II, have all the teeth of the inner rotor in contact with those of the outer rotor, the contacts being maintained continuously during rotation; and such a relation makes it essential that the tooth curves shall be such that the height of every generated crown curve from the curve of generation at the bottom of a tooth space is equal to twice distance between the rotor centers. The contour of the inner rotor is generated by the circular tooth of the
20 outer rotor at uniform angular speed. Any variation from this exact dimension, except the bottoms of the tooth spaces, causes jamming or leakage, so that the generated dimension must be an exact one. The patent to Myron F. Hill, 1,682,563, August 28, 1928, describes it in detail.

In order that such exact curves may operate in their precision relations the rotors must be mounted upon the exact eccentricity upon which
30 rotor curve generation is effected.

Rotors which may maintain such an exact relation without looseness or pressure other than that of driving, require a third member for mounting the rotors on exact eccentricities and this I accomplish with my eccentric plate, which
35 also requires equal precision of manufacture.

The exactness of manufacture of these three members essential to high efficiency is beyond the reach of the usual pump manufacturer unless
40 he undertakes the development of expensive special machinery, while the rest of the pump manufacture, excluding the three members which constitute my rotor unit, being concentric and circular in character, lie within the practice of
45 the usual modern pump factory.

My invention enables such pump factories to obtain these units and install them in casings of their own manufacture.

The unit also provides for such casings correct side wall film spaces, a bearing for the outer rotor in the bore of the eccentric plate, and grooves in the bearing, if desired, for high pressure oil so that the outer rotor floats in its own pressure. Also there may be anti-leak grooves
50 to prevent leakage between the casing members. It is noted that gaskets which prevent precision in the clearance or film spaces on the side walls of the rotors are not used.

The pump casing parts are readily machined on automatic machinery with all parts machined on one center, which center is the axis of the inner rotor, or its shaft. The right hand or rear member 1, Fig. I, of the casing is provided with a face 2, adjacent to the rotor side
60 walls. There are also an outside machined shoulder surface 5 and a machined shoulder face 5a upon which is centered the ring 6, fitting closely upon 5 and closely abutting 5a. This casing member 1, has at its outer or rear end a female threaded bore 8 and an inner plain bore forming a chamber 7. A tall piece or stub 42 is threaded to engage the threaded bore 8. A relief connection is provided at 9 to relieve excessive pressure from the chamber 7. The casing
70

is also provided with a bearing 10, in which one end of shaft 18 is journaled, with its axis concentric with the cylindrical shoulder surface at 5. The ring 6 surrounds the eccentric bearing plate 11 (Figs. I, III and IV), whose external diameter has its axis coincident with the axis of the shaft 18 maintaining it in correct relation with the other parts.

As shown in Fig. IV the eccentric bearing plate is provided with loose bolt holes 11a so that bolts may be passed through it in assembling. There is also a dowel hole 13, fixing its position by means of a dowel pin 16 with respect to front casing member or body 1 and casing head 15 in which the ports are located. As stated hereinbefore, the width of the eccentric bearing plate provides and maintains the necessary clearances between the side walls of the rotors and the casing faces.

The casing head 15 is provided with a face 14 and with a bearing 17 whose axis coincides with that of the bearing 10 in the casing body. The bearing in these two casing members journal the shaft 18 to which the inner rotor 4 is trued and closely fitted and keyed at 19. The inner rotor, driven by shaft 18, drives outer rotor 3 which is journaled in the eccentric bore of the eccentric bearing plate.

The joints between the sidewalls of eccentric bearing plate and the walls of casing body 1 and casing head 15 effectually prevent oil from leaking from the pump between these parts when assembled and fastened together by the bolts 12.

These joints are finished by grinding and lapping to minimize leakage. However, to further assure that such leakage be prevented grooves 20, one on each face of the eccentric ring are provided. These grooves are connected with each other by means of a slot across the width of the eccentric bearing plate at 20a, Fig. IV, and with chamfers 20b on the edges of the bearing plate which chamfers are also connected across the width of the bearing plate by slots 20c. There are also communications slots 20d on the casing head 15 and on casing head 1, see Figs. II, VII and VIII, which communicate on one end with the system of grooves, slots and chamfers and on the other with a suction port 25, and in addition by a passage 20e to the intake passageway leading from the suction pipe connection 23 to the suction port 25. This relief prevents leakage at the joints.

When the pump is in operation a pressure develops on the pressure side of the rotors, that is, to the right of the center line in Fig. II in the particular design of pump shown. This pressure thrusts the outer rotor to the right against the eccentric bore of the eccentric bearing plate. By means of the slots 20f, connected to chamfers 20g, similar to chamfers 20b, which register with the slots 20h, Figs. II and VII, which slots also communicate with the discharge port 26, this pressure between outer rotor and eccentric bearing is equalized.

Slots 20c act in a similar manner to balance the pressure developed on the inlet side of the center line, this pressure however is not of such importance as the pressure on the outlet side.

The casing head 15, Figs. I, VII and VIII has a cylindrical surface 22 and a shoulder 22a concentric with bearing 17 and is lined up with casing body 1, by means of the ring 6, which accurately fits the cylindrical portion 5 and abuts the
75

shoulder 5a of the said casing body, but does not contact shoulder 22a when assembled.

The ports 25 and 26 are connected by the passages indicated leading to the pipe line connections 23 and 24 in the casing head. The casing head and body as well as the eccentric bearing plate are provided with suitable holes to loosely receive cap screws or bolts by which these parts are assembled and held together. The pipe line connections 23 and 24 are preferably made in the form of male union studs for connection with the female threaded collar 30 of unions as shown in Fig. VIII and as such have the usual coned surfaces for contact with the coned surfaces of the other part of the unions held by the collars 30.

The bearing bore in the casing head 15 is closed at its outer end, Fig. I. A hardened steel ball 33 is centered in a cavity 29 in this closed end and projects beyond the flat face of the closure. Against this hardened ball a plug or spring button 34 bears, the button being thrust against the ball by the spring 35. At its other end this spring presses against a shoulder on the plug 36, which in turn presses against the coupling disc 37. The plug 36 is preferably of hardened steel and as shown in Figs. XX, XXI has angular corners freely entering V grooves in the shaft 18, Fig. XV, so that it rotates with said shaft. The grooves 38, and flat sides of the plug 36 permit fluid pressure to be balanced on the ends of the shaft. The shaft 18 has lugs 39 engaging the recesses 40 floatingly. These recesses have a depth greater than one half of the coupling disc width. When the coupling disc is driven, the shaft 18, is likewise carried around turning the pump rotors and carrying around the spring buttons and spring. This spring presses button 36 against the face of the coupling disc, pressing it against the seat 41 which is on the left end face of the tail stub 42, Fig. I, making a seal therewith. The disc 37 performs the double function of connecting floatingly the two parts of a separable tandem shaft system and of making a pressure seal between the pump end and the driving end of the said shaft system.

This tail piece or stub may be of hardened steel screwed into the threads 8 and the flange 42b upon it contacts a finished face at the end of the casing body 1 to provide an oil tight joint. The joint between the coupling disc 37 and the face 41 prevents oil from escaping outwardly from the pump proper and may be relied upon in practical operation to prevent all leakage either while running or when idle.

The coupling disc 37 is connected by a driving link or toggle 43 shown in Figs. I, XVI, XVII to the power source. One end of toggle 43 engages the recess at 44 which has a depth greater than one half the thickness of the disc 37, shown in Figs. XI and XII, so that the lugs 39 on the drive shaft 18 actually straddle and overlap the end of the toggle 43 in the recess 44 of the coupling disc 37, thus preventing any tendency to break the integrity of the seal through canting.

The rear end of this toggle 43 is engaged by a corresponding recess 45 in the hub cap 46 shown in Figs. I, XVIII and XIX. This hub cap is secured by means of screws 47 to the hub 48 of a pulley (Fig. I) which is journaled at 49 upon the tail stub 42. This tail stub 42 on the end adjacent to the sealing disc 37, is cone bored at 42a with the larger diameter towards the holes 55 so that it assists the outward flow to the holes

55 of any liquid accidentally seeping or leaking between the face of the sealing disc 37 and the contacting face of the tail stub 42. The pulley 48 has an outer flange 50 provided with a groove 50a adapted to receive a belt and to be driven thereby from any suitable source of power, as for example, a motor. This toggle 43 or the disc 37 may engage any suitable driving device in place of the pulley shown or be driven directly from the source of power.

In order to lubricate the journal 49 the pulley hub is provided with a concentric groove or reservoir 51 within its bore capable of holding lubricating oil. This reservoir opens inwardly to lubricate the outside bearing surface of said tail stub. It is found, particularly, when protected by a groove 52 in the bore of the pulley 48, bevelled on its left side that this lubricating oil when in proper amount does not leak out and escape from the journal. An oil filling hole is provided for chamber 51, closed by a screw 53. The oil is thrown outwardly by centrifugal force during rotation so that during running it can't escape. As the motor stops the oil on the upper side drops by gravity onto the bearing and then drains down to the bottom of the reservoir where it can't escape. The bearing, however, has its lubrication maintained.

If too much lubricating oil is supplied to the reservoir so that when standing still its level rises above the bottom of the bearing, the excess slowly seeps out through the hollow shaft and holes 55, appearing on the floor. When the excess oil is disposed of, the rest of it remains in the reservoir except as it is used up in the bearing. The reservoir holds enough for at least one whole winter season's service.

If fuel oil leaks out through holes 55 a faulty seal is indicated—a convenience at the testing stand.

The pulley is held upon the tail stub by means of a hardened steel split end thrust washer 54, shown in Fig. X, the two halves of which are (see also Fig. I) inserted in a circumferential groove in the right hand end of the tail stub. In order to insert this split washer 54 the pulley 18 is shifted to the left until the circumferential groove is uncovered. The split washer is then inserted, the pulley is pulled back over the washer locking it in place so that it acts as a stop for the pulley, and the driving plate 46 is screw connected to the hub of the pulley.

In the flange portion of the tail stub at 42b are radial holes 55, shown particularly in Fig. IX, providing for the escape of any fluid that may accidentally pass the sealing joint and indicate by passing out at the holes 55, a possible need for attention at the joint.

Figs. VI and IX show threaded ends of the two bottom bolts extending (see also Fig. I) through a pedestal 57 which is attached by means of nuts 56 to the pump. This pedestal 57 thereby acts as a mounting for the pump and its base may be bolted to any suitable foundation in the usual way by means of holes or slots 58 shown in Figs. II and V or as may be desired.

In operation a belt drives the pulley 48 which in turn transmits its motion to the various parts in the following order; to the hub cap 46, driving link or toggle 43, coupling disc 37, shaft 18, including spring buttons and spring, inner rotor 4 and outer rotor 3.

The hub cap 46 is centered on the pulley hub and engages one end of the link 43; the other end of 43 engages the disc 37; the disc 37 is

floatingly connected to the shaft 18, and wears to its natural position under the influence of the spring 35 which presses it firmly against its seat 41. The spring 35 presses against the thrust ball 33 and with the plugs 34 and 36 is free to move endwise without affecting the position or action of the shaft 18. The rotors are carried at about the middle of the shaft and the journal pressures on both sides of the rotors are balanced so that the clearances at the sides of the rotors may be exceedingly close without rubbing.

While I have described my invention in the form actually built, I would not have it understood that it is limited thereto; since it is obvious that many of its features are adaptable to other forms of construction and to a wide variety of purpose.

I claim:

1. In a pump, a casing, a pump drive shaft, a separate hollow tail stub having means for joining said stub to said casing, a power driving device surrounding and rotatably mounted on said stub, a radially free link within said hollow stub and driven from said device, an internal bearing end face on said stub surrounding its bore, a radially free coupling disk engaging and centered by said driving shaft, sealing against fluid escape by contacting said bearing end face; said link floatingly driving said coupling, and rotatable spring means in said casing pressing said disc against said seat.

2. In a rotary pump, a casing having four members, a main body, a cover, an eccentric spacing plate and an outer centering ring, rotors within said casing, one within and eccentric to the other, opening and closing rotor chambers for operation on or by fluid pressures, a driving shaft centered on the axis of the inner rotor, the outer circumference of said eccentric plate centered also on said axis of the inner rotor, the bore of said eccentric plate being centered upon the axis of the outer rotor, said eccentric plate being thicker than the rotors and interposed between said body and cover to separate them to provide clearance for the rotors to work in, said outer centering ring centered by a shoulder on the pump body, and in turn centering the outside of said eccentric plate.

3. The combination claimed in claim 2, having a shaft bore also in the cover member, and a shoulder centering it with said centering plate, said shoulder being concentric with said shaft bore.

4. In a fluid mechanism for operation on fluids or by fluid pressures, intake and outlet passages therefor, front and rear casing members, a centering ring to center them in assembly, bearings in said front and rear members aligned by said centering ring, and a rotor unit in said mechanism comprising an eccentric plate and internal rotors, one rotor within and eccentric to the other, forming chambers between them which open and close during rotation, said rotors being located between said front and rear casing members, the inner rotor centered in said aligned bearings, said eccentric plate located within and centered by said centering ring and between said front and rear members, the axis of the outer diameter of said eccentric plate coinciding with the axis of said aligned bearings of the inner rotor, and the axis of the bore of said eccentric plate coinciding with the axis of the outer eccentric rotor, said eccentric rotor being journaled therein, said eccentric plate having the thickness of said rotors plus their running clearance, and

fluid tight joints between said eccentric plate and said casing members.

5. In a pump, a casing having a hollow tail stub, a rotor movement in said casing, a shaft system to drive said rotor movement, a driving device rotatably mounted on said hollow tail stub, surrounding one end of said shaft system, an oil reservoir in said driving device surrounding and opening radially inward to said tail stub to lubricate it, a separable driving plate engaging said shaft system to drive it, a fluid tight joint between said driving plate and said driving device mounted on said stub, a thrust bearing face on said tail stub on its inward portion, a sealing member rotatably contacting said thrust bearing face, and radial escape vents in said stub between said sealing member and said driving plate to permit the escape of excess oil in said reservoir.

6. As an article of manufacture, a rotor unit comprising toothed rotors one within the other, one having one more tooth than the other, their axes having a fixed eccentricity, the contours on one co-operating with the contours on the other, opening and closing chambers between them and maintaining continuous engagements between them during the performance of pressure functions, a plate surrounding said rotors, the outer rotor journaled in the bore of said plate, and the outer surface of said plate having as its axis that of the inner rotor, said plate having the thickness of said rotors plus additional thickness to fix the side clearance necessary for said rotors in service.

7. The combination set forth in claim 6 including bolt holes and interconnected grooves on the opposite faces of said eccentric plate and between said bolt holes and said bore.

8. The combination claimed in claim 6 having leak relief grooves on the faces of said eccentric plate.

9. In a pump, a casing having inlet and outlet passages, engaging pump elements rotatively mounted therein, a shaft system connected in driving relation to one of said elements, a hollow stub surrounding one end of said system, means for driving said system, including a hub having a shouldered cylindrical bore fitting the exterior of said stub, said bore being provided with an annular oil reservoir open to said stub and extending radially into the hub whereby oil inside the reservoir is pocketed both by gravity and centrifugal force, a detachable thrust member fitted in said stub and locked within the bore of said hub in engagement with the shouldered portion thereof to position said stub on said hub and means fitting said hub for driving said shaft system.

10. The combination claimed in claim 9 in which said means includes an imperforate driving plate mounted on said hub to close the open end of said hollow stub and connected to said system for driving the same.

11. The combination claimed in claim 9 in which said stub is provided with a sealing face adjacent the hollow portion thereof and the shaft system includes the sealing member contacting said sealing face to prevent leakage along said shaft system.

12. A fluid casing having a chamber containing drive members operating upon the fluids, a shaft attached to said drive members for performing work on or by said fluids, an opening in said casing through which power is transmitted to said shaft, an imperforate rotatable disk entirely closing said opening, a smooth regular

sealing surface around said opening on said casing, a smooth surface upon said imperforate disk fitted to said surface in a plane transverse to the axis of rotation of said disk around said opening acting as a seal to prevent the inlet or exit of fluids through said fitted joint, means to apply a resilient force upon said disk at its middle portion and between the sides of said fitted surfaces whereby the pressure upon said fitted surfaces around said opening is evened up and a loose driving connection upon each side of said disk, one connection for said shaft and the other connection for a driving means, said driving connections engaging said disk in a common plane which lies on one side of the plane through the seal surfaces to prevent driving moments of force from upsetting said disk from its seat.

13. The combination claimed in claim 12 in which said driving means comprises an external driving device loosely connected to said imper-

forate disk at one end and having the other end centered in a power device whereby said power is transmitted to said disk without tipping it off its seating surface.

14. The combination claimed in claim 12 having the surfaces around said opening and the fitted surfaces on said disk in a common plane, one of said loose shaft connections holding the disk loosely upon the axis of said shaft.

15. The combination claimed in claim 12 having said seal disk radially free to find its own center in said casing.

16. The combination in claim 1 having in said casing a pair of internal rotors driven by said pump drive shaft, one eccentric to the other, an eccentric ring or plate surrounding said rotors, the bore of said ring having as its center the axis of the outer rotor, and having its exterior a circle centered upon the axis of the inner rotor.

WILLIAM H. NICHOLS.