

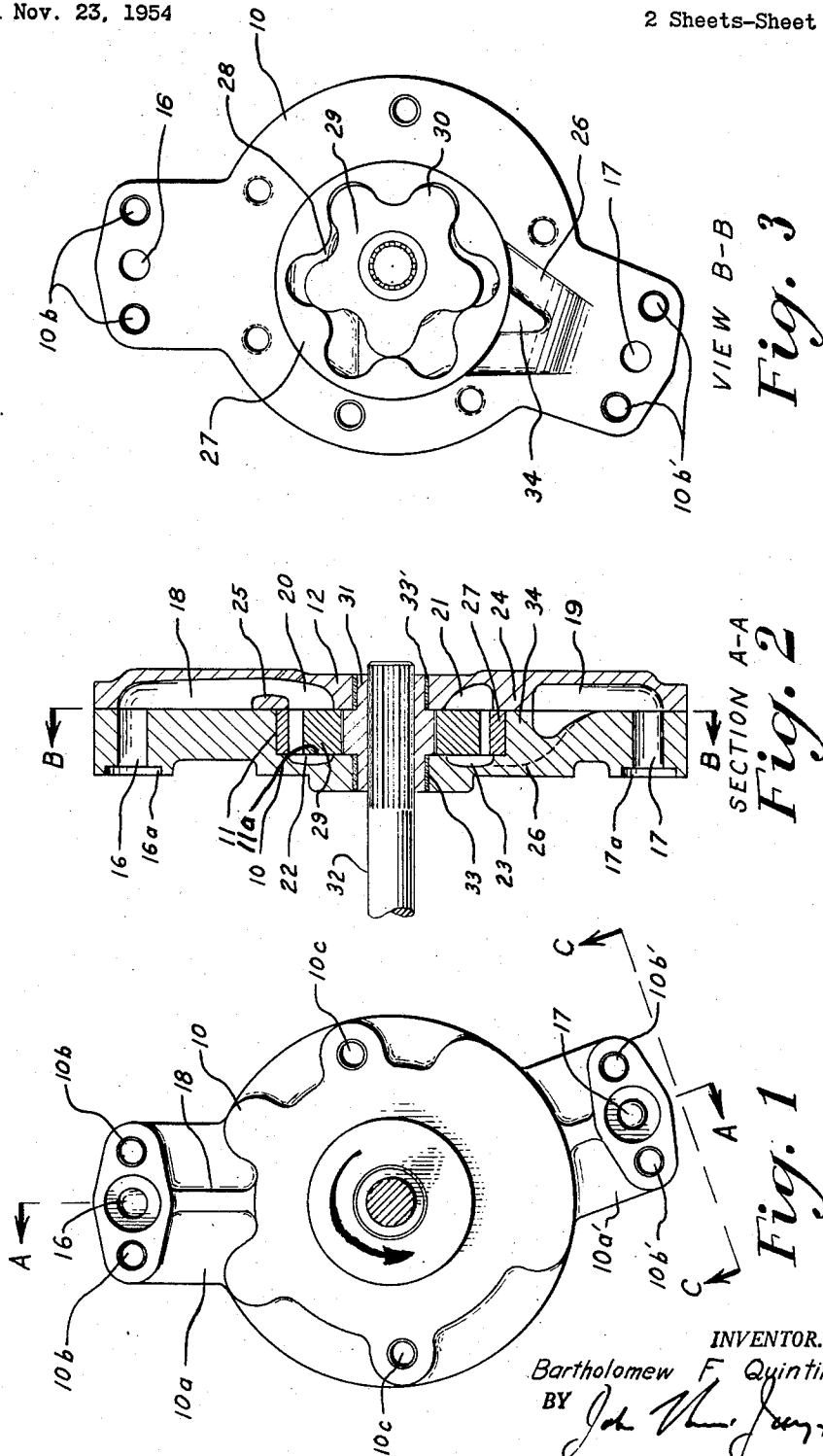
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B. F. QUINTILIAN
HYDRAULIC PUMP OR MOTOR

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2 Sheets-Sheet 1



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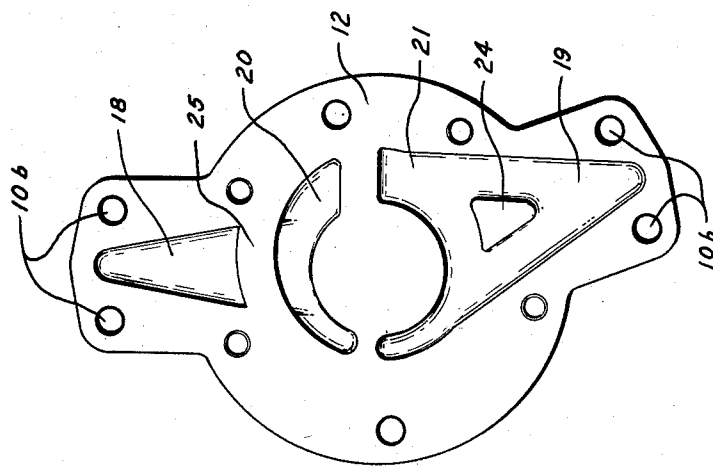
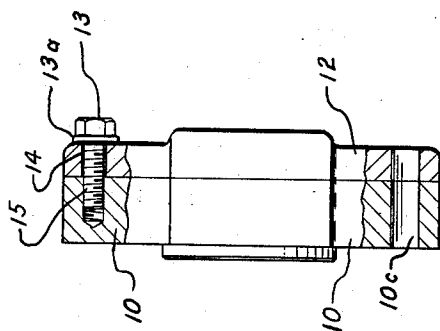


Fig. 4



VIEW C-C

Fig. 5

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2,872,872

HYDRAULIC PUMP OR MOTOR

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3 Claims. (Cl. 103—126)

My invention relates to rotary hydraulic pumps and motors and more particularly to a hydraulic pump in which rotatable elements provide a plurality of fluid compartments of continuously varying dimensions.

An object of my invention is to provide a rotary pump which is simple, small, compact, rugged and inexpensive; which has long life and low wear even under conditions of continuous pumping of fluid which may contain abrasive particles; which has both high volumetric and high mechanical efficiency, smooth and uniform flow, requiring minimum maintenance, supervision and repair; which has only a minimum number of moving parts all of which are readily interchangeable, has low relative rotational speed between the component parts; and which requires no speed reducers.

Other objects in part will be obvious and in part pointed out hereinafter in connection with the following description taken in the light of the claims at the end of this specification.

Accordingly, my invention consists of the various combination of parts, arrangement of elements, and features of construction, and in the relation of each of the same to one or more of the others as described herein, or shown in the accompanying drawings, and set forth in the following claims.

In the drawings, wherein is shown solely by way of illustration and not in any sense by way of limitation, a preferred embodiment of my invention:

Fig. 1 is a plan view of the pump or motor of my invention,

Fig. 2 is a sectional view taken substantially along line A—A of Fig. 1,

Fig. 3 is a view taken substantially along line B—B of Fig. 2, partly in section, to show the inner face of one part of my pump or motor,

Fig. 4 is a plan view of the inner surface of the enclosing head of my pump or motor, and

Fig. 5 is a side view of my device, partly in section, to illustrate the location of the mounting holes and bolts for joining the major parts.

Like reference characters denote like parts throughout the several views.

As conducive to a more ready understanding of the exact nature of my invention, it will be noted that in the past the use of intermeshing gear teeth to pump a fluid has been developed to a present construction whereby a plurality of separate compressor or pumping compartments are defined between complementary tooth portions of an inner and an outer intermeshing pump rotor. The pumping action is based fundamentally on the relative rotation occurring between the inner and outer rotors as a result of having teeth of the inner rotor one less in number than corresponding teeth and recesses of the outer rotor.

The outer rotor generally comprises a circular ring or cylinder that is annularly toothed so as to form a plurality of inwardly projecting rounded teeth with inter-

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vening valley or concave portions. With this outer rotor construction and with teeth of the inner rotor engaged about its periphery, then upon rotation of one of the rotors to drive the other, a constant but slow gain in revolutions occurs between the two rotors. The teeth of the inner rotor remain at all times in contact with the outer rotor and thus define a plurality of compartments of continuously varying dimensions.

With proper design, the compartments between inner and outer rotor teeth are so that when a fluid such as air or liquid is introduced through a suitable port into the compartments at a point where these latter have approximately their greatest dimensions, then in subsequent phases of any particular revolution of the driving rotor the several compartments decrease in dimensions to a minimum, thereby compressing the fluid contained therein. A suitable port is provided adjacent the region of minimum dimensions through which the compressed fluid is discharged.

Pumps of this type have received widespread acceptance in the art. They are compact, simple, and due to the small number of moving parts, display long wear and require little maintenance, repair and supervision. Properly designed, hydrostatic balance is experienced so that to a certain extent at least a sort of floating action is occasioned between the moving parts of the construction.

Despite the manifest advantages of the construction just described, however, it will be noted that as the rotors are necessarily enclosed in a suitable housing, there is contact between the external running surface of the outer rotor and the housing, as well as the cooperating parts of the inner and outer rotors, that is frictional and sliding in nature. When the pump is operated under conditions such that the hydraulic fluid being pumped may become contaminated with abrasive foreign particles such as sand, dust, filings, or other granular material, these particles become entrapped and cause undue damage to the finely machined running surfaces of the pump. Therefore, readjustment and replacement of parts is required more frequently than is desired. Definite limitations are thus placed upon the range of utility of this type of pump. Expensive broaching and other machining operations are required in producing the outer rotors so that any replacement or repair is expensive and most undesirable.

An important object of my invention therefore is to provide a construction which in substantial measure eliminates the aforementioned disadvantages of prior pumps and motors and which at the same time is characterized by the substantial exclusion of abrasive particles, which may be carried by the hydraulic fluid, from the corresponding running surfaces of the rotors and housing, and which is characterized by its extremely long life and low wear under substantially all conditions of usage and when handling substantially all types of fluids.

Referring now more particularly to the practice of my invention, attention is directed to the accompanying drawings wherein Figure 1 shows a rotary pump having a body portion 10, illustrative cylindrical in form, having extensions 10a and 10a' and having an inner cylindrical recess or bore indicated generally at 11 (see Fig. 2) terminating at its inner end in a machined wall 11a which for example is a plane surface perpendicular to the axis of the bore. The extensions 10a and 10a' are disposed on opposite sides of the circular portion of the body 10 and are preferably not diametrically opposed. In the embodiment of Fig. 1, I locate these extensions in an angular relationship between their axis of approximately 170° on the side of the body where the fluid manifolds 20, 21 have their largest width.

A cover plate or head 12 (see Figs. 2 and 5) in the

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form of a circular disc seals the open end of the bore 11 in any suitable manner as by bolts 13 which extend through washers 13a and holes 14 in the head 12 and seat in corresponding threaded apertures 15 in the adjacent end of the body portion 10. The body 10 and head 12 together comprise the casing of my new construction.

For ease and adaptability in mounting my pump, I provide mounting holes 10b and 10b' in the body extensions 10a and 10a' and mounting holes 10c in the body member 10 which extend through the body 10 and head 12 parallel to the pump axis.

I provide ports 16, 17 generally circular in cross-section and preferably countersunk at their outer ends as at 16a and 17a which extend completely through extensions 10a and 10a'. These ports are so located that they communicate at their inner ends with fluid passages 18 and 19 in the head 12. These passages expand radially inwardly as seen in Fig. 4. Passage 18 (see also Fig. 2) terminates in manifold 20 and passage 19 terminates in manifold 21 which are disposed in sidewise relationship to the recess 11. These manifolds are so constructed that from one end they gradually increase in width and extend in a circular arc of approximately 180°, as indicated in Fig. 4. I also provide shallow circular recesses 22 and 23 in the recess wall 11a which correspond to the shape of the manifold area exclusive of the tapered portions 18, 19. I also provide a raised portion 24 within passage 19 and a portion 25 within passage 18 integral with the head 12 which is necessary to define the fluid passages of my construction. I also cut away a section of the body portion 10 as at 26 to expose a portion of the outer rotor periphery to more fully develop the nature of my invention. The utility of these passages and manifolds will be developed hereinafter.

I provide an outer rotor 27 (Figs. 2 and 3) which snugly fits within the casing defined by body 10 and head 12 and which contains a plurality of radially disposed teeth 28 formed on its inner surface. The outer periphery of this rotor rotates on the machined surface of recess 11 and its sides are received in sliding relationship on the cooperating machined surfaces of the head 12 and the recess wall 11a. Any number of teeth may be chosen for the outer rotor and for the purposes of illustration, I have shown in my embodiment of Fig. 3 six teeth.

An inner rotor 29 movable relative to the outer rotor is disposed within the confines of the outer rotor as shown in Fig. 3. It is toothed in such a manner that it has the general appearance of a fluted star wheel but with one tooth less than the outer rotor, five teeth being used in the illustrative example. The diameter and tooth size of the inner rotor are so arranged with respect to those of the outer rotor that the teeth project within the bases of the teeth of the outer rotor on one side of the rotor and contact the tips on the other side for reasons which are dealt with hereinafter.

The inner rotor 29 is connected to drive shaft 32 by way of a coupling 31 to which it is keyed, as shown in Fig. 2. The coupling, itself, is made fast to the shaft by a suitable spline. As the outer rotor is not connected to the shaft 32, the shaft imparts no direct rotational impetus thereto, the outer rotor 28 being driven by the inner rotor 29.

The coupling is carried in suitable bearings 33, 33' provided in body 10 and head 12 which bearings are mounted in holes bored eccentric to bore 11. These bearings may be of any suitable type. In the present instance, I employ bushings.

While I have disclosed the rotors as being powered through shaft 32 and coupling 31 to which inner rotor 29 is made fast, it is, of course, equally feasible to power the outer rotor through any suitable means as by a spider, and to permit the outer rotor to drive the inner rotor 29.

The inner rotor 29 comprises a plurality of radially disposed teeth 30 between which are formed recesses

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or valleys of cycloidal or other suitable configuration. The teeth are of uniform contour and spacing. In number, teeth 30 illustratively amount to one less than the number of teeth 28 in the outer rotor as noted above.

5 Keeping in mind that, as shown, the rotor 29 is eccentrically disposed with respect to the outer rotor, it will be seen that at any given time one tooth of the inner rotor is substantially fully meshed and engaged momentarily with two adjacent teeth of the outer rotor while the remaining inner rotor teeth are in various stages of mesh or contact with the remaining outer rotor teeth as shown in Fig. 3 for example. A number of separate compartments or chambers are formed between the teeth of the two rotors.

15 Upon rotation imparted to one or the other of the inner or outer rotors, the rotors will be moved at high speed relative to the casing comprised by parts 10 and 12 and will undergo a slow change of phase relative to each other inasmuch as the outer rotor will rotate at slightly lower speed than does the inner rotor. And the chambers between teeth change in volume, increasing and then decreasing. It is this change in volume which affects the pumping action as dealt with more fully below. In the embodiment shown, wherein the outer rotor has six teeth while the inner rotor has five teeth, it will be seen that the outer rotor rotates at a speed which is $\frac{5}{6}$ that of the inner rotor. Any number of teeth may be chosen as long as the number of teeth on the inner rotor is one less than the number of teeth on the outer rotor, or more than one less, say two or three less.

It is to be noted that the number and size of teeth 28 and 30 determines in large measure the ultimate capacity of the pump. It is equally notable that proper choice of teeth contour has appreciable bearing on pump efficiency. Since such design does not per se comprise part of this invention, no effort will be devoted herein to a development of such constructional details. By the use of proper epicycloidal and hypocycloidal contours, or other suitable shapes, it is insured that tight contact is always maintained between the opposing teeth of the inner and outer rotor.

As specifically illustrative of the operation of my pump, the shaft is rotated so that the inner rotor 29 rotates in the direction shown by the arrow in Fig. 1. Fluid enters through port 17 serving as the intake port provided with suitable connections to the fluid source. This fluid may be either gas, vapor, or liquid or any mixture thereof. With the two rotors revolving at different speeds, there is a continuous opening and closing of compartments or chambers defined between the two rotors. The constant contact of the teeth of the inner rotor with the teeth of the outer rotor create a series of small spaces filled with fluid. During any small increment of time, some of these spaces are increasing in size. This creates a suction and draws fluid from the intake manifold into these spaces. Others of these spaces are decreasing in size causing pressure. These spaces discharge as they pass the exhaust passages.

Under the suction created in the intake passages, the fluid makes a 90° turn into passage 19 in the head 12 and moves upwardly toward the rotors in this tapered passage. The fluid then enters into the arcuate manifold 21 (see Fig. 4) and the corresponding arcuate recess 23 in the body 10 where it flows into the compartments defined by the teeth of the inner and outer rotor. As noted above, these compartments are gradually increasing in dimension along the length of the manifold 21, and therefore constitute the suction compartments of the pump.

The periphery of the outer rotor is running on the machined recesses in the bore and has additional lateral support from the raised portion 24 in the head 12. I have found at this point in the pumping operation that if the pumped fluid is contaminated with any abrasive material such as sand, grit, metal filings, etc., such par-

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ticles will become trapped within these highly machined surfaces and severe scoring and pitting will result. I have discovered that by cutting away a portion of the body 10 as at 26 to provide surface interruptions on the outer rotor periphery, the abrasive particles will drop away and not enter the running surfaces. Fig. 3 shows clearly where I have cut away the body 10 to provide grooves 26 communicating with recess 23 (see also Fig. 2). A supporting portion 34 is left for alignment purposes and also to provide the two passages, one on each side of solid portion 34, to accommodate foreign material.

I find that with the intake passages noted, my pump is provided with self-cleaning properties, and the major portion of the running surfaces are maintained free from scoring or other damage, therefore increasing the pump life and minimizing replacement costs. I have noted that as no surface interruption is provided on the running surfaces of the inner rotor and corresponding surfaces of the body 10 and head 12 that abrasive particles become trapped therein and some scoring results.

It is to be noted that as the rotor continues in its counter-clockwise rotation and as each successive compartment reaches its approximate maximum volume, the end portion of the exhaust manifold 20 of greatest width is now alongside the compartment. Compression of the fluid therefore begins at this point. The compartments now begin to decrease in volume and the fluid begins to discharge through the manifold 20 making a 90° turn around the portion 25 of the head 12 into the passage 18. The fluid makes another 90° turn into the outlet hole 16 of the body 10 to which a suitable discharge connection has been made. As the rotors continue to rotate, the compartments decrease in volume with further counter-clockwise rotation until a position of minimum volume is reached at the lower end of the exhaust manifold 20.

It is the eccentric relation of the inner rotor 29 with respect to the outer rotor and the design of rotor 29 with at least one less tooth than that of rotor 27 which gave rise to the formation of compartments of continuously varying dimensions. While the rotors rotate at high velocity relative to the casing, nevertheless, their phase change relative to each other is comparatively low. Ample time is provided by the long manifolds 20, 21 for charging fluid into the compartments and for discharging the fluid therefrom. Moreover, the long sweep of the manifolds effectively distribute the intake and discharge impulses in such a manner that smooth, uniform, non-pulsating pumping action is achieved. Thus it will be seen that I have provided in my invention a pump and motor in which the various objects herein before set forth are successfully achieved.

My pump, or motor, is comparatively simple and inexpensive to produce. The various component elements are themselves of low first cost and require a minimum of expensive manufacturing operations. Rate of wear is materially decreased and useful operation is increased. My pump is admirably adapted to handle dirty water, dirty oil and the like; the abrasive particles carried by the fluid are prevented from becoming trapped between the highly machined surfaces causing scoring. Inasmuch as the relative rotational speed of the inner and outer rotors is comparatively low, it is entirely practical to operate the pump at high speed, ranging up to 5000 revolutions per minute for example. The necessity of expensive auxiliaries in the form of speed reducers is effectively avoided.

While I have described my new device as a pump and while therein lies its principal sphere of utility, it is of course possible to achieve motor action by reversing the coursing of fluid through the parts of the casing and by permitting the fluid under pressure, to enter into the compartments of minimum volume, and thereafter to expand

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the compartment causing a moving and change of rotor position. In such instance, power take-off can be achieved through either the inner or outer rotor.

As many possible embodiments may be made of my invention and many changes may be made in the embodiments hereinbefore set forth, it is to be understood that all matter described herein, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. A hydraulic pump or motor comprising a cylindrical casing having a central bore; an outer rotor having a plurality of inwardly extending radial teeth disposed within said bore with its peripheral outer surface in sliding contact with the face of said bore; an inner rotor having at least one less peripheral tooth than the outer rotor, said rotors being eccentrically mounted with respect to each other and with the teeth of one in constant sealing contact with the teeth of the other to provide, together with the end walls of said bore, a series of sealed compartments of continuously varying dimensions constituting pumping chambers; and intake and exhaust passages within said casing communicating with said series of sealed compartments on diametrically opposite sides of said cylindrical casing and in wide arcuate segment, said intake passage being formed in part by interrupting the arcuate segment of the same to break communication between said passage and said outer rotor through a portion of the wide arcuate segment of the same and provides space for foreign particles appearing in the fluid being pumped.

2. A hydraulic pump comprising a casing having a bored body portion with cylindrical inner surface; an inlet port and an outlet port on opposite sides of said body; a head portion adapted to be secured to the open side of said body portion and containing two diametrically oppositely disposed radial passages, said passages respectively communicating at their outer ends with said inlet and outlet ports and extending inwardly to form at their inner ends diametrically oppositely disposed inlet and outlet arcuate chambers communicating with said bore adjacent said cylindrical inner surface; and nested inner and outer tooth rotors disposed snugly in said cylindrical bore eccentrically of each other, with the teeth of one rotor being in constant sealing contact with the teeth of the other to provide, together with said bore and said head portion, a series of sealed compartments of continuously varying dimensions constituting pumping chambers in communication with said arcuate chambers; said body portion having a U-shaped groove communicating at the bottom of the U with said inlet radial passage, the two ends of the U terminating at the outer rotor periphery and providing space for foreign particles appearing in the fluid being pumped.

3. A hydraulic pump comprising a cylindrical casing containing a central bore; an outer rotor containing a plurality of inwardly extending radial teeth disposed within said bore with its peripheral outer surface in sliding contact with the face of said bore; an inner rotor having one less peripheral tooth than the outer rotor, said rotors being eccentrically mounted with respect to each other with the teeth of one rotor in constant sealing contact with the teeth of the other to provide, together with the ends of said bore, a series of sealed compartments of continuously varying dimensions constituting pumping chambers; intake and exhaust passages within said casing and on diametrically opposite sides thereof, respectively communicating with said pumping chambers through substantial arcs, said intake passages having an interrupted opening along the inner surface of said casing bore and exposing at least two adjacent portions of the outer rotor and providing space for foreign particles appearing in the fluid being pumped; and shaft driving means connected to said inner rotor and journaled with-

in said casing eccentrically of said outer rotor and casing bore.

References Cited in the file of this patent

UNITED STATES PATENTS

947,670	Nielsen	Jan. 25, 1910
1,348,773	Auger	Aug. 3, 1920
1,624,099	Haight	Apr. 12, 1927
1,732,871	Wilsey	Oct. 22, 1929

5

1,768,818
2,053,919
2,433,360
2,547,392
2,696,170
2,701,532
2,732,802
2,739,538

Bock	July 1, 1930
Pigott	Sept. 8, 1936
Haight	Dec. 30, 1947
Hill et al.	Apr. 3, 1951
Hill	Dec. 7, 1954
Bakewell	Feb. 8, 1955
Eames	Jan. 31, 1956
Witchger	Mar. 27, 1956