March 11, 1952 E. E. BIDWELL 2,588,342

FLUID ENGINE

Filed Jan. 2, 1943 4 Sheets-Sheet 1

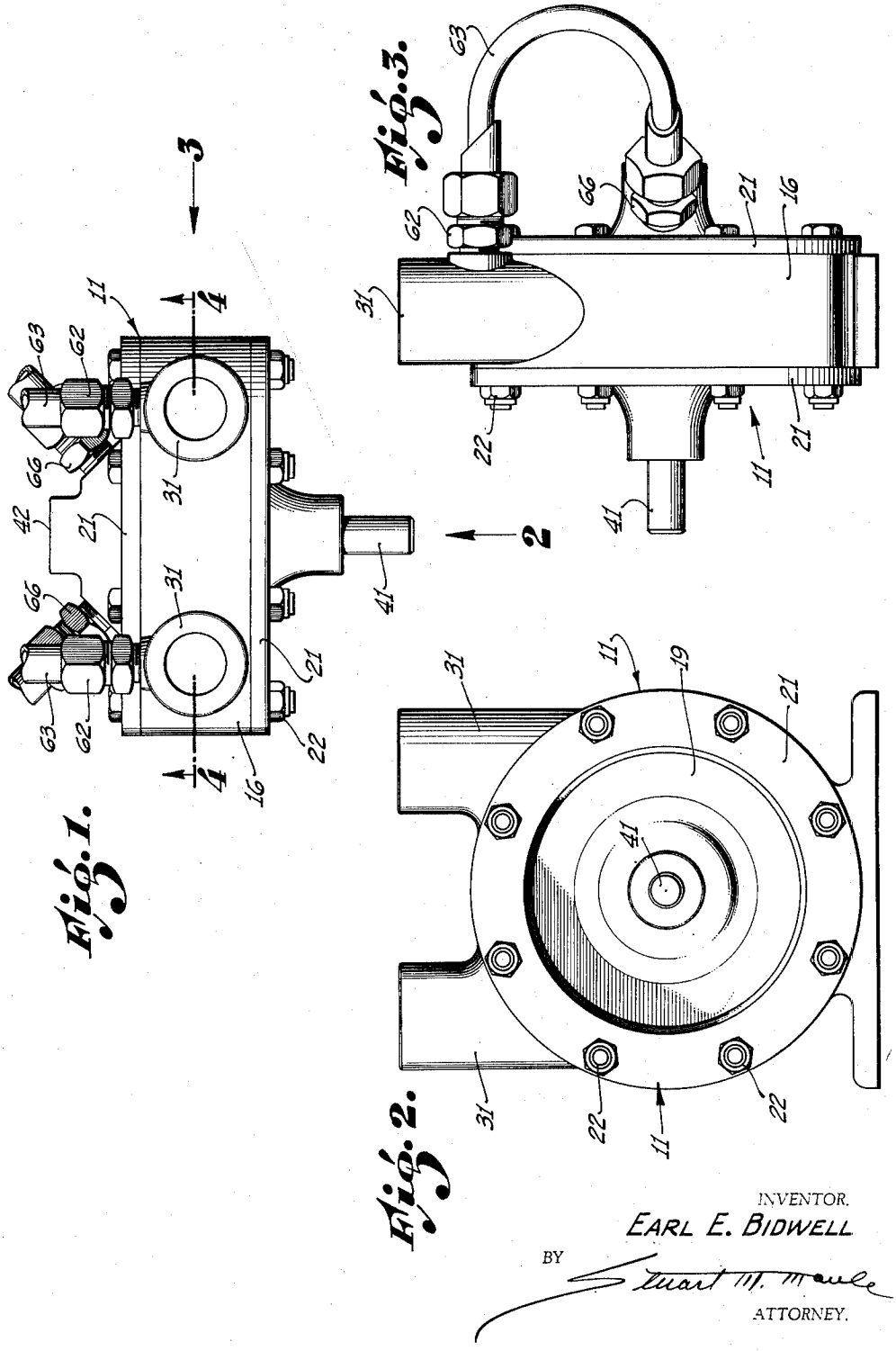


Fig. 1.

Fig. 3.

Fig. 2.

INVENTOR.
EARL E. BIDWELL
BY Stuart M. Maule
ATTORNEY.

March 11, 1952 E. E. BIDWELL 2,588,342

FLUID ENGINE

Filed Jan. 2, 1943 4 Sheets-Sheet 2

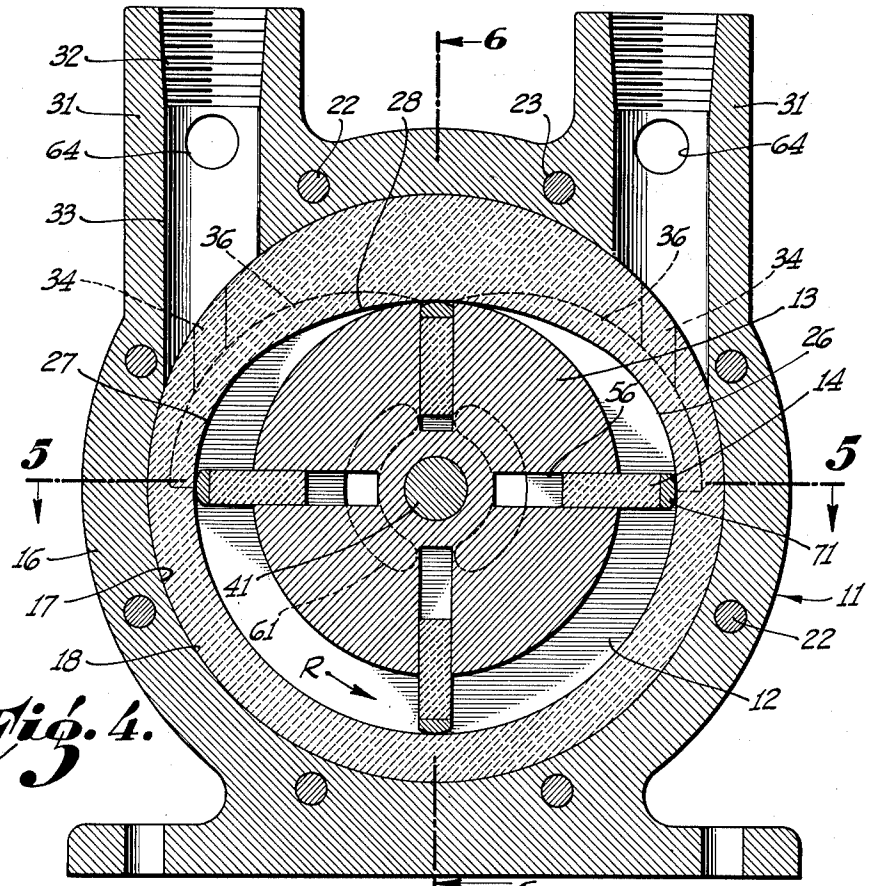


Fig. 4.

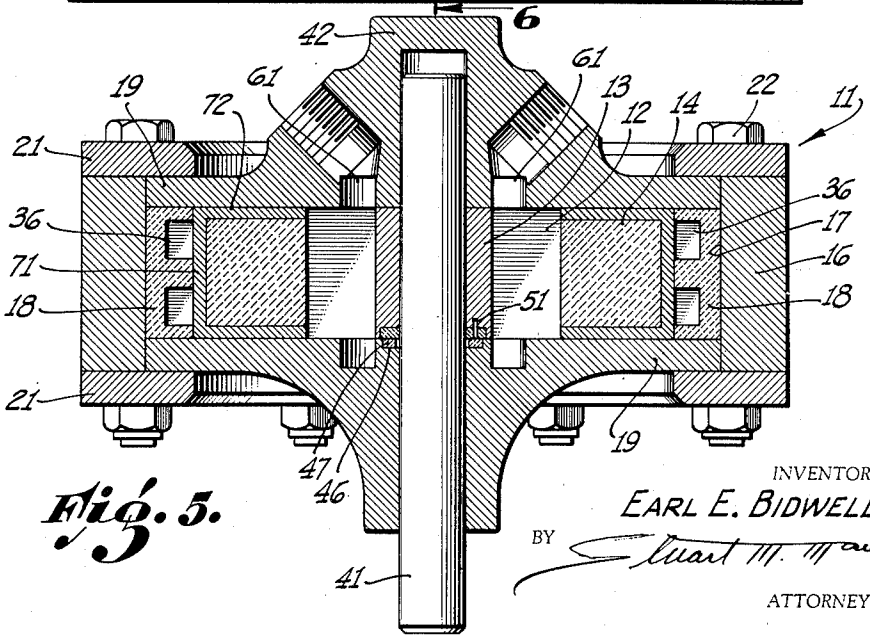


Fig. 5.

INVENTOR.
EARL E. BIDWELL
BY Stuart M. Maule
ATTORNEY.

March 11, 1952 E. E. BIDWELL 2,588,342

FLUID ENGINE

Filed Jan. 2, 1943 4 Sheets-Sheet 3

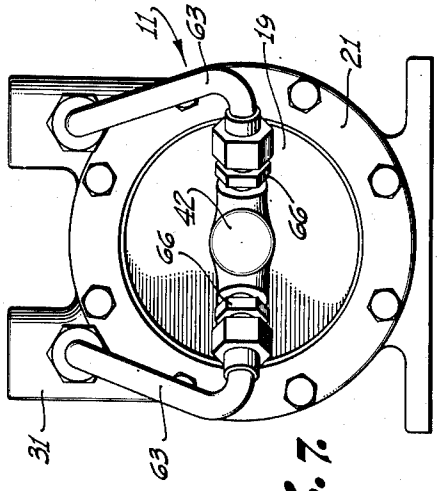


Fig. 7.

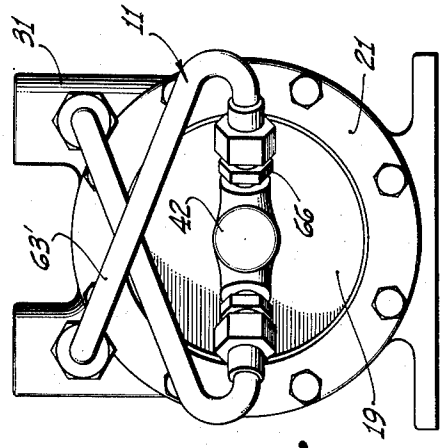


Fig. 8.

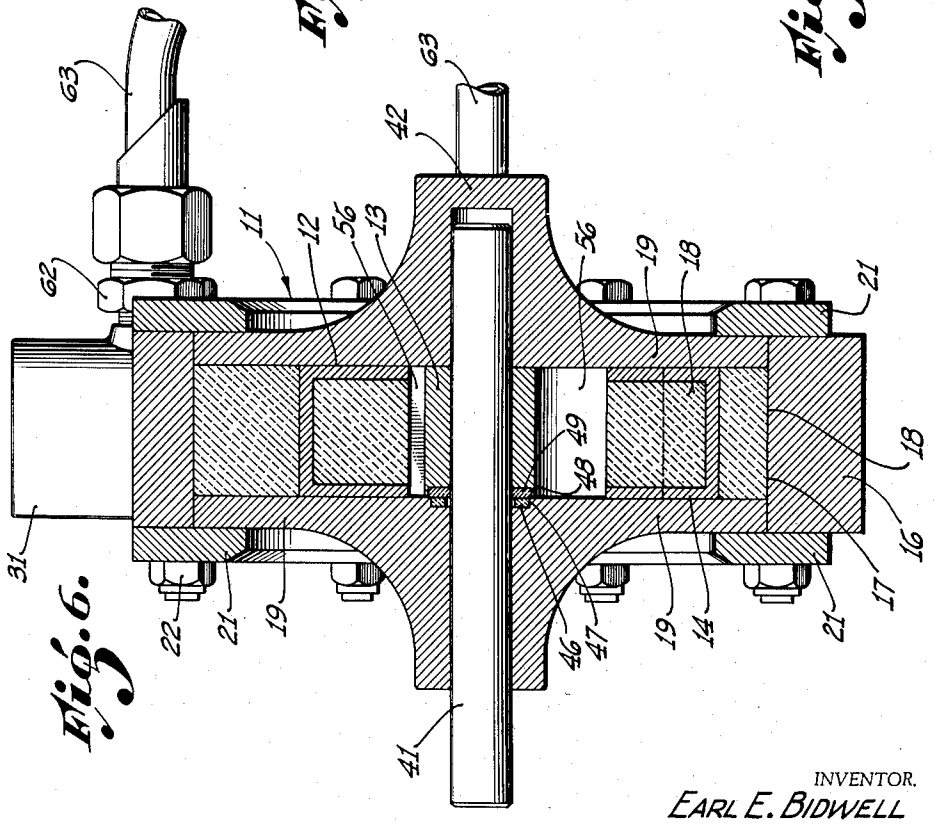


Fig. 6.

INVENTOR.
EARL E. BIDWELL

BY Stuart W. Mauk

ATTORNEY.

March 11, 1952 E. E. BIDWELL 2,588,342

FLUID ENGINE

Filed Jan. 2, 1943 4 Sheets-Sheet 4

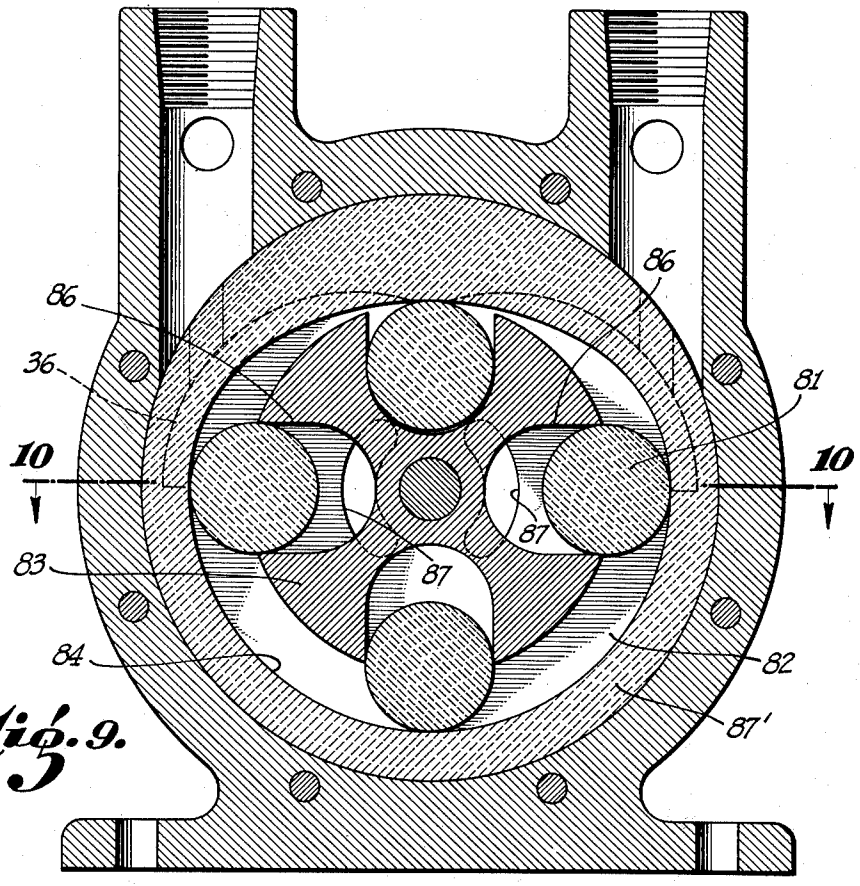


Fig. 9.

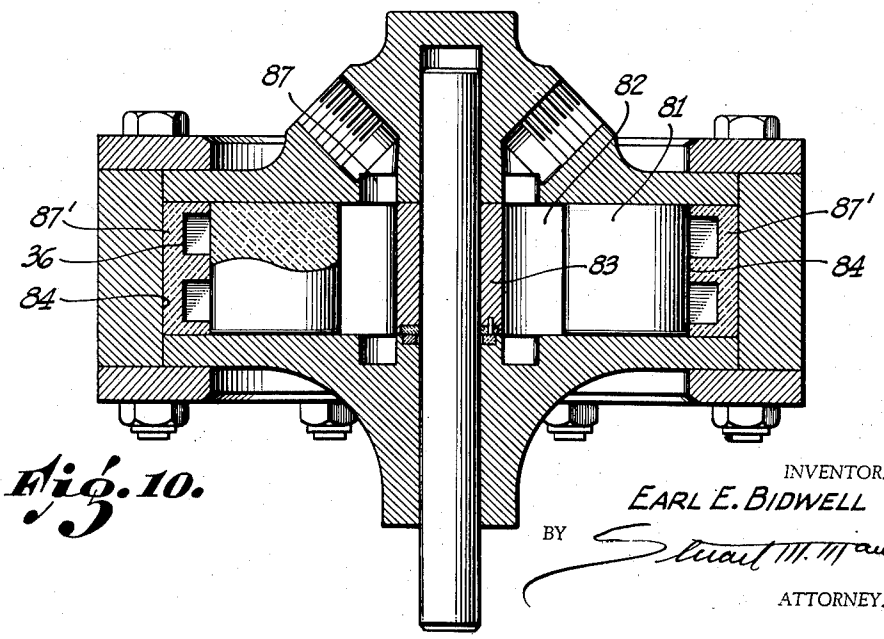


Fig. 10.

INVENTOR.
EARL E. BIDWELL
BY
ATTORNEY.

Patented Mar. 11, 1952

2,588,342

UNITED STATES PATENT OFFICE

2,588,342

FLUID ENGINE

Earl E. Bidwell, Los Angeles, Calif., assignor to Walter P. Innes, Jr., Wichita, Kans.

Application January 2, 1943, Serial No. 471,099

3 Claims. (Cl. 103—3)

1

This invention relates to fluid engines, i. e. to engines which either are operated by or operate upon fluids.

An object of my invention is to provide an engine of simple, compact and inexpensive design which is so arranged that not only is it fully reversible in the sense that it can operate with full efficiency with its rotor turning optionally in either direction, but also it is capable, with only a very minor adjustment, of being operated optionally as a motor driven by a motivating fluid or as a pump to impel a fluid. A further object of the present invention is to provide a fluid engine of the general character indicated, the rotor of which is provided with vanes maintained in efficient wiping contact with the casing by the simple and yet fully effective and dependable expedient of magnetism, thereby eliminating the necessity of employing springs for performing this function.

A further object is to provide a novel and exceedingly simple fluid seal, i. e. a seal for preventing escape of fluid under pressure through the interstice between relatively moving machine parts.

The invention possesses other objects and valuable features, some of which, with those enumerated, will be set forth in the following description of the preferred embodiments of my invention illustrated with the drawings accompanying and forming a part of the specification. It is to be understood that I do not limit myself to the showing made by the said drawings and description, as I may adopt variations of the preferred embodiments within the scope of my invention as defined by the claims.

Referring to the drawings:

Figure 1 is a top plan view of a fluid motor incorporating the principles of the present invention. Portions of the figure are broken away to reduce its size.

Figure 2 is a side elevation with the direction of view as indicated by the arrow 2 of Figure 1.

Figure 3 is a view in end elevation, the direction of view being indicated by arrow 3 of Figure 1.

Figure 4 is an enlarged longitudinal, vertical, sectional view taken upon the line 4—4 of Figure 1, with the directions of view as indicated.

Figure 5 is a horizontal sectional view taken upon the line 5—5 of Figure 4, with the direction of view as indicated.

Figure 6 is a transverse, vertical, sectional view taken upon the line 6—6 of Figure 4 with the direction of view as indicated.

2

Figure 7 is a rear elevation drawn to reduced scale showing the engine arranged to operate as a motor.

Figure 8 is a view similar to Figure 7, but showing the engine arranged to operate as a pump.

Figure 9 is a view similar to Figure 4, but showing a modified form of engine using a slightly different design of impeller vanes.

Figure 10 is a horizontal sectional view taken on the line 10—10 of Figure 9, with a direction of view as indicated.

Referring first to that modification of my invention which is illustrated in Figures 1 to 8 inclusive, my improved hydraulic engine comprises a housing 11 having a working chamber 12 therein, within which is revoluble a rotor 13 provided with a plurality of blades or vanes 14. The housing 11, instead of being of unitary construction, preferably is composed of a plurality of assembled parts so interfitted that they automatically operate to align themselves with the degree of extreme accuracy which is so desirable in mechanisms of this nature. The housing 11 comprises an outer retaining member 16, having a circular bore 17 within which is fitted a substantially annular member 18, the central aperture of which defines the working chamber 12. Also received within the bore 17 of the outer retaining member 16 are a pair of opposed side plates 19. The combined thickness of the side plates 19 and the annular member 18 is slightly greater than the width of the outer retaining member 16, the purpose being to cause clamping rings 21, one of which is provided upon each face of the engine, to exert their pressure principally against the side plates 19 and thereby assure their being pressed into such intimate contact with the side faces of the annular member 18 that a hermetic seal is established therebetween of sufficient efficiency to prevent the escape of fluid from within the housing 11, even though relatively great hydrostatic pressures be encountered. The clamping rings 21 overlap the juncture of the side plates 19 and the outer retaining member 16, and they are drawn toward each other into this clamping engagement with the side plates 19 as by a plurality of bolts 22 extending through bolt holes 23 so arranged the outer retaining member 16 that they register with the holes provided in the side plates 19.

Construction of the housing 11 in this manner has been found advantageous not only because it minimizes the time and expense entailed in producing the housings in relatively large quantities but also because it permits determin-

ing the dimensions of the working chamber 12 with the utmost accuracy. Since the annular member 18, which serves as the peripheral wall for the working chamber 12, is constructed with its lateral faces perfectly plain and parallel, these faces can be ground or otherwise finished in parallel planes with as close tolerances as may be desired, and also the member 18 can be constructed to the exact thickness desired to extremely fine tolerances. Hence, the rotor 13 can be fitted to the chamber 12 with just as nice a degree of accuracy as may be desired to meet any particular set of circumstances as determined by the type of fluid in conjunction with which the engine is to be used, and the pressures apt to be encountered.

Whereas the rotor 13 is of circular form, the periphery of the working chamber 12 is of such form that at one location therein, it is disposed very closely adjacent to the periphery of the rotor. Preferably actual wiping contact between these two members is established so that the rotor 13 can turn freely within the housing 11 and yet actually make contact with the peripheral wall of the chamber 12 and thereby prevent flow of fluid therebetween.

The preferable configuration for the peripheral wall 12 is with its lower half truly semi-circular and co-axial with respect to the rotor 13. The upper half of the peripheral wall, however, is preferably formed of three separate but merging arcs. The two arcs 26 and 27 at the sides of the upper half of the chamber 12 merge at their lower ends with the lower circumference but they are drawn about smaller radii than that of the lower circumference so that the upper ends of these arcs 26 and 27 are spaced a smaller distance from rotor 13 than are their lower ends. The upper ends of the arcs 26 and 27 are joined by the third arc 28, the ends of which merge with the upper ends of the lateral arcs 26 and 27; and the parts are so proportioned and arranged that the central portion of the upper arc 26 establishes sliding contact with the peripheral surface of the rotor 13. Hence, a working chamber 12 is presented which is symmetrical about a medial vertical plane and whereas the upper half of the peripheral surface of the chamber 12 slopes gradually inwards from its portion of greatest radius to its portion of least radius, which is at the top of the chamber 12, the several arcs which cooperate to develop this peripheral surface all merge one into the other so that a smooth movement of the vanes 14 from one arc to the next and thus throughout a complete revolution within the chamber 12 is assured.

Means are provided for connecting conduits to the housing 11 so as to conduct fluid to and from the working chamber 12. An extension 31 is provided on each side of the outer retaining member 16, each of these extensions 31 being hollow and provided with threads 32 for attaching a suitable conduit thereto. The bore 33 of each extension 31 communicates with a port 34 extending through the upper portion of the annular member 18 to communicate with the working chamber 12. Communicating with each of the ports 34 is preferably a plurality of grooves 36, extending from closely adjacent the point at which the rotor 13 makes contact with the peripheral wall of the chamber downwards to the lower end of the associated arc 26 or 27 as the case might be. Hence, the grooves 36 extend throughout that portion of the peripheral wall of the chamber 12 with which the vanes 14 make wiping contact while they are moving either radially inwards or radially outwards with respect to the rotor 13.

The rotor 13 is carried by a shaft 41 at least one end of which extends to the exterior of the housing 11 to receive a pulley, gear, or other means (not shown) for transmitting mechanical power. Preferably, the other end of the shaft 41 is journaled in a bearing the outer end of which is closed by an integral portion 42 of the side plate 19, thereby precluding all possibility of escape of fluid from the chamber 12 through this bearing. However, in certain cases it is expedient to provide a fluid packing for the shaft 41 in association with the journal in the other side plate 19 so that to prevent escape of fluid, and, whereas any suitable type of packing may be employed, I prefer to use one which operates by magnetic action because of the simplicity, dependability, permanence and economy of such a packing. Toward this end I employ a packing ring 46 seated within a recess 47 in the side plate 19. The inside diameter of the ring 46 is sufficiently greater than the shaft 41 to assure free rotation of the shaft therein; but the outside diameter of the ring 46 is so proportioned with relation to the inside diameter of the recess 47 that the ring establishes a tight press fit therein, thereby precluding possibility of fluid leakage around the outside of the ring 46. Similarly fitted within a recess 48 in the rotor 13 is another ring 49 encircling the shaft 41 and preferably fitted to the shaft to establish a sliding fit thereon, thus permitting whatever amount of play of the shaft 41 may be required for the satisfactory operation of the rest of the mechanism. It is desired that the ring 49 rotate with the shaft 41 and the rotor 13 and therefore one or more dowel pins 51 may be employed interconnecting the ring 48 and rotor 13. Since the ring 49 turns with respect to the ring 46, it is preferably provided with a brass coating or other suitable bearing surface to minimize wear. Both of the rings 46 and 49 are of suitable magnetic material and one or both of the rings are magnetized. Since it is desired that the magentization be transversely of the rings, it is desired that the rings be composed of material subject to magnetization in this manner. One type of material suitable and available for this purpose is an alloy of aluminum, nickel and cobalt. If only one of the rings is magnetized, the matter of polarity is unimportant; however, if both rings are magnetized, the two rings should be arranged with their unlike poles together so that the rings will be attracted to each other, thereby preventing escape of fluid between the two rings 46 and 49.

The vanes 14 are urged also radially outward of their respective slots 56 by mechanical force. With this object in view, each of the vanes 14 also is formed of magnetic material and is permanently magnetized, whereas the annular member 18 which defines the peripheral wall of the chamber 12 is of magnetic material, such as ordinary machine steel, so that it is capable of functioning as an armature for the several magnetic vanes 14, with the result that the vanes 14 are continually urged radially outwards to maintain efficient wiping contact with the peripheral wall as the rotor 13 turns. It is desirable therefore that both the rotor 13 and the side plates 19 be composed of material possessing a high degree of magnetic reluctance, such as brass or bronze, so

as to offer no interference with the efficiency of the magnetic action upon which operation of the vanes 14 and the rings 46 and 49 is dependent.

Formed preferably in each of the side plates 19 is a pair of symmetrically arranged arcuate passages 61, arranged concentrically about the axis of the rotor 13. These passages 61 are arranged so that as the rotor 13 turns the inner ends of slot 56 communicate alternately with 61. Moreover, the passageways 61 are so proportioned that they are spaced apart at both their upper ends and their lower ends by a distance slightly greater than the width of each of the slots 56 so that at no period in the rotation of the rotor 13 is any of the slots 56 enabled to establish communication between the two passageways 61.

Means are provided for establishing communication between each of the passageways 61 and either one or the other of the ports 34. Each of the housing extensions 31 is provided with a coupling member 62, whereby a length of tubing 63 may be attached thereto with the bore of the tubing 63 communicating with the port 34 through a suitable opening 64 in the side wall of the extension 31. One of the side plates 19 is similarly provided with a pair of coupling members 66, each of which serves to connect one of the tubes 63 to the end plate 19 with its bore communicating with one of its arcuate passageways 61. Figure 7 illustrates the two tubes 63 arranged to establish communication between a port 34 and the passageway 61 on the same side of the engine, this arrangement being employed when the engine is to operate as a motor wherein the rotor 13 is caused to rotate by forcing fluid under pressure to flow through the engine. However, when it is desired to operate the engine as a pump to generate pressure upon a hydraulic fluid by applying mechanical force to shaft 41 and thus cause the rotor 13 to turn, tubes such as those indicated at 63' are employed wherein each port 34 is connected with the passageway 61 on the opposite side of the engine. Whether the device is to be operated as a pump or a motor, it can operate in either direction with equal efficiency owing to the fact that the device is of symmetrical construction about its vertical, medial plane.

Operation

Say, for example, that fluid under pressure is supplied to the housing extension 31 at the left hand side of the engine as illustrated in Figure 4, then, since the arcuate passageway 61, which also is on the left hand side of that figure, is connected to the port 34 by one of the tubes 63, the same fluid pressure will prevail in that left hand passageway 61 and also within the inner end of any slot 56 which happens to be in registry with any portion of that slot. When the rotor is in the position illustrated in Figure 4, the fluid will exert its pressure in a downward direction against the upper face of the horizontally disposed vane 14 at the left hand side of the figure; and since no pressure is exerted tangentially in the opposite direction because of the fact that the uppermost vane 14 is not contacted by the fluid, the rotor 13 will be turned in the direction of the arrow R. As the vane 14 at the left hand side of the figure passes the lower ends of the grooves 36, the uppermost vane will reach such a position that the upper ends of the grooves extend beyond that vane, permitting full fluid pressure to be imposed upon the trailing side of the vane. From this point on until this uppermost vane has turned through 90°, fluid pressure will be exerted equally upon both sides of the vane, whereas full fluid pressure is exerted only upon the the upper side of the vane which is 90° in advance thereof. Accordingly, the rotor 13 will be caused to turn until it has completed 90° of rotation, whereupon the same operation is continued with the next succeeding vanes, this operation being continued as long as fluid under pressure is supplied to the port 34 on the left hand side of Figure 4, thereby imparting continuous rotation to the rotor 13.

The fact that the left hand arcuate passageway 61 communicates with the inner ends of the slots 56 throughout such time as they are in communication therewith, thereby permitting full fluid pressure to prevail within these slots, is of importance because the fluid under full pressure is thus enabled to cooperate with the magnetic force by pushing the vanes radially outwards of their respective slots and thereby aid in maintaining efficient closure between these vanes and the peripheral wall of the working chamber. However, after any of the vanes has turned through more than 180° from the high spot of the peripheral wall (i. e. from the point at which the peripheral wall and the rotor 13 contact each other), the inner end of its slot will establish communication with the annular passageway 61 at the right hand side of Figure 4, which, as stated, communicates with the corresponding port 34, which in this instance is the outlet port. Since the pressure at the outlet port is much less than that at the inlet port, similarly, the pressure within the inner ends of the slots 56 moving upwards from their lowermost position will be correspondingly low, thus permitting the vanes 14 to be pushed back into their respective slots 56 by the converging portion of the peripheral wall.

On the other hand, if the engine is to be operated as a pump, then tubes such as those indicated at 63' should be employed so as to connect each of the ports 34 with the arcuate passageway 61 on the opposite side of the engine. Again assume that the rotor is to be turned in the direction of the arrow R, Figure 4, it being understood that a suitable source of mechanical power (not shown) is provided to effect such rotation. Here again the port 34 at the left hand side of the figure is the inlet port, while the port at the other side of the figure functions as the outlet port. As the vane 14 at the top of the rotor 13 moves to the left (as viewed in Figure 4) from the high point of the peripheral wall, the inner end of the associate slot 56 will come into communication with the arcuate passageway 61 which communicates with the outlet port 34, thereby permitting the same high pressure to prevail within that slot 56 and below the associated vane 14 as that which prevails at the outlet port 34. Hence, as the rotor 13 turns, carrying this uppermost vane 14 away from the high point of the peripheral wall and thus permitting the vane to move radially outwards within its associated slot 56, the fluid under relatively high pressure which is entrapped beneath the vane will cooperate with the magnetic force by pushing the vane radially outwards and thus maintain closure between the moving vane and the stationary peripheral wall. Furthermore, this high pressure within the inner end of the slot will prevail even after the vane has reached the portion of full radius of the housing and thus aid in maintaining the vane in its outermost position, although outward motion of the

vane has ceased, until the vane reaches its extreme lowermost position.

As a vane at the lower portion of the housing starts moving upwards, its slot 56 moves into communication with the arcuate slot 61 at the right hand side of Figure 4 and since this slot is in communication with the inlet port 34 where a partial vacuum prevails, a partial vacuum will immediately be developed in the inner end of this upwardly moving slot. Accordingly, when the vane reaches that position in which it starts to be pushed inwards by the converging portion of the peripheral wall, this partial vacuum which prevails at the inner end of the vane will aid in causing that vane to move inwards, thereby decreasing the amount of friction between the vane and the converging portion of the wall.

As a further aid toward decreasing the amount of frictional wear which develops between these two portions of the device, I prefer that each of the vanes be constructed with a bushing or facing 71 of brass or other wear resistant material on its outer end. If desired, a leg 72 integral with the facing 71 may be provided to extend along each lateral edge of the vane so as to assist in retaining the facing 71 in position.

Figures 9 and 10 illustrate a slightly modified form of the engine of my present invention, wherein the vanes 81, instead of being of rectangular cross section are of circular cross section so that each vane is in the form of a rod corresponding in length to the lateral width of the working chamber 82. Each of these vanes 81 should be slightly greater in diameter than the maximum clearance between the rotor 83 and the peripheral wall 84, so as to preclude the possibility of the vane dropping out of its associated slot 86 at any point during the turning of the rotor. Consequently, the slots 86 must be correspondingly increased in width and the distance between both the upper ends and the lower ends of the two arcuate passageways 87 shou'd be increased so far as to prevent communication from being established between the two passageways 87 through any one of the slots 86. As in the previously described modification, these cylindrical vanes 81 are permanently magnetized and the annular member 87' the inner face of which is the peripheral wall 84 of the working chamber is of suitable magnetic material so that in this modification also the vanes 81 are urged to their proper operating positions by magnetic action.

An important feature of my invention which is common to both of the modifications described herein and to which particular attention should be directed, is that fluid pressure is equalized on both sides of the vanes when they are experiencing any movement with respect to the rotor 13 or 83, as the case might be. This is accomplished by means of the grooves 36 extending from both ports throughout the entire associated portion of the casing's peripheral wall of varying radius. The principal advantage of this construction arises from the fact that it avoids permitting any vane to perform any work while it is moving within its associated rotor slot. This completely eliminates one of the main difficulties commonly encountered in hydraulic engines of more conventional construction, since it removes all danger of cutting the faces of the vanes or the rotor faces defining their slots as the result of too great pressures of one on the other while any relative movement therebetween occurs.

I claim:

1. In a hydraulic engine, a housing comprising spaced, parallel walls and a peripheral wall defining a chamber, a rotor revolubly mounted within said chamber and having a plurality of slots extending inwards from the periphery thereof, the portion of said peripheral wall associated with half of said chamber being semi-circular and co-axial with respect to said rotor, and the remainder of said peripheral wall being formed of three arcs, the outer two of said three arcs being of less radius than and merging at one end of each with one end of said semi-circular portion of said peripheral wall, and the center one of said three arcs being of less radius than either of said outer arcs, and merging at each of its ends with one of said outer arcs said rotor substantially making sliding contact with said peripheral wall of said chamber at one location thereon located within said central arc and being spaced therefrom elsewhere, a vane reciprocable within each of said slots, and means urging said vanes outwards of said slots to maintain wiping contact with said peripheral wall as said rotor turns, said housing having inlet and outlet ports communicating with said chamber and arranged symmetrically on opposite sides of the area of contact between said rotor and said peripheral wall of said chamber, and said housing also having a pair of passages arranged symmetrically about said area of contact and in position to communicate successively with said slots adjacent their inner ends, each of said passages communicating with one of said ports.

2. In a hydraulic engine, a housing comprising spaced, parallel sidewalls and a peripheral wall defining a chamber, a rotor revolubly mounted within said chamber and having a plurality of slots extending inwards from the periphery thereof, said rotor substantially making sliding contact with said peripheral wall of said chamber at one location thereon and being spaced therefrom elsewhere, a vane reciprocable within each of said slots, means urging said vanes outwards of said slots to maintain wiping contact with said peripheral wall as said rotor turns, said peripheral wall of said housing having inlet and outlet ports therein communicating with said chamber and arranged symmetrically on opposite sides of the area of contact between said rotor and said peripheral wall of said chamber, and said housing also having a pair of passages arranged symmetrically about said area of contact and in position to communicate successively with said slots adjacent their inner ends, and means for connecting each of said passages with a selected one of said ports.

3. In a hydraulic engine, a housing comprising spaced, parallel side walls and a peripheral wall defining a chamber, a rotor revolubly mounted within said chamber and having a plurality of slots extending inwards from the periphery thereof, said chamber being of substantially the same radius as said rotor at one location of the circumference thereof whereby said peripheral wall makes sliding contact with said rotor at that location and the radius of said chamber becoming gradually greater on both sides of the area of contact between said rotor and said peripheral wall of said chamber to present portions of said peripheral wall sloping gradually outwards from said rotor, and a vane reciprocable within each of said slots, and means urging said vanes outwards of said slots to maintain wiping contact with said peripheral wall as said rotor turns, each of said sloping portions of said peripheral wall of said housing having a port therein communicating with said chamber substantially through-

out the length of the associated one of said sloping portions of said peripheral wall, and each of said ports being entirely contained within the associated portion of said peripheral wall, said housing also having a pair of passages in position to communicate alternately with the inner ends of said slots while their vanes engage said sloping portions of said peripheral wall, and means for connecting each of said passages optionally with either of said ports.

EARL E. BIDWELL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 22,160	Davis	Aug. 18, 1942
4,853	Hale	Nov. 14, 1846
858,778	Austin	July 2, 1907
963,690	Curtis	July 5, 1910
1,123,977	Baker et al.	Jan. 5, 1915
1,200,505	Killman	Oct. 10, 1916
1,572,576	Thomas	Feb. 9, 1926
1,737,942	Pagel	Dec. 3, 1929
1,869,933	Cooke	Aug. 2, 1932
2,055,296	Lane	Sept. 22, 1936
2,077,733	Amtsberg	Apr. 20, 1937
2,135,881	Wentworth	Nov. 8, 1938
2,249,059	Stenger	July 15, 1941
2,259,459	Kendrick	Sept. 16, 1941
2,335,284	Kendrick	Nov. 30, 1943
2,373,656	Brull	Apr. 17, 1945

FOREIGN PATENTS

Number	Country	Date
186,271	Great Britain	Sept. 28, 1922
681,601	France	Feb. 3, 1930