May 5, 1964 E. F. PAULUS 3,131,610

OSCILLATING HYDRAULIC MOTOR HAVING COMPRESSIBLE SEALING MEANS

Filed March 28, 1957 2 Sheets-Sheet 1

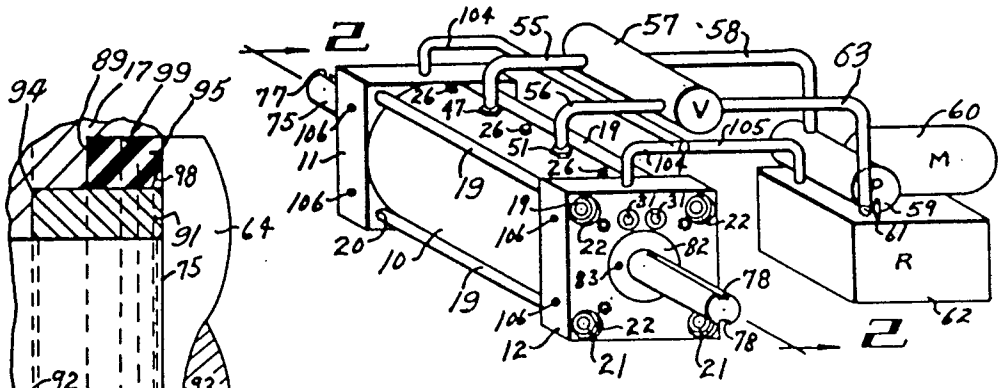


Fig. I

Fig. II

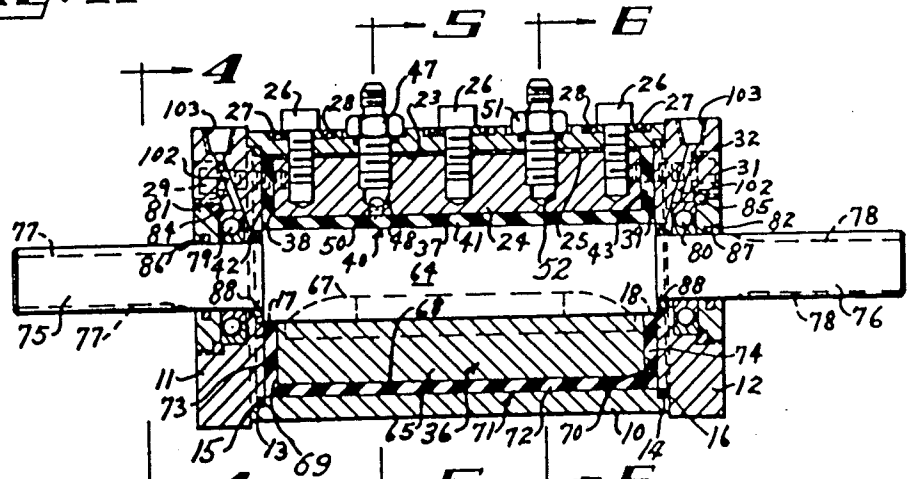


Fig. 2

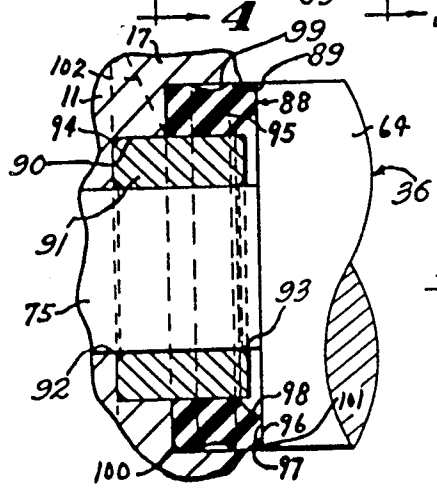


Fig. 3

INVENTOR.
EDWARD F. PAULUS

BY
Donnelly, Ingenty & Herrington
ATTORNEYS

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OSCILLATING HYDRAULIC MOTOR HAVING COMPRESSIBLE SEALING MEANS

Filed March 28, 1957 2 Sheets-Sheet 2

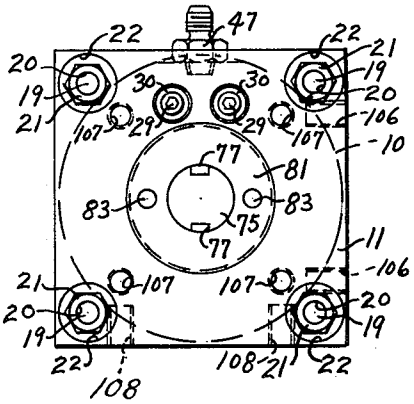


Fig. 4

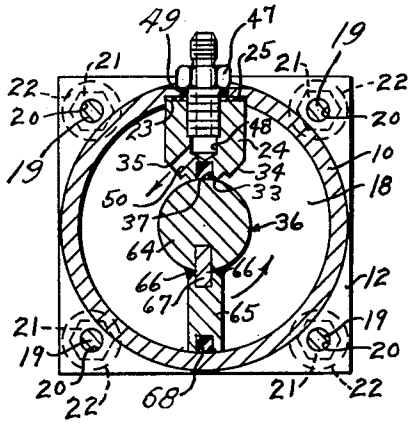
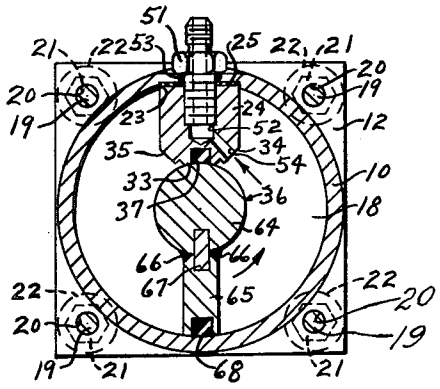


Fig. 5



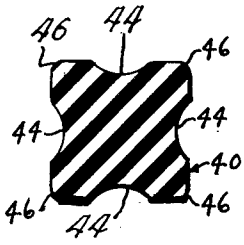


Fig. 8

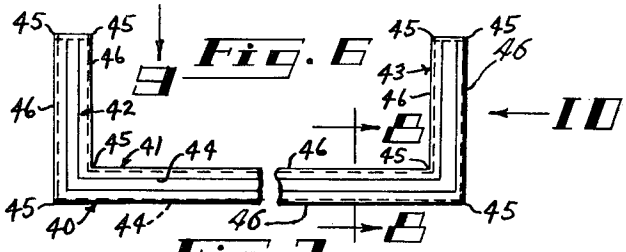


Fig. 7

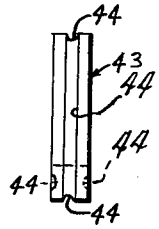


Fig. 10

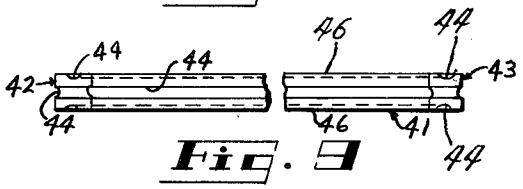


Fig. 9

INVENTOR.
EDWARD F. PAULUS

BY
Donnelly, Ingentag & Harrington

ATTORNEYS

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OSCILLATING HYDRAULIC MOTOR HAVING COMPRESSIBLE SEALING MEANS

Edward F. Paulus, Detroit, Mich., assignor, by mesne assignments, to Roto Actuator Corporation, a corporation of Michigan

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3 Claims. (Cl. 92—125)

This invention relates generally to fluid motors, and, more particularly to a novel fluid actuated oscillating or reversing motor adapted to provide reciprocating rotary motion through a portion of a revolution.

It is the primary object of this invention to provide an oscillating fluid motor capable of providing equal power in each direction of rotary movement throughout a 280 degree arc of travel and which will be useful for many purposes or operations as, for example, lifting, dumping, tumbling, agitating, mixing and so forth.

It is a further object of this invention to provide an oscillating fluid motor constructed and arranged to provide a minimum of friction, leakage and wear between the moving and stationary parts thereof, whereby, the motor is adapted to be powered by any suitable fluid as air, water or any suitable hydraulic oil.

It is a still further object of this invention to provide an oscillating fluid motor including a novel stator and vane or rotor which are each provided with a novel and improved seal which is precision compounded and moulded to provide optimum characteristics of hardness, strength, wear resistance, fluid resistance and compression set.

It is another object of this invention to provide an oscillating fluid motor including a novel and improved rotor shaft bearing and seal construction adapted to provide a minimum of fluids leakage along said shaft.

It is still another object of this invention to provide an oscillating fluid motor which is simple and compact in construction, economical of manufacture, efficient in operation, and which can be made in any size.

Other objects, features and advantages of this invention will be apparent from the following detailed description and appended claims, reference being had to the accompanying drawings forming a part of the specification wherein like reference numerals designate corresponding parts of the several views.

In the drawings:

FIG. 1 is a perspective view of an illustrative embodiment of the invention;

FIG. 2 is an elevational sectional view of the structure illustrated in FIG. 1, taken along the line 2—2 thereof, and looking in the direction of the arrows;

FIG. 3 is an enlarged fragmentary view, partly in section, of the structure illustrated in FIG. 2;

FIG. 4 is an end elevational view of the structure illustrated in FIG. 2, taken along the line 4—4 thereof, and looking in the direction of the arrows;

FIG. 5 is an elevational sectional view of the structure illustrated in FIG. 2, taken along the line 5—5 thereof, and looking in the direction of the arrows;

FIG. 6 is an elevational sectional view of the structure illustrated in FIG. 2, taken along the line 6—6 thereof, and looking in the direction of the arrows;

FIG. 7 is an enlarged broken side elevational view of a vane and stator seal employed in the invention;

FIG. 8 is an elevational sectional view of the vane and stator seal illustrated in FIG. 7, taken along the line 8—8 thereof, and looking in the direction of the arrows;

FIG. 9 is a broken top plan view of the vane and stator seal illustrated in FIG. 7, taken in the direction of the arrow marked "9";

FIG. 10 is an end elevational view of the vane and

stator seal illustrated in FIG. 7, taken in the direction of the arrow marked "10"; and

FIG. 11 is an enlarged fragmentary view, partly in section, and identical to FIG. 3, but showing the novel inner shaft seal in a compressed operative condition.

Referring now to the drawings, and in particular to FIGS. 1 and 2, wherein is illustrated an oscillating fluid motor made in accordance with the principles of the invention, the numeral 10 indicates a hollow cylindrical body member which is enclosed at both ends by means of the head members 11 and 12. The body member 10 is provided at each end thereof with an annular groove disposed along the inner perpihery thereof, as 13 and 14, in which is operatively mounted an annular seal as 15 and 16, respectively, and which is made from any suitable sealing material. The head members 11 and 12 are substantially rectangular in cross section and are each provided on the inner face thereof with an inwardly extended integral annular boss, as 17 and 18, respectively. The bosses 17 and 18 are adapted to be seated in the grooves 13 and 14, respectively, in sealing contact with the seals 15 and 16 and to enclose the ends of the body member 10.

The head members 11 and 12 are fixedly secured on the body member 10 by the four tie rods designated by the reference numeral 19. The tie rods 19 are adapted to be evenly disposed around the body member 10 with the ends thereof being threaded and extended through the holes 20 in the head members 11 and 12. The tie rods 19 are secured in place by means of the lock nuts 21 which are adapted to be seated in the recesses or enlarged holes 22.

As shown in FIGS. 2, 5 and 6, a longitudinally extended slot 23 is formed in the inner periphery of the body 10 along the upper side thereof. An elongated abutment member or stator 24 is seated in the longitudinal slot 23 and extends from the inner face of the annular boss 17 to the inner face of the annular boss 18. A gasket 25, made from any suitable material, is mounted in the longitudinal slot 23 between the upper face of the abutment member 24 and the body 10. The abutment member or stator 24 is fixedly secured to the body 10 by means of a plurality of bolts 26 which extend through the body 10 and are threadably mounted into the stator 24. A suitable bolt seal 27 is mounted in a recess 28 around each of the bolts 26 to prevent any leakage past the bolts. As shown in FIGS. 2 and 4, the stator 24 is fixedly secured to the head member 11 by the retaining bolts 29 which are provided with a suitable seal 30 around the outer ends thereof. The stator 24 is secured to the head member 12 by means of the retaining screws 31 which are each provided with a suitable seal as 32 around the outer ends thereof. It will be seen from the aforegoing description that the stator 24 is strongly and rigidly connected to the body member 10.

As shown in FIGS. 2, 5 and 6, the lower end of the stator 24 is provided with a centrally disposed concavely shaped face 33. The lower end of the stator 24 on each side of the concave face 33 is tapered, as indicated by the numerals 34 and 35, to provide abutment means for the rotor member, generally designated by the numeral 36, and which is more fully described hereinafter. A centrally disposed longitudinally extended groove 37 is formed on the lower end of the stator 24 and extends inwardly from the concave face 33. The stator 24 is provided with similar centrally disposed radial grooves on each end face thereof, as indicated by the numerals 38 and 39. The end grooves 38 and 39 communicate with the longitudinal groove 37. A U-shaped seal member, generally designated by the numeral 40, is adapted to be operatively mounted in the grooves 37, 38 and 39. The seal member 40 comprises the longitudinally extended bight portion 41 which is adapted to be seated

in the longitudinal groove 37 and the two radially extended leg portions 42 and 43 which are adapted to be seated in the grooves 38 and 39, respectively. The seal bight portion 41 is integral with the leg portions 42 and 43.

As shown in FIGS. 7, 8, 9 and 10, the U-shaped seal member 40 is substantially rectangular in cross-section, and is provided with longitudinally extended grooves as 44 on all four sides of the bight portion 41 and also on all four sides and on the upper end of each of the leg portions 42 and 43. The grooves 44 are preferably concave in cross-section as, for example, on one model the grooves were formed on a radius of approximately .065 inch and were formed to a depth of approximately .018 inch for a seal of an overall thickness of approximately .105 inch. The corners of the seal 40, indicated by the numeral 45, are preferably formed so as to provide a sharp corner with a radius thereon no greater than .003 inch. The U-shaped seal member 40 is preferably made from a molded sealing material known as Buna "N" 70 Duro-Moly which is readily available on the market. The edge corners 46 are preferably rounded within a maximum radius of .018 inch.

As shown in FIGS. 2 and 5, a tube fitting 47 is adapted to pass through the body 10 and to be threadably mounted into the hole 48 in the upper side of the stator 24. A suitable tube fitting seal 49 is disposed around the tube fitting 47 to prevent leakage thereby. A port 50 is formed in the lower side of the stator 24 and is adapted to provide communication between the hole 48 and the interior of the body member 10. As shown in FIGS. 2 and 6, a second tube fitting 51 is adapted to pass through a suitable hole in the body 10 and to be threadably mounted in the hole 52 in the upper side of the stator 24. A suitable tube fitting seal 53 is provided around the upper end of the tube fitting 51 to prevent leakage thereby. A second port 54 is formed in the stator 24 and is adapted to connect the hole 52 with the inside of the body 10.

As shown in FIG. 1, the tube fittings 47 and 51 are adapted to be operatively connected to the tubes 55 and 56, respectively, which are connected to a suitable conventional flow directional control valve 57. The control valve 57 is connected to the tube 58 which is connected to a suitable conventional fluid pump, as 59. The pump 59 is connected by a fluid supply line 61 to a fluid reservoir 62. The pump 59 is adapted to be driven by the usual motor 60. A fluid return tube 63 connects the control valve 57 to the fluid reservoir 62.

As shown in FIGS. 1, 2 and 6, a rotor member 36 is rotatably mounted inside the body 10 and comprises a shaft or rod 64 to which is fixedly connected a vane 65. The shaft 64 is adapted to abut the bight portion 41 of the U-shaped seal 40 and be in rotatory sealing engagement therewith. The vane 65 is rigidly connected to the shaft 64 by welding along the upper side of the vane, as at the points marked 66, and also by means of the longitudinal lock key 67. As shown in FIGS. 2, 5 and 6, a centrally disposed groove 68 is formed on the lower edge of the vane 65 and this groove communicates with similar centrally disposed grooves 69 and 70 which are formed in the end faces of the vane 65. A U-shaped seal member, generally designated by the numeral 71, is adapted to be seated in the grooves 68, 69 and 70. The U-shaped seal member 71 comprises the longitudinally extended bight portion 72 and the integral radially extended integral leg portions 73 and 74. The seal 71 is the same in size, shape and make as the seal 40 which is carried on the stator 24. The seal 71 functions to provide an efficient sealing engagement with the inner face of the body 10.

The rotor shaft 64 is provided with the integral outwardly extended output shafts 75 and 76 which are provided with the usual key slots 77 and 78, respectively. As shown in FIG. 2, the output shafts 75 and 76 are operatively journalled in the roller bearings 79 and 80, respectively, which are operatively mounted in stepped recesses in the head members 11 and 12. The roller bearings 79 and 80 are retained in place by the retainer plates 81 and 82, respectively, which are threadably mounted in the head members 11 and 12. The retainer plates 81 and 82 are provided on the outer face thereof with suitable wrench holes, as 83. A suitable bearing retaining seal, as 84 and 85, is operatively mounted between each of the retainer plates 81 and 82, respectively, and the bearings 79 and 80, respectively. The retaining plates 81 and 82 are each provided with an outer shaft seal as 86 and 87, respectively, for preventing leakage along the output shafts 75 and 76, respectively.

As shown in FIGS. 2 and 3, an inner shaft seal member, generally designated as 88, is provided at each end of the rotor shaft 64. As shown in FIG. 3, the seal members 88 are operatively mounted in a stepped recess formed in the inner face of the annular bosses 17 and 18. The aforementioned stepped recess comprises an outer enlarged portion 89 and an inner reduced portion 90. The seal member 88 comprises an annular metal sleeve member, preferably formed from a suitable bearing metal as S.A.E. 660 Bronze. The output shafts 75 and 76 are rotatably mounted through the sleeve members 91. The edges of the inner periphery of the sleeve member 91 are chamfered, as indicated by the numerals 92 and 93. The outer corner of the outer periphery of the sleeve member 91 is also chamfered, as indicated by the numeral 94. A second annular member 95 is concentrically mounted around the approximately inner two-thirds of the metal sleeve member 91. The member 95 is preferably mounted on the member 91 with a press fit. The metal sleeve 91 is adapted to be seated in the inner reduced portion 90 of the stepped recess in the bosses 17 and 18 and the seal member 95 is adapted to be seated in the outer enlarged portion of said stepped recess. The annular seal member 95 is adapted to be made from any suitable sealing material, and, preferably is made from a sealing material available on the market and known as Buna "N" 70 Duro-Moly. The inner face 96 of each of the annular sealing members 95 is adapted to abut the shoulder 97 on each of he ends of the rotor shaft 64. FIG. 3 shows the combination thrust bearing and sealing member 88 in the free state before the head members 11 and 12 have been fully secured in place. In the free state the inner edge of the inner periphery of each of the sealing members 95 is concavely chamfered and in one installation a chamfer radius of approximately .065 inch was found to be preferable. In the free state, the inner edge of the sealing member 95 extends inwardly beyond the inner edge of the metal sleeve member 91 for a slight distance as, for example, in one installation it extended approximately .010 inch beyond the inner end of the metal sleeve member 91. A centrally disposed groove 99 is formed on the outer periphery of the annular sealing member 95 and this groove is preferably concave in cross-section, and, in one installation it was found that a radius of .062 inch was preferable for forming this groove. The outer peripheral corner 100 is preferably rounded slightly as, for example, to a radius of approximately one sixty-fourth of an inch. The inner peripheral corner 101 is preferably formed to a sharp corner with no more than a .003 of an inch radius. In the operative state or condition, with the head members 11 and 12 secured in position, the sealing member 95 is compressed in the recess 89, and the shoulders 97 on the shaft 64 abut the inner ends of the metal sleeve 91, as shown in FIG. 11. Any endwise thrust load is thus taken by the metal sleeves 91.

As shown in FIG. 2, each of the head members 11 and 12 are provided on the upper sides thereof with a tube fitting hole 103 which communicates with a drain passage 102 which extends down to the bearings 79 and 80 and the inner shaft seal member 88. When the fluid motor

of the present invention is being powered with a hydraulic oil, fluid return tubes, as **104**, shown in FIG. 1, are connected to the tube fitting holes **103**. The tubes **104** are connected to a drain or return tube **105** which is connected to the fluid reservoir **62**. It will be seen that any leakage of hydraulic fluid past the inner shaft seals **88** is thus carriied back to the fluid reservoir **62**. As shown in FIGS. 1 and 4, suitable threaded holes, as **106**, **107** and **108**, may be formed in the side faces, and faces and bottom faces, respectively, of the head members **11** and **12** for mounting the fluid motor on any suitable supporting means. The oscillating fluid motor of the present invention may be powered by any suitable fluid, as for example, air, water or a hydraulic fluid. The output shafts **75** and **76** may be operatively connected to any object which is to be turned through a portion of a revolution for operations such as lifting, rolling over, dumping, tumbling, agitating and so forth. Assuming that the vane **65** is at a starting point in an abutting position against the tapered face **35**, on the lower end of the stator **24**, the motor may be put into operation by operating the control valve **57** to admit fluid under pressure from the line **58** into the line **55** and through the fitting **47**, hole **48** and port **50**, and into the body **10**. The pressurized fluid will operate against the vane **65** so as to rotate it counter-clockwise, as viewed in FIG. 5. The vane **65** will rotate until it engages the tapered face **34** on the other side of the stator **24**. The travel arc through which the vane **65** moves is approximately equal to 280°. The vane **65** may be reversed and rotated back to its starting position against the tapered face **35** by operating the directional control valve **57** so as to connect the tube **55** with the return tube **63** and the pressurized fluid supply line **58** with the tube **56**. Pressurized fluid will then pass through the tube fitting **51**, as shown in FIG. 6, and through the hole **52** and port **54** and into the body **10**. The vane **65** will then be operated in the reverse or clockwise direction, as viewed in FIG. 5, and it will be moved back to its starting position against the tapered face **35**. The directional control valve **57** may be of any suitable conventional type and may be manually or automatically operated. It will be obvious that the control valve **57** may be operated at any time during the cycle or travel of the vane **65** so as to provide for rotation of the vane **65** through travel arcs shorter than the entire possible travel of 280°. If desired, the rate of travel of the vane **65** may be speeded up or slowed down by any suitable flow control means for obtaining such results.

It will be seen that the instant invention provides a novel and improved oscillating fluid motor which contains few moving parts and which is self contained and provides a fully sealed construction. The novel U-shaped sealing members **40** and **71** provide an efficient sealing action between the stator and rotor members and the body and head members, and, the shaft inner seals **88** provide a highly efficient shaft sealing means. The annular sealing members **95** function to produce a result heretofore not achievable by the prior art fluid motor shaft seals. The radial chambers **98** and the peripheral grooves **99** permit the sealing members **95** to be compressed in the recesses **89** without undue adverse jamming effects, whereby, as the sealing members **95** wear they will flow out of the recesses **89**. An effective and efficient sealing contact is thus constantly maintained between the inner face **96** of each of the sealing members **95** and the adjacent shoulder **97** on shaft **64**.

When the fluid motor is powered by pressurized air, the return lines **104** and **105** are removed and suitable grease fittings are mounted in the holes **103** for the purpose of lubricating the bearings **79** and **80**. The sealing material Buna "N" 70 Duro-Moly is sold by the Dow Chemical Co. of Midland, Michigan.

While it will be apparent that the preferred embodiment of the invention herein disclosed is well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What I claim is:

1. An oscillating fluid motor of the class described, comprising: a hollow cylindrical body; a head member fixedly mounted on each end of said body for enclosing the same; a longitudinally extended slot formed in the inner surface of said cylindrical body; a radially disposed longitudinal stator fixedly mounted in said slot and extending from one head member to the other head member; a shaft in said body extending axially therethrough and being rotatably mounted in bearing members mounted in said head members; a U-shaped seal mounted on said stator and adapted to engage said head members and said rotatable shaft; a radially disposed longitudinal vane fixedly mounted on said shaft and extending from one head member to the other head member; a U-shaped seal mounted on said vane and adapted to engage said head members and the inner surface of said body; an output shaft connected to said shaft and extended outwardly of said body; a pair of annular shaft seal members mounted in each of said head members on opposite sides of the shaft bearing member; one seal of each pair of said annular shaft seal members being adapted to operatively engage a shoulder on said first named shaft and being provided with a peripheral groove and being carried on a sleeve bearing which is adapted to operatively engage said first named shaft; and, means for admitting fluid under pressure successively and selectively to alternate sides of said stator for actuating said vane through a reciprocatory cycle.

2. An oscillating fluid motor of the class described comprising: a hollow cylindrical body; a head member fixedly mounted on each end of said body for enclosing the same; a longitudinally extended slot formed in the inner surface of said cylindrical body; a radially disposed longitudinal stator fixedly mounted in said slot and extending from one head member to the other head member; a shaft in said body extending axially therethrough and being rotatably mounted in bearing members mounted in said head members; a U-shaped seal mounted on said stator and adapted to engage said head members and said rotatable shaft; a radially disposed longitudinal vane fixedly mounted on said shaft and extending from one head member to the other head member; a U-shaped seal mounted on said vane and adapted to engage said head members and the inner surface of said body; an output shaft connected to each end of said shaft and extended outwardly of said body; a first shaft seal member mounted in each of said members at a point outwardly of the bearing in each of the head members; a sleeve bearing mounted in a recess in the inner face of each of said head members and adapted to operatively engage said first named shaft; a second shaft compressible seal member carried on each of said sleeve bearings and mounted in a recess in the inner face of the respective head member; each of said second compressible seal members, when in the free state, being adapted to extend beyond the inner end of the sleeve member it is mounted on and being adapted to be compressed in its respective recess when in sealing operation, whereby, as it wears it will flow out of its recess; and, means for admitting fluid under pressure successively and selectively to alternate sides of said stator for actuating said vane through a reciprocatory cycle.

3. An oscillating fluid motor of the class described, comprising: a hollow cylindrical body; a head member fixedly mounted on each end of said body for enclosing the same; a longitudinally extended slot formed in the inner surface of said cylindrical body; a radially disposed longitudinal stator fixedly mounted in said slot and extending from one head member to the other head member; a shaft in said body extending axially therethrough and being rotatably mounted in bearing members

mounted in said head members; a U-shaped seal mounted on said stator and adapted to engage said head members and said rotatable shaft; a radially disposed longitudinal vane fixedly mounted on said shaft and extending from one head member to the other head member; a U-shaped seal mounted on said vane and adapted to engage said head members and the inner surface of said body; an output shaft connected to said shaft and extended outwardly of said body; a pair of annular shaft seal members mounted in each of said head members on opposite sides of the shaft bearing member; one seal of each of said pair of annular shaft seal members being adapted to operatively abut a shoulder on said first named shaft and being provided with a peripheral groove and a radial chamfer on the inner edge of the inner periphery thereof; and, means for admitting fluid under pressure successively and selectively to alternate sides of said stator for actuating said vane through a reciprocatory cycle.

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