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McDermott

[11] **3,846,051**

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[54] **VALVING ARRANGEMENT IN A HYDRAULIC DEVICE**

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[52] **U.S. Cl.** .... **418/61 B**, 418/186

[51] **Int. Cl.** **F01c 1/02**, F03c 3/00, F04c 1/02

[58] **Field of Search** .... 418/61 B, 186, 187, 188

[56] **References Cited**

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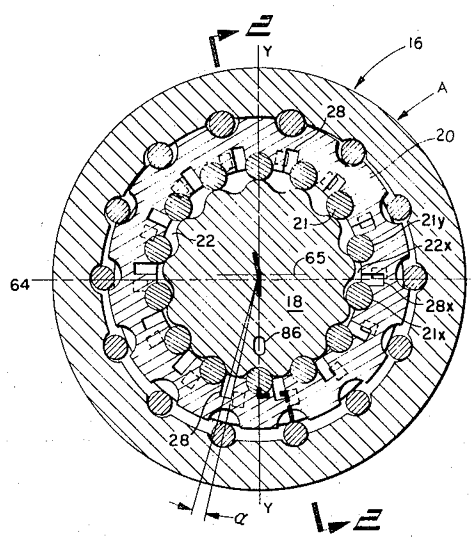
Attorney, Agent, or Firm—Teagno & Toddy

[57] **ABSTRACT**

An improved valving arrangement for a fluid operated pulley motor of the gerotor type wherein an internally-toothed member having a number (N) of teeth eccentrically receives an externally-toothed member having one less (N−1) teeth. The members are relatively movable to define a number (N) of contracting and expanding volume chambers formed by tooth interaction. The externally toothed member is fixedly mounted on a stationary shaft having tubular portions at its opposite ends configured for attachment to a pressurized fluid supply and fluid exhaust respectively. The internally toothed member is mounted for orbital and rotational motion about the axis of the externally toothed member to define a moving line of eccentricity which separates the expanding chambers from the contracting chambers. A number (N) of equally spaced discontinuous recesses extend from each axial end face of the ring member and open to the volume chambers. Each axial end face of the internally toothed member abuttingly engages a confronting face within the gerotor housing containing a similar number (N) of particularly disposed valving passages. The passages and recesses are orientated and arranged so that orbital motion of the ring member provides fluid communication between certain of the passages adjacent one axial end face and all expanding volume chambers; and fluid communication between certain of the passages adjacent the other axial end face and all of the contracting chambers. Thus, high pressure at one axial end face may be communicated to all of the expanding chambers at one side of a line of eccentricity while low pressure at the other axial end face communicates with all of the contracting chambers at the other side of the line of eccentricity.

3 Claims, 8 Drawing Figures



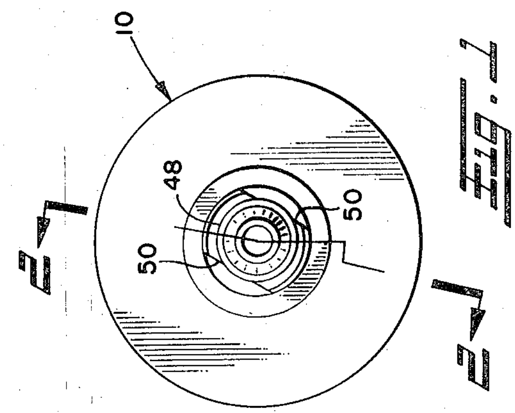


FIG. 1

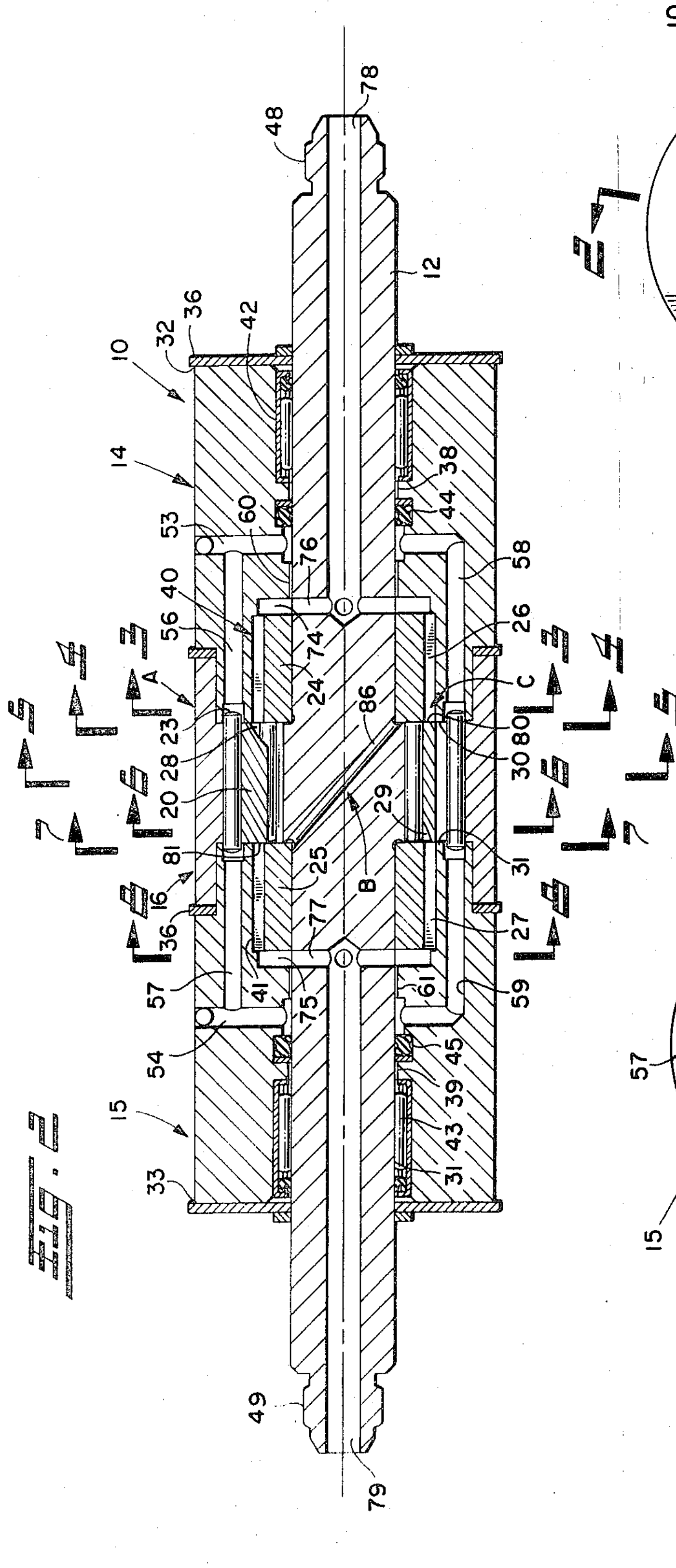


FIG. 2

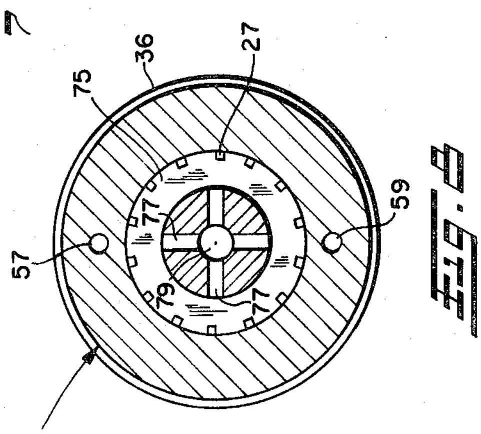


FIG. 6

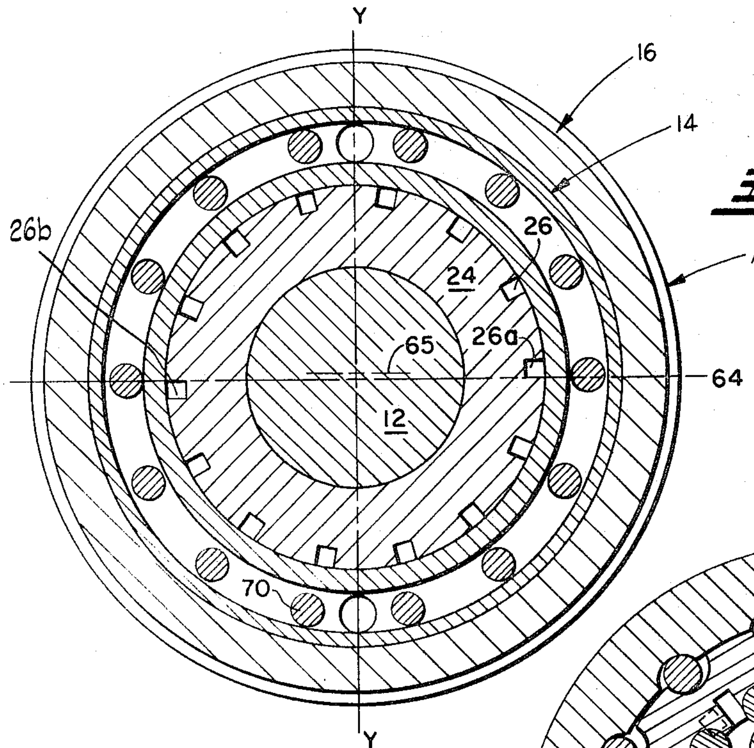


FIG. 3

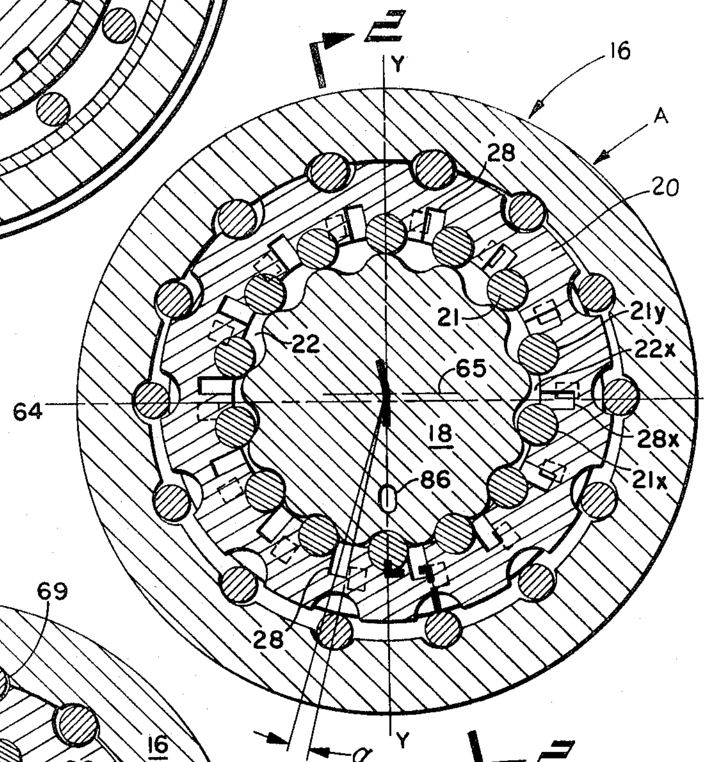


FIG. 4

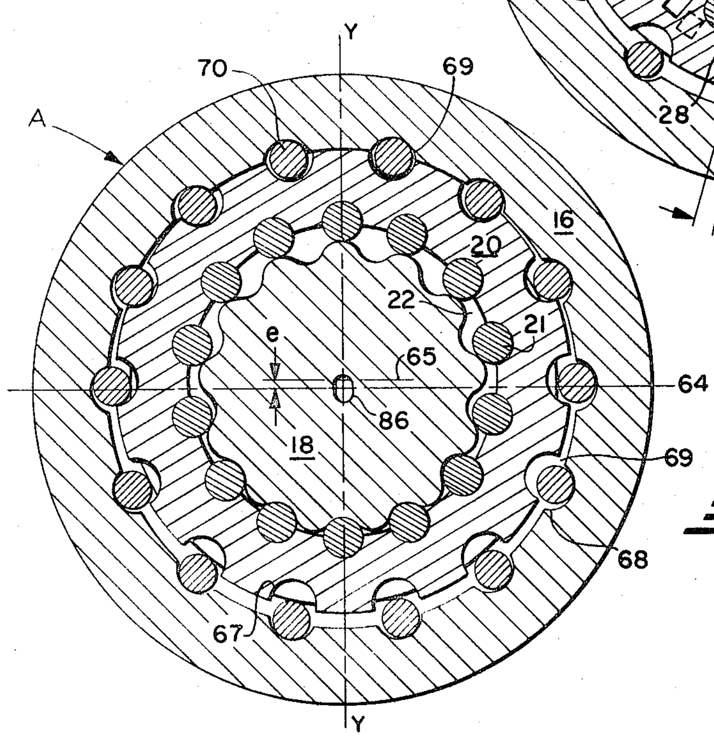


FIG. 5

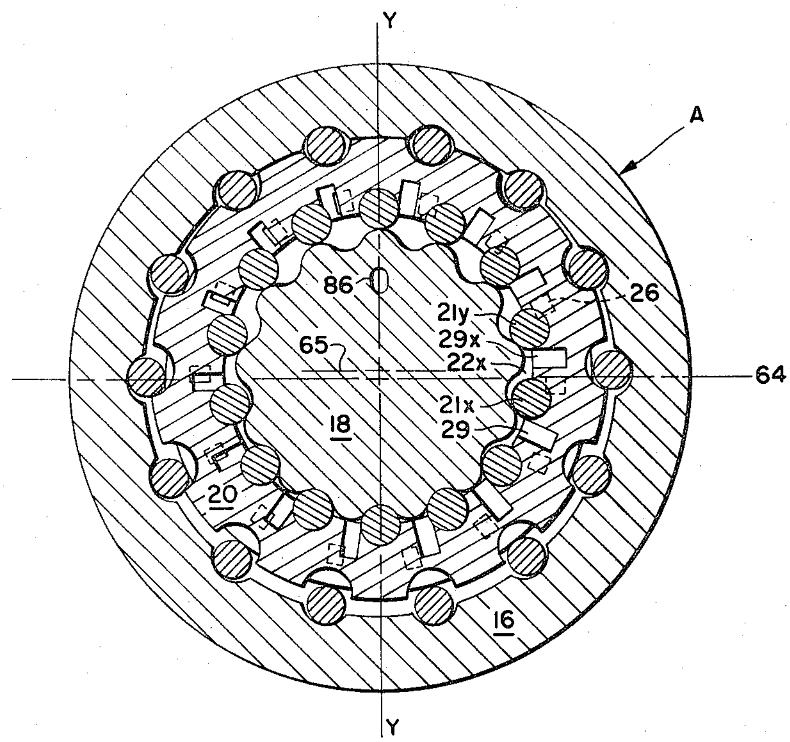

Y
A
86
26
21y
29x
65
22x
64
21x
18
29
20
16
Y

Fig. 6

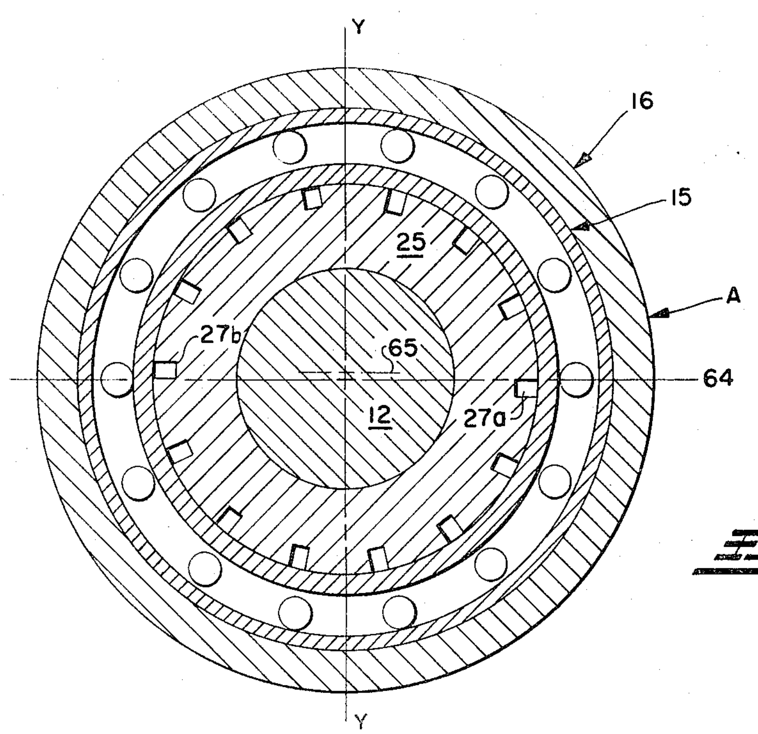

Y
16
15
25
A
27b
65
64
12
27a
Y

Fig. 7

VALVING ARRANGEMENT IN A HYDRAULIC DEVICE

This invention relates to fluid-operated devices of the rotary pump or motor type and more particularly to a valving arrangement employed in fluid-operated devices of the gerotor type.

The invention is particularly applicable for use as a pulley motor having a rotating housing which drives a timing belt or the like and will be described with particular reference thereto. However it will be appreciated that the valving arrangement may also be employed in any fluid-operated device wherein one displacement member orbits relative to another as in gerotor type devices.

Gerotor devices of the type to which invention relates comprise an internally-toothed ring member having a number (N) of teeth which eccentrically receives an externally-toothed star member of less number of teeth (N-1) to define N expanding and contracting volume chambers as one member orbits relative to an axis of the other. An imaginary line extending between the axes of the members divides expanding volume chambers lying one one side of the line from contracting volume chambers on the other side and is known as the line of eccentricity. The line of eccentricity rotates at the oribiting speed of the orbiting member of the device. Fluid valving communicates high pressure to those chambers on one side of the line of eccentricity and low pressure to those chambers on the other side of the line.

Heretofore this valving function has been accomplished in many different ways. One common example is the use of a commutator valve arrangement. In this arrangement, a first member has a number (N) of fluid passages therein each of which communicate with a volume chamber at one end thereof. The other end of the (N) passages is positioned to be sequentially placed in fluid communication and with 2(N-1) passages in a second member. The 2(N-1) passages in the second member in turn communicate with the inlet and outlet ports. The passages in the second member are alternately arranged with N-1 passages communicating with the inlet port and N-1 passages communicating with the outlet port. Relative rotation of the gerotor members is used to drive the second member by a universal-joint dogbone shaft to achieve the desired valve timing and sequencing.

While such valving arrangements function adequately, their design calls for a large number of parts manufactured to close tolerances to maintain valve timing. This becomes especially critical when the gerotor is designed with a large number of volume chambers to produce a very smoothly-operating device. Furthermore, an additional problem occurs when a gerotor arrangement is used as a pulley motor wherein an exterior housing rotates and not the output shaft. Looseness in the drive arrangement of the pulley motor resulting from wear tends to impart undesirable orbiting motion to the rotating housing. Such a pulley motor is shown in the U.S. Pat. No. 3,552,893 which employs a conventional spool and sleeve valving arrangement actuated by universal-joint shafts as noted above. Importantly, timing error may result from torsional loading of the driving connection between the first and second members. Another problem is that an excessively long motor housing is required in order to obtain space for high capacity radial load bearings which are required in most pulley motor applications. The added length is due mainly to the use of universal joint shafts to operate the valving members. It is thus a principal object of this invention to provide a pulley motor of the gerotor type which utilizes a simplified positive action valving mechanism.

In accordance with the invention there is provided an elongated member having inlet and outlet portions at its opposite ends and an externally-toothed star member fixedly mounted at its central portion. An internally toothed ring member is eccentrically disposed about the externally toothed star member and the teeth of the members intermesh to form expanding and contracting volume chambers during relative orbital and rotational movement therebetween. Because of the difference in the number of teeth, oribiting of the ring member about the axis of the star member results in rotation of the ring member which in turn is transmitted by roller joint connections to a casing which forms the pulley motor housing.

In accordance with another aspect of the invention a number (N) of discontinuous recesses extend from each axial end face of the ring member and open to the internal periphery thereof at points adjacent volume chambers. Each axial end face of the ring member is confronted by a fixed surface in the housing containing a like number (N) of passages. The passages and recesses are orientated and arranged so that orbital motion of the ring member provides fluid communication between certain of the passages adjacent one axial end face and all expanding volume chambers; and fluid communication between certain of the passages adjacent the other axial end face and all of the contracting chambers. Thus, high pressure at one axial end face may be communicated to all of the expanding chambers at one side of a line of eccentricity while low pressure at the other axial end face communicates with all of the contracting chambers at the other side of the line of eccentricity.

It is thus an object of this invention to provide a conveyor motor of the gerotor type having an externally-rotating housing wherein opposite ends of a stationary through shaft are configured to supply and exhaust fluid to the motor and wherein one displacement member is stationary while the other orbits and rotates to provide an improved valving function.

It is another object of this invention to provide novel, positive action valving means in a fluid-operated device of the gerotor type.

The invention may take physical form in certain parts and arrangement of parts, a preferred embodiment of which may be described in detail herein and illustrated in the accompanying drawings which form a part hereof and wherein:

FIG. **1** is an end view of a motor;

FIG. **2** is a sectional view of the motor taken along Line **2—2** of FIG. **1**; and

FIGS. **3,4,5,6,7,** and **8** are cross-sectional views taken along respective lines of FIG. **2.**

Reference is now made to the drawings wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting the same.

FIG. **2** shows a pulley motor **10** for driving a conveyor belt (not shown). The pulley motor **10** comprises a housing assembly A containing a fluid displacement gerotor assembly B, and a valving arrangement C. Housing assembly A comprises hollow cylindrical end casing sections **14,15** abutting against a ring roller casing **16.** Depending on the direction of rotation desired from the housing A either end section **14** or **15** would be subjected to inlet fluid pressure, the other would be ported to return pressure. Journalled within the end casing sections **14, 15** is a one-piece through shaft **12** having an externally toothed star member **18** integrally formed over its central portion. It will be appreciated that alternatively the externally toothed member could be formed separately and then fixedly attached to the shaft **12.** Fluid displacement gerotor assembly B comprises the externally toothed star member **18** about which is eccentrically disposed an internally toothed ring member **20** which in turn is disposed within the ring-roller casing **16.** A roller pin drive arrangement **23** is used to translate the orbiting rotational motion of member **20** into pure rotational motion at the housing A. The construction and operation of the roller pin drive arrangement will be better understood by reference to my application Ser. No. 27,191 filed Apr. 9, 1970 which is for reissue of my U.S. Pat. No. 3,389,618. Valving arrangement C comprises valving members **24,25** disposed within inlet and outlet casing sections **14,15** and sealingly against respective axial end faces of internally toothed member **20.** Valving passages **26,27** in valve members **24,25** sequentially communicate with discontinuous recesses or charging chambers **28,29** disposed at opposite axial end faces of the ring-roller member **20** upon orbital movement of the ring-roller member **20** about the star member **18.**

HOUSING ASSEMBLY

Housing assembly A comprises hollow, cylindrically shaped inlet and outlet end casing sections **14,15** having inner axial end faces **30,31** and outer axial end faces **32,33,** respectively. A ring-roller cylindrically-shaped casing **16** is interposed the end faces **30,31** of casing end sections **14,15.** Spacing discs **36** between the casing sections **14,15** and ring-roller casing **16** protrude above the housing A and serve as guides for a multi-piece belt (not shown). Spacing discs **36** and casing sections **14,15,16** are secured together by a suitable adhesive such as epoxy, to provide a compact design. It will be appreciated by those skilled in the art that other fastening means such as bolts or threaded ends of the casing sections could secure the housing assembly A together.

Inlet end casing **14** has a longitudinal chamber **38** extending from axial end face **32** and communicating with a larger inlet valve member opening **40** which extends to the inner axial end face **30** of casing **14.** Similarly outlet end casing **15** has a longitudinal chamber **39** extending from the axial end face **33** and communicating with an outlet valve member opening **41** at the axial end face **31.** Each casing **14,15** has recesses formed in the longitudinal chambers **38,39** for receiving a prepacked needle bearing assembly **42,43** and seal arrangements **44,45** respectively for journalling and sealing the one-piece inlet and outlet shaft **12** extending through the chambers **38,39.** Shaft **12** has inlet and outlet fittings **48,49** which have oppositely disposed flat facings **50** for receiving a "C" clamp fixture (not shown) to prevent rotation of the shaft **12.**

A drilled hole **53,54** in each inlet and outlet casing **14,15** extends from the exterior surface of each casing where it is plugged to a point beyond the inlet and outlet chambers **38,39** respectively. A pair of longitudinally-extending lubricating passages **56,58** and **57,59** extend from each drilled hole **53,54** to the inner axial end faces **30,31** of the inlet and outlet casings **14,15** respectively and are adapted to lubricate the roller drive arrangement between internally toothed member **20** and ring-roller casing **16** by transferring leakage from high to low pressure across shaft clearances **60,61.**

GEROTOR ASSEMBLY

As best shown in FIGS. **3** through **7** gerotor assembly B comprises an externally toothed star member **18** eccentrically disposed within an internally toothed member **20** which in turn is disposed within a ring-roller casing **16.**

As is known to those skilled in the art the internally toothed member **20** has a plurality of N internal roller teeth **21** and is eccentrically mounted relative to the externally toothed member **18** having a plurality of N-1 external teeth with the eccentricity *e* of the device shown as the distance between internally toothed member's axis **64** and the externally toothed member's axis **65.** As shown in FIG. **4,** the interaction between the teeth of the members **18,20** define a plurality of N volume chambers **22** with all of the expanding chambers lying on one side of the Y—Y axis and all of the contracting volume chambers lying on the other side thereof. The Y—Y axis may thus be defined as a moving line of eccentricity and always extends between the axis **64,65.** It should be apparent that this line of eccentricity moves as relative movement between the members occurs. In the embodiment shown, in FIGS. **4,5,** and **6** it is understood that the letter N designates the number of chambers (**14**) and "N-1" designates the number of teeth (**13**) in the externally toothed member.

As thus described, members **18,20** will interact with one another in the usual manner. More particularly with the member **18** fixed against rotation, the member **20** will orbit hypocycloidally about the member **18** whereby the axis **64** will define a circle about the axis **65** of radius equal to the eccentricity *e*. This movement of the member **20** will expand and contract each of the N volume chambers **22** while the member **20** rotates a peripheral distance equal to one tooth space. Furthermore, it will be appreciated that the Y—Y axis or line of eccentricity will also rotate at an angular velocity equal to the orbiting speed of the member **20.**

The external surface of the member **20** has a plurality of circumferentially-spaced, axially-extending grooves **67** and the internal surface of ring-roller casing **16** has a like number of grooves **68.** The grooves **67,68** of member **20** and ring-roller casing **16** coact with one another to form a plurality of articulated holes **69.** Received within each hole is a drive pin **70** which provides means for rotating ring-roller casing **16** in the same direction and with the same rotational speed as member **20.** In order to obtain the most uniform driving relationship between the member **20** and the ring-roller casing **16** in either direction of rotation, it should be noted that the driving rollers **70** and articulated holes **69** are equal in number to the number of displacement chambers **22** and are located on radial center lines bisecting the angles between the roller teeth **21.** As noted in my U.S. Pat. No. 3,389,618, now Reissue Application Ser. No. 27,191, filed Apr. 4, 1970, the effective diameter of each articulated hole 69 is equal to the diameter of the drive pin 70 plus the eccentricity *e* of the gerotor members 18,20. This relationship assures that only rotational and not orbital motion of the member 20 will be transmitted to the ring-roller casing 16.

VALVING ARRANGEMENT

Valving arrangement C comprises inlet and outlet valving members 24,25 disposed within inlet and outlet casing sections 14,15 and each having N valving passages 26,27 therein adapted to coact with N discontinuous recesses 28,29 in each end of member 20 respectively.

More particularly, cylindrically-shaped valving members 24,25 are fixedly mounted within the stepped bores 40,41 respectively so that the axial end faces 72,73 of the valving members 24,25 are aligned with the axial end faces 30,31 of the end casing sections 14,15. A central opening extends through valving members 24,25 to provide a slight clearance for receiving the shaft 12 therethrough. The valving members 24,25 are securely fixed in the stepped bores 40,41 such as by a press fit whereby the members 24,25 rotate in unison with the housing 16. Importantly the axial length of valving members 24,25 is slightly shorter than the axial length of the stepped counterbores 40,41 in the casing end sections 14,15 to define annular feed openings 74,75 respectively.

As shown in FIGS. 2 and 8 annular feed openings 74,75 communicate the valving passages 26,27 in the valving members 24,25 with four radially-extending passages 76,77 in the shaft 12. The passages 76,77 in turn communicate with longitudinally-extending inlet and outlet passages 78,79, at opposite ends of shaft 12 respectively. Because the device of the subject invention is illustrated as a motor, all inlet valving passages 26 are adapted to be at high pressure while all outlet valving passages 27 are at low pressure.

As shown in FIG. 3 the valving passages 26 in the valving member 24, are identical in dimensional size and are shown circumferentially-spaced in equal increments about the external periphery of valving member 24. Importantly, the inlet valving member 24 is oriented in the inlet valve member opening 40 so that at assembly one valving passage 26*a* extends on one side of a line perpendicular to the line of eccentricity (in the position shown in FIG. 3 this is axis 64) and a diametrically opposed passage 26*b* extends from the other side of said line. Thus as shown in FIG. 3 passage 26*a* extends upwardly from axis 64 and has one side substantially in line contact with axis 64 while passage 26*b* extends downwardly from axis 64 and also has one side substantially in line contact with axis 64. For purposes of locating the passages 26*a* and 26*b*, the line is taken as an axis of housing 16 which is perpendicular to the line of eccentricity at final assembly.

Likewise valving passages 27 in valving member 25 are identical in size to passages 26 and are circumferentially-spaced in equal increments about the external periphery of valving member 25. Importantly, the outlet valving member 25 is orientated in the outlet valve member opening 41 in a mirror image of that previously stated for member 26. As shown in FIG. 7 one passage 27*a* extends substantially from one side of an axis of housing 16 perpendicular to the line of eccentricity in a direction opposite that of corresponding inlet passage 26*a*. The corresponding diametrically-opposed passage 27*b* extends from the opposite side of the same line and in a direction opposite that of corresponding inlet passage 27*a*. Thus, in the position shown in FIG. 7 passage 27*a* has one side substantially in line contact with axis 64 and extends downwardly from axis 64 while passage 27*b* has one side substantially in line contact with axis 64 and extends upwardly therefrom. The phasing and arrangement of outlet passages 27 is thus the mirror image of the phasing and arrangement of inlet passages 26 and vice-versa. As shown in FIG. 2 internally toothed member 20 has a plurality of N discontinuous recesses 28,29 at each axial end face 80,81 thereof. The recesses 28,29 are adapted to coact with their corresponding valve passages 26,27. The discontinuous recesses 28 are circumferentially-spaced in equal increments about the internal periphery of the member 20 and extend from the end face 80 inwardly and open to the internal periphery of the member 20 to communicate with volume chambers 22. Correspondingly, the outlet recesses 29 are circumferentially-spaced in equal increments about the member 20 with each recess 29 extending inwardly from the end face 81 and opening to the internal periphery of the member 20. In FIG. 4, it should be noted that one edge of the recesses 28 and 29 extends from a radius of member 20 so that the recesses 28,29 are spaced a slight angle α ahead of or behind the center of the associated chamber depending on the direction of rotation of member 20 and whether the recess 28 or 29 is an inlet or outlet passage.

Because each volume chamber 22 is defined as extending between adjacent roller teeth 21 of member 20, the width of each discontinuous recess 28,29 is shown as extending from a roller tooth 21 to a point defining one-half the distance between adjacent roller teeth. Importantly the discontinuous recesses are so positioned with respect to the roller teeth 21 of the member 20 that the inlet side discontinuous recesses 28 appear as the mirror image of outlet side recesses 29 in the same manner as that discussed above for the inlet and outlet valving passages 26,27. Thus as shown in FIGS. 4 and 6, an inlet recess 28*x* is disposed adjacent roller tooth 21*x* as opposed to outlet recess 29*x* which is disposed adjacent roller tooth 21*y*. The space between roller teeth 21*x* and 21*y* defines one volume chamber 22*x*. Additionally the height of each discontinuous recess 28,29 extend beyond the valving passages 26,27 a distance at least equal to the eccentricity *e* of the device.

As thus described, at a given time and in a given position during operation, and as best shown in FIGS. 4 and 6, N/2 inlet passages 26 will communicate with discontinuous recesses 28 leading to expanding volume chambers lying on one side of the line of eccentricity and N/2 outlet passages 27 will communicate with discontinuous recesses leading to contracting volume chambers on the other side of the line of eccentricity. This relationship is assured in the embodiment illustrated by the dimensional sizing of passages 26,27 and recesses 28,29. More particularly if the width of a volume chamber is defined as that peripheral distance betwen radial lines extending from the center of the housing or axis 64 and bisecting adjacent rollers, and approximately one-half of that distance is occupied by the roller teeth, the remaining half-distance is divided equally between the discontinuous recesses 28,29. Likewise the valving passages 26,27 also encompass substantially the same width as recesses 28,29 to assure adequate fluid flow therebetween. It will be appreciated by those skilled in the art that valve timing may be adjusted by varying the widths of passages 26,27 and recesses 28,29.

It should further be appreciated that at the inlet side, each particular inlet passage 26*a* is always associated with the same recess 28*x* and the same volume chamber 22*x*. The same relationship is true at the outlet side. This materially aids in simplifying manufacture and assembly of the device.

Valving arrangement C also includes a pressure relief groove 86 extending diagonally from one axial end face of the gerotor assembly B to the opposite axial end face of the gerotor assembly as shown in FIGS. 2,4,5, and 6.

OPERATION

Housing assembly A is fixed to a support fixture (not shown) which grasps the flat facings 50 of inlet and outlet fittings 48,49 to prevent the inlet and outlet shaft 12 from rotating. A belt (not shown) having three separate width sections is applied around the exterior surface of housing assembly A, each belt section fitting between and being guided by the outwardly-extending spacing discs 36.

Fluid supplied under pressure from a pump (not shown) is introduced into the inlet passage 78 whereupon it travels through the inlet radially-extending passages 76 into the inlet annular feed opening 74 and from thence into inlet valving passages 26, all valving passages 26 being under high pressure. Because of the geometrical relationship between valving passages 26,27 and recesses 28,29 as shown in FIGS. 4 and 6, communication of high pressure occurs only between those inlet valving passages 26 and inlet recesses 28 which are aligned with expanding volume chambers 22 lying on one side of the line of eccentricity (Y—Y axis in FIGS. 4 - 6). Likewise on the low pressure side of the device, the contracting volume chambers 22 communicate only with outlet valving passages 27 via their respective outlet recesses 29. The fluid is then exhausted from the device by passing from the outlet valving passages 27 through the outlet annular feed opening 75 into the outlet radially-extending passages 78 and from thence through the outlet passage 79 to a reservoir (not shown). It should be noted that during operation, the members 24 and 25 rotate in synchronism with both the housing 16 and internally toothed member 20. However, since member 20 also is orbiting, the inlet and outlet recesses 28,29 in member 20 each have a complex orbiting motion with respect to their associated inlet or outlet passages 26,27. It is this complex relative motion which provides the fluid communication necessary for operation of the device.

High pressure thus introduced into the inlet side of the device causes the ring member 20 to rotate and orbit about the star member 18 in a counterclockwise direction as shown in FIG. 5. However, only the rotational movement of the member 20 can be transmitted to the ring-roller casing 16 through the drive pins 70 thus causing rotation of housing assembly A to drive a belt or the like. Reversing inlet and outlet pressure connections produces rotation in the opposite direction.

Additionally it should be noted that drive pins 70 are lubricated by fluid leaking from the slight shaft clearance 60 on the high pressure side of the device which is communicated to the drive pin 70 via the inlet drilled hole 52 and inlet lubricating passages 56,58. The fluid is exhausted from the clearance between the member 20 and ring-roller casing 16 by the outlet drilled hole 53 and lubricating passages 57,59 in the outlet casing 15. As in the inlet side of the device, the fluid travels from the shaft clearance 61 into the annular outlet feed opening 75 thence through the radially-extending outlet passages 77 into the outlet passage 79.

In accordance with another aspect of the invention axial end face leakage occuring on the high pressure side of the gerotor arrangement B is transferred by a pressure relief groove 86 to the low pressure axial end face where it is exhausted through outlet valving chambers 27, in the normal manner. While the invention has been described with reference to a motor application thereof, it is apparent that the device could similarly function as a pump by supplying fluid to the device at low pressure and rotating the housing assembly A.

The invention has been described with reference to a preferred embodiment. Obviously other modifications and alterations will occur to others upon reading and understanding of the specification. It is my intention to include all such modifications and alterations insofar as they come within the scope of the present invention.

It is thus the essence of my invention to provide a new and improved valving arrangement which simplifies the structure of the gerotor type devices in which it is applied.

Having thus described my invention, I now claim:

1. A pulley motor of the gerotor type comprising:

a one-piece shaft having an externally-toothed member extending over a central portion thereof, said shaft having tubular portions at its opposite ends to define a fluid inlet and a fluid outlet for said motor;

a first hollowed cylindrical casing section disposed around said shaft at one side of said externally toothed member and journalling said shaft therein;

a second hollowed cylindrical casing section disposed at the other side of said externally toothed member and journalling said shaft therein;

a cylindrical ring casing member interposed and secured to said first and second casing sections to define a housing;

an internally-toothed member having more teeth than said externally toothed member and being eccentrically disposed for movement relative to said externally toothed member, the teeth of said members interenmeshing to define contracting and expanding volume chambers during relative movement therebetween;

said internally toothed member being disposed within said ring casing member;

drive means co-acting between said ring casing member and said internally toothed member and operable to rotate said ring casing member in response to hypocycloidal movement of said internally toothed member about said externally toothed member; and

valve means operable between said inlet at one end of said shaft and said outlet at the other end of said shaft to connect said inlet to the expanding volume chambers and said outlet to contracting volume chambers to cause said internally toothed member to hypocycloidally move about said externally toothed member;

said valve means including first and second valve members mounted in said housing for rotation therewith adjacent opposite ends of said internally toothed member,

said valve members each having a plurality of flow passages therein, the number of flow passages in each member being equal to the number of volume chambers, a particular one of said flow passages in each member being associated with a particular one of said volume chambers, and

said internally toothed member having a like plurality of flow recesses in each axial end surface thereof, the arrangement of said recesses being such as to provide a fluid flow path between the expanding chambers and their associated passages in said first valve member and between the contracting chambers and their associated passages in said second valve member through said recesses during movement of said internally toothed member relative to said externally toothed member.

2. A fluid-operated device of the gerotor type comprising:

a housing;

a ring casing member forming a portion of said housing;

an internally-toothed member disposed within said ring casing member;

drive means operably associated between said internally toothed member and said ring-casing member to transmit rotational driving motion therebetween while permitting relative orbital motion therebetween;

a shaft member journalled in said housing for rotation relative thereto and defining a fluid inlet and a fluid outlet at opposite axial ends thereof;

an externally-toothed member with less teeth than said internally toothed member mounted on said shaft and extending over a portion thereof;

said internally toothed member being eccentrically disposed for rotational and orbital motion relative to said externally toothed member;

the teeth of said members interenmeshing to form a predetermined number of expanding and contracting volume chambers during relative movement therebetween;

the axes of said members defining a moving line of eccentricity during operation of said device to divide the expanding volume chambers from contracting volume chambers; and

valve means for providing fluid communication between said inlet and those volume chambers on one side of said line of eccentricity, and for providing fluid communication between said outlet and those volume chambers on the other side of said line;

said valve means including a first valve member having a plurality of first fluid passages therein, a second valve member having a plurality of second fluid passages therein, all of said first passages having constant fluid communication with said inlet and all of said second passages having constant fluid communication with said outlet, said first and second valve members being fixedly secured in said housing to prevent relative motion therebetween, and each axial end face of said internally toothed member having a plurality of circumferentially arranged, equally spaced, discontinuous recesses therein, each of said recesses extending from an axial end face of said internally toothed member and opening to the internal periphery of said member adjacent a volume chamber, said recesses cooperating with said passages to alternately provide a fluid flow path to and from each of said volume chambers during orbital motion of said internally toothed member.

3. The fluid-operated device of claim 2 wherein said valving passages and said recesses at one axial end face of said internally toothed member are orientated in the mirror image of said recesses and valving passages at the opposite axial end of said member.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,846,051 Dated November 5, 1974

Inventor(s) Hugh L. McDermott

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 14, "in" should read -- on --.

Column 6, line 49, after "28,29" insert -- must --.

Signed and sealed this 7th day of January 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

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