United States Patent [19]

Woodling

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[45] **Mar. 27, 1973**

[54] **ANTI-FRICTION ORBITAL AND ROTARY DEVICE**

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[21] Appl. No.: **131,130**

[52] **U.S. Cl.** **418/61,** 418/113, 418/117, 418/124

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

[58] **Field of Search**.....418/56, 61, 113, 117, 143, 418/152, 225, 124

[56] **References Cited**

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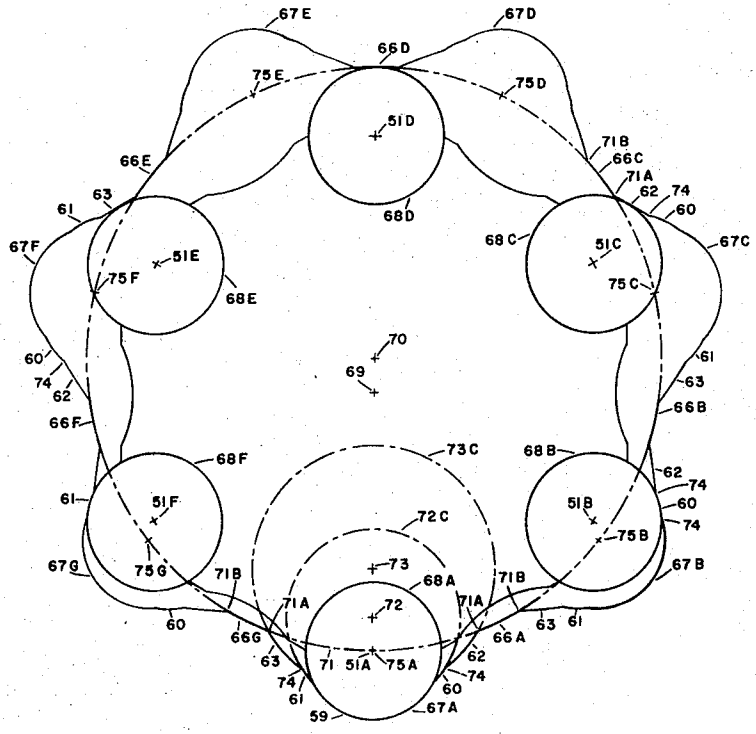
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Assistant Examiner—John J. Vrablik
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[57] **ABSTRACT**

Orbital and rotary device including outer and inner relatively movable body means having a combined relative movement therebetween comprising a relative orbital movement and a relative rotational movement, wherein said inner body means has anti-friction bearing means for making engagement with the internal surface of said outer body means, and wherein all of the contactable wall portions between the inner and outer body means point outwardly in the same direction.

17 Claims, 16 Drawing Figures



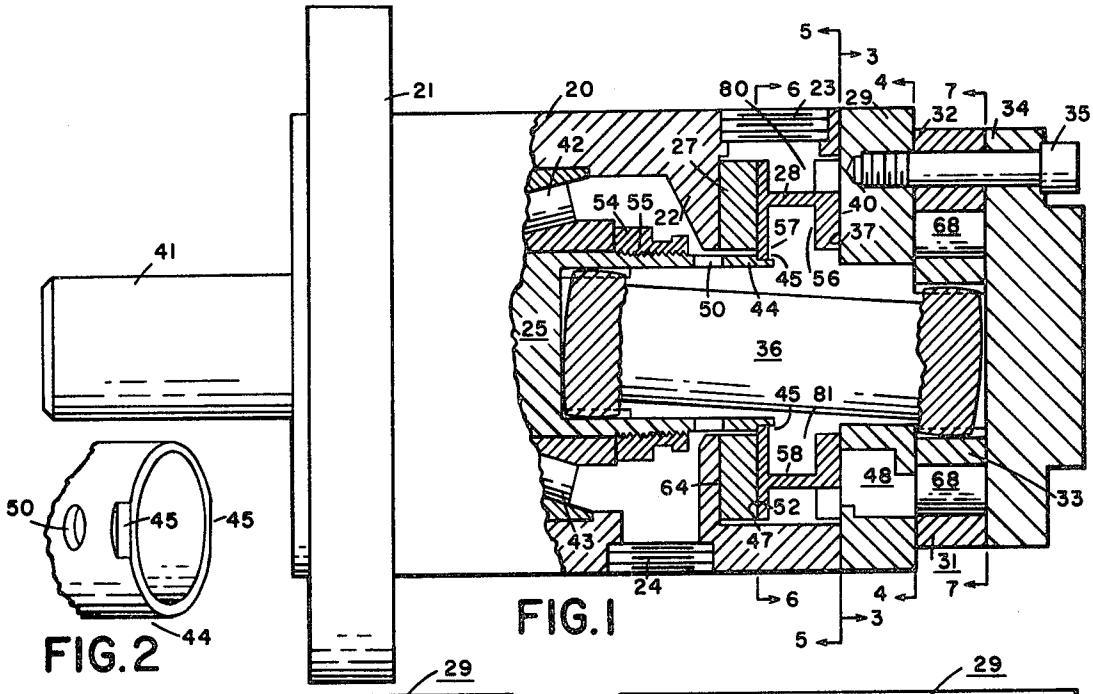


FIG. 1

FIG. 2

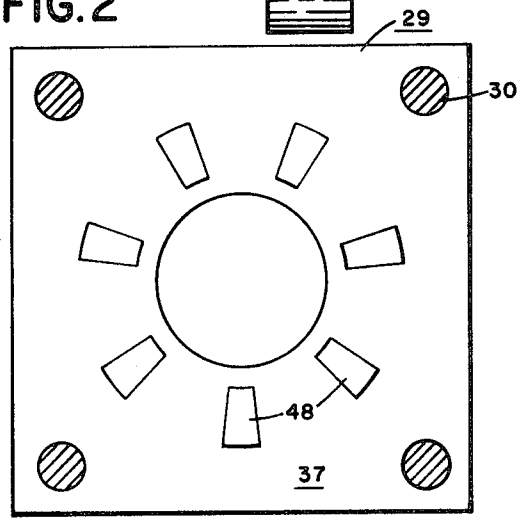


FIG. 3

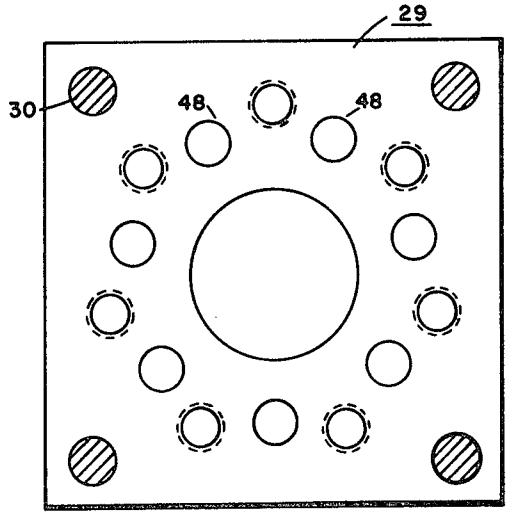


FIG. 4

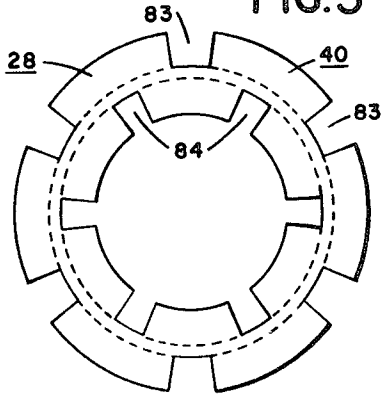


FIG. 5

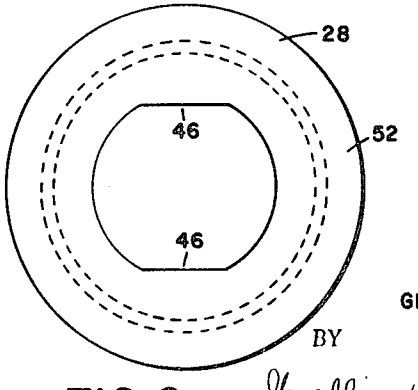


FIG. 6

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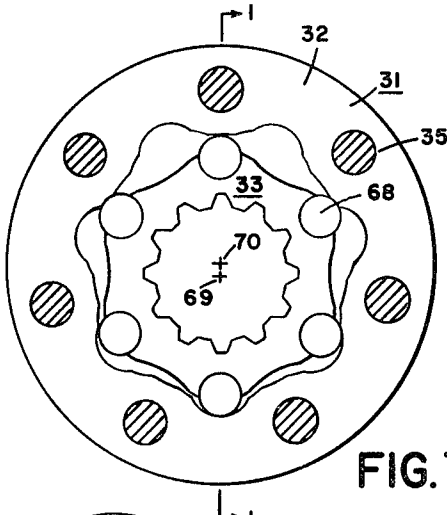


FIG. 7

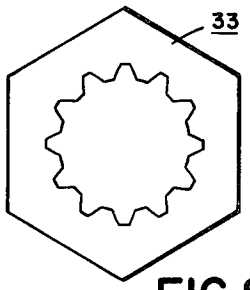


FIG. 8

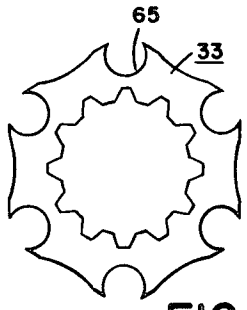


FIG. 9

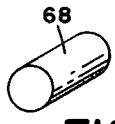


FIG. 10

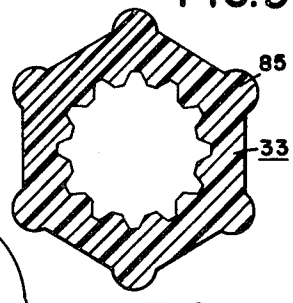


FIG. 14

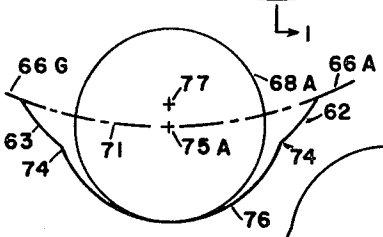


FIG. 12

FIG. 11

FIG. 13

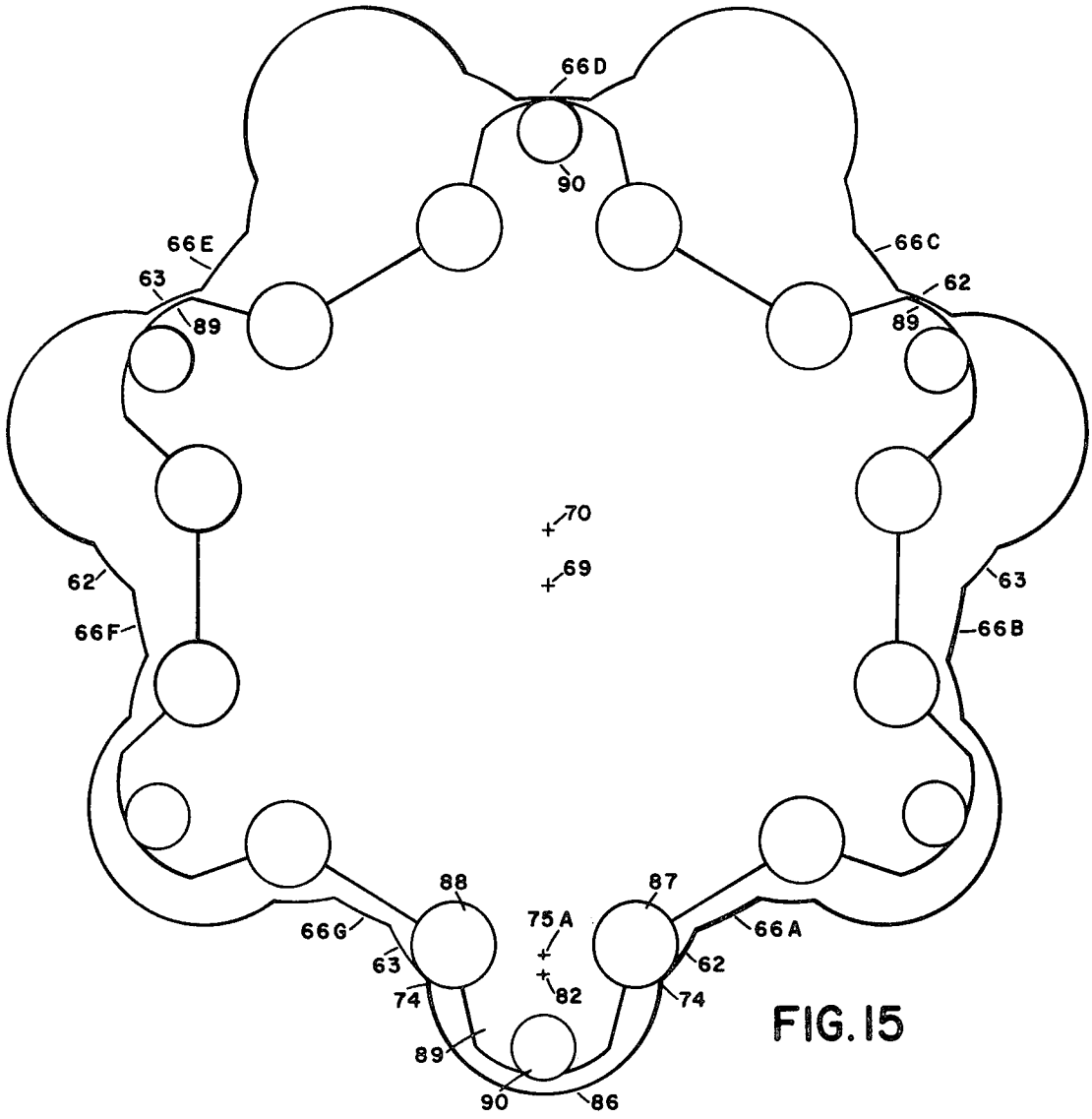


FIG. 15

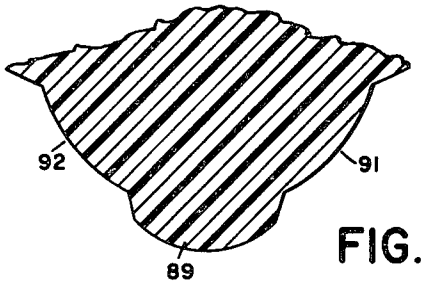


FIG. 16

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ANTI-FRICTION ORBITAL AND ROTARY DEVICE

BACKGROUND OF THE INVENTION

A useful application for applicant's present device is that for a stator-rotor mechanism in a fluid pressure device. It is found that the mutually engageable wall means between the stator and rotor of a conventional stator-rotor mechanism are disposed to have a considerable amount of frictional wear which reduces the over-all efficiency of the fluid pressure device.

My U.S. Pat. No. 3,591,320, application Ser. No. 814,300 shows anti-friction cylindrical rollers cage-mounted in the stator (outer body member). In this arrangement, the rollers, naturally, have to be relatively large in order to accommodate the external arcuate contours of the rotor (inner body member), all of which means that the entire mechanism is proportionally larger than a conventional non-roller type. In my present invention, provision is made to cage-mount cylindrical rollers on the rotor, whereby the entire stator-rotor mechanism may be substantially the same size as that for the conventional non-roller type.

Another objection found in the conventional non-roller stator-rotor mechanism is that both the stator and rotor have "male" engaging tips, that is, tips which point toward each other. Naturally, the high points of these male tips are subject to an excessive amount of wear because the tips work "up-hill" against each other. My present invention obviates this "up-hill" relationship and includes a female-male tracking relationship between the stator and rotor which accommodates cage-mounted rollers on the rotor, a provision, heretofore, considered impossible.

Accordingly, it is an object of my invention to provide cage-mounted rollers on the rotor of a stator-rotor mechanism.

Another object is the provision of a female-male tracking relationship between the stator and rotor.

Another object is the provision of anti-friction bearing means on the rotor.

Another object is the provision wherein one of said stator and rotor members have substantially a fixed axis and bearingly supports the other.

Still another object is the provision wherein the tracking relationship includes a circumferential stator internal wall having a plurality of sockets disposed therearound at substantially equally spaced annular intervals.

Another object is where the rotor includes a polygon having cylindrical rollers cage-mounted on the corner portions thereof.

Another object is where the rotor has twin-rollers cage-mounted therein.

Still another object is where the rotor makes at least a three-point bearing contact with the stator.

Another object is the provision where the female-male tracking relationship includes a plurality of sockets connected together by a plurality of bridging walls.

Still another object is where the sockets have a circumferential width at least substantially three times that of the bridging walls.

Another object is the provision where at least one of the stator and rotor members is constructed of anti-friction plastic material.

SUMMARY OF THE INVENTION

The invention constitutes orbital and rotary means including inner and outer relatively movable body means having a combined relative movement therebetween comprising a relative orbital movement and a relative rotational movement, said outer body means having internal tracking means including a plurality of substantially circumferential tracking bridge wall means and a plurality of socket wall means alternately disposed therebetween, said inner body means including a plurality of polygonally disposed substantially cylindrical roller means respectively adapted to engage said tracking bridge wall means and said socket wall means in successive order in response to said combined relative movement, said plurality of roller means being less in number than that of said plurality of socket wall means.

Other objects and a fuller understanding of this invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial, elongated sectional view of a fluid pressure device embodying the features of my invention, the section being taken along the line 1—1 of FIG. 7;

FIG. 2 is a representation of a male shank provided on a terminal end portion of a hollow shaft adapted to slidably fit within a female socket of a rotary valve;

FIG. 3 is a view of the front side of a stationary valve, taken along the line 3—3 of FIG. 1;

FIG. 4 is a view of the back side of the stationary valve, taken along the line 4—4 of FIG. 1;

FIG. 5 is a view of the front side of a rotary valve, taken along the line 5—5 of FIG. 1;

FIG. 6 is a view of the back side of the rotary valve, taken along the line 6—6 of FIG. 1;

FIG. 7 is an end view of my stator-rotor mechanism, taken along the line 7—7 of FIG. 1, under the end cap;

FIG. 8 is an end view of a polygon body from which my rotor may be constructed;

FIG. 9 shows the corner portions of the polygon body of FIG. 9 provided with cage-pockets and with the side portions dished-out to provide clearance spaces;

FIG. 10 shows a cylindrical roller adapted to fit into a cage-pocket;

FIG. 11 is a diagrammatical illustration showing the basis for the construction of the stator-rotor mechanism of FIG. 7;

FIG. 12 shows a modification of the stator-sockets in FIG. 11;

FIG. 13 shows a further modification of the stator sockets in FIG. 11;

FIG. 14 shows the rotor of FIG. 7 made of anti-friction plastic material, the view illustrating a cross-section thereof;

FIG. 15 shows a modified stator-rotor mechanism, diagrammatically illustrated;

FIG. 16 shows a fragmentary view of a rotor for FIG. 15 made of anti-friction plastic material, the view illustrating a cross-section thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The fluid pressure device in which my invention may be incorporated may comprise a fluid motor or any other fluid device having a fluid valve.

With reference to the drawings, the fluid pressure device in which my invention may be incorporated comprises generally a main housing **20** having substantially a square cross-section. A mounting flange **21** may be secured to the left-hand end of the housing by means of suitable screws (not shown). The housing is hollow from end-to-end, and intermediate the ends of the housing there is provided an annular internal rim **22** which generally separates the hollow housing into a left-hand end compartment and a right-hand end compartment.

Rotatively mounted in the left-hand end compartment is a main load shaft **25** having an axis substantially coinciding with the longitudinal axis of the fluid pressure device. The main shaft **25** comprises an enlarged internal portion having a reduced external portion **41** extending axially outwardly of the main housing through the mounting flange **21**. The enlarged internal portion of the main shaft is supported preferably by tapered roller bearings **42** and **43** which provide end thrust as well as radial thrust. A lightening nut **54** which threadably engages male threads **55** secures the bearings **42** and **43** against axial movement upon the main shaft. The tightening nut **54** may be provided with a built-in locking feature to prevent loosening.

On the right-hand end of the hollow housing **20**, there is mounted a square stationary valve member **29** by means of screws **30**. The stationary valve member **29** has a stationary valve face **37**. The annular internal rim **22** has reaction wall means **64** facing the stationary valve face **37** and is axially spaced therefrom. Between the stationary valve face **37** and the reaction wall means **64**, there are mounted rotary valve means **28** and bushing means **27**. The rotary valve means **28** is adapted to be rotated relative to the stationary valve member **29** for controlling the entrance of fluid to and the exit of fluid from a stator-rotor mechanism **31** comprising a stator **32** and a rotor **33**. An end cap **34** encloses the stator-rotor mechanism **31**. The stator-rotor mechanism **31** and the end cap **34** are secured to the stationary valve member **29** by means of screws **35**. Fluid is delivered to and from the housing **20** through a pair of fluid ports **23** and **24**. An interconnecting shaft **36** interconnects the main shaft **25** and the rotor **33** of the stator-rotor mechanism **33** and is adapted to transmit torque therebetween.

The bearings **42** and **43** constitute common bearing means for the main shaft **25** and the rotary valve means **28**. The common bearing means directly supports the main shaft **25** and indirectly supports the rotary valve means **28** through extension drive means comprising a hollow shaft **44** integrally connected to the main shaft **25**. The hollow shaft **44** extends axially through the internal rim **22** into the right-hand end compartment and makes a driving connection with the rotary valve means **28** for driving same. The hollow shaft **44** terminates with a male shank **45** which slidably fits within a female socket **46** provided in the rotary valve means **28**, see FIG. **6**. This connection comprises a non-rotative connection and rotates the rotary valve means **28** upon rotation by the main shaft. This connection also provides slidable axial movement between the rotary valve means **28** and the hollow shaft **44** to accommodate for axial movement of the load shaft without interfering with the operation of the rotary valve means **28**. The axial slidable movement which is permitted between the male shank **45** and the female socket **46** is greater than the maximum distance that the load shaft **25** may be moved in an axial direction during operation. As illustrated in FIG. **1**, the rotary valve means **28** and the right-hand housing compartment in which it is mounted has a radial clearance **47** therebetween to accommodate for radial movement of the main shaft **25** without interfering with the operation of the rotary valve means **25**. The radial clearance **47** is greater than the maximum distance that the main shaft **25** may move in a radial direction during operation. The radial clearance **47** also extends between the bushing means **27** and the main housing.

The rotary valve means **28** is generally H-shaped in cross-section and comprises first and second opposite body sides or flanges **56** and **57** interconnected by an annular cross-bar **58**. The first flange **56** has a rotary valve face **40** (FIG. **5**) which is constrained against the stationary valve face **37**. The second flange **57** has engageable face wall means **52** which faces the reaction wall means **64**. The bushing **27** is mounted between the engageable face wall means **52** and the reaction wall means **64**.

As illustrated in FIG. **1** the rotary valve means **28** and the bushing means **27** both have external wall means and internal wall means. The external wall means defines a first fluid chamber means **80** in constant fluid communication with the fluid port **23**. The internal wall means defines a second fluid chamber means **81** in constant fluid communication with the fluid port **24** through openings **50** in the hollow shaft **44**.

As shown, the fluid chamber means **80** and **81** are in valve communication with the stator-rotor mechanism. The valve communication to and from the first fluid chamber means **80** is provided through fluid conduction means **83** in the outer flange portion of the flange leg **56** of the rotary valve means. The valve communication to and from the second fluid chamber means **81** is provided through fluid conduction means **84** in the inner flange portion of the flange leg **56** of the rotary valve means. The fluid conduction means **83** and **84** are disposed to register, upon rotation of the rotary valve means, with a plurality of fluid openings **48** provided in the stationary valve member **29** which communicate with the stator-rotor mechanism.

The operation of the rotary valve means **28** in commutation with the stationary valve member **29** is such that there is a first series of commutating fluid connections between the fluid port **23** and the stator-rotor mechanism and a second series of commutating fluid connections between the stator-rotor mechanism and the fluid port **24**. The commutating valve action, and the flow of fluid between the fluid ports **23** and **24** and the stator-rotor mechanism is substantially the same as that shown and described in my U.S. Pat. No. 3,405,603.

My stator-rotor mechanism **31**, which comprises the stator **32** and the rotor **33**, has a female-male tracking

arrangement. As illustrated in FIGS. 7 and 11, the stator has internal female tracking means including a plurality of substantially circumferential tracking bridge wall means 66A to 66G and an equal number of a plurality of socket wall means 67A to 67G alternately disposed therebetween. The rotor 33 includes a polygon body having its corner portions provided with cage-pockets 65 which respectively receive a substantially cylindrical roller 68, whereby the rollers are polygonally disposed with respect to a rotor axis 69. The tracking bridge wall means 66A to 66G and the socket wall means 67A to 67G are annularly arranged with respect to the stator axis 70, whereby the stator and rotor, upon the application of fluid power to the mechanism, have a combined relative movement therebetween, which comprises a relative orbital movement and a relative rotational movement. The plurality of rollers 68, numbered 68A to 68F, are one less in number than that of the plurality of socket wall means and respectively have centers 51A to 51F. Thus, there are (n) number of socket wall means and $(n-1)$ number of rollers. Accordingly, the rollers are disposed substantially $360°/n-1$ apart from each other, whereas the socket wall means are disposed substantially $360°/n$ apart from each other. In the drawings, (n) equals 7, and $(n-1)$ equals 6. Upon the application of fluid power and in response to the combined relative movement thereof, the rollers are adapted to engage the tracking bridge wall means and the socket wall means in successive order. In FIG. 11, the profile contour of the socket wall means 67A to 67G are respectively illustrated as being located about stator-points 75A to 75G. The stator-point 75A coincides with the center 51A of the roller 68A.

As shown, the socket wall means 67A to 67G respectively comprise an intermediate socket wall 59, a first pair of diverging side wall means 60 and 61 and a second pair of diverging side wall means 62 and 63, see, for example, the socket wall means at 67A. The diverging side wall means interconnect the intermediate socket wall 59 with the tracking bridge wall means. In FIG. 11, the intermediate socket wall 59 comprises a portion of substantially a cylindrical wall having a diameter substantially equal to the diameter of the respective rollers. The socket wall means 67A to 67G have substantially like profile contours and are annularly located with respect to a stator or reference circle 71, illustrated by a dash-dot line. The stator or reference circle 71 constitutes a basis for establishing the tracking bridge wall means 66A to 66G and for locating the stator-points 75A to 75G.

The diverging side wall means are disposed to provide a side socket clearance when the rollers are entering and leaving the socket wall means. The first pair of diverging side wall means 60 and 61 are respectively disposed to provide a side socket clearance for the rollers when occupying a position as shown at 68B and 68F, and the second pair of diverging side wall means 62 and 63 are respectively disposed to provide side socket clearance for the rollers when occupying a position at 68C and 68E. Thus, for example, the diverging side wall 60 has a profile contour that substantially matches that portion of the cylindrical roller 68B which is contacting it at 67B. Accordingly, the diverging side wall means 60 comprises a portion of a cylindrical wall having a center substantially coinciding with the center 51B of a cylindrical roller at 68B. The diverging side wall means 62 at 67C, for example, comprises a portion of a cylindrical wall which may be established by drawing an arc about a center which substantially coincides with the stator-point 75A, the arc passing through a point 71A on the stator circle 71. The point 71A is a terminal end of a tracking bridge wall means. The point 71B is the other terminal end of the tracking bridge wall means. The circumferential length of a tracking bridge wall means is arranged to be substantially equal to the circumference of the stator or reference circle 71 divided by the product of (n) times $(n-1)$. The respective tracking bridge wall means is located midway between two adjacent stator-points. The diverging side wall means 62 defines a juncture with the diverging side wall means 60 at 74. The socket wall means have a circumferential width at least substantially three times that of the tracking bridge wall means. The drawings show the circumferential width of the socket wall means to be more than three times that of the tracking bridge wall means.

In manufacture, the tracking bridge wall means 66A to 66G may be circle-machined about a center substantially coinciding with the stator axis 70. The diverging side wall means 60 and 61 may be circle-machined about a selected center 72 which generates a side wall matching circle 72C shown by a dash-dot line. Likewise, the diverging side wall means 62 and 63 may be circle-machined about a selected center 73 which generates a matching side wall circle 73C, shown by a dash-dot line. The circle-machining provides a profile contour that is substantially perfect and thus clearancewise accommodates for the combined relative movement between the stator and the rotor, whereby a close tracking tolerance is maintained between the rotor and the stator. The surfaces defining the close tracking tolerance between the rotor and stator function as bearing surfaces and thereby bearingly stabilize the relative orbital and the relative rotational movement between the stator and rotor. Consequently, if the stator, for example, is stationarily mounted and if the rotor is axlelessly mounted therein, the stator will bearingly support the rotor for relative movement. Under a reverse mounting situation, the rotor will bearingly support the stator for relative movement. As shown in FIG. 7 and 11, the roller 68A and the two rollers respectively at 68C and 68E make a three-point contact with the stator. Also, the roller 68A and the two rollers 68B and 68F make a three-point contact with the stator. These three-point contacts bearingly stabilize the rotor within the stator. While FIGS. 7 and 11 show two, three-point contacts, only one is necessary for bearing stabilization.

The socket wall means 67A to 67G may be characterized as constituting female (concave) wall means and the rollers 68A to 68F may be characterized as constituting male (convex) wall means. Also, the tracking bridge wall means 66A to 66G may be characterized as constituting female wall means. Upon relative movement between the stator and the rotor, there is no male-to-male contact which may readily wear out, as in the case of a conventional non-roller stator-rotor mechanism.

When fluid operated, the rotor **33** defines with the stator **32**, a pressure chamber and an exhaust chamber which are sealed from each other at two diametrical locations; namely, where the roller **68A** contacts the socket wall means **67A** and where the roller **68D** contacts the tracking bridge wall means **66D**. There are three provisions which makes the fluid seal between the two chambers effective even where there may be some wear or where the clearance tolerance may be machined slightly on the loose side. Thus let it be supposed that the pressure chamber in FIGS. **7** and **11** is on the right side and that the exhaust chamber is on the left-side. In this situation, the pressure tends to urge the roller at **68A** to the left against the left-side of the bottom wall of the socket wall **59**. This makes an effective seal therebetween. As a second provision, the relationship between the roller at **68A** and the bottom of the socket wall **59** produces a mechanical wedging action and thereby tends to urge the roller at **68D** against the tracking bridge wall means **66D** for making an effective seal therebetween, even where there may be some wear or where the machine tolerance may be on the loose side. It is to be noted that it is not necessary that the rollers at **68B** and **68C** under this situation make a sealing contact with the stator. The third provision is that the fluid tends to urge the rollers in the cage-pockets outwardly against the track wall means. The rollers may fit relatively loose in the cage-pockets, whereby the fluid may flow to the bottom of the cage-pockets for urging the rollers outwardly.

FIG. **12** shows a modified socket arrangement, in that the intermediate socket wall, now numbered **76**, has been enlarged in diameter and is drawn about a new center **77**, whereby the bottom part of the modified socket is still contacted by the rollers. The modified socket wall **76** intersects the juncture point **74**, with the result that the diverging side wall **60** and **61** are now merged into the modified enlarged socket wall **76**. The modified socket arrangement shown in FIG. **12** is embodied in the stator-rotor mechanism shown in FIG. **7**.

FIG. **13** is a reverse arrangement to that in FIG. **12**, in that the intermediate socket wall **59** remains the same size, but the diameters of the rollers, now numbered **78**, have been reduced to produce an equivalent clearance in the socket. The smaller rollers **78** have a new center **79**.

FIG. **14** shows the rotor for FIG. **7** made of anti-friction plastic material. The rotor is totally solid and will operate substantially the same as the rotor with rollers for some applications where the load is not too heavy.

FIG. **15** shows a modified stator-rotor mechanism with the rollers re-arranged from that shown in FIGS. **7** and **11**. The rotor in FIG. **15** has twin-rollers (instead of one) cage-mounted in the inside corner portions of the polygon. The twin rollers are numbered **87** and **88** and are adapted to bearingly engage the diverging side wall means **62** and **63** in response to the combined relative movement between the stator and rotor. The arrangement shown in FIG. **15** is particularly adapted for deep socket operation, where the eccentricity is relatively large. Thus the intermediate socket wall **86** is relatively deep and is generated about a center **82** below the stator-center **75A**. The intermediate socket wall **86** still intersects the juncture **74**. Extending outwardly from, and between the twin rollers **87** and **88**, there is provided a center tip portion **89** having a sealing roller **90** which is spaced from the intermediate wall **86**. The rotor in FIG. **15** is substantially a polygon body with the tip portions **89** extending outwardly from the corner portions thereof. The tip portions **89** have sides defining juncture portions with the sides of said polygon body. The juncture portions have cage-pockets therein to receive the twin rollers. The primary purpose of the sealing roller **90** is to provide a fluid seal with the tracking bridge wall means substantially diametrically opposite the socket. The major part of the bearing load is carried by the twin-rollers to provide anti-friction operation. It is to be observed that the rotor in FIG. **15** shows at least a three-point contact engagement with the stator; namely where the twin rollers engage a pair of diverging side wall means **62** and **63** and where the two opposing top tip portions **89** are about ready to respectively engage the diverging side wall means **62** and **63**. The rotor is thus bearingly stabilized in the stator.

FIG. **16** shows a rotor for FIG. **15** made of an anti-friction plastic material. The twin-bulged portions **92** and **91** ride on the diverging side wall means **62** and **63**, and the operation is substantially the same as that for the twin rollers.

In all the embodiments, the female socket means have a circumferential width at least substantially three times that of the tracking bridging wall means, whereby there is no tracking interference.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. Fluid pressure means including inner and outer relatively movable body means, said body means being relatively rotatable, one of said body means being rotatable about an axis displaced relative to that of the other body means, said inner and outer body means respectively having male and female teeth disposed to intermesh with each other and define fluid chamber means, said male teeth being one less in number than that of said female teeth, said outer body means comprising an annular body surrounding said inner body means and having internal wall means defining said female teeth, said male and female teeth respectively having male and female contactable wall portions, all of said male contactable wall portions respectively comprising segmental male cylindrical wall means, all of said female contactable wall portions comprising an annular series of successive segmental female cylindrical wall means, all of said female teeth respectively including at least three of said successive segmental female cylindrical wall means, and passages communicating with said fluid chamber means for flow of fluid thereto and therefrom.

2. The structure of claim **1**, wherein all of said male teeth respectively comprise rotatable means journalled in said inner body means.

3. The structure of claim 1, wherein said male and female teeth intermeshingly form expanding and contracting fluid chambers upon relative movement of said inner and outer body means.

4. The structure of claim 1, wherein said successive segmental female cylindrical wall means all have angularly related juncture means therebetween.

5. The structure of claim 1, wherein certain ones of said segmental female cylindrical wall means respectively define female socket wall means.

6. The structure of claim 5, wherein other certain ones of said segmental female cylindrical wall means respectively define bridge wall means.

7. The structure of claim 6, wherein said female socket wall means respectively include an intermediate female socket wall and oppositely disposed diverging female side walls extending to said bridge wall means.

8. Orbital and rotary means including inner and outer relatively movable body means having a combined relative movement therebetween comprising a relative orbital movement and a relative rotational movement, said outer body means having internal tracking means including a plurality of substantially circumferential tracking bridge wall means and a plurality of socket wall means alternately disposed therebetween, said inner body means including a plurality of polygonally disposed substantially cylindrical roller means respectively adapted to engage said tracking bridge wall means and said socket wall means in successive order in response to said combined relative movement, said plurality of roller means being less in number than that of said plurality of socket wall means, all of said tracking bridge wall means respectively comprising segmental female cylindrical wall means, and all of said socket wall means respectively comprising a series of successive segmental female cylindrical wall means.

9. The structure of claim 8, wherein socket wall means respectively include an intermediate socket wall and diverging side wall means extending outwardly therefrom to said tracking bridge wall means.

10. The structure of claim 8, wherein said inner body means includes substantially a polygon body having cage-pockets in the corner portions thereof, said roller means being mounted in said cage-pockets.

11. The structure of claim 8, wherein said roller means include twin-rollers adapted to engage said socket wall means.

12. The structure of claim 8, wherein said inner and outer relatively movable body means comprise respectively stator means and rotor means defining fluid chamber means, and valve means for controlling the entrance of fluid to and the exit of fluid from said chamber means.

13. The structure of claim 8, wherein said tracking bridge wall means lie substantially on a reference circle, and wherein said socket wall means respectively have a center which lies on said reference circle.

14. The structure of claim 13, wherein the circumferential length of the respective tracking bridge wall means is substantially equal to the circumference of said reference circle divided by a product number equal to the number of socket wall means multiplied by the number of roller means.

15. The structure of claim 13, wherein said socket wall means has a circumferential width substantially at least three times that of said tracking bridge wall means.

16. Orbital and rotary means including inner and outer relatively movable body means having a combined relative movement there-between comprising a relative orbital movement and a relative rotational movement, said outer body means having internal tracking means including a plurality of substantially circumferential tracking bridge wall means and a plurality of socket wall means alternately disposed therebetween, said inner body means including a plurality of polygonally disposed substantially cylindrical roller means respectively adapted to engage said tracking bridge wall means and said socket wall means in successive order in response to said combined relative movement, said plurality of roller means being less in number than that of said plurality of socket wall means, said inner body means includes substantially a polygon body having projecting tip portions extending outwardly from the corner portions thereof, said tip portions having sides defining juncture portions with said polygon body, said juncture portions having cage-pockets therein, said roller means being mounted in said cage-pockets.

17. The structure of claim 16, wherein said tip portions respectively has a tip cage-pocket therein, and substantially cylindrical roller means mounted in said tip cage-pockets.

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