United States Patent

Woodling

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[54] **FLUID PRESSURE RESPONSIVE MECHANISM IN A FLUID PRESSURE DEVICE**

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[52] **U.S. Cl.** **418/61**, 418/125, 418/225, 418/249

[51] **Int. Cl.**..........**F01c 1/02**, F03c 3/00, F01c 19/00

[58] **Field of Search**........418/61, 124, 125, 129, 166, 418/170, 171, 174, 225, 249

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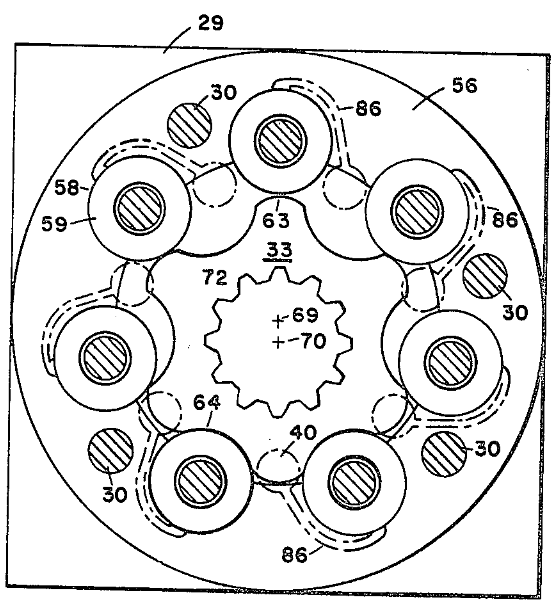
[57] **ABSTRACT**

Fluid pressure responsive mechanism in a fluid pressure device including first and second internal fluid chamber housing means and fluid pressure operating means, wherein said fluid pressure operating means include first and second pressure containing means mountable for relative movement. Said first fluid containing means surrounds said second containing means and defines therewith operating chamber means and includes at least an open pocket having a major closed side and a minor open side in communication with said operating chamber means. Said second containing means has at least a contractable portion. Said open pocket has fluid pressure responsive means mounted therein with a minor portion exposed through said minor open said of said pocket for contact with said contractable portion. Said pocket is pressurized by fluid from said first and second fluid chamber housing means through internal wall conduction means extending internally from said fluid chamber housing means and leading internally to said pocket. When the pocket is pressurized, the exposed minor portion of said fluid pressure responsive means tends to seek contact with said contractable portion.

6 Claims, 12 Drawing Figures



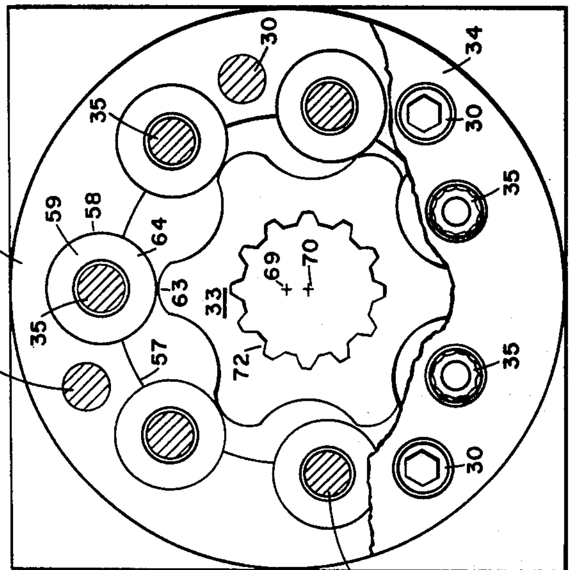


FIG.3

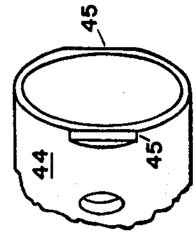


FIG.2

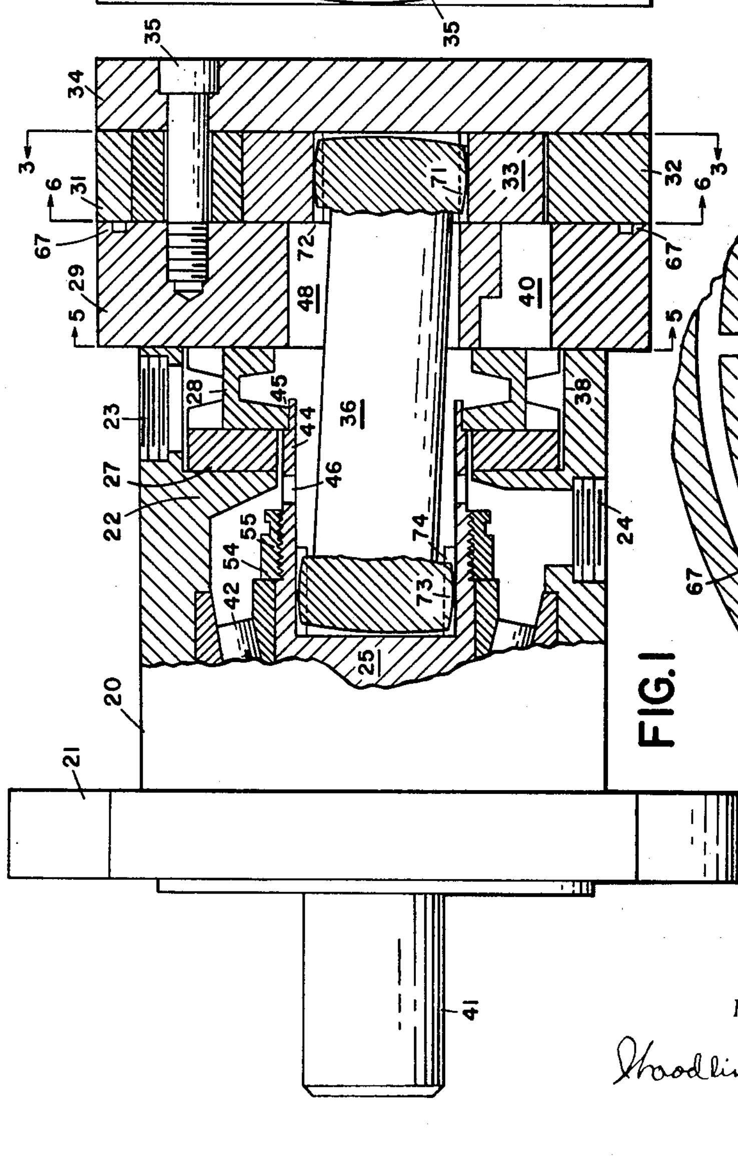


FIG.I

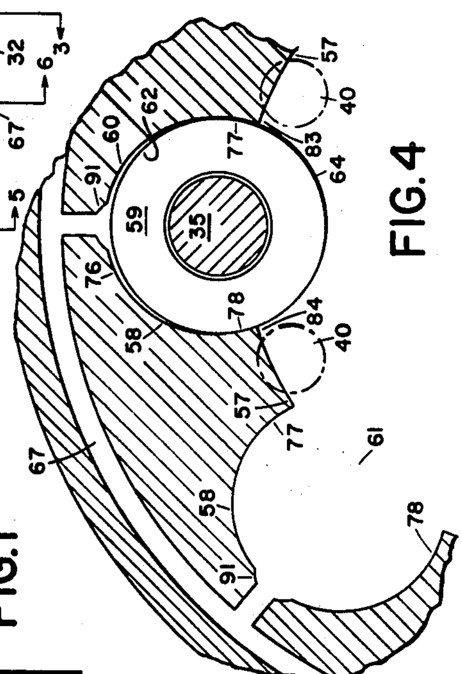


FIG.4

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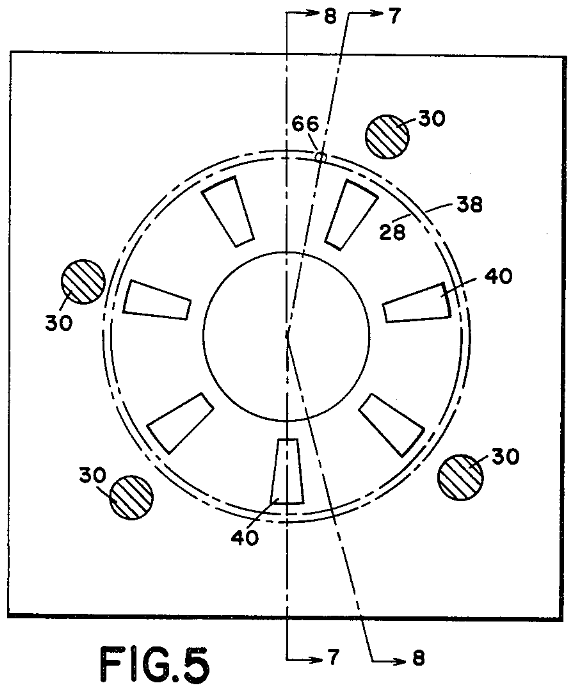

FIG.5

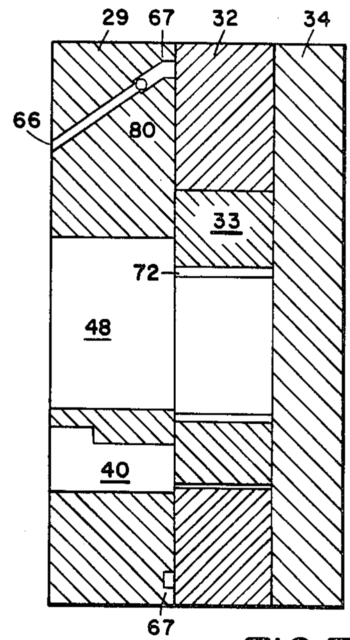

FIG.7

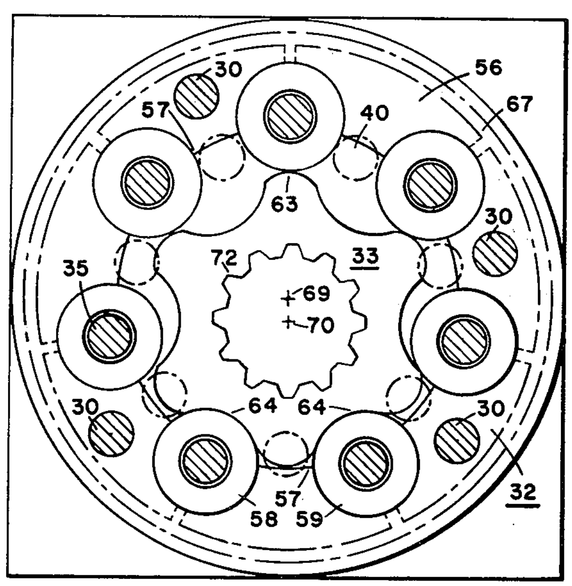

FIG.6

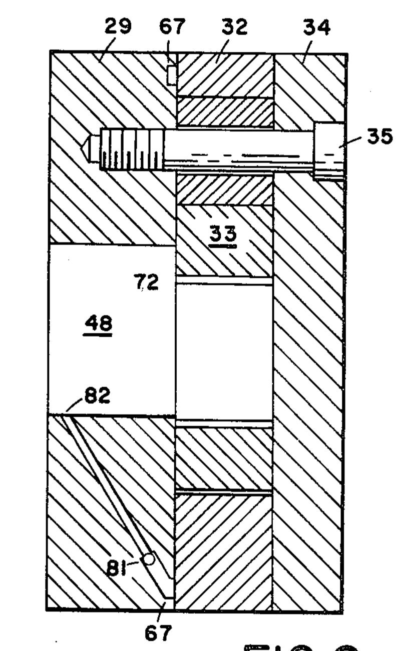

FIG.8

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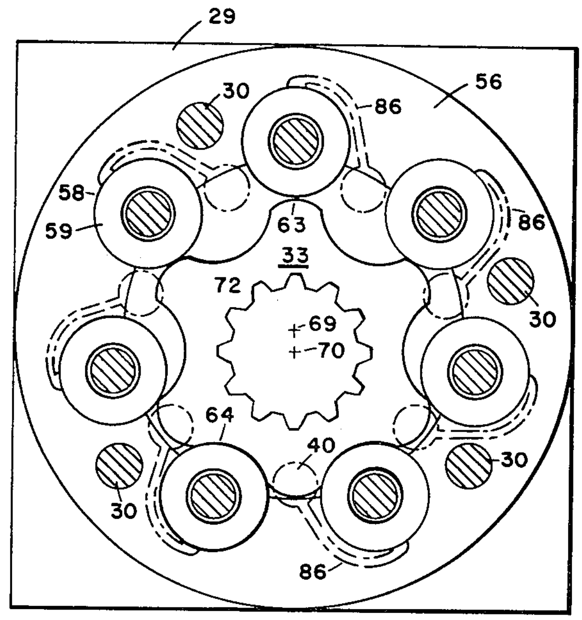

FIG.9

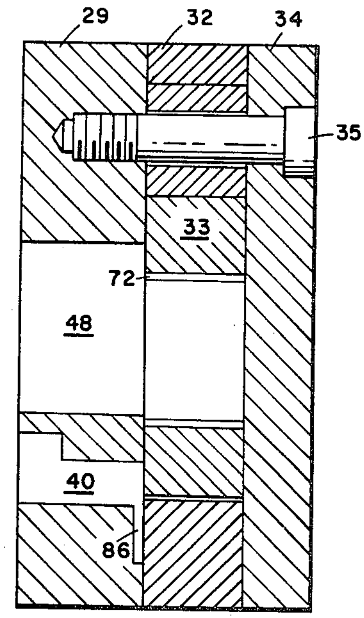

FIG.10

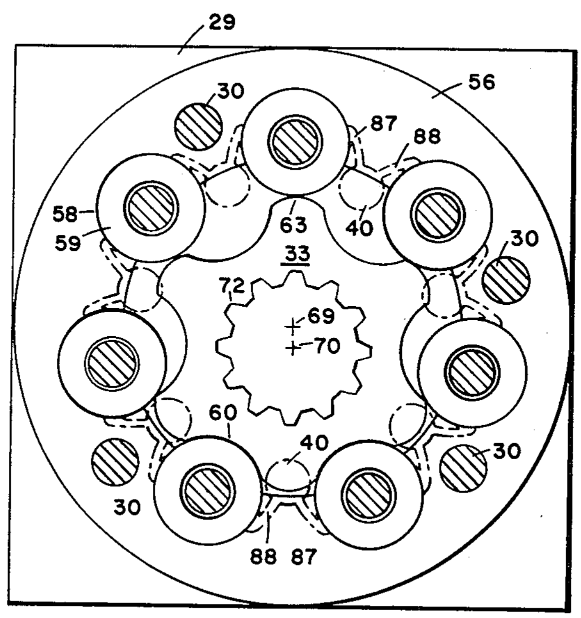

FIG.11

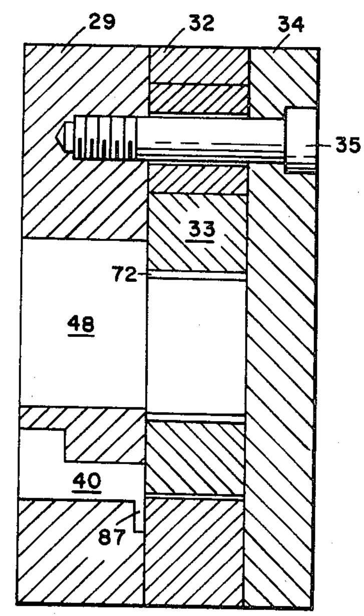

FIG.12

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FLUID PRESSURE RESPONSIVE MECHANISM IN A FLUID PRESSURE DEVICE

BACKGROUND OF THE INVENTION

This application is an improvement upon my application, Ser. No. 814,300, now U.S. Pat. No. 3,591,320. While not limited thereto, the improvement resides in the fact that the open pockets, which have fluid pressure responsive means mounted therein, are pressurized from the fluid ports through internal wall conduction means extending internally from the fluid ports and leading internally to the open pockets instead of through external piping as shown in my above-mentioned patent. The open pockets may also be pressurized by commutated fluid leading from the commutating valve means, whereby certain ones of the fluid pressure responsive means are pressurized where most needed.

Accordingly, it is an object of my invention to provide for pressurizing the open pockets through internal wall conduction means extending internally from the fluid port means rather than through external piping.

Another object is to pressurize the open pockets by commutated fluid leading from the commutating valve means, wherein certain ones of the fluid responsive means mounted in the open pocket are pressurized where most needed at any given instance.

Another object is the provision wherein the fluid pressure responsive means comprise substantially cylindrical roller means.

The invention constitutes a fluid pressure responsive mechanism in a fluid pressure device including first and second internal fluid chamber housing means and fluid pressure operating means, said fluid pressure operating means defining operating chamber means, first and second fluid connection means including fluid valve means for communicatingly interconnecting said first and second fluid chamber housing means with said operating chamber means, said fluid pressure operating means including first and second pressure containing means mountable for relative movement, said first containing means surrounding said second containing means and defining therewith said operating chamber means, said first containing means including at least an open pocket having a major closed side and a minor open side in communication with said operating chamber means, said second containing means having at least a contactable portion, fluid pressure responsive means in said open pocket, said fluid pressure responsive means having a minor portion extending through said minor open side and disposed for contact with said contactable portion, said major closed side of said pocket having opposed terminal wall means and intermediate wall means therebetween, said intermediate wall means and said fluid pressure responsive means defining a fluid clearance space therebetween, said fluid pressure responsive means in said pocket having opposed confronting wall means respectively confronting said opposed terminal wall means and being respectively contactable therewith, said fluid clearance space having fluid entrance means disposed circumferentially intermediate said opposed terminal wall means, first fluid conduction means defined by first internal wall means for conducting pressurized fluid from said first fluid chamber housing means to said fluid clearance space, said first internal wall means extending internally from said first fluid chamber housing means and leading to said fluid entrance means, second fluid conduction means defined by second internal wall means for conducting pressurized fluid from said second fluid chamber housing means to said fluid clearance space, said second internal wall means extending internally from said second fluid chamber housing means and leading to said fluid entrance means, said fluid pressure responsive means under influence of pressurized fluid being urged to seek contact with both of said opposed terminal 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:

FIG. 1 is a longitudinal, partial sectional view of an orbital fluid pressure device embodying the features of my invention;

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

FIG. 3 is a partial cross-sectional view taken along the line 3—3 of FIG. 1, under the end cap, showing the pressurized fluid responsive means comprising substantially cylindrical rollers;

FIG. 4 is an enlarged illustration, showing a representation of a roller journalled in an open pocket and illustrating an exaggerated clearance space therebetween;

FIG. 5 is a front view of the face of the stationary valve means, taken along the line 5—5 of FIG. 1;

FIG. 6 is a view of the face of the fluid pressure operating means, taken along the line 6—6 of FIG. 1;

FIG. 7 is a cross-sectional view of the energy head assembly comprising the stationary valve means, the fluid pressure operating means and the end cap as shown in FIG. 1, but taken along the line 7—7 of FIG. 5;

FIG. 8 is a view similar to FIG. 7, but taken along the line 8—8 of FIG. 5;

FIG. 9 is a view similar to FIG. 6, showing a modification thereof;

FIG. 10 is a view similar to the corresponding energy head assembly of FIG. 1, but showing the duct arrangement for FIG. 9;

FIG. 11 is a view similar to FIG. 9, showing a further modification; and

FIG. 12 is a view similar to FIG. 10, but showing the duct arrangement for FIG. 11.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, the fluid pressure device in which my invention may be incorporated, comprises generally a hollow housing 20 having substantially a square cross-section. A mounting flange or end plate 21 may be secured to the left-hand end of the hollow housing. Intermediate the ends of the hollow housing 20, 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 shaft 25 having an axis substantially coinciding with the longitudinal axis of the fluid pressure device. A bushing 27 and a rotary valve 28 are mounted within a cylindrical bore 38 in the right-hand end compartment. On the right hand end of the hollow housing, there is mounted a square stationary valve member 29. The rotary valve 28 is adapted to be rotated relative to the stationary valve member 29 for commutatively controlling the entrance of fluid to and the exit of fluid from a fluid pressure operating means comprising a stator-rotor mechanism 31 including a stator 32 and a rotor 33. An end cap 34 encloses the stator-rotor mechanism 31. The entrance of fluid to and the exit of fluid from the stator-rotor mechanism flows through a plurality of fluid openings 40 in the stationary valve member 29 controlled by the rotation of the rotary valve 28. The stator-rotor mechanism 31 and the end cap 34 are secured to the stationary valve member 29 by means of screws 35. The stationary valve member 29 is secured to the right-hand end of the hollow housing 20 by screws 30 which also extend through the end cap 34 and the stator-rotor mechanism 31. Fluid is delivered to and from the housing 20 through a pair of fluid ports 23 and 24. An orbital shaft 36 interconnects the main shaft 25 with the rotor 33 of the stator-rotor mechanism 31 and is adapted to transmit torque therebetween.

The main shaft 25 comprises an enlarged internal portion having a reduced external portion 41 extending axially outwardly of the hollow housing 20 through the mounting flange 21. The enlarged internal portion of the main shaft is supported preferably by tapered roller bearings, generally indicated by the reference character 42. A tightening nut 54 which threadably engages male threads 55 secures the bearing 42 against axial movement upon the main shaft.

The tapered roller bearings 42 constitute common bearing means for the main shaft 25 and the rotary valve 28. The common bearing means directly support the main shaft and indirectly support the rotary valve 28 through extension drive means constituting a hollow shaft 44 integrally connected to the main shaft. The hollow shaft 44 extends into the right-hand compartment and supportingly rotates the rotary valve 28 relative to the stationary valve member 29. The hollow shaft 44 terminates in a male shank 45 which slidably fits within a female socket provided in the rotary valve. This connection comprises a non-rotatable connection and rotates the rotary valve 28 upon rotation by the main shaft.

Although not limited thereto, the stator 32 has seven internal teeth and the rotor 33 has six external teeth. The stator 32 may be said to have (n) number of internal teeth and the rotor 33 may be said to have (n-1) number of external teeth. The intermeshing teeth upon relative movement therebetween define operating fluid chambers. The rotor 33 has an axis 70 which orbits about a fixed axis 69 of the stator. The rotor 33 also rotates about its own axis. The orbital shaft 36, which interconnects the rotor 33 and the main shaft 25 is disposed to drive the rotary valve 28 relative to the stationary valve member 29. The right-hand end of the orbital shaft 36 has an operative connection with the rotor 33 and comprises male spline teeth 71 fitting within female spline teeth 72 of the rotor. The left-hand end of the orbital shaft 36 has an operative connection with the main shaft 26 and comprises male spline teeth 73 fitting within female spline teeth 74 in the main shaft.

As shown in FIGS. 4 and 6, my invention is incorporated in the stator 32 and comprises a stator ring 56 having an internal wall portion 57 defining an internal opening. The stator ring 56 has seven open pockets 58 disposed around the internal opening and are spaced apart at substantially equal circumferential intervals from each other. Journalled in the open pockets 58 for rotational movement, are a plurality of substantially cylindrical rollers 59. The screws 35 extend through hollow openings in the rollers 59. Each of the open pockets circumferentially have a closed major portion of substantially a cylindrical wall 60 and an open minor portion 61 communicating with the internal opening. The closed major portion (cylindrical wall 60) constitutes a confronting wall enclosing a major cylindrical portion 62 of a roller journalled therein, whereby a minor cylindrical portion 64 of the roller extends into the internal opening through the open minor portion 61 of the pocket. The stator ring 56 and the rollers 59 journalled in the pockets 58 constitute the stator means 32, whereby the minor cylindrical portions 64 of the adjacently disposed roller means define seven internal teeth.

The stator means 32 and the rotor means 33 are mounted between opposed side member means, namely, the stationary valve member 29 on the left-hand side and the end cap 34 on the right-hand side. The rollers 59 have end wall means abuttably confined between the stationary valve member 29 and the end cap 34. The outer ends of the external teeth of the rotor means 33 define round tips 63 which are disposed to sealingly engage the rollers (minor cylindrical portion 64) upon relative movement between the stator and rotor means. The rollers 59 are disposed to rotate in the pockets 58 as the tips 63 move relative thereto, whereby a rolling movement is provided therebetween.

With my invention, pressurized fluid is conducted to flow from a pressurized fluid port through the stationary valve member 29 to a clearance space 76 between the pockets and rollers, see exaggerated clearance space 76 in FIG. 4. When the fluid port 23, for example, is pressurized, fluid first flows into an external chamber surrounding the rotary valve 28 and from there the fluid flows through a duct 66 past a ball check valve 80 to a circumferential groove 67 in the right-hand face of the stationary valve member 29 to which the respective clearance spaces 76 are connected. As shown in FIG. 5, the duct 66 defines an opening with the external chamber surrounding the rotary valve 28 at a radial location between the outer circumference of the rotary valve, represented by the dash-dot circle 28 in FIG. 5 and the inner bore 38 surrounding the valve, represented by the dash-dot circle 38 in FIG. 5. When the fluid port 24, for example, is pressurized, fluid first flows into an internal chamber 48 through openings 46 in the hollow shaft 44. From the internal fluid chamber 48 fluid flows through a duct 82 past a ball check valve 81 to the circumferential groove 67. The ball check valves 80 and 81 operate to check flow of fluid from the circumferential groove 67 back to the respective fluid ports 23 or 24. The clearance spaces 76 may be provided with a recess 91 on the top thereof to permit the fluid to readily flow from one end of the roller to the other end. To simplify the drawing, the recess 91 is shown only in FIG. 4. Pressurized fluid forces the rollers against the tips 63 of the rotor teeth and thereby provides a good fluid sealing engagement therebetween. In manufacturing, there is no need to maintain extraordinarily fine machining tolerances, because a little freedom between the rollers and the pockets is helpful to better operation. The pressurized fluid continually forces the rollers 59 against the tips 63, so that a good fluid seal is maintained therebetween even though there may be some wear on the tips.

As best illustrated in FIG. 4, the confronting walls of the pockets have first and second terminal end wall portions 77 and 78 circumferentially spaced apart at substantially 180 degrees from each other. The first terminal end wall 77 meets with the internal wall portion 57 of the stator ring 56 and defines a first apex body portion 83 therebetween. The second terminal end wall 78 meets with the internal wall portion 57 of the stator ring 56 and defines a second apex body portion 84 therebetween. As illustrated, the roller 59, for example, in FIG. 4, under pressurized fluid is forced to seek engagement against both of the opposed terminal wall means 77 and 78 and provide a fluid seal therebetween. The rollers are thus forced in substantially a direct radial, inward direction, against the rotor teeth. The clearance space 76 is defined by a roller mounted in a pocket and an intermediate wall of the pocket which extends between the opposed terminal wall means 77 and 78. As shown in FIG. 4, the circumferential groove 67 communicates with the clearance space 76 at a location substantially mid-way between the first and second terminal end portions 77 and 78. In FIG. 6 the circumferential groove 67 is shown by two concentric dash-dot lines and illustrates the location where it confronts against the stator ring 56. Also, the locations where the plurality of fluid openings 40 confront against the stator ring 56 are shown by dash-dot circles.

FIGS. 9 and 10 show a modification of the fluid conduction means for pressurizing the clearance spaces 76 from the fluid ports 23 and 24. In this modification, commutated fluid which is delivered by the rotary valve 28 to the plurality of fluid openings 40 is conducted to the clearance spaces 76. As shown, a feed groove 86 in the right-hand face of the stationary valve member 29 extends from each of the fluid openings 40 to the top of the clearance space 76. In FIG. 9, the feed grooves 86 as well as the right-hand end of the fluid openings 40 are shown in dash-dot lines and indicate the locations where they confront against the stator ring 56. In FIG. 10, a feed groove 86 is shown to illustrate the general location, but is not a true view. Thus, commutated fluid in the fluid openings 40, as delivered by the rotary valve 28, is conducted to the clearance spaces 76 through the feed grooves 86. In this arrangement, only certain ones of the clearance spaces 76 are pressurized at any given instance. The clearance spaces 76 are thus pressurized in orbital sequence, which means that the rollers 59 are forced inwardly against the tips 63 of the rotor teeth in orbital sequence. The action of the rollers 59 thus occur where most needed at any given instance.

FIGS. 11 and 12 show a further modification, in that two feed grooves 87 and 88 in the right-hand face of the stationary valve member 29 extend from each of the fluid openings 40 to the inner opposed sides of adjacently disposed rollers. In FIG. 12, a feed groove 87 is shown to illustrate the general location, but is not a true view. Accordingly, each clearance space 76 has two fluid entrance means disposed on opposite sides of the rollers. Due to the fact that the rollers are pressurized from their opposed sides, they act as their own check valves and operate to check flow of fluid from one fluid opening 40 to the next adjacent fluid opening 40, while at the same time fluid pressure on top of the rollers tends to force the rollers inwardly against the tips 63 of the rotor teeth in orbital sequence. In FIG. 11, the feed grooves 87 and 88 and the ends of the fluid openings 40 are shown by dash-dot lines where they confront against the stator ring 56.

In all the illustrations, pressurized fluid from the fluid port 23 and 24 is conducted to the clearance spaces 76 through the stationary valve member 29. The conduction of the pressurized fluid to the clearance spaces is thus internally of the fluid pressure device instead of through piping externally thereof.

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 responsive mechanism in a fluid pressure device including housing means and fluid pressure operating means, said fluid pressure operating means defining operating chamber means, fluid valve means including stationary valve means and rotary valve means for commutatively controlling the flow of fluid to and from said operating chamber means, said stationary valve means including (n) number of fluid openings communicatingly connected to said operating chamber means, said fluid pressure operating means including first and second pressure containing means mountable for relative movement, said first containing means surrounding said second containing means and defining therewith said operating chamber means, said first containing means having (n) number of open pockets and (n) number of fluid pressure responsive means respectively mounted therein, said open pockets respectively having a major closed side and a minor open side in communication with said operating chamber means, said second containing means having (n—1) number of contactable portions, said fluid pressure means respectively having a minor portion extending through said minor open side and disposed for contact with said contactable portions, said major closed side of said pockets respectively having opposed terminal wall means and intermediate wall means therebetween, said fluid pressure responsive means in said pockets defining (n) number of fluid clearance spaces with said intermediate wall means, said clearance spaces having (n) number of fluid entrance means, and (n) number of fluid conduction means for providing fluid communication respectively between said (n) number of fluid openings and said (n) number of fluid entrance means.

2. The structure of claim 1, wherein said fluid pressure responsive means comprise roller means respectively mounted in said pockets and defining (n) number of fluid clearance spaces, said fluid clearance spaces

respectively having first and second fluid entrance means disposed on opposite sides of said roller means and circumferentially intermediate said opposed terminal wall means, first means for providing first fluid communication respectively between said (n) number of fluid openings and said first fluid entrance means of said (n) number of fluid clearance spaces, and second means for providing second fluid communication respectively between said (n) number of fluid openings and said second fluid entrance means of said (n) number of fluid clearance spaces.

3. The structure of claim 2, wherein said roller means in said pockets act as check valve means to check flow of fluid between said first and second fluid entrance means.

4. Fluid pressure responsive mechanism in a fluid pressure device including housing means and fluid pressure operating means, said fluid pressure operating means defining operating chamber means, fluid valve means including stationary valve means and rotary valve means, said rotary valve means having external wall means spaced inwardly from and defining with said housing means an external valve chamber, said rotary valve means also having internal wall means defining an internal valve chamber, said stationary valve means being disposed between said operating chamber means and said external and internal valve chambers, said stationary valve means including an annular face wall portion between said rotary valve means and said housing means, said external valve chamber being defined in part by said annular face wall portion, said stationary valve means also including an internal annular wall defining an opening inconstant communication with said internal valve chamber, first and second fluid connection means including said fluid valve means for communicatingly interconnecting said external and internal valve chambers with said operating chamber means, said fluid pressure operating means including first and second pressure containing means mountable for relative movement, said first containing means surrounding said second containing means and defining therewith said operating chamber means, said first containing means including at least an open pocket having

a major closed side and a minor open side in communication with said operating chamber means, said second containing means having at least a contactable portion, fluid pressure responsive means in said open pocket, said fluid pressure responsive means having a minor portion extending through said minor open side and disposed for contact with said contactable portion, said major closed side of said pocket having opposed terminal wall means and intermediate wall means therebetween, said intermediate wall means and said fluid pressure responsive means defining a fluid clearance space therebetween, said fluid pressure responsive means in said pocket having opposed confronting wall means respectively confronting said opposed terminal wall means and being respectively contactable therewith, said fluid clearance space having fluid entrance means disposed circumferentially intermediate said opposed terminal wall means, first fluid conduction means defined by first internal wall means extending through said stationary valve means for conducting pressurized fluid from said external valve chamber to said fluid clearance space, said first internal wall means extending from said annular face wall portion and leading to said fluid entrance means, second fluid conduction means defined by second internal wall means extending through said stationary valve means for conducting pressurized fluid from said internal valve chamber to said fluid clearance space, said second internal wall means extending from said internal annular wall of said stationary valve means and leading to said fluid entrance means, and fluid pressure responsive means under influence of pressurized fluid being urged to seek contact with both of said opposed terminal wall means.

5. The structure of claim 4, wherein said first fluid conduction means has first check valve means therein to check reverse flow of fluid therein and wherein said second fluid conduction means has second check valve means therein to check reverse flow of fluid therein.

6. The structure of claim 4, wherein said fluid pressure responsive means comprises substantially cylindrical roller means.

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