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(54) Gerotor motor dynamic brake

(57) A hydraulic motor including a gerotor gear set (15), and a valve (41) disposed forwardly of the gerotor. Disposed rearwardly of the gerotor is an endcap member (21) defining a chamber (71) in which is disposed a brake disc pack (89). The outer brake discs (91) are fixed to be non-rotatable relative to the endcap member (21), while the inner brake discs (93) are splined to a disc mounting portion (97) of an insert member (54). The insert member (54) includes an insert portion (109) received within the orbiting and rotating star member (31) of the gerotor, such that the inner brake discs (93) orbit and rotate relative to the outer brake discs (91). The dynamic brake of the invention does not require any substantial redesign of the motor, forward of the endcap member (21), and its location means that the brake disc pack (89) is required to hold only a fraction of the full output torque of the motor.

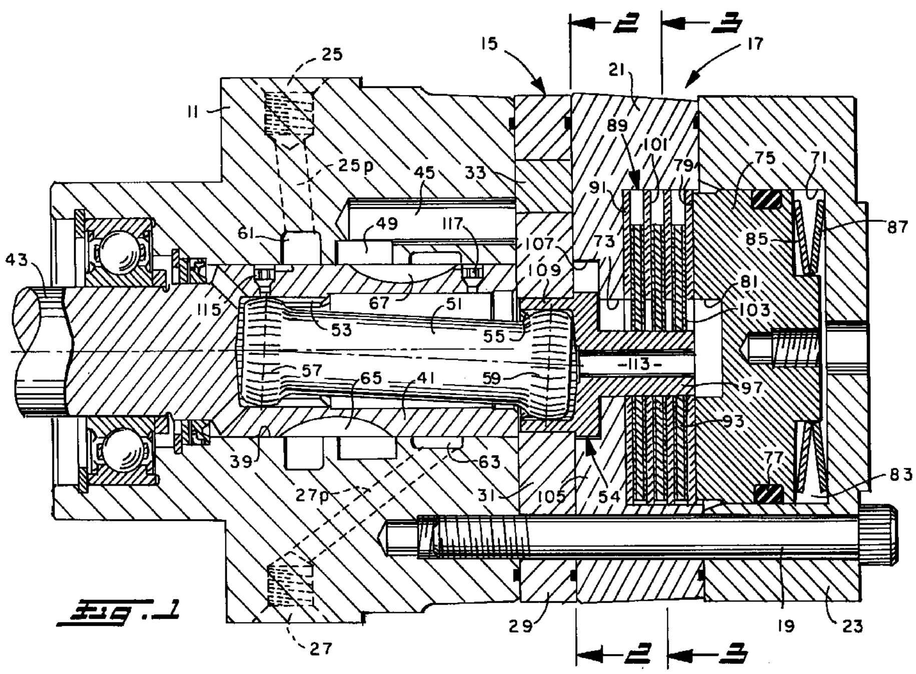

FIG. 1

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Description

BACKGROUND OF THE DISCLOSURE

The present invention relates to rotary fluid pressure devices, and more particularly, to such devices of the type including a fluid displacement mechanism which comprises a gerotor gear set.

Although the present invention may be included in a gerotor type device being utilized as a pump, it is especially adapted for use in a low-speed, high-torque gerotor motor, and will be described in connection therewith.

For years, many of the gerotor motors made and sold commercially, both by the assignee of the present invention as well as by others, have had the motor valving disposed "forwardly" of the gerotor gear set (i.e., toward the output shaft end of the motor), thus having nothing disposed "rearwardly" of the gerotor gear set, except for an endcap. The present invention is not limited to gerotor motors of this type, although it is especially adapted for use with gerotor motors of this type, and will be illustrated and described in connection therewith.

In many vehicle applications for low-speed, high-torque gerotor motors, it is desirable for the motor to have some sort of parking brake or parking lock, and in certain vehicle applications, it is desirable for the motor to have some sort of dynamic brake which can be applied while the vehicle is still moving, to bring the vehicle to a stop. It should be understood that, as used herein, the term "dynamic" brake means a brake having dynamic capabilities, i.e., one which can begin to be applied while the vehicle is still moving, but "dynamic" does not mean a true service-type brake which would be applied when the vehicle is traveling at its normal operating speed.

For many years, those skilled in the art have attempted to incorporate brake and lock devices into gerotor motors. Examples of such devices are illustrated and described in U.S. Patent Nos. 3,616,882 and 4,981,423. In the device of 3,616,882, a braking element is disposed adjacent the forward end of the gerotor star, and is biased by fluid pressure into frictional engagement therewith. Such an arrangement involves a certain degree of unpredictability of performance, in view of variations in clearances, etc. Such an arrangement also requires a substantial redesign of the wear plate and forward bearing housing of the motor.

In the device of 4,981,423, there is a multi-disc brake assembly which is of the "spring-applied, pressure-released" type. The arrangement of 4,981,423 also requires almost total redesign of the forward bearing housing, and also results in a much larger bearing housing. In addition, the disc pack is in splined engagement with the output shaft and, therefore, must be able to brake or hold the full output torque of the motor, thus necessitating that the discs, the spring, and the apply/release piston all be relatively larger than is desirable. A related problem is that such a brake arrangement can reduce certain of the performance ratings of the motor, such as the side load capacity of the output shaft, which is generally considered very undesirable by the OEM customer.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a gerotor motor including a dynamic brake which overcomes the above-described disadvantages of the prior art.

It is a more specific object of the present invention to provide a dynamic brake for a gerotor motor which does not require any major redesign of the gerotor gear set, or the portion of the motor disposed forwardly of the gerotor gear set.

It is another object of the present invention to provide such a dynamic brake device which is positioned such that it is not required to brake or hold the full output torque of the motor.

It is a further object of the present invention to provide such a dynamic brake device which does not involve engagement by a lock or brake member on the profile of the gerotor star.

The above and other objects of the invention are accomplished by the provision of a rotary fluid pressure device of the type including housing means defining a fluid inlet port and a fluid outlet port. The device includes a rotary fluid displacement mechanism including an internally toothed ring member and an externally toothed star member eccentrically disposed within the ring member for orbital movement relative thereto. Either the ring member or the star member has rotational movement, and the teeth of the ring member and the star member interengage to define expanding and contracting fluid volume chambers in response to the orbital and rotational movements. A valve means cooperates with the housing means to provide fluid communication from the inlet port to the expanding volume chambers, and from the contracting volume chambers to the outlet port. The device includes output means and means operable to transmit torque from the member having rotational movement to the output means. An endcap is disposed rearwardly of the fluid displacement mechanism.

The improved rotary fluid pressure device is characterized by the endcap defining an internal chamber. A first means defines at least a first braking surface fixed to be non-rotatable relative to the endcap. A second means defines at least a second braking surface fixed to be non-rotatable relative to one of the star member and the ring member. A lock piston is disposed in the internal chamber, and is movable between a retracted position and an applied position in which the lock piston causes engagement of the first and second braking surfaces to retard movement of the one of the star member and the ring member.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an axial cross-section of a gerotor motor including the dynamic brake mechanism of the present invention, in its engaged position.

FIG. 2 is a transverse cross-section, taken on line 2-2 of FIG. 1, illustrating one aspect of the present invention.

FIG. 3 is a transverse cross-section, taken on line 3-3 of FIG. 1, illustrating another aspect of the present invention.

FIG. 4 is a fragmentary, axial cross section, similar to FIG. 1, illustrating an alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, which are not intended to limit the invention, FIG. 1 is an axial cross-section of a low-speed, high-torque gerotor motor of the type with which the dynamic brake mechanism of the present invention is especially advantageous. The gerotor motor shown in FIG. 1 may be of the general type illustrated and described in U.S. Patent No. 4,592,704, assigned to the assignee of the present invention and incorporated herein by reference.

The gerotor motor of FIG. 1 comprises a valve housing section 11, and a fluid energy-translating displacement mechanism, generally designated 15, which, in the subject embodiment, is a roller gerotor gear set. The motor includes an endcap assembly 17, held in tight sealing engagement with the valve housing section 11 by means of a plurality of bolts 19, the endcap assembly 17 including an endcap member 21 disposed immediately adjacent the gerotor gear set 15, and an endcap member 23, held in fluid sealing engagement with the endcap member 21 by means of the plurality of bolts 19. The endcap assembly 17 will be described in greater detail subsequently.

The valve housing section 11 includes a fluid inlet port 25, and a fluid outlet port 27, shown only schematically in FIG. 1. It is understood by those skilled in the art that the ports 25 and 27 may be reversed, thus reversing the direction of operation of the motor.

Referring now to FIG. 2, in conjunction with FIG. 1, the gerotor gear set 15 includes an internally toothed ring member 29, through which the bolts 19 pass (only one of the bolts 19 being shown in FIG. 1), and an externally toothed star member 31. The internal teeth of the ring member 29 comprise a plurality of cylindrical rollers 33, as is now well known in the art. The teeth 33 of the ring 29 and the external teeth of the star 31 interengage to define a plurality of expanding volume chambers 35, and a plurality of contracting volume chambers 37, as is also well known in the art.

The valve housing section 11 defines a spool bore 39, and rotatably disposed therein is a spool valve 41. Formed integrally with the spool valve 41 is an output shaft 43, shown only fragmentarily in FIG. 1. In fluid communication with each of the volume chambers 35 and 37 is an axial passage 45 formed in the valve housing section 11. Each of the axial passages 45 communicates with the spool bore 39 through an opening 49. The housing section 11 also defines fluid passages 25p and 27p, providing fluid communication between the spool bore 39 and the inlet port 25 and outlet port 27, respectively.

Disposed within the hollow, cylindrical spool valve 41 is a main drive shaft 51, commonly referred to as a "dog bone" shaft. The spool valve 41 defines a set of straight internal splines 53, and the star 31 receives an insert member 54 which will be described in greater detail subsequently, but which defines a set of straight internal splines 55. The drive shaft 51 includes a set of external crowned splines 57 in engagement with the internal splines 53, and a set of external crowned splines 59 in engagement with the internal splines 55. Thus, the orbital and rotational movements of the star member 31 are transmitted, by means of the dog bone shaft 51, into purely rotational movement of the output shaft 43, as is well known in the art.

The valve housing section 11 defines an annular groove 61 in continuous fluid communication with the inlet port 25, through the passage 25p, and defines an annular groove 63, which is in continuous fluid communication with the outlet port 27, through the passage 27p. The spool valve 41 defines a plurality of axial slots 65 in communication with the annular groove 61, and a plurality of axial slots 67 in communication with the annular groove 63. The axial slots 65 and 67 are also frequently referred to as feed slots or timing slots. As is generally well known to those skilled in the art, the axial slots 65 provide fluid communication between the annular groove 61 and the openings 49, disposed on one side of the line of eccentricity of the gerotor set 15, while the axial slots 67 provide fluid communication between the annular groove 63 and the openings 49, which are on the other side of the line of eccentricity. The resulting commutating valve action between the axial slots 65 and 67 and the openings 49, as the spool valve 41 rotates, is well known in the art and will not be described further herein.

Those portions of the motor described up to this point, with the exception of the insert member 54, are generally conventional. Referring still primarily to FIG. 1, the dynamic brake mechanism of the present invention will now be described. The endcap members 21 and 23 cooperate to define a relatively larger, rearward internal chamber 71, and a relatively smaller, forward internal chamber 73. In the subject embodiment, both of the chambers 71 and 73 are generally cylindrical. Disposed within the chamber 71 is a generally cylindrical lock piston 75, which includes an O-ring seal 77 disposed about its outer periphery and in sealing engagement with the internal surface of the chamber 71. The lock piston 75 includes a forward, transverse surface 79 and a centrally disposed, generally cylindrical recess 81.

Disposed at the rearward end of the piston 75 there is defined an annular groove 83 within which is disposed a pair of Belleville washers 85 and 87, which bias the piston 75 in a forward direction (to the left in FIG. 1) toward an engaged position, to be described subsequently. Disposed immediately forward of the lock piston 75 is a brake disc pack, generally designated 89, which comprises a set of outer brake discs 91, and a set of inner brake discs 93. One disc of each of the sets is at least partly visible in FIG. 3. The outer brake discs 91 are in engagement with the endcap member 21 by means of a plurality of tangs 95, which are received within mating, milled axial slots in the endcap member 21. Thus, the discs 91 are non-rotatable relative to the endcap member 21, but are permitted to move axially relative thereto, in a manner common in the brake and clutch art. Similarly, the inner brake discs 93 are in engagement with a generally cylindrical disc mounting portion 97 of the insert member 54 by means of a set of splines 99. Thus, the discs 93 are non-rotatable relative to the insert member 54, but are permitted to move axially relative thereto.

Preferably, each of the outer brake discs 91 comprises a stamped steel disc, wherein each side of the disc serves as a friction or braking surface 101. Each of the inner discs 93 preferably comprises a stamped steel disc as a substrate, to which a layer of friction material 103, such as paper or pyrolytic carbon, is bonded to each side to serve as a braking surface.

The endcap member 21 includes a forward wall portion 105 which is disposed immediately adjacent the gerotor gear set 15, thus sealing the rearward side of the volume chambers 35 and 37. The wall portion 105 defines the forward internal chamber 73, and also defines an enlarged forward recess 107, the function of which will be described subsequently. It should be apparent that one purpose of the wall portion 105 is as a reaction member, whenever a load is applied to the brake disc pack 89 to achieve engagement thereof.

The insert member 54 includes an insert portion 109 which, as may best be seen in FIG. 2, is received within the star member 31, and is fixed to rotate therewith by means of a set of splines 111. The insert portion 109 defines, about its inner periphery, the set of straight, internal splines 55 which are normally defined by the star member, in a conventional gerotor motor. Therefore, the insert member 54 orbits and rotates with the star member 31, and as a result, the disc mounting portion 97 and the inner brake discs 103 also orbit and rotate with the star member 31, and are always disposed eccentrically relative to the endcap member 21 and the outer discs 91. The insert member 54 includes a shoulder portion disposed axially between the insert portion 109 and the disc mounting portion 97. The shoulder portion is disposed within the recess 107, such that the entire insert member 54 is thereby restrained in the axial direction.

In the operation of a gerotor motor, as is well known to those skilled in the art, a certain amount of fluid collects within what is known as the "case drain region" of the motor. In the subject embodiment, the case drain region is generally the volume within the spool valve 41. In accordance with one aspect of the present invention, the disc mounting portion 97 defines an axial fluid passage 113 which permits fluid communication from the case drain region, through the passage 113, and into the recess 81. The area of the recess 81 is selected, relative to the typical case drain pressure for the motor, such that, whenever the motor is operating and case pressure is present, the lock piston 75 is biased rearwardly, in opposition to the force of the Belleville washers 85 and 87. With the washers 85 and 87 biased rearwardly, the outer brake discs 91 and the inner brake discs 93 are "unloaded' or disengaged, thus permitting the insert member 54 and the star member 31 to orbit and rotate in a normal manner. Preferably, there is enough axial travel of the lock piston 75 that, when it is in the disengaged position, the outer discs 91 and inner discs 93 are truly disengaged, i.e., there is very little contact therebetween, and there is very little retarding torque exerted by the fixed, outer discs 91 on the orbiting and rotating inner discs 93.

In the subject embodiment, and by way of example only, the disengagement of the brake disc pack 89 is controlled by case pressure which, in turn, is determined by controlling the return pressure, downstream of whichever of the ports 25 or 27 is the return port. As may be seen in FIG. 1, the spool valve 41 is provided with a pair of check valves 115 and 117 which permit communication of fluid from the case drain region to the annular grooves 61 and 63, respectively. Therefore, assuming that the port 25 is the inlet port and the port 27 is the return port, an increasing pressure in the return line, downstream of the port 27 will result in an increasing case pressure, which will be communicated through the axial passage 113 into the recess 81, building a force tending to bias the piston 75 to the right in FIG. 1, in opposition to the force exerted by the Belleville washers 85 and 87. When the operator wishes to apply the brake, the return pressure is decreased (which may be done manually or "automatically" in response to some vehicle criteria such as speed, etc.) and case pressure decreases until the pressure in the recess 81 is overcome by the force of the Belleville washers 85 and 87. When the lock piston 75 is biased forwardly (to the left in FIG. 1), it begins to load or compress the disc pack 89, thus retarding the orbiting and rotating of the star member 31. Preferably, the case pressure required to disengage the brake disc pack 89 should be less than the "starting torque", i.e., the operating pressure in the motor required to initiate orbital and rotational movement of the star member 31, and rotation of the output shaft 43.

Alternatively, rather than using case pressure to control the disengagement or release of the lock piston 75, the motor could be provided with a separate signal line, for example, with a port being located in the end cap member 21 or the end cap member 23 and communicating with the recess 81. Then, the operator would control the release pressure in the recess 81 in a more direct manner, by controlling the pressure of the external signal. It should be understood by those skilled in the art that the specific method of controlling the release pressure is not an essential feature of the invention. All that is essential is that there be some means provided for releasing the brake disc pack 89. One advantage of utilizing case pressure, which is relatively low, to disengage the brake disc pack 89 is that the presence of case pressure in the internal chamber 71, while the motor is operating biases the forward wall portion 105 into tighter sealing engagement with the adjacent star member 31. The result is that leakage from the expanding volume chambers 35 along the face of the star member 31 is reduced, thus increasing the volumetric efficiency of the motor.

In the subject embodiment, and by way of example only, there are seven of the outer brake discs 91 and six of the inner brake discs 93, thus providing a known, predictable amount of braking torque. It is one important aspect of the present invention that, for motors requiring less braking torque, one or more of each of the sets of discs 91 and 93 can be left out, with the axial space being filled by some sort of spacer member. In this way, only the amount of braking torque actually required will be provided, there will be a cost savings from the reduced number of friction discs, but no overall change in the design is needed.

Referring now primarily to FIG. 4, there is illustrated an alternative embodiment of the present invention, in which like elements bear like numerals and modified elements bear the same numerals, plus a prime mark, and new elements bear a reference numeral in excess of "120". The primary difference in the embodiment of FIG. 4 is that it includes a gerotor gear set 15' which includes an internally toothed ring member 29', an externally toothed star member 31', and a plurality of rollers 33' which are all substantially longer, axially, than in the embodiment of FIG. 1. As a result, it is not necessary to have the external splines 59 of the dogbone shaft 51 disposed within the insert member. Instead, in the FIG. 4 embodiment, the star member 31' defines the straight internal splines 55' in the conventional manner and, disposed axially adjacent thereto, there is an insert member 121. The insert member 121 includes an externally splined insert portion 123, in splined engagement with the internal splines 55', and an externally splined disc mounting portion 125. In the embodiment of FIG. 4, the portions 123 and 125 still define the axial fluid passage 113 (only a portion of which is shown in FIG. 4). Thus, it may be seen that the insert member 121 will still orbit and rotate with the star member 31' in the same manner as in the FIG. 1 embodiment, causing the inner brake discs 93 to orbit and rotate relative to the outer brake discs 91. In order to prevent axial movement of the insert member 121, it may be desirable to press the splines of the portion 123 into the internal splines 55', or alternatively, to provide a snap ring or other suitable retainer, about the outer periphery of the insert member 121.

In some situations, it may even be desirable to merely have the disc mounting portion formed integrally with the star member, for example, if the star comprises a PM (powdered metal) part. What is essential to the present invention is that one of the sets of brake discs be fixed to orbit and rotate with whichever member of the gerotor gear set orbits and rotates.

It should be understood by those skilled in the art that, although the subject embodiment includes spool valving, the invention is not so limited, and the present invention may be utilized with gerotor motors having various types of disc valving, as long as the disc valving is disposed either forwardly of the gerotor gear set 15, or disposed rearwardly of the gerotor set, but with the valving action occurring far enough radially outward that the valving does not interfere with the brake disc pack 89.

Thus, it may be seen that the present invention provides a dynamic brake which is not located such that the dynamic brake is required to hold the full output torque of the motor. In the subject embodiment, in which the gerotor is a 6/7 gerotor, the torque required to prevent orbital and rotational motion of the star 31 is only one-sixth the torque required to prevent rotational motion of the output shaft 43. The reason for this is well understood by those skilled in the art of gerotor gear sets.

Furthermore, the present invention provides a dynamic brake which does not engage the profile of the star 31, thus eliminating potential damage to the profile, and does not require any substantial redesign of any portion of the motor disposed forwardly of the endcap 21. In other words, the dynamic brake of the present invention could be an optional feature for a standard motor in which the only change would be to replace the conventional endcap with the endcap assembly 17 shown herein and provide the insert member 54.

It is believed to be well within the ability of those skilled in the art to select the Belleville washers 85 and 87, the dimensions of the lock piston 75, the pressure for the recess 81, etc. to achieve the desired load holding capability, relative to the rated torque of the motor, while still being able to disengage the lock piston 75 under load.

The invention has been described in great detail in the foregoing specification, and it is believed that various alterations and modifications of the invention will become apparent to those skilled in the art from a reading and understanding of the specification. It is intended that all such alterations and modifications are included in the invention, insofar as they come within the scope of the appended claims.

Claims

1. A rotary fluid pressure device of the type including housing means (11) defining a fluid inlet port (25) and a fluid outlet port (27); a rotary fluid displacement mechanism (15) including an internally-toothed ring member (29) and an externally-toothed star member (31) eccentrically disposed within said ring member (29) for orbital movement relative thereto, one of said ring member (29) and said star member (31) having rotational movement, the teeth of said ring member and said star member interengaging to define expanding and contracting fluid volume chambers (35, 37) in response to said orbital and rotational movements; valve means (41) cooperating with said housing means (11) to provide fluid communication from said inlet port (25) to said expanding volume chambers (35), and from said contracting volume chambers (37) to said outlet port (27); output means (43) and means (51) operable to transmit torque from said member having rotational movement to said output means (43); and an endcap disposed rearwardly of said fluid displacement mechanism (15); characterized by:

   (a) said endcap (17, 21, 23) defining an internal chamber (71);
   (b) first means (91) defining at least a first braking surface (101) fixed to be non-rotatable relative to said endcap (17, 21, 23);
   (c) second means (93) defining at least a second braking surface (103) fixed to be non-rotatable relative to one of said star member (31) and said ring member (29);
   (d) a lock piston (75) disposed in said internal chamber (71) and being moveable between a retracted position and an applied position (FIG. 1) in which said lock piston causes engagement of said first (101) and second (103) braking surfaces to retard movement of said one of said star member (31) and said ring member (29).

2. A rotary fluid pressure device as claimed in claim 1, characterized by said second means (93) defining said second braking surface (103) being fixed to be non-rotatable relative to said star member (31).

3. A rotary fluid pressure device as claimed in claim 2, characterized by said first means comprises a first brake disc (91) defining said first braking surface (101), and said second means comprises a second brake disc (93) defining said second braking surface (103).

4. A rotary fluid pressure device as claimed in claim 3, characterized by said first (91) and second (93) brake discs being disposed in said internal chamber (71), axially between said fluid displacement mechanism (15) and said lock piston (75).

5. A rotary fluid pressure device as claimed in claim 4, characterized by said endcap (17, 21, 23) including a forward wall portion (105) disposed immediately adjacent said fluid displacement mechanism (15), and axially between said fluid displacement mechanism (15) and said first (91) and second (93) brake discs.

6. A rotary fluid pressure device as claimed in claim 3, characterized by said first brake disc (91) and said endcap (17, 21, 23) cooperating to define means (95) operable to prevent substantial rotation of said first brake disc (91) relative to said endcap (17, 21, 23), while permitting axial movement of said first brake disc (91) relative to said endcap.

7. A rotary fluid pressure device as claimed in claim 3, characterized by said star member (31) including means (54, 97) extending axially therefrom and cooperating with said second brake disc (93) to define means (99) operable to prevent substantial rotation of said second brake disc (93) relative to said star member (31), while permitting axial movement of said second brake disc (93) relative to said star member (31).

8. A rotary fluid pressure device as claimed in claim 7, characterized by said means extending axially from said star member (31) comprises a generally cylindrical member (54) including an insert portion (109) disposed partly within said star member (31), and further including a disc mounting portion (97) extending axially from said insert portion (109).

9. A rotary fluid pressure device as claimed in claim 8, characterized by said disc mounting portion (97) and said second brake disc (93) cooperating to define engaging sets of splines (99).

10. A rotary fluid pressure device as claimed in claim 3, characterized by said first brake disc (91) being disposed concentrically relative to said internally-toothed ring member (29), and said second brake disc (93) being disposed concentrically relative to said externally-toothed star member (29), whereby said second brake disc (93) is disposed eccentrically relative to said first brake disc (91), and orbits and rotates relative thereto.

11. A rotary fluid pressure device as claimed in claim 1, characterized by said lock piston (75) having means (85,87) biasing said lock piston (75) toward said applied position (FIG. 1), said lock piston (75)

defining a fluid pressure chamber (81) in fluid communication with a source of fluid pressure sufficient to overcome the force of said biasing means (85,87), and move said lock piston to said retracted position.

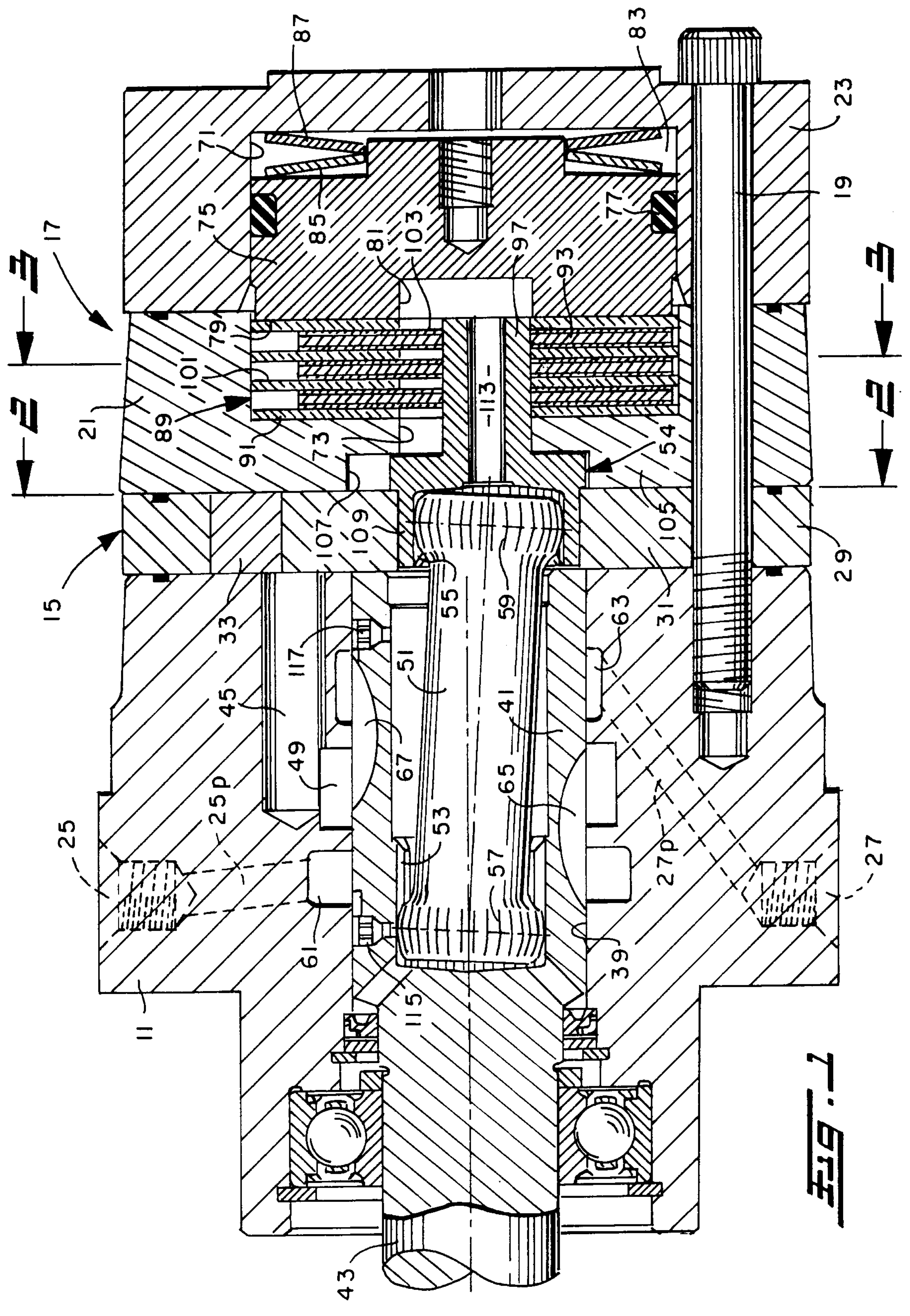
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Fig. 1

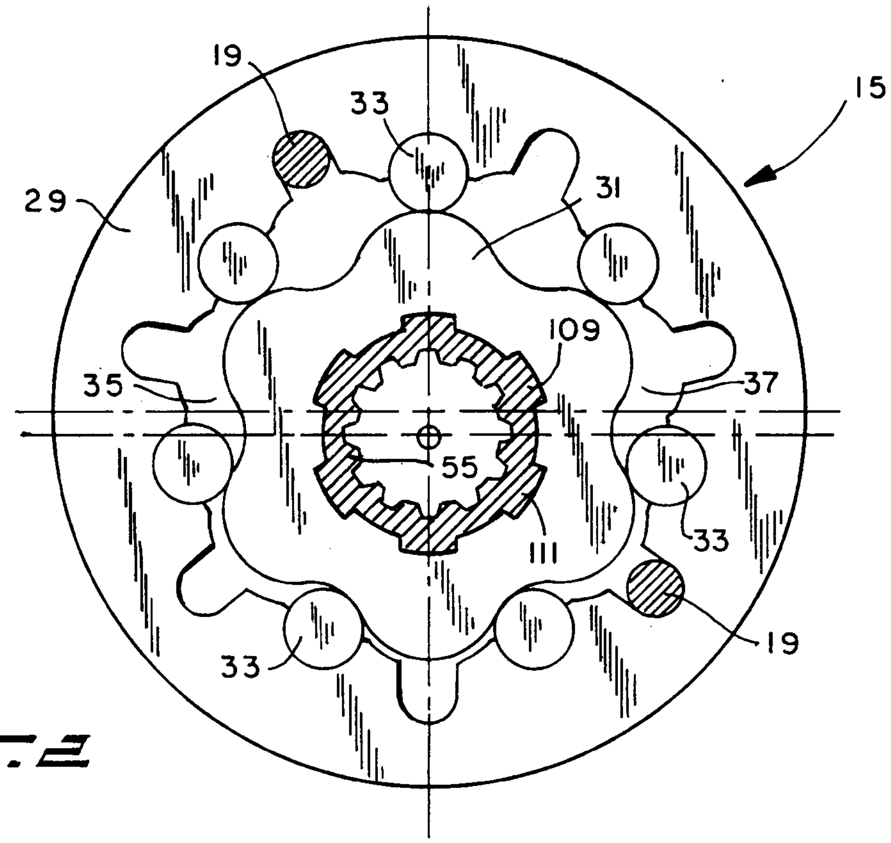
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FIG. 2

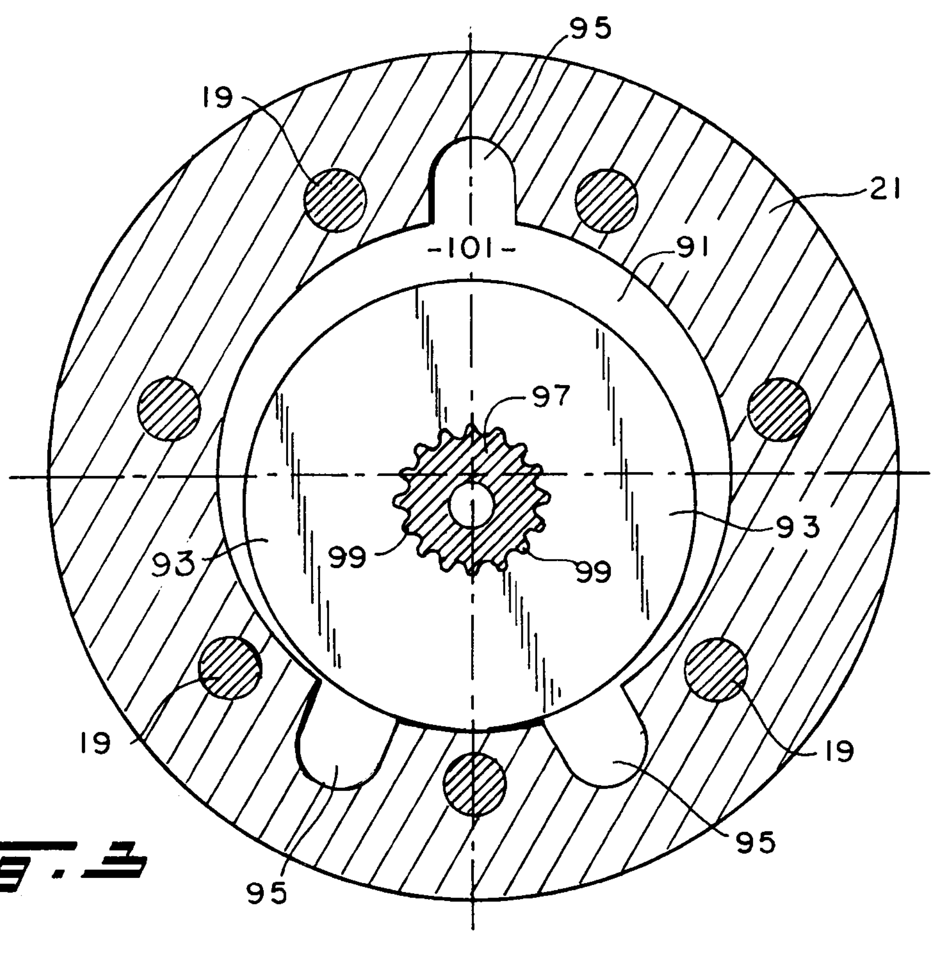
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FIG. 3

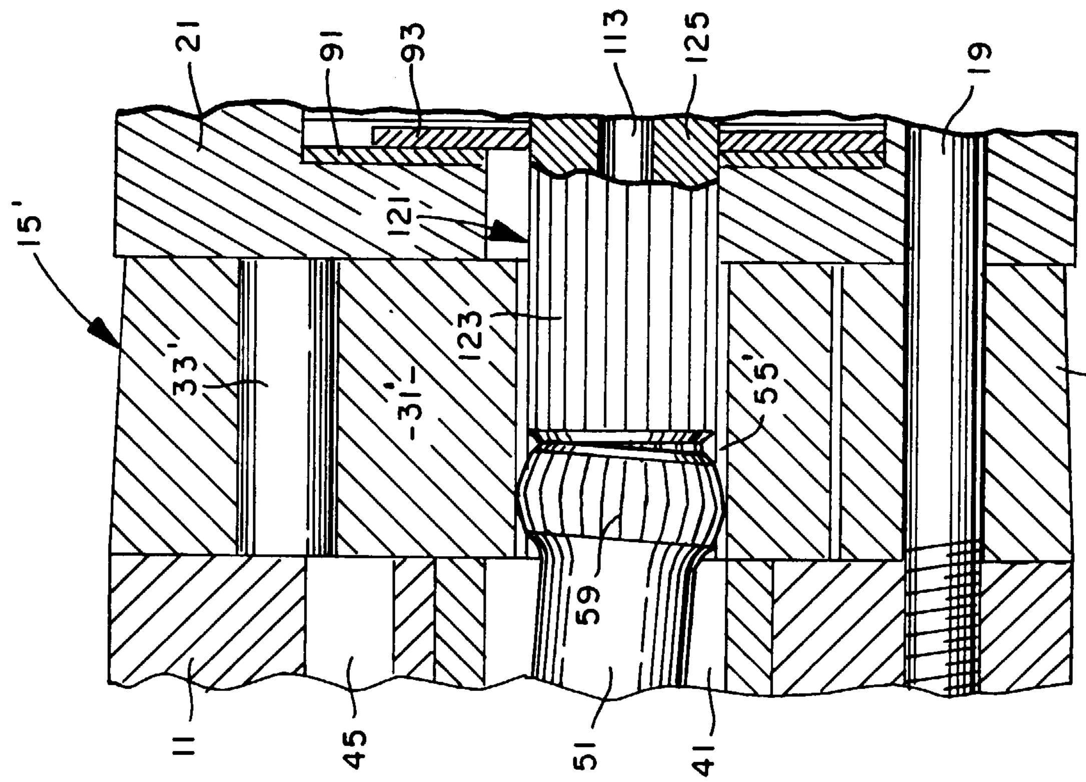

Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 5403

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 183 (M-235) '1328! , 12 August 1983 -& JP 58 085370 A (SUMITOMO IITON KIKI K.K.), 21 May 1983, * abstract *	1-6	F03C2/08 F04C2/10 F04C15/00
A	EP 0 442 031 A (KINSHOFER GREIFTECHNIK GMBH) 21 August 1991 * claim 1; figure 1 *	1	
A	DE 31 25 087 A (DANFOSS A/S) 13 January 1983 * claim 1; figure 1 *	1	
A	US 3 960 470 A (KINDER) 1 June 1976 * claim 1; figure 1 *	1	
D,A	US 4 981 423 A (BISSONNETTE) 1 January 1991 * claim 1; figure 1 *	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F04C
F03C
F16D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 June 1998	Dimitroulas, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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