Feb. 14, 1967 D. W. HAGEMANN 3,303,794

PISTON RETURN MECHANISM

Filed May 31, 1966 2 Sheets-Sheet 1

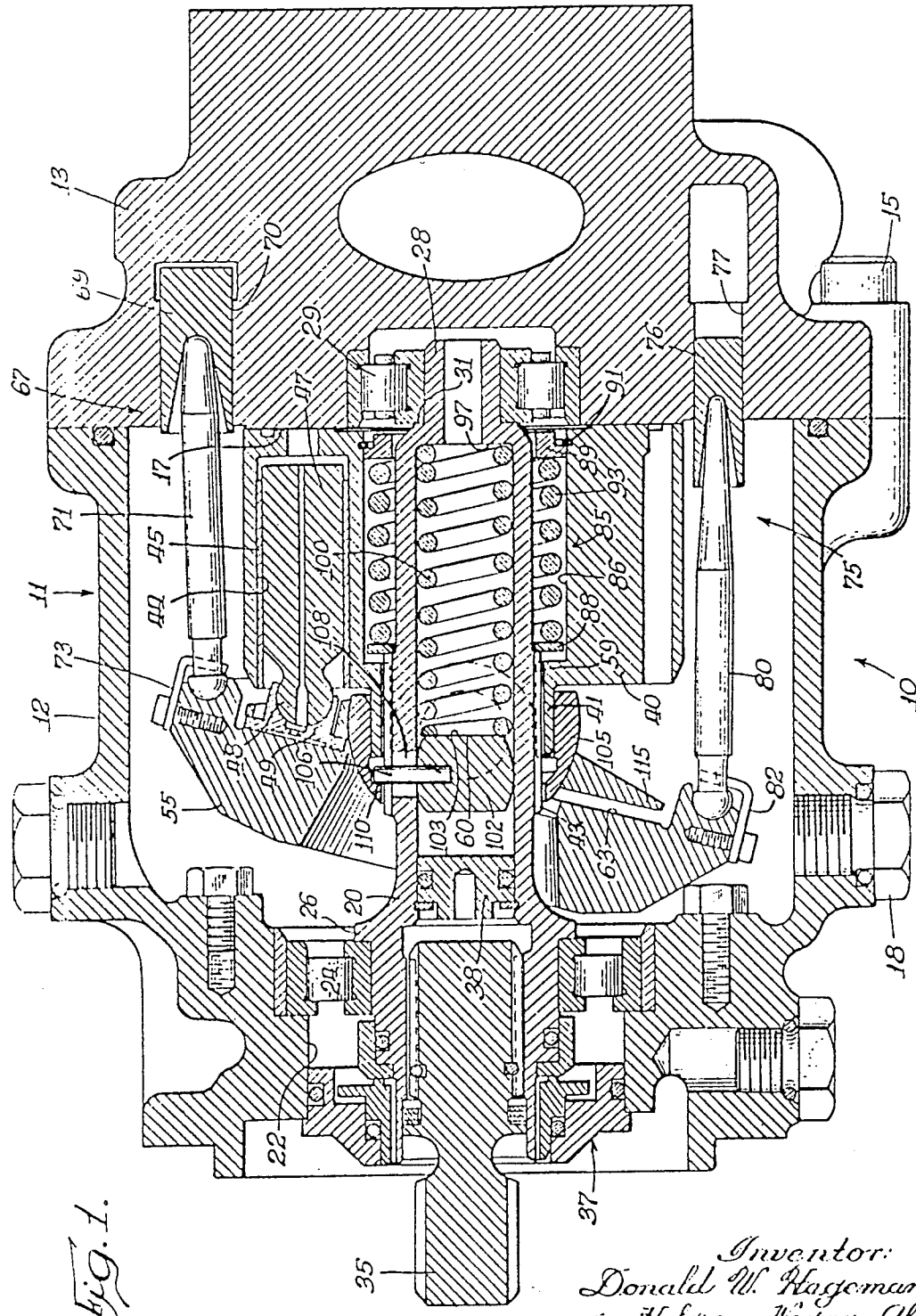


Fig. 1.

Inventor:
Donald W. Hagemann
By: Hofgren, Wegner, Allen, Stellman & McCord
Attys

Feb. 14, 1967 D. W. HAGEMANN 3,303,794

PISTON RETURN MECHANISM

Filed May 31, 1966 2 Sheets-Sheet 2

Fig. 2.

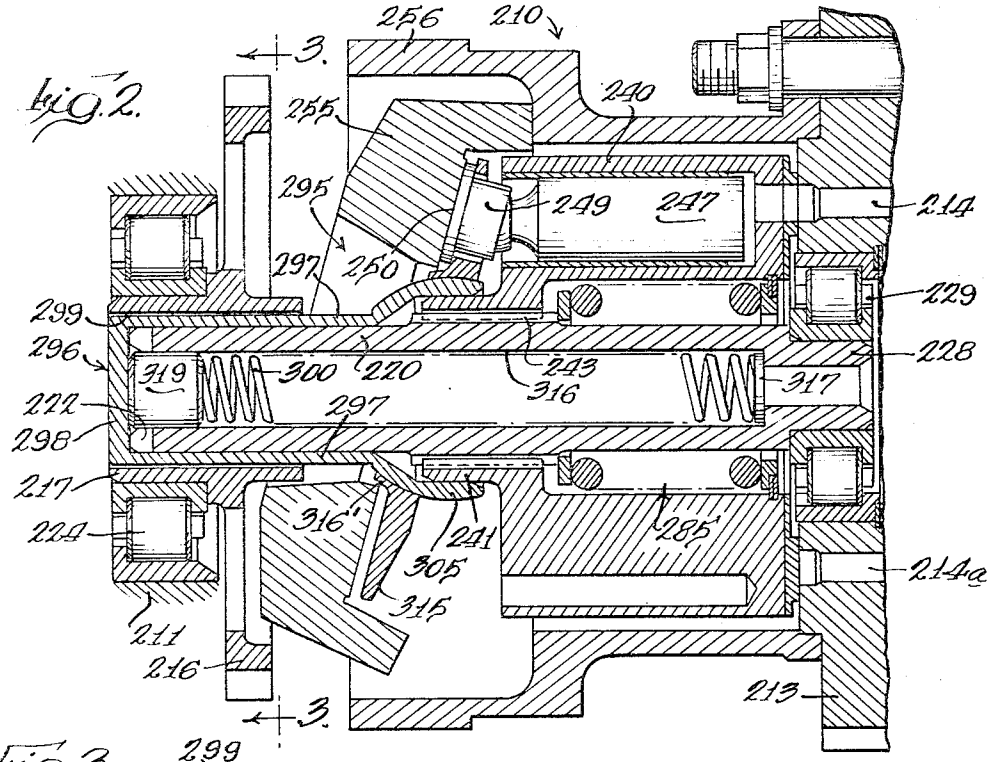
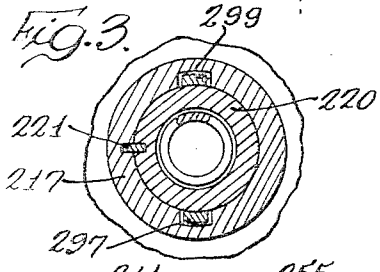


Fig. 3.



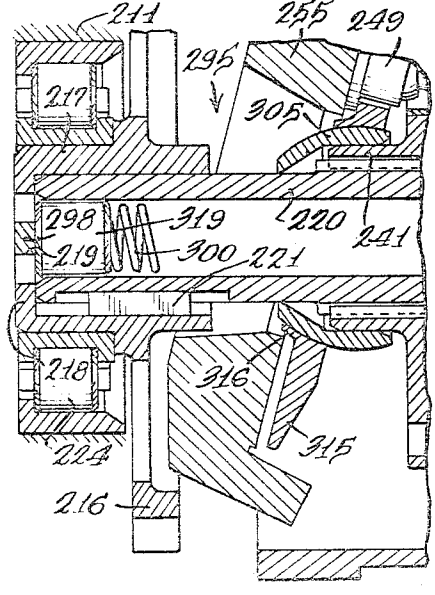
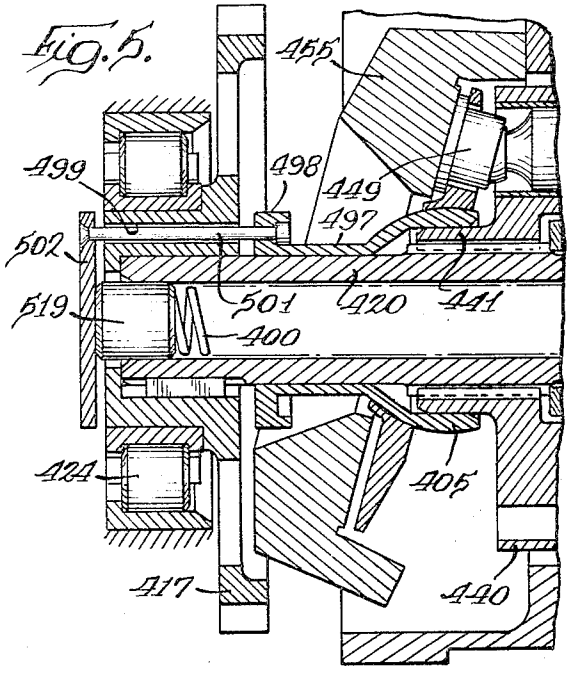


Fig. 4.

Fig. 5.



United States Patent Office 3,303,794 Patented Feb. 14, 1967

3,303,794

PISTON RETURN MECHANISM

Donald W. Hagemann, Rockford, Ill., assignor to Sundstrand Corporation, a corporation of Illinois

Filed May 31, 1966, Ser. No. 553,861
11 Claims. (Cl. 103—162)

This application is a continuation-in-part of my prior copending application Ser. No. 466,589 filed June 24, 1965, and relates generally to hydraulic fluid energy translating devices and more particularly to axial piston pumps and motors.

In devices of the type described, a rotatable cylinder block is provided with axially disposed cylinders having pistons reciprocable therein. An inclined cam plate or swashplate is connected to reciprocate the pistons as the block rotates against a porting member having inlet and outlet ports. The cylinders communicate serially with the inlet and outlet ports, and as the pistons reciprocate, fluid is drawn into the cylinders and expelled therefrom through the ports. In devices of this type, it is desirable that the cylinder block be resiliently biased toward the relatively stationary port member to maintain the proper running engagement between the cylinder block and the port member and to prevent excessive fluid leakage from between these members. In the absence of such a biasing means, the inherent forces placed on the cylinder block would tend to displace the cylinder block from the port plate.

It is also desirable in this type of axial piston unit to maintain a force transmitting contact between the ends of the reciprocating pistons and the inclined cam plate. Conventionally, bearing slippers with spherical sockets are provided on the ends of the pistons engaging the cam plate to transmit the necessary reciprocating force between the cam plate and the pistons. It has been proposed in the past that spring means be provided reacting between the cylinder block and the piston bearing slippers to maintain not only the contact of the piston bearing members with the cam plate, but also contact between the cylinder block and the port plate. However, in some designs of fluid energy translating devices, it has been found that the force desirable to maintain the piston bearing members in contact with the cam plate is different from and sometimes much greater than that necessary to maintain the cylinder block in proper contact with the port plate. In the prior spring arrangements, biasing force on the cylinder block is at least as great as the piston hold-down force. Therefore, if a suitable hold-down force is provided in these prior hydraulic units, the cylinder block biasing force may be excessive. This leads to unnecessary friction, wear and loss of efficiency.

It is, therefore, a general object of the present invention to provide a new and improved piston return mechanism for an axial piston pump or motor device which biases the pistons toward the cam plate without reacting on the rotating cylinder block.

Another object of the present invention is to provide a new and improved piston return mechanism of the type described immediately above and a separate and independent biasing means for urging the rotating cylinder block into engagement with the port member to assure the proper sliding engagement therewith.

A more specific object of the present invention is to provide an axial piston hydraulic pump or motor of the type having bearing members for transmitting the reciprocating force between an inclined cam plate and the reciprocable pistons with a new and improved piston return mechanism including an axially extending coiled compression spring mounted within the main drive shaft of the pump or motor and reacting against the interior of the shaft so that the biasing force will be absorbed by the

bearings which support the shaft rather than the cylinder block; the hollow shaft having a biasing piston slidable therein urged away from the port plate by the compression spring, the slidable piston having projections extending through the hollow shaft and engaging a spherical retaining member which urges the piston bearings against the inclined cam face, the hollow shaft also having an abutment thereon which serves as a spring seat for another coiled compression spring surrounding the shaft and engaging the cylinder block so that the block is urged into engagement with the port plate completely independent of the means for urging the piston bearings into engagement with the cam plate.

A further object of the present invention is to provide an axial piston pump of the type described generally above, and according to a modified form of the present invention, in which the spherical retaining member has a projection which extends rearwardly therefrom away from the cylinder block and around the end of the hollow shaft, with the compression spring within the shaft biasing the projection to urge the piston bearing means into engagement with the cam member.

Other objects and advantages of the present invention will become readily apparent from the following detailed description taken in connection with the accompanying drawing in which:

FIG. 1 is a longitudinal cross section of a hydraulic pump or motor embodying one form of the present invention;

FIG. 2 is a cross section of a hydraulic pump or motor of a somewhat different construction than that shown in FIG. 1, embodying another form of the present invention;

FIG. 3 is a fragmentary section taken generally along line 3—3 in FIG. 2;

FIG. 4 is a fragmentary section of a portion of the pump shown in FIG. 2 with the parts rotated 90 degrees; and

FIG. 5 is a fragmentary section of a hydraulic pump or motor of the type illustrated in FIG. 2 embodying still another form of the present invention.

While illustrative embodiments of the invention are shown in the drawings and will be described in detail herein, the invention is susceptible of embodiment in different forms, and it should be understood that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the embodiments illustrated. The scope of the invention will be pointed out in the appended claims.

Referring now to the embodiment shown in FIG. 1, an axial piston pump is generally designated by the numeral 10 and includes a suitable housing 11. The housing consists of a generally bell-shaped housing member 12 and a port member 13 fixed on the open end of the housing member 12 by suitable threaded fasteners 15. The port member 13 has a surface 17 with arcuate inlet and outlet ports therein (not shown) for conveying fluid to and from the pump or motor device. Suitable plugs 18 are provided in the housing member 11 for permitting the addition or withdrawal of lubricating fluid from within the interior of the housing.

A hollow drive shaft 20 is rotatably mounted within the housing 11 and is adapted to transmit torque to or from the hydraulic unit 10 depending upon whether the unit is operating as a pump or motor. The left end of hollow drive shaft 20 is rotatably mounted in bore 22 of housing member 12 by a suitable roller bearing 24. Shaft 20 has an annular flange 26 thereon engaging the inward side of the inner race of bearing 24 so that this bearing serves as a thrust bearing, as well as a radial bearing, thereby preventing axial movement of the shaft 20 to the

left, as shown in the drawing. The right end of hollow shaft **20** is reduced or stepped as at **28** and mounted within roller bearing **29** in turn mounted within the port member **13**. The stepped end **28** defines a shoulder **31** which abuts the inward face of the inner race of bearing **29** so that this bearing serves as a thrust bearing preventing any rightward movement of hollow shaft **20**.

The drive shaft **20** has an extension shaft **35** splined thereto and extending from the housing member **12** where it may be connected to a suitable prime mover when the hydraulic unit is acting as a pump, or a suitable load when the hydraulic unit is acting as a motor. A seal assembly **37** is provided for preventing the egress of fluid from within the housing **11** and also for preventing the entry of foreign matter into the hydraulic unit. As the details of the seal **37** form no part of the present invention, they are not described in detail. Further, a seal plug **38** is provided in the left end of hollow shaft **20** to prevent the egress of fluid from the unit through the center of the shaft.

A generally cylindrical cylinder block **40** is provided with an axial extension **41** having inwardly directed splines thereon which interengage splines **43** on the hollow drive shaft **20**. In this manner, torque is transmitted from the shaft to the cylinder block or from the cylinder block to the shaft during operation of the hydraulic unit. Cylinder block **40** has a plurality of axially disposed cylinders **44** therein, in annular array about the axis of shaft **20**. Cylinders **44** may have suitable bearing sleeves **45** bonded therein, as shown. Each of the cylinders **44** has a piston member **47** slidable therein. The pistons **47** have spherical ends **48** received in the sockets of bearing slippers **49**.

A normally stationary cam or swashplate member **55** is provided for reciprocating the pistons **47** within the cylinder block as the block rotates. Cam plate **55** is pivotally mounted within the housing **11** by suitable trunnions **56** (shown only in dotted lines in the drawing) for pivotal movement about axis **60** which lies in a plane containing the pivotal connections of the pistons with the slippers **49** and intersects the shaft axis. The cam plate **55** has a camming surface **63** which slidably engages the rear faces of the slippers **49** thereby transmitting reciprocating motion to the pistons **47**.

The angular position of cam face **63** and the cam member **55** may be varied by a suitable control motor assembly **67** which includes a piston **69** slidably mounted within a cylinder **70** formed in the valve member **13**. Piston **69** is connected to rotate the cam plate **55** counterclockwise about axis **60** by a suitable link **71** mounted within the piston **69** at one end and within a socket in the cam plate **55** at its other end. A bracket **73** on cam plate **55** retains the link **71** within the socket in the cam plate.

A swashplate biasing assembly **75** is provided for continuously biasing the swashplate **55** in a clockwise direction about pivot **60**, as shown in the drawing. The assembly **75** includes a piston **76** slidably disposed in a bore **77** in valve member **13**. The piston is continuously biased to the left by fluid in bore **77** from a suitable source. A link **80** interconnects piston **76** and the swashplate **55**. A bracket assembly **82**, similar to bracket assembly **73** is provided for maintaining the link **80** in engagement with its complementary spherical seat in the cam plate **55**.

It will be seen that as fluid is ported to the control cylinder **70** from a suitable source of control fluid that the cam plate will pivot counterclockwise from the position shown against the biasing force of fluid in bore **77** to reduce the displacement of the pump. Subsequently, if it is desired to increase pump displacement, fluid may be ported from cylinder **70** and the bias assembly **75** will urge the cam plate **55** in a clockwise stroke increasing direction. If desired, control fluid may as well be selectively ported to bore **77**, as well as cylinder **70**, so that a double acting control may be achieved.

A cylinder block spring assembly **85** is provided for biasing the cylinder block **40** against the face **17** of valve plate **13** to maintain a fluid tight relationship therebetween as the cylinder block rotates. Cylinder block **40** has an enlarged central recess **86** which accommodates the spring assembly **85**. The latter includes a washer-like spring seat **88** which abuts a shoulder on the hollow shaft **20** such as the end of splines **43** preventing leftward movement of the seat **88**. At the end of the central recess **86** adjacent the port plate, a second annular spring seat **89** is provided, fixed with respect to the cylinder block **40**. A suitable snap ring **91**, seated within a complementary groove in the central recess **86**, prevents the rightward movement of spring seat **89**. A helical coiled compression spring **93** is seated at one end against the spring seat **88** and at its other end engages spring seat **89** on the cylinder block. In this manner, the spring assembly **85** continuously biases the cylinder block against the valve plate **13**. The reaction forces of helical compression spring **93** are transferred to the drive shaft **20** and bearing **24** which serves as a thrust bearing for this purpose.

A piston return spring assembly **95** is provided for continuously urging the piston slippers **49** against the cam surface **63** on cam plate **55**. The hollow shaft **20** has a stepped portion adjacent its right end forming a spring seat **97** for one end of a relatively long compression spring **100**. An axially slidable piston member **102** is provided within the hollow shaft **20** having a surface **103** defining the other seat for spring **100**. Piston **102** has a spherical outer surface to permit limited pivotal movements thereof. It is seen that the piston **102** is continuously biased away from the valve plate by spring **100**. This biasing force is transmitted from the piston **103** to a spherical retaining ball **105** by radially extending pins **106** mounted in the piston **102**. Pins **106** project through axially elongated slots **108** in the hollow shaft **20**, so that the piston **103** is permitted to move axially with respect to the shaft. In the exemplary construction shown in the drawing, three pins **106** and slots **108** are provided, but it should be understood that a different number may be employed, when desired.

The distal ends of pins **106** are received in complementary recesses **110** in the interior of the retainer ball **105**, so that the ball is urged to the left, as shown in the drawing. The spherical retainer ball **105** is also driven in rotation by pins **106**, so that the ball is driven in rotation with the shaft, but may move axially with respect thereto on extension **41**.

A retainer plate **115** is carried by the spherical ball **105** and has a complementary central opening permitting pivotal movement between the retainer plate **115** and the retainer ball **105** as the displacement of the hydraulic unit is varied by the control **67**. Plate **115** has a plurality of openings therein for receiving the slipper members **49**. One side of plate **115** engages the slippers and urges them against the cam surface **63**. As the cyllinder block and drive shaft **20** rotate so do the pistons **103**, spherical ball **105**, and the retainer plate **115**. It will be seen that the slippers **49** are continuously biased against the cam surface **63** by the compression spring **100** through the piston **103**, pins **106**, spherical retainer ball **105**, and the retaining plate **115**.

It should be noted that the piston return assembly **95** is completely independent of the cylinder hold-down spring assembly **85**. The reaction force of spring **100** is transferred to the housing **11** by spring **93** through the spring seat **97** and bearing **29** which serves in this regard as a thrust bearing. None of the piston hold-down force is transferred to the cylinder block **40**, so that the cylinder block biasing force and the piston return force may be selected as desired, independently of one another.

A somewhat modified form of the present invention is illustrated in FIGS. 2, 3, and 4. As shown a piston return assembly **295** is shown incorporated into an axial piston pump or motor **210** of the general type disclosed in the copending application of C. J. Gantzer, Serial No. 421,483,

filed December 28, 1964, and assigned to the assignee of the present invention, to which reference may be made for details of construction and operation of a hydraulic unit of this type, although it is generally similar to the pump or motor disclosed with reference to FIG. 1.

As described in the above mentioned application, the hydraulic unit **210** comprises one-half of a pump and motor combination fixed to a valve plate **213** which has inlet and outlet ports **214** and **214***a* formed therein. A housing **211** shown diagrammatically in FIG. 2 surrounds the pump and motor combination along with associated gearing (not shown). A gear **216**, which transfers torque to or from the hydraulic unit **210**, depending on whether it is operated as a pump or as a motor, has an axial sleeve portion **217** formed integrally therewith. A bearing **224**, fixed within the housing **211**, receives the sleeve portion **217** and thereby rotatably supports the gear **216** in the housing. A hollow shaft **220** has one end thereof received within the gear sleeve **217**, and is rotatably fixed thereto by a key **221** as shown in FIGS. 3 and 4. As shown more clearly in FIG. 4, the sleeve **217** has an inwardly extending flange **218** engaging the end of shaft **220**. The other end of the shaft **220** is stepped as at **228** and received in a roller bearing **229** mounted within valve plate **213**. Bearings **224** and **229** take the axial thrust force from shaft **220** in a manner similar to that in which bearings **24** and **29** are loaded in the FIG. 1 embodiment.

Shaft **220** is splined to cylinder block **240** as at **243**. Cylinder block **240** has pistons **247** axially slidable therein with bearing slippers **249** pivotally connected to the projecting ends thereof. Slippers **249** have bearing surfaces **250** slidably engaging a pivotally adjustably cam member **255**. Cam **255** is pivotaly mounted in a partial housing **256** which is fixed to valve plate **213**. The piston return mechanism **295** is generally similar in fuction to the return mechanism **95** shown in FIG. 1 although it is of somewhat simpler construction.

A retaining plate **315** is generally similar to the retaining plate **115** in FIG. 1 except that it has an additional spherical lip or flange portion **316** to provide more seating surface on a spherical retainer **305**.

The spherical retainer **305** is piloted on a rearward extension **241** of the cylinder block **240** and has a generally U-shaped strap or projection **296** consisting of legs **297** fixed to the rearward end of the spherical member **305** and slidable on shaft **220** and a radial bight portion **298** extending over the end of shaft **220**.

As shown more clearly in FIG. 3, the sleeve portion **217** of gear **216** has two axially extending diametrically opposed slots **299** slidably receiving the legs **297**, and which serve to transfer torque from the gear **216** to the spherical ball **305**.

The flanged portion **218** is slotted as shown at **219** in FIG. 4 to slidably receive the bight portion **298** of the strap. A diametral slot **222**, shown in FIG. 2, in the end of shaft **220** partially receives and permits axial movement of the bight portion **298** toward the cylinder block.

Within the hollow shaft **320** is a coiled compression spring **300** housed in a bore **316** and reacting against a seat member **317** which in turn bears against a stepped portion of bore **316** near the valve plate **213**. The other end of the spring biases a cylindrical plug **319** slidable in the other end of bore **316** and projecting somewhat therefrom. Spring **300** serves to bias the plug **319** into engagement with the bight portion **298** of the projection **296**. This biases the spherical ball **305**, and the retainer plate **315** as a unit away from the cylinder block urging the bearing slippers **249** into engagement with the cam member **355**.

A cylinder block hold-down spring mechanism **285** is similar in operation and construction to the assembly **85** shown and described with reference to FIG. 1, so that a detailed description thereof is not believed necessary.

The embodiment shown in FIGS. 2, 3 and 4 permits a greater seating surface of the retainer plate **315** as shown at **316'** on the spherical retainer **305**. It further permits the use of a stiffer shaft than in the FIG. 1 embodiment, and permits the spring force to be directly applied to the spherical ball assembly **305**. An additional advantage is that due to the relatively great length of the spring **300**, it is not necessary to use shims on the spring **300** during assembly to assure a uniform hold-down force.

The embodiment shown in FIG. 5 is similar to that shown in FIG. 2, except that spherical ball **405** and its connection with spring **400** are somewhat different. Spherical ball **405** is piloted on cylinder block projection **441** and has a rearwardly extending sleeve portion **497** surrounding shaft **420** with an annular flange **498** positioned between gear **417** and cylinder block **440**. Bores **499** in gear **417** slidably receive pins **501** fixed at one end to the flange **498** and at the other end to a transversely extending plate **502** across the open end of the shaft **420**. Spring **400** biases plug **519** into engagement with the plate **502** thereby tending to slide the spherical ball assembly **405** rearwardly urging slippers **449** into engagement with the cam **455** in a manner similar to that in the construction of FIGS. 2, 3 and 4.

I claim:

1. In an axial piston pump or motor device, housing means, a rotatable cylinder block in said housing means having a plurality of axial cylinders and a central recess, a drive shaft in said recess connected for rotation with the cylinder block, bearing means in said housing for constraining axial movement of said shaft, a plurality of pistons having ends reciprocable in said cylinders, a cam plate at one end of said cylinder block having a bearing face inclined to the end of the cylinder block, said drive shaft extending completely through said cylinder block and said cam plate, said bearing means supporting said drive shaft in said housing at both ends thereof, second bearing means on the outer ends of said pistons engaging said cam plate, ports communicating the cylinders with the opposite end of said cylinder block, a port member adjacent the opposite end of the cylinder block, and spring means wholly within said drive shaft for urging said second bearing means into engagement with said cam plate.

2. A pump or motor device as defined in claim **1**, wherein said first spring means includes abutment means fixed on said shaft adjacent the central recess in the cylinder block, and a coiled compression spring surrounding said shaft within said central recess and having one end engaging the abutment means and an opposite end engaging the cylinder block, whereby the cylinder block is urged against the port member by the compression spring which reacts against the shaft.

3. A pump or motor device as defined in claim **1**, wherein said shaft is hollow, said second spring means including a compression spring within said shaft having one end in reacting engagement therewith, projection means extending radially of said shaft and axially movable with respect thereto, the other end of said compression spring within the hollow shaft engaging said projecting means and urging said projecting means away from said port member, a portion of said projecting means extending radially from said shaft and connected to urge said second bearing means into engagement with said cam plate.

4. A hydraulic pump or motor device, comprising: a housing member having a port member adjacent one end thereof with inlet and outlet ports therein adapted to convey fluid to and from the device, a hollow shaft rotatable within said housing, bearing means in said housing for supporting said shaft and for preventing axial movement thereof, a rotatable cylinder block surrounding a portion of said shaft and having a port face in sliding engagement with said port member, a plurality of axial cylinders in annular array in said cylinder block, a plurality of ports in said cylinder block providing communication between the cylinders and said port face whereby the cylinders serially communicate with said inlet and outlet

ports during rotation of the cylinder block, pistons slidable within said cylinders, a pivotal cam plate mounted within said housing adjacent one end of said cylinder block for reciprocating said pistons, pivotal bearing means on the end of each piston engaging said cam plate, a retaining plate engaging said pivotal bearing means for urging the bearing means and the pistons toward said cam plate, a generally spherical retaining member surrounding said shaft and rotatable therewith, said spherical retaining member having an outer surface engaging said retaining plate permitting pivotal movement therebetween, said cylinder block having a central recess therein, first spring means in said recess for urging the cylinder block against the port plate, and second spring means within said hollow shaft for biasing said retainer ball against said retainer plate, said retainer plate against said piston bearing members, and said piston bearing members against said cam plate.

5. A pump or motor device as defined in claim **4**, wherein said first spring means includes an abutment fixed on said shaft adjacent said central recess in the cylinder block, a coiled compression spring having one end engaging said abutment, shoulder means on said cylinder block defining one end of said central recess, the other end of said coiled spring engaging said cylinder block shoulder whereby the cylinder block is urged into engagement with the port plate, said second spring means including an axially disposed coiled compression spring mounted within said hollow shaft, said hollow shaft having axially extending recess means therein adjacent said spherical retaining member, an axially slidable member within said hollow shaft, said axially slidable member having radial projections extending through said shaft recess means and engaging said spherical retaining member, one end of said coiled spring within the hollow shaft engaging said axially slidable member and urging it away from the port member whereby the piston bearings are urged into engagement with the cam plate.

6. A pump or motor device as defined in claim **5**, wherein said shaft is hollow throughout a substantial portion of the length of the cylinder block, the inside of said hollow shaft being stepped adjacent the port member to define a spring seat therein, said second coiled compression spring extending throughout a substantial portion of the length of the cylinder block, said axially slidable member having a curved outer surface to permit limited pivotal movement thereof, said elongated recess means in the hollow shaft including a plurality of circumferentially spaced axially elongated slots, said radial projections including a plurality of pins mounted in said axially slidable member and extending through said slots, said spherical retaining member having grooves for receiving said pins.

7. In an axial piston pump or motor device, housing means, a rotatable cylinder block in said housing means having a plurality of axial cylinders and a central recess, a hollow drive shaft disposed in said recess and connected for rotation with the cylinder block, bearing means in said housing means supporting the shaft for rotation and restraining it against axial movement, pistons reciprocable in said cylinders, respectively, a swashplate at one end of said cylinder block having a bearing face inclined to the end of the cylinder block, bearing means on the outer ends of said pistons engaging said swashplate, a hold-down member engaging the last recited bearing means to hold the latter on the swashplate, ports communicating the cylinders with the opposite end of said cylinder block, a port member adjacent said opposite end of the cylinder block, first spring means surrounding said shaft and second spring means in said drive shaft, both spring means grounded on said drive shaft, means transmitting the force of one of said spring means to urge the cylinder block toward the port member, and means transmitting the force of the other of said spring means to urge the hold-down member toward the swashplate.

8. A pump or motor device as defined in claim **1**, wherein said shaft has a bore therein opening to the end of the shaft adjacent the cam plate, said second spring means including a compression spring within said shaft having one end in reacting engagement therewith, a retainer member surrounding said shaft for urging the second means into engagement with the bearing face, and projection means extending axially from said retainer member to said end of the shaft and having a radially inwardly extending portion adjacent said shaft bore, said spring being connected to bias said radially inwardly extending portion of the projection means axially away from the cylinder block.

9. A pump or motor as defined in claim **8**, and further including a generally flat retainer plate engaging said second bearing means, said retainer member being a spherical member, a gear surrounding and rotatably fixed to said shaft between said one end of the shaft and the spherical retainer, said axial projection extending through said gear.

10. A pump or motor device as defined in claim **9**, wherein said bearing means includes a bearing in said housing supporting said gear, said gear having two axial slots therethrough along said shaft, said projection means including a generally U-shaped member having legs extending through said slots and fixed to said spherical retainer, and a cylindrical plug slidable in said shaft bore and engaging said U-shaped member, said spring biasing said plug into engagement with said U-shaped member which in turn urges the second bearing means into engagement with the bearing face on the cam.

11. A pump or motor as defined in claim **9**, wherein said bearing means in said housing includes a bearing supporting said gear, said gear having at least one axial opening therethrough, said spherical ball having a rearward extension, an annular flange extending radially from said rearward extension, said projection means including at least one pin fixed to said flange at one end and extending through said opening and projecting from said gear, a plate fixed to the other end of said pin and extending radially over the open end of said bore, and a cylindrical plug slidable in said bore and engaging said radially extending plate, said spring biasing said plug into engagement with said radially extending plate to urge said second bearing means into engagement with said cam face.

References Cited by the Examiner

UNITED STATES PATENTS

2,776,628	1/1957	Keel	103—162
3,191,543	6/1965	Hann et al.	103—162
3,232,056	2/1966	Heinrich et al.	103—162

FOREIGN PATENTS

1,038,588	5/1953	France.
441,952	3/1927	Germany.
628,472	4/1936	Germany.
855,582	12/1960	Great Britain.

DONLEY J. STOCKING, *Primary Examiner.*

R. M. VARGO, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,303,794 February 14, 1967

Donald W. Hagemann

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 44, strike out "wherein said first spring means includes"; line 53, strike out "second".

Signed and sealed this 6th day of May 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

Edward J. Brenner

Commissioner of Patents