Oct. 2, 1962 A. F. BOHNHOFF 3,056,357

RADIAL BALL PISTON PUMP

Filed Dec. 1, 1958 3 Sheets-Sheet 1

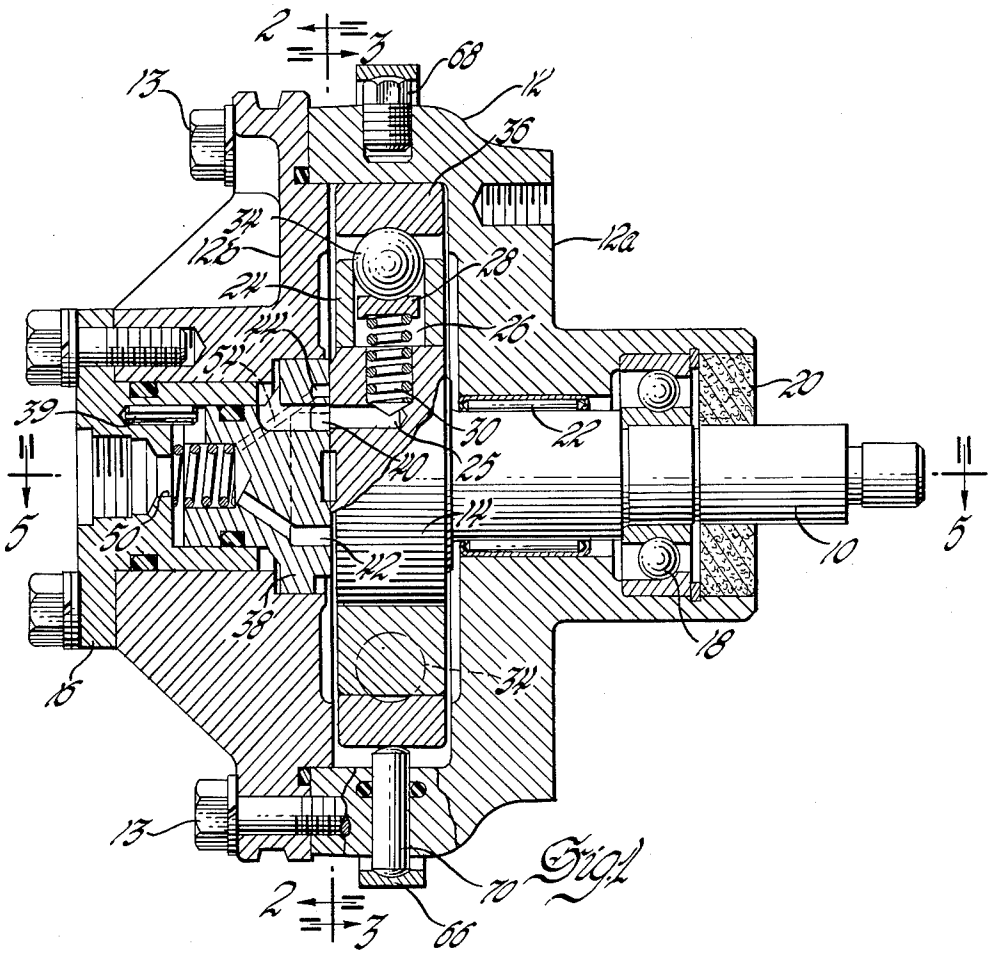


Fig. 1

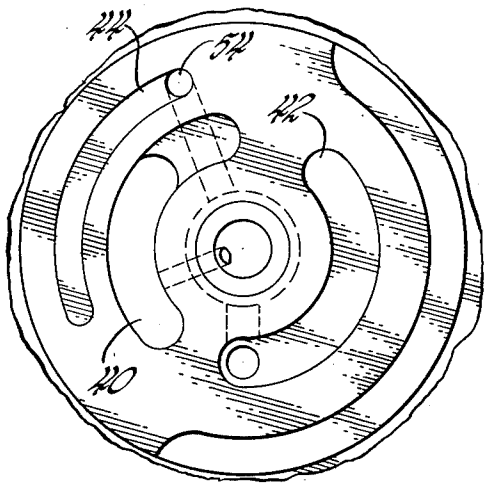


Fig. 2

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Oct. 2, 1962 A. F. BOHNHOFF 3,056,357

RADIAL BALL PISTON PUMP

Filed Dec. 1, 1958 3 Sheets-Sheet 2

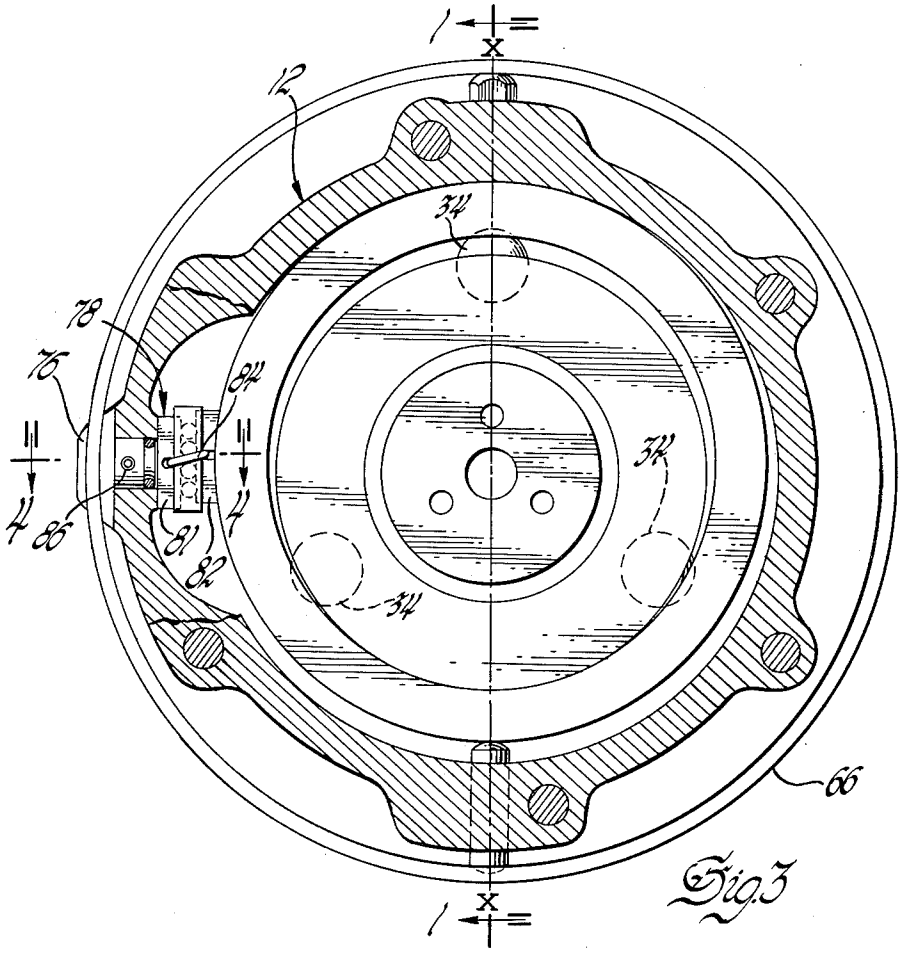


Fig. 3

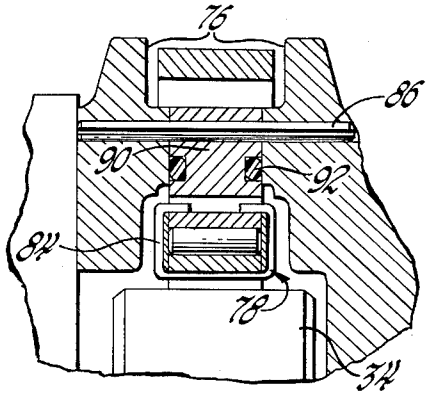


Fig. 4

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Oct. 2, 1962 A. F. BOHNHOFF 3,056,357

RADIAL BALL PISTON PUMP

Filed Dec. 1, 1958 3 Sheets-Sheet 3

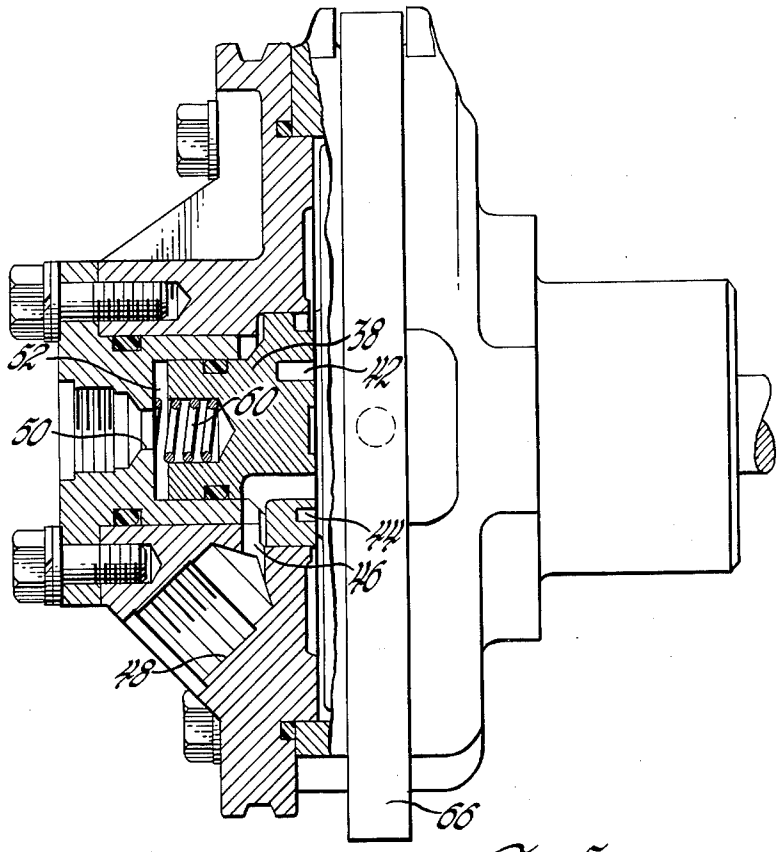


Fig. 5

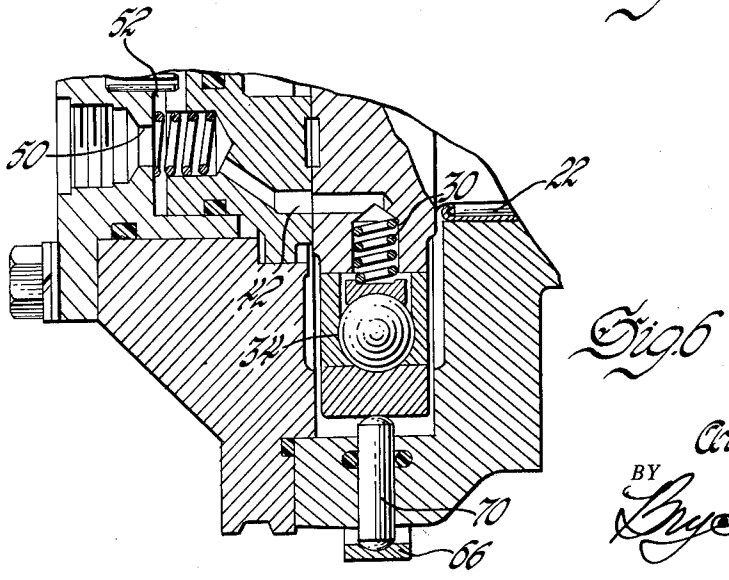


Fig. 6

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United States Patent Office

3,056,357

Patented Oct. 2, 1962

3,056,357

RADIAL BALL PISTON PUMP

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Filed Dec. 1, 1958, Ser. No. 777,253
8 Claims. (Cl. 103—161)

This invention relates to rotary fluid pressure transmission devices and more particularly pertains to a rotary pump having associated therewith means for varying the displacement thereof as determined by the demand thereon.

The pump herein is especially adapted for use in fluid servo mechanisms but may be otherwise applied with advantage. A particular use contemplated is fluid power steering where the pump conventionally used is of constant displacement and thus because of friction drag represents a horsepower loss particularly when the vehicle is travelling at cruising speeds, under which condition the demand on the pump is negligible because of the low steering resistance. Efforts toward providing means for automatically varying the displacement of the conventional pump have met with little success primarily because the mechanisms which have been found acceptable from a cost standpoint are prone to cause leakage difficulties.

As suggested, a principal object of the invention is to provide a pump assembly suited for the purposes indicated which includes means for automatically reducing the displacement of the pump to cut its output as the demand thereon slackens.

Another object is to provide such a pump mechanism which is easily assembled from readily fabricated and inexpensive parts.

Still anotoher object is to supply a pump which presents virtually no leakage problem.

Further objects and features of the invention will be apparent from the following description of a preferred embodiment thereof. The description will proceed with reference to the accompanying drawings wherein:

FIGURE 1 is a longitudinal view wherein certain parts appear in section, others in elevation or broken away;

FIGURE 2 is an elevation of a port plate forming part of the assembly;

FIGURE 3 is a section on the line 3—3 in FIGURE 1;

FIGURE 4 is a fragmentary section taken on the line 4—4 in FIGURE 3;

FIGURE 5 is a view on the line 5—5 in FIGURE 1; and

FIGURE 6 is a fragmentary sectional view illustrating the relationship of certain passages, the moving parts appearing rotated 180° relative to FIGURE 5.

Referring now particularly to FIGURE 1, the numeral 10 denotes a drive shaft terminating within the pump casing 12 in a flange 14. Casing 12 will be seen formed of a pair of body members 12*a* and 12*b* interconnected by bolts 13. A cover plate 16 is similarly secured to body member 12*b*. Member 12*a* has a boss portion confining ball bearings 18 for the shaft 10 and a ring seal 20. Inward of the ball bearings 18 are needle bearings 22.

A ring element 24 press-fitted over the flange 14 is formed to provide a plurality of pumping chambers 26. Each such chamber communicates with a passage 25 in flange 14 and confines a follower 28 biased radially outwardly against a ball piston 34 by a spring 30 accommodated in a bore in the flange 14.

The balls 34 are to be noted as maintained against the inner periphery of a cam ring 36 by the force of the springs 30. Such ring 36 is held in eccentric disposition

with reference to the axis of the shaft 10 by means hereinafter to be described.

Leftward (FIGURE 1) of the flange 14 is a plate 38 secured against rotary movement by a pin 39 and having therein arcuate ports 40 and 42 and an arcuate recess 44, these being best shown by FIGURE 2. Port 40 connects via passage 46 with the pump intake 48 (FIG. 5), while port 42 opens to a discharge passage 50 (FIG. 6). The latter passage includes a chamber 52 outward of the plate 38. In operation, discharge fluid in the chamber 52 exerts a force against the plate 38 tending to maintain it in sealing engagement against the flange 14.

A passage 54, seen in FIGURE 1, extends from the discharge passage 50 to the recess 44 in the plate 38. The purpose of recess 44 is to provide for the balancing of the plate 38, it having been found that in the absence of such means the pressure at 42 tends to cock the plate destroying the seal between it and the flange 14 with loss in the operating efficiency of the pump.

In the operation of the pump as so far described, it should be clear that as the shaft 10 and ring 24 rotate the volumetric capacity of the chambers 26 is varied by the radial reciprocation of the ball pistons 34, this reciprocation being induced by the cam ring 36 which, as previously noted, is normally positioned eccentrically with relation to the axis of the shaft 10. The outward movement of the balls is accompanied by registry of port 40 with passages 25 and charging of fluid to the chambers 26, while the inward movement of the balls is marked by the discharging of fluid into passage 50 via such passages and the port 42.

Seen surrounding the casing 12 in FIGURES 1, 3, 4 and 5 is a hoop spring 66 preloaded by a screw 68 threaded into the casing and bearing against the inner peripheral surface of the hoop spring. This hoop spring sets the normal eccentricity of the cam ring 36, being operably connected to the cam ring by means of a pin 70 extending through an aperture in the casing 12, more particularly, the body member 12*a*. In accordance with the invention, hoop spring 66 is carefully selected and tensioned to yield from the pressure of the discharge fluid as applied to it through the cam ring 36 and pin 70 when such pressure reaches a predetermined value determined by the particular purpose to which the pump is applied. Upon the development of such pressure, a cam ring 36 is displaced along the axis X—X (FIG. 3) with reduction in its eccentricity, the extent of the displacement being a function of the magnitude of the pressure. With the ring 36 in its position of minimum displacement the pump output is, of course, zero.

As shown in FIGURES 3 and 4, to insure that the hoop spring 66 will move along the X—X axis, casing 12 is suitably formed to provide guide walls 76 while in the interest of promoting smooth movement of cam ring 36 along such axis a roller bearing 78 is supplied. This bearing comprises blocks 81 and 82 linked via a connector 84 permitting movement of block 82 relative to block 81. As illustrated, the two blocks are spaced by the rollers comprised in the bearing. Block 81 is secured to the casing wall via a roll pin 86 extending through a plug 90 recessed to accommodate a seal 92 and suitably connected to or made integral with the block 81.

What is claimed is:

1. In a pump having within a casing radially disposed chambers and radially movable means for varying the volumetric capacity of said chambers to provide a pumping action, such action being a function of eccentric means encircling and engaging said radially movable means within said casing, said radially movable means being cyclically subject to discharge pressure radially applied thereagainst in the direction of said eccentric means, the combination of a preloaded hoop spring en-

circling said casing, means extending through said casing to operably interconnect said eccentric means and said hoop spring, the force of the latter as applied against said means extending through the casing serving to set the normal eccentricity of said eccentric means, and means associated with said casing for preventing axial displacements of said hoop spring, said pump being characterized in operation in that a predetermined discharge pressure said eccentric means becomes displaced in a direction normal to the axis of said hoop spring with reduction in the eccentricity of said eccentric means, such displacement being effected by the pressure of the discharge fluid applied through said radially movable means.

2. In a pump having within a casing radially disposed chambers and radially movable means for varying the volumetric capacity of such chambers to provide a pumping action, movement of said means being induced by a normally eccentrically disposed cam ring encircling and engaging said means within said casing, said radially movable means being cyclically subject to discharge pressure radially applied thereagainst in the direction of said cam ring, the combination of a preloaded hoop spring encircling said casing, a pin extending through an aperture in said casing to engage the outer surface of said cam ring and the inner surface of said hoop spring, the force of the latter as applied against said pin serving to set the normal eccentricity of said cam ring, and means associated with said casing for preventing axial displacements of said hoop spring, said pump being characterized in operation in that at a predetermined discharge pressure said cam ring becomes displaced in a direction normal to the axis of said hoop spring with reduction in the eccentricity of said cam ring, such displacement being effected by the pressure of the discharge fluid applied through said radially movable means.

3. A pump comprising a casing, rotary drive means terminating within said casing in a flange, means carried by said flange providing a plurality of chambers, radially movable means within each chamber adapted to vary the volumetric capacity thereof, a normally eccentrically disposed cam ring within said casing having encircling engagement with said last means to cause radial movement thereof, a plate within said casing adjacent said flange having arcuate intake and discharge ports communicating with said chambers as said drive means rotates, such rotation being accompanied by cyclical subjection of said radially movable means to discharge pressure radially applied thereagainst in the direction of said cam ring, a preloaded hoop spring encircling said casing, means extending through said casing to operably interconnect said cam ring and said hoop spring, the force of the latter as applied against said means extending through the casing serving to set the normal eccentricity of said cam ring, and means associated with said casing for preventing axial displacements of said hoop spring, said pump being characterized in operation in that as a predetermined discharge pressure said cam ring becomes displaced in a direction normal to the axis of said hoop spring with reduction in the eccentricity of said cam ring, such displacement being effected by the pressure of the discharge fluid applied through said radially movable means.

4. A pump comprising a casing, rotary drive means terminating within said casing in a flange, means carried by said flange providing a plurality of chambers, radially movable means within each chamber adapted to vary the volumetric capacity thereof, a normally eccentrically disposed cam ring within said casing having encircling engagement with said last means to cause radial movement thereof, a plate within said casing adjacent said flange having arcuate intake and discharge ports communicating

with said chambers as said drive means rotates, such rotation being accompanied by cyclical subjection of said radially movable means to discharge pressure radially applied thereagainst in the direction of said cam ring, a preloaded hoop spring encircling said casing, a pin extending through an aperture in said casing, one end of said pin abutting the outer peripheral surface of said cam ring, the other end abutting the inner peripheral surface of said hoop spring, the force of the latter as applied against said pin serving to set the normal eccentricity of said cam ring, and means associated with said casing for preventing axial displacements of said hoop spring, said pump being characterized in operation in that at a predetermined discharge pressure said cam ring becomes displaced in a direction normal to the axis of said hoop spring with reduction in the eccentricity of said cam ring, such displacement being effected by the pressure of the discharge fluid applied through said radially movable means.

5. A pump according to claim 4 comprising means for changing the preload of said hoop spring and thus the said predetermined discharge pressure.

6. A pump according to claim 5 where such last-named means takes the form of a member threaded into said casing and bearing against the inner peripheral surface of said hoop spring.

7. A pump comprising a casing, rotary drive means terminating within said casing in a flange, a ring press-fitted over said flange and providing a plurality of chambers, a ball piston within each said chamber spring-biased radially outwardly, a normally eccentrically disposed cam ring within said casing having encircling engagement with said balls to cause radial movement of the same, a plate within said casing adjacent said flange having arcuate intake and discharge ports communicating with said chambers as said drive means rotates, such rotation being accompanied by cyclical subjection of each said ball piston and to discharge pressure radially applied thereagainst in the direction of said cam ring, a preloaded hoop spring encircling said casing, a pin extending through an aperture in said casing, one end of said pin abutting the outer peripheral surface of said cam ring, the other end thereof abutting the inner peripheral of said hoop spring, the force of the latter as applied against said pin serving to set the normal eccentricity of said cam ring, and means associated with said casing for preventing axial displacements of said hoop spring, said pump being characterized in operation in that at a predetermined discharge pressure said cam ring becomes displaced in a direction normal to the axis of said hoop spring with reduction in the eccentricity of said cam ring, such displacement being effected by the pressure of the discharge fluid applied through said ball pistons.

8. A pump according to claim 7 further comprising roller bearing means supported by said casing and engaging said cam ring, said roller bearing means being functional on the said displacement of said cam ring.

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CERTIFICATE OF CORRECTION

Patent No. 3,056,357 October 2, 1962

Arthur F. Bohnhoff

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 1, line 36, for "anotoher" read -- another --; column 3, line 8, after "that" insert -- at --; same column, line 57, for "as" read -- at --.

Signed and sealed this 19th day of February 1963.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents