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(54) Axial piston pump with rocker cam counterbalance feed

(57) A rocker cam type, variable displacement, axial piston pump (10) where working pressure fluid supplied to a pump housing (12) is fed to a pair of counterbalance pockets (72, 74) formed in the rocker cam (38) through fluid passage (86, 88, 92, 96) located within the rocker cam (38).

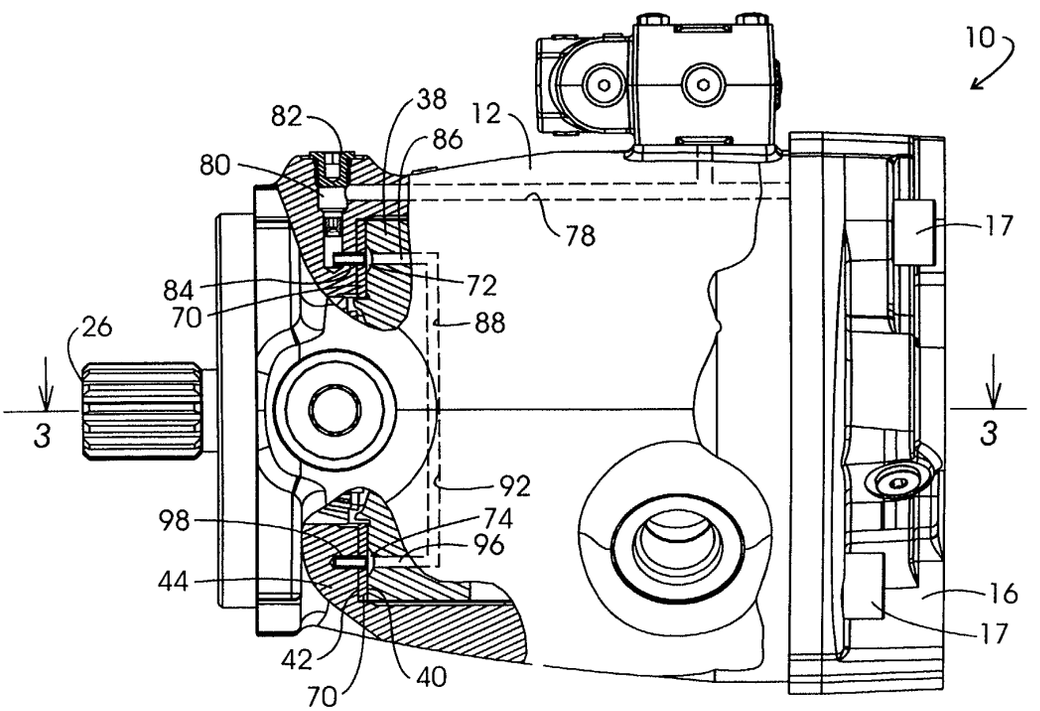

FIG. 2

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Description

BACKGROUND OF THE INVENTION:

[0001] This invention relates to a variable displacement, axial piston pump having a rocker cam pivotally mounted in a rocker cradle formed in the pump housing to thereby permit the displacement of the pump to be changed. Such a pump includes a rotatably mounted pump barrel having a plurality of longitudinal bores each housing a pump piston. Each piston has a shoe pivotally attached to a head end which projects from the barrel and is retained against a thrust surface formed on the rocker cam. A prime mover rotates the barrel causing the pistons to reciprocate and thereby pump fluid as the piston shoes slide over the thrust surface. The angle of the rocker cam thrust surface determines the displacement of the pump. If the rocker cam is centered, i.e. off-stroke, the thrust surface is perpendicular to the axes of the pistons and they do not reciprocate. If the rocker cam is not centered, i.e. on-stroke, the thrust surface is angled with respect to the ends of the shoes and the piston reciprocates as the barrel is rotated.

[0002] The rocker cam may be pivoted to change the displacement of the pump by a rotary servo controlled fluid motor as described in U.S. Patent Number 3,967,541. Alternatively, the pump may be put on-stroke by a spring which biases the rocker cam to a full on-stroke position as is common with a pressure compensated pump of the type disclosed in the instant application. One type of pressure compensated pump may be seen in U.S. Patent Number 4,289,452.

[0003] During the operation of an axial piston pump, forces caused by pumping working pressure fluid are transmitted through the pistons and the thrust surface to the interface between the rocker cam and the rocker cradle. As the pressure of the working fluid increases, the pumping forces applied to the rocker cam/rocker cradle interface increase. In order to overcome the pumping forces at the rocker cam/rocker cradle interfaces, fluid pockets are formed in either the rocker cradle or the rocker cam. Working pressure fluid is supplied through the piston shoes, the thrust surface and the rocker cam to the fluid pockets to provide a counterbalancing force to the pumping forces applied to the rocker cam/rocker cradle interface. The counterbalancing force greatly reduces the force a pressure compensator control or a rotary servo control must be capable of exerting to change the displacement of the pump.

[0004] Because of the complexities involved in balancing the piston shoes, it is desirable to provide a means of supplying working pressure fluid to the rocker cam/cradle interface fluid pockets which does not require feeding the fluid from the piston shoes into the rocker cam.

SUMMARY OF THE INVENTION:

[0005] An axial piston pump for pumping fluid at a set working pressure which comprising a housing, a barrel rotatably mounted in the housing, a plurality of bores in the barrel, a piston mounted for reciprocation in each of said bores, a shoe mounted on the end of each piston, a rocker cam support in the housing, a rocker cam having a pair of spaced arcuate bearing surfaces pivotally mounted in complementary arcuate bearing surfaces formed in said rocker cam support, a thrust surface on said rocker cam, a holddown for clamping said piston shoes against said thrust surface wherein said shoes slide over said thrust surface when said barrel is rotated and the pistons reciprocated in their bores when the rocker cam thrust surface is angled to the axis of said barrel, a counterbalance fluid pocket formed in each of said rocker cam arcuate bearing surfaces, a first fluid passage formed in said housing connected to a source of working pressure fluid for conducting working pressure fluid to one of said counterbalance fluid pockets and a second fluid passage formed in said rocker cam connecting said one and the other of said counterbalance fluid pockets such that working pressure fluid supplied to said one counterbalance fluid pocket through said first fluid passage in said housing is supplied to said other counterbalance fluid pocket through said second fluid passage formed in said rocker cam.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0006]

Figure 1 is a perspective view of a rocker cam type pump which incorporates the instant invention looking at the intake and discharge ports;
Figure 2 is a side view, partially sectioned of the pump in Figure 1;
Figure 3 is an axial sectional view of the pump taken along line 3-3 of Figure 2;
Figure 4 is a sectional view of the portion of the pump housing having a rocker cradle formed therein;
Figure 5 is a perspective view of the pump with the housing removed to illustrate the rocker cam and other internal parts;
Figure 6 is a perspective view of a rocker cam; and
Figure 7 is a rear view partially in section of the rocker cam depicted in Figure 6.

DESCRIPTION OF THE PREFERRED EMBOIDMENT:

[0007] Referring to Figs. 1 through 5 of the drawings, a pressure compensated, variable displacement, axial piston pump **10** having a rocker cam pivotally mounted in a cam support or cradle may be seen to include a central housing **12**, having a mounting pilot end **14** and a port cap **16** at the other end. Bolts **17** connect port cap

16 to housing **12**.

[0008] Housing **12** defines a cavity which houses a rotatable barrel **18** mounted on a drive shaft **20.** The inner end of drive shaft **20** is supported in a bearing **22** mounted in the port cap **16**. Drive shaft **20** also is supported in a bearing **24** mounted within housing **12** and has a splined drive end **26** which projects outwardly of housing **12**.

[0009] Barrel **18** has a plurality of bores **28** equally spaced circumferentially about its rotational axis. Each bore **28** contains a piston **30** having a ball shaped head **32**. A shoe **34** is swedged onto head **32** of piston **30** such that the shoe can pivot about the end of the piston. Each of the shoes is clamped against a flat thrust plate or swash plate surface **36** formed on the face of a pivotal rocker cam **38** utilizing a conventional shoe retainer assembly of the type described in detail in U.S. Patent Number 3,904,318.

[0010] Turning to Figs. 2 through 6, it may be seen that rocker cam 38 has a pair of arcuate bearing surfaces **40** which are received in complementary arcuate bearing surfaces **42** which comprise a rocker cam support or cradle **44** formed in mounting pilot end **14** in housing **12**. Rocker cam **38** pivots about a fixed axis perpendicular to the axis of rotation of barrel **18** to change the displacement of pump **10.** In operation, the prime mover, not shown, affixed to spline drive end **26** rotates drive shaft **20** and barrel **18** within housing **12.** When thrust surface **36** on rocker cam **38** is perpendicular to the axis of rotation of barrel **18**, rotation of barrel **18** will cause the shoes to slide across the surface of thrust surface **36** but no pumping action will occur inasmuch as the pistons **30** will not reciprocate within bores **28**. In other words, when thrust surface **36** is perpendicular to the axis of drive shaft **20**, the pump is in a position of minimum fluid displacement. As rocker cam **38** and thrust surface **36** are inclined from this position, the pistons **30** will reciprocate within bores **28** as shoes **34** slide over the surface of thrust plate **36.** As the pistons **30** move inwardly of bores **28** i.e. away from port plate **46,** low pressure fluid is drawn into cylinder bores **28** from inlet port **48.** As piston shoes **34** slide across thrust surface **36** and move toward port plate **46**, high pressure fluid is expelled through outlet port **50.** It should be noted that fluid displacement increases as the angle of inclination of thrust surface **36** increases. Referring to Fig. 3, it may be seen that rocker cam **38** and thrust surface **36** are shown in a position of maximum fluid displacement. Rocker cam **38** may be pivoted clockwise to reduce the displacement of pump **10**. Although, pump **10** of the instant embodiment is depicted as a pressure compensated pump which does not cross center, the instant invention described hereinbelow applies equally to a rocker cam type variable displacement axial piston where rocker cam **38** may be pivoted clockwise across center such that the intake and exhaust ports are reversed and the device is providing maximum fluid displacement in the opposite direction. Such a pump may be seen in U.S. Patent Number 5,076,145 . The instant invention also applies equally to a rocker cam type, variable displacement pump having a rotary servo or linear servo type control.

[0011] In the instant embodiment, in which pump **10** is depicted as a pressure compensated device, a piston **52** is slidably mounted in a bore **54** formed in a cylinder **56** rigidly mounted within port cap **16**. A spring **58** around cylinder **56** biases piston **52** against a button **60** mounted on one side of rocker cam **38** to force the rocker cam to pivot to a position of maximum fluid displacement. A stroking piston **62** is slidably mounted in a bore **64** of a cylinder **66** rigidly secured in port cap **16** at a position within pump housing **12** diametrically opposite that of biasing piston **52.** Stroking piston **62** engages a button **68** mounted in rocker cam **38** at a position diametrically opposite that of button **60.**

[0012] In a pressure compensated pump it is necessary to reduce the displacement of the pump when the pressure of the discharge fluid becomes excessive. When this condition occurs, pressure fluid is supplied to the end of stroking piston **62** to force it to move outwardly of bore **64** and thereby cause rocker cam **38** to pivot clockwise (as viewed in Figure 3) towards a position of reduced fluid displacement. Stroking piston **62** will continue to pivot rocker cam **38** until such time as the discharge pressure of working fluid falls below a maximum setting. When this occurs, pressure fluid no longer is supplied to stroking piston **62** and biasing spring **58** moves stroking piston **52** outwardly to thereby pivot rocker cam **38** in a counterclockwise direction and thereby increase the displacement of the pump. Inasmuch as the instant invention is for any type of rocker cam type pump independent of its displacement control, a further description of the pressure compensated mechanism of pump **10** is not required.

[0013] As mentioned above, when rocker cam **38** is pivoted counterclockwise sufficiently to cause working pressure fluid to be expelled from pump **10** at a relatively high pressure, large pumping forces are exerted through pistons **30** to rocker cam **38**. These forces are transmitted through the complementary arcuate bearing surfaces **40** and **42** into rocker cam support **44.** The large pumping forces cause large friction forces to occur at the interface of rocker cam bearing surfaces **40** and rocker support bearing surfaces **42** to make movement of rocker cam **38** within rocker support **44** very difficult. In an attempt to reduce the friction forces between rocker cam **38** and rocker support **44** plane bushings **70** are inserted between rocker cam arcuate bearing surfaces **40** and rocker support arcuate bearing surfaces **42** as depicted in Fig. 2. While plain bushings **70** reduce the aforementioned frictional forces to some extent, they are inadequate by themselves to reduce the frictional forces to a satisfactory level.

[0014] Accordingly, working pressure fluid is supplied to counterbalance pockets **72** and **74** formed in the rear faces **76** of rocker cam **38** as depicted in Figures in 2,

5 and 6. The areas of the counterbalance pockets **72** and **74** are designed such that when they receive working pressure fluid they reduce the force required to pivot rocker cam **38** within cam support **44** to within desirable levels. Heretofore, working pressure fluid has been supplied to counterbalance pockets in rocker cam where the working pressure fluid source is a pumping piston and fluid is supplied to the piston shoe and thereafter to bores in the thrust plate which bores connect to the counterbalance pockets.

[0015] Applicant has discovered a unique means for supplying working pressure fluid to the counterbalanced pockets **72** and **74** formed in the rear face **76** of rocker cam **38** where the fluid source is in the housing **12**.

[0016] Turning to the Figures 2 and 4 through 7, it may be seen that a fluid passage **78** connected to a source, not shown, of working pressure fluid is formed in housing **12**. Fluid passage **78** opens into a fluid passage **80** formed in housing **12** one end of which is closed by a plug **82** which may be replaced with a sensor or other device utilizing working pressure fluid for control purposes.

[0017] A hollow roll pin **84** is mounted in a central bore of plain bushing **70**, in cam support arcuate bearing surface **42** and in a corresponding bore in housing **12**. Roll pin **84** serves two purposes. It anchors plain bushing **70** on cam support or cradle **44** and it intersects fluid passage **80** to thereby connect that passage to a fluid passage **86** formed in rocker cam **38** and in arcuate cam surface **40**. Fluid passage **86** intersects an angled fluid passage **88** formed in rocker cam **38** and closed by a plug **90**. Fluid passage **88** intersects an oppositedly angled passage **92** closed at one end by a plug **94.** The fluid passage **96** which parallels fluid passage **86** has one end which intersects fluid passage **92** at a right angle and another end which opens into fluid pocket **74** formed in rear face **76** of rocker cam **38.** Turning to Fig. 2, it may be seen that a roll pin **98** anchors plain bushing **70** to cam support surface **44.**

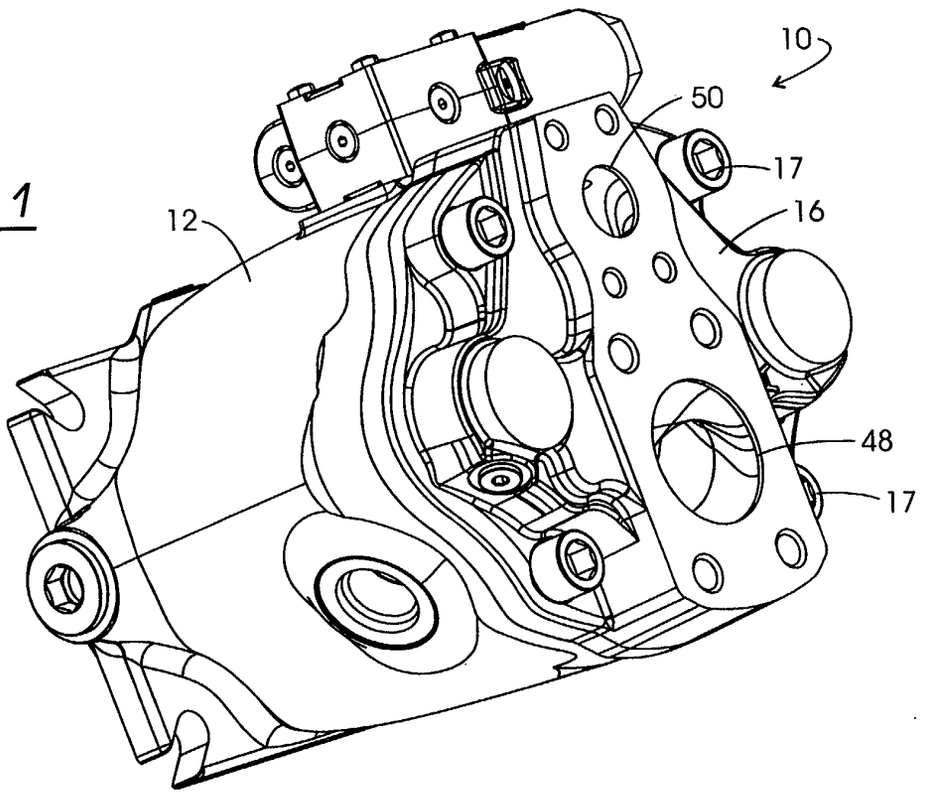
[0018] Thus, it may be seen that the instant invention provides a means of taking source of working pressure fluid in the pump housing and supplying the fluid to the counterbalance pockets **72** and **74** formed in the rear face **76** of rocker cam **38** which pockets are connected through passages formed in rocker cam **38**. This greatly simplifies supplying pressure fluid to the counterbalance pockets **72** and **74.**

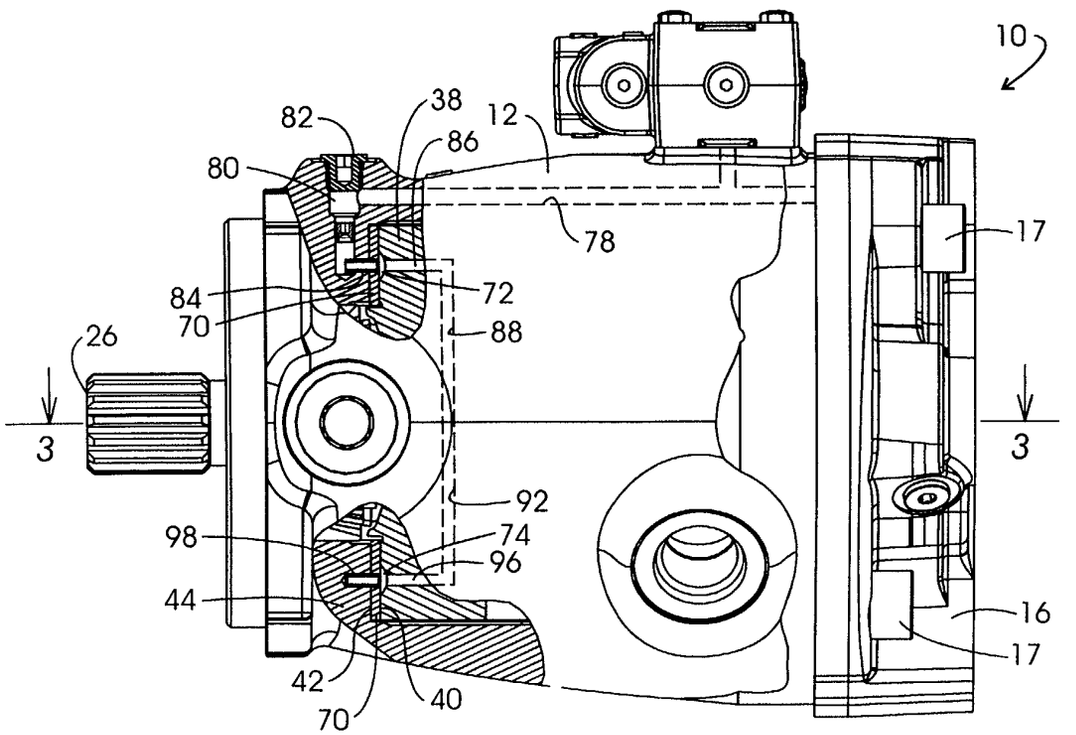
Claims

1. An axial piston pump for pumping fluid at a set working pressure which comprising a housing, a barrel rotatably mounted in the housing, a plurality of bores in the barrel, a piston mounted for reciprocation in each of said bores, a shoe mounted on the end of each piston, a rocker cam support in the housing, a rocker cam having a pair of spaced arcuate bearing surfaces pivotally mounted in complementary arcuate bearing surfaces formed in said rocker cam support, a thrust surface on said rocker cam, a holddown for clamping said piston shoes against said thrust surface wherein said shoes slide over said thrust surface when said barrel is rotated and the pistons reciprocated in their bores when the rocker cam thrust surface is angled to the axis of said barrel, a counterbalance fluid pocket formed in each of said rocker cam arcuate bearing surfaces, a first fluid passage for receiving a source of working pressure fluid formed in said housing, a second fluid passage formed in said housing and connected to said first fluid passage for conducting working pressure fluid to one of said counterbalance fluid pockets and a third fluid passage formed in said rocker cam connecting said one and the other of said counterbalance fluid pockets such that working pressure fluid from said first fluid passage supplied to said one counterbalance fluid pocket through said second fluid passage is supplied to said other counterbalance fluid pocket through said third fluid passage.

2. The axial piston pump of claim 1 further comprising a pressure compensator control.

FIG. 1


10
50
17
16
12
48
17


10
82
38
12
86
80
78
17
84
72
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88
26
3
3
92
98
74
96
44
16
17
42
40
70

FIG. 2

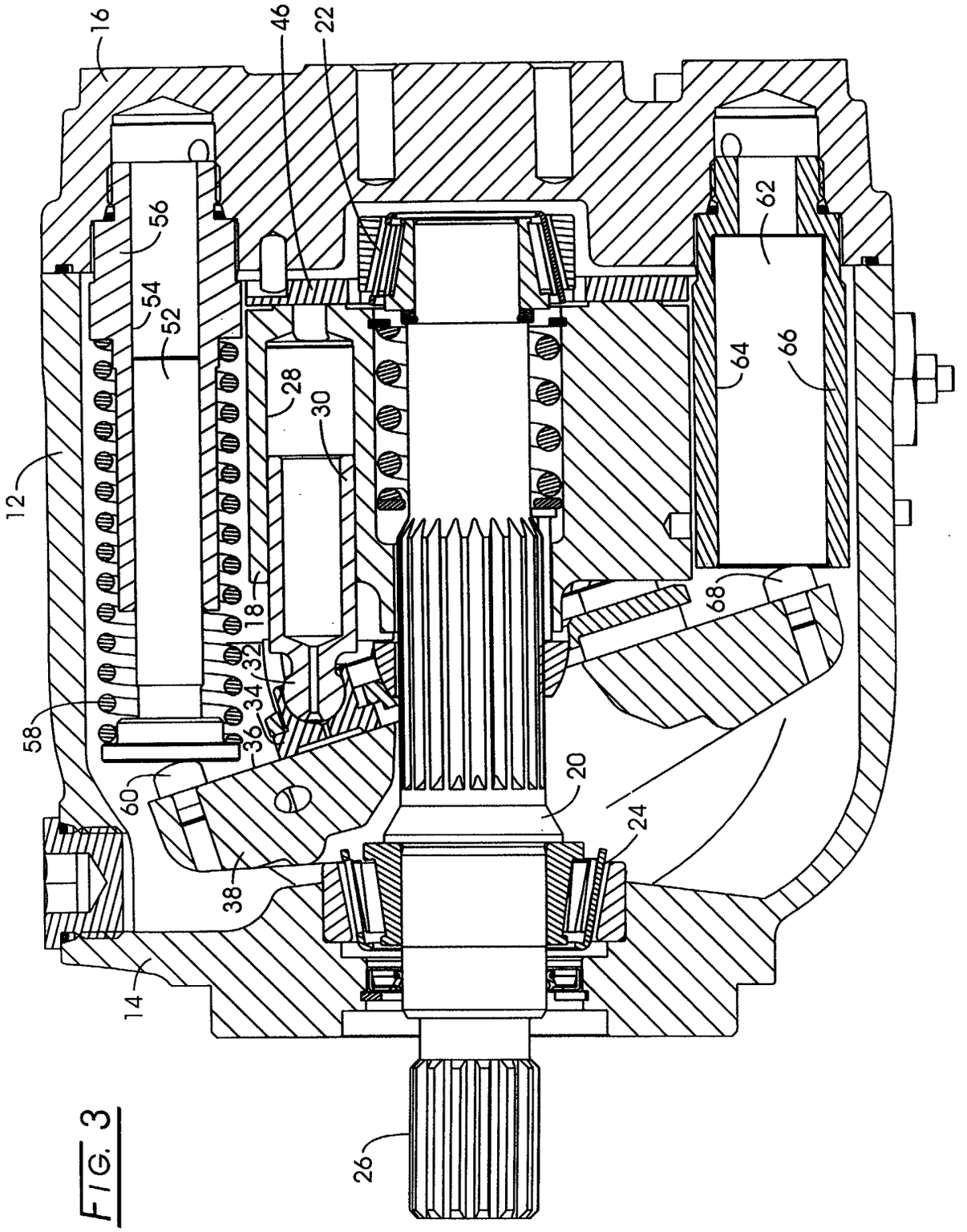

FIG. 3

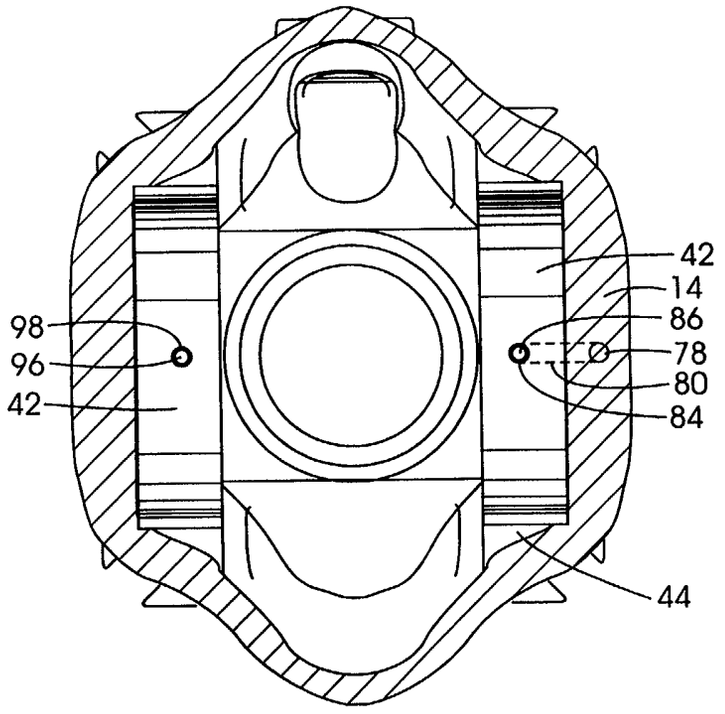
42
14
86
78
80
84
98
96
42
44

FIG. 4

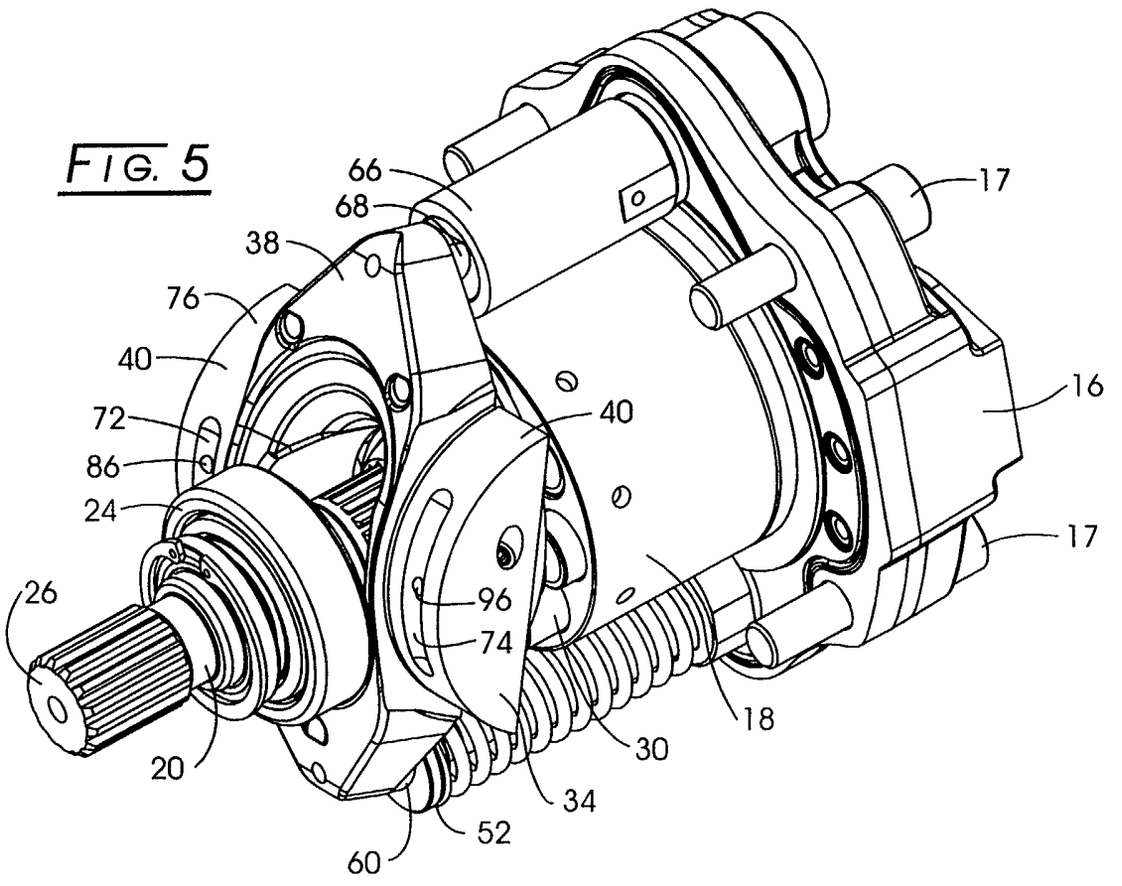
66
68
38
76
40
72
86
24
26
20
96
74
40
60
52
34
30
18
16
17
17

FIG. 5

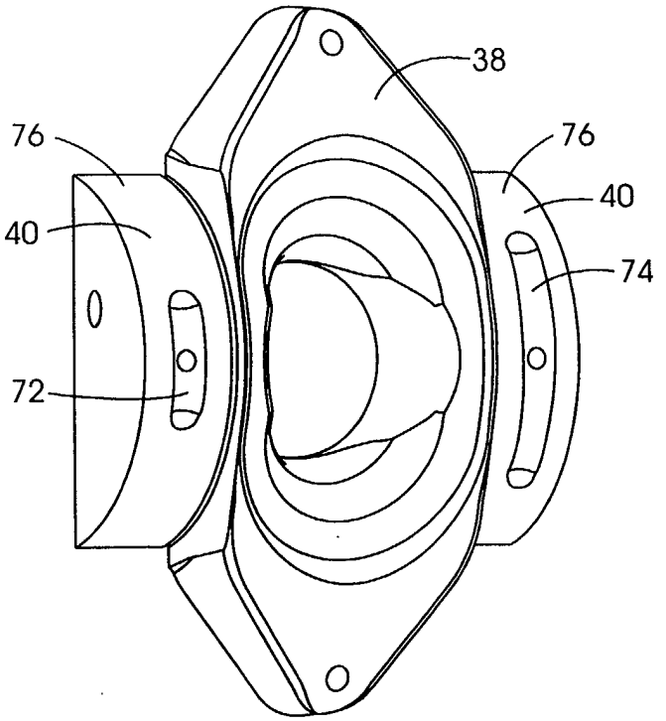

FIG. 6

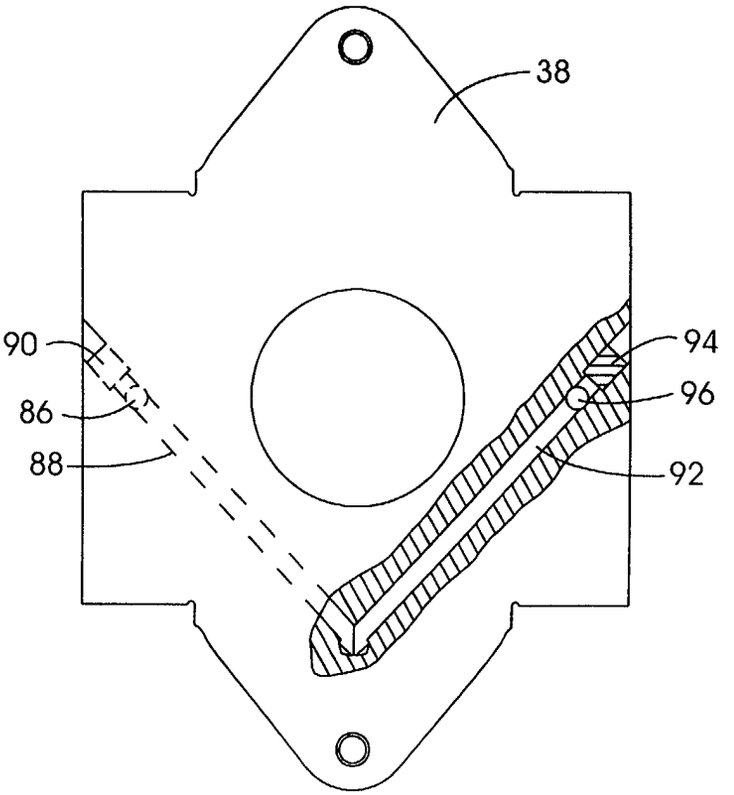

FIG. 7