United States Patent [19]

Clark et al.

[11] **3,728,046**

[45] **Apr. 17, 1973**

[54] **POWER STEERING PUMP**

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[73] Assignee: **TRW Inc.,** Cleveland, Ohio

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[52] **U.S. Cl.** **417/79,** 418/133, 418/135

[51] **Int. Cl.** **F01c 19/08,** F04c 27/00, F04b 23/12

[58] **Field of Search**.....418/131, 133, 135; 417/79

[56] **References Cited**

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Assistant Examiner—Richard Sher
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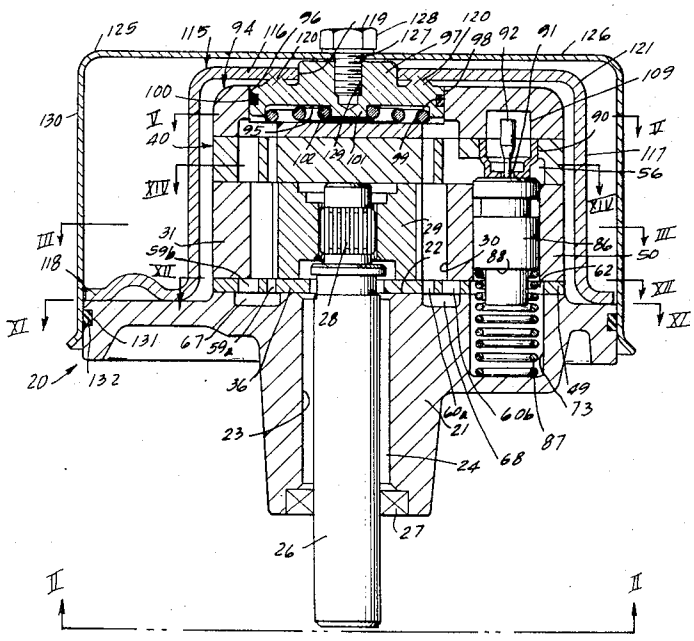
[57] **ABSTRACT**

A power steering pump with the flow control valve in the cam and having pressure loading of the stacked pump elements with a controllable area for pressurization and using a drawn steel shell materially reduces the pressurized area acting on the upper pressure plate and hence on the stacked pump elements, thereby permitting selection of an optimized pressure area.

8 Claims, 15 Drawing Figures



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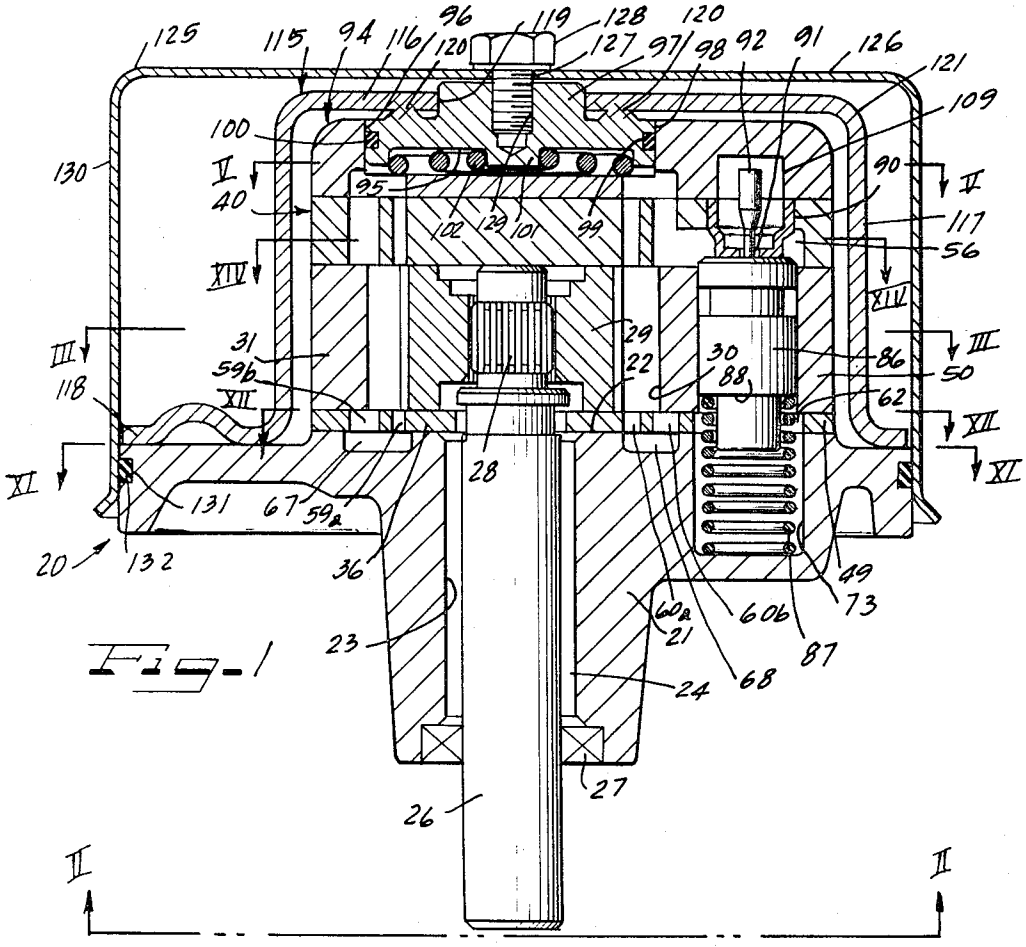

Fig-1

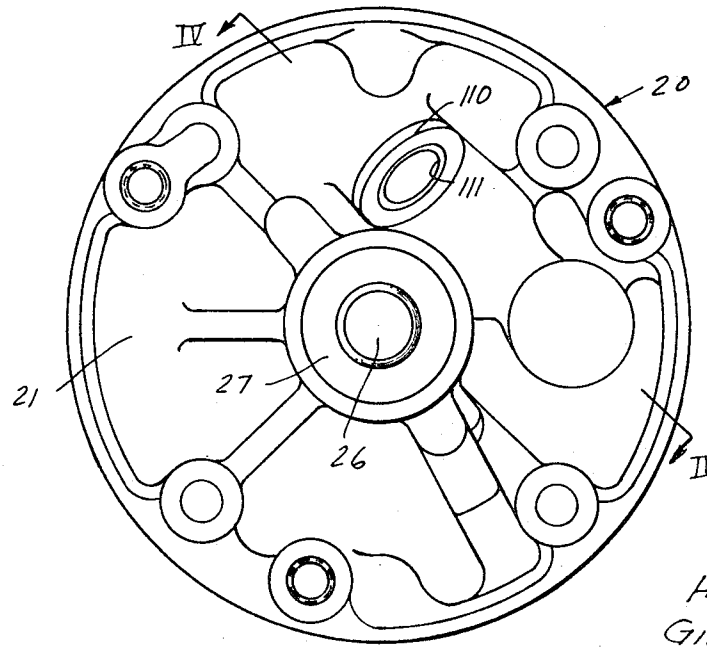

Fig-2

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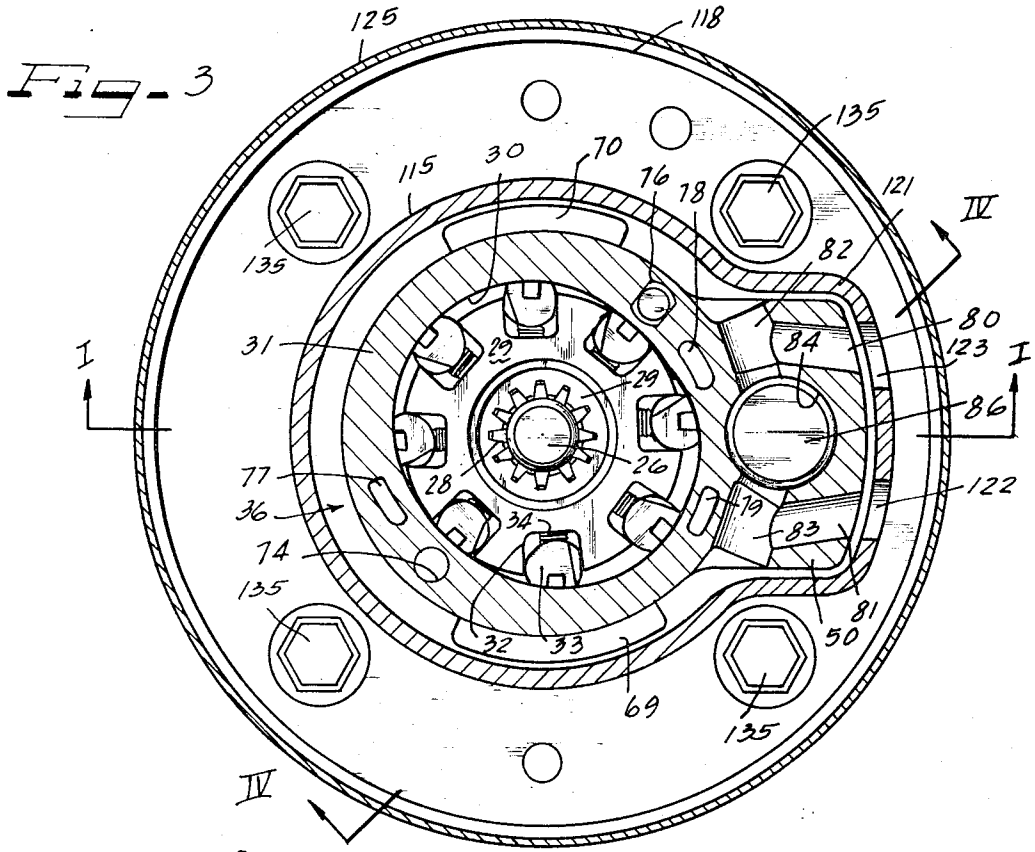
Fig. 3



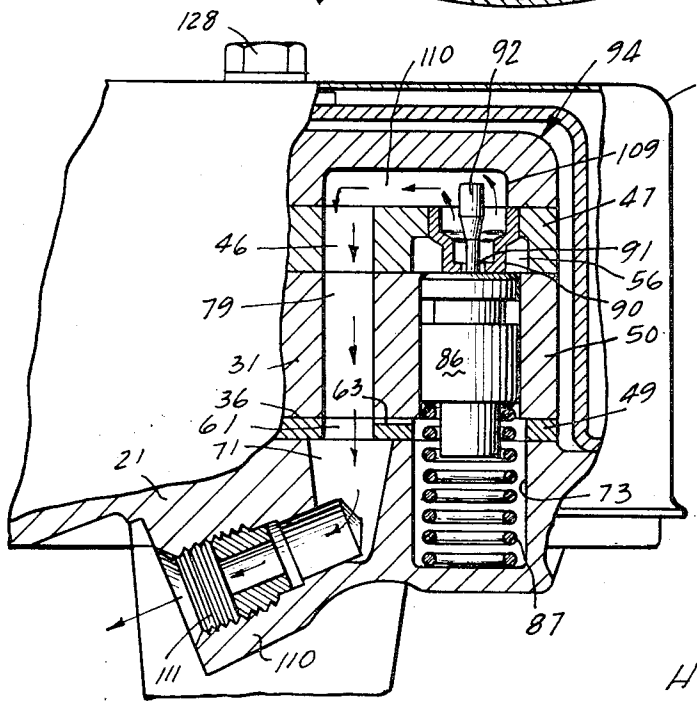


Fig. 4

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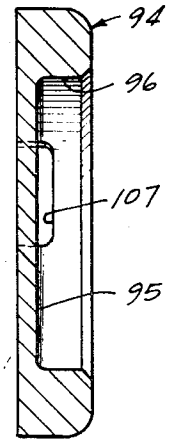
Fig. 6



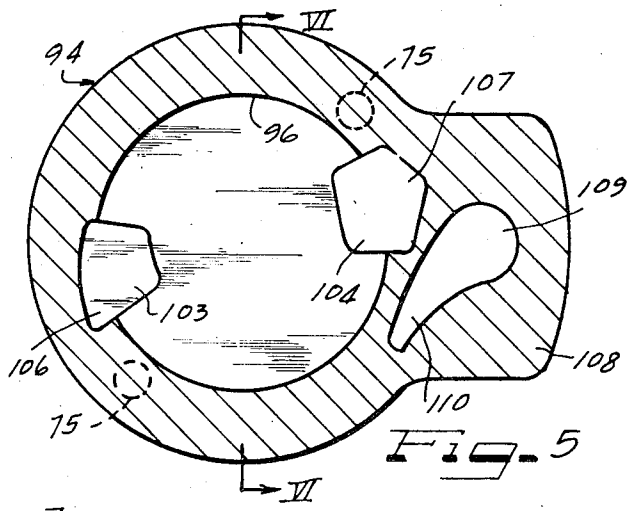


Fig. 5

Fig. 7

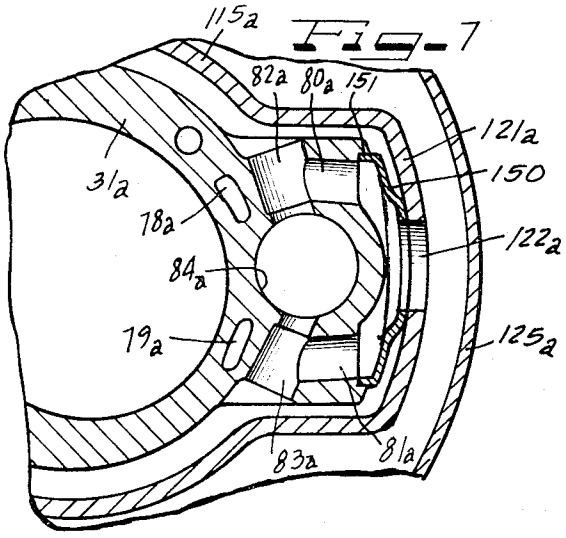


Fig. 8

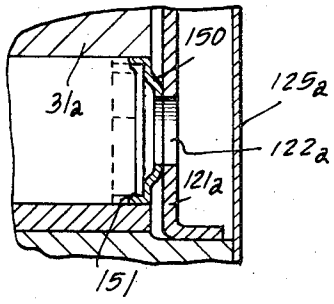


Fig. 9

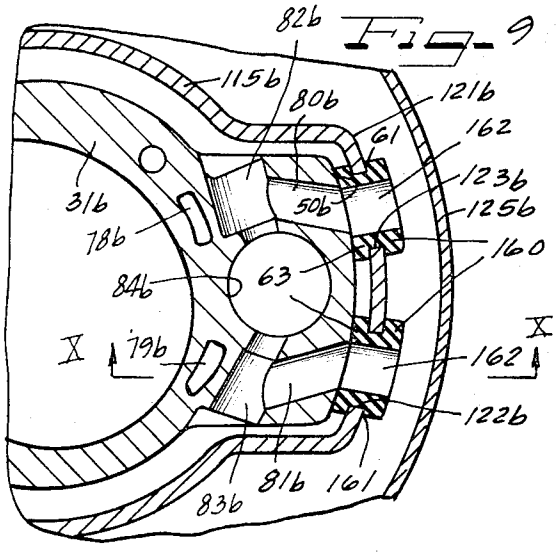


Fig. 10

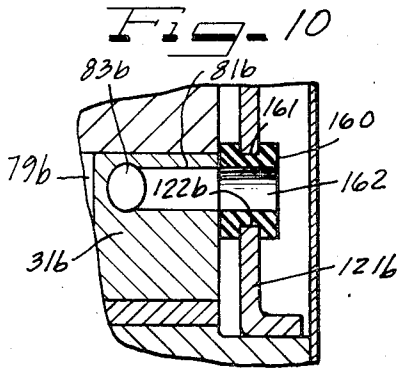


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Fig. 11

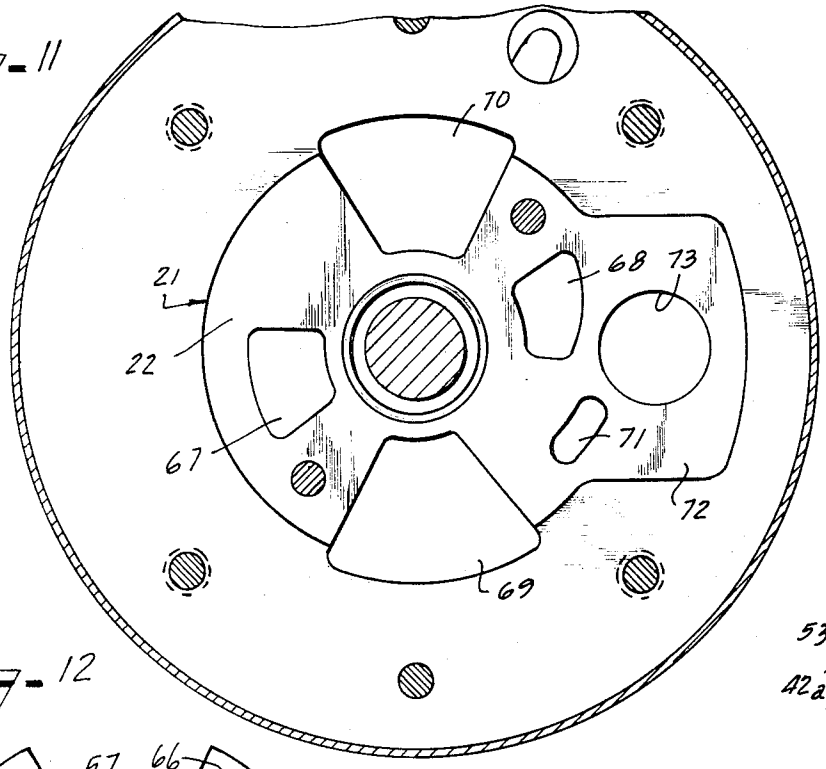


Fig. 12

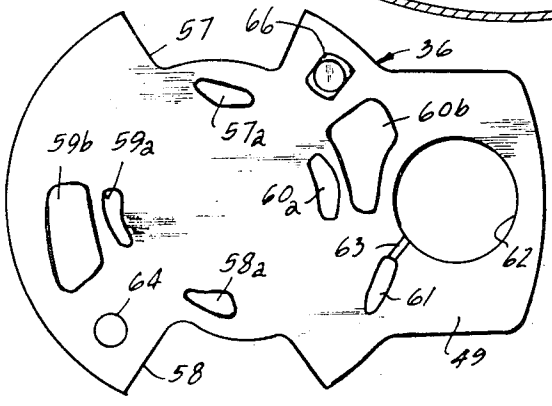


Fig. 15

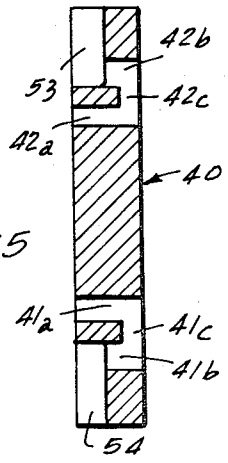
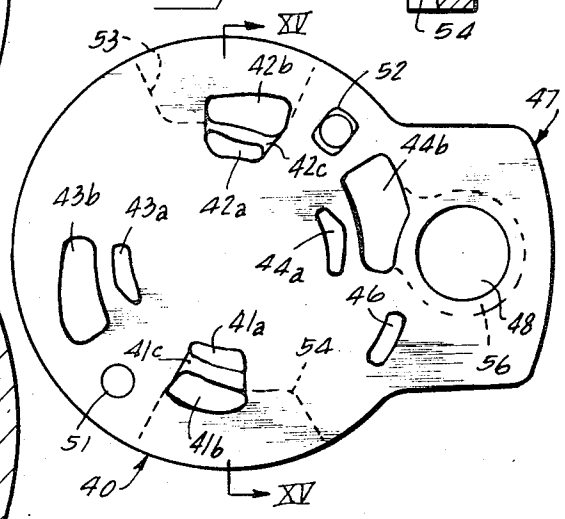


Fig. 13



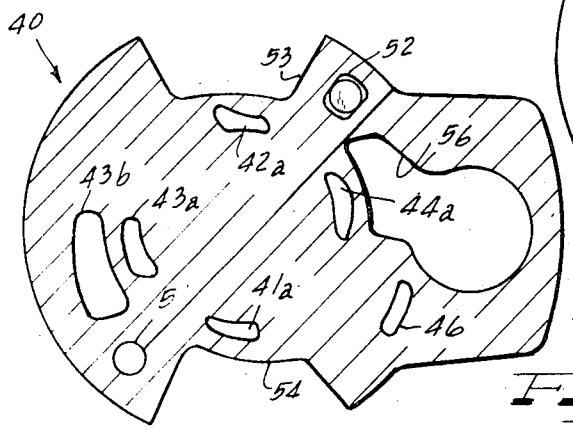


Fig. 14

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POWER STEERING PUMP

BACKGROUND OF THE INVENTION

1. The Field of the Invention

This invention relates generally to a pump of the type wherein a plurality of slippers in a rotor are free to rock angularly and to move radially while following the adjoining wall of a pumping chamber bore and more specifically relates to a pump of that general type used for power steering wherein a flow control valve is carried in the cam ring providing the pumping bore for the pump.

2. The Prior Art

The prior art is exemplified by our earlier U.S. Pat Nos. 3,273,503 and No. 3,403,630. In U.S. Pat. No. 3,273,503, the concept is disclosed whereby a pressurized area acting on the upper pressure plate and thence on the stacked pump elements tends to hold the stack of pump elements in assembly with one another. If the pressure on such area is great, excessive deflection of both the upper plate and the cam may lead to variations in the end clearance of the rotor during operation and thereby reduce efficiencies at lower operating pressures and supply a potential for end seizure at higher pressures.

In U.S. Pat. No. 3,403,630 fastening bolts were extended through the stack-up of parts, however, the clamping of the assembly by means of bolts makes it difficult, if not impossible to apply equal torque on each bolt, thereby providing the possibility of misaligning the stack and making effective sealing difficult at the stacked joints. It is also possible that the stretching of the bolts under high pressure might lead to increased end clearances and inefficient pump operations.

SUMMARY OF THE INVENTION

The present invention contemplates the provision of a top plate having radially inwardly extending portions terminating in axial walls forming a reduced opening in which is received a guide member which may be integrated by attachment or assembly to the end wall of a drawn steel shell. There is thus provided between the top plate and the adjoining upper pressure plate a reduced area chamber which comprises an optimized area which can be pressure-loaded with a controllable pressure, thereby completely eliminating the necessity of using bolts and also eliminating the inherent difficulties which were part of the prior art constructions. Accordingly, the arrangement of the present invention eliminates the necessity of clamping the assembly by means of bolts and thereby eliminates the near impossibility of applying equal torque on each bolt and eliminates bolt stretching under high pressure.

By virtue of the reduced controllable pressurized area between the top plate and the upper pressure plate, sealing is easier and more efficient.

By the use of a rigid steel shell having a guide member cooperable with the top plate improved sealing of the shell is accomplished.

The structure of the pump disclosed herein also provides a solution of the problem of preventing supercharged fluid from around the cam ring and inside of the shell housing from interfering with the intake of fluid from the reservoir.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross-sectional view taken on line I—I of FIG. 3 and shows a power steering pump incorporating the principles of the present invention;

FIG. 2 is a bottom plan view taken on the plane of line II—II of FIG. 1;

FIG. 3 is a cross-sectional view taken on line III—III of FIG. 1;

FIG. 4 is a fragmentary view with parts shown in section taken on the plane of line IV—IV of FIG. 2;

FIG. 5 is a cross-sectional view taken on line V—V of FIG. 1 but with parts removed to show additional details of construction of the top plate;

FIG. 6 is a cross-sectional view taken on line VI—VI of FIG. 5;

FIG. 7 and FIG. 8 show one way of preventing the super-charged fluid around the cam ring and inside the steel shell from interfering with the intake of fluid from the reservoir through the holes in the housing shell and into the aspirator holes in the cam ring;

FIG. 9 and FIG. 10 taken on line X—X of FIG. 9 show a construction which is alternative to the arrangement of FIGS. 7 and 8 and wherein grommets may be snapped into the housing shell before assembly over the pump element stack;

FIG. 11 is a cross-sectional view taken generally on line XI—XI of FIG. 1;

FIG. 12 is a view showing a lower pressure plate taken on the plane of FIG. XII—XII of FIG. 1;

FIG. 13 is a top view of the upper pressure plate;

FIG. 14 is a cross-sectional view taken on line XIV—XIV of FIG. 1; and

FIG. 15 is a cross-sectional view taken on line XV—XV of FIG. 13.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the present invention find a particularly desirable application in a power steering pump and such a pump is shown in FIG. 1 generally at **20**. A housing plate **21** has a flat wall **22** intersected by a bore **23** in which is received a bearing sleeve **24** and through which extends a shaft **26** which may be rotatably driven through an appropriate drive connection with a vehicular power source. A shaft seal **27** is shown diagrammatically.

The end of the shaft **26** projects beyond the surface **22** and includes a spline **28** effecting a driving connection with a rotor **29** which is rotatably driven within a pump bore **30** provided by a cam ring **31**.

The rotor **29** has a plurality of peripheral notches **32**, each receiving a slipper-type pumping element **33** which is free to rock angularly and to move radially in following the adjoining bore wall **30**. A loading spring **34** preloads each respective pumping element **33** radially outwardly of a corresponding notch.

If desired, a lower pressure plate **36** may be interposed between the face **22** of the housing plate **21** and the cam ring **31** and rotor **29**.

In accordance with the principles of this invention, an upper pressure plate is provided which is shown generally at **40**. As will be noted upon referring to FIG. **13** in connection with FIG. **1**, the upper pressure plate has two sets of inner and outer inlet ports **41***a* and **41***b*

being located on one side and 42*a* and 42*b* being located at the opposite side. The upper pressure plate is also provided with two sets of outlet ports shown respectively at 43*a* and 43*b* and 44*a* and 44*b*. A line outlet passage is shown at 46.

Although the main body portion of the upper pressure plate is generally circular in configuration, there is a boss portion 47 projecting to one side in which is formed an opening 48. The boss portion 47 corresponds to generally similar shaped boss portions provided on the lower pressure plate at 49 and on the cam ring at 50.

The upper pressure plate also includes a fixed dowel hole 51 and a slotted dowel hole 52. As shown on FIG. 15, the upper pressure plate 40 is notched as at 53 and at 54 to provide communication with corresponding inlet portions of the pumping bore 30, which in this particular pump, comprises a double-lobed pumping bore having two working chambers so that a double pumping impulse is generated on each rotation of the rotor. Note that the respective outlet ports 42*a* and 42*b* are intercommunicated as at 42*c*. In like manner, the ports 41*a* and 41*b* are intercommunicated as at 41*c*.

One side of the upper pressure plate 40 is also relieved at the discharge port 44*b*, thereby to provide a communicating passage 56.

The lower pressure plate 36, as shown in FIG. 12, is correspondingly ported. Thus, there is provided an inlet notch 57 and inlet port inwardly thereof at 57*a*. Opposite thereto is an inlet notch 58 and a corresponding inner inlet port 58*a*.

A pair of outlet ports are shown at 59*a* and 59*b* and at 60*a* and 60*b*. A line outlet passage is shown at 61. The boss portion 49 has an opening 62 formed therein and line outlet passages communicated therethrough via a passage 63. A fixed dowel hole is shown at 64 and a slotted dowel hole at 66.

The face 22 of the housing plate is recessed as at 67 to intercommunicate the ports 59*a* and 59*b* of the lower pressure plate and is recessed as at 68 to intercommunicate the ports 60*a* and 60*b*. Inlet notches are shown at 69 and 70 and a recess 71 is disposed in register with the line outlet passage 61. The housing plate 21 also includes a boss 72 in which is formed a recess 73 in register with the opening 62.

Referring now to FIG. 3, it will be noted that the cam ring 31 has a fixed dowel opening 74, as well as a slotted dowel opening 76. There is also an axial opening 77 which is in register with the discharge passages of the adjacent plates and a corresponding axial opening 78 diametrically opposite thereto. Another axial passage 79 is in register with the line discharge passage 46 of the upper pressure plate and 61 of the lower pressure plate.

At the boss portion 50, the cam ring 31 is formed with a pair of aspirator holes 80 and 81, each of which intersects a corresponding by-pass hole 82 and 83. The by-pass holes 82 and 83 are arranged to lead from a valve passage 84 formed in the boss 50 to an inlet zone surrounding the cam ring 31.

Disposed within the passage 84 of the cam ring 31 is a flow control valve shown generally at 86. The flow control valve 86 has a coil spring 87 bottomed at one end against the housing plate 21 within the recess 73 and the other end is bottomed against a shoulder 88 formed on the valve 86.

The upper pressure plate 40 is particularly characterized by having pressed therein an orifice plug having a flow orifice 91 formed therein through which all of the fluid discharged by the pump is directed. A tapered stem 92 forming part of the flow control valve 86 extends through the orifice 91, thereby to give the pump a drooping flow characteristic.

The top plate of the present invention is shown generally at 94 and includes radially inwardly extending portions forming a wall 95 which terminates in axial walls of a restricted opening, as shown at 96.

A guide member shown generally at 97 has axial walls 98 which are received within the restricted opening 96. Sealing means may be disposed between the adjoining walls 96 and 98. In this embodiment, the guide member 97 has a peripheral recess 99 formed in the walls 98 and an O-ring sealing member 100 is contained therein to provide an adequate seal between the walls 96 and 98.

The guide member 97 has an inwardly projecting pilot portion 101 extending into the coils of a coil spring 102 which is loaded against the wall 95 and the top plate 94, thereby to exert a continuous spring bias thereagainst.

The top plate is apertured as at 103 and 104 and is recessed as at 106 and 107 to intercommunicate the outlet ports of the upper pressure plate 43*a*, 43*b* and 44*a*, 44*b* and also so that fluid at pump-generated pressure can be communicated to the space radially inwardly of the walls 96. Clearance holes 75 are provided for the dowels. It will be noted that the top plate 94 has a boss 108 which projects to one side of its generally cylindrical body and in which is formed a generally tear-shaped recess including a hole 109 and a passage 110. The boss 108 overlies the corresponding boss 47 of the upper pressure plate and thus the passage 110 communicates fluid at discharge pressure to the line discharge passage 46 from whence the fluid is directed through the line discharge passage 79 in the cam ring 31 and the line discharge passage 61 in the lower pressure plate 36 and the line pressure passage 71 in the housing plate 21. The housing plate 21 is formed with a fitting boss 110 which is tapped as at 111 for attachment thereto of an appropriate conduit leading to a point of utilization.

It is further contemplated by the present invention to provide a rigid steel shell which may be formed by drawing into a generally cup-shaped configuration so as to include a steel shell shown generally at 115 having an end wall 116 and side walls 117 terminating in an outwardly directed circumferentially extending flange 118. The end wall 116 is formed with an opening 119 in which is received an upstanding portion of the guide member 97. Thus, the edges of the opening 119 overlie the portions of the guide member which are disposed inwardly of the steel shell 115. It is contemplated by the present invention that the guide member 97 and the steel shell 115 be placed in sealed-together assembly by means of a weldment 120.

The end wall 116 of the steel shell 115 is spaced somewhat above the top plate 94 and is also spaced somewhat radially outwardly of the other pump components. With respect to the shape of the steel shell 115, it should be noted that the hollow shell is generally cylindrical in configuration but in conformance with the configurative disposition of the other parts, the

steel shell **115** also has a boss portion **121** apertured as at **122** and **123** in register with the aspiration holes **80** and **81** in the cam ring **31**.

The side walls **117** of the steel shell **115** are spaced somewhat radially outwardly of the pump components, thereby to form an inlet zone which completely surrounds the pump, thereby surrounding the pump with a body of oil to promote good sound insulation and to insure adequate supply of inlet fluid to the inlet ports of the plate members.

To provide a reservoir of fluid for the pump, a thin reservoir can is provided as shown at **125**. The reservoir can **125** is generally cup-shaped in configuration having an end wall **126** apertured as at **127** to pass a fastening **128** which is threadedly received in a corresponding threaded opening **129** formed in the guide member **97**. The can **125** also has side walls **130** which are closely received around the radially outermost portions of the plate housing **21**. The plate housing is peripherally recessed as at **131** and receives an O-ring sealing member **132** to establish a good seal with the walls **130** of the reservoir can **125**. Thus, the make-up holes **122** and **123** in the steel shell **115** communicate with the contents of the reservoir inside of the reservoir can **125**.

In operation, fluid is drawn into the pump at the corresponding inlet areas of each working chamber and the fluid is discharged through the discharge ports **43a**, **43b** and **44a**, **44b** and thence into a discharge zone **56** in the upper pressure plate.

The flow of fluid from the discharge zone is regulated by the flow control valve in response to the pressure drop across the orifice **91**. The discharged fluid then flows through the passages **110**, **46**, **79**, **61**, **71** to the point of utilization. Fluid is returned to the reservoir, or if it is by-passed by the flow control valve **86**, it passes through the by-pass passages **82** and **83** directly into the inlet zone between the steel shell **115** and the pump components. Fluid flowing through the by-pass passages **82** and **83** has an aspirating effect on the aspirating passages **80** and **81**, thereby drawing make-up fluid through the make-up holes **122** and **123**.

As shown on FIG. **3**, the steel shell **115** is connected in firm assembly to the plate housing **21** by four bolts **135**, which pass through corresponding holes in the radially outwardly extending flange of the steel shell **118**.

If any problem is presented in preventing supercharged fluid around the cam ring **31** and inside the drawn steel shell **115** from interfering with the intake of fluid from the reservoir **125** through the make-up holes **122** and **123** and into the aspirator holes **80** and **81** in the cam ring **31**, two specific arrangements are shown herein.

In FIGS. **7** and **8**, the boss portion of the steel shell is shown at **121***a* and is provided with only a single make-up opening **122***a*. A baffle **150** is formed to fit a notch **151** in a cam ring **31a** and is disposed inside of the steel housing shell and the upper and lower pressure plates. The baffle **150** snaps into projections on the cam ring provided by the notch **151** prior to assembly of the housing shell **115***a* over the pump element stack. It will be apparent that the baffle **150** isolates the zone inside of the housing shell from the reservoir **125***a*.

In the arrangement of FIGS. **9** and **10**, the housing shell is shown at **115***b* and includes a boss portion **121***b*. In this form of the invention, the make-up holes in the steel shell **115***b* are shown at **122***b* and **123***b*. Rubber grommets are shown at **160** and each grommet is circumferentially grooved as at **161** to receive the edges of a corresponding opening **122***b* or **123***b*. The grommets **160** are each provided with a through aperture **162** which is disposed to register with a corresponding aspirator opening **80***b* or **81***b*. The end surface of each grommet **160** shown here at **163** seals up against the end surface of the adjoining wall of the cam ring shown at **50***b*. Again, it will be apparent that the grommets **160** isolate the zone inwardly of the steel shell **115***b* from the reservoir section **125***b*.

Although various minor modifications might be suggested by those versed in the art, it should be understood that we wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of our contribution to the art.

We claim as our invention:

1. In a pump of the type having a housing plate through which extends a shaft for rotatably driving a rotor carrying a plurality of slippers and wherein a cam ring surrounds the rotor and an upper pressure plate abuts the cam ring and rotor on the side opposite the housing plate, the improvement of

a top plate adjacent said upper pressure plate and including a radially inwardly disposed recess in one face thereof bounded by axially extending walls,

said recess comprising a reduced pressure area communicating with the pump-generated pressure at the upper pressure plate to receive said pressurized fluid,

a guide member having a portion shaped for complemental fit in said recess and together with said top plate confining pressurized fluid in said reduced area recess,

thereby optimizing the size of the pressure area acting on the upper pressure plate.

2. In a pump as defined in claim **1** and further characterized by a rigid shell made of metal formed in a cup-shaped configuration and having an end wall fastened to said guide member and having side walls surrounding the other portions of the pump with sufficient clearance to receive and retain a supply of inlet fluid therein,

said shell member being flanged for sealing assembly to the housing plate.

3. In a pump as defined in claim **2** and further characterized by

a flow control valve extending axially through the cam ring and the upper pressure plate, and having a line outlet passage formed in said top plate through which flow may be directed,

said line outlet passage extending through said upper pressure plate, said cam ring and said housing plate.

4. A pump comprising, in combination,

a housing plate through which a drive shaft extends,

a cam ring having a bore forming a pumping chamber and including an integral boss projecting to one side of said ring through which extends a valve passage for receiving a flow control valve,

a rotor in said pumping chamber carrying a plurality of slipper pumping elements which are free to rock angularly and to move radially in following the bore contour of the adjoining wall of said pumping chamber,

an upper pressure plate overlying said cam ring, rotor, and pumping elements and having ports formed therein through which pump-generated pressure is ported,

said upper pressure plate having a correspondingly disposed and shaped boss overlying the cam ring boss,

a top plate overlying said upper pressure plate and having a corresponding boss overlying the boss on said upper pressure plate,

said top plate having a reduced area recess formed therein bounded by axial walls and having ports formed therein receiving fluid at pump-generated pressure,

a guide member having a portion shaped to be received in said reduced area recess,

thereby forming a reduced area pressure chamber for optimizing the size of the pressure area acting on the upper pressure plate,

a steel shell drawn to a shape including an end wall for attachment to said guide member and side walls including a substantially cylindrical portion surrounding the cam ring, upper pressure plate and top plate and having a boss portion extending to one side sufficiently to enclose the other corresponding boss portions of said plate and said cam ring,

said steel shell being flanged for attachment to said housing plate,

and a housing shell attached to said guide member and having side walls sealingly engaged with said housing plate to form a reservoir surrounding said steel shell.

5. A pump as defined in claim **4**, said cam ring having an axially extending opening in said boss portion receiving a flow control valve, said cam ring having a pair of oppositely extending by-pass passages extending from said flow control valve to the area between said cam ring and said steel shell,

said cam ring further including a pair of aspirator passages each intersecting a corresponding by-pass passage and extending generally radially outwardly through said boss portion,

said steel shell having a pair of make-up openings communicating fluid from said reservoir into said aspirating passages.

6. A pump as defined in claim **5** and means for preventing supercharged fluid around the cam ring and inside the steel shell from interfering with the intake of fluid from the reservoir.

7. A pump as defined in claim **6** and further characterized by said last mentioned means comprising a baffle formed to fit said cam ring inside of the steel shell and upper and lower pressure plates, said baffle and said cam ring having a snap assembly means for connection of said baffle prior to assembly of the housing shell over the pump element stack, thereby to isolate the inlet zone inwardly of said steel shell from the reservoir area.

8. A pump as defined in claim **6** wherein said last mentioned means comprise rubber grommets disposed between said steel shell and said ring and having passages extending through said grommets directly communicating with said aspirator passages, thereby to isolate the inlet zone inwardly of said steel shell from the reservoir.

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