Aug. 11, 1970 L. H. DADIAN ET AL 3,523,746

FLUID TRANSLATING DEVICE

Filed Oct. 31, 1968 5 Sheets-Sheet 1

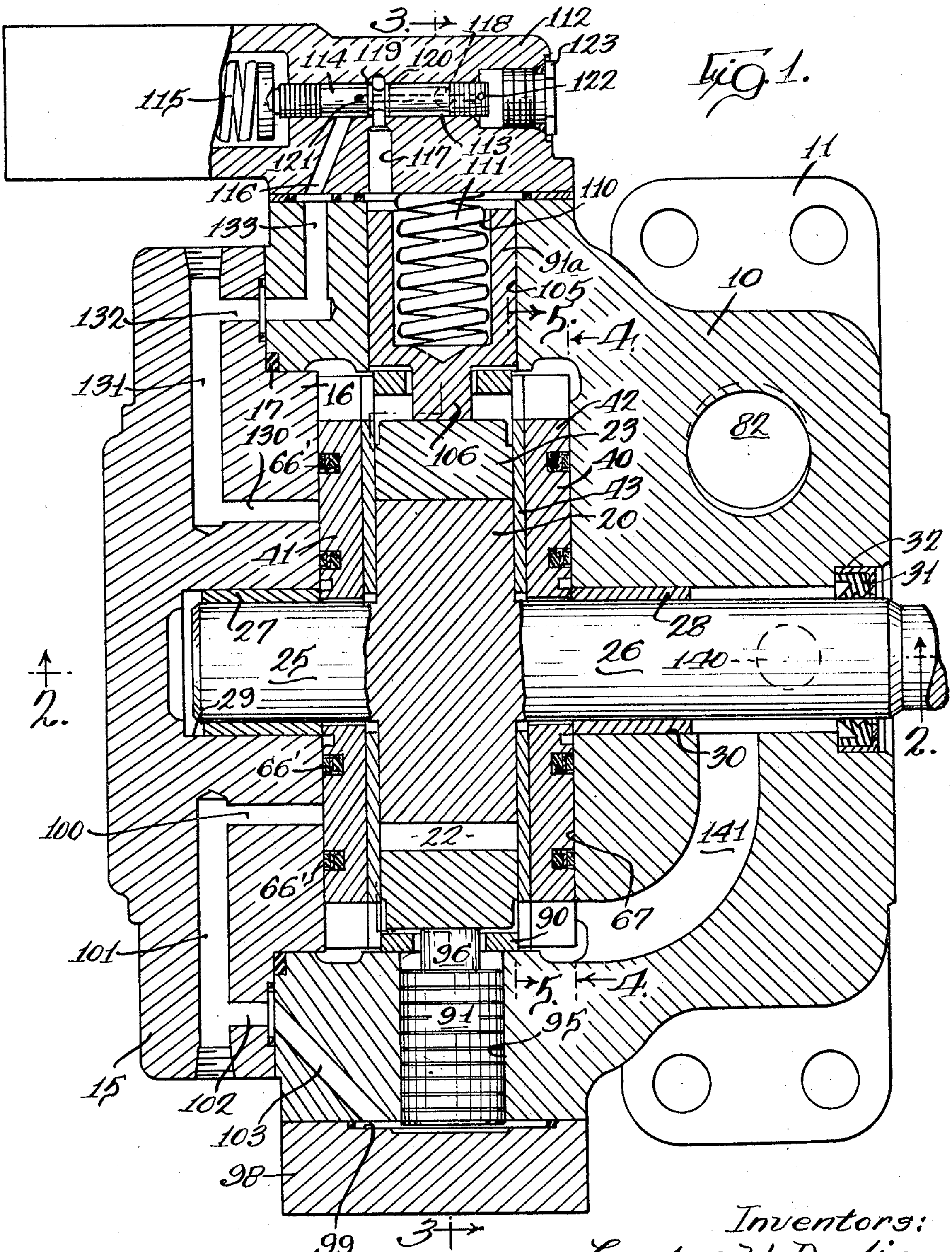

Fig. 1.

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Roger O. Griffiths
By Hofgren, Wegner,
Allen, Stellman & McCord Atty's

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FLUID TRANSLATING DEVICE

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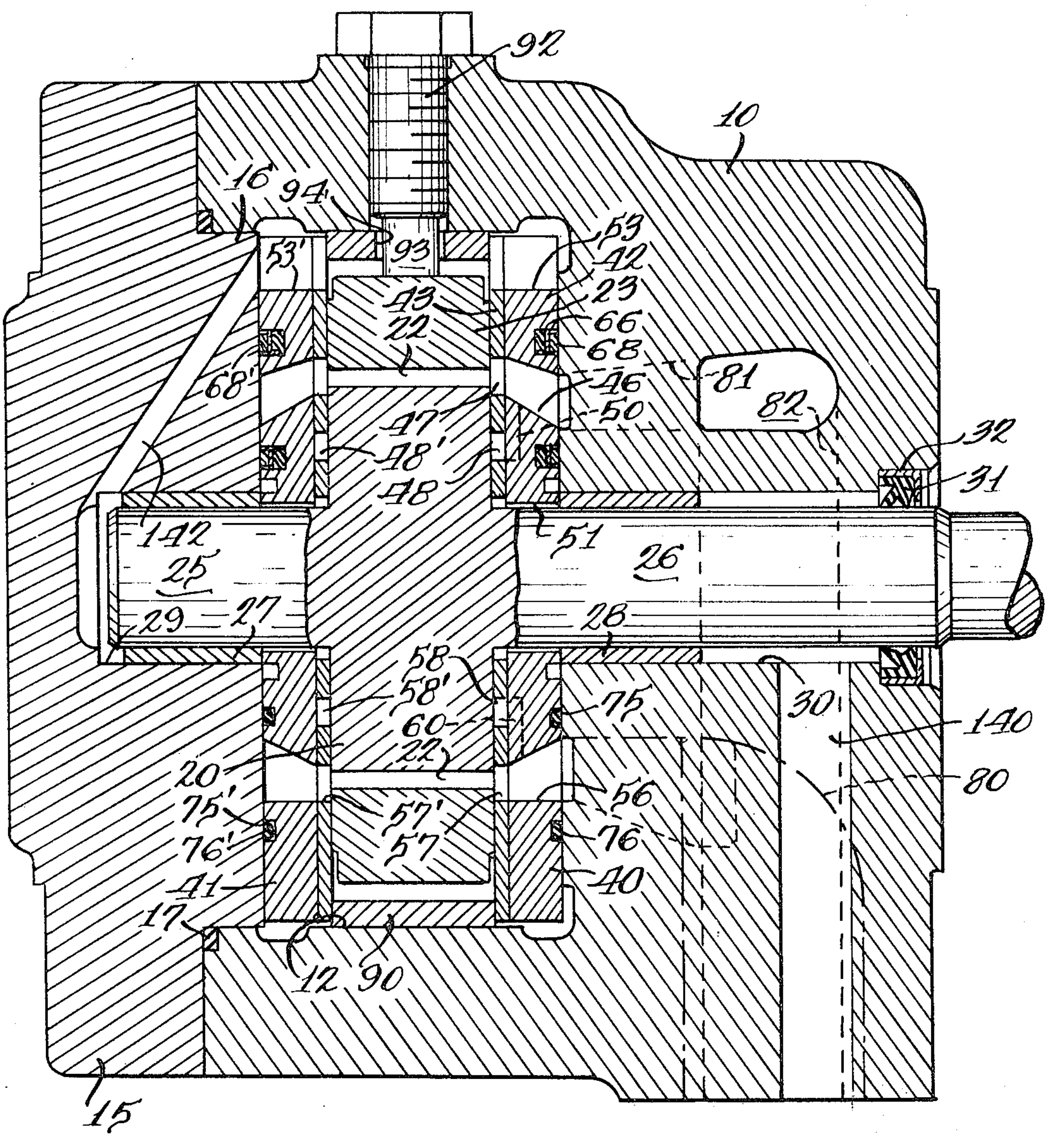
Fig. 2.



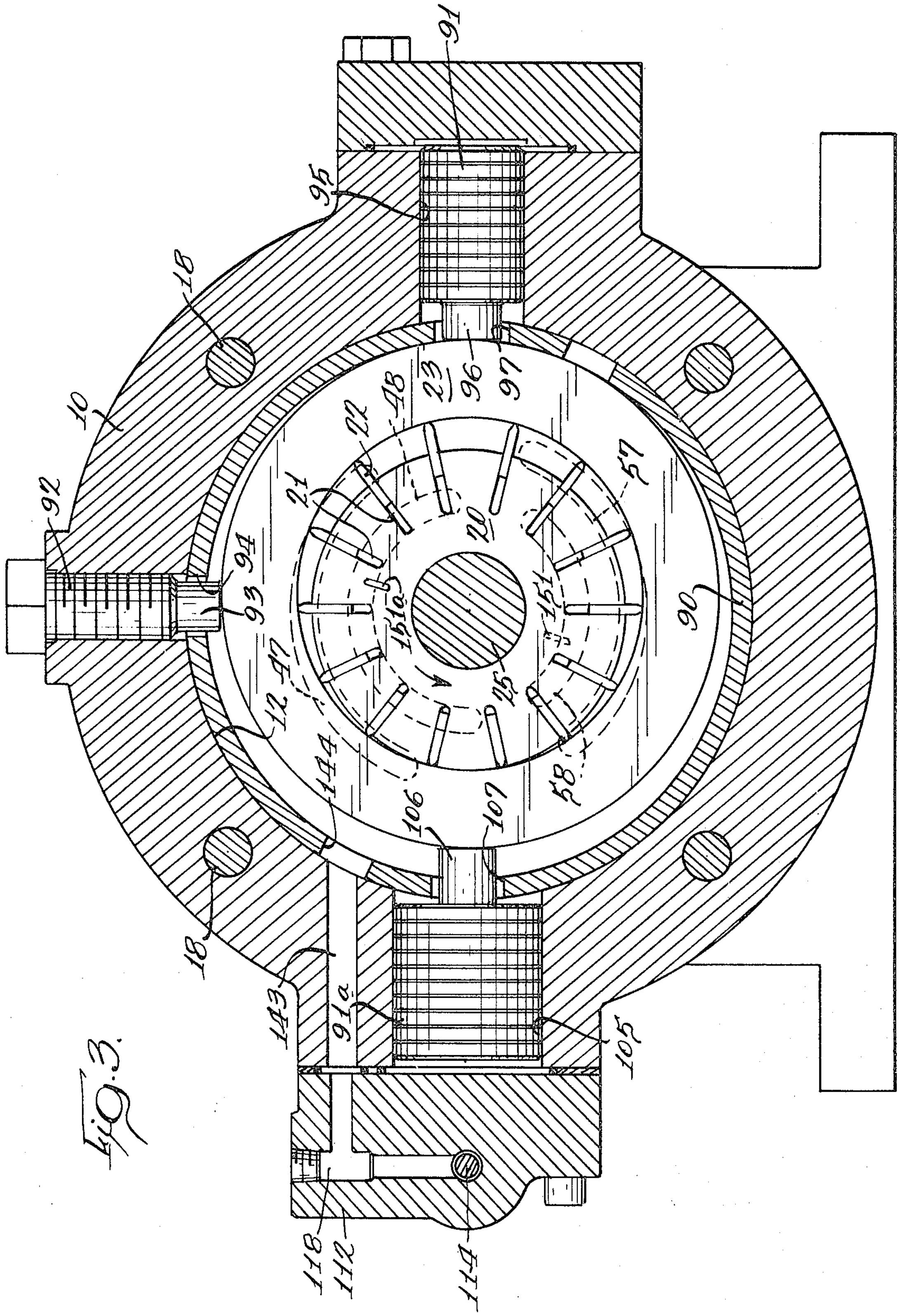


Fig. 3.

FLUID TRANSLATING DEVICE

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Fig. 4.

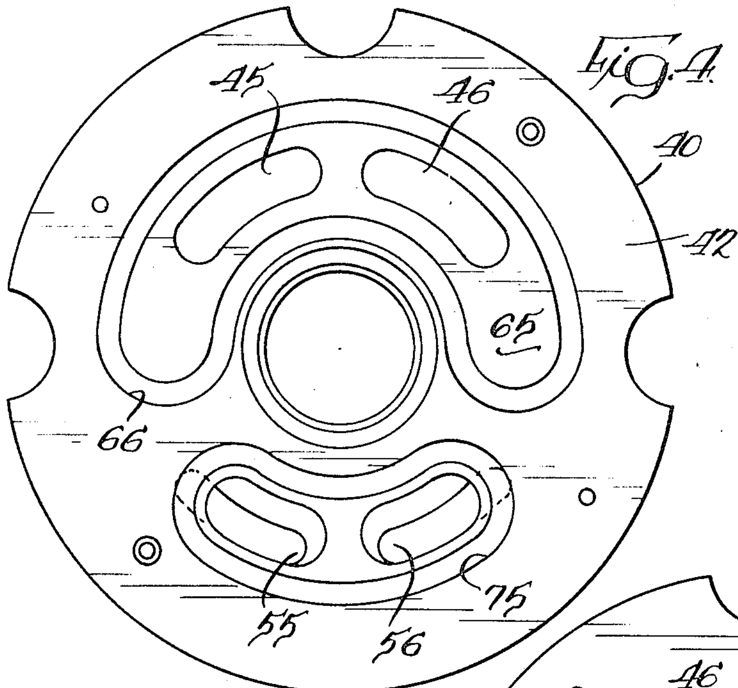


Fig. 8.

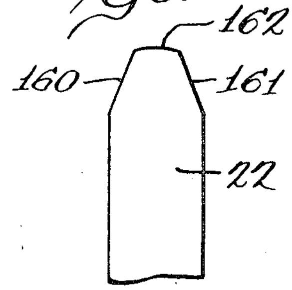


Fig. 5.

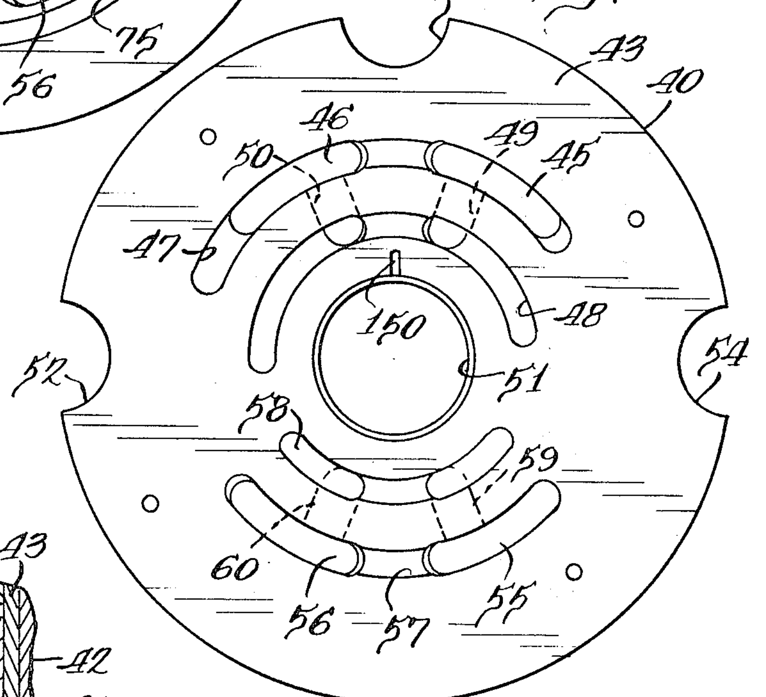


Fig. 6.

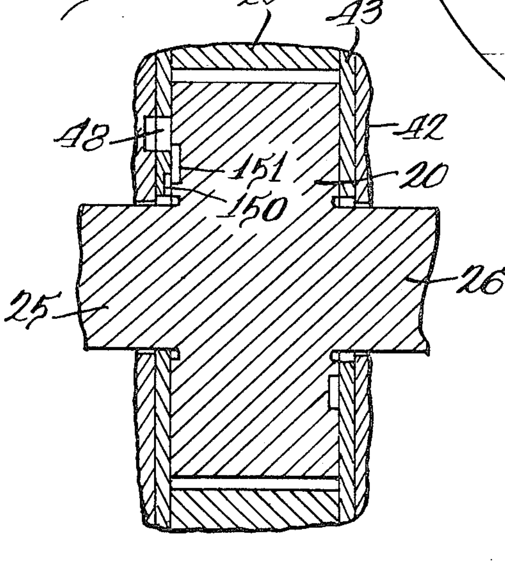


Fig. 7.

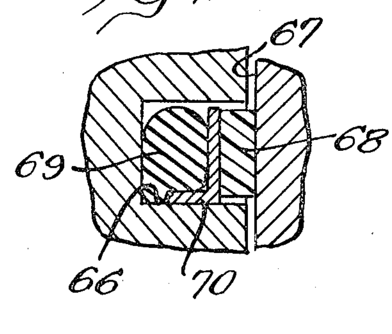


Fig. 9.

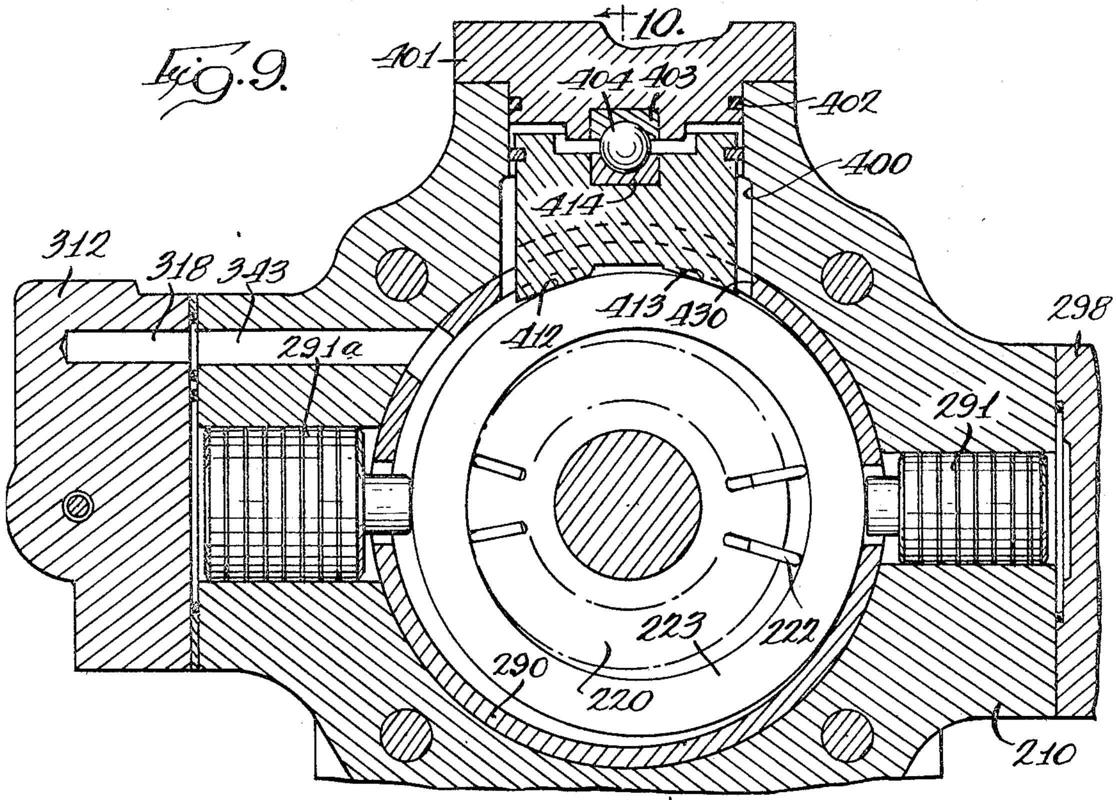
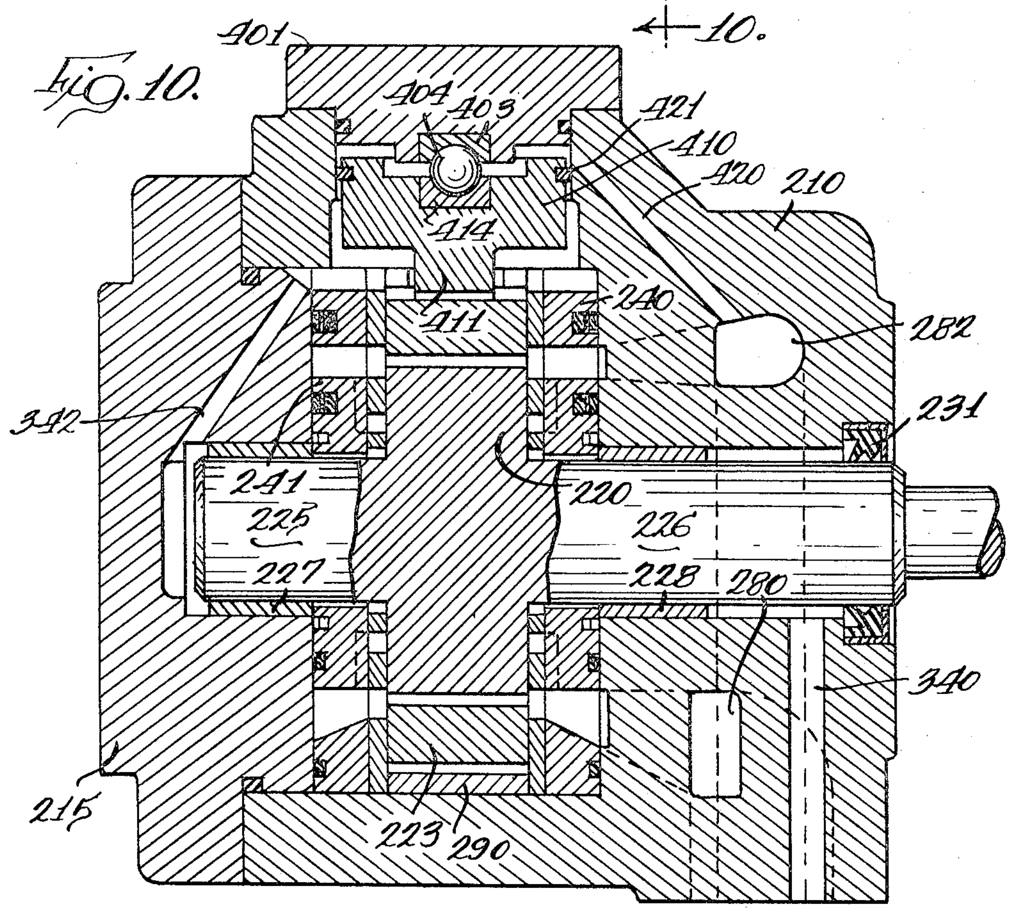

10.
401
404
403
402
400
414
312
318
343
413
430
412
291a
298
291
223
222
290
220
210
10.

Fig. 10.


401
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FLUID TRANSLATING DEVICE

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Int. Cl. F04c *1/00, 5/00, 15/02*
U.S. Cl. 418—26 19 Claims

ABSTRACT OF THE DISCLOSURE

A fluid translating device, such as a pump, having a pumping chamber with pumping elements including a slotted rotor with movable vanes, a movable ring surrounding the rotor for controlling the movement of the vanes outwardly of the rotor, and pressure plates on opposite sides of the rotor and ring having ports therein for conducting fluid to and from the vanes. A peripherally-sealed pressure area surrounds the pressure ports to urge the pressure plates toward the rotor and movable ring to oppose the pressure generated by the pump and maintain an effective seal to reduce pump leakage. A spacer member is positioned between the pressure plates against which the pressure plates abut to limit inward movement of the pressure plates to avoid binding the movable ring. Pressure compensation control of the movable ring is provided by opposed fluid pistons. Provision is made for intermittent lubrication of the bearings mounting the rotor shaft during operation of the pump by passages placed in communication during revolution of the pump rotor. Hertz stress on the movable ring of the pump is reduced by curved ends on the movable vanes.

BACKGROUND OF THE INVENTION

This invention relates to a fluid translating device and, more particularly, a variable volume vane type pump having new and improved structure for control of the movable ring of the pump, for reducing leakage in the pump and for providing overall improved operation in a pump handling relatively high pressures.

It has been generally known in variable volume vane type pumps to urge pressure, or port, plates laterally against the pumping elements to reduce leakage in operation of the pump. However, such systems have not maximized the reductions of leakage while still controlling the amount of forces acting to urge the pressure plates toward opposite sides of the rotor with provision for maintaining minimum spacing of the pressure plates to reduce restraint on the movable ring and wear on the relatively movable parts.

Additional problems involved in the prior art have to do with shaft lubrication, stresses in the movable ring, and pump casing size required by the size of the movable ring, all of which have been solved by features of the invention described hereinafter.

SUMMARY

An object of this invention is to provide a new and improved fluid translating device and, more particularly, a variable volume vane type pump having one or more of the features of: improved mounting and control of the movable ring of the pump; reductions in pump leakage by controlled forces urging the pressure plates against the rotor and movable ring of the pump; controlled positive lubrication of the rotor shaft bearings; effective sealing of the ports in the pressure plates; and improved coaction between the movable vanes and movable ring of the pump.

Further objects and advantages will become apparent from the following detailed description taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a central plan section of the fluid translating device;

FIG. 2 is a vertical section taken generally along the line 2—2 in FIG. 1;

FIG. 3 is a vertical section taken generally along the line 3—3 in FIG. 1;

FIG. 4 is an elevational view of one side of a pressure plate and taken generally along the line 4—4 in FIG. 1;

FIG. 5 is a view of the opposite side of the pressure plate taken generally along the line 5—5 in FIG. 1;

FIG. 6 is a fragmentary view of the rotor and shaft and associated structure showing the parts rotatably positioned to provide for lubrication of a bearing positioned to the left of the structure shown in FIG. 6;

FIG. 7 is an enlarged view of the seal structure for the pressure plate;

FIG. 8 is a fragmentary elevational view of a pumping vane;

FIG. 9 is a view similar to FIG. 3 of a second embodiment of the fluid translating device; and

FIG. 10 is a vertical section, taken generally along the line **10—10** in FIG. 9.

DESCRIPTION OF THE EMBODIMENTS

While this invention is susceptible of embodiment in many different forms, there is shown in the drawing and will herein be described in detail an embodiment of the invention together with a modification thereof with the understanding 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.

One embodiment of the fluid translating device is disclosed in FIGS. 1–8 and shown generally in FIGS. 1, 2 and 3 and comprises a vane-type unit and, in the description, is specifically described as a variable volume vane type pump.

The pump has a two-part casing including a first part **10** having a mounting base **11** and a cylindrical chamber **12** for receiving the pumping elements to be described. A second casing part **15** has a cylindrical section **16** which fits into the cylindrical chamber **12** to close off the chamber. The casing parts are sealed together by a seal **17** positioned therebetween and are held together by threaded attaching members **18**.

The pumping elements include a rotor **20** having a series of outwardly-extending slots **21**, each of which receives an outwardly movable vane **22**, shown particularly in FIG. 8, with the outward extent of the vane movement being controlled by a variably positionable ring **23** in the form of an annular member surrounding the rotor **20**.

The rotor **20** is rotatably mounted by an integral shaft having sections **25** and **26** extending outwardly from opposite sides of the rotor to rotatably fit in bearings **27** and **28**, respectively, received in concentric openings **29** and **30** in the casing parts **15** and **10**. The opening **29** in casing part **15** does not extend to the outer face of the casing part; however, the section **26** of the rotor shaft extends outwardly of the pump casing for a drive connection. A seal **31** is fitted in a recess **32** in the casing part **10** to surround and seal the rotor shaft section **26**.

In order to form closed pumping spaces between adjacent vanes **22** and the movable ring **23**, the sides of said spaces are closed off by a pair of pressure plates **40** and **41** positioned in the chamber **12** and at opposite sides of the rotor **20**. The pressure plate **40** is shown particularly in FIGS. 4 and 5. Each of the pressure plates is of generally the same construction and reference will be made particularly to pressure plate **40** in describing the construction thereof. The pressure plate is generally disc-shape and of composite construction, with the major section **42** thereof being formed of conventional material. The major section has a face section **43** bonded thereto with a surface layer of bearing-type material, such as bronze, to have facial engagement with the sides of the rotor **20**, the vanes **22**, and the movable ring **23**. A pair of pressure ports **45** and **46** extend through the pressure plate **40** and communicate with an arcuate pressure channel **47** in the plate section **43**, which is of an arcuate extent to communicate with the spaces between a plurality of the vanes **22**. The section **43** also has a vane balancing groove **48** which communicates with the inner end of the rotor slots **21** to urge the vanes outwardly and provide partial pressure balancing for the vanes **22** during crossover. Pressure fluid is supplied to the balancing groove **48** through a pair of passages **49** and **50** which extend between the ports **45** and **46** and the balancing groove **48**. With the foregoing structure as the fluid is delivered by the pump, it discharges from the spaces between vanes **22** through the ports **45** and **46** for discharge from the pump.

The pressure plate **40** has a central opening **51** to receive the rotor shaft section **26** with a loose fit and a series of peripheral notches **52, 53** and **54** which lie outwardly of the movable ring **23** and communicate with case drain for the pump.

The pressure plate **40** has a pair of suction ports **55** and **56** which extend through the pressure plate and communicate with a suction groove **57** in the plate section **43** and which has an arcuate extent sufficient to supply fluid to a plurality of spaces between adjacent vanes **22**. An arcuate vane balancing groove **58** is supplied with fluid through a pair of passages **59** and **60** in order to balance the vanes.

In order to have a pump of high efficiency and with reduced leakage, the pressure plate **40** is urged toward the rotor **20** and movable ring **23** by pump pressure. The necessary force is obtained by sealing off an area of the outer face of the pressure plate of a size which, when subjected to pump pressure slightly exceeds the forces generated by fluid under pressure between the vanes **22** in the pressure side of the pump. As pump pressure varies, the force will vary in direct proportion thereto. This pressure balancing area is shown particularly in FIG. 4 as a kidney-shaped area **65** which is defined by a correspondingly-shaped continuous groove **66** surrounding the pressure ports **45** and **46** and which receives seal structure which seals against the adjacent face **67** of the first casing part **10**. This seal structure is shown particularly in FIG. 7 and comprises a kidney-shaped seal member **68** of material, such as Teflon, which is urged against the casing face **67** by pressure fluid which moves outwardly from the area **65** into the groove **66** and acts against an O-ring **69** which engages against a flexible seal member **70**, such as fish paper, whereby the pressure causes deformation of the O-ring **69** to seal against the bottom of the groove **66** and urge the seal member **68** outwardly against the adjacent face of the casing. The seal components are all continuous and generally of the same shape as the groove **66** to a continuous seal around the pressure balancing area.

Further to minimize leakage, a kidney-shaped groove **75** is provided in the section **42** of the pressure plate surrounding the suction ports **55** and **56** and receives a similarly-shaped O-ring **76** to seal against the face **67** of the casing part **10** and preclude leakage of fluid from the area surrounding the suction ports.

The construction and operation of the pressure plate **41** is substantially the same as the pressure plate **40**, as is evident in FIGS. 1 and 2 and the same parts have been given the same reference numeral with a prime affixed thereto. Inasmuch as the balancing ports **48′** and **58′** communicate with the balancing ports **48** and **58** of pressure plate **40**, the pressure plate **41** does not require the passages **49** and **50**, **59** and **60** of the pressure plate **40**.

The suction ports **55** and **56** of the pressure plate **40** are connected to tank by a passage **80** extending upwardly within the casing part **10** from the bottom thereof and having a laterally-extending upper end communicating with the suction ports. Fluid delivered by the pump discharges from the pressure ports **45** and **46** and flows through a lateral arcuately-shaped passage **81** to a vertical passage **82** in the casing part **10** whereby suitable fluid connections can be made to the pump at the bottom thereof.

With pressure balancing of the pressure plates **40** and **41** caused by the kidney-shaped areas on the outer faces thereof, it is important to limit the pressure of the pressure plates against the rotor and movable ring to minimize wear on the inner faces of the pressure plates resulting from rotation of the rotor and to prevent binding of the movable ring which must move to provide the variable volume control of the pump. This result is accomplished by use of a spacer member positioned between the pressure plates **40** and **41** and, as shown, comprises a spacer ring **90** surrounding the movable ring and in spaced relation thereto. This ring defines a minimum spacing between the pressure plates of a dimension to permit the pressure plates to effectively seal against the rotor **20**, vanes **22**, and movable ring **23** without undue pressure thereon.

The movable ring **23** is controlled in its positioning relative to the rotor **20** to control the output of the pump by hydraulic means including a pair of opposed hydraulic pistons **91** and **91*a*** engaging the outer surface of the movable ring **23**. The porting in the pressure plates **40** and **41** is arranged to have the force vector of the pumping forces act upwardly on the ring **23** in a direction toward a thrust pin **92** threaded in the casing part **10** and having a lower end **93** extending through an opening **94** in the spacer ring **90** to support the movable ring against the pumping forces. This structural relation results in a minimal amount of force derived from the pumping action acting along a line which is coincident with the axes of the pistons **91** and **91*a***.

The piston **91** is movable in a chamber **95** in the casing part and has an operative end **96** extending through an opening **97** in the spacer ring **90** to engage the outer surface of the movable ring **23**. The chamber **95** is closed off by a cover **98** secured to the casing part **10** and with a recess **99** providing a fluid chamber adjacent the end of the piston chamber **95**. The piston **91** is always subjected to the pressure existing in the pressure ports **45** and **46** by communicating passages **100, 101** and **102** formed in the second casing part **15** which extend between the kidney-shaped pressure area at the back side of the pressure plate **41** and a passage **103** formed in the casing part **10** which communicates with the fluid chamber **99** at the outer end of the piston chamber **95**. As a result, the piston **91** will urge the movable ring **23** away from the eccentric position shown in FIG. 3 relative to the rotor **20** toward a position in which the ring is concentric with the rotor to reduce the volume of the pump output.

The actual position of the movable ring **23** is controlled by the hydraulic piston **91*a*** acting in opposition to the piston **91**. The piston **91*a*** is movable in a chamber **105** formed in the casing part **10** and has a reduced end **106** extending through an opening **107** in the spacer ring **90** to engage against the outer surface of the movable ring **23**. The cross-sectional area of the piston **91*a*** is approximately twice that of the piston **91**.

The piston **91*a*** has an internal recess **110**, shown in FIG. 1, opening to the rear end thereof which receives a spring **111** urging the piston **91*a*** toward the ring **23**. The end of the piston chamber **105** is closed off by a pressure-compensating servo valve assembly including a body **112** fixed to the casing part **10**.

The pressure compensator control valve is disclosed and claimed in a copending application and only general reference is made herein to the valve. This valve has a bore **113** in the body **112** extending longitudinally thereof mounting a valve spool **114** which is urged toward the right as viewed in FIG. 1 by an adjustable control spring **115**. The valve bore communicates with three passages, with a first passage **116** receiving fluid from the pressure ports of the pump. A second passage **117** communicates with the end of the piston chamber **105** and a third passage **118** connects to case drain of the pump. A pair of lands **119** and **120** on the valve spool lie to either side of the passage **117** and control the connection of this passage to either the pressure passage **116** or the drain passage **118**. Pressure fluid is delivered to the right-hand end of the valve bore **113** to act against the right-hand end of the spool **114** in opposition to spring **115** by an internal passage in the valve spool having an inlet **121** and an outlet **122**. The valve bore is closed by a threaded cap **123**.

Pressure fluid from the pump is supplied to the passage **116** by a series of passages formed in the body parts **10** and **15** extending between the kidney-shaped pressure area at the back side of the pressure plate **41** and the passage **116**. These passages include connecting passages **130** and **131** and **132** in the body part **15** and a passage **133** in the valve body part **10**. The pressure at which the pressure compensator valve will start to obtain compensating action by movement of the ring **23** from the position of FIG. 3 toward a concentric position is set by the adjustable spring **115**. Prior to such time, the control spring **115** urges the valve stem **114** to the right to permit fluid communication between the passages **116** and **117**, past the land **119** whereby the piston **91** is subjected to outlet fluid pressure to urge the ring toward the right as viewed in FIG. 3. As the pressure increases, this pressure acts against the right-hand end of the valve spool **114**, as viewed in FIG. 1, to urge the spool and land **119** to the left against the spring **115** and reduce the communication between the passages **116** and **117**. Upon a sufficient increase in pump pressure, communication is blocked between passages **116** and **117** by land **119** and opened between the control passage **117** and the tank passage **118** past land **120**, whereby fluid can flow to drain to reduce the pressure acting on the piston **91*a*** whereby the piston **91** controls to urge the movable ring **23** to a substantially concentric relation with the rotor **20**.

A case drain passage **140** is shown in FIGS. 1 and 2 and directly communicates with fluid passing through the rotor shaft bearing **28** and with the outer perimetral space surrounding the pressure plates **40** and **41** through a passage **141** communicating therewith as shown in FIG. 1. This latter space also receives fluid passing through the bearing **27** by means of a passage **142**, shown in FIG. 2, and receives fluid from the outlet passage **118** of the pressure compensating valve by way of a passage **143** in casing body part **10** communicating with the passage **118**, as shown in FIG. 3. This communication is through an opening **144** in the spacer ring **90**.

Provision is made for obtaining controlled lubrication of the rotor shaft sections **25** and **26** and their associated bearings **27** and **28** by intermittent fluid jets from the pump. This controlled lubrication provides for a charge of fluid to each bearing once in each revolution of the rotor **20**.

The structure for accomplishing this is shown particularly in FIGS. 5 and 6 wherein the inner section **43** of the pressure plate **40** has a radial slot **150** opening to the center opening **51** of the pressure plate and terminating short of the pressure balancing groove **48**. This slot coacts with a radial notch **151** on the face of the rotor **20** which is a short distance from the inner end of the rotor and which spans the pressure balancing groove **48** and the radial slot **150** of the pressure plate once in each revolution of the rotor to connect the pressure balancing groove **48** with the rotor shaft section whereby a jet of fluid under pressure is injected into the adjacent bearing.

The other pressure plate has a similar radial slot which coacts once in each revolution with a similar adjacent radial notch **151*a*** on the rotor side to inject a jet of oil into the other shaft bearing.

An additional feature of the pump construction is in the shaping of the vanes with a radius at the tip thereof to reduce Hertz stress on the movable ring **23**. This is shown in FIG. 8 wherein a fragmentary detail of a pump vane is shown. The pump vane **22** has an upper end provided with a pair of upwardly inclined converging surfaces **160** and **161** which are connected by an outer end **162** having a convexly curved surface.

A modified form of the fluid translating device is shown in FIGS. 9 and 10, which is of generally the same construction as the embodiments of FIGS. 1 to 8, except for the construction of the thrust block for the movable ring and the thickness of the latter and parts similar to the embodiment of FIGS. 1 to 8 have been given the same reference numerals with "200" added thereto.

In the embodiment of FIGS. 9 and 10, a thrust block construction is provided to react against the pumping forces and directly against the movable ring **223** and to provide for a reduced thickness of the movable ring **223**. This thrust block construction is located in a recess **400** in the pump body part **210** and embodies a cap **401** sealed to the body part by an O-ring **402** and which has an insert **403** against which a hardened steel ball **404** engages. The thrust block has an upper cylindrical end **410** which loosely fits in the recess **400** and an integral lower generally rectangular end **411** with a pair of spaced surfaces **412** and **413** each making line contact with the outer surface of the movable ring **223**. The back side of the thrust block has an insert **414** engaging against the ball **404** whereby the thrust block can pivot within the recess **400** on the ball **404** to follow the ring **223** in its movement. The load on the pivot ball is substantially reduced by supplying system pressure to the space between the back of the thrust block and the cap **401** through a passage **420** which communicates with the pressure passage **282**. This space is sealed by an outwardly urged seal ring **421** in a groove in the thrust block which seals the perimeter of the thrust block to the wall of the recess **400** but still permits slight rocking movement of the thrust block. The overall area of the back end of the thrust block **410** is dimensioned to have system pressure acting thereon function to reduce by approximately 60%–95% the loading on the pivot ball **404**.

The two point support of the movable ring reduces the maximum loading on any one part of the ring as compared to a single point support in the embodiments of FIGS. 1 to 8 whereby the movable ring **223** can be of a lesser radial thickness for the same pressure rating of the pump. This will be noted by the reduced radial thickness of the ring **223** as compared to the radial thickness of the ring **23** in the embodiment of FIGS. 1 to 8.

The spacer ring **290** is provided with an opening **430** of a size to permit the lower end of the thrust block **411** to extend into engagement with the movable ring **223**.

We claim:

1. A variable volume vane type pump comprising a two-part casing with one part of the casing having a cylindrical chamber to receive a plurality of components including a slotted rotor with movable vanes, a movable ring surrounding the rotor, and a pair of pressure plates disposed one at each side of the rotor and ring, means between said casing and the adjacent side of each of said pressure plates defining a peripherally sealed pressure area whereby fluid under pump pressure urges said pressure plates toward the rotor and ring to oppose the pressure generated by the pump, and a spacer ring surrounding said movable ring against which said pressure plates abut to limit movement of the pressure plates and permit free unbound movement of the movable ring.

2. A variable volume vane type pump as defined in claim 1 including opposed pistons for controlling the position of the movable ring and each having an end engaging the ring, and a pair of openings in the spacer ring through which said ends extend to engage the movable ring.

3. A variable volume vane type pump as defined in claim 1 including a thrust block for opposing a force vector on the movable ring created by the pumping forces and having a pair of spaced apart faces engaging with line contact the outer perimeter of the movable ring means mounting the thrust block for rocking movement as the movable ring shifts position, and means for applying pump pressure to the back side of the thrust block.

4. A variable volume vane type pump as defined in claim 3 wherein said thrust block is loosely mounted and supported by a ball for the rocking movement.

5. A variable volume vane type pump as defined in claim 4 wherein said thrust block has a surface at the back side of a size subjected to pump pressure to create force sufficient to counteract a major part of the ring load acting on the thrust block, and a peripheral seal member on the thrust block.

6. A variable volume vane type pump as defined in claim 1 wherein said movable vanes have rounded ends engageable with the interior of the movable ring to reduce Hertz stress on said movable ring.

7. A variable volume vane type pump as defined in claim 1 wherein said slotted rotor has a shaft rotatably supported at either side of the rotor in bearings, and means for injecting fluid under pressure into the bearings at least once in each revolution of the rotor, said fluid being internally supplied by the pump.

8. A variable volume vane type pump as defined in claim 7 wherein said fluid injecting means includes a radial slot positioned between the center of one pressure plate and an adjacent pressure port in the pressure plate and a radial notch on a side face of the rotor adjacent the rotor shaft which spans said port and slot once in each revolution of the rotor.

9. A variable volume vane type pump as defined in claim 1 wherein each of said pressure plates has a pair of arcuate radially spaced pressure ports for transmitting fluid under pressure from one side of the pressure plates to the other, said pressure ports being located within said sealed pressure area, and said means defining said sealed pressure area comprising a continuous groove in the rear plate surrounding said pressure ports and a pressure seal positioned in said groove and urged against the casing by pressure of fluid in said groove behind the seal.

10. A variable volume vane type pump as defined in claim 9 wherein said pressure plates have suction ports for transmitting inlet fluid from one side of the pressure plate to the other, and a sealed kidney-shaped suction area surrounding said suction ports defined by a continuous groove with an O-ring therein sealing the space between the pressure plates and adjacent walls of the casing.

11. A variable volume vane type fluid translating device comprising a casing having a chamber to receive a plurality of components including a slotted rotor with movable vanes and a movable ring surrounding the rotor, a pressure plate at a side of the rotor and movable ring and having a pressure port, a kidney-shaped sealed pressure area between the adjacent faces of the pressure plate and the casing surrounding said pressure port whereby fluid under pressure urges the pressure plate toward the rotor and ring to oppose the pressure at the opposite side of the pressure plate, and a spacer member against which said pressure plate abuts to permit free movement of the movable ring.

12. A device as defined in claim 11 including opposed pistons for controlling the position of the movable ring and each having an end engaging the ring, and a pair of openings in the spacer ring through which said ends extend to engage the movable ring.

13. A variable volume vane type fluid translating device comprising, a casing having a chamber to receive a plurality of components including a slotted rotor with movable vanes and a movable ring surrounding the rotor, a pressure plate at a side of the rotor and movable ring and having a pressure port, a kidney-shaped sealed pressure area between the adjacent faces of the pressure plate and the casing surrounding said pressure port whereby fluid under pressure urges the pressure plate toward the rotor and ring to oppose the pressure at the opposite side of the pressure plate, and a thrust block for opposing a force vector on the movable ring having a pair of legs with faces engaging the outer perimeter of the movable ring.

14. A device as defined in claim 13 wherein the thrust block is mounted for rocking movement on a ball supported by the casing, and means for applying pressure to the back side of the thrust block to reduce the loading on the ball.

15. A variable volume vane type fluid translating device comprising, a casing having a chamber to receive a plurality of components including a slotted rotor with movable vanes and a movable ring surrounding the rotor, a pressure plate at a side of the rotor and movable ring and having a pressure port, a kidney-shaped sealed pressure area between the adjacent faces of the pressure plate and the casing surrounding said pressure port whereby fluid under pressure urges the pressure plate toward the rotor and ring to oppose the pressure at the opposite side of the pressure plate, and said movable vanes having rounded ends engageable with the interior of the movable ring to reduce Hertz stress on said movable ring.

16. A variable volume vane type fluid translating device comprising, a casing having a chamber to receive a plurality of components including a slotted rotor with movable vanes and a movable ring surrounding the rotor, a pressure plate at a side of the rotor and movable ring and having a pressure port, a kidney-shaped sealed pressure area between the adjacent faces of the pressure plate and the casing surrounding said pressure port whereby fluid under pressure urges the pressure plate toward the rotor and ring to oppose the pressure at the opposite side of the pressure plate, a shaft carrying said slotted rotor, a bearing supporting said shaft, and means for injecting fluid under pressure into the bearing at least once in each revolution of the rotor including a radial notch on a side face of the rotor and a radial slot in the pressure plate opening to said shaft with said radial notch connecting fluid in the chamber with said slot once in each revolution of the shaft.

17. A variable volume vane type pump comprising, a casing having a chamber to receive a plurality of components including a slotted rotor with movable vanes and a movable ring surrounding the rotor, a pressure plate at a side of the rotor and movable ring and having a pressure port, a kidney-shaped sealed pressure area between the adjacent faces of the pressure plate and the casing surrounding said pressure port whereby fluid under pressure urges the pressure plate toward the rotor and ring to oppose the pressure at the opposite side of the pressure plate, a suction port in said pressure plate, and a sealed kidney-shaped suction area surrounding said suction port defined by a continuous groove with an O-ring therein sealing the space between the pressure plate and adjacent wall of the casing.

18. A variable volume vane type pump having a casing with a cylindrical chamber to receive a plurality of pumping elements including a shaft with a slotted rotor with movable vanes, bearings for said shaft, a movable ring surrounding the rotor, and a pair of pressure plates disposed one at each side of and spanning the rotor and movable ring, each of said plates having an arcuate pressure port and an arcuate suction port with corresponding vane balancing ports, means between the outer side of

each pressure plate and adjacent wall of the casing defining a peripherally sealed kidney-shaped pressure area encompassing the pressure port and balancing port to confine fluid under pump pressure to urge the pressure plates toward the rotor and oppose the pressure generated by the pump, a spacer member against which said pressure plates abut to limit inward movement of the pressure plates and prevent binding of the movable ring, means sealing the space surrounding the suction port and associated balancing port comprising an O-ring between the outer face of each pressure plate and adjacent casing wall, opposed fluid pistons for controlling the position of the movable ring with each piston having an end engaging the movable ring, and means for injecting pumped fluid into said bearings including a radial slot on the inner face of each pressure plate extending radially outward from a central opening in the pressure plate to a point short of the pressure vane balancing port, and a radial notch on each side face of the rotor which spans said pressure vane balancing port and the radial slot once in each revolution of the rotor.

19. A pump as defined in claim **18** including a thrust block loosely mounted in said casing for opposing forces on the movable ring created by the pumping action, said thrust block having a pair of spaced surfaces engaging the movable ring, a ball mounting the thrust block for rocking movement, and means for applying pump pressure to a surface at the back side of the thrust block to counteract a major part of the ring load acting on the thrust block and free the thrust block for rocking on said ball to freely follow movement of said movable ring.

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