Sept. 29, 1953 R. F. HORTON 2,653,542

RADIAL PISTON ROTARY PUMP

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FIG. 1.

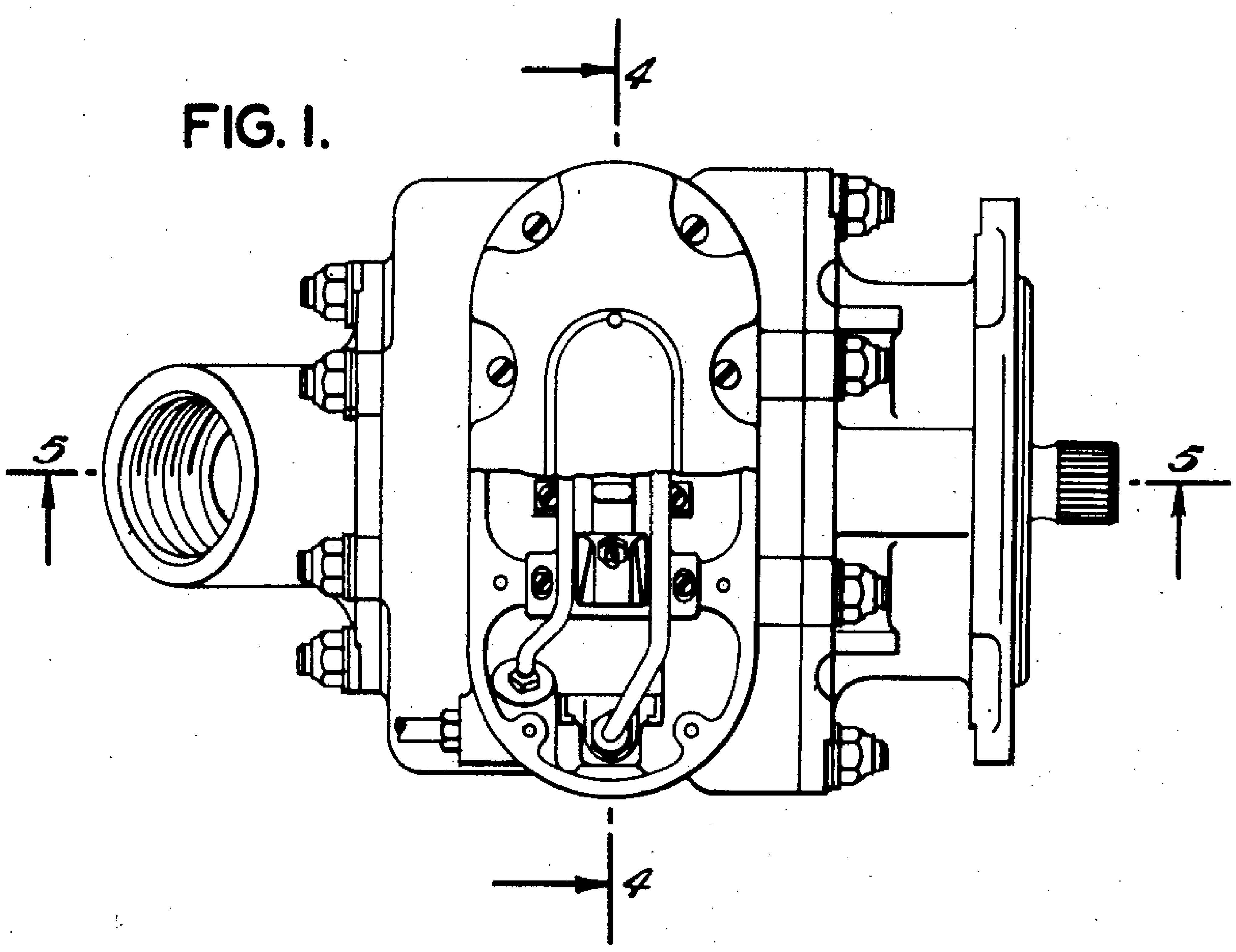


FIG. 2.

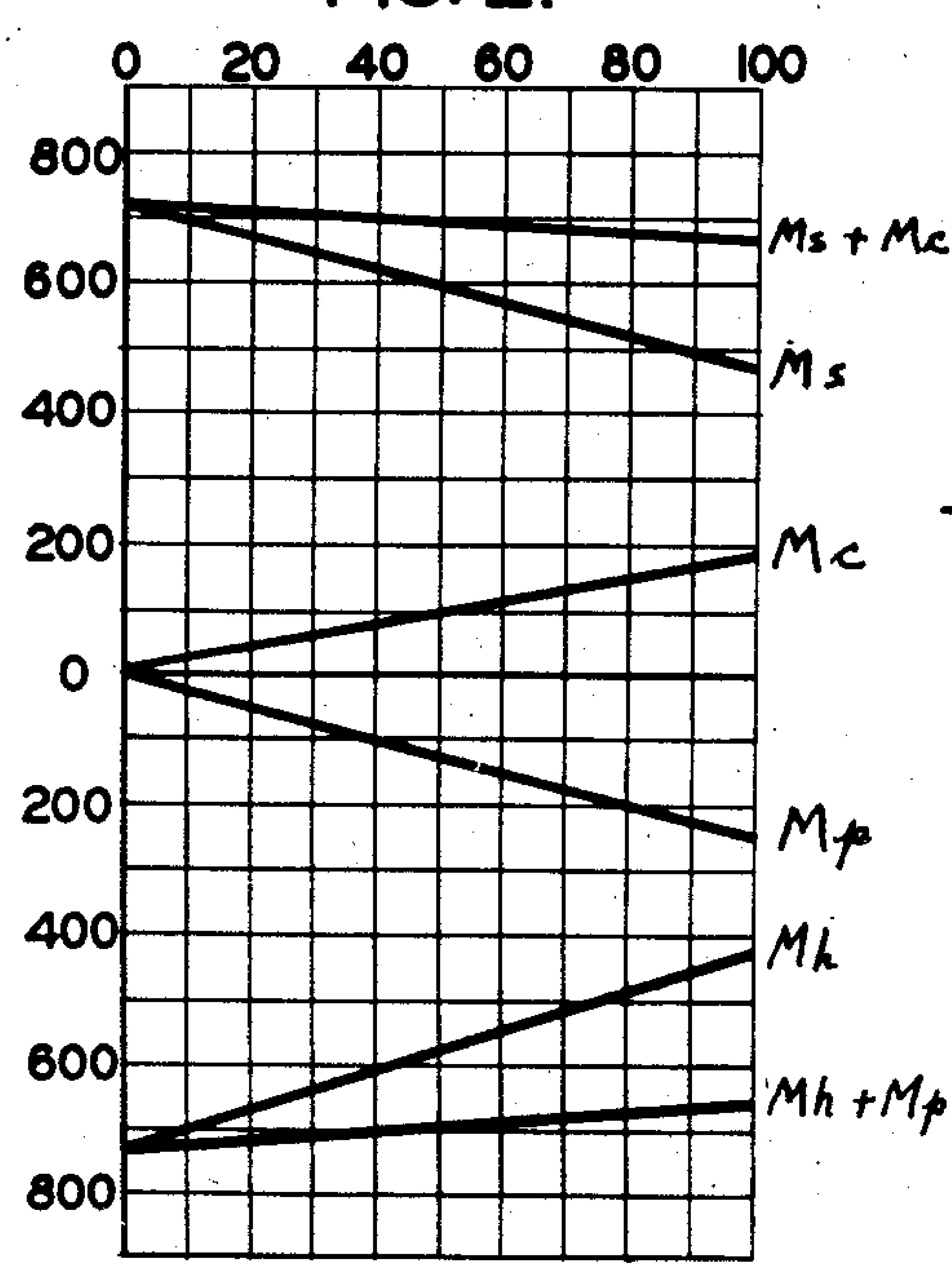
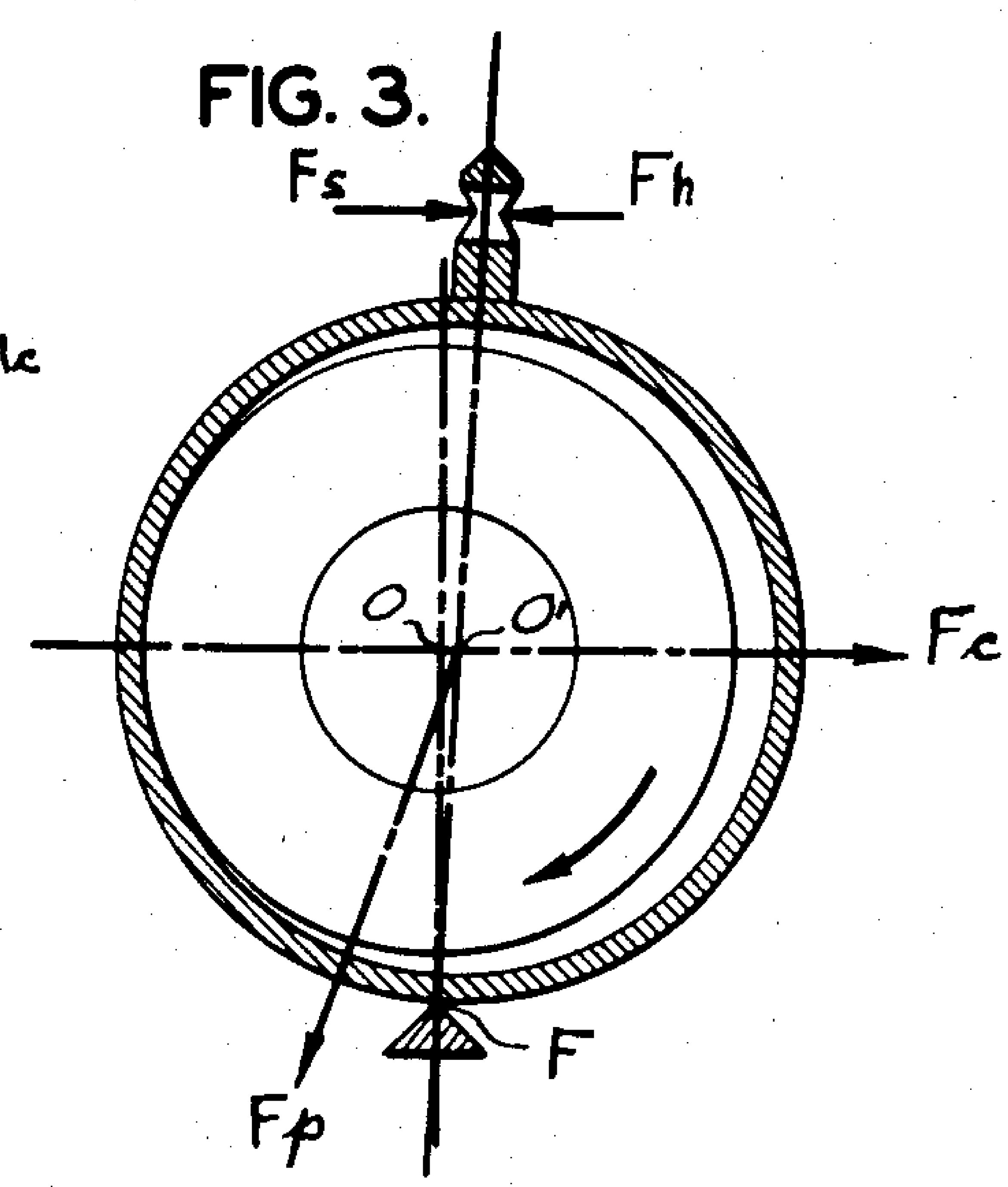


FIG. 3.



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RADIAL PISTON ROTARY PUMP

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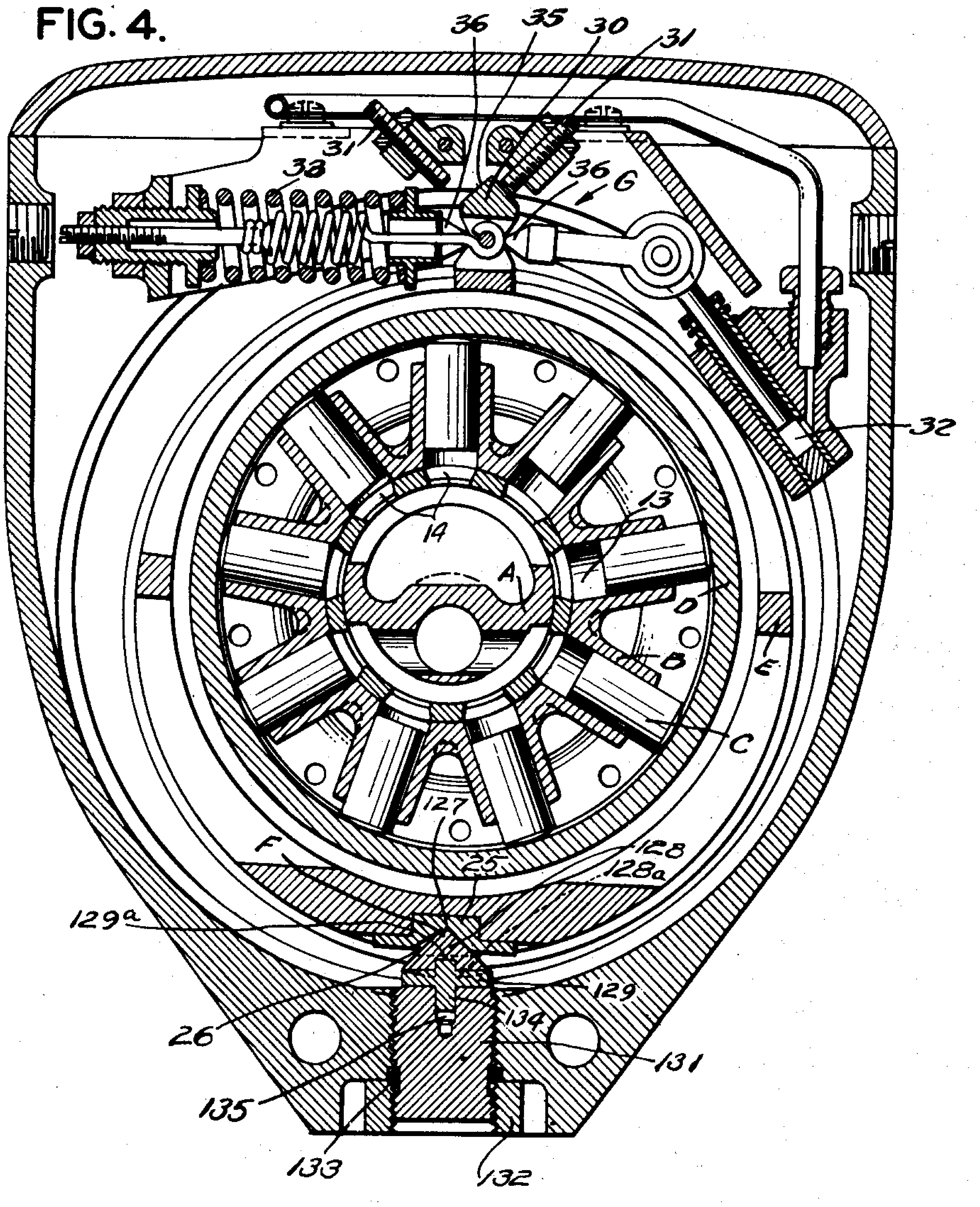
FIG. 4.



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RADIAL PISTON ROTARY PUMP

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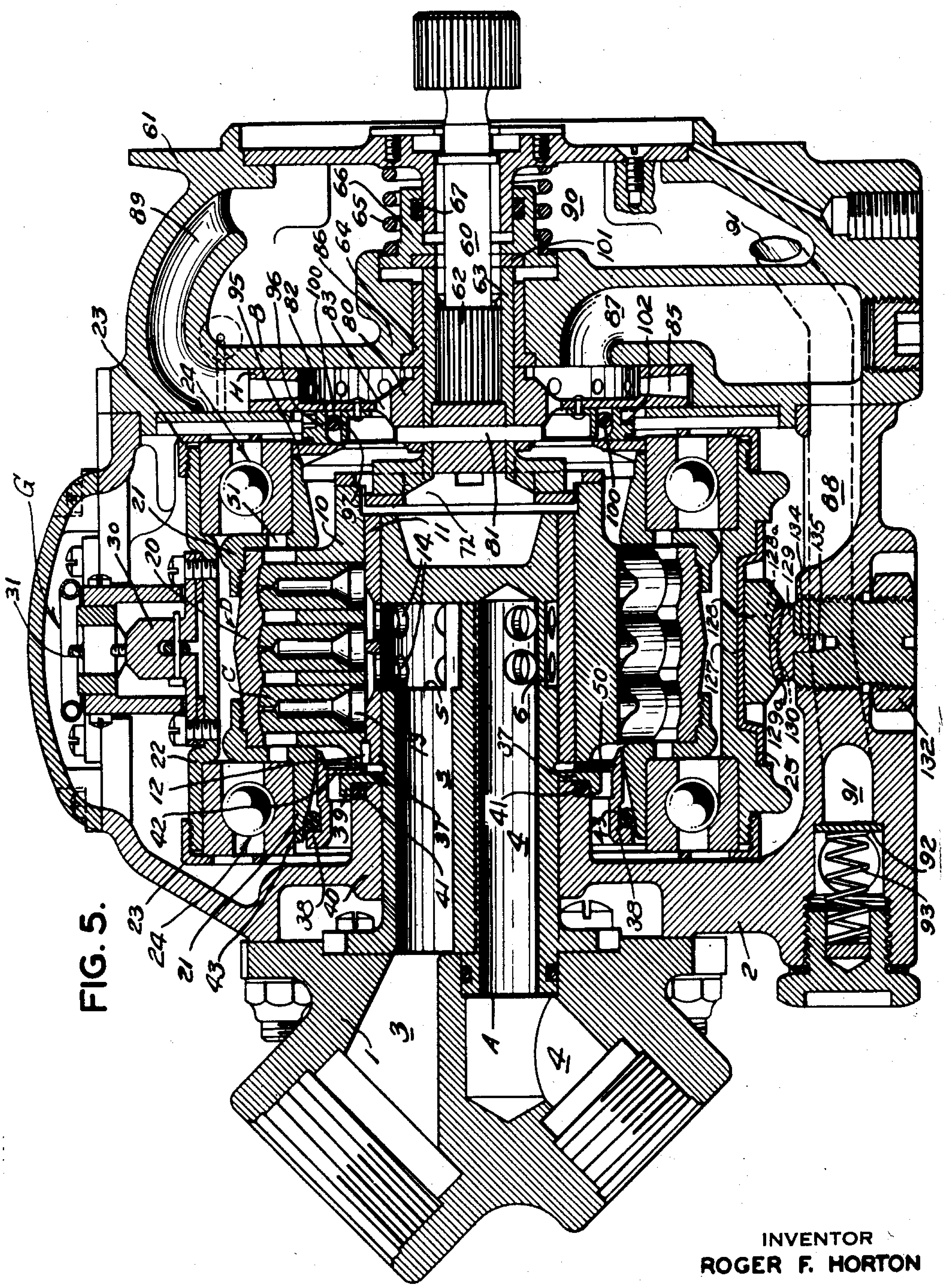

FIG. 5.

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RADIAL PISTON ROTARY PUMP

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FIG. 6.

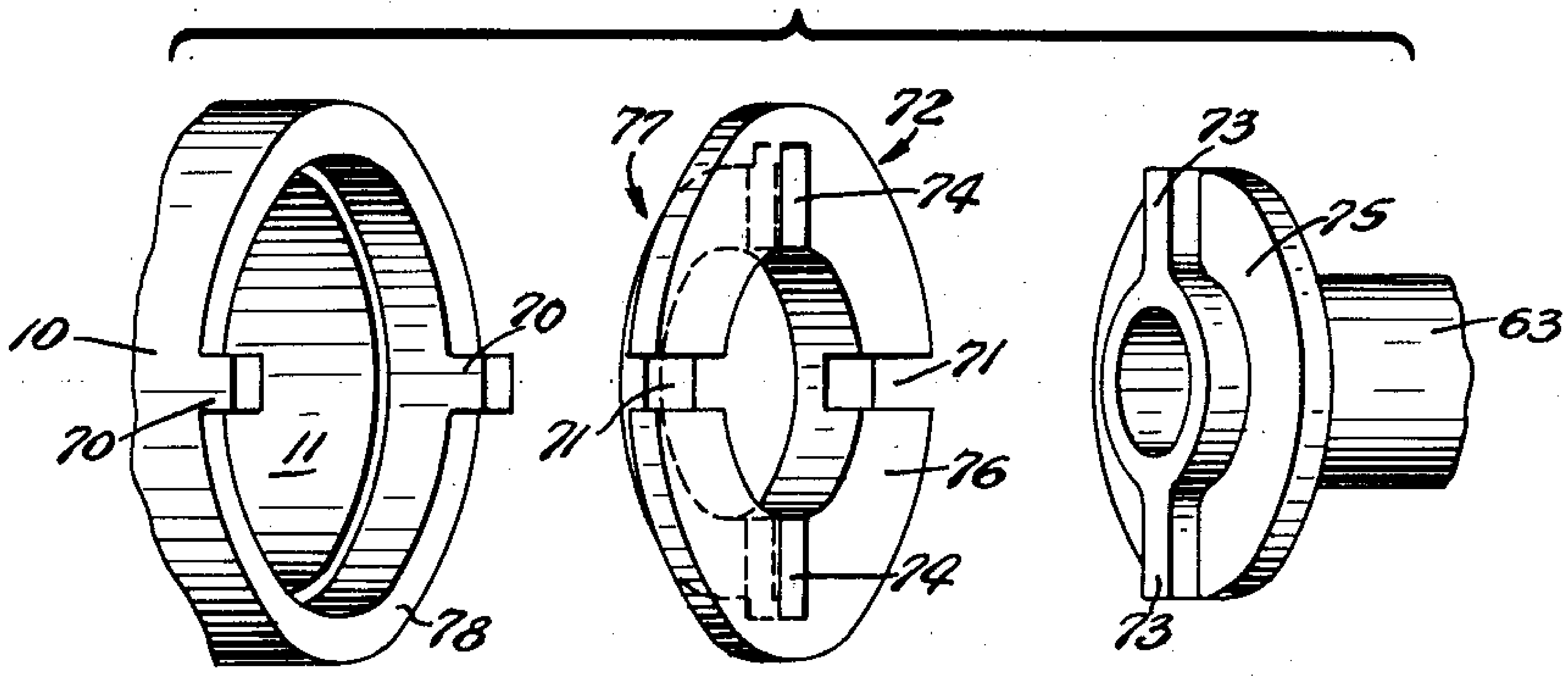


FIG. 7.

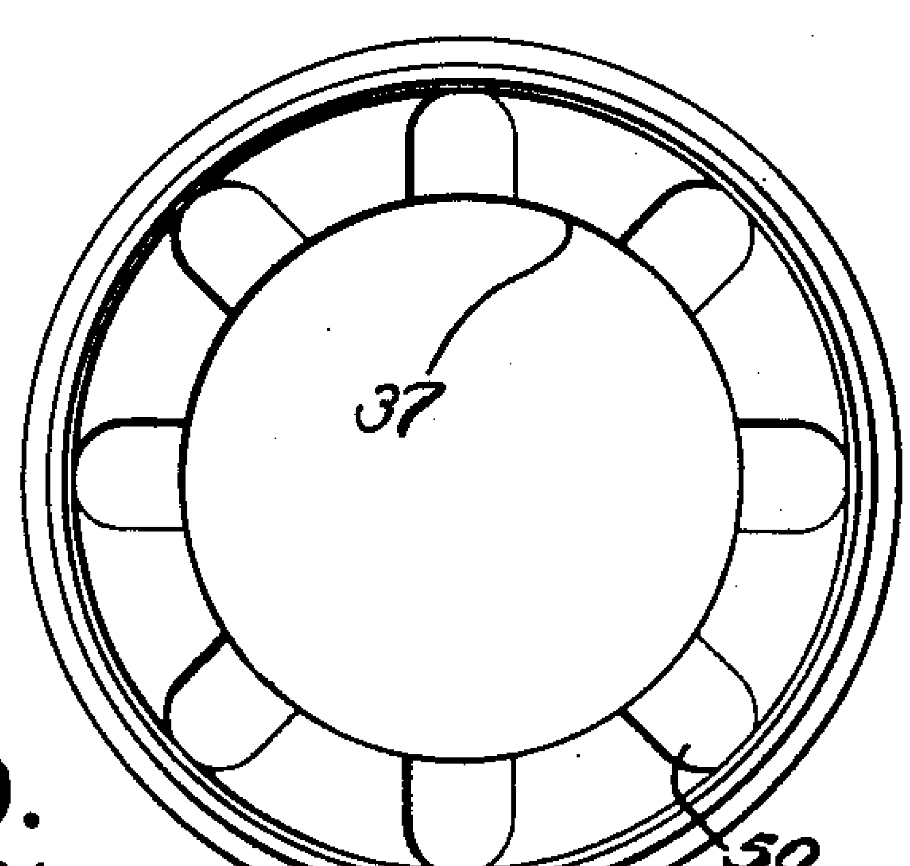


FIG. 8.

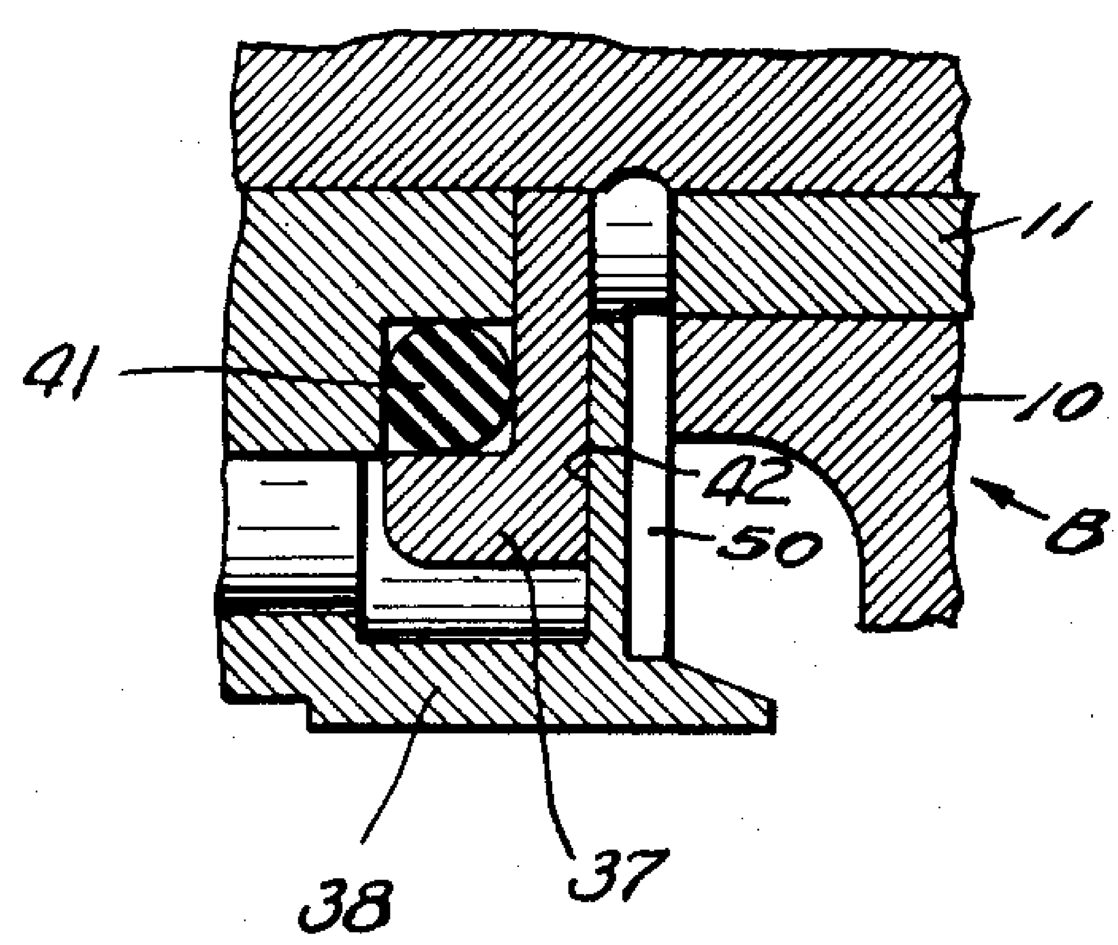
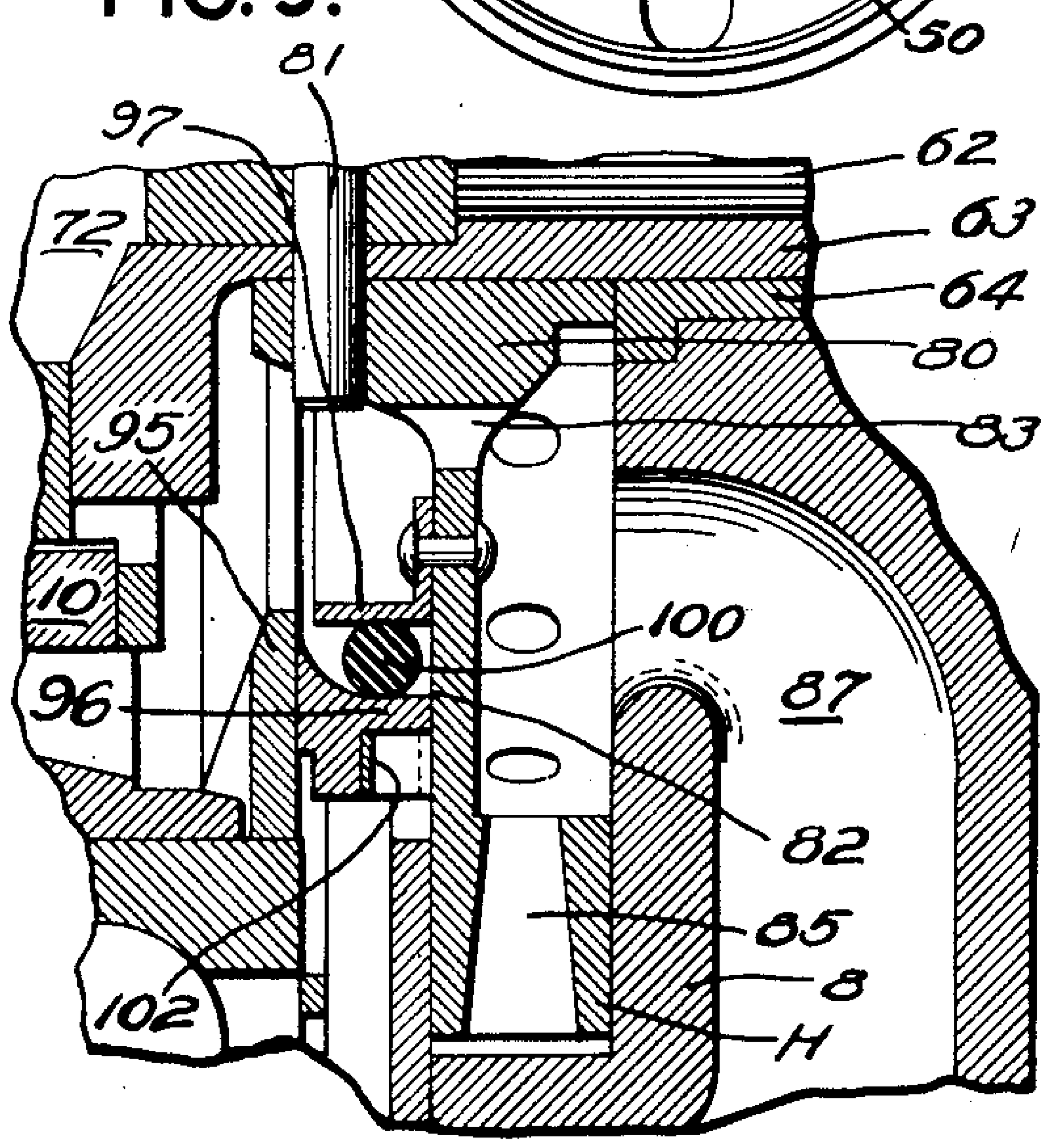


FIG. 9.



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2,653,542

UNITED STATES PATENT OFFICE

2,653,542

RADIAL PISTON ROTARY PUMP

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Application March 24, 1951, Serial No. 217,340

15 Claims. (Cl. 103—4)

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This invention relates to improvements in radial piston rotary pumps.

It is an object of the invention to provide an improved means for sealing the space surrounding the rotor of the radial piston pump to better control the flow of leakage fluid.

It is a further object of the invention to provide a sealing arrangement of the character indicated, which does not interfere with movement of the parts in their rotation, or the movement of the parts due to deflection under pressure, or movement of the parts during stroke change.

A further object of the invention is to provide means for priming the scavenger pump element for pumping leakage and lubrication oil from the casing.

With the foregoing objects as well as others which will appear in mind, a pump embodying the invention in preferred form will now be described in detail with reference to the accompanying drawing, and the features forming the invention will then be pointed out in the appended claims.

In the drawing:

Figure 1 is a plan view of a pump embodying the invention in a preferred form, part of the cover being broken away to show internal structure;

Figures 2 and 3 are, respectively, moment diagrams and force diagrams, showing certain moments and forces acting on the support and track rings of the pump;

Figure 4 is a cross section on the line **4—4** of Figure 1;

Figure 5 is a central axial section on the line **5—5** of Figure 1;

Figure 6 is an exploded isometric view of a coupling connecting the drive shaft to the rotor;

Figure 7 is an elevation view of a sealing ring; and

Figure 8 is an enlarged view of a portion of Figure 5 showing certain sealing arrangements at the anti-drive end of the rotor illustrating in detail the section appearing below the pump axis in Figure 5.

Figure 9 is an enlarged detail cross section of the drive end sealing arrangement.

The general elements of the pump (Figure 4) include a pintle A around which the rotor B rotates, the pistons C being reciprocably mounted in the rotor with their ends against a track ring D, which, in turn, is carried in a support ring E by antifriction bearings. The support ring is pivoted on a fulcrum block F and its eccentricity with relation to the pintle and rotor is con-

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trolled by mechanism indicated generally at G and including a pressure control.

As pointed out in my previous application, Serial No. 628,942 filed November 15, 1945, now Patent No. 2,547,645, the immersion and rotation of the operating parts in a body of oil within the pump casing results in considerable power losses. In the pump of that application, there is provided a scavenger pump or disc, and a similar disc or rotor H (Figure 5) is provided in the pump of the present invention. Inasmuch as the pump of the present invention is designed for horizontal as well as vertical operation, it is desirable to provide elements in the nature of seals for insuring that the scavenger rotor will be primed and will be ready to remove leakage oil at all times, and such sealing, as hereinafter described, is an important feature of the invention. The pump structure in general will now be described to the extent necessary for an understanding of the features forming the present invention, reference being made to my aforesaid application as well as to my applications for improvements in Support Ring Mounting for Rotary Radial Piston Pump, Serial No. 187,030 filed September 27, 1950, and for improvements in Piston Construction for Rotary Radial Piston Pump or Motor, Serial No. 180,027 filed August 16, 1950, for details of the structures not specifically described herein.

Pintle and pintle mounting

The pintle A is bolted to an end casting **1**, which, in turn, is fixed to the main casting **2** of the pump. Intake and exhaust passages **3** and **4** are formed in the pintle and end casting **1**, and communicate with intake and exhaust ports **5** and **6**, as shown. It may be noted that the other end of the pintle is not supported by the frame structure so that in operation there may be a certain amount of deflection of the pintle, which necessitates certain expedients for permitting relative movement hereinafter referred to.

Rotor

The rotor B comprises a main body **10** and a liner **11** closely fitting in it and fastened to it as by means of pins **12**, and the piston C are reciprocably mounted in bores **13** formed in the body **10**. A pair of apertures **14** through the liner **11** serves each group of three axially aligned pistons C, as indicated in Figures 4 and 5, and there are nine such groups spaced around the rotor, as indicated in Figure 4. The rotor is positioned axially of the pintle and driven in a manner hereinafter described in detail.

Track ring and support ring

The track ring D comprises a center section **20** having grooves, as shown, in which the rounded piston heads run and to which are screwed a pair of side members **21** having the shape indicated. The support ring comprises a shell **22**, apertured for lightness, and to which are screwed end caps **23**. Antifriction bearings **24** are held between the end members **21** of the track ring and the members **22** and **23** of the support ring as shown in Figure 5, so that free rotation of the track ring is permitted but the track ring and support ring are held together as a unit for movement axially of the pintle or tilting movement therewith with respect to the casing.

Support ring mounting

The support ring E is mounted on the fulcrum F as shown. A block **25** is fixed in the lower part of support ring E and is formed with a concavity **26**, triangular in cross section, for cooperating with a bearing edge or fulcrum **127** of the support.

For convenience of manufacture the pivot is formed of a pair of elements **128**, **129** positioned relative to each other by an arcuate slot **128***a* formed in the lower portion of element **128** and a cooperating arcuate tongue **129***a* protruding from element **129**, thus forming a pivot combination having the fulcrum edge **127** at its top and and arcuate bearing surface **130** between the elements **128**, **129**. The pivot **128**, **129** sits in a bearing seat formed in the upper end of a screw plug **131**. This plug is received in a correspondingly threaded bore in the main casing **2**. By turning the plug **131** the height of fulcrum edge **127** may be adjusted, and the plug is held in adjusted position by a lock nut **132**. An O-ring **133** may be utilized to seal against leakage at this point.

Pin **134** which is integral with the element **129** extends downwardly into a bore **135** in the plug **131**. The pivot elements **128**, **129** permit support ring E to be rocked about the fulcrum or knife edge **127** by the stroke control mechanism described hereinafter. As the support ring is rocked about the fulcrum **127** the elements **128**, **129** will form an absolutely rigid support in the plane of rocking. This is best seen by referring to Figure 4 where it is noted that the elements **128**, **129** are keyed together against movement in this plane.

However under load should the pintle deflect, the rotor, track and support ring would also tend to tilt with respect to the axis of rotation. Under such conditions while still supporting the ring evenly on the entire length of fulcrum **127**, elements **128**, **129** permit relative adjustment therebetween on the arcuate surface **130** (Figure 5) to accommodate the aforementioned deflection.

The support ring is positioned in the desired eccentricity with respect to the pintle and rotor for imparting stroke to the pistons, by means of the assembly G described in detail in my application above referred to for Support Ring Mounting for Rotary Radial Piston Pump. It is sufficient to note in the present connection that the assembly G acts on the block **30** fastened to the top of the support ring, that the pivotal movement of the support ring may be limited by screws **31**, or that the support ring may be fixed in a definite position by adjustment of these screws, and that the support ring eccentricity and hence the volume pumped may be regulated automatically by means of the hydraulic cylinder **32** and spring **33**. The present invention is not concerned with the particular method employed for adjusting the position of the support ring. It will be noted, however, that the fulcrum mounting F as above described permits a pivoting or rocking movement of the support ring in the plane of Figure 4 and also permits tilting movement thereof in an axial plane. The mechanism G does not interfere with such movement, by reason of the fact that the screws **30** act against surface **35** of the block **30**, permitting relative sliding movement, while the cylinder **32** and spring **33** act through knife edges **36** which engage in notches in the member **30** and permit similar sliding movement.

Rotor seals at intake and discharge end

The space within the track ring is closed off at one end by means of a pair of ring shaped elements **37** and **38** (Figure 5). The element **37** is formed as a washer having a flange **39** and abuts against an inward extension **40** of the main casing **2**. A seal between the main casing **2** and the washer **37** is provided by means of an O-ring **41**. The member **38** (Figure 8) has a generally flat portion **42** seated against the member **37** but slidable radially with respect thereto, and abuts against an end member **21** (Figure 5) of the track ring as shown. An O-ring **43** is held between the member **38** and member **21** to provide a seal. The rotor B is pressed against member **38** by means later described, and the face of member **38** against which the rotor is pressed is formed with grooves **50** (as best shown in Figures 7 and 8), these grooves permitting escape of oil into the space between the rotor and the track ring. Grooves **50** prevent axial thrust on the rotor due to high pressure oil between the same and the elements **37** and **38**. Lubrication of the antifriction bearings **24** by means of leakage oil is provided for by holes **51** in the members **21** or suitable other means.

Rotor drive

The rotor is driven by drive shaft **60** (Figure 5) carried in an end casting **61** fastened to the main casing **2**, and by means now about to be described. The drive shaft **60** is splined as indicated at **62** to a hollow shaft **63** journaled in the casting **61** at **64**. A spring **65** urges shaft **60** inwardly of the housing, acting through a thrust member **66** which is faced with bearing material **101** which substantially forms a fluid seal with the outboard end of shaft **63** to effect a running fluid seal therebetween. A static seal is provided by an O-ring **67**, as indicated. The rotor is driven from hollow shaft **63** by an Oldham coupling, the parts of which are shown in detail in Figure 6. As there shown, the body **10** of the rotor is formed with a pair of projections **70** adapted to fit in slots or grooves **71** of a cup shaped intermediate member **72**, while the shaft **63** is enlarged as indicated, and has a pair of projections **73** which enter slots **74** in the member **72**. The end of shaft **63** is formed generally as a disc **75** engaging a flat face **76** of the member **72**. Flat face **77** of this member in turn engages the generally flat end **78** of the rotor body **10**. This form of coupling permits the reqquired small universal movement between the drive shaft **63** and the rotor.

Scavenger pump

The scavenger pump rotor H (Figure 5) has a hub **80** fastened to the shaft **63** by a pin **81** and has a generally cup-shaped form. The face **82** is solid except for intake apertures **83** and the periphery has a number of openings or passages **85** through which the leakage oil is pumped. Casting **61** forms a closure for the outer face of the scavenger rotor as indicated at **86**, and a passage or conduit **87** communicates with the space **88** at the bottom of the casing for sucking leakage oil up into the scavenger rotor. The scavenger rotor acts as centrifugal pump and discharges oil through passage **89** into the space **90** within the end casting **61** at the drive end, whence it passes through conduits **91** and passes check valves **92** to discharge. Valves **92** are loaded by springs **93**, so as to maintain slightly higher than atmospheric pressure in the space **90**, thus preventing the sucking in of air through any points of leakage which may exist. The oil discharged through the conduits **91** may be returned to the reservoir or conducted into the intake **3**, as desired.

By use of the sealing members herein referred to at each end of the main rotor, a reasonably fluid tight cavity is provided having as its only exit the slots or apertures **83**. This results in continuous autopriming of the scavenger rotor H assuring an induced flow of bearing lubricating fluid out of space **88** thus maintaining the main housing clear of fluid at all times.

Seals at scavenger end of the rotor

Reference is now made to Figures 5 and 9. At the scavenger end of the main rotor, ring shaped elements **95**, **96** and **97** cooperate to form a seal. The element **97** is angular in section and is fastened to the scavenger rotor hub **80** as shown. If desirable the element **97** may be integral with the hub **80**. Element **96** is loose and is sealed to the element **97** by means of an O-ring **100**. Element **95** has the form of a washer and fits within the anti-friction bearing **24** and against track ring member **21**. Since element **95** is slidable with relation to element **96**, transverse movement of the track ring (as for example during stroke variation) is not interfered with while a sufficient seal is provided. A corrugated annular spring **102** holds **96** against **95**. It should be added that the O-ring **100** is pressed in position so that it provides a frictional driving connection between elements **96** and **97**.

Track ring adjustment

The mechanism indicated at G serves to pivot the support ring and track ring about the fulcrum F, in the plane of Figure 4, so as to vary the stroke of the pistons and hence the volume delivered by the pump. The effective moments involved in this action are shown diagrammatically in Figure 2, in which the abscissa reads in percentage of maximum stroke for which the pump may be set and the ordinate reads in inch pounds of moment about the fulcrum. Figure 3 indicates the direction of the forces resulting in the moments of Figure 2. In that figure also, the center of the pintle and rotor is indicated at O, while the center of the track ring in a given position of displacement is indicated at O′. The arrows F_s and F_h indicate the forces applied by the spring **33** and hydraulic cylinder **32**, the arrow F_c indicates the centrifugal forces resultant and the arrow F_p indicates the resultant force which is the vector sum of the various piston head forces plus other forces on the track ring such as torque, sliding friction of pistons etc. Similarly, in Figure 2, the moments M_s and M_c are the moments (clockwise) due to the forces F_s and F_c, while the moments M_p and M_h are the moments (counterclockwise) due to the forces F_p and F_h. While, as indicated in Figure 2, the moments corresponding to these various forces may be balanced about the fulcrum, there is a large force corresponding to the resultant of the forces F_p and F_c directed in a generally upward direction against the pintle. With discharge pressures of the order of several thousand pounds per square inch, the force on the pintle is sufficient to deflect it upwardly, lifting its free end by an appreciable amount. The spherical and sliding seating of the fulcrum and support ring permits a corresponding tilting of the support ring and track ring so as to maintain the rotor in a truly concentric position on the pintle without increasing the load at the running surfaces. The support ring and track ring are entirely positioned by the piston heads in their grooves so that proper alignment of the piston heads in their grooves is free of interference. This naturally follows since the support ring and the track ring are permitted to follow rotor tilting. The seals described above provide for and permit this movement. With reference to the transverse movement of the support ring and track ring, it will be apparent that members **42** and **95** may slide on members **37** and **96** without disturbing the seal. The tilting movement, which may be very small, is also permitted since member **38** is permitted a small axial movement with respect to member **21** as also is member **96** with respect to the face of scavenger rotor H as permitted by corrugated annular spring **102**.

Operation of the scavenger

Scavenger H operates as before stated as a scavenger pump, sucking in internal seal leakage and bearing lubricating oil up from the bottom of the casing through passage **87** and discharging it through passage **89**. Confining the leakage oil in the space around the pump rotor where it may flow through passages **83** into the scavenger H keeps this element primed at all times, thus maintaining a suction in the passage **87** and preventing undue accumulation of oil in the pump housing. As will be apparent, it is not essential that the seals around the pump rotor be completely effective and the leakage past these seals into the casing generally may equal or exceed the amount of leakage oil retained within the seals, since it is only necessary that sufficient oil be retained to prime the scavenger pump.

Although only one embodiment of this invention has been illustrated and described herein, it will be evident that various changes and modifications can be made in the shape and arrangement of the various parts without departing from the scope of this novel concept.

What is claimed is:

1. In a radial piston rotary pump, a casing, a pintle mounted in the casing and a pump rotor rotatable thereon, a drive shaft for the pump rotor passing through the casing for connection to an external drive, a seal for preventing passage of fluid through the casing around the drive shaft thereby retaining leakage fluid within the casing and in a space surrounding the rotor, a pocket in the casing surrounding the seal, a scavenger rotor driven by the drive shaft for pumping oil leaking from the pump rotor, a discharge passageway for the scavenger rotor communicating with the said pocket, and a discharge passage from the said pocket, whereby

oil pumped by the scavenger rotor may surround the drive shaft seal at pressures higher than atmospheric to prevent intake of air therethrough.

2. The combination according to claim 1, comprising also a check valve in the discharge passage from the pocket for resisting flow therefrom and maintaining a pressure higher than atmospheric therein.

3. In a radial piston rotary pump, and in combination, a pintle, a pump rotor rotatable thereon, a stop for limiting axial movement of the rotor on the pintle, a spring for urging the rotor toward the stop, and sealing means for retaining leakage fluid within a space around the rotor and including a washer element surrounding and movable transversely of the pintle and interposed between the rotor and the stop.

4. The combination according to claim 3, in which the washer element has channels for permitting flow of oil outwardly from the pintle.

5. The combination according to claim 3, comprising also a second washer element interposed between the stop and the first mentioned washer element, and a resilient sealing element between the stop and the second washer element.

6. In a radial piston rotary pump having a casing, a pintle mounted in the casing, a pump rotor rotatable thereon, a rotatable track ring and pivotally mounted support ring for the track ring, and in combination, sealing means for retaining oil in a space around the rotor and within the track ring, a centrifugal scavenger rotor coupled to the pump rotor for rotation therewith, said sealing means sealing the space around the pump rotor from said scavenger rotor, and an intake for said scavenger rotor communicating with the said space, and a passage providing fluid communication between the scavenger rotor intake and the pump casing outside the said space for pumping leakage oil therefrom.

7. The combination according to claim 6, in which the sealing means comprises means for sealing the track ring to the scavenger rotor.

8. The combination according to claim 9, in which the seal between the track ring and rotor comprises a washer movable with the track ring, an annular member slidably engaging against the

washer and against the scavenger rotor, and resilient means for sealing the said annular member to the scavenger rotor.

9. The combination according to claim 8, in which the resilient means is compressed radially.

10. The combination according to claim 6, comprising also a spring for urging the rotor axially of the pintle, and a stop for limiting movement of the rotor thereon, and in which the sealing means comprises a member transversely movable with and sealed to the track ring and having a washer shaped portion interposed between the rotor and the stop.

11. The combination according to claim 10, in which the said washer shaped portion has channels for permitting flow of fluid outwardly from the pintle.

12. The combination according to claim 10, comprising also a resilient sealing ring compressed radially between the said member and the track ring.

13. The combination according to claim 12, comprising also a washer interposed between the said member and the stop and a resilient sealing ring for sealing the said washer to the stop.

14. In a radial piston rotary pump having a casing, a pintle mounted in the casing, a pump rotor rotatable on said pintle, a rotatable track ring surrounding said rotor forming a chamber therebetween, sealing means for retaining leakage fluid within the chamber, a centrifugal scavenger rotor externally of said chamber, and an intake for the scavenger rotor communicating with said chamber for pumping leakage fluid therefrom.

15. The combination according to claim 14 wherein said casing forms a second chamber with said track ring which receives leakage past said sealing means and a passageway provides fluid communication between said second chamber and the intake of the scavenger rotor.

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