

Sept. 29, 1953

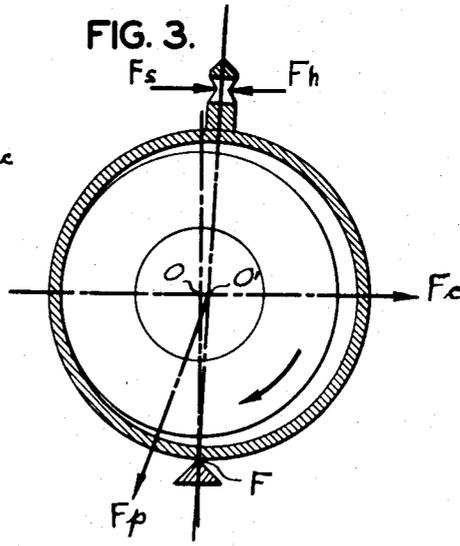
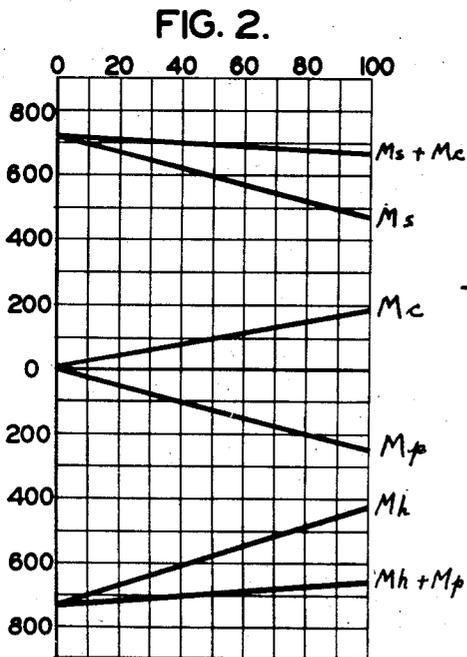
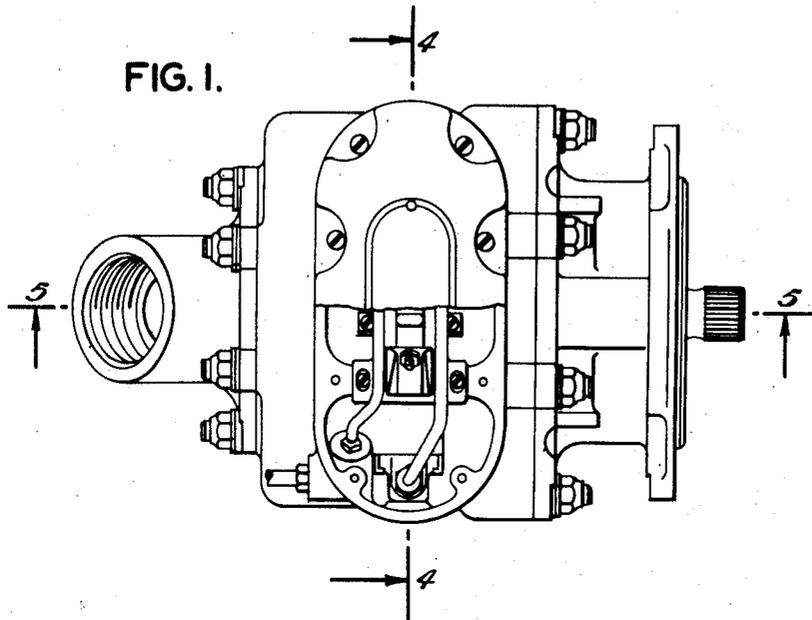
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2,653,542

RADIAL PISTON ROTARY PUMP

Filed March 24, 1951

4 Sheets-Sheet 1



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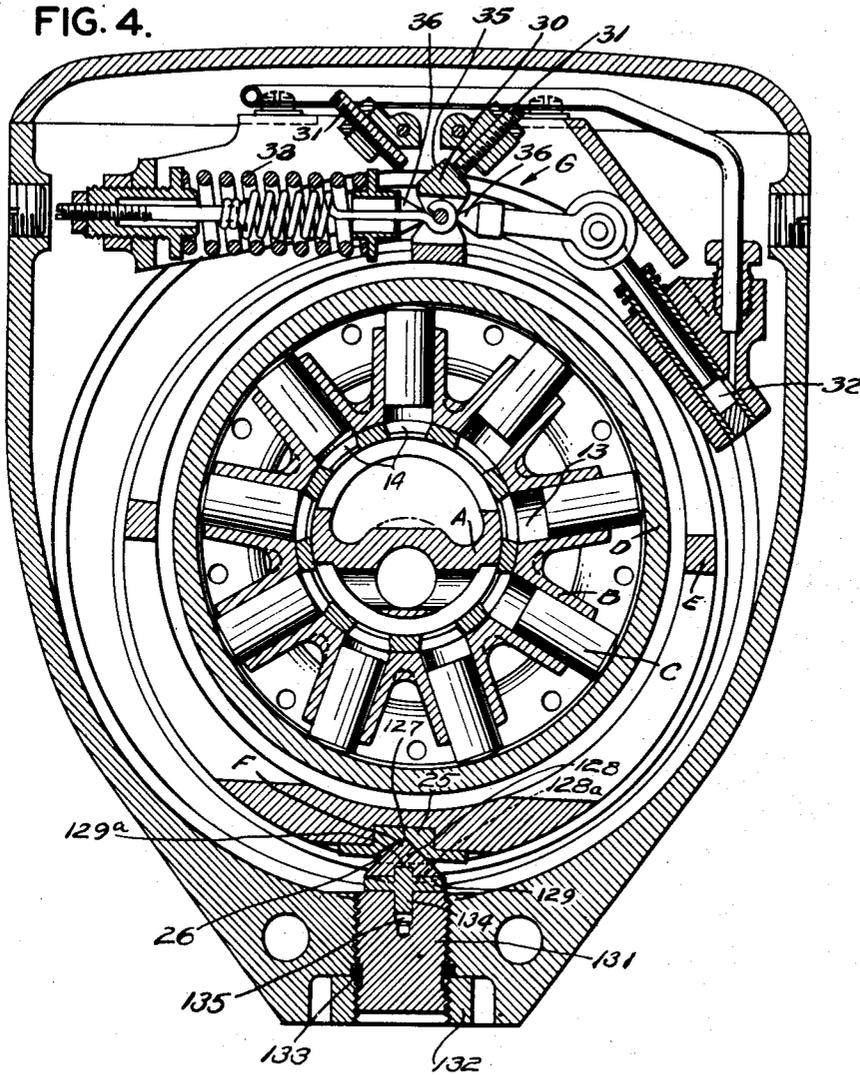
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4 Sheets-Sheet 2

FIG. 4.



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4 Sheets-Sheet 3

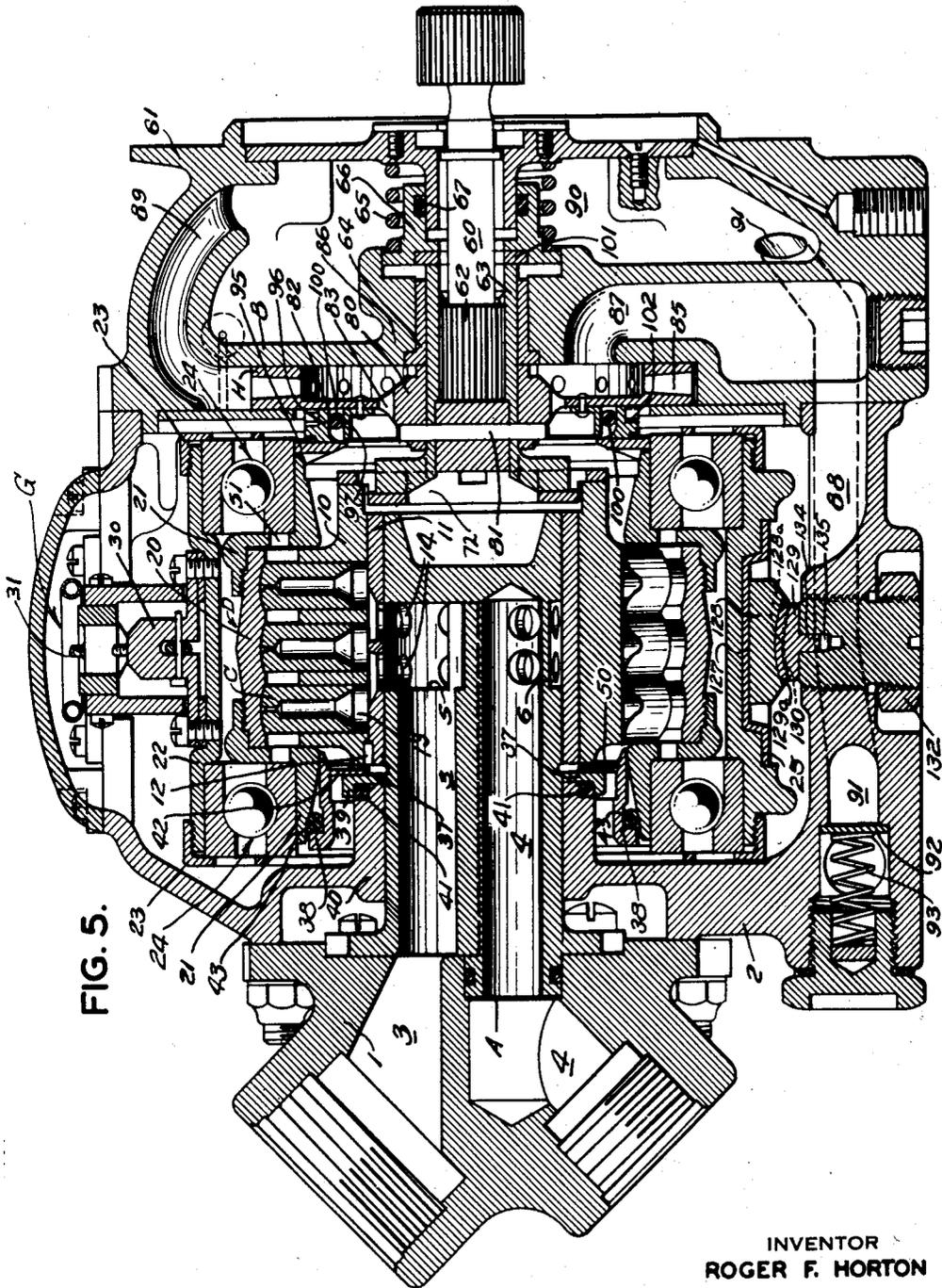


FIG. 5.

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2,653,542

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4 Sheets-Sheet 4

FIG. 6.

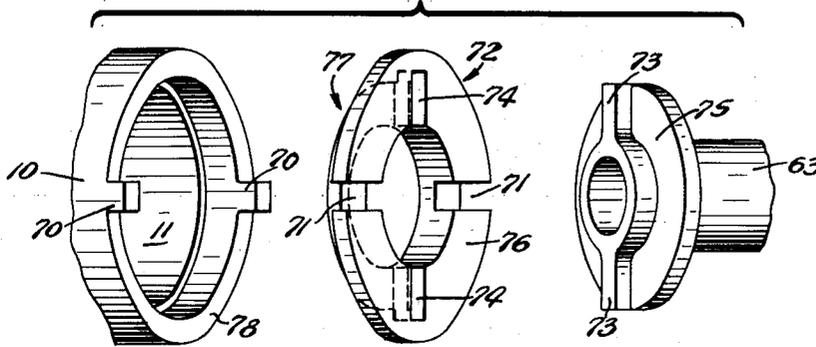


FIG. 7.

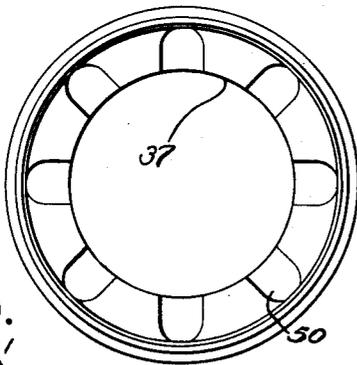


FIG. 8.

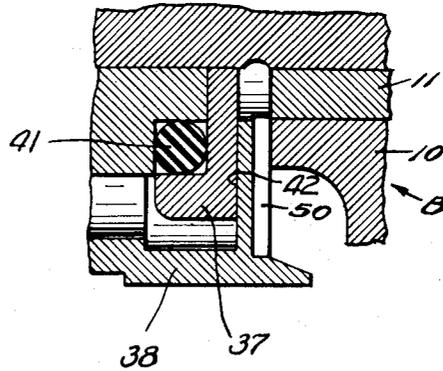
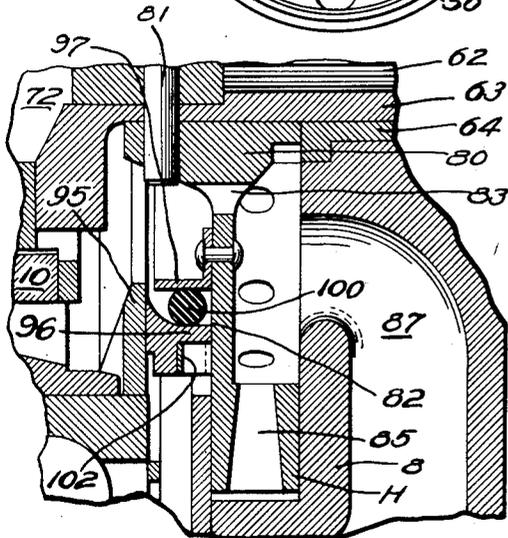


FIG. 9.



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RADIAL PISTON ROTARY PUMP

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15 Claims. (Cl. 103—4)

1

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 reciprocally mounted in the rotor with their ends against a track ring D, which, in turn, is carried in a support ring E by antifricition bearings. The support ring is pivoted on a fulcrum block F and its eccentricity with relation to the pintle and rotor is con-

2

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 reciprocally 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 128a formed in the lower portion of element 128 and a cooperating arcuate tongue 129a 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 required 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

7

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

8

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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Number	Name	Date
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