March 30, 1954

R. F. HORTON

SUPPORT RING MOUNTING FOR ROTARY RADIAL PISTON PUMPS OR MOTORS

Filed Sept. 27, 1950

2,673,526

3 Sheets-Sheet 1

FIG. 1.

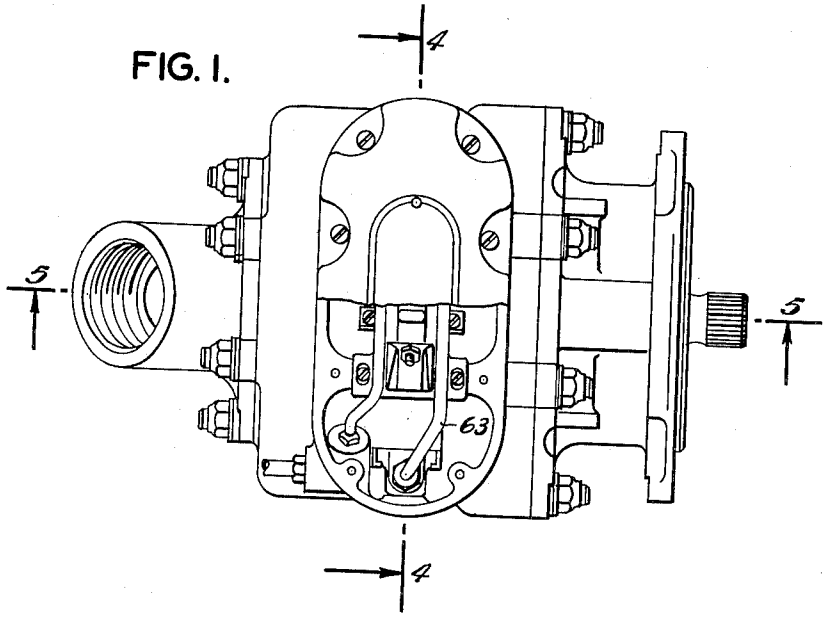


FIG. 2.

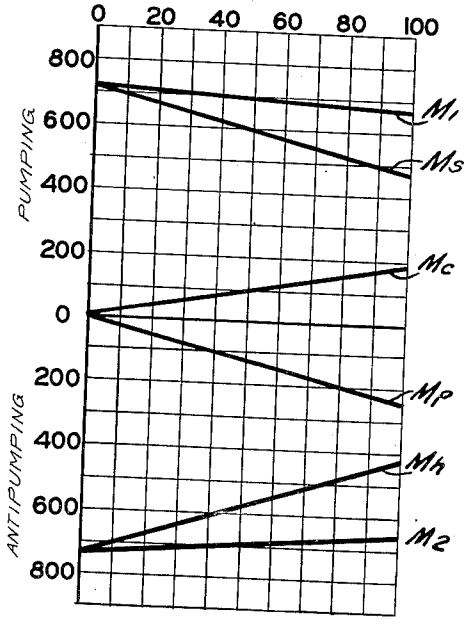
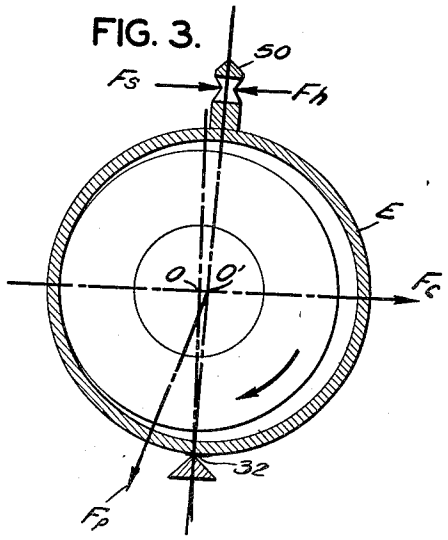


FIG. 3.



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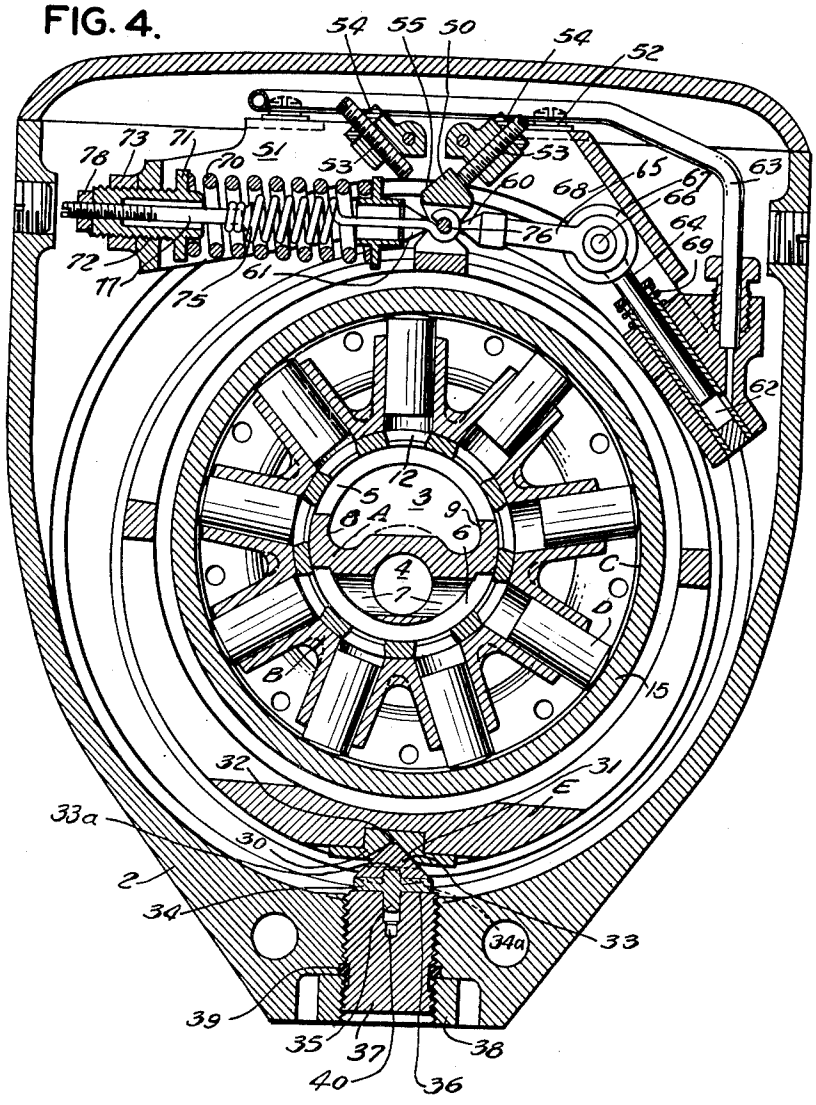
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Filed Sept. 27, 1950

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FIG. 4.



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SUPPORT RING MOUNTING FOR ROTARY RADIAL PISTON PUMPS OR MOTORS

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Filed Sept. 27, 1950

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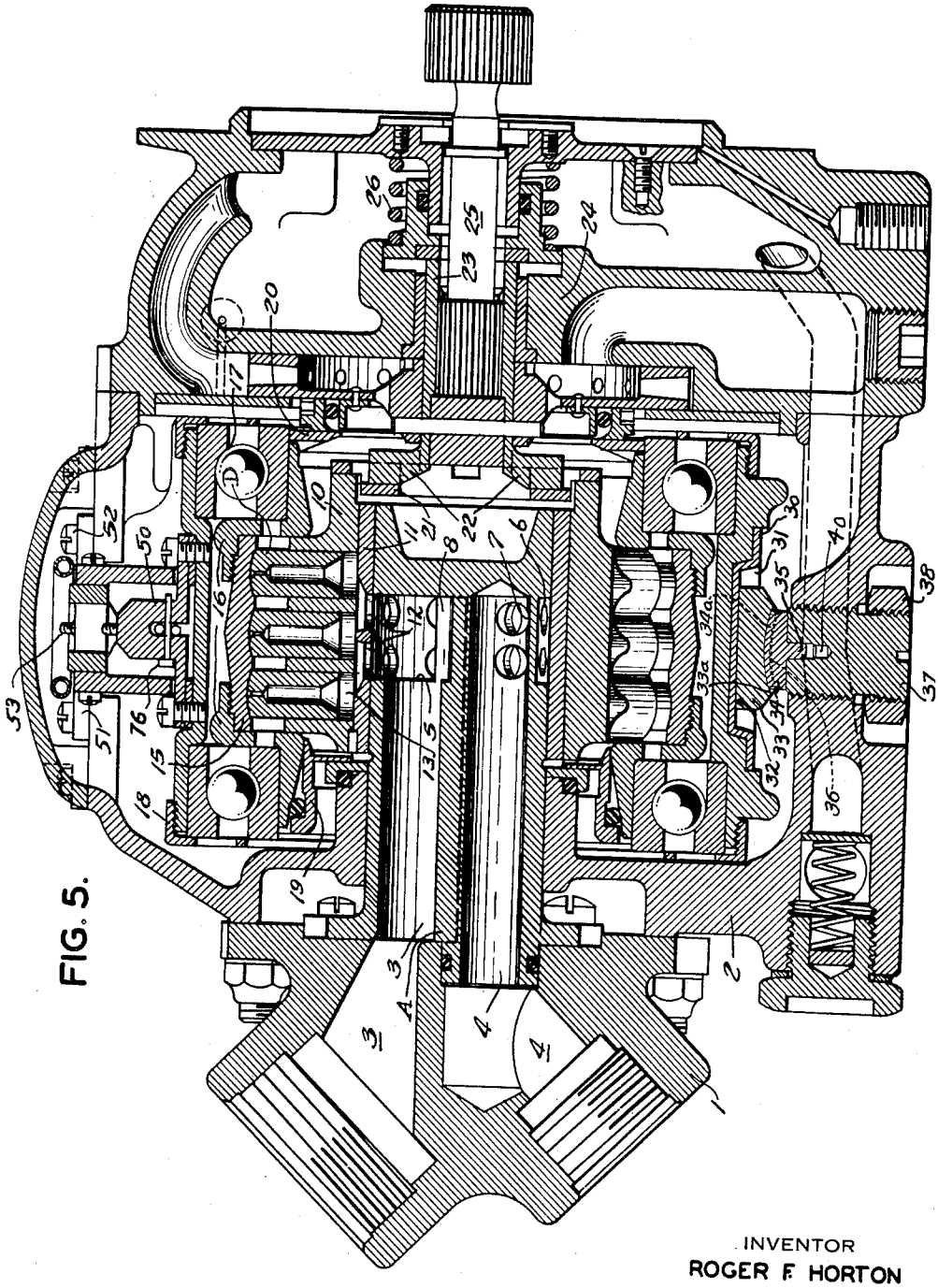


FIG. 5.

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Patented Mar. 30, 1954

2,673,526

UNITED STATES PATENT OFFICE

2,673,526

SUPPORT RING MOUNTING FOR ROTARY RADIAL PISTON PUMPS OR MOTORS

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Application September 27, 1950, Serial No. 187,030

8 Claims. (Cl. 103—161)

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This invention relates to improvements in rotary piston pumps or motors and more particularly in support ring mountings therefor.

The invention is concerned with pumps or motors in which the stroke is regulated by means of a pivotally mounted track ring, and it is an object of the invention to provide an improved pivotal mounting.

Another object of the invention is to permit the rotor to rotate freely and concentrically on the pintle, despite deformation of certain parts of the device due to the hydraulic pressures involved.

Further objects of the invention are to provide improved pressure control for regulating the action of a variable delivery pump and to provide a pressure control which does not interfere with the accommodation of the rotor to deflection of the pintle.

With these objects, and still other objects which will appear in the following description in mind, a pump embodying the invention in a preferred form of embodiment will now be described with reference to the accompanying drawing and the features constituting the invention will then be pointed out in the appended claims.

In the drawing:

Figure 1 is a plan view of the pump, part of the cover plate being removed;

Figure 2 is moment diagram;

Figure 3 is a force diagram showing the forces producing the moments of Figure 2;

Figure 4 is a section on the line 4—4 of Figure 1, and on a larger scale; and

Figure 5 is a section on the line 5—5 of Figure 4.

The principal pump operating elements include the pintle A, on which the rotor B rotates and in which the intake and discharge ports are formed; the track ring C, against which the ends of the rotor pistons D bear; and the support ring E, in which the track ring is rotatably carried.

Pintle A is bolted to and supported by an end casting 1 (Figure 5), which in turn is fastened to the main housing casting 2 as by studs and nuts. The fluid pumped, which usually will be oil, is supplied through intake passage 3 and discharged through passage 4. Intake 3 leads to a suction port 5 and discharge 4 connects to a discharge port 6 through bores 7. These ports are formed in the pintle A, as indicated, and are separated, circumferentially, by lands 8 and 9 (Figs. 4 and 5).

The rotor B is formed, for convenience of manufacture, as a main body 10 and a liner 11 fastened therein so that the two parts form a single rigid structure. A pair of apertures 12 in the liner serves a group of three pistons D reciprocably mounted in cylinder bores 13 in the body 10, the pistons comprising the group being aligned in spaced relation along the pump axis. Hydraulically, each pair of apertures 12 is equivalent to a single opening and the three pistons D served thereby are equivalent to a single piston of corresponding area and stroke. As is apparent from Figure 4, a single piston of corresponding area would subtend an excessive arc and create difficulty in providing sufficient rotor strength, or would require an increase in the pintle diameter and overall pump size and weight. There are also considerations affecting the choice of piston stroke, as pointed out hereinafter. Nine groups of pistons are provided, as indicated in Figure 4.

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The track ring C includes a center member 15 to which are screwed a pair of end members 16 (Fig. 5) which include outwardly protruding flanges forming annular L-shaped supports. The track ring is supported by means of anti-friction bearings 17, the inner races of which fit into members 16 as indicated and the outer races of which are held in the support ring E by end caps 18 screwed onto the latter. The space within the track ring and around the pintle is sealed by sealing assemblies at 19 and 20 located adjacent the anti-drive and drive ends of the rotor respectively. These sealing assemblies are described in detail in my application for Scavenging System for Radial Piston Rotary Pumps filed as application Serial No. 217,340 on March 24, 1951, which matured into Patent No. 2,653,542 dated September 29, 1953, and will not be described in detail herein, it being sufficient to note that the nature of the seals is such that they do not interfere with the movements of parts as described below.

The rotor is driven through an Oldham coupling, having a cup-shaped intermediate member 21 and driven by lugs 22 carried on a hollow shaft 23 journaled in the drive end closure or casting 24 which is fastened to the main casing 2 as by studs and nuts (Figure 1). The hollow shaft 23 is driven by drive shaft 25 splined thereto and is pressed inwardly by a spring 26. These elements as well as other drive end structures are fully described in my said application for Scavenging Systems for Radial Piston Rotary Pumps, and will not be further described herein, since their specific form does not affect the present invention. It is sufficient to note that the structure is such as to permit the movement of parts as described below.

A block 30 is fixed in the lower part of support ring E and is formed with a concavity 31, triangular in cross section, for cooperating with a bearing edge or fulcrum 32 of the lower pivoted support.

For convenience of manufacture the pivot is formed of a pair of elements 33, 34 positioned relative to each other by an arcuate slot 33a formed in the lower portion of element 33 and a cooperating arcuate tongue 34a protruding from the element 34, forming a pivot combination having the fulcrum edge 32 at its top and an

arcuate bearing surface 36 between the elements 33, 34. The pivot 33, 34 sits in a bearing seat formed in the upper end of a screw plug 37. This plug is received in a correspondingly threaded bore in the main casing 2. By turning the plug 37 the height of fulcrum 32 may be adjusted, and the plug is held in adjusted position by a lock nut 38. An O-ring 39 may be utilized to seal against leakage at this point.

Pin 35 which is integral with the element 34 extends downwardly into a bore 40 in the plug 37. The pivot elements 33, 34 permit the support ring E to be rocked about the fulcrum or knife edge 32 by the stroke control mechanism described hereinafter. As the support ring is rocked about the fulcrum 32 the elements 33, 34 will form an absolutely rigid support in the plane of the rocking. This is best seen by referring to Fig. 4 when it is noted that the elements 33, 34 are keyed together against movement in this plane.

However, under load should the pintle deflect, the rotor, the 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 32, the elements 33, 34 permit relative adjustment therebetween on the arcuate surface 36 (Fig. 5) to accommodate the aforementioned deflection.

The pivotal position of the support ring E eccentric to the pintle axis is regulated by a pressure control mechanism acting on a block 50 fixed to the top of the support ring. This mechanism is mounted on a frame structure 51 fastened to casting 2 by screws 52. It includes adjustable stop screws 53 provided with lock nuts 54, and acting against bevels 55 at the top of block 50. These screws may be set so as to hold the support ring in a definite angular position on its fulcrum 32, where constant displacement operation is desired, or may be set, as shown, to limit the movement of the support ring within a desired range.

The automatic pressure control mechanism comprises opposed knife edge members 60 and 61 thrusting against notches in the sides of block 50. Member 60 applies a force varying with the pump discharge pressure and member 61 applies an adjustable spring force. The knife edge members 60, 61 it should be noted as well as the block 50 have lateral dimension to permit relative lateral movement without becoming disengaged to accommodate the above-mentioned support ring tilting.

A small hydraulic cylinder 62 is connected to discharge as by tubing 63 (Figures 4 and 1) and operates hydraulic plunger 64. Link 65, pivotally connected to plunger 64 at 66, carries the knife edge 60. A roller 67, coaxial with the hinge axis of members 64 and 65, thrusts against a cam surface 68. Backlash is taken up by a small spring 69 when there is no pressure against the hydraulic plunger as when the device is not operating. The parts are so dimensioned and positioned as to apply a counterclockwise movement to the support ring, which movement is a desired predetermined function of discharge pressure and support ring position.

A compression spring 70 presses knife edge 61 against the block 50. The spring pressure is adjusted by means of thrust member 71 which is threaded and carried in a threaded bore 72 in the frame 51. Lock nut 73 holds the member 71 in adjusted position. Tension spring 75 may be used to offset certain forces in spring 70 to obtain certain types of discharge pressure-flow relationships. One end of this spring passes through an opening through the knife edge 61 and hooks around a pin 76 in the block 50 and the other end is attached to a screw threaded rod 77. Rod 77 is carried in a threaded bore in the member 71 and is fixed in adjusted position by a lock nut 78.

The forces acting in the track ring are represented schematically in Figure 3, and the corresponding moments about the support ring fulcrum in Figure 2. In Figure 3 the arrows F_s and F_h represent the forces applied by the spring 70 and hydraulic cylinder 62 respectively in the pressure control. These forces have a relatively large and substantially constant moment arm about fulcrum 32 which moment arm is somewhat longer than the track ring diameter. Arrow Fc represents the centrifugal force resultant, acting in the direction indicated and having a substantially constant moment arm which is equal to about half the support ring diameter. Arrow F_p indicates the pressure resultant force due to the hydraulic pressure forcing the piston heads against the track ring. This force has a variable moment arm about the fulcrum 32. No attempt is made in the figure to indicate the magnitudes of the forces involved, but only their directions and moment arms.

In Figure 2 the abcissa represents the support ring eccentricity, or distance between the pintle center O and support ring center O' (Figure 3), as percentage of maximum eccentricity for which the pressure control mechanism is set. The ordinate represents moments about the fulcrum 32 in inch pounds, for a pump chosen by way of example.

The lines M_s, M_h, M_p and Mc represent the moments corresponding to the forces F_s, etc. of Figure 3.

The spring moment M_s is shown as somewhat over 700 inch pounds (clockwise) at zero eccentricity and drops linearly as the eccentricity increases, in accordance with Hooke's law. The centrifugal force moment Mc results from the fact that the pistons are rotating at constant angular velocity about the center O but are at different distances from that center. The resultant pressure on the track ring thus increases with increasing eccentricity. Where the eccentricity is zero, this moment is likewise zero, and it increases to a value of nearly 200 inch pounds (clockwise) for maximum eccentricity. The moments M_s and Mc add up to the moment M_1.

The pressure resultant moment M_p is shown as zero for zero eccentricity, since in this position the force F_p is directed through the fulcrum 32. As the eccentricity increases, the moment arm increases and at 100% eccentricity the moment M_p is shown as equalling 250 inch pounds (counterclockwise). The moment M_p results primarily from unbalanced pressures against the track ring of the pistons communicating with suction and with discharge, and may also include frictional and other moments which may be lumped together. The total counterclockwise moment, M_2, equals the sum of the moments M_p and M_h.

For given speed of rotation, the moments M_h and M_p are functions of discharge pressure as well as displacement. Figure 2 assumes a constant discharge pressure which may be, for example, 3,000 pounds per square inch, and shows equal and opposite total moments M_1 and M_2 through a range of support ring eccentricity. Assuming the mechanism is set for 3,000 pounds

per square inch discharge pressure, and that an increased volumetric load is applied, as for example, by opening the valve to a hydraulic actuator, the decrease in external hydraulic resistance will tend to lower the discharge pressure. Both of the counterclockwise or anti-pumping moments M_p and M_h will tend to drop correspondingly, so that clockwise or pumping moment M_1 exceeds the anti-pumping moment M_2. Support ring E accordingly moves clockwise to a position of greater eccentricity such that the increased volumetric rate of discharge into the lower external resistance raises the discharge pressure to the set value. Decreased load operates in the reverse direction, so that the system automatically accommodates to variations in the external load.

The system, as described, is thus designed for constant pressure output over a range of varying rates of delivery of the fluid. Where different pressure delivery relationships are desired, the moment M_2 may be made a different function of the discharge pressure and eccentricity by varying the form of the cam surface 68. Theoretical consideration of the form of this surface is unnecessary as it can be determined graphically for a desired moment in the usual manner for laying out cam profiles.

The flexibility of the system herein described is readily apparent in that an arrangement is possible whereby the force F_h can be provided by a separate and independent system. Thus the independent system may be provided with hydraulic pressure from a separate and conventional pump while the herein described system would obtain pressure from the pump of this invention. Then by connecting the pressure control sensing line 63 into the independent system the latter can control the pressure-discharge rate relationships of the system herein shown.

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 it is desired to obtain by Letters Patent is:

1. In a radial piston rotary pump having a pintle, a rotor rotatable about the pintle axis, cylinders formed in said rotor and pistons reciprocably carried in said cylinders and having respective heads therefor, a track ring surrounding and engaging the heads of the pistons for operating the same, a support ring for the track ring, and pivot means for permitting the support ring to swing transversely of the pintle axis and tilting with respect to said axis in the plane thereof, comprising a pivot element having a fulcrum supporting the support ring for swinging transversely of said axis, a lower surface on said element having a curve in one plane, a member having formed therein a seat to engage said curved surface, the face of said member opposite said seat being flat transversely of said plane, and means to support said member.

2. In a radial piston rotary pump having a pintle, a rotor rotatable thereon, cylinders formed in said rotor and pistons reciprocably carried in said cylinders and having respective heads therefor, a track ring surrounding and engaging the heads of the pistons for operating the same, a support ring surrounding the track ring, means rotatably mounting the track ring within the support ring, means pivoting the support ring for swinging transversely of the pintle axis including a pivot element having a fulcrum supporting the support ring and having an arcuate lower surface, and a member having formed therein a seat for said arcuate surface, said pivot element and said seat including a tongue and groove arrangement whereby slight relative movement between the pivot element and said seat is permitted in the plane of the arc of said arcuate surface.

3. A combination according to claim 2 comprising also a pin integral with said seat member, a member adjustably fixed relative to said support ring and element, said last recited member having a bore receiving said pin for positioning said seat.

4. In a radial piston rotary pump having a track ring and a support ring therefor, a support ring pivot comprising a pivot block having a fulcrum edge formed on one of its sides to engage a fulcrum seat formed in the support ring, an arcuate supporting surface formed on another side of said pivot block, a member having an arcuate seat engaging said surface, and means for limiting movement of said surface with respect to said seat.

5. A support ring pivot according to claim 4 including a fixed member engaging said seat carrying member, and means for positioning said seat carrying member with respect to said fixed member.

6. In a radial piston rotary pump having a track ring and a support ring therefor, a support ring pivot comprising a two element pivot block, a fulcrum edge engaging said support ring and carried by one of said elements, an arcuate mating surface between said elements permitting limited movement of said one element in the plane of the arc, a fixed member engaging the other of said elements, and means for positioning said other element with respect to said member.

7. A support ring pivot according to claim 6 wherein said positioning means comprises a pin carried by said other element and received by said member.

8. In a radial piston rotary pump having a pintle, a rotor rotatable about the pintle axis, cylinders in said rotor and pistons carried in said cylinders and having heads therefor, a track ring surrounding and engaging the heads of the pistons for operating the same, a support ring for the track ring, a pivot engaging said support ring, means for positioning the support ring for swinging transversely of said axis about said pivot, said positioning means including a piston, a pair of pivotally joined links one of which is operatively connected to said piston and the other of which engages said support ring, a roller carried at the pivot of the links, and a cam surface engaging and controlling said roller.

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