June 7, 1966 J. N. MAZUR 3,254,570

MOTOR

Filed March 26, 1964 2 Sheets-Sheet 1

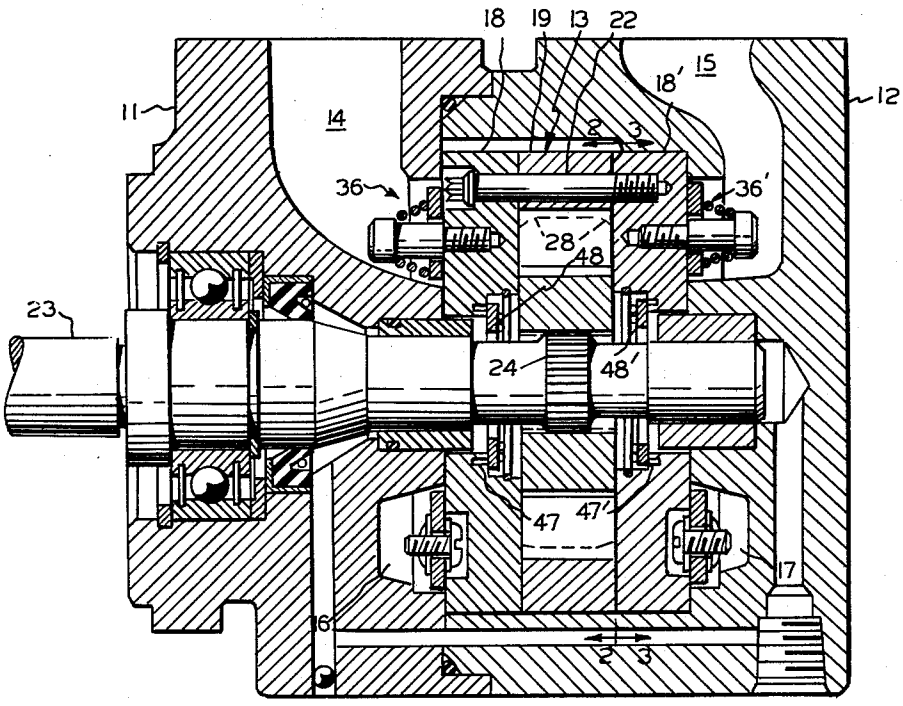


FIG. 1

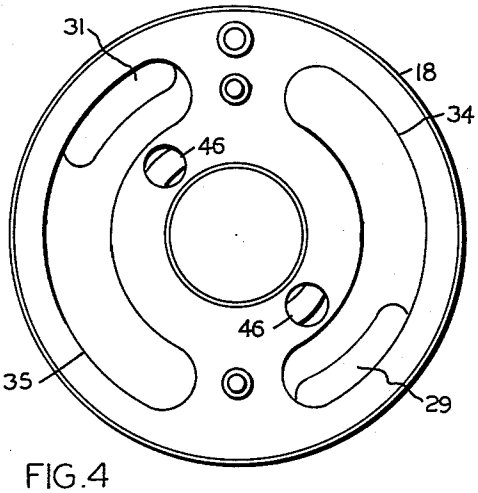


FIG. 4

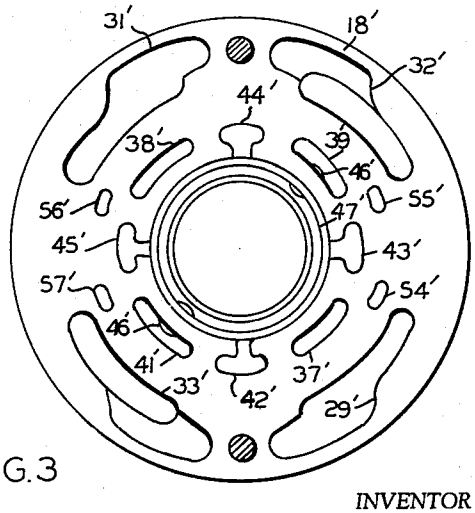


FIG. 3

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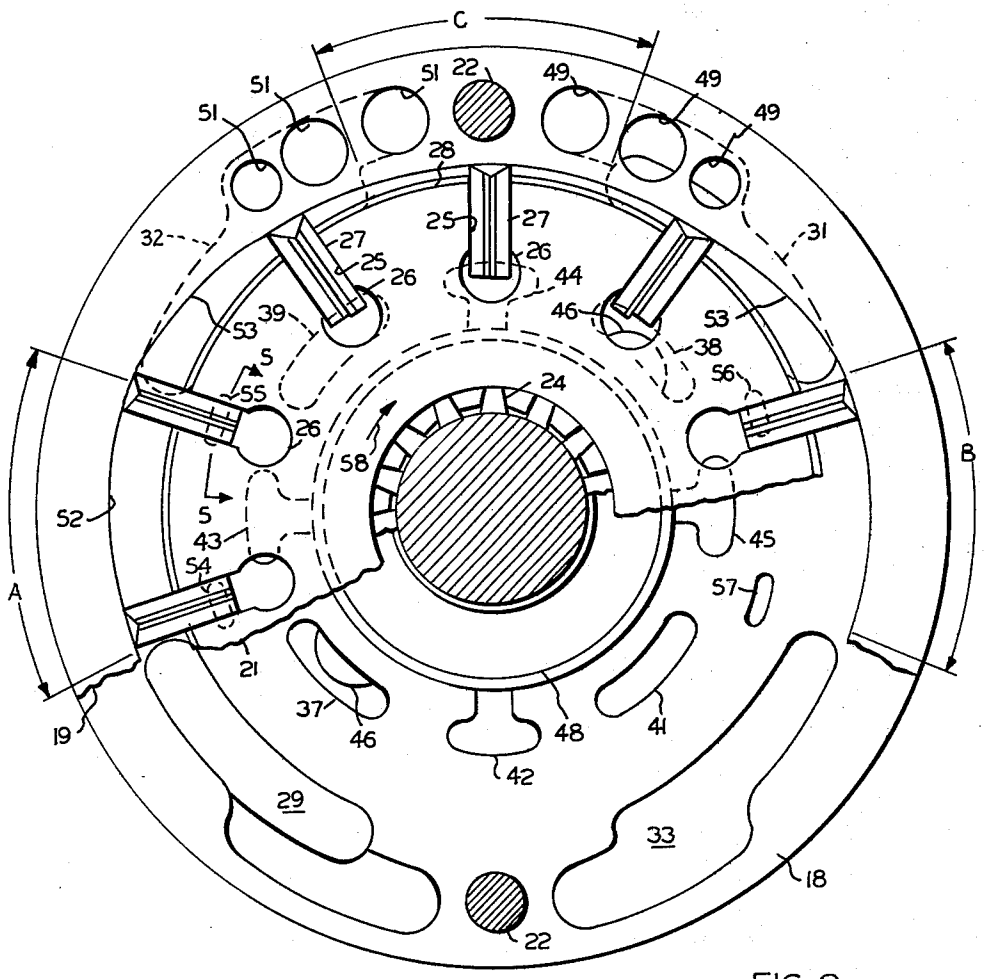


FIG. 2

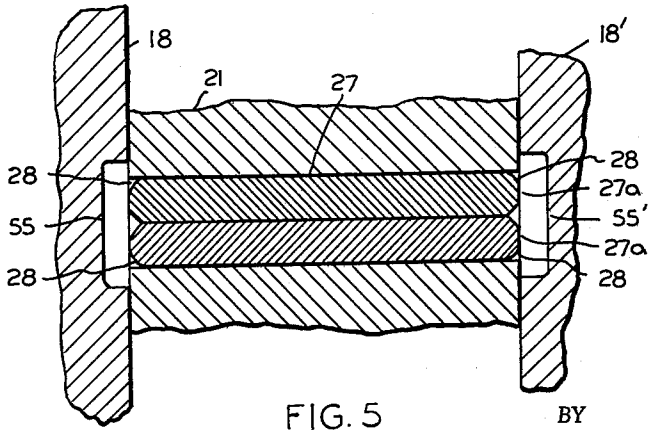


FIG. 5

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MOTOR

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3 Claims. (Cl. 91—138)

This invention relates to rotary hydraulic motors of the vane type having fluid pressure biased vanes.

In motors of this kind, it is common practice to vent the space in each vane slot beneath the vane as the vane moves through the discharge or low pressure zone. This allows the vane to be retracted freely by the cam ring and thus minimizes wear of the cam surface. However, it has been found that use of this scheme sometimes causes fluctuations in the torque output of the motor. This is attributable to the fact that as the vane enters the discharge zone, the intervane working space behind it is still at a high pressure. Thus, when the space beneath the vane is suddenly vented, the pressure in the working space forces the vane inward away from the cam ring.

The object of this invention is to provide an improved vane motor including means for eliminating the vane separation problem in the region of the entrance to the discharge zone. According to this invention, the motor includes means for venting to the discharge zone the intervane working space behind each vane as the vane approaches that zone and before the space at the inner end of its vane slot is vented. This means is rendered effective after the intervane working space behind the vane is isolated from the high pressure inlet zone by the next succeeding vane, and, therefore, it insures that the outer tip of the vane will not be subjected to a high pressure when its inner end is vented. Since the invention reduces the pressure that develops the inward directed force on the vane, it eliminates the vane separation problem.

The preferred embodiment of the invention is described herein with reference to the accompanying drawings in which:

FIG. 1 is an axial sectional view of a double lobe vane motor incorporating the invention.

FIG. 2 is an enlarged sectional view taken on line 2—2 of FIG. 1, some of the parts being broken away to show the front face of port plate 18.

FIG. 3 is a sectional view taken on line 3—3 of FIG. 1 showing the front face of port plate 18'.

FIG. 4 is a view showing the back face of port plate 18.

FIG. 5 is an enlarged sectional view taken on line 5—5 of FIG. 2.

As shown in the drawings, the motor comprises a housing having separable sections 11 and 12 which are joined by bolts (not shown) and which are formed to receive and hold a motoring cartridge 13. The housing is provided with a pair of ports 14 and 15 and communicating manifolds 16 and 17. Although either of the ports 14 and 15 may serve as the inlet port depending upon the desired direction of motor rotation, it is assumed in this description that port 14 is the inlet port and that port 15 is the discharge port.

Motoring cartridge 13 includes a pair of identical port plates 18 and 18', a cam ring 19, and a rotor 21, and is held together by a pair of diametrically opposed bolts 22. The rotor 21 is connected in driving relation with shaft 23 by splines 24, and is formed with ten uniformly spaced, radial slots 25 whose bases are defined by through cross bores 26 and which receive sliding vanes 27. The

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outer peripheral edges of the rotor are beveled at 28 to improve access between the ports in port plates 18 and 18' and the intervane working spaces. Vanes 27 are of the type described in Rosen Patent 2,393,223, granted January 15, 1946, and each includes a pair of identical leaves 27a. The outside edges of the vane leaves are chamfered, as by tumbling, to define with the walls of the slots 25 and the port plates 18 and 18' a restricted passage 28 (see FIG. 5) at each side of the leaf. The purpose of these restricted passages will be explained later.

The front face of port plate 18 contains two diametrically opposed inlet ports 29 and 31 which extend through the port plate, and two diametrically opposed, blind discharge ports 32 and 33; all of these ports being positioned radially to register with the intervane working spaces. The angular distances between adjacent ends of the inlet ports 29 and 31 and the discharge ports 32 and 33 are approximately equal to the intervane interval, i.e., the angular distance between the trailing edge of one vane and the leading edge of the next succeeding vane. Inlet ports 29 and 31 communicate with kidney-shaped recesses 34 and 35, respectively, formed in the rear face of the port plate, and these recesses in turn communicate with manifold 16 through the asymmetric flow valve 36. Valve 36 is of the same general type as the one described in Stewart Patent 2,808,814 granted October 8, 1957, and serves to restrict flow from manifold 16 to recesses 34 and 35 and to permit substantially unrestricted flow in the reverse direction.

The front face of port plate 18 also contains eight equispaced vane biasing ports 37, 38, 39 and 41–45 which are positioned radially to register with the cross bores 26 in rotor 21. Biasing ports 37 and 38 lie in the region of inlet ports 29 and 31, respectively, and are connected with manifold 16 via bores 46 extending through the port plate, whereas biasing ports 39 and 41 lie in the regions of discharge ports 32 and 33 and are blind. Biasing ports 42–45 also are blind but they have inward extensions that communicate with a central opening in port plate 18. These ports receive fluid from manifold 16 via bores 46, annular groove 47 and the disk check valve 48.

Since port plates 18 and 18' are identical, their porting arrangements, in the assembled condition of cartridge 13, are reversed. Thus, the ports 29', 31', 37' and 38' in port plate 18', which face the through ports 29, 31, 37 and 38, respectively, in port plate 18, are blind, and the ports 32', 33', 39' and 41', which face blind ports 32, 33, 39 and 41, respectively, open through the rear face of port plate 18' and communicate with manifold 17. The blind inlet ports 39' and 31' in plate 18' are connected with the through ports 29 and 31 in plate 18 by two sets of passages 49 extending through cam ring 19, and the blind discharge ports 32 and 33 in plate 18 are connected with the through ports 32' and 33' in plate 18' by two additional sets of passages 51 extending through the cam ring. Only two of these interconnecting sets of passages 49 and 51 are illustrated in FIG. 2.

The cam surface 52 of a cam ring 19 comprises two diametrically opposed circular arcs A and B of equal radius, two additional diametrically opposed circular arcs (one being indicated at C in FIG. 2) of equal radius which are symmetrical about an axis normal to the axis that bisects arcs A and B, and four blend curves or ramps 53 that join the adjacent ends of the four arcs. All four arcs have the same angular extent and all are centered

on the axis of rotation. However, as will be evident from FIG. 2, the radius of arcs A and B is greater than the radius of the remaining two arcs.

The motor described thus far is conventional. The improvement added by this invention consists, in the case of the illustrated double-lobe, reversible motor, of four blind ports 54–47 located in the front face of port plate 18, and four corresponding ports 54'–57' located in the front face of port plate 18'. These eight ports are positioned radially intermediate the outer periphery of rotor 21 and the inner ends of the vanes 27 when the vanes are fully extended, and are positioned circumferentially to span each van slot 25 just prior to registration of that slot with one of the low pressure biasing ports, i.e., the ports 39, 39', 41 and 41' when the rotor is rotating in the direction of arrow 58 in FIG. 2, and the ports 37, 37', 38 and 38' when the rotor is rotating in the reverse direction. The intervane interval is so selected that those ports 54–57 and 54'–57' immediately in advance of a discharge zone span a vane slot after the next succeeding vane has moved onto one of the true arcs A and B and isolated the included intervane working space from the high pressure inlet zone.

Since the illustrated motor is of the double-lobe type, and thus affords two motoring cycles per revolution of rotor 21, the description of operation will be confined only to one cycle, namely the one involving inlet ports 29 and 29' and discharge ports 32 and 32'. As the rotor 21 revolves in the direction of arrow 58 in FIG. 2, the vanes 27 in the inlet region move outward along a ramp 53 under the combined action of centrifugal force and the pressure force developed by the fluid transmitted to the inner ends of the vane slots through high pressure biasing ports 37 and 37'. Because of the presence of the asymmetric flow valve 36, the pressure acting beneath the vanes 27 is higher than the pressure in the intervane working space so the vanes in this region are maintained in sealing engagement with the cam ring. When a vane 27 moves onto the arc A, the associated cross bore 26 moves out of registration with biasing ports 37 and 37' and then into registration with biasing ports 43 and 43'. Since the ports 43 and 43' are part of a closed circuit which is maintained liquid-filled by flow from manifold 16 through check valve 48, the vanes will be held against the cam ring as they travel toward the discharge region even though the pressure acting on their outer ends is full inlet pressure.

As a vane 27 approaches the region of discharge ports 32 and 32', the associated cross bore 26 is disconnected from biasing ports 43 and 43'. Simultaneously, the port 55 spans the vane slot 25. The intervane working space behind the vane is now vented to the discharge region through the restricted passages 28 at opposite sides of the trailing leaf 27*a*, the ports 55 and 55', and the restricted passages 28 at opposite sides of the leading leaf 27*a*. Although the flow along this path is very small, being on the order of a drop of oil, it is adequate, in view of the incompressible nature of the oil and the fact that the following vane has now isolated the intervane working space from the inlet region, to drop the pressure in the intervane working space. Continued movement of the rotor 21 brings the cross bore 26 into registration with the low pressure biasing ports 39 and 39'. Since the pressure at the outer end of the vane has been dissipated, the vane is not shot inward but moves inward gradually under the action of ramp 53.

As stated previously, the drawings and description relate only to the preferred embodiment of the invention. Since changes can be made in the structure of this embodiment without departing from the inventive concept, the following claims should provide the sole measure of the scope of the invention.

What I claim is:

1. In a vane motor including inlet and discharge ports and a working chamber having inlet and discharge zones that communicate respectively with the inlet and discharge ports, a rotor located in the working chamber and containing a plurality of circumferentially spaced slots for receiving sliding vanes, and a low pressure biasing port which communicates with the space in each vane slot beneath the vane as the vane moves through the discharge zone, the improvement which comprises means for venting to the discharge port the intervane working space behind each vane as the vane approaches the discharge zone and before the associated vane slot communicates with the low pressure biasing port.

2. In a vane motor including inlet and discharge ports and a working chamber having inlet and discharge zones that communicate, respectively, with the inlet and discharge ports, a rotor located in the working chamber and containing a plurality of circumferentially spaced slots for receiving sliding vanes, transverse end wall means closing opposite ends of the working chamber, and a low pressure biasing port in the transverse end wall means and positioned to communicate with the space in each vane slot beneath the vane as the vane moves through the discharge zones, the improvement which comprises

(a) a vent port located in the transverse end wall means and positioned circumferentially in advance of the low pressure biasing port and radially between the outer periphery of the rotor and the inner ends of the vanes when the vanes are fully extended; and

(b) restricted passages associated with each vane and extending inward from the intervane working spaces ahead of and behind the vane, the passages registering with the vent port as a vane slot crosses that port to thereby vent the intervane working space behind the vane to the discharge zone,

(c) the intervane spacing being so chosen that when the restricted passages of a vane register with the vent port the intervane working space behind the vane is isolated from the inlet zone by a succeeding vane.

3. In a vane motor including inlet and discharge ports and a working chamber having inlet and discharge zones that communicate, respectively, with the inlet and discharge ports, a rotor located in the working chamber and containing a plurality of circumferentially spaced slots for receiving sliding vanes, transverse end wall means closing opposite ends of the working chamber, circumferentially spaced low and high pressure biasing ports located in the end wall means and positioned to communicate with the space in each vane slot beneath the vane as the vane moves through the discharge and inlet zones, respectively, and an intermediate pressure biasing port located in the end wall means and positioned to communicate with the space in each vane slot beneath the vane when the vane is in a transition zone located between the inlet and discharge zones, the improvement which comprises

(a) a vent port located in the transverse end wall means and positioned radially between the outer periphery of the rotor and the inner ends of the vanes when the vanes are fully extended, the vent port being positioned circumferentially to span each vane slot after the slot is disconnected from the intermediate pressure biasing port but before the slot communicates with the low pressure biasing port; and

(b) a pair of restricted passages associated with each vane and defined by portions of the vane, the vane slot and the transverse end wall means, one restricted passage being at the leading side of the vane and the other restricted passage being at the trailing side of the vane, said restricted passages extending inward and serving to interconnect the intervane working spaces ahead of and behind the vane through the vent port when the vane slot spans that port,

(c) the intervane spacing being so chosen that when a

vane slot is spanned by the vent port the intervane working space behind that vane is isolated from the inlet zone by a succeeding vane.

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