Nov. 16, 1965 D. RACICOT 3,217,744

ROTARY VALVE

Filed Dec. 16, 1963 2 Sheets-Sheet 1

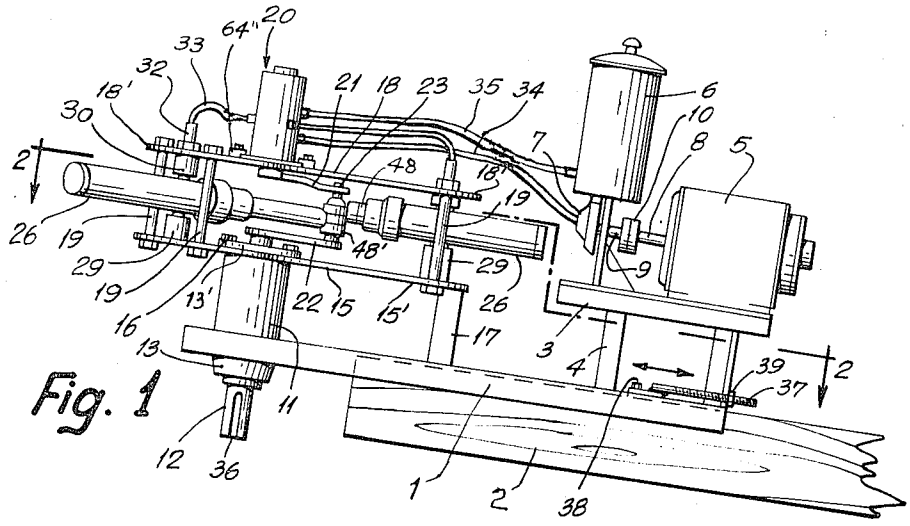

Fig. 1

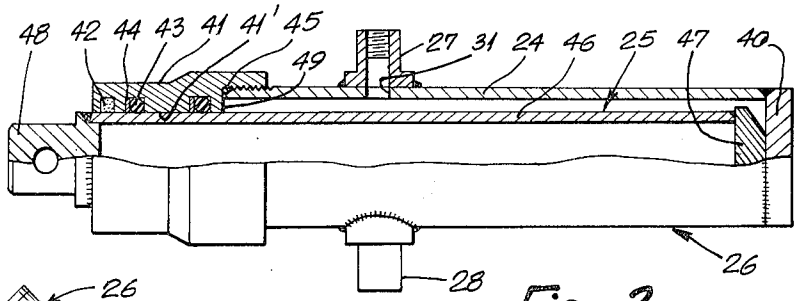

Fig. 3

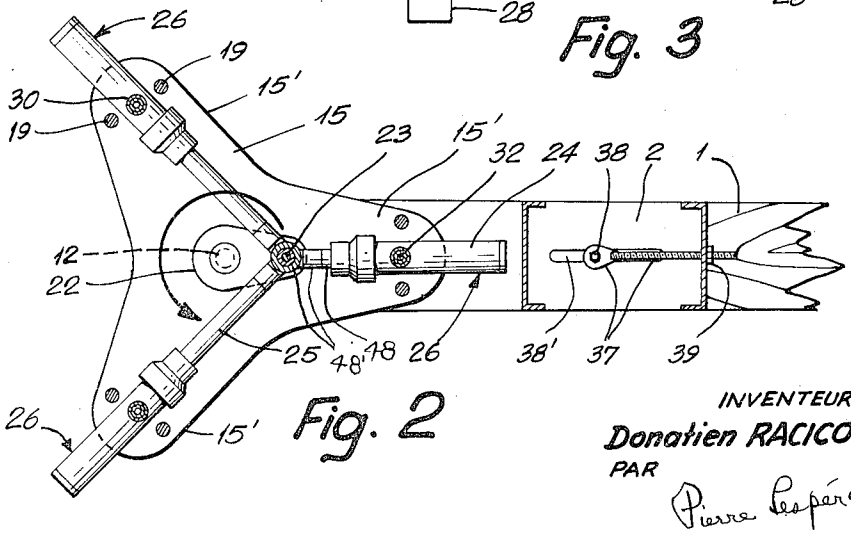

Fig. 2

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ROTARY VALVE

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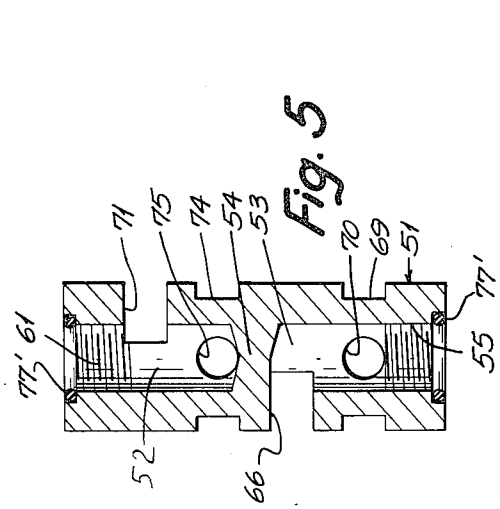

Fig. 5

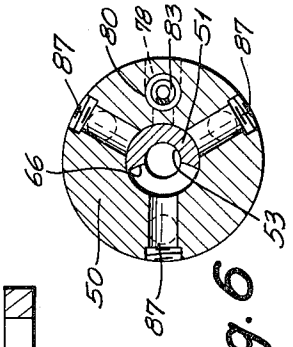

Fig. 6

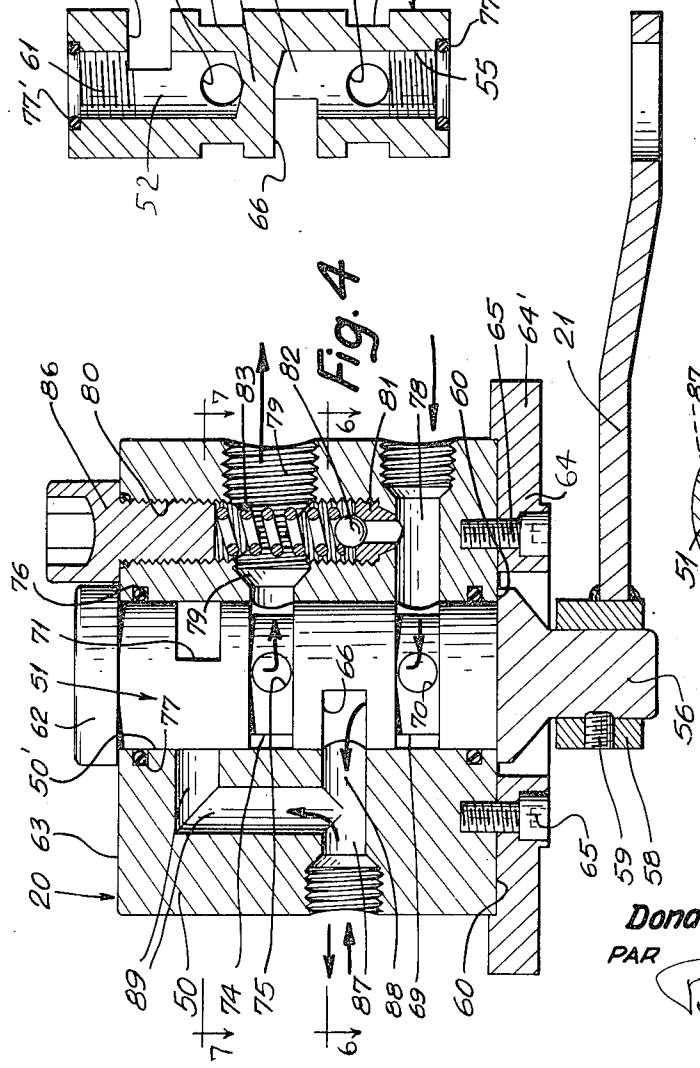

Fig. 4

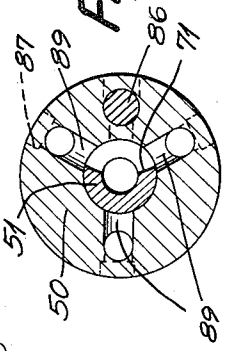

Fig. 7

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3,217,744

ROTARY VALVE

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6 Claims. (Cl. 137—596.12)

The present invention relates to a hydraulic rotary valve.

The general object of the present invention resides in the provision of a hydraulic rotary valve, the rotor of which is arranged to have a continuous rotational movement, so that the valve will control the operation of hydraulic motors in succession and in accordance with a repeating cycle.

Another object of the present invention resides in the provision of a rotary valve of the character described, which controls the return as well as the feeding of hydraulic fluid under pressure to the hydraulic motors.

Another object of the present invention resides in the provision of a rotary valve of the character described, which is more particularly adapted to be used in association with hydraulic cylinder and piston units of the single-acting type and which controls the feeding and return of the hydraulic fluid in accordance with a repeating cycle.

Yet another object of the present invention resides in the provision of a rotary valve of the character described, which is of simple construction and which can easily be disassembled for cleaning, part replacement, and the like.

Yet another object of the present invention resides in the provision of a rotary valve of the character described, which is particularly adapted for controlling the operation of a hydraulic drive for actuating the endless chain of a stable-cleaning apparatus, such as the drive described in a co-pending patent application, by the same inventor, entitled, "Hydraulic Drive."

The foregoing and other important objects of the present invention will become more apparent during the following disclosure and by referring to the drawings, in which:

FIGURE 1 is a side elevation of a hydraulic drive controlled by the rotary valve in accordance with the invention;

FIGURE 2 is a plan section taken along line 2—2 of FIGURE 1;

FIGURE 3 is a side elevation, on an enlarged scale, of one cylinder and piston unit, partly shown in longitudinal section;

FIGURE 4 is a longitudinal section of the rotary valve of the present invention;

FIGURE 5 is a longitudinal section of the rotor of the rotary valve;

FIGURE 6 is a plan section taken along line 6—6 of FIGURE 4; and

FIGURE 7 is a plan section taken along line 7—7 of FIGURE 4.

Referring now more particularly to the drawings in which like reference characters indicate like elements throughout, the hydraulic drive with which is associated the rotary valve in accordance with the invention, comprises a base 1 in the form of an elongated metal channel resting on and slidably fitting over a support beam 2.

A shelf 3 is supported by the inner end portion of channel 1 by means of upstanding legs 4. Shelf 3 supports an electric motor 5, a hydraulic fluid tank 6 and a hydraulic pump 7, driven in rotation by motor 5 through motor shaft 8, pump shaft 9, and flexible coupling 10. A sleeve 11 is mounted on top of and is secured to the outer portion of the channel-shaped base 1 and serves as a housing for a drive shaft 12, which is

rotatably mounted in sleeve 11 by means of thrust bearings 13 and 13', the latter being inserted in sleeve 11 and secured thereto by bolts 16.

Drive shaft 12 is mounted substantially perpendicular to base 1 and freely extends through said base. A plate member 15 having a star shape providing three equally angularly spaced radially protecting arms 15' is secured at its center to the top of sleeve 11 by welding or the like, and one arm is aligned with and overlies channel-shaped base 1, being secured thereto at its inner end by means of support leg 17.

A second plate-like member 18, having the same shape as plate member 15, is spacedly disposed over the same with its arms 18' in alignment with arms 15', being secured to the first plate 15 and supported thereby by means of three pairs of spacer rods 19 connecting the arms of the two plate members.

A rotary valve assembly 20, the description of which will be given hereinafter, is mounted on the top plate 18 with its rotor co-axial with the drive shaft 12.

The rotor of valve 20 has a crank arm 21, the outer end of which is connected to the outer end of a crank arm 22, which is secured to drive shaft 12, by means of a wrist pin 23.

Three hydraulic cylinder and piston units 26 are mounted for pivotal movement between the two plate members 15 and 18. Each unit 26 comprises a cylinder 24 and a piston rod 25, the free end of which is pivotally connected to wrist pin 23.

Each cylinder 24 is provided intermediate its ends with aligned upper and lower pivot members, disposed between the spacer rods 19 of each pair and pivotally supporting units 26. Said pivot members consist of upper and lower stud shafts 27 and 28 secured to cylinder 24 and of upper and lower pivot blocks 29 and 30 secured to top and bottom plate members 18 and 15. The stud shafts rotatably engage the bore of the respective pivot blocks.

Upper stud shaft 27 is hollow, being in the form of a tube, in communication through opening 31 with the inside of cylinder 24. Said tube is inwardly threaded for receiving a coupling 32 passing through the bored upper pivot block 30 and through the top plate member 18, said coupling being connected to flexible tubing 33 for the transmission of hydraulic fluid and return thereof to and from cylinder 24.

The tubing 33 of each cylinder unit is connected to a port made in the housing of rotary valve 20. Fluid under pressure is transmitted from the outlet port of pump 7 to the rotary valve 20 by flexible tubing 34, while the fluid is returned from the valve through flexible tubing 35 to the tank 6.

The free end of the drive shaft 12 is splined, as shown at 36, to receive a sprocket gear, not shown, which is in meshing arrangement with the chain (not shown) of a stable-cleaning system. However, it is obvious that the shaft could be provided with any type of gear or pulley means for driving other conveyor systems.

The entire drive assembly is displaceable in adjusted manner along beam 2, in order to confer the desired tautness to the conveyor chain. For this purpose, an eye bolt 37 has its eye portion secured to beam 2 by means of bolt 38 passing through a longitudinal slot 38' made in the channel-shaped base 1.

The threaded end of eye bolt 37 passes through a hole of leg 4 and receives the nut 39. By screwing nut 39, the whole drive assembly is displaced outwardly from the outer end of beam 2, to thereby tighten the conveyor chain.

The three cylinder and piston units 26 are angularly spaced 120° apart and are pivotable in a plane parallel to the top and bottom plates 18 and 15 and their piston

rods 25 are adapted to rotate crank arms 21 and 22 of the rotary valve 20 and of the drive shaft 12. Each cylinder 24 consists of a cylindrical housing having a welded closure disc 40 at one end and externally threaded to receive a header sleeve 41, having its inwardly protruding internal cylindrical surface 41' provided with three annular grooves, one receiving a graphite wiper ring 42 and the other two each receiving an O-ring 43 and back-up washer 44. An O-ring 45 seals the threaded connection between the header sleeve 41 and the cylinder proper.

The piston rod consists essentially of a cylindrical member 46 welded to a disc-like cap 47 at its inner end and to an apertured coupling member 48 at its outer end. A ring member 48' surrounds wrist pin 23 and has a sleeve in which member 48 is inserted and connected by means of a bolt passing through said sleeve and the aperture of said member 48.

Member 46 has a sliding fit with the inner cylindrical surface 41' of the header sleeve 41 and is spaced inwardly from the cylinder 24, which defines an annular space therewith. Cap 47 protrudes radially outwardly from member 46 and abuts against shoulder 49 of header sleeve 41 in the extended limit position of the piston rod.

This cylinder and piston unit is a single-acting hydraulic unit and the hydraulic fluid is fed to and is returned from the cylinder through the single communication constituted by opening 31 and coupling 32.

Rotary valve 20 in accordance with the present invention consists of a cylindrical body 50 having an axial through bore 50', in which is rotatably fitted a rotor 51.

Rotor 51 is in the form of a cylindrical tube having a bore divided into upper and lower sections 52 and 53 by means of a transverse portion 54. The lower end of the rotor is inwardly threaded at 55 and a cap-like coupling member 56 is screwed therein.

Crank arm 21 has a collar 58 fitted over the outer end of the coupling member 56 and secured thereto by a set screw 59. The coupling member 56 has a portion overlying and having a sliding fit with the bottom end face 60 of the body 50.

The uper end of the rotor is inwardly threaded at 61 for receiving a cap 62, screwed therein and overlying the top end face 63 of body 50. Thus, cap 62 and coupling member 56 positively maintain the rotor in a predetermined longitudinal position within the body 50, while allowing free rotation thereof by means of crank arm 21.

A bracket 64 is removably secured to the bottom face 60 of the body 50 by means of bolts 65 and serves to secure the rotary valve 20 on the top plate member 18 of the drive assembly, in a position with the rotor 51 coaxial with the drive shaft 12. Bracket 64 provides a circular flange 64' retained by overlapping fasteners 64'' (see FIG. 1) to thereby fix the valve body 50 in angularly adjusted position on top plate 18.

The lower feeding section 53 of the bore of the rotor 51 is provided with a lateral elongated opening 66, extending through a little less than 180°. An annular groove 69 is made on the outside surface of rotor 51 below opening 66 and is in communication with the inside of the rotor through hole 70.

The upper return section 52 of the rotor 51 is similarly provided with a lateral elongated opening 71, which is diametrically opposed to opening 66 and which also extends through a little less than 180°. Below the return opening 71, the rotor 51 is provided with an annular groove 74 in communication with the interior of the section 52 by a hole 75.

The body 50 is provided with spaced annular narrow grooves 76 for receiving O-rings 77 which are disposed above opening 71 and below groove 69. Additional O-rings 77' at both ends of rotor 51 seal the connections of the latter with member 56 and cap 62.

Groove 69 and its hole 70 are in alignment with a feeding port 78, while groove 74 and hole 75 are in alignment with return port 79.

A longitudinal threaded bore 80 is made in the body 50 of the valve and establishes communication between the two ports 78 and 79 to form a by-pass, in which is located a pressure release valve formed by a valve seat 81, a ball 82, a coil spring 83, and a screw plug 86.

Bore 80 opens at the top end face 63 of the valve body 50 for inserting and removing the valve arrangement, said bore being closed by plug 86.

Each cylinder and piston unit 26 of the drive assembly is connected to a related pair of feeding and return openings made in the feeding section 53 and return section 52 of rotor 51, by means of a cylinder port 87 made in the body of the rotary valve. As there are three cylinder and piston units 26, consequently there will be three cylinder ports 87, which are equally angularly space at 120° apart in the body 50 of the rotary valve.

Each cylinder port 87 has a feeding branch 88 at the level of the corresponding rotor feeding opening 66. Each cylinder port 87 has, furthermore, a return branch 89, standing vertically within the body of the valve and opening at the level of return opeing 71, in the vertical plane containing branch 88.

The system in accordance with the invention operates as follows:

Upon starting electric motor 5, pump 7 is rotated and delivers hydraulic fluid under pressure through the rotary valve intake port 78 and the fluid under pressure enters the feeding section 53 and rotor 51 through groove 69 and hole 70. The fluid under pressure leaves the rotor 51 through feeding opening 66, and the valve body through the cylinder port or ports 87 momentarily in communication with feeding opening 66. Thus, the cylinder unit connected with cylinder port 87 exerts a pushing stroke on the crank arm 22 of the drive shaft 12, thereby starting rotation of the latter. Said drive shaft 12 in turn rotates the crank arm 21 of rotary valve 20, whereby the rotor 51 is caused to rotate in the same direction of rotation as the drive shaft 12.

When the system is stationary, there is always at least one cylinder port 87 having its feeding branch 88 in communication with the feeding section of the rotor, while the return branches 89 of the remaining cylinder ports 87 are in communication with the return section 52 of the rotor 51. Thus, upon starting, at least one cylinder is caused to exert an active stroke while the two other cylinders return their fluid back through the return section of the rotary valve. Due to the action of the active cylinder, the fluid is returned through the return branches 89 through the same hosing connected to the cylinders being emptied of fluid through the return section opening 71 and back into the tank 6 and intake of the pump 7.

Upon rotation of the rotor 51, the feeding opening of said rotor successively comes in communication with the three angularly spaced feeding branches 88 of the cylinder ports 87, thereby causing an active stroke of the three cylinder units in succession at each 120° rotation of rotor 51. Feeding opening 66 and return opening 71, each extends through 180° less the diameter of feeding or return branches 88, 89. Thus, each cylinder receives pressure fluid for 180° of rotor rotation and returns the fluid for the remaining 180° of rotor rotation.

There is continuous rotation of the drive shaft under the succesive actions of the three cylinder units, and the admission and return of pressure fluid to the three cylinder units is perfectly synchronized due to the fact that this valve rotor is directly connected by crank arm 21 to the crank arm 22 of the drive shaft.

The drive shaft is rotated at a relatively low speed, which is dependent on the torque produced on the drive shaft and the pressure and flow of the fluid delivered to the cylinders by the pump.

If there are any obstructions preventing movement of the conveyor driven by shaft 12, thereby preventing

proper functioning of the cylinder units, by-pass valve 82 simply opens at a calibrated overload pressure and the pressure fluid entering intake port 78 passes directly through the by-pass valve 80, 81 into the return port 79 and back into the tank 6. However, during this return, pressure continues to be exerted by the cylinder units on the drive shaft until the obstruction is either overcome or the electric motor is stopped. However, the pump 7 can continue to operate indefinitely without any wear and tear on the drive mechanism or breakdown of the conveyor chain, because the by-pass valve opening pressure can be set at the exact proper value.

The hosing connecting the cylinder units to the rotary valve 20 and the latter to the pump 7 are preferably made of rubber or other elastic material and, therefore, act as shock absorbers in the event of sudden pressure changes within said hosing.

As shown in FIGURE 1, it is a simple matter to adjust the angular position of the valve body 50 with respect to the cylinder arrangement, whereby the drive can be made to rotate clockwise or anticlockwise, depending on the particular application.

Referring to FIGURE 4, it will be seen that the feeding and return openings in the rotor 51, which are disposed at 180° apart, define an apertureless portion of the rotor having a width corresponding to the diameter of the cylinder port, such that for any given cylinder when feeding with pressure fluid is stopped, the cylinder is immediately connected to the return circuit of the fluid.

The rotary valve of the present invention can be associated with systems of hydraulic motors other than the system given as an example in the present description.

The crank arm 21 can also be driven by separte motor means in ocntinuous rotation and at constant or non-constant speed. The single-acting motors may not be mechanically connected to each other, but should be of the type which is adapted to operate in accordance with predetermined time delays and in accordance with a repeating cycle.

The construction of the valve in accordance with the present invention enables to vary the number of cylinder ports 87, in which case the included angle of openings 66 and 71 will be modified accordingly, while keeping the diametrically opposite relationship of these openings in the feeding and return sections of rotor 51.

While a preferred embodiment in accordance with the present invention has been illustrated and described, it is understood that various modifications may be resorted to without departing from the spirit and scope of the appended claims.

What I claim is:

1. A continuously rotatable hydraulic valve for controlling feeding and return of hydraulic fluid to and from a plurality of hydraulic motors of the single-acting type, in accordance with a repeating cycle and at predetermined time intervals, said valve comprising a body having an axial bore, a rotor disposed within said bore for continuous rotation with respect to said body, means exterior to said body, connected to said rotor, for continuously rotating said rotor, said body having an inlet and an outlet port opening in said bore and longitudinally spaced with respect to said body, said body having a series of angularly spaced motor ports, each adapted to be connected to a single-acting hydraulic motor, each motor port having a feeding and a return branch made in said body and opening within said bore in two longitudinally spaced points and in a plane passing through the long axis of said body, said rotor having a longitudinal bore and a partition dividing said bore into a feeding section and a return section, both sections each associated with an annular groove formed at the exterior surface of said rotor and disposed opposite said inlet and outlet ports, respectively, each section having a hole making communication between said sections and their respective annular grooves, each section further having an elongated slot disposed opposite the openings of said branches within said bore, respectively, each slot having a substantial included angle, said slots being diametrically opposed with respect to the long axis of said rotor, whereby during rotation of said rotor hydraulic fluid under pressure entering said inlet port feeds each of said hydraulic single-acting motors connected to said motor ports during the time the slot of said feeding section of said rotor is in communication with said feeding branches, and hydraulic fluid is returned from said motors through each of said return branches during the time each return slot of said return section of the rotor is disposed opposite said return branches, said hydraulic motors being operated successively at time intervals determined by the speed of rotation of said rotor and by the angle separating the branch openings in said valve body.

2. A rotary valve as claimed in claim 1, wherein said feeding and return slots have each an included angle of 180° less the diameter of said feeding and return branch openings.

3. A rotary valve as claimed in claim 1, wherein said body has a by-pass bore directly communicating with said inlet and said outlet ports and a pressure release valve mounted within said by-pass bore to allow the direct passage of hydraulic fluid under excess pressure from said inlet to said outlet port.

4. A rotary valve as claimed in claim 1, wherein the openings of said return and feeding branches within said body bore are angularly equally spaced apart.

5. A rotary valve as claimed in claim 1, wherein the longitudinal bore of said rotor is open at both ends of said rotor and further including cap members closing said ends of said rotor bore, said cap members overlapping the end faces of said valve body for maintaining said rotor in a predetermined axial position with respect to said body, while permitting rotation of said rotor.

6. A rotary valve as claimed in claim 5, further including gasket members disposed between said rotor and said body bore.

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