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[54] **ROTARY SLIDE VALVE**
5 Claims, 2 Drawing Figs.

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[51] **Int. Cl.** **F16k 11/02**
[50] **Field of Search** 417/269; 137/112, 625.21, 625.22, 625.23, 625.24; 251/283; 91/180, 476

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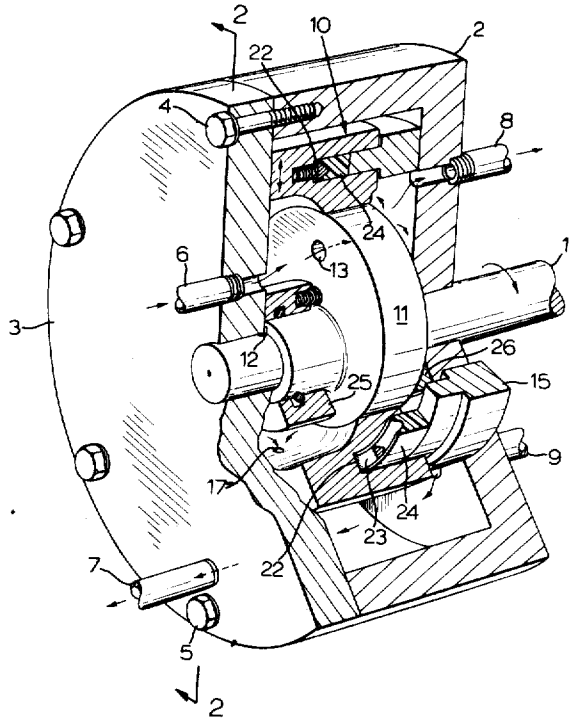
ABSTRACT: This invention relates to a valving arrangement for a hydraulic power transducer of the type which has cylinders and pistons located radially of a crankshaft. The valving arrangement comprises a hollow cylindraceous rotating slide valve which is driven eccentrically about a central point in a valve chamber by the crankshaft of the power transducer so that the slide valve rotates exactly in synchronism therewith. The slide valve chamber is provided with connecting passages for conducting the hydraulic fluid to and fro between the working chambers of the power transducer. Provision is made to have the slide valve bear with suitable bearing force against a pair of opposed substantially parallel walls by making the slide valve from two cooperating cylindraceous pieces. A chamber is provided between the two cylindraceous pieces which is arranged to be fed with high-pressure hydraulic fluid to cause the two valve pieces apart against the opposing walls of the valve chamber no matter which direction the power transducer is rotating.



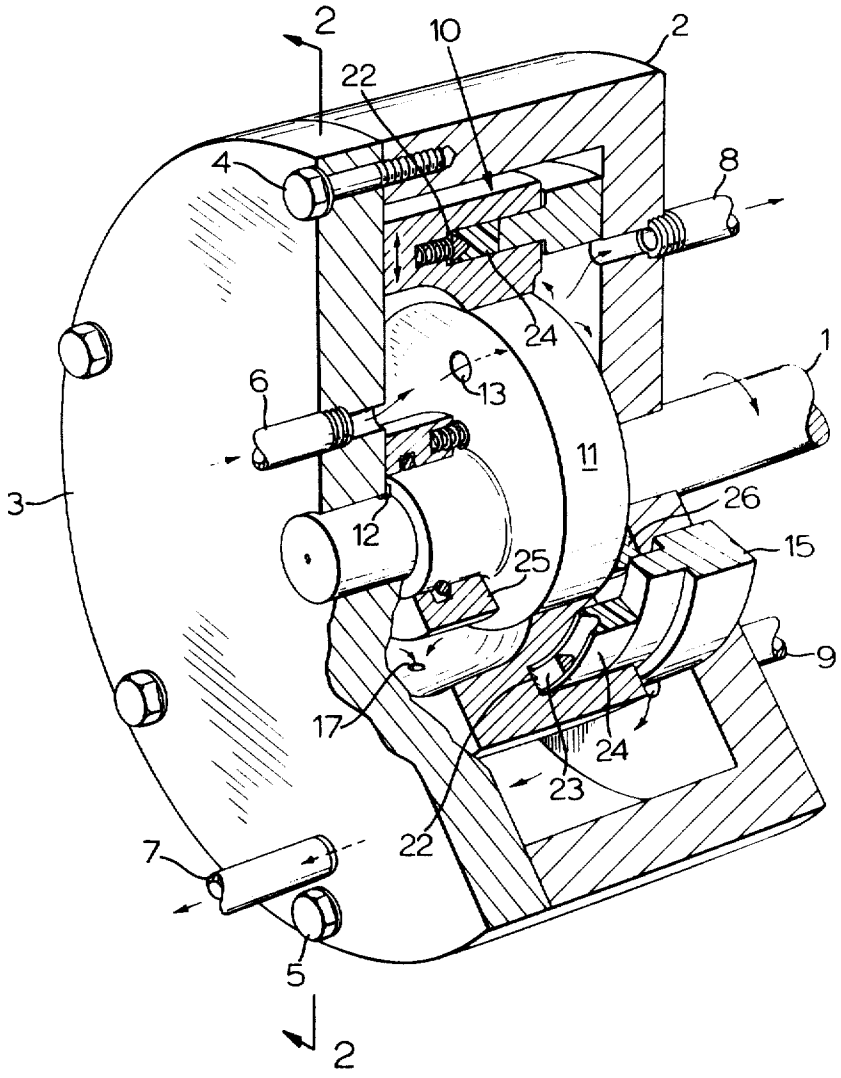


FIG. 1

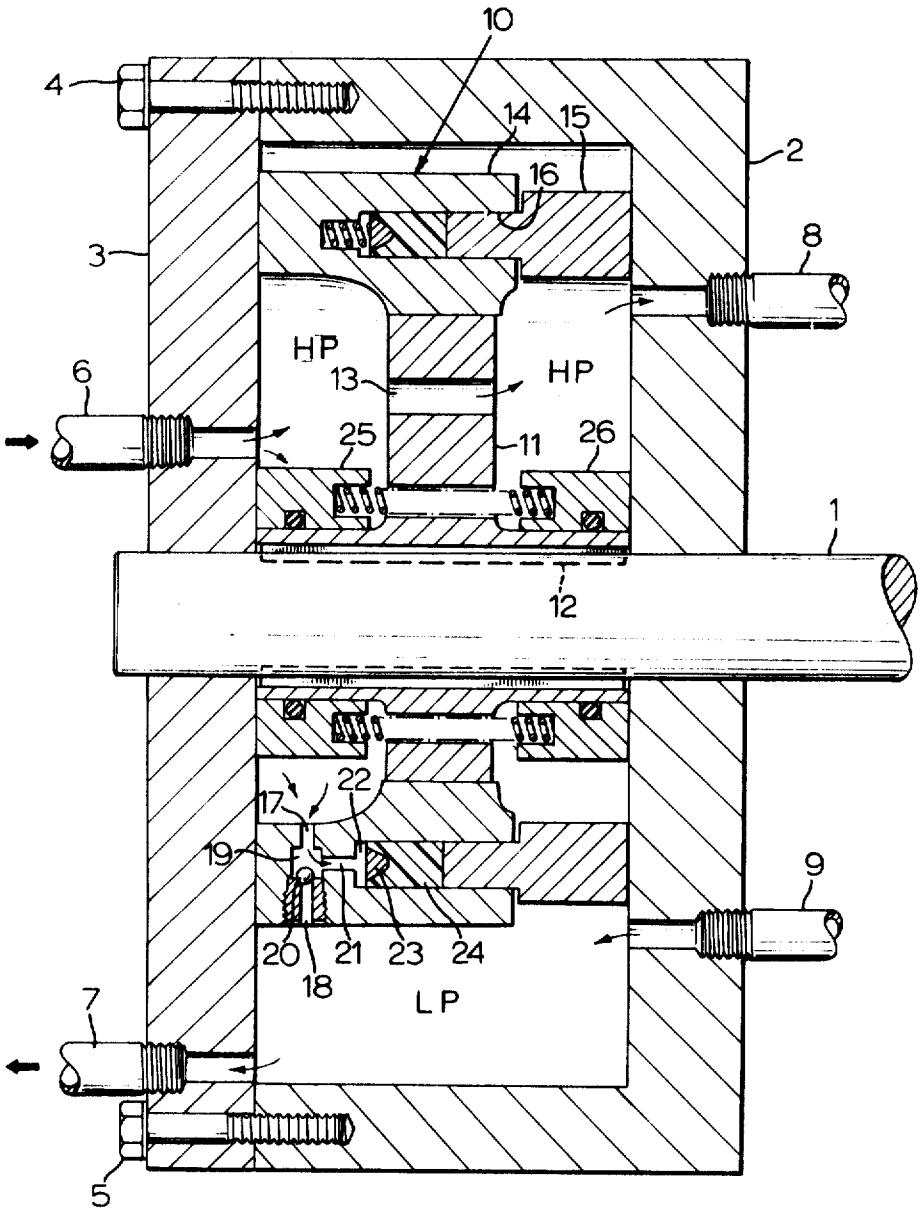


FIG. 2

ROTARY SLIDE VALVE

BACKGROUND OF THE INVENTION

It is well known in any internally expanding hydraulic motor or pump of the radial type where the cylinders and pistons are arranged radially of a central crankshaft, a suitable valving device must be present to control the flow of hydraulic fluid to and from the transducer. In the past, this has largely been accomplished by what is generally referred to as a cylindrical valve. This is a cylindrically shaped valve which is housed in a suitable bearing housing which housing is arranged such that high-pressure hydraulic fluid may be ported from a suitable source to the inlet ports of the transducer, for instance a hydraulic motor. Simultaneously, the cylindrical valve ports return fluid from the hydraulic motor cylinders through the housing to a reservoir. The porting is generally done by recesses formed in the surface of the cylindrical valve body so that communication may periodically be made between the ports of the motor and the source of high-pressure fluid or the reservoir. Because of the necessity of maintaining a logical porting sequence the cylinder port lines are generally connected to the housing at evenly spaced circumferential intervals about a certain section of the valve body. On one side of the housing and located adjacent the cylinder port lines, a source of high-pressure hydraulic fluid is connected to said housing. Provision is made to connect said source of high-pressure hydraulic fluid to the valve chamber. The reservoir line is also connected to said housing on the opposite side of the housing remote from the side to which said high-pressure hydraulic fluid is connected. Suitable provision is made to connect said reservoir to said valve chamber. The two recesses formed in the surface of the valve body are arranged so that at all times one recess is in communication with the port connections requiring high-pressure fluid and the opposing recess is porting low-pressure fluid to the balance of the ports. One of the recesses is generally laterally shifted from the other on the valve body to achieve this function. For many functions, this type of mechanism is entirely satisfactory; however, it is easily seen that the flow of hydraulic fluid is largely constrained because of the limitation in the depth of the recesses in the cylindrical valve body. In many applications it is desirable to be able to direct large amounts of high-pressure fluid to the ports of a power unit, and it is in circumstances such as these that the cylindrical valve body is incapable of operating.

SUMMARY OF THE INVENTION

The hydraulic machine of this invention is provided with a rotating cylindraceous slide valve which moves eccentrically about a central point and is connected to a crankshaft of a power transducer so that the slide valve rotates in an especially provided chamber which has connecting passages for conducting the hydraulic fluid to-and-fro between the working chambers of the power transducer and the valve mechanisms required.

The valve chamber has radial walls upon which sealing members of the sliding valve body and the eccentric slide valve bear with suitable bearing force. In order for the slide valve to bear in a suitable sealing manner against the walls of the valve chamber, it is necessary to divide the slide valve into two mating portions which may move relative to one another in an axial direction. It is proposed to provide a pressure chamber between the two mating parts of the slide valve and use the high-pressure working fluid to force the two mating portions of the slide valve apart, so as to ensure sealing engagement between the slide valve members and the two opposing walls of the slide valve chamber. The operation is made possible by assuring that the pressure retaining chamber between the two movable portions of the slide valve is always subjected to high-pressure hydraulic fluid no matter which direction the valve assembly is rotating. If the hydraulic machine were intended for operation in one direction only, it would be quite simple to expose high-pressure hydraulic fluid to the high-pressure side of the slide valve in such a manner as

to cause the members of the slide valve to seal tightly against both opposing walls of the slide valve chamber. In practice, it is generally necessary to reverse the direction of rotation of such a machine and alternative solutions must be provided because during periods of reversal and vice versa, so that under certain circumstances there is a substantial reduction in the sealing pressure and consequently much leakage the high-pressure fluid to the low-pressure side of the slide valve chamber. To overcome this problem the slide valve is divided into two mating portions which are movable relative with respect to one another and which are provided with a suitable space between the two movable members, which may be selectively loaded with hydraulic fluid under pressure from which ever side of the slide valve members is operating at high pressure. By establishing a suitable space between the two relatively movable members of the slide valve and connecting this passage to both high- and low-pressure pressure chambers simultaneously and providing a means of preventing the flow of fluid from the high-pressure chamber to the low-pressure chamber directly, it is possible to utilize the high-pressure fluid to force the two mating portions of the slide apart.

It is necessary to incorporate a valve in the passage between the high- and low-pressure chambers in order that the high-pressure fluid may not flow directly through the slide valve member to the low-pressure chamber. This is accomplished by what is commonly referred to as a "double-ball check valve" located so as to direct the flow of oil from whichever chamber is operating in high pressure to the space between the two mating slide valve members. The space between the two movable members of the slide valve will hereinafter be referred to as a "trap space." In order to be able to disassemble the rotating slide valve mechanism, it is necessary that the fluid in the trap space be allowed to escape and this is provided by the inherent action of the ball check valve. As soon as neither chamber is subjected to a fluid under high pressure, the force pressing the two mating sections of the slide valve apart diminishes to zero and consequently the two portions may be pressed together for ease of disassembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view having a cutaway portion of the valve which is a subject of this invention; and

FIG. 2 is a cross-sectional view of the valve shown in perspective in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A crankshaft 1 is shown extending into housing 2. It will be understood that the portion of the crankshaft 1 shown to the right of the housing 2 will be connected to a set of power pistons in a power unit and the valve assembly will be used to modulate the flow of fluid under pressure to the pistons of the power unit in a logical sequence. In the diagram, crankshaft 1 is itself used for mounting the valve slide member thereon, however it will be understood by those skilled in the art that it is possible to connect the valve slide member by means of shafts, gears or pulleys in such a manner to operate successfully with the power unit. The only requirement is that the valve slide operates in synchronism with the crankshaft of the power unit. Crankshaft 1 is allowed to rotate in a housing 2. The housing 2 may be composed of any number of pieces as long as suitable bearing surfaces are provided for the crankshaft 1 and a suitable chamber is provided for the rotation of the valve slide member therein. It will be noted in this instance that chamber 2 is shown composed of two portions, an open cylindrical portion generally designated as 2 and a circular cover plate denoted by the numeral 3. It is understood that cover plate 3 is securely attached to the housing 2 by means of bolts shown as 4 and 5 which are evenly spaced about the circumference thereof. It will be noted that an inlet conduit 6 is threadably received in the cover plate 3 in the upper portion shown and an outlet conduit designated 7 is threadably received in the lower portion of the cover plate.

Also shown, threadably engaging the housing 2 is a cylindrical conduit designated 8 which is in a position to conduct high-pressure fluid from the valve chamber to the appropriate cylinder of the power unit. A similar conduit 9 is also shown threadably engaging the housing 2 for the conduction of fluid from the appropriate cylinder of the power unit to the return side of the valve chamber. A valve slide generally designated as 10 is eccentrically connected to the crankshaft 1 and rotates synchronously therewith. Valve slide member 10 is composed of various pieces including an eccentric disc 11 which is keyed to crankshaft 1 by means of keying device 12. Disc 11 is provided with various through passages such as the one designated by the numeral 13 to allow hydraulic fluid to pass freely therethrough. On the periphery of disc 11 is slidably mounted one of the two slide members designated as 14. Slide member 14 is mounted on the disc 11 so as to be axially movable on the disc in order to seal against cover plate 3 in a good sealing relation. A second slide member 15 is slidably mounted in a suitable recess 16 in sliding member 14 so as to allow the second member 15 to be movable axially with respect to the first member 14. It will be seen that it is necessary to the successful operation of this device for the member 15 to be freely movable axially with respect to the member 14, and yet form a good seal between the members 14 and 15 in order to prevent excessive flow from the high-pressure chamber to the low-pressure chamber.

In order that the bearing pressure between the slide members 14 and 15 and their respective sealing walls on the cover plate 3 and the housing 2 respectively is of a sufficient magnitude to prevent the direct flow of fluid under pressure from the high-pressure chamber to the low-pressure chamber in the slide valve assembly, some method must be used to assure that the members 14 and 15 are pressed apart in order to effectively stop the through passage of oil. This pressure is provided by means of two communicating passages shown as 17 and 18. It will be seen that passage 17 is connected in this instance to the high-pressure portion of the slide valve chamber and conduit 18 is connected to the low-pressure side of the valve slide chamber. Both conduits lead to a common chamber designated as 19 wherein ball bearing 20 is free to move. A third chamber 21 is provided to connect chamber 19 to the trap space designated as 22. A circular wedging ring of triangular cross section shown here as 23 is provided to sealingly wedge the member 24 against the second slide member 15.

Various other sealing members are necessary and are shown for illustrative purposes only, such as the sealing rings 25 and 26 which are spring-loaded against the cover plate 3 and the housing 2 respectively. These devices are merely to prevent the passage of hydraulic fluid from the valve slide chamber to the bearings of the crankshaft. The operation of the valve slide mechanism is as follows.

High-pressure fluid is led into conduit 6 and into the high-pressure side of the valve slide mechanism. The fluid passes freely through passages such as the passage designated 13 and passes out through the outlet 8 to the appropriate cylinder in the power unit to push the piston during the power stroke. Simultaneously, as the power piston is being moved in the power unit another piston in the power unit will have completed its power stroke and is now on the return stroke forcing fluid from the cylinder into the conduit 9 so that the fluid passes through the low-pressure chamber of the valve mechanism to the outlet conduit designated as 7. The high-pressure fluid is led into passage 17 and into chamber 19 provided in the slide valve member 14. The fluid will of course attempt to pass by the ball check valve into the passage 18 and the ball 20 will of course move to cover the opening in the chamber 19 and prevent the passage of high-pressure hydraulic fluid from the high-pressure chamber to the low-pressure chamber. The fluid must therefore move into passage 21 when provided and fill the trap space 22 with high-pressure fluid. The high-pressure fluid acts as a piston on the wedge-shaped member 23 and forces the sealing member 24 which is composed of a resilient sealing material against the member 15 to cause the members 14 and 15 to bear sealingly against the respective walls of the cover plate 3 and the housing 2. It will be noted if the direction of rotation of the valve slide is reversed that the only change required is that the ball check valve 20 will then prevent the passage of fluid from the passage 18 into the passage 17 and the trap space 22 will still be loaded with fluid under high pressure. The pressure pushing the members 14 and 15 apart may be regulated by changing the size of the trap space in effect of varying the area subjected to fluid under high pressure. It is thus seen that this arrangement of the ball check valve in the communication passages 17 and 18 allows the high-pressure fluid to pass into the trap space 22 no matter which direction the valve slide is forced to rotate. The slide member 10 is not only axially movable on the eccentric disc 11, but is also free to rotate or not rotate thereupon so that during operation it may only sweep out its circular path of travel but is free to rotate on the disc 11 to allow a substantial reduction in the wear upon the faces of the slide members 14 and 15 where the walls of the chamber are engaged. It is further seen that the sealing engagement described provides other advantages not immediately apparent, in that no heavy springs are necessary to force the members 14 and 15 apart to form the sealing engagement of the walls of the chamber. Because of the absence of such springs, the assembly and dismantling of such a valve slide is much simplified. Further upon removal of the unit from the delivery of high pressure, the members 14 and 15 are no longer biased apart, because of the fact that the conduit 21 is always connected to either conduit 17 or conduit 18, thus allowing the high-pressure fluid to escape from the trap space 22 and thus allow the removal of the force pushing the members 14 and 15 apart. This example serves only to illustrate the invention generally and forms no restriction in the scope of protection that is so desired for this invention, thus while only two connections 6 and 7 have been shown corresponding to an inlet and outlet port for a valve assembly, and only two communication conduits 8 and 9 have been shown leading to the power unit, it will be recognized by those skilled in the art that there may in fact be many inlets and outlets and a multiplicity of communication conduits, because such power units are generally composed of an odd number of cylinders, thus while only two communication conduits have been shown, it is desired that this is no way limit the scope of the invention.

It is also possible to utilize the power unit as a pump and in this instance the slide valve will function in same manner as previously to isolate high-pressure fluid from the low-pressure fluid, while providing the proper sequential porting connections between the power unit and the various reservoirs.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A rotary slide valve mechanism for sequentially connecting high-pressure hydraulic fluid and low-pressure hydraulic fluid to a mechanical transducer in a predetermined logical manner, said mechanism comprising a housing containing a rotary valving device, said housing having two mutually opposed spaced apart parallel walls, through which passes a driving shaft on which is engageably mounted eccentric means for driving a pair of cooperating cylindraceous members in an eccentric manner, said member being a male and a female pair, such that the female member contains a concentric cylindraceous recess for receiving said male member in concentric axial relationship, in such a manner that said members are axially movable, said members having a cylindrically shaped space formed in said female member at the end of said male member, conduit means in one of said members extending radially through said member, a check valve chamber containing check valve means located in said conduit means to prevent the flow of fluid through said conduit means, a second conduit means connecting said check valve chamber to said space between said cylindraceous members.

2. A pair of cylindraceous members as claimed in claim 1 wherein the sliding sealing engagement is formed by means of a deformable packing ring of substantially the same diameter

as said other member, said deformable packing ring being deformed by a substantially nondeformable annulus of wedged-shaped cross section, said annulus tending to wedge said deformable packing ring into sealing engagement with said other member in said trap space.

3. A rotary slide valve as claimed in claim 1 in which sealing means is provided in said space said sealing means comprising a pair of annularly shaped members, one of said members being of a resilient nature, and the other of said pair having a surface which tends to wedge said first member into sealing engagement with said recess in said female member.

4. A rotary slide valve mechanism housed in a chamber having a pair of spaced apart substantially parallel sidewalls, shaft means passing through said housing orthogonally to said sidewalls, one of said sidewalls having a pair of conduits carrying hydraulic fluid at a substantial pressure differential connected thereto at different radial positions with respect to said shaft means, the second of said sidewalls having connected thereto at evenly spaced circumferential intervals at the same radial distance from said shaft means, a series of conduits connected in a logical sequence to the cylinders of a pressure transducer, eccentric means on said shaft means, a pair of cooperating male and female cylindraceous members mounted to slidingly engage said eccentric means so as to be driven in an eccentric manner about said shaft in said chamber, said female member having a cylindraceous recess so as to receive said male member therein in sealedly, sliding coaxial relationship, said members mating together to engage said sidewalls in sliding sealing relationship so as to divide said chamber into a pair of subchambers internal and external of said cooperating members, said members having a cylindraceous trap space formed therebetween, said trap space having substantially the same shape and configuration as said male member, passage means extending radially through one of said members, a check valve chamber located in said passage means, to prevent the passage of hydraulic fluid from one subchamber to the other, second passage means connecting said check valve chamber and said trap space, so as to subject said trap space to high-pressure hydraulic fluid.

5. A rotary slide valve as claimed in claim 4 in which sealing means is provided in said trap space comprising a pair of cooperating substantially annularly shaped members, one of said pair being of a resilient material which may be wedged into sealing engagement with said cylindraceous recess, the other of said pair being of a rigid nature and being of a generally triangular cross section, so as to be able to wedge said resilient member into sealing engagement with said recess.

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