

[54] **LEAKAGE REDUCING ARRANGEMENT
FOR AN AXIAL PISTON MACHINE**

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[56] **References Cited**

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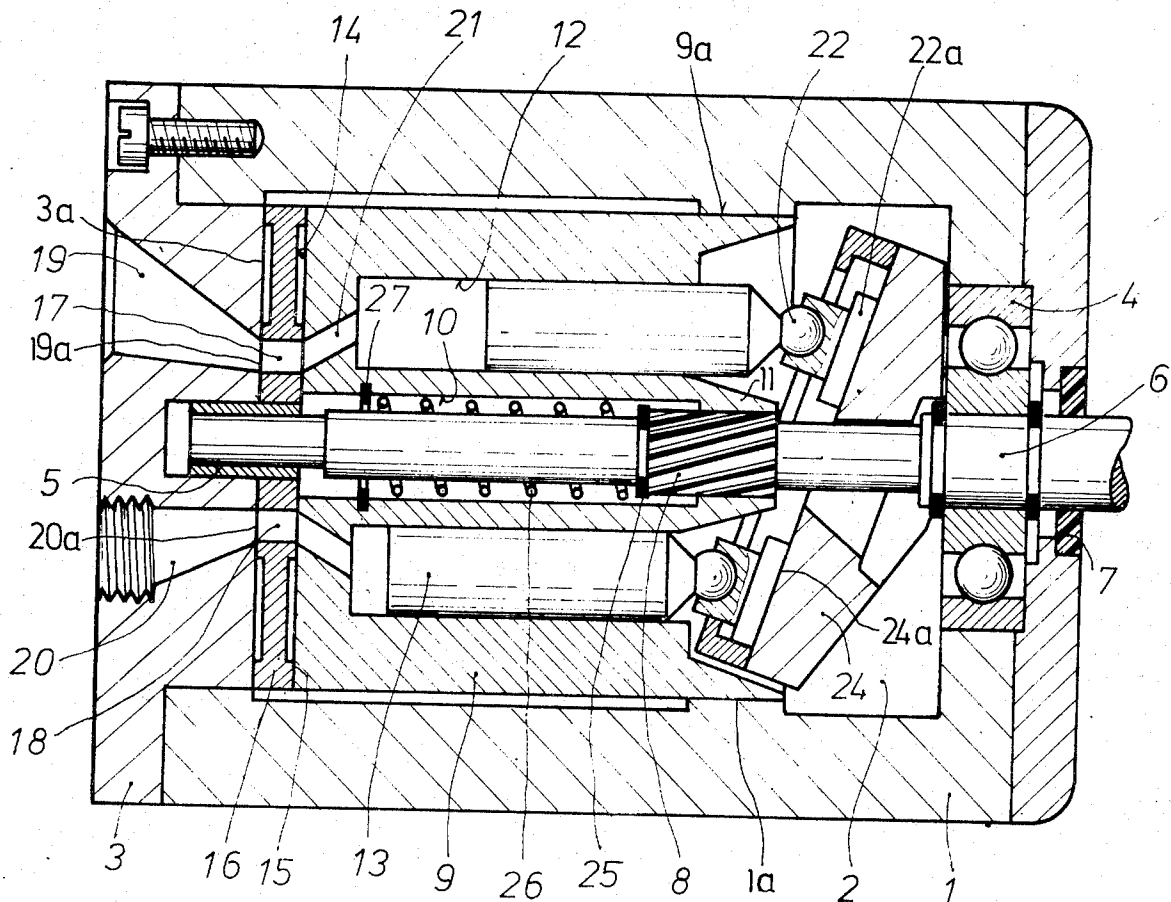
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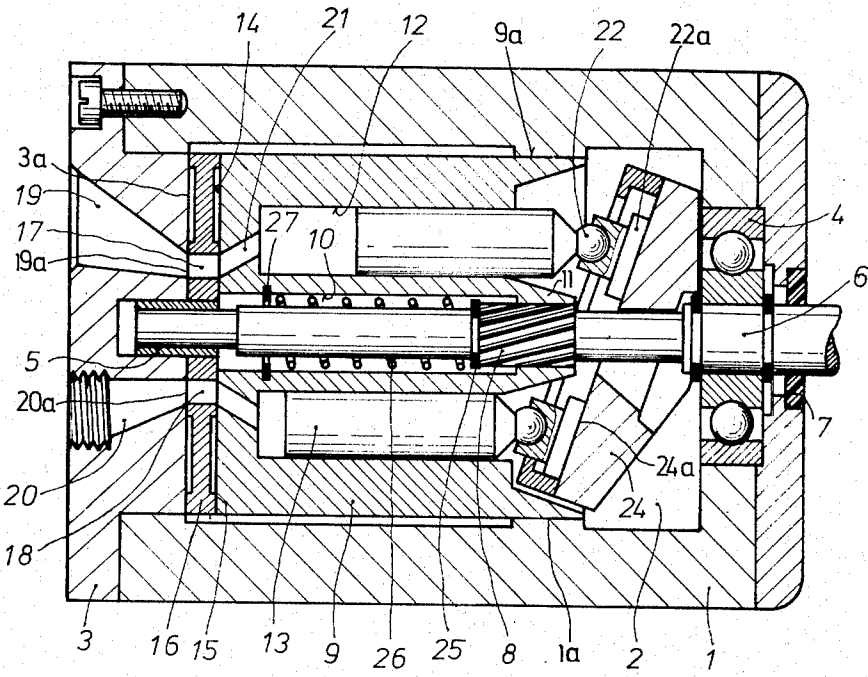
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[57] **ABSTRACT**

An arrangement for reducing in a hydraulic axial piston machine, leakage from the area between the rotary cylinder block end face, and the control face of a valve plate having inlet and outlet ports. The cylinder block is mounted on the drive shaft for small axial movement, but is connected for rotation with the drive shaft by a pair of meshing gears having slanted teeth so that the end face of the cylinder block is pressed against the control face with an axial force which depends on the torque transmitted between the drive shaft and the cylinder block so that leakage from the area between the end face and the control face is prevented, irrespective of the fluid pressure and load.

10 Claims, 1 Drawing Figure





LEAKAGE REDUCING ARRANGEMENT FOR AN AXIAL PISTON MACHINE

BACKGROUND OF THE INVENTION

The present invention is concerned with an improvement of axial piston machines, which may be pumps or hydraulic motors of the type provided with a rotary cylinder block which cooperates with a control surface of a valve plate, and has means for obtaining a sealed contact between the rotary cylinder block end face, and the stationary control face of the valve plate.

The U.S. Pat. No. 907,737 discloses a swash plate axial piston machine whose cylinder block is fixedly secured to the drive shaft. Pistons in the cylinders cooperate with the swash plate, and in order to obtain an axial pressure between the rotary end face of the cylinder block and the control face of the valve plate, three adjusting screws, spaced angles of 120°, are provided.

It is a disadvantage of this apparatus that the axial pressure between the rotary end face of the cylinder block and the control face of the valve plate must be adjusted in accordance with the maximum load, and is independent of the fluctuating load acting on the machine. When the hydraulic machine does not operate at maximum load, the pressure pressing the valve plate against the rotary end face of the cylinder block, is too high so that great friction develops between the rotary end face and the stationary control face which cause a low mechanical efficiency.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a hydraulic axial piston machine in which the axial pressure of the cylinder block against a stationary valve control surface depends on the actual load to which the machine is subjected.

Another object of the invention is to reduce leakage from the area between the engaging rotary end face of the cylinder block and the stationary control face of the housing.

Another object of the invention is to provide a fluid film between the rotary end face of the cylinder block, and the stationary control face which is sufficient to prevent extreme friction, but is too small to cause leakage.

With these objects in view, the present invention provides between the cylinder block and the drive shaft, a coupling means which transmits torque between the drive shaft and the cylinder block, but has at least one guide face slanted to the axis of the drive shaft, and exerting on the cylinder block an axial force depending on the torque acting on the drive shaft, and pressing the rotary end face of the cylinder block against the stationary control face, which is preferably provided on a valve plate abutting a housing portion.

Since the axial component of the force transmitted by the slanted guide face to the cylinder block depends on the torque transmitted from the drive shaft to the cylinder block, a load dependent sealing contact between the rotary and stationary faces is obtained.

In the preferred embodiment of the invention, the coupling includes two meshing gears having teeth slanted to the axis of the drive shaft. By suitably selecting the angle at which the teeth and flank surfaces of the coupling gears are slanted, the axial component of the force transmitted by the interconnected gears, is just right to maintain a sealing contact between the ro-

tary and stationary control faces, and it is advantageous that such axial force is produced by the machine only during rotation.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is an axial sectional view of an axial piston machine provided with an arrangement according to one embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The pot-shaped housing part 1 of the axial piston pump is closed by a cover 3 which has inlet and outlet means 19 and 20, opening in ports 19a and 20a on the inner surface 3a of cover 3. A blind bore forming a slide bearing 5 is provided at the center of cover 3, and supports one end portion of a shaft 6 whose other end portion is mounted in a ball bearing 4 supported by the bottom wall of the housing 1. A shaft portion projects out of bottom wall 1, and is driven by a motor when the machine operates as a pump. Shaft 6 is provided with an annular gear portion 8 having teeth slanted to the direction of the axis of shaft 6.

In the interior 2 of housing 1, a cylinder block 9 is located, and may be mounted on drive shaft 6 which passes through a central bore 10. A spring ring 25 abuts a shoulder formed by the gear ring 8 on drive shaft 6 at one end of a spring 26, which abuts at the other end on a spring ring 27 secured to the wall of the inner bore 10 of the cylinder block 9. The spring 26 urges the cylinder block 9 to move in axial direction until its rotary end face 14 abuts the stationary control surface 15 of a valve plate 16 which abuts the inner surface 3a of cover wall 3. Cylinder body 9 has at the end of the central bore 10, an inner gear which has inner teeth slanted at the same angle as the teeth of the outer gear 8, and engaging the same. In substantially the same plane in which the gears 8 and 11 are located, an annular guide face 1a guides the outer cylindrical surface 9a of cylinder block 9 and supports cylinder block 9 for axial movement.

The valve plate 16 is provided with two part-cylindrical control ports 17 and 18 which communicate with the inlet and outlet ports 19a, 20a. Axially extending cylinders 12 are provided in the cylinder block 9, and are open at one end of the cylinder block so that pistons 13 located in the cylinders 12, project out of the cylinder block. Each piston 13 has a spherical head 22 mounted in a corresponding spherical recess of slide shoes 22a which slide along a circular path on a surface 24a of a stationary swash plate 24.

The passages 21 have ports on the rotor end face 14 located along a circle corresponding to the center circle of the part-circular ports 17 and 18 in the valve plate 16. Consequently, fluid flowing through inlet and outlet means 19, 20, inlet and outlet ports 19a, 20a, and part-circular ports 17 and 18, flows alternately into alternate passages 21 to the cylinders 12 whose

chambers are expanded and contracted by the axial movement of the pistons 13 which depends on the slant of the swash plate 24, shown in the drawing turned an angle of 90°.

When shaft 6 is not driven, spring 26 urges the cylinder block 9 to the left as viewed in the drawing, to a position in which the rotor end face 14 abuts the control surface 15. The pressure produced by spring 26 is low, since there is no fluid pressure when the machine does not operate.

When shaft 6 is driven by a motor, not shown, a torque is transmitted by the slanted teeth of gear ring 8 to the corresponding teeth of the inner gear 11 so that cylinder block 9 rotates with pistons 13 which are forced by the swash plate 24 to reciprocate so that fluid is supplied through inlet 20 and pumped out of outlet 19.

When shaft 6 is rotated in clockwise direction as viewed from the right in the drawing, not only torque is transmitted to the cylinder block 9, but also an axial force is transmitted from the teeth of the gear 8 to the teeth of an inner gear 11, urging cylinder block 9 to the left as viewed in the drawing to a position in which the rotor end face 14 presses against the stationary control surface 15 of the valve plate 16. The circumferential force and the axial force transmitted between the shaft 6 and cylinder block 9, together are the resultant force acting on the teeth. Since the force exerted by the slanted teeth of gear 8 on the teeth of inner gear 11 increases with an increased load acting on the pump, and corresponding to an increased torque acting on drive shaft 6, the axial component and thereby the axial pressure between the rotor end face 14 and the stationary control surface 15 is proportionally increased. Consequently, leakage from the area between the faces 14 and 15 is prevented at all torques and loads occurring during operation, but the pressure exerted by the rotor end face 14 on the stationary control surface 15 never becomes so high as to cause wear of the contacting faces 14 and 15.

At low loads, and at low rotary speeds of shaft 6, the axial force component may be insufficient to completely seal the control faces 14 and 15, and under such conditions, the axial pressure produced by spring 26 is sufficient to maintain the engaging control faces 14 and 15 in sliding engagement without substantial leakage.

It is evident that, if the slanted teeth coupling shown in the drawing and described above as used, the favorable effect of the axial force component is obtained only during rotation in one direction when the apparatus operates as a pump, and in the opposite direction if the apparatus operates as a hydraulic motor.

If the desired effect and axial force component is to be obtained in both directions of rotation, the two gears have to be provided with two axially adjacent portions provided with teeth slanted in opposite direction and forming an arrow pattern on the outer gear on shaft 6 and the inner gear of cylinder block 9. The angular position of the flanks of the teeth, and the play between the teeth must be selected so that during rotation in either direction those tooth faces abut each other which produce an axial force in the desired direction for moving the cylinder block 9 toward the valve plate 16 and control surface 15.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of leakage reducing

arrangement for hydraulic machines, differing from the types described above.

While the invention has been illustrated and described as embodied in an arrangement for reducing leakage between a rotor end face and a control surface of a stationary valve plate by means of an axial force produced by coupling means with slanted teeth, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge readily adapt it for various applications without omitting features that from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

I claim:

1. Leakage reducing arrangement for an axial piston machine, comprising housing means including bearing means defining an axis, and having inlet means and outlet means, and a control surface having inlet and outlet ports communicating with said inlet and outlet means; rotor means including a drive shaft mounted in said bearing means for rotation about said axis, a cylinder block having a plurality of cylinders open at one end of said block, a rotor end face at the other end of said cylinder block slidably engaging said control surface, and passages connected with said cylinders and having rotor ports on said rotor end face communicating during rotation successively with said inlet and outlet ports, means mounting said cylinder block for limited axial movement; a swash plate mounted in said housing opposite said one end of said cylinder block; piston means in said cylinders slidably engaging said swash plate; and coupling means including a first part secured to said drive shaft and a second part secured to said cylinder block, at least one of said first and second parts having at least one guide face slanted to said axis and engaging the respective other part of said first and second parts to transmit rotary motion from said drive shaft to said cylinder block while exerting on said cylinder block an axial force depending on the torque acting on said drive shaft and pressing said rotor end face against said control surface in sealing contact whereby leakage is reduced during torque variations.

2. Arrangement as claimed in claim 1 wherein said housing means includes a housing having said inlet and outlet means, and a valve plate abutting said housing on one side thereof, and having said control surface on the other side thereof; and wherein said inlet and outlet ports are part-circular and penetrate said valve plate so as to communicate on said one side with said inlet and outlet means.

3. Arrangement as claimed in claim 1 wherein said cylinder block has a central bore through which said drive shaft passes; and further comprising a spring in said central bore surrounding said drive shaft and having one end abutting said cylinder block and an other end abutting said drive shaft so that said cylinder block is biased in axial direction to move to a position in

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which said rotor end face abuts said control face even if said axial force is small.

4. Arrangement as claimed in claim 1, wherein said mounting means include a circular inner guide face portion of said housing means slidably engaging a peripheral circular surface portion of said cylinder block located substantially in a plane transverse to said axis and passing through said coupling means.

5. Arrangement as claimed in claim 1, wherein said cylinder block has a central bore through which said drive shaft passes; and wherein said mounting means includes a portion of said drive shaft.

6. Arrangement as claimed in claim 1 wherein at least said first part includes a set of slanted teeth disposed around said drive shaft and engaging said second part on said cylinder block.

7. Arrangement as claimed in claim 1 wherein said cylinder block has a central bore through which said drive shaft passes; and wherein at least said second part includes a set of slanted inwardly projecting teeth in said central bore and engaging said first part on said drive shaft.

8. Arrangement as claimed in claim 1 wherein said first part is a gear having teeth slanted to said axis and

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radially projecting from said drivenshaft; wherein said cylinder block has a central bore through which said drive shaft passes; and wherein said second part is an inner gear within said central bore engaging said gear, the engaging teeth of said engaged gears having abutting tooth faces slanted the same angle to said axis.

9. Arrangement as claimed in claim 8 wherein each of said gears has first and second gear portions whose teeth are slanted in opposite directions relative to said axis, and wherein said first gear portions have teeth with lateral play on one side so as to engage when said drive shaft rotates in one direction of rotation, and said second gear portions have teeth with lateral play on the other side so as to engage when said drive shaft rotates in the opposite direction of rotation.

10. Arrangement as claimed in claim 9 wherein said housing means includes a housing having said inlet and outlet means, and a valve plate abutting said housing on one side thereof, and having said control surface on the other side thereof; and wherein said inlet and outlet ports are part-circular and penetrate said valve plate so as to communicate on said one side with said inlet and outlet means.

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