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POWER TRANSMISSION

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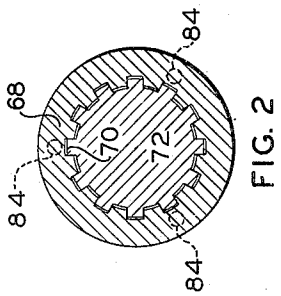



FIG. 2




FIG. 1

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# POWER TRANSMISSION

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This invention relates to power transmissions, and is particularly applicable to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a fluid motor.

The invention is more particularly concerned with a fluid pump or motor construction of the type having a rotary cylinder barrel abutting a stationary valve plate and provided with axial cylinders and pistons reciprocal therein which abut against a thrust plate, the axis of which is inclined to the axis of rotation of the cylinder barrel. It is particularly concerned with that class of devices wherein the pistons abut directly against the inclined thrust plate without the use of articulated connecting rods so that the driving torque is transmitted to the pistons acting as cantilevers by reason of that component of piston thrust against the inclined thrust plate which is normal to the shaft axis.

When a unit of this type is operating under pressure, certain related areas are so proportioned that the cylinder barrel is positively biased toward the valve plate by that pressure in a manner well known in the art. For purposes of starting, however, it is necessary that the barrel be mechanically biased against the valve plate. Further, it is necessary that the pistons be biased outwardly toward the thrust plate to provide proper operation of the device.

In such devices, the normal thrust component or side thrust on the piston not only creates the driving torque but also results in a substantial lateral force on the cylinder barrel tending to displace it from its normal position. In counteracting this lateral force it is important that the cylinder barrel be maintained flatly against the valve plate or it will frequently lift off completely due to fluid flow conditions let up when it starts to lift off slightly. This of course renders the whole device inoperative and may be very hazardous where the device is connected to operate certain types of loads. The axial position of the point of application of the cylinder barrel supporting force may be so selected as to minimize tilting forces on the barrel as hereinafter described.

In prior art devices of this class, support for the cylinder barrel against lateral displacement has been provided by two general schemes. The first of these provides a radial bearing encircling the cylinder barrel directly interposed between the cylinder barrel and the housing. The second scheme has been to support the cylinder barrel directly on the shaft at the driving connection therewith, and transmit the lateral thrust thereon to the housing through the shaft and shaft support.

The second of these schemes has an advantage in that the size and weight of the units can be reduced, and its cost lowered. However, in the past, when the cylinder barrel was shaft supported, the means utilized for biasing the cylinder barrel into engagement with the valve plate and for biasing the pistons outwardly against the thrust plate were generally unsatisfactory.

It is an object of the present invention to provide an



improved cantilever piston type pump or motor of rugged, low cost construction.

More specifically, it is an object to provide such a device having improved means for biasing the cylinder barrel against the valve plate and the pistons outwardly against the thrust plate. A further object is to provide such means which are particularly well suited for use with a cantilever piston pump in which the cylinder barrel is drive shaft supported.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing:

Figure 1 is a longitudinal transverse section of a fluid pressure energy translating device incorporating a preferred form of the present invention.

Figure 2 is a partial section taken on line 2—2 of Figure 1.

The embodiment of the invention selected for illustration comprises a pump 10 of the cantilever piston type. The housing 12 of pump 10 comprises two parts 14 and 16 secured together by bolts, not shown. An O ring seal 20 insures a fluid tight juncture of the two parts and the dowel pin 22 maintains proper angular alignment between them. Body 12 includes a pilot portion 24 and a mounting flange 26 having mounting holes 28 therein.

A bore 30 in housing 12 provides a chamber 32 having a cylinder barrel 34 positioned therein. Cylinder barrel 34 is provided with a plurality of bores 36 each having a piston 38 axially slidable therein and a cylinder port 37. Pistons 38 have spherical ends 40 on which are swaged the socketed shoes 42. The cylinder barrel 34 is positioned axially between a valve plate 44 and an inclined thrust plate 46. Valve plate 44 may be the type described in the patent to Harry F. Vickers et al., 2,313,407, and serves in a well known manner to provide properly phased fluid connection between ports 37 of bores 36 and the external inlet and outlet connection ports of the device, indicated at 48 and 49. Thrust plate 46 may be secured to the housing 12 by a number of screws, not shown.

Shoes 42 have outwardly extending flanges 54 which are contacted by an annular cage 56 provided with holes 58 corresponding to each piston 38. A sleeve 60 is provided with a shoulder 62 to contact cage 56 and has a truncated conical bore 64 therein. Conical bore 64 contacts the spherical outer surface 66 of a collar 68 which is provided with a female spline to engage a male spline 70 on the drive shaft 72. The spline connection between shaft 72 and collar 68 provides, in a short axial distance, strong support for collar 68 against cocking relative to the shaft axis.

A spring 74 is positioned in a central recess 76 in cylinder barrel 34. One end of spring 74 acts against a washer 78 and a snap ring 80 in cylinder barrel 34. The other end of spring 72 is exerted against a washer 82 which abuts a plurality of push rods 84 extending axially through holes 86 in cylinder barrel 34 into engagement with collar 68. Force exerted by spring 74 thus brings the face 35 of cylinder barrel 34 into engagement with face 45 of valve plate 44 and also biases the shoes 42 into engagement with the face 47 of thrust plate 46.

The drive shaft 72 is supported between bearings 73 and 75 and is effective to transmit torque from a prime mover, not shown, to the cylinder barrel through a driving connection at 88. A conventional shaft seal is provided at 77. It can be seen that the only radial support for cylinder barrel 34 is provided by the contact between the barrel and the shaft 72 at connection 88. Connec-

tion 88 is illustrated as a spline connection comprising the male spline 70 and a mating female spline in the cylinder barrel 34. Connection 88 preferably is of the universal type, that is, it prevents relative radial movement at the point of connection between shaft 72 and barrel 34 but permits axial movement of the barrel and existence of angularity between the shaft and cylinder barrel axes. Thus, juncture of the faces 35 and 45 locates cylinder barrel 34 as to axial position and determines the angular position of its axis, and connection 88 locates the barrel radially.

Neglecting friction, torque applied to cylinder barrel 34 by drive shaft 72 is resisted by a force exerted on shoes 42 and hence pistons 38 by thrust plate 46. The force on each piston acts in a direction normal to face 47 of thrust plate 46 and has an effective point of application at the center of the spherical ends 40 of the pistons 30. This force on each piston can be resolved into an axial force and a radial force acting at the center of the spherical piston end. The summation of the radial forces is the radial force which must be supported by shaft 72 at the connection 88.

It is well known in the art that tipping forces on the cylinder barrel of such a unit can be kept to a minimum by providing its radial support as close as possible to a radial plane through the point of intersection of the drive shaft axis and the plane which includes the centers of the spherical ends of the pistons. The plane containing the centers of the piston ends is indicated at 90 and the point of intersection with the shaft axis at 92. It can be seen that connection 88 is positioned in close axial proximity to intersection 92 thus minimizing tipping forces on the barrel 34.

The axis 94 of the conical bore 64 intersects the axis of shaft 72 at the point 92, and point 92 is also the center of the spherical surface 66 of collar 68 as indicated by the radius 96. The geometrical arrangement described insures that sleeve 69 and collar 68 can rotate freely about their respective axes while at the same time full circle contact is maintained between the spherical surface 66 and the conical bore 64. Further, relative motion between the cages 56 and shoes 42 is thus minimized. The spring 74 is effective to bias the cylinder barrel 34 against valve plate 44 and shoes 42 against thrust plate 46 without appreciable flexure during operation of the unit. Long trouble free life is thus assured.

It will thus be seen that the present invention provides a rugged, compact, and low cost cantilever piston pump or motor having improved means for biasing the cylinder barrel against the valve plate and the pistons outwardly against the thrust plate. Further, the invention provides such means especially well suited for use in a unit having a shaft supported cylinder barrel since the cylinder barrel support and the piston biasing collar may be in close axial proximity even though a large rugged biasing spring is provided to exert its force between the coller and the cylinder barrel.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A fluid pressure energy translating device comprising: a drive shaft; a housing having a stationary valve plate; a rotatable cylinder barrel in abutment with the valve plate and having a plurality of axial cylinder bores; a female spline in said cylinder barrel mating with said male spline on the drive shaft to form a driving connection; pistons reciprocable in the bores; an inclined thrust plate mounted in the housing in driving relation with the pistons; inlet and outlet ports alternately connectable through the valve plate to said cylinder bores by rotation of the cylinder barrel; an axially slidable collar encircling the drive shaft and supported concentric therewith and having a spherical outer surface; a sleeve member having a central recess contacting the spherical outer surface of the collar; a mechanical force transmitting connection between said sleeve and said pistons; a central recess in the cylinder barrel; first abutment means in said cylinder barrel; second abutment means on said collar opposed to said first abutment means; resilient biasing means positioned in the recess in said cylinder barrel; and a mechanical force transmitting connection between the resilient means and the second abutment including at least one axial push rod extending from said recess in said cylinder barrel through a portion of said barrel to contact said collar, said push rod being positioned radially outward of said driving connection and axially spanning said driving connection.

2. A fluid pressure energy translating device comprising: a drive shaft; a housing having a stationary valve plate; a rotatable cylinder barrel in abutment with the valve plate and having a plurality of axial cylinder bores; a female spline in said cylinder barrel mating with said male spline on the drive shaft to form a driving connection, said driving connection also providing the sole means for locating the cylinder barrel as to lateral movement; pistons reciprocable in the bores; an inclined thrust plate mounted in the housing in driving relation with the pistons; inlet and outlet ports alternately connectable through the valve plate to said cylinder bores by rotation of the cylinder barrel; an axially slidable collar encircling the drive shaft and supported concentric therewith and having a spherical outer surface; a sleeve member having a central recess contacting the spherical outer surface of the collar; a mechanical force transmitting connection between said sleeve and said pistons; a central recess in the cylinder barrel; first abutment means in said cylinder barrel; second abutment means on said collar opposed to said first abutment means; resilient biasing means positioned in the recess in said cylinder barrel; and a mechanical force transmitting connection between the resilient means and the second abutment including at least one axial push rod extending from said recess in said cylinder barrel through a portion of said barrel to contact said collar, said push rod being positioned radially outward of said driving connection and axially spanning said driving connection.

3. A fluid pressure energy translating device comprising: a drive shaft; a housing having a stationary valve plate; a rotatable cylinder barrel in abutment with the valve plate, and having a plurality of axial cylinder bores; means forming a driving connection between the cylinder barrel and the drive shaft; pistons reciprocable in the bores; an inclined thrust plate mounted in the housing in driving relation with the pistons; inlet and outlet ports alternately connectable through the valve plate to said cylinder bores by rotation of the cylinder barrel; an axially slidable collar encircling the drive shaft and supported concentric therewith and having a spherical outer surface; a sleeve member having a central recess contacting the spherical outer surface of the collar; a mechanical force transmitting connection between said sleeve and said pistons; a central recess in the cylinder barrel; first abutment means in said cylinder barrel; second abutment means on said collar opposed to said first abutment means; resilient biasing means positioned in the recess in said cylinder barrel; and a mechanical force transmitting connection between the resilient means and the second abutment including at least one axial push rod extending from said recess in said cylinder barrel through a portion of said barrel to extend axially across at least part of said driving connection and to contact said collar.

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