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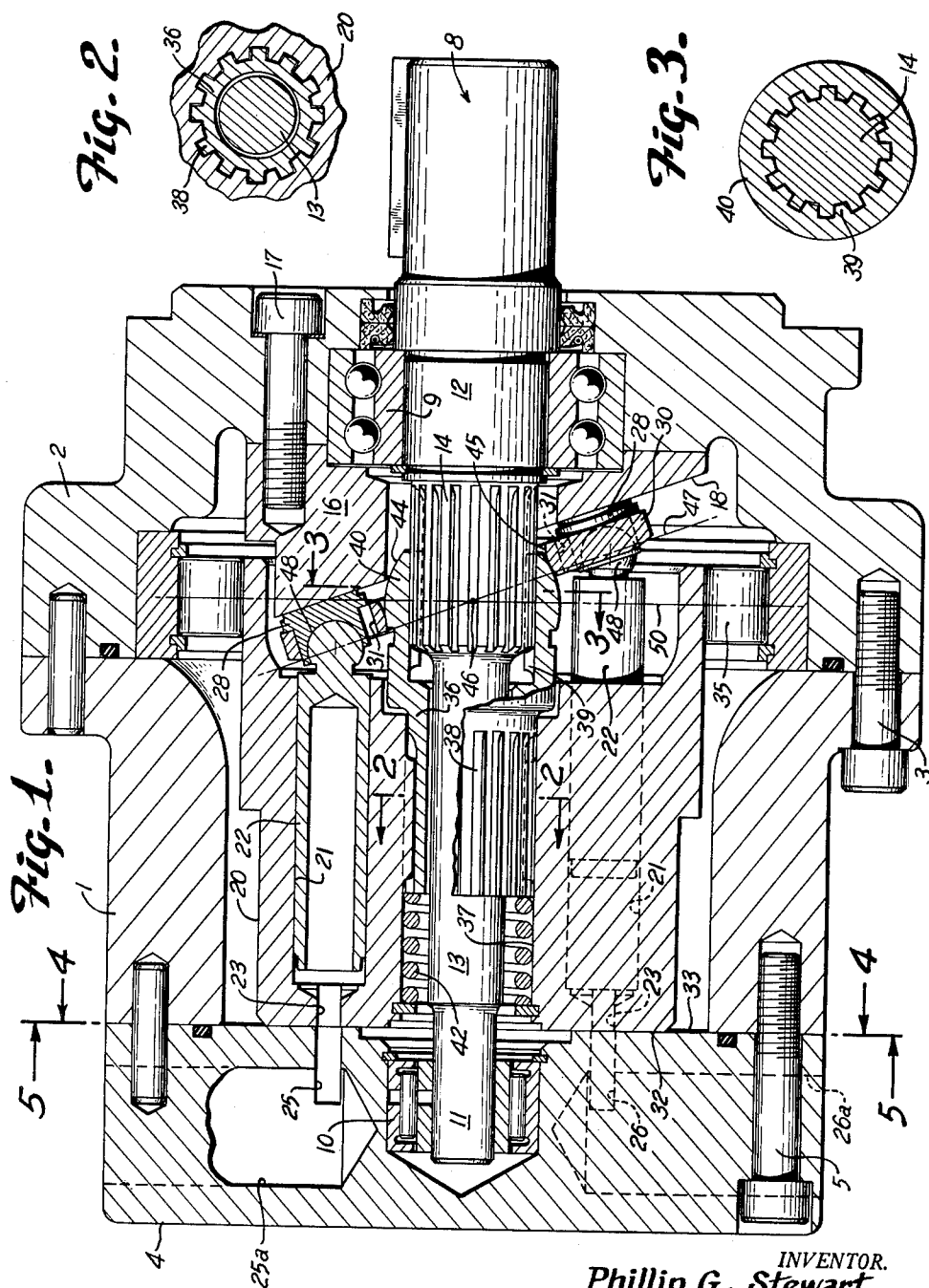
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3,139,038

ENGINE

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2 Sheets-Sheet 1



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Fig. 5.

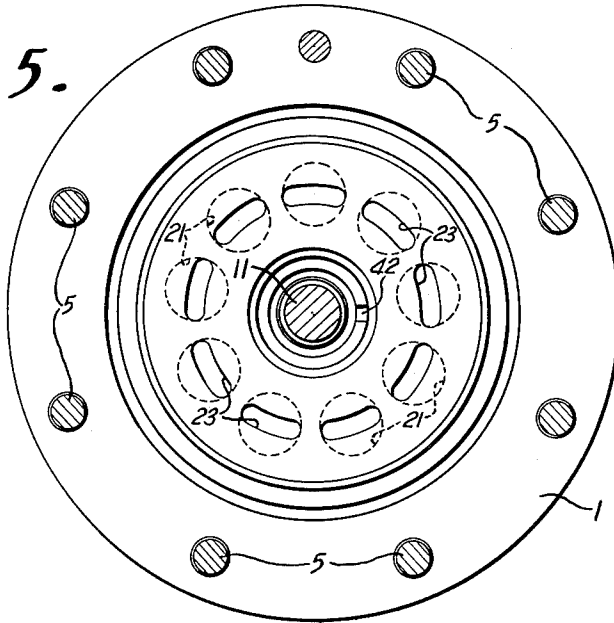
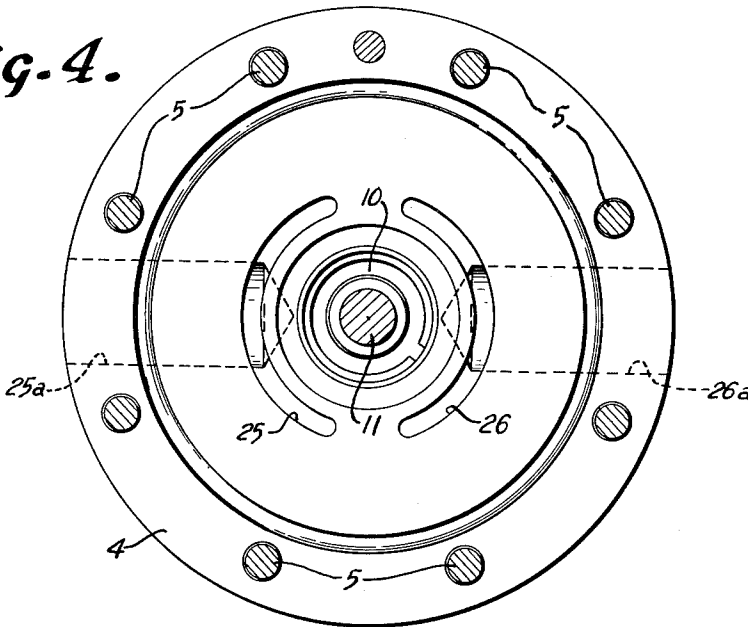


Fig. 4.



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This invention relates to fluid pressure engines and more particularly to engines of the rotary cylinder barrel, longitudinally reciprocating piston type. As used herein, the term engine means a device which is capable of being operated as either a pump or motor.

Engines of the type mentioned are well known in the art and include a rotatable cylinder barrel containing a plurality of circumferentially spaced longitudinal cylinder bores, a piston slidably received in each bore and having a spherical surface formed on one of its ends, an inclined cam plate associated with the pistons at their spherical ends for moving them on their discharge strokes, and a valve member for sequentially transmitting fluid to and from the cylinder bores as the barrel rotates.

The engines shown for purposes of illustrating the present invention are of the above type which are furthermore of the non-articulated piston type, having a cam plate with an uninterrupted surface which bears against slippers carried by the pistons. The force transmitted to each piston through the slipper acts in a direction normal to the surface of the cam plate. The present invention also utilizes a valve member of the ported plate type which abuts against an end face of the cylinder barrel.

The force transmitted between the cam plate and each piston acts in a direction normal to the surface of the cam plate and this force, of course, can be resolved into two components, one being in the direction of the piston axis and the other normal thereto.

The first mentioned component acts to force the pistons through their discharge strokes, but the second tends to cause tilting of the cylinder barrel with respect to the valve plate. This angular misalignment between the cylinder barrel and the valve plate results in leakage and the problems in this respect are dealt with in the U.S. Patent 2,925,046 which issued on February 16, 1960, and over which the present invention is an improvement.

More specifically, the present invention relates to an improved torque tube means for mounting the cylinder barrel to minimize leakage between it and the valve plate, and which also universally mounts the keeper ring for the tiltable piston slippers and maintains the latter in firm engagement with the swash plate.

The arrangement provided by the present invention is such that one end of the barrel is more or less free to adapt itself into sealing engagement with the valve plate, and at the same time, the torque tube or sleeve on which the barrel is mounted acts to support the keeper ring and urge it, together with its slippers, toward the swash plate.

The invention also provides a motor of the above type in which the location and relative positioning of the swivel points for the slippers and their keeper ring is such that minimum relative movement occurs therebetween.

The cylinder barrel is supported by means of a large bearing which is mounted in the motor housing, and the center of contact between this bearing and the barrel is positioned to be precisely in the plane in which the sum of the normal components of the piston-cam thrust forces tends to act. Thereby, movements due to the normal components of the thrust force will counterbalance each other about the point of support and the cylinder barrel will experience no tilting.

These and other objects and advantages will appear

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hereinafter as this disclosure progresses, reference being had to the accompanying drawings in which:

FIGURE 1 is a longitudinal sectional view through a fluid motor embodying the present invention;

FIGURE 2 is a transverse sectional view taken generally along line 2-2 in FIGURE 1;

FIGURE 3 is a transverse sectional view taken along line 3-3 in FIGURE 1;

FIGURE 4 is a view of the valve plate taken on line 4-4 of FIGURE 1 and showing the kidney shaped inlet and outlet grooves, and

FIGURE 5 is a view taken on line 5-5 in FIGURE 1 and showing the ports leading to the piston chambers.

Referring more particularly to the drawings, the motor housing comprises a generally circular section 1 to which the rear section 2 is fastened by cap bolts 3. The housing also includes a cover in the form of the valve plate 4 which is secured to section 1 by cap bolts 5. These sections are held in sealing engagement with one another in the well-known manner.

An output shaft 8 is journaled in the housing at two axially spaced locations by the anti-friction bearing assemblies 9 and 10, and includes a small end portion 11 piloted in the bearing assembly 10 and a larger diameter portion 12 journaled in the bearing assembly 9. The output shaft also includes an intermediate portion 13 and a larger diameter intermediate portion 14 which is externally splined.

A swash plate 16 is fixed to the interior of the housing by cap bolts 17 (only one shown) and presents an inclined surface 18 against which the slippers, to be described, slide as they rotate.

The cylinder barrel 20 is connected to the shaft 8 for rotation therewith, and includes a plurality of circumferentially spaced and axially positioned chambers or cylinders 21 in each of which a hollow piston 22 is adapted to reciprocate. An arcuate passage or slot 23 extends from each of the chambers, which slots contribute to more efficient flow between the chambers 21 and the inlet and outlet grooves 25 and 26 in the valve plate. Thus, the chambers communicate alternately with the kidney-shaped inlet and outlet grooves 25 and 26 as the barrel rotates. Grooves 25 and 26 communicate with their respective external ports 25a and 26a.

Each of the pistons terminates at its rear end in a spherical portion on which a tiltable slipper 28 is held captive and swivelly mounted in the well-known manner. These slippers are adapted to slide against the inclined surface 18 of the fixed swash plate and as the cylinder barrel rotates the pistons are reciprocated to drive shaft 8 in the known manner when the device is functioning as a motor.

A keeper ring 30 has a series of circumferentially arranged apertures 31, in each of which one of the slippers 28 is loosely mounted. Sufficient play is left between the slipper and its respective aperture 31 to permit the slipper to slide within the aperture as the pistons rotate around the swash plate.

The cylinder barrel 20 has a smoothly finished front end 32 which sealingly engages the adjacent surface 33 of the valve plate, and this surface of the barrel rotates against the valve plate surface 33 so as to permit fluid to pass from the porting in the valve plate to and from the chambers 21. In order that leakage is held to a minimum between the barrel and the valve plate, it has heretofore been found necessary to prevent the cylinder from cocking or wobbling to any extent as it rotates. In other words, the cylinder barrel must "float" to a certain extent, which action permits the surface 32 of the barrel to adapt itself in sealing engagement with the valve plate surface 33.

The barrel is mounted around the periphery of its rear end in the housing by means of the large bearing assem-

bly having antifriction roller bearings 35, the assembly being firmly mounted in the housing. The front end of the barrel is free to "float," so it may adapt itself in tight sealing engagement with the valve plate.

In accordance with the present invention, a drive means has been provided for the cylinder barrel which permits the latter to "float" in the above-mentioned manner and which also urges the pistons, through their respective slippers and keeper ring, toward the extended position, in other words, biased toward the swash plate. The drive means for accomplishing these functions will be presently described.

A sleeve 36 is located on shaft 8 and in the bore 37 of the barrel and is splined to each for rotation therewith as a unit. The sleeve can also slide axially relative to both the shaft 8 and barrel 20, as follows: The bore 37 is internally splined and thus drivingly connected with the externally splined portion 38 of the sleeve. The internally splined portion 39 of the sleeve is drivingly connected to the externally splined and enlarged portion 14 of the shaft 8.

A spring 42 surrounds the portion 13 of shaft 8 and is located in the bore 37 of the barrel, and serves to urge the sleeve toward the swash plate.

The periphery of the enlarged portion 40 of the sleeve is formed generally as a sphere 44 on which the keeper ring is mounted for swivelling thereon. The internal diameter of the aperture 45 formed in the center of the ring is somewhat smaller than the outside diameter of the sphere 44 and thus the sphere is effective to urge the keeper ring toward the swash plate. In other words, the minimum internal diameter 45 is positioned to the right (as viewed in FIGURE 1) of the maximum diameter of the sphere.

As shown in FIGURE 1, the point about which the keeper ring swivels on the sphere has been indicated at 46. A plane 47 which passes through all of the centers of the balls 48 of each of the pistons also passes through point 46. By so positioning these points, the travel of the slippers in their respective apertures 31 of the keeper ring is held to a minimum.

It should furthermore be noted that a plane 50 passing through the center of the roller bearings 35 in an axial direction also passes through point 46. In other words, the swivel point 46 is in alignment in an axial direction with the center of bearings 35 in an axial direction. This arrangement prevents any wobbling or cocking of the barrel for the following reason: When the pistons are pushing their slippers against the swash plate, certain components of these forces extend in a radial direction. The resultant of all of these component forces in the radial direction will pass through point 46 which is the pivot point for the keeper ring and also the point included in the plane of all of the points of swivel for the slippers. Thus, the resultant radial force will pass directly through the center of and be absorbed by bearing 35 which has the effect of preventing any tilting or wobbling of the barrel. As a result, a highly stable barrel is provided which adapts itself in sealing engagement with the valve plate. A particularly smoothly operating pump results having minimum leakage at the valve plate.

The sleeve or torque tube 36 also provides a swivel mounting for the keeper ring, and resilient means urge this tube and its associated keeper ring toward the cam surface of the swash plate and consequently, the slippers firmly against the cam surface. The improved torque tube connects the input shaft to the cylinder barrel without transmitting any radial locating force to said barrel. Consequently, one end of the barrel is solely located radially by the large bearing assembly 35. The barrel is positioned angularly and longitudinally by its contact with the valve plate. Hydraulic pressure plus spring force causes the barrel to ride in contact with the valve plate.

The antifriction bearing assembly 35 is firmly mounted

in the pump housing and is located adjacent to and around the periphery of one end of the cylinder barrel, thereby laterally fixing that end of the barrel accurately in the housing and in respect to the drive shaft 8. The other end of the barrel can move laterally only a small amount, but sufficiently so its end sealingly bears against the valve plate.

At the same time, the torque tube or sleeve universally mounts the keeper ring and urges it, together with its slippers, toward the swash plate. The floating of one end of the barrel is required to overcome the eccentricity that exists between the shaft centerline and centerline of the barrel when it is riding in proper sealing contact with the cover plate. The majority of this eccentricity is a result of three factors:

(1) The machining tolerances that allow eccentricity of the housings, valve plate, and barrel relative to their true centerline.

(2) The machining tolerances that allow non-perpendicularity of the ends of the housings, of the valve plate wearing surface, and of the barrel wearing surface to their true centerline.

(3) The clearance that exists in the large housing bearing. This clearance is a factor because when the motor is operating, the normal component of the cam-piston thrust force will cause the cylinder barrel to engage the housing bearing, thus eliminating all clearance on one side of the bearing and causing all of the clearance to occur on the other.

This arrangement overcomes the high leakage problem which exists in units where the cylinder barrel is mounted in a housing bearing and also is mounted on a shaft.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. A fluid pressure engine including a rotatable cylinder barrel having an axial chamber therethrough defined by a cylindrical wall, a plurality of pistons in said barrel for rotation therewith and each piston having a tiltable slipper attached to one end of a non-rotatable swash plate having an inclined surface against which said slippers are adapted to slide and for causing reciprocation of said pistons as they rotate with said barrel, a keeper ring in which said slippers are mounted, a drive shaft extending through the length of said chamber, a sleeve having an outer surface of a first end splined to said wall and the inner surface of its second end splined to said shaft causing said shaft and barrel to rotate as a unit but permitting relative slidable movement between said barrel and said shaft longitudinally of said shaft, said sleeve having a portion adjacent said second end on which said ring is tiltable mounted, and resilient means biasing said sleeve and said ring toward said swash plate for causing said slippers to engage said surface.

2. A fluid pressure engine as defined in claim 1 further characterized in that said portion is generally spherical and said ring is tiltable mounted about its central aperture on said portion, and said aperture having a diameter less than said spherical portion whereby said spherical portion can push said ring in an axial direction.

3. An engine as defined in claim 1 including a main bearing located adjacent and around the periphery of one end of said barrel for rotatably supporting the latter, and further characterized in that the center point of swivel is in alignment in an axial direction with the axial center of said bearing.

4. The fluid pressure engine defined in claim 3 wherein said center point of swivel is located in a plane passing through points about which said slippers pivot.

5. An engine as defined in claim 3 including a main bearing located about the periphery of one end of said barrel for rotatably supporting the latter end, and further

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characterized in that said swivel point is in alignment in an axial direction with the axial center of said bearing and in a plane normal to said shaft which intersects the mid-point of the longitudinal length of said bearing.

6. An engine comprising a housing; a drive shaft journaled in the housing; a rotatable cylinder barrel encircling the drive shaft and radially spaced from it; a circumferential series of cylinder bores extending through the barrel; a valve plate located in the housing in abutment with an end face of the cylinder barrel and having inlet and discharge ports which sequentially register with each cylinder bore as the barrel rotates; pistons, one reciprocable in each cylinder bore and having a spherical surface at the end remote from the valve plate; a keeper ring encircling said drive shaft; a tiltable slipper secured to each said spherical surface and mounted in said ring; an inclined cam plate for moving the pistons on their discharge strokes with a force which acts in a direction normal to the surface of the cam plate; an anti-friction bearing assembly mounted in said housing and around the periphery of one end of said barrel for laterally but not longitudinally locating said end of the cylinder barrel with

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respect to the shaft, said bearing also providing free rotation of the barrel axis about the point of intersection of the shaft axis and the plane of the centers of the spherical surfaces on the pistons; and a torque tube splined at respective opposite ends to the cylinder barrel and to the shaft; said ring being tiltably mounted on said tube; and resilient means for urging said tube and said ring toward said cam plate.

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