ABSTRACT

This device for retaining the hydrostatic shoes of oleohydraulic pumps or motors of the barrel-cylinder type comprises a bearing member formed with peripheral recesses which urges said shoes against an inclined plane surface in conjunction with the thrust exerted by a part-spherical washer responsive to a resilient member prestressed between a bearing face of the driving shaft and the part-spherical washer, the flexion of said resilient member being adjustable in a manner known per se by means of a device for adjusting the operating play between the hydrostatic shoes and the inclined plane surface.

2 Claims, 9 Drawing Figures
DEVICES FOR RETAINING THE SLIDING SHOES OF BARREL PUMPS AND MOTORS

The present invention relates in general to oleohydraulic pumps and motors of the barrel-cylinder type, wherein the pistons are reciprocated in a direction parallel to the axis of the pump or motor. This reciprocating motion is controlled by an impeller or swash plate on which the piston heads are caused to slide, these piston heads being generally provided to this end with so-called hydrostatic sliding shoes.

It is the essential object of the present invention to provide means for constantly urging said shoes against said swash plate.

In the following disclosure only pumps will be referred to for the sake of simplicity, but it will be readily understood by those conversant with the art that this disclosure applies as well to motors of the aforesaid type.

During a rotation of the pump cylinder barrel, it is known that each piston is accelerated during the delivery stroke, then accelerated again but in the reverse direction and also decelerated in this reverse direction during the suction phase. During the delivery stroke deceleration, and during the suction stroke acceleration, the vis inertia or kinetic energy of the pistons and shoes tend to separate these shoes from the swash plate. On the other hand, during the suction stroke, the friction force developing between the pistons and cylinders tends to facilitate this separation. Though the delivery pressure of the pump, during one fraction of the movement urges the pistons and shoes towards the plate, complementary retaining means are provided so that their efficiency can be relied upon under all operating conditions.

Pumps are well known wherein the hydrostatic shoes are urged against the swash plate by a retaining plate. This retaining plate has formed therein a recess for a dished washer urged by a spring tensioned or prestressed between the washer and the bottom of said recess, so that this spring also assists in pressing the cylinder barrel against the distributor plate.

This arrangement is attained by the exertion, by the cylinder barrel, of an excessive pressure against the distributor plate, in comparison with the force necessary for ensuring a satisfactory pump operation when the pump is of the high rotational speed type, for the kinetic energy exerted on the pistons are abnormally high. The considerable force urging the barrel against distributor plate are particularly detrimental when the pump is started.

Pumps are known wherein the sliding shoes crimped on the piston heads are constantly urged against the swash plate by a retaining plate urged in turn against the plate by tappets screwed to said plate. However, this arrangement is objectionable in that it requires a high degree of precision as far as the thicknesses of the retaining plate, of the shoe bases and of the tappets are concerned, in order to avoid any excessive play or, in contrast thereto, any jamming of the parts involved. It also requires a good condition of the contact surfaces between the plate and tappets, for the relative speeds between shoes and tappets may cause premature wear or sizing.

In the French Pat. No. 1,577,889 there is described a pump wherein the pistons are crimped on the part-spherical heads of the hydrostatic shoes. The shoes engage a rotary, hydrostatically balanced plate bearing against the swash plate. A shoe retaining plate is rigidly connected by means of screws to the rotary plate and prevents the shoes from moving away from this rotary plate due to the provision of recesses slidably engaged by the flat base faces of said shoes.

Now this arrangement requires an accurate machining of these base faces and also of the retaining recesses, if it is desired to eliminate any risk of seizing, without resorting to undesirably broad machining tolerances.

On the other hand, the sum of the efforts due to the kinetic energy or vis inertia of the different pistons and shoes produces a torque tending to increase the inclination of the retaining plate in relation to the barrel axis. The corresponding reaction torque can be provided only by an eccentric reaction of the swash plate which is balanced by a prestressed spring housed in the barrel. The aforesaid spring must therefore have dimensions sufficient to compensate this reaction in case the pump were caused to rotate at high speed under zero load conditions. Since this spring also urges the barrel against the distributor plate, the sliding contact surfaces of the barrel and/or distributor plate are most likely to be damaged when the pump is operated under these conditions.

The device according to this invention is intended for retaining the pistons and sliding shoes of pumps and motors of the above-defined type against the surface of the swash or impeller plate by means of a connecting device of the type permitting the adjustment and taking up of play through a resilient member. This invention is also directed to an elastic coupling member adapted to exert on the shoes moderate retaining forces at low speeds and relatively considerable retaining forces at high speeds.

Furthermore, this invention provides a shoe retaining device permitting the separate adjustment of the force urging the cylinder barrel against the distributor plate.

The device according to this invention, which comprises a bearing member formed with peripheral recesses and adapted to press the shoes against an inclined flat surface in conjunction with the thrust exerted by a part-spherical washer responsive to the action of a resilient member, is characterized in that said resilient member is mounted in a prestressed condition between a bearing surface formed on the pump driving shaft and the part-spherical washer, and that the permissible flexion of said resilient member is adjustable in a manner known per se by means of a device for adjusting the operating clearance between the hydrostatic shoes and said inclined flat surface.

Other features and advantages of this arrangement will be disclosed as the following description proceeds with reference to the accompanying drawings illustrating diagrammatically by way of example a few typical forms of embodiment of the invention.

In the drawings:
FIG. 1 is a sectional view of a pump, the section being taken along the line I—I of FIG. 2;
FIG. 2 is an end view of the pump barrel;
FIG. 3 is a fragmentary sectional view of the pump, taken along the line III—III of FIG. 2;
FIG. 4 is a plane view of the pump shoes bearing member;
FIG. 5 is a section taken along the line V—V of FIG. 4;
FIG. 6 is an orthogonal projection on the impeller or swash plate of the rotational axis of the cylinder barrel and of the point of intersection of the axis of rotation of the shoe on the plate surface:

FIG. 7 is a sectional view showing a hydrostatic shoe on a larger scale, and FIGS. 8 and 9 are two axial sectional views showing two modified forms of embodiment of pumps according to this invention.

Referring to the drawings, the hydrostatic shoes 1 are connected to the relevant pistons 2 by means of partspherical barrel members 3 retained by a clip.

These hydrostatic shoes 1 are adapted to slide on the registering surface of a rotary plate 4 bearing in turn against the swash or impeller plate 5. This plate 5 comprises hydraulic bearings 6 corresponding in shape to the hydraulic bearings 7 provided between the cylinder barrel 8 and the distributor plate 9. A bearing member 10 contacting the face 11 of said hydrostatic shoes 1 is formed with recesses 12, shown more in detail in FIGS. 4 and 5, which permit the passage of the cylindrical necks 13 of said shoes. The bearing member 10 comprises on the other hand a recess 14 having a partspherical surface central to the axis of rotation of plate 4 and at least two centering studs 15. This bearing member 10 is centered by means of its partspherical surface 14 engaging a washer 16 bounded by a partspherical outer surface complementary to the surface of member 10, and centered to the shaft 17 of the pump and in the plane of the centers of the partspherical or barrel members 3 of the hydrostatic shoes. The bearing member 10 engages one face of shaft 17 (shown in the form of its spline 18 connecting this shaft to cylinder barrel 8) through the medium of a resilient member such as an elastic washer 19 and a rigid washer 20. The elastic washer 19 is adapted, from its stressed condition, to be deflected by a few tenths of millimeter. The centering and rotary coupling or rotary plate 4 in relation to bearing member 10 are obtained by means of the centering studs of this member which engage corresponding cavities formed in said rotary plate, as shown notably in FIG. 3.

The bearing member 10 is rotatably driven on the one hand by the frictional engagement with the partspherical washer 16 and on the other hand by the cylindrical necks 13 of the hydrostatic shoes 1 slidably engaging the recesses 12 of this bearing member with a play sufficient to permit their relative movement during the operation of the device. In fact, as shown in FIG. 6, the projection on the swash plate 5 of the swivel ball of each shoe 1 describes during the operation of the device an ellipse $e$, at an angular speed $\omega$ and an amplitude varying during the movement at a rotational speed $\omega_2$ of barrel 2 which is assumed to be constant. The angular shift between the projections, on swash plate 5, of the centers of two successive shoes 1 will also vary during a barrel revolution, so that the bearing plate 10 of which the recesses 12 are disposed at spaced angular intervals along its periphery is driven in succession by all the shoes 1 during one fraction of a revolution.

The synchronous rotation of pistons 2, shoes 1, bearing member 10 and rotary plate 4 is necessary for delivering lubricating oil under pressure to the bearings 6 of impeller or swash plate 5 through orifices 21 formed in the rotary plate 4 and opening into the shallow cavity formed in the sliding contact surface of the base of each shoe 1.

The centering studs 15 may consist of insert pieces. The swash or impeller plate 5, of which the rear face has the shape of a portion of cylinder having its axis directed towards the center of the part-spherical surface of washer 16, engages the complementary cylindrical surface of the end bearing of the pump casing or body.

The shaft 17 is mounted in this bearing by means of a compound rolling-contact bearing 22 comprising axial and radial rollers. The mounting is obtained by using a nut 23 engaging a counter-plate 24.

When assembling the parts, the adjustment device comprising this nut 23 is tightened home, so that the resilient washer 19 is fully compressed and the parts inserted between the spline 18 of shaft 17 and the nut 23 are in successive direct engagement, i.e., without any play. Then the nut 23 is released by an angle such that its axial movement corresponds to the desired operating clearance for the aforesaid stacked parts, and the lock washer 25 is eventually bent to fix the desired adjustment position.

This play is sufficient for absorbing such dimensional variations in the stacked parts as may result from temperature variations, speed and load variations (which alter the thickness of the oil films), and also from geometrical defects.

In the following disclosure it will be assumed that the force necessary for compressing home the resilient washer 19, although of moderate magnitude, is greater than the force of spring 26 of which the only function is to keep the barrel in frictional contact with the distributor plate. It may be noted that the reverse disposal may be used as well.

In the case illustrated by way of example the operating clearance resulting from the calculated release of nut 23 is taken up completely by the resilient washer 19, and the dimensional variations occurring during the pump operation in the parts stacked between the shaft spline 18 and nut 23 are compensated by this resilient washer 19. Since this play remains relatively moderate in comparison with the total channel of washer 19 in its unstressed condition, this washer produces an effort approximating that required for obtaining its maximum compression.

As the pump shaft speed increases and as a function of the angle of inclination of swash plate 5, the inertia or kinetic energy of pistons 2 and hydrostatic shoes 1 increases and is attended by a reaction exerted by the aforesaid bearing member 10 against the part-spherical washer 16.

This reaction is subordinate to the pump pressure for during one fraction of the shoe movement the thrust exerted by the oil on the pistons balances the inertia forces tending to move the shoes away from the rotary plate.

However, as long as this reaction remains inferior to the pressure exerted by the resilient washer, the camber of this washer remain unchanged. When this reaction is superior to said pressure, the resilient washer is gradually compressed and the hydrostatic shoes move away from the rotary plate by a value depending on their position but remaining relatively moderate, of the order of magnitude of the operating clearance contemplated initially.

Under these conditions, it will be seen that the arrangement according to this invention permits of adjusting the maximum play between the rotary plate and
the hydrostatic shoes by properly releasing the previously tightened nut 23 as explained hereinabove. Under these conditions it will be seen that it is particularly advantageous to utilize a resilient washer such that the minimum force necessary for compressing same completely be inferior to the force with which the complete set of shoes 1 bear against the swash plate.

It will also be seen that at low speeds the pressure exerted by bearing member 10 on shoes 1, by these shoes 1 on the rotary plate 4 and by this rotary plate 4 on swash plate 5, are low in comparison with the pressure values necessary for overcoming the inertia forces at high speeds and with a greater inclination of swash plate 5. Therefore, the mechanical efficiency at low speed is improved and the risks of seizing the parts are reduced considerably.

This arrangement further permits a proper choice of the spring 26 urging the barrel against the distributor plate, since the spring action is independent of that of said resilient washer 19 urging the bearing member 10, shoes 1 and rotary plate 4 against the swash plate 5. Consequently, these two resilient forces may be adjusted separately.

Another advantage resulting from this arrangement is that it minimizes the degree of overhang of the radial effort exerted on piston heads in the outermost position of these pistons in relation to their cylinders, this overhang being eliminated completely in the innermost position.

FIG. 7 illustrates another possibility of synchronizing and centering the rotary plate 4 in relation to the hydrostatic shoes 1 by means of studs 15, inserted in these shoes 1 and engaging corresponding recesses 27 formed in the rotary plate, with a play sufficient for permitting their relative movements during the pump operation; in fact, any point of the axis of each stud 15, describes an ellipse whereas the center of each recess 27 describes a circle as already explained hereinabove. The studs 15, are hollow and comprise a slot 28 permitting the delivery of oil to the shoe bearing and to the impeller or swash plate bearings 6. It will be noted that these studs 15, may as well be secured to the rotary plate 4, the operating play being provided in this case by a recess similar to recesses 27 but formed in the shoe.

Moreover, it is clear that the operating play adjustment nut 23 may be replaced by a circlip, the counterplate 24 being in this case selected among a series of gauged counterparts having different thicknesses, the choice of the proper plate 24 being subordinate to the measurement of the necessary play when assembling the parts.

According to the modified form of embodiment illustrated in FIG. 8 the hydrostatic shoes 1 are in direct sliding contact with the swash plate 5, without any intermediate rotary plate. On the other hand, no centering studs are provided on the bearing member 10. This arrangement is advantageous in that it is considerably simpler but attended by a considerable speed in the relative sliding movements between shoe and plate; thus, the thrust, not hydrostatically, is relatively high especially when the angle of inclination of the swash plate is relatively great.

The arrangements described hereinabove are also applicable to constant-output pumps. In this case the swash plate 5 is rigid with the pump body or casing. They are also applicable to any type of swash or impeller plates, notably those adapted to pivot about pivot pins 30 of relatively small diameter, disposed on either side of the barrel and having their common axis disposed in the plane containing the centers of the part-spherical ball members 3 of the hydrostatic shoes 1, this axis also passing through the center of the spherical surface of the part-spherical washer 16, as illustrated in FIG. 9.

Although a few forms of embodiment of this invention have been described and illustrated herein, it will readily occur to those conversant with the art that various modifications and variations may be brought thereto without departing from the spirit and scope of the invention as set forth in the appended claims.

What is claimed as new is:

1. Device for retaining the hydrostatic shoes of oleo-hydraulic pumps and motors of the barrel-cylinder type, wherein the pistons are reciprocated by means of a swash plate inclined in relation to the axis of rotation of the barrel in a direction parallel to the driving shaft of said pump or motor and the barrel-cylinder being urged toward the distributor plate by a spring, this device comprising a bearing member formed with peripheral recesses urging the shoes against an inclined plane surface in conjunction with the thrust exerted by a part-spherical washer responsive to the action of a resilient washer, said resilient washer being mounted in a prestressed condition between a bearing face located on the driving shaft and said part-spherical washer, the flexion of said resilient washer being adjustable by means of a device for adjusting the operation clearance between the hydrostatic shoes and said inclined plane surface comprising a means external to the device and adapted to permit the axial positioning of said driving shaft so that said resilient washer can yield at high speed and said inclined plane surface held in sliding contact with said shoes being formed on a rotary plate centered and rotatably driven together with said bearing member by the mutual engagement of studs and recesses therefor, said rotary plate being provided with orifices permitting the passage of fluid, the number of these orifices corresponding to that of said shoes, said orifices opening under each shoe and also into a hydrostatic bearing provided between the rotary plate and said swash plate.

2. Device for retaining the hydrostatic shoes of oleo-hydraulic pumps and motors of the barrel-cylinder type, wherein the pistons are reciprocated by means of a swash plate inclined in relation to the axis of rotation of the barrel in a direction parallel to the driving shaft of said pump or motor and the barrel-cylinder being urged toward the distributor plate by a spring, this device comprising a bearing member formed with peripheral recesses urging the shoes against an inclined plate surface in conjunction with the thrust exerted by a part-spherical washer responsive to the action of a resilient washer, said resilient washer being mounted in a prestressed condition between a bearing face located on the driving shaft and said part-spherical washer, the flexion of said resilient washer being adjustable by means of a device for adjusting the operation clearance between the hydrostatic shoes and said inclined plane surface comprising a means external to the device and adapted to permit the axial positioning of said driving shaft so that said resilient washer can yield at high speed and said inclined plane surface in sliding contact
with the shoes being a rotary plate centered and rotatably driven with the shoes by the mutual engagement of studs and recesses therefor, said rotary plate having fluid passage orifices equal in number to said shoes, said passage orifices opening under each shoe respectively and into a hydrostatic bearing of said rotary plate engaging said swash plate. * * * *