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(54) AXIAL PISTON MACHINE

(71) We, LINDE AKTIENGESELLSCHAFT, a German Company, of Abraham-Lincoln-Strasse 21, D-6200 Wiesbaden, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an axial piston machine which can be operated like a motor or preferably like a pump.

For many axial piston machines, in particular those which are operated by a combustion engine and are directly connected to the same, it is important that, when they have been brought to a stop, they are returned to the zero stroke conditions thereof so that they do not deliver at the time when the combustion engines are restarted and thus pick up a high torque and, perhaps, actuate the engines which are driven via the gears.

In the case of restoring devices hitherto known for axial piston machines having angularly adjustable rockers, a spring touches a lever arm beyond the swivel axis. In this context, some designs have on each of the two sides of the swivel axis a pre-stressed spring assembly which is arranged inside a servo adjusting cylinder provided here. Such an arrangement is extremely expensive and requires a great deal of structural space and weight and, above all, points are necessary in which play can occur. Moreover, arrangements of this kind are not easily accessible for the purpose of adjustment from the outside. Known restoring devices for axial piston machines of angularly adjustable rocker design having a servo (power amplification) arrangement for swivelling the swivel housing are provided with a spring coaxial with the servo adjusting piston, whereby this spring is clamped between stops in such a way that, each time the adjusting piston is displaced from that position thereof which is assigned to the zero stroke position of the pump, the spring is compressed, irrespective of the direction of displacement motion of the adjusting piston. In this case as well, a moving joint where play can occur is required between the spring and the swivelling part.

It is the aim of the invention to produce a simple restoring device which requires little space and which, if possible, touches the swivelling part directly, i.e. without inserting articulated elements having play and which, if possible can be adjusted from the outside.

Accordingly, the present invention consists in a variable displacement axial piston machine having a spring-loaded restoring device which interacts with stops fixed to the machine housing for the purpose of returning an angularly adjustable part of the machine to the zero stroke position thereof, said spring acting upon a yoke-lever component which is always in contact with said angularly adjustable part and which, when said part is in the zero stroke position thereof, rests against said stops. Here, in the case of a swivelling axis machine, the yoke-lever component can swivel with the swivel housing and can rest against a surface fixed to the housing, which surface serves as a stop face, or can be arranged in the part fixed to the housing or rest against a stop face at the swivel housing. Here, for example, two tension springs can touch the ends of the yoke-lever component. However, the preferred application is to axial piston machines having angularly adjustable rockers.

Preferably, the spring is a pressure spring which is arranged in such a way that its axis or line of force intersects

the swivel axis of the angularly adjustable part. By means of this arrangement of the invention, it is possible to design the restoring device in such a way that a single restoring spring or a single restoring-spring assembly is necessary, so that only one restoring spring system is required.

It is particularly advantageous for the stop fixed to the housing to be capable of being adjusted. Indeed, it is generally known to employ adjustable top with retoring devices of the kind referred to in the preamble. In accordance with a subsidiary feature of the invention, however, it is possible to arrange these adjustable stops in such a way that they are easily accesible and adjustable from the outside of the axial piston machine.

In Claims 4 and 5, further expedient arrangements are indicated which will be described later. In connection with the adjusting device of an axial piston machine, to employ a yoke-lever which, when the engine is in the zero stroke condition thereof, rests under the effect of the force of a spring against two stops and which, when it swings out from the zero stroke position thereof, supports itself at one of these two stops, is already generally known (see German Patent Specification No. 1,232,026). In this case, however, the use of a yoke-lever is intended in connection with the adjusting lever to be operated at random, on which forces are exerted by means of the spring. Transfer to a restoring device independent of the adjusting lever, which can be employed not only together with an adjusting lever to be operated at random, but also together with a servo (power amplification) arrangement, and the measures required for the specific adaptation, are thus not suggested.

The device in accordance with the invention has in the case of an angularly adjustable rocker machine, where the rocker is formed on a body which rests by means of a convex semi-cylindrical surface against a concave semi-cylindrical surface of the housing, the additional advantage that the spring which is provided for the purpose of centring (i.e. restoration to a zero position) at the same time presses the body against the concave cylindrical surface, so that any lifting of the body away from this bearing surface is prevented. Lifting of this kind does not have to be feared so long as the operating pressure acts upon the machine, and as a result the pistons are pressed against the inclined disc by means of the operating pressure and thus, in turn, press the body against the concave semi-cylindrical bearing surface; i.e. in the operating state where an effect of the centring spring in the direction of a return to the zero stroke position is not necessary, it is also not necessary to press the body into the bearing shell.

A particularly expedient embodiment of a machine according to the present invention is one in which one end of the spring rests frictionally against a spring plate which in turn bears against a central projection on the yoke-lever component and the other end of the spring rests against a second spring plate which has a cylinder-shaped extension in which there is arranged a piston which is connected to the first-mentioned spring plate. If no hydraulic pressure acts on the piston referred to in the preceding sentence, the spring presses the first-mentioned spring plate against the yoke-lever component. However, if hydraulic pressure acts upon said piston, the spring becomes compressed and the first mentioned spring plate is lifted away from said projection the yoke-lever component. But, immediately on pressure failure, the spring or spring assembly becomes operative and presses the angularly adjustable part into the zero stroke position thereof and, in the case of a swash plate machine of the kind referred to, presses the rocker against the hollow cylindrical bearing surface. Here, it can be intended that the operating pressure of the axial piston machine acts upon the piston which is connected to the first-mentioned spring plate, and it can also be intended, in the case of an axial piston machine having a servo (power amplification) device, that the control pressure acts upon said piston. On this score, it should be noted that it is already generally known, in connection with restoring devices of the kind referred to, to connect the spring to an auxiliary piston which lifts the spring from the respective stop (see German Patent Specification No. 1,776,206).

The present invention will now be more particularly described with reference to the accompanying drawings which illustrate the application of a restoring device to a rocker body of a swash plate axial piston machine as exemplary embodiments. In the drawings:—

Figure 1 shows a view into the housing cover of one embodiment of the machine;

Figure 2 shows a section through the cover along the line 11-11 of Figure 1;

Figure 3 illustrates the respective positions of the various elements illustrated in Figure 1 when a rocker of said machine has been moved angularly in an anti-clockwise direction about its swivel axis out of the zero stroke position thereof; and

Figure 4 is a view of a part of an alternative embodiment of the machine.

Referring to Figures 1 to 3 of the draw-

ings, a housing cover 1 is provided with a flange 2 by means of which the cover rests upon a housing 3 of an axial piston machine. Inside said housing 3, a concave cylindrical surface 4 is formed against which rests a convex cylindrical surface 6 of a rocker body 5, said body 5 also having on the side thereof opposite the cylindrical surface 6 of a planar surface 7. In Figure 1, the rocker body 5 is indicated by a dash-dotted line only. By a different dash-dotted line, a possible final angularly adjusted position of the body 5 is indicated, whereas another possible final angulary adjusted position is indicated only by the position of the outermost edge of the rocker body 5.

In each of two bores extending through the cover 1, a pin 8 is inserted which at its lower end (as seen in Figure 2) is provided with an eccentric head 9 and which is threaded at its upper end. By turning a pin 8 in its respective bore, the position of the eccentric 9 can be adjusted and the pin 8 can be firmly clamped in a selected setting by tightening a nut 10 on the thread of the pin 8. Said eccentrics 9 constitute stops, as will become apparent from the ensuing description.

A yoke-lever component 11 is provided with two circular-arc slots 12 and 13, the centre of curvature of the slot 12 being situated in Figure 1 in the right-hand end of the slot 13 and the centre of curvature of the slot 13 being situated in the right-hand end of the slot 12. The eccentrics 9 are located in the slots 12, 13.

The yoke-lever component 11 is additionally provided with two projections 14, each of which forms a defined bearing surface for resting against the planar surface 7 of the rocker body 5. The yoke-lever component 11 has, moreover, a projection 15 whose surface is a circular arc as seen in Figure 1 and against which rests a spring plate 16 which is connected to a guide pin 17. The projection 15 is preferably part-cylindrical but it could be part-spherical. A spring assembly consisting of two concentrically arranged springs 18, 19 is supported at one end thereof on the spring plate 16 and at the other end thereof on a second spring plate 20 having an extension which is provided with an axial bore 21 in which the outer end of the guide pin 17 (namely, the right hand end thereof as seen in Figure 1) is accommodated. The spring plate 20 is also provided with a lug 22 by means of which the spring plate 20 is connected to the housing cover 1 by means of releasable fastenings 23 (in the present case, two notched pins).

The restoring device just described requires such little installation space that it can be accommodated in a standard housing cover 1, so that the structural volume of the axial piston machine is not increased in size when compared with that of an axial piston machine which is devoid of a restoring device. In particular, the axial piston machine is a pump which is always returned to the zero stroke condition by the restoring device. However, the axial piston machine can also be a hydraulic motor, if the eccentrics 9 which act as stops are adjusted to be appropriately asymmetric (so that on account of said stops the smallest swing-out position is defined) provided that it is required to guide the motor into the smallest respective swing-out position, which in the case of a given delivery flow, corresponds to the highest speed. The restoring device hereinbefore described with reference to Figures 1 to 3 is independent and separated in space from surfaces upon which the control pressure acts, or form a possibly existing servo adjusting device. Because of the force from the springs 18, 19, the convex semi-cylindrical surface of the rocker body 5 is pressed into contact with the concave cylindrical bearing surface 4, so that, for example during transport of the equipped axial piston machine, the rocker body does not shift or fall about in the housing but is always in its proper position. Each eccentric 9 can easily be adjusted from the outside by means of the angularly adjustable pin 8 and locked by means of the nut 10. Indeed by appropriate rotation of the pin, an adjustment to such an extent is possible that a return of the rocker exactly to the zero stroke position thereof takes place and, being in this position, an attachment free from play is ensured, namely, with the two projections 14 in contact with the planar surface 7 and with the eccentrics 9 in contact with the corresponding ends of said slots 12, 13. The installation of springs 18, 19 possessing high elasticity does not present any difficulties. The yoke-lever component 11 is such a straightforward component that it can be produced in a simple way as a moulded or stamped part.

The mode of operation is as follows:— in that position of the rocker body 5 which corresponds to zero stroke, i.e. in the position where the planar surface 7 is vertical to the axis of rotation of the cylinder barrel which is not shown in the drawing, the two projections 14 of the yoke-lever component 11 rest against the surface 7 and each of the two eccentrics 9 rests against the right-hand end of its respective slot 12 or 13 as seen in Figure 1. The springs 18, 19, via the spring plate 16 and the projections 14, press the yoke-

lever component 11 not only against the surface 7 but also against the eccentrics 9. Thus, the attitude of the surface 7 is positively ensured by means of the angular positions of the eccentrics 9.

If, owing to a control device, the rocker body 5 is swung, for example, in an anti-clockwise direction about its swivel axis, from that position thereof which is indicated in Figure 1 by a dash-dotted line into the position thereof which is indicated by the different dash-dotted line in Figure 1 and which is illustrated in Figure 3, the surface 7 presses against the lower proection 14 of the yoke-lever component 11 and lifts away from the upper projection 14. This causes the component 11 to pivot in an anti-clockwise direction around the upper eccentric 9 with the result that there is relative movement between the component 11 and the lower eccentric 9 by virtue of the slot 13. In this way, a force couple (moment) is created, namely, on the one hand by the combined forces of the springs 18, 19 on the projection 15 and, on the other hand, by the upper eccentric 9 (in the drawing) in the slot 12, so that under the effect of this moment the lower projection 14 (in the drawing) exerts on the surface 7 a force tending to reset the rocker to the zero stroke position thereof. An analagous effect in the reverse sense results when the rocker body 5 is swung clockwise from the zero stroke position thereof.

A particularly expedient embodiment of an axial piston machine according to the present invention is illustrated, in part, in Figure 4, it being understood that said embodiment includes a yoke-lever component which has a projection against which rests a spring plate which is connected to a guide pin 17. The springs 18, 19 rest frictionally against the spring plate (not illustrated) at the ends thereof which are not shown in Figure 4 and rest frictionally apainst the second spring plate 20 and the cylinder-shaped extension of the spring plate 20, respectively, at the other ends thereof. The guide pin 17 is connected to an auxiliary piston 32 which is displaceable along the axial bore 21 of said extension. If no hydraulic pressure acts on the annular face of the piston 32, the springs 18, 19 press the spring plate which is not illustrated in Figure 4 against the projection on the yoke-lever component. However, if hydraulic pressure acts upon the annular face of the piston 32, the springs 18, 19 become compressed and the spring plate which is not illustrated in Figure 4 is lifted away from said projection on the yoke-lever component. If hydraulic pressure is provided, it is not necessary for the springs 18, 19 to exert a pressing force on the rocker body because, in such a case, hydraulic pressure is exerted on the pistons in the cylinder barrel of the machine; as said pistons are supported against the surface 7 of the rocker body 5, said hydraulic pressure exerted through the pistons forces the rocker body against the concave cylindrical surface 4. But, immediately on pressure failure, the springs become or the spring assembly becomes operative and press(es) the angularly adjustable part into the zero stroke position thereof and, in the case of a swash-plate machine of the kind referred to, presses the rocker against the hollow cylindrical bearing surface. Here, it can be intended that the operating pressure of the axial piston machine acts upon the auxiliary piston 32, and it can also be intended, in the case of an axial piston machine having a servo (power amplification) device, that the control pressure acts upon the auxiliary piston 32.

The guide pin 17 with the spring plate 16 shown in Figures 1 to 3 is not absolutely necessary; on the contrary, a spring which is equivalent to the springs 18, 19 can rest directly against the middle part of the yoke-lever component 11. When designing this spring, its buckling stress has to be taken into consideration.

In order that the pins 8 for adjusting the eccentrics 9 can be rotated and handled easily, an hexagonal recess 24 is provided in the head of each pin.

WHAT WE CLAIM IS:—

1. A variable displacement axial piston machine having a spring-loaded restoring device which interacts with stops fixed to the machine housing for the purpose of returning an angularly adjustable part of the machine to the zero stroke position thereof, said spring acting upon a yoke-lever component which is always in contact with said angularly adjustable part and which, when said part is in the zero stroke position thereof, rests against the stops.

2. A machine as claimed in Claim 1, wherein the spring is a compression spring which is arranged in such a way that its axis intersects the swivel axis of said angularly adjustable part.

3. A machine as claimed in Claim 1, wherein the stops fixed to the housing can be adjusted.

4. A machine as claimed in Claim 2, wherein the spring is connected to the yoke-lever component by means of a hinge connection whose axis is situated in the vicinity of said swivel axis.

5. A machine as claimed in Claim 1 or Claim 4, wherein the yoke-lever component is provided with two circular-arc slots in which eccentric pins acting as

stops are disposed and said eccentric pins resting at corresponding one ends of the respective slots when the angulary adjustable part is in the zero stroke position thereof, the centre of curvature of each slot being situated in said one end of the other slot.

6. A machine as claimed in Claim 1, wherein the restoring device is mounted on a cover of the machine housing.

7. A machine as claimed in any one of the preceding Claims, wherein the spring rests frictionally against the yoke-lever component and is connected to an auxiliary piston by means of which the spring is lifted away from the yoke-lever component.

8. A variable displacement axial piston machine constructed, arranged and operable substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

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1573485 COMPLETE SPECIFICATION
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Sheet 1

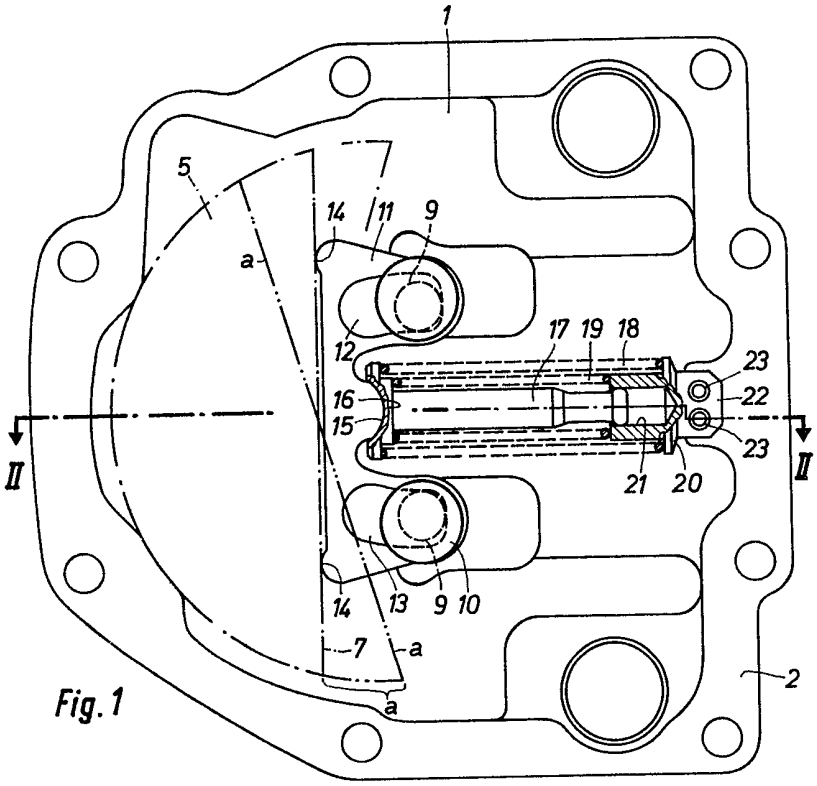

Fig. 1

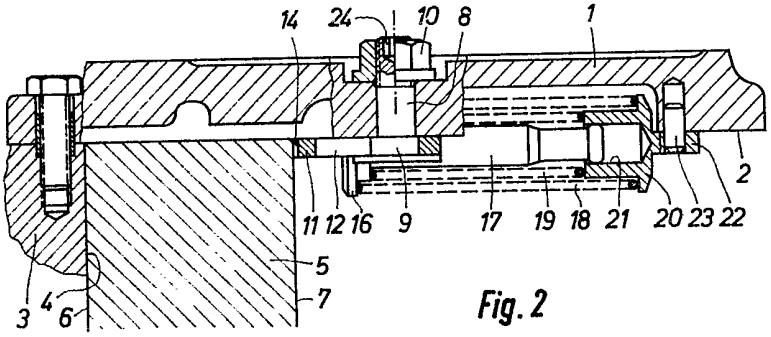

Fig. 2

1573485 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

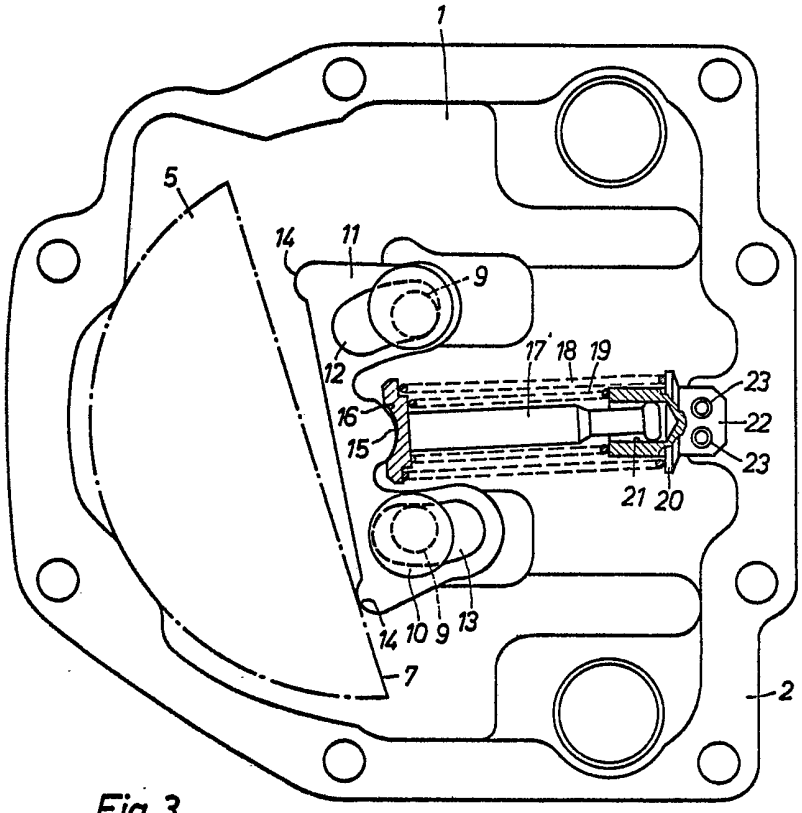

Fig. 3

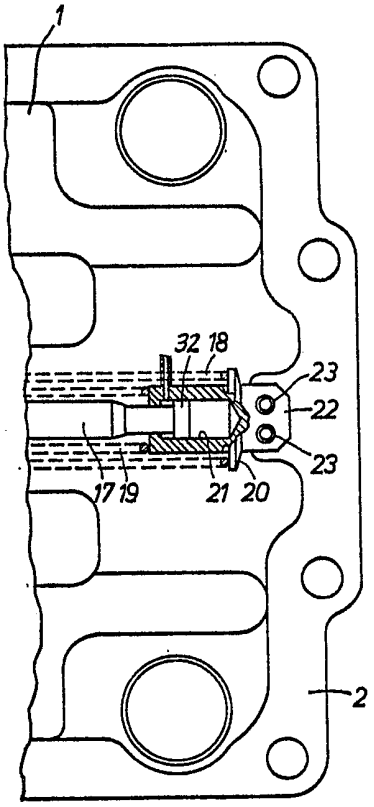

Fig.4