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HYDRAULICALLY OPERATING TRANSMITTING DEVICES OF THE PISTON-TYPE
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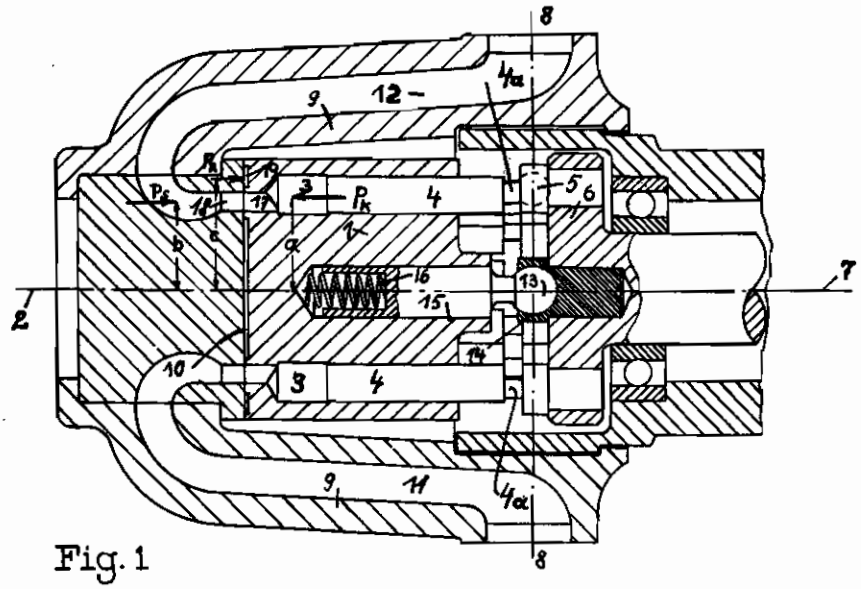


Fig. 1

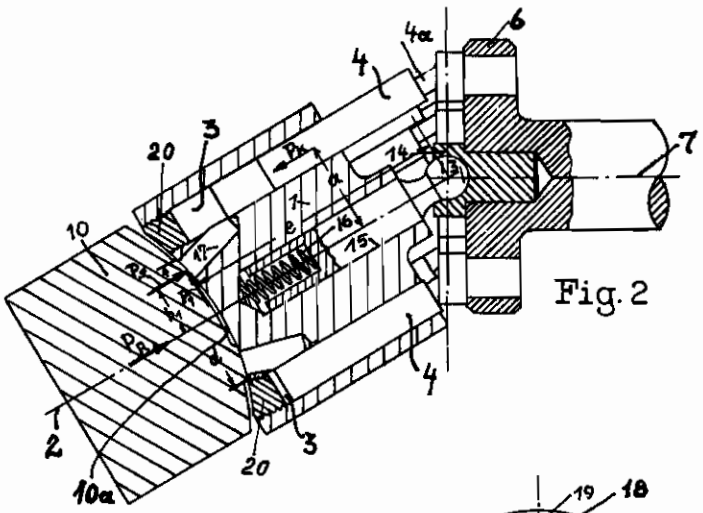


Fig. 2

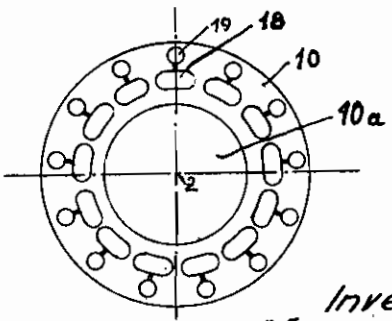


Fig. 3

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# ALIEN PROPERTY CUSTODIAN

## HYDRAULICALLY OPERATING TRANSMITTING DEVICES OF THE PISTON-TYPE

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This invention relates to improvements in or relating to hydraulically operating transmitting devices of the piston type, comprising a cylinder block having several cylinder bores, said block being turnably mounted around its longitudinal axis, and a driving member whose axis of rotation may be inclined against the cylinder block longitudinal axis for changing the piston stroke. The piston rods of the piston reciprocating in said cylinder block are hinged to said driving member.

The wellknown devices of this type are usually provided with a cardan joint for driving the cylinder block from the driving member. In some cases the cardan joint is arranged to simultaneously transmit the actuating moment to the cylinder block.

As is wellknown, such a cardan joint may be dispensed with in order to simplify the manufacture of the transmitting device. In this embodiment the piston rods themselves are provided as transmitting member for the cylinder block or the driving member.

The primary object of the invention is to provide a special centering member for positively guiding said driving member and said cylinder block with respect to one another concentrically to the centre of the effective driving plane. This centre is to be defined as the centre in which the driving member axis intersects the plane comprising the hinging points of the piston rods to the driving member. In this way several advantages are obtained as will be explained in the following description.

A further object of the invention is to overcome the difficulties encountered in cases in which said special centering member is provided and at the same time the piston rods are hinged to the driving member.

Furthermore the invention aims to improve the means for hydraulically relieving the controlling mirror face cooperating with the end face of the cylinder block.

Other objects, aims and advantages of the invention will be more fully explained in the following description with reference to the accompanying drawing in which:

Fig. 1 is a sectional view of the transmitting device according to one embodiment of the invention.

Fig. 2 is a sectional view of the transmitting device according to another embodiment, in which the controlling mirror face and the end face of the cylinder block are spherically formed.

Fig. 3 is a plane view of the controlling mirror face of the embodiment shown in Fig. 2.

Referring now to the drawing

Fig. 1 illustrates the wellknown transmitting device of the piston type, comprising a cylinder block 1 having several cylinder bores 3 arranged around the axis of rotation 2. 4 is a piston provided in each of said bores 3, the piston rod 4a being hinged at its outer end to a driving disc or flange 6. By means of a ball 5 the axis of rotation 7 of the driving disc 6 may be inclined relative to the cylinder block 1 as shown in Fig. 2. For this purpose the cylinder block 1 is swingably mounted around an axis 8 passing through the point of intersection of the two axes 2 & 7 mentioned above. Therefore, the axis 8 lies in the plane comprising the centre of the balls 5. 9 is a frame mounted for angular adjustment around the axis 8, said frame being shown to have a controlling mirror face 18 which is in engaging relation with the end face of the cylinder block 1 so as to control in a wellknown manner the communication of the cylinder bores 3 with the input- and the output channels 11 and 12 respectively.

In the embodiment shown in Fig. 1 these two channels lead to the pivot axis 6. The special centering member for auxiliary centering of the driving disc or flange 6 and the cylinder block 1 with respect to one another is shown to be a ball 13 whose centre coincides with the centre of the effective driving disc plane, i. e. the point of intersection of the two axes 7 & 8.

According to Fig. 1, the ball 13 is arranged at the cylinder block 1, whilst the supplemental ball cup 14 surrounding said ball 13 is mounted at the driving disc or flange 6. In this event the ball 13 is guided in a centric bore 15 of the cylinder block 1 and is kept in engaging relation in said cup 14 by means of a spring 16.

Of course the ball and its cup may be exchanged, i. e. the ball may be arranged at the driving disc or flange 6 and the cup at the cylinder block 1, then it is possible to fixedly arrange the ball to the driving disc. In the reversed arrangement according to Fig. 1 care should be taken that in spite of any deviations of the pivot axis 8 from the effective driving disc plane the centre points of the balls remain in this plane. For this reason the ball 13 is arranged axially displaceable at the cylinder block 1 as shown in Fig. 1. As will be seen, the ball 13 may displace itself in said bore 15. On the other hand by means of the spring 18 the end face of the cylinder block 1 is always held in contact re-

lation with the controlling mirror face 10. In this respect it is to be noted that the cylinder block may be displaced in its longitudinal direction in order to guarantee the engagement of or contact with the controlling mirror surface and to render ineffective any deviations of the pivot axis 8 from the effective driving disc plane.

From the foregoing it follows that the cylinder block 1 is guided only by means of the centering ball 13, its end face engaging the controlling mirror face 10. This is of importance in view of the fact that it is practically impossible to avoid difficulties in the event that the cylinder block is positively guided in the swingable frame 9 as is usual. According to the invention, the said guiding of the cylinder block 1 at its frame 9 results from the contact of its end face on the controlling mirror face so that the danger of clamping of the cylinder block is avoided.

The embodiment shown in Fig. 2 differs from that shown in Fig. 1 therein that the controlling mirror face 10 has a spherical shape instead of the customary plane shape. In order to explain the advantages obtained by this feature in the following the forces existing at the cylinder block end face are considered:

These forces are:

1. The force $P_K$ which is caused by the piston
2. The force $P_S$ which results from the delivery pressure existing in the controlling slit 17.

In order that the cylinder block 1 continues to engage the controlling mirror the force $P_K$ (with the larger lever arm $a$) must be greater than the force $P_S$ (with the smaller lever arm $b$). The magnitude of the force $P_S$ now depends to a high degree on how the pressure between the tightening surfaces of the controlling mirror 10 and the cylinder block 1 decreases around the controlling slit. Due to this the force $P_S$ is not predetermined so that an auxiliary force $P_T$ is created by hydraulical means for the purpose of compensating fluctuations of the force $P_S$. The force $P_T$ is thus created that in the cylinder block an equilibrium chamber 10a is provided. The pressure in this chamber is controlled in dependence on the distance between controlling mirror and cylinder block.

The force $P_T$ must now be so applied to the cylinder block 1 that it balances the resulting moment of the two forces $P_K$ and $P_S$. This means that in the illustrated embodiment the lever arm $c$ has a certain length. This must be the longer, the smaller the lever arm $b$ of the force $P_S$ is in relation to the lever arm $a$ of the force $P_K$. Thus the necessity results in case of the wellknown plane controlling mirror to seek a compromise between the size of the lever arm $c$ and that of the lever arm $b$; because $c$ should not surpass the usual dimensions of the cylinder block 1. On the other hand it is desirable to keep the lever arm $b$ as small as possible in order to give a circular form to the controlling opening 18, keeping in mind at the same time the necessary flow cross-section and a sufficient distance from the controlling opening of the neighboring cylinder bore. In case of a plane controlling mirror one must dispense with the mentioned circular form and give the controlling opening 18 the form to be seen in Fig. 3 due to the relation of the lever arms $b$ and $c$ to one another.

The difficulties arising due to this may easily be removed by using a spherical shaped controlling mirror according to Fig. 2, because the explained force-relation is more favourable. Retaining the moment $P_K \cdot a$, the moment $P_S \cdot b_1$ may be made essentially smaller in case of the same force $P_S$. The torque resulting from these two moments on the cylinder block, which is effective around the ball 13, is compensated in case of suitable ball radius by a moment resulting from a force $P_1$ and the lever arm $e$. The force $P_1$ results from the forces of the spherically constructed controlling mirror. As formerly, a resulting force $P_T$ on the controlling surface remains. As the moments, as proved above, are balanced without the help of the force $P_T$, this force $P_T$ may now become effective in the axis 2 of the cylinder block. Therefore, it does not necessitate a special equilibrium chamber of greater diameter, this being also advantageous with respect to the friction losses.

Regarding the manufacture, it is further essential in this connection that the controlling openings 18 may be vertical to the controlling mirror in spite of their inclined position in the cylinder block.

The ball form of the controlling mirror also results in a decrease of the diameter $d$ of the contact surface of the cylinder block, this being not only favourable with respect to the friction losses, but also has the advantage that the cylinder bores may lead through the entire length of the cylinder block in order to close them afterwards by means of a stop 20 or the like. These lie outside of the controlling mirror surface and, therefore, cannot influence its quality.

It may be pointed out that the transmission device according to the embodiments shown and described operates without the usual cardan joint, because the piston rods themselves serve as moment transmitting member for the cylinder block or the driving disc or flange. For this purpose the play between the pistons and their rods is limited to the lost motion necessary for kinematics as far as possible. It is advisable to keep the auxiliary lost motion between the pistons and their rods for assembly reasons as small as possible. The smaller this auxiliary lost motion is, the lesser the cylinder block lags when actuated by the driving disc or flange and, therefore, the lesser is the disturbing influence due to the fact that upon a lag the piston rods exert turning moments on the cylinder block in opposition to the direction of actuation.

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