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(54) Hydraulic piston motor.

(57) Hydraulic piston motor comprising a housing, at least one cam disk with an internal cam curve (8), at least one cylinder block (6) with a number of cylinders (5), and so-called roller cage pistons, running in said cylinders. According to the invention each roller cage piston consists of a roller cage part (2) and a piston part (3) forming an integral unit. The roller cage part is formed as a hydrostatic bearing with a bearing surface which is in the form of a cylindrical segment and is adapted to rollers running against said cam curve (8). At its inner end the piston part is formed with two flanges (19, 20) with an intermediate piston ring slot (21). Those surfaces of the flanges which are facing the cylinder wall together exhibit a double-curved convex surface, which allows an angular deviations, of the order of magnitude of 1°, between the cylinder (5) and the roller cage piston (1). A seal is arranged in the piston ring slot.

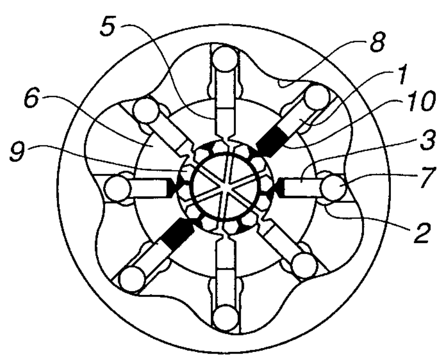
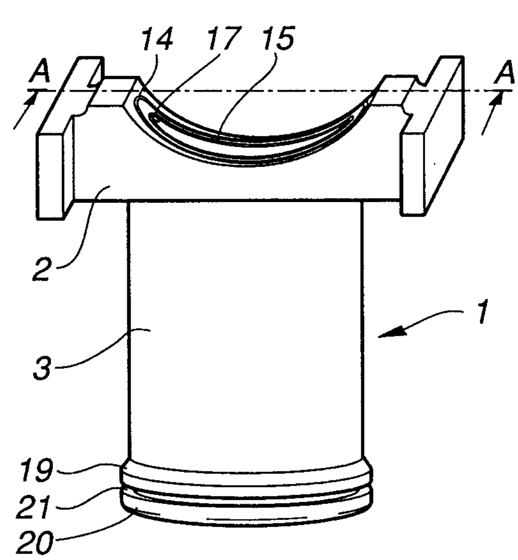


Fig. 1

Fig. 3a



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The invention relates to a hydraulic piston motor according to the precharacterising part of claim 1. Such hydraulic piston motors can be connected to a driven shaft, to a wheel or to a cable drum for a winch or the like

The invention may, for example, be arranged in a motor of the type described in SE-B-456 517 entitled "Hydraulic radial piston motor". It is a hydraulic piston motor with a cam disk with an internal cam curve and a cylinder block with a number of cylinders. In each cylinder runs a piston which presses a roller against the cam curve so that a torque arises on the cylinder block. The rollers are formed with guide members which run in slits in guide units which take up tangential forces. The rollers are journalled in roller cages which are formed with hydrostatic bearings with a bearing surface, which is adapted to the roller path of the rollers. Either the housing of the hydraulic piston motor may be stationary and the cylinder block rotatable, or the cylinder block may be stationary and the motor housing rotatable.

The maximum allowed power presents a problem in hydraulic piston motors where hydraulic force is converted to mechanical force with the aid of rollers.

In the above-mentioned hydraulic piston motor the pistons are formed at their outer end with a spherical annular bearing surface. The roller cages are correspondingly-formed with a spherical bearing surface cooperating with the bearing surface of the pistons. This allows the roller cages to tilt in all directions around the centre of the spherical bearing.

At a high power output, that is, when the contact pressure between the rollers and the roller cages is high and when the sliding speed of the rollers in relation to the roller cages is high, there is a risk of seizing, above all between the rollers and the roller cages, but also between the pistons and the roller cages caused by the tilting movement. It would be advantageous to form the pistons and the roller cages in one unit so as to avoid seizing. However, this involves difficulties since the roller cages must be able to tilt in all directions due to imperfections in the cam curve and in the guides for the rollers.

To obtain a high maximum allowed power, the mechanical load is to be absorbed by as large a part of the mechanical bearing surface as possible so as to equalize the surface pressure.

Another important factor is the leakage of pressure medium between the rollers and the roller cages, the so-called bearing leakage. The bearing leakage arises when the roller cages are deformed upon loading. To obtain a minimum bearing leakage, it is desirable for the bearing surfaces and the rollers to make close contact with each other both when being loaded and when not being loaded. This is difficult to attain since the surface pressure and the bearing leakage between the parts when in operation can considerably change, among other things due to deformations. Also between the piston and the roller cage an undesired leakage arises because of deformations upon loading.

In the above-mentioned SE-B-456 517 the balancing of the compressive forces takes place with the aid of hydrostatic balancing between the rollers and the roller cages. This results in a reduction of the mechanical contact pressure. To make possible the hydrostatic balancing, the bearing surface of the roller cage has been provided with slots between which a sealing surface, cooperating with the roller, is formed. To avoid leakage, the bearing surface has been provided with a recess to make possible a certain deformation without the roller and the sealing surface separating. Because of the slots and the recess, the bearing surface has been reduced.

The invention aims at developing a hydraulic piston motor of the above-mentioned kind which is largely freed from the problems of the conventional hydraulic piston motors described above.

To achieve this aim the invention suggests a hydraulic piston motor according to the introductory part of claim 1, which is characterized by the features of the characterizing part of claim 1.

Further developments of the invention are characterized by the features of the additional claims.

More particularly, the invention relates to a device, called roller cage piston, in a hydraulic piston motor, which device comprises a piston part and a roller cage part which together form an integral unit. This roller cage piston may, for example, be arranged in a hydraulic piston motor of the type referred to above.

At its outer end the roller cage piston is formed as a roller cage, this part thus constituting the roller cage part. The roller cage part is formed as a hydrostatic bearing with a bearing surface which is adapted to a roller running against a roller path arranged in the hydraulic piston motor. The roller cage part may either be made rigid to provide negligible deformations in the roller cage part, or weak for absorption of any deformations. The advantage of the weak roller cage part is that the maximum allowed power can be further increased while at the same time the bearing leakage can be reduced by forming the roller cage part according to the roller. The maximum allowed power is increased by increasing the mechanical bearing surface and utilizing it more efficiently, which in turn entails a reduction and equalization of the mechanical surface pressure and an increase of the maximum allowed power of the roller cage part. The bearing leakage is reduced by the roller and the roller cage making close contact with each other.

To obtain hydrostatic balancing in the bearing surface of the roller cage part, a suitable pattern of holes and/or slots for pressure medium is arranged. The holes and/or the slots are connected to each other by means of one or more channels.

To be able to provide the slots with pressure medium, the roller cage piston is formed with a continuous bore. Via the bore, pressure medium in the cylinder has free passage through the roller cage piston to a channel in the roller cage part which supplies pressure medium to the holes and/or slots in the bearing surface of the roller cage part.

To avoid edge contact and hence high contact pressures, the inner end of the roller cage piston is formed with a double-curved surface, which makes contact with the cylinder bore, and is formed such that the roller cage piston can be guided by the cylinder bore. To allow the roller cage part to tilt in all directions, the guiding part of the roller cage is short.

The double-curved surface may, for example, be formed with the aid of two flanges with an intermediate piston ring slot. The contact surfaces of the two flanges with the cylinder bore together exhibit a convex surface of revolution. At the widest portion of the double-curved surface, across the longitudinal axis of the piston, runs an annular recess which constitutes the piston ring slot.

In the piston ring slot a piston ring is arranged to limit the leakage of pressure medium between the roller cage piston and the cylinder bore, the so-called piston leakage. The two flanges have a larger diameter than that of the other piston part whereas the piston ring slot has a smaller diameter than that of the flanges. The piston ring can, of course, be arranged also outside the double-curved surface and then suitably axially displaced towards the internal part of the piston part. The double-curved surface can then consist of one single flange with a double-curved surface.

The advantage of the invention is thus that the maximum allowed power is increased by the relatively large contact surface between the roller and the roller cage part and that the surface is utilized more efficiently. The roller cage and the piston together constitute one unit which can allow angular deviations of the piston part in relation to the cylinder bore since the piston part, with the aid of the double-curved surfaces of the piston part, is guided by the cylinder bore. The leakage is reduced because of a smaller number of leakage points and by avoiding undesired deformations. In addition, the fewer parts and the simpler embodiment of the roller cage piston make it both simple and inexpensive to manufacture.

By way of example, the invention will now be described in greater detail with reference to the accompanying drawings showing in

Figure 1	schematically a radial section of a hydraulic piston motor of conventional type, with which the invention can be implemented,
Figure 2	a roller cage piston according to the invention from above,
Figure 3a	a perspective views of a first embodiment of a roller cage piston with a rigid roller cage part,
Figure 3b	a perspective views of a second embodiment of a roller cage piston with a weak roller cage part, a so-called leg piston,
Figure 4a	a sections taken along line A-A in Figure 3a,
Figure 4b	a sections taken along line B-B in Figure 3b,
Figure 5	a cross section of an annular piston ring,
Figure 6	a section through a roller cage part with a winding angle greater than 180°.

The invention relates to a roller cage piston 1, according to Figures 3a or 3b, which is formed integral as a roller cage part 2 and a piston part 3.

Such a roller cage piston 1 can be arranged, as shown, on reduced scale, in Figure 1, in a conventional hydraulic piston motor of the type referred to above. The roller cage pistons 1 according to the invention run in cylinders 5 arranged in a cylinder block 6. Each roller cage piston 1 presses a roller 7 against an internal cam curve 8 such that a torque on the cylinder block 6 and the cam curve 8 arises. Inside the cylinder block 6 there is a rotatable slide 9 for distributing pressure medium 10 to the cylinders 5.

At its outer end, that is the end protruding from the cylinder, the roller cage piston 1 is formed as a roller cage, this part thus being designated "roller cage part" 2. According to Figure 2, the roller cage part 2 is formed as a hydrostatic bearing with a bearing surface 11, which has the form of a cylindrical segment and is adapted to the rollers 7, according to Figure 1, running against the cam curve 8. The roller cage part 2 can either be made rigid or weak (elastically deformable).

To obtain a rigid roller cage part 2, the piston part 3, according to Figures 3a and 4a, is substantially made solid. The roller cage part 2 is thus dimensioned such that the rigidity allows only a negligible deformation of the roller cage part 2, which in turn means that the area of the bearing surface 11 can be increased and utilized efficiently due to the fact that a recess in the bearing surface 11 is not needed. According to the SE-B-456 517, referred to above, a recess is provided in the bearing surface such that deformations can be allowed without the roller separating from a sealing surface cooperating with the roller.

Another way is to make the roller cage part 2 weak so that it may adapt to the shape and diameter of the rollers 7. The weakness is obtained by making the roller cage part 2 thin and forming the area between the roller cage part 2 and the inner end of the piston part 3 with at least tow legs 12, 13 according to Figure 4b. A roller cage piston 1 with such legs 12, 13 is called a leg piston. The legs 12, 13 transmit the load, in the form of compressive forces from the piston part 3 to the roller cage part 2. The roller cage part 2 is subjected to tangential tensile forces in a section parallel to the axial direction of the roller 7 and is thus extended around the roller 7 such that it may adapt thereto. It is important that the attachment of the legs 12, 13 to the roller cage part 2 is made such that the roller cage part 2 is extended around the roller 7. The surface pressure may otherwise become too low which leads to leakage of pressure medium 10 between the roller 7 and the roller cage 2.

To obtain hydrostatic balancing, a suitable pattern of pressure medium holes and/or pressure medium grooves is arranged. An advantageous embodiment, according to Figure 2, is obtained if one or more, but preferably two, annular grooves 14, 15 are chosen, one of the grooves serving as a drainage groove 14 and the other as a pressure medium groove 15. To obtain the hydrostatic balancing, the roller cage piston 1 is formed with a continuous bore 16, through which the bearing surface 11 is supplied with pressure medium 10. The continuous bore 16 opens out into a hole 17 at the pressure medium groove 15.

Between the grooves 14, 15 an annular sealing surface 18 is formed, which cooperates with the roller 7. A pressurized area is created inside the sealing surface 18 and has a size approximately consisting of a mean value of the area inside the drainage groove 14 and the area inside the pressure medium groove 15. The pressurized area is used as supporting hydraulic bearing surface, and its size is chosen such that the desired hydrostatic balancing of radial compressive forces from the roller cage piston 1 towards the roller 7 is obtained.

The radial compressive forces acting on the roller cage part 2 are hydrostatically balanced at a rate of more than 75 %, suitably at a rate of between 85 % and 95 %, that is, the mechanical surface pressure is replaced by a hydraulic surface pressure. The large mechanical bearing surface, that is the bearing surface 11 reduced by the grooves 14, 15 and the hole 17, and the hydraulic balancing cause the mechanical pressure on the rollers 7 from the bearing surface 11 of the roller cage part 2 to become relatively low.

In the leg piston design, the continuous bore 16 may be arranged in one or more legs or, for example, via a tube between the piston part 3 and the roller cage part 2. Pressure medium 10, for example in the form of oil or oil-water mixture, in the cylinder has free passage, via the bore 16, through the roller cage piston 1 to the annular pressure medium groove 15 in the bearing surface 11 of the roller cage part 2 and thereby conveys pressure medium 10 to the bearing surface 11. The pressure medium 10 is drained via the drainage groove 14.

At its inner end, which extends into the cylinder of the cylinder block, the roller cage piston 1 is formed with a double-curved surface which constitutes the guiding part of the roller cage piston 1. The double-curved surface may, for example, be formed according to Figure 3 with the aid of two adjacent flanges 19, 20 separated from one another by an intermediate piston ring slot 21. The two flanges 19, 20 have a larger diameter than the rest of the piston part 3. The piston ring slot, in its turn, has a smaller diameter than the flanges 19, 20.

To allow angular deviations, of the order of magnitude of 1°, between the cylinder 5 and the roller cage piston 1, the guiding part of the roller cage piston 1 is made short. The guiding part means that the roller cage piston 1 can be allowed a certain angular deviation but that it is guided by the cylinder bore when a maximum allowed angle between the roller cage piston 1 and the cylinder bore is attained. The maximum allowed angle may be different in different lateral directions.

Those surfaces of the flanges 19, 20 which face the wall of the cylinder bore together exhibit the double-curved surface. Part of the double-curved surface constitutes a contact surface which is suitably formed as a convex surface of revolution. In a vertical section the contact surface is limited, in case of maximum allowed angular deviation, by a first and a second contact point. The diametrical distance between the first and second contact points on either side of the piston part 3 in the vertical Section is larger than the diameter of the cylinder bore. In normal operation, the contact surface only has one contact point towards the cylinder bore.

In the piston ring slot 21 there is arranged a piston ring in the form of a completely closed metallic seal 22 which may have a secondary seal 23 on the inside. The secondary seal 23 may, for example, consist of an O-ring of rubber. Such a piston ring is described in greater detail in SE-B-451 087. The piston ring may be designed completely closed since it has such a small cross section in relation to its outer envelope surface that no high, harmful surface pressures, for example caused by temperature differences, arise. The advantage of this piston ring is that it is a wear-resistant metallic seal which is almost completely tight. Thus, the piston ring only lets through an amount of pressure medium 10 which is needed to lubricate the cylinder bore.

The piston ring can also be arranged outside the double-curved surface. It is then suitably arranged with an axial displacement towards the interior part of the piston part 3.

In this connection, the double-curved surface suitably consists of one flange only.

In freewheeling operating mode, hydraulic motors with a freewheeling facility may be pressurized such that the pistons 1 are held down at the bottom of the cylinders 5, the motor thus being disengaged. There are also motors where the pistons are held down in the cylinders in some other way, for example by magnets or springs. In these embodiments, the roller cage part 2 must surround the rollers 7 by more than 180° so that the rollers 7 are radially fixed in the roller cage part 2. In case of such a winding angle the roller cage part 2 may be divisible, as shown for example in Figure 6. The roller cage part 2 here comprises two parts 24, 25 which can be retained with the aid of bolts 26.

In hydraulic piston motors without freewheeling facilities, the winding angle may be less than 180°. The reason is that in this case the rollers 7 need not be fixed since, because of the feed pressure of the pressure medium 10, the rollers 7 are all the time pressed out against the cam curve 8 by the roller cage pistons 1.

Claims

1. Hydraulic piston motor comprising a housing, at least one cam disk with an internal cam curve (8), at least one cylinder block (6) with a number of cylinders (5) and pistons running in these cylinders, roller cages with hydrostatic bearings, rollers (7) running between the cam curve (8) and the roller cage, which surrounds the roller with a winding angle, and guide members for the rollers**, characterized** in that the roller cages and the pistons are formed as one unit, called roller cage piston (1), with a roller cage part (2) and a piston part (3), and that the contact surface between the piston part and the wall of the cylinder bore exhibits a double-curved surface, which cooperates with the cylinder block in such a way that an angular movement between the piston part and the cylinder bore is possible in all directions.

2. Hydraulic piston motor according to claim 1, **characterized** in that a piston ring (4) is arranged in a piston ring slot (21) in, or outside, the double-curved surface of the piston part.

3. Hydraulic piston motor according to claim 2, **characterized** in that the piston ring is completely closed.

4. Hydraulic piston motor according to claim 2 or 3, **characterized** in that the piston ring is metallic.

5. Hydraulic piston motor according to any of the preceding claims, **characterized** in that in the hydrostatic bearings, the mechanical compressive forces acting on the roller are balanced at a rate of at least 70%.

6. Hydraulic piston motor according to any of the preceding claims, **characterized** in that via one or more continuous holes (16) in the roller cage piston, the roller cage part communicates with pressure medium (10) in the cylinders (5) and receives lubricant through that path.

7. Hydraulic piston motor according to any of the preceding claims, **characterized** in that a sealing surface (18), cooperating with the roller, is arranged in the roller cage part (2).

8. Hydraulic piston motor according to any of the preceding claims, **characterized** in that the roller cage part (2) is made rigid by a solid design of the piston part (3), with the exception of the continuous hole (16).

9. Hydraulic piston motor according to any of claims 1 to 7, **characterized** in that the roller cage part (2) is made weak by forming the roller cage piston between the roller cage part and the inner part of the piston part with at least two legs (12, 13).

10. Hydraulic piston motor according to any of the preceding claims, **characterized** in that in case of the hydraulic piston motor having freewheeling facilities, the winding angle is greater than 180°.

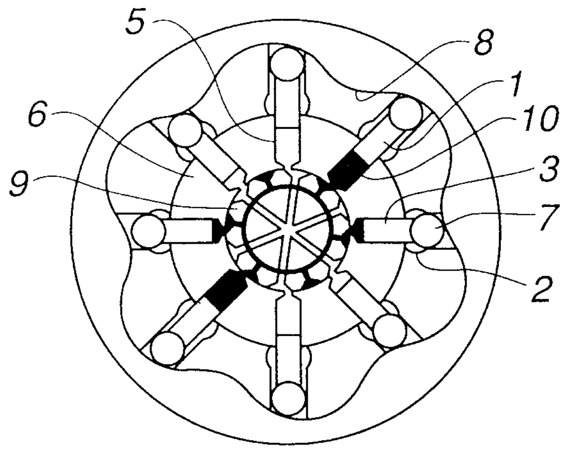


Fig. 1

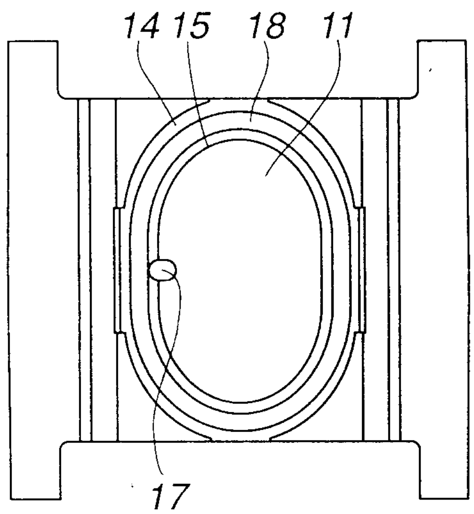


Fig. 2

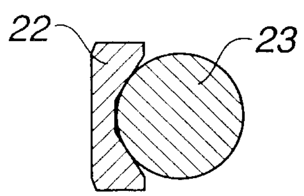


Fig. 5

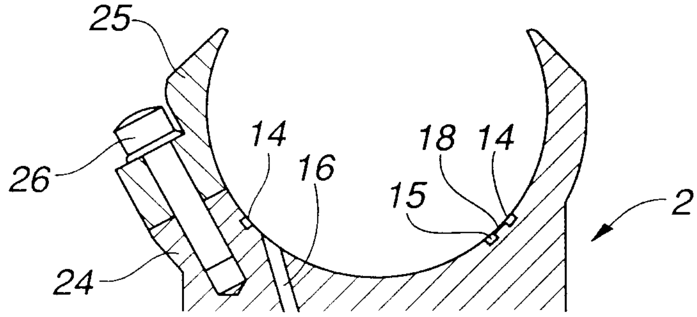


Fig. 6

Fig. 3a

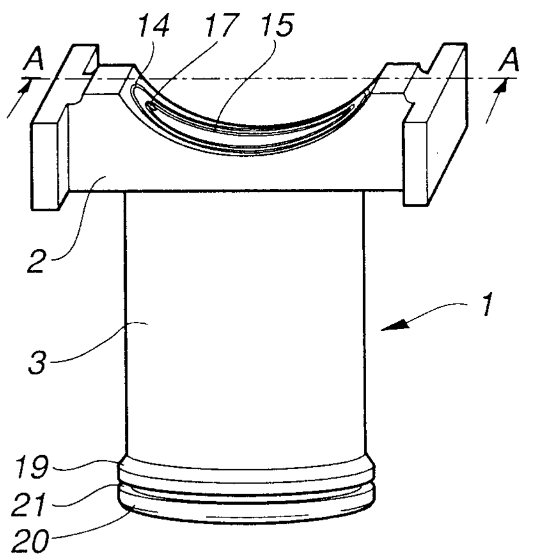


Fig. 3b

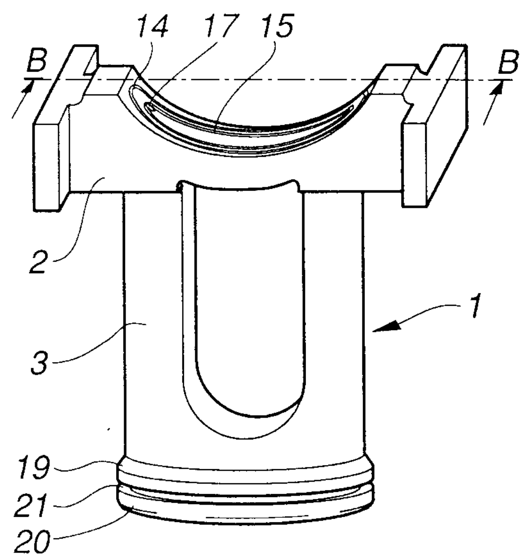


Fig. 4a

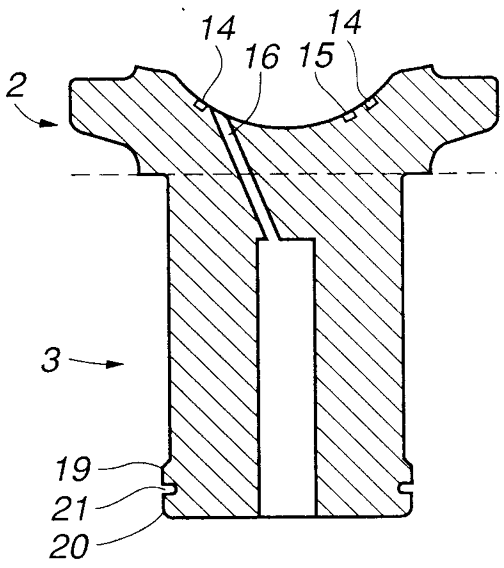
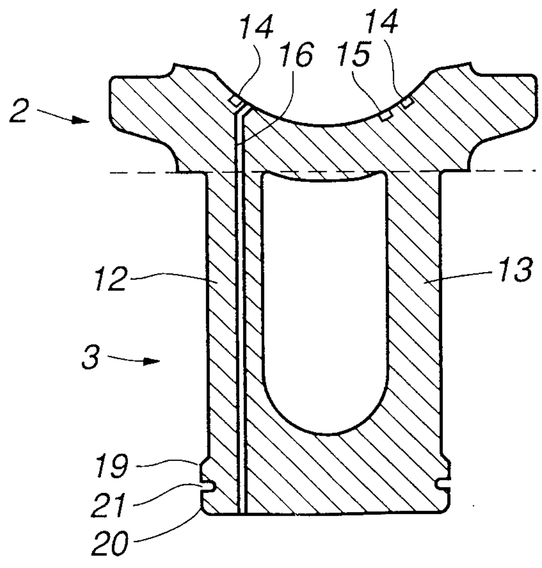


Fig. 4b



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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 0445

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 358 566 (CYPHELLY) * page 3, line 21 - page 10, line 3; figures * ---	1,6	F03C1/04 F04B1/04
X Y	FR-A-2 215 543 (HITACHI CONSTRUCTION MACHINERY) * page 3, line 38. - page 11, line 35; figures * ---	1-3,5,6,8 4,7,10	
Y A D	EP-A-0 102 915 (SAMUELSSON) * the whole document * & SE-B-456 517 ---	7 1,5,6	
Y D	WO-A-8 701 783 (STENLUND) * page 25, line 26 - line 35; figures * & SE-B-451 087 ---	4	
Y A	US-A-3 978 771 (BURNIGHT) * the whole document * -----	10 1-3,8	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F03C
F04B
F01B
F16J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03 NOVEMBER 1992	VON ARX H.P.

CATEGORY OF CITED DOCUMENTS

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