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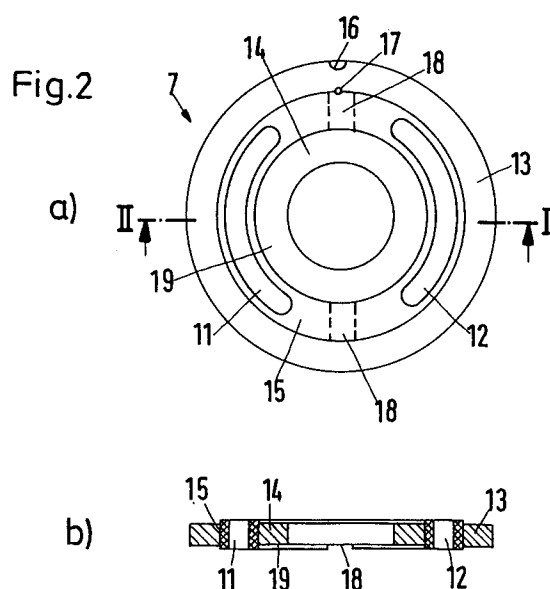
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(54) **Control plate for a hydraulic piston machine.**

(57) A control plate (7) for a hydraulic piston engine is disclosed, which has a cylinder body rotatable relative to the control plate, the control plate having at least two control kidneys (11, 12) which on rotation of the cylinder body lie in the path of movement of an opening of a cylinder in the cylinder body.

Using such a control plate, it is should be possible to operate a machine even with poorly lubricating hydraulic fluid, which will nevertheless achieve an acceptable volumetric efficiency.

For that purpose, the control kidneys (11, 12) are formed in at least one insert (15) of plastics material which is secured in a carrier body (13, 14).

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The invention relates to a control plate for a hydraulic piston machine, which has a cylinder body rotatable relative to the control plate, the control plate having at least two control "kidneys" which on rotation of the cylinder body lie in the path of movement of an opening of a cylinder in the cylinder body; the invention also relates to a method for the manufacture of the control plate.

In piston pumps as known, for example, from DE-AS 12 67 985, the cylinder body has to be pressed with a relatively large pressure against the control plate in order to keep the transition from the cylinders to the control plate as tightly sealed as possible. The greater the number of unsealed points in this region, the larger is the leakage, which has an adverse effect on the volumetric efficiency of the engine. The high pressure creates considerable frictional forces on the contact surfaces between cylinder body and control plate, however, which without further measures lead relatively quickly to wear or even to destruction of the engine. This phenomenon can be counteracted partly by lubricating the contact surface in order to reduce friction. In many cases the hydraulic fluid is used for this purpose. However, this presupposes that the hydraulic fluid has adequate lubricating properties. This requirement considerably restricts the range of hydraulic fluids that can be used. Fluids that have satisfactory lubricating properties are in many cases harmful from the point of view of their impact on the environment, especially when they are synthetic oils.

Further, from DE 16 53 529 B2 it is known to arrange straight strips of carbon in correspondingly arranged straight grooves in the control plate in order to reduce friction between the contact surface of the cylinder body and the contact surface of the control plate. It is difficult, however, to keep the control plate and the end face of the cylinder body close enough together, so that considerable leakage is able to occur here, leading in turn to a reduced volumetric efficiency of the engine.

The invention is based on the problem of providing a control plate for a hydraulic engine which can be operated with poorly lubricating hydraulic fluids yet nevertheless achieves an acceptable volumetric efficiency.

This problem is solved in a control plate of the kind mentioned in the introduction in that the control kidneys are formed in at least one insert of plastics material which is secured in a carrier body.

In this construction, the friction between the contact surface of the cylinder body and the control plate in the region of the control kidneys is effected exclusively through a combination of materials, which is constituted in the region of the control plate by the plastics material, but in the region of the cylinder body by the material of the

cylinder body, which will normally be a metal, especially steel. The use of the plastics material transfers the "lubrication" function to a machine element. It is known that there are combinations of materials which are able to slide against one another with relatively little friction even under relatively great pressures. By suitable choice of the material for the insert, the friction in the region of the contact surface can therefore be drastically reduced, without it being necessary to supply a lubricating fluid. Plastics materials which are possibilities for the insert are, in particular, materials from the group of high-performance thermoplastic plastics materials on the basis of polyarylether ketones, in particular polyetherether ketones (PEEK), polyamides, polyacetalenes, polyarylethers, polyethyleneterephthalates, polyphenylene sulphides, polysulphones, polyethersulphones, polyetherimides, polyamidimides, polyacrylates, phenol resins, such as novolak resins, or similar substances; glass, graphite, polytetrafluoroethylene or carbon, particularly in fibre form, can be used as fillers. If such materials are used, water may also be used as the hydraulic fluid.

The use of the plastics material is restricted here to the insert. The forces acting on the control plate are therefore mainly absorbed by the carrier body. The machine is therefore still capable of being operated with the necessary pressures. The carrier body not only absorbs the forces, but also prevents the insert from being deformed to any appreciable degree. In practice, the function of mechanical stability, which is fulfilled substantially by the carrier body, and the reduction in friction, which is fulfilled substantially by the insert, are separated here. At the same time, the insert continues to serve for conduction of the fluid, so that the path of the hydraulic fluid into the cylinder body can be ensured with relatively few problems.

The insert preferably projects from the carrier body at least in the direction towards the cylinder body. The projection need not be great. Normally, a few tenths or even a few hundredths of a millimetre will be adequate. This measure ensures, however, that the only area of contact between the control plate and the contact surface of the cylinder body is created on the insert. The cylinder body does not therefore come into contact with the carrier body.

The insert is preferably of ring-shaped construction. With the exception of the control kidneys, it therefore forms a closed face against which the contact surface of the cylinder body permanently lies. Problems that could arise because of transitions or steps are consequently precluded from the start.

It is especially preferred to provide a means safeguarding against rotation between the insert and the carrier body. The insert is therefore held in the carrier body so that it does not rotate relative thereto. The control behaviour of the machine cannot therefore be accidentally or unpredictably changed through rotation of the insert in the carrier body.

The insert is preferably joined to the carrier body by means of a press fit. The press fit on the one hand secures a sufficiently firm seat of the insert in the carrier body, and on the other hand it does not require any additional fixing means, for the use of which the carrier body or the insert would have to undergo additional machining. The press fit at the same time creates a certain seal between the carrier body and the insert, but this seal need not be absolute.

The insert advantageously projects from the carrier body also on the side facing away from the cylinder body. This side normally lies adjacent to a so-called rear flange in the hydraulic machine, through which the inlet and outlet ducts for the hydraulic fluid pass. If the insert projects also on this side above the control plate, when the control plate is pressed against the rear flange a better seal between the control plate and the rear flange can be achieved than would be the case if the carrier body alone were to be arranged adjacent to the rear flange. Additional seals are therefore unnecessary when the insert is constructed projecting from the carrier body also on the side facing away from the cylinder body.

It is especially preferable for a pressure relief channel to be provided in the insert or in the carrier body on the side facing away from the cylinder body and for it to be arranged between the control kidneys. If the insert projects on this side beyond the carrier body, an enclosed space is created between the carrier body and the rear flange into which hydraulic fluid is able to penetrate under certain circumstances. The pressure relief channel prevents the incoming fluid building up an uncontrollable pressure here. On the contrary, incoming hydraulic fluid is able to flow away without problems so that neither the insert nor the carrier body can be stressed.

The insert is preferably divided. One could also say that in this construction there are two inserts. The two parts of the insert or the two inserts can be matched to the particular conditions. The insert that lies opposite the cylinder body can be constructed with a view to reducing friction. The part that lies adjacent to the rear flange can be considered more from the point of view of its sealing function, because the control plate does not normally move with respect to the rear flange.

In a preferred construction, the carrier body is formed from two rings which lie adjacent to the insert radially inwardly and outwardly. The control plate is therefore divided into three, with, from the inside radially outwards, one ring forming part of the carrier body, one ring constituting the insert and a further ring forming part of the carrier body lying adjacent to one another. Mechanical stability is ensured by the two rings of the carrier body, whilst sliding quality and the creation of the seal between the control plate and the cylinder body is ensured by the plastics material insert. A control plate of that kind can be manufactured relatively easily, because the rings, which are preferably formed from stainless steel, can be manufactured relatively simply. Machining of the carrier body to produce the control kidneys is not required.

As an alternative, the carrier body may have a circumferential annular groove to receive the insert. In that case, the carrier body can also accommodate forces that act axially, which means that the control plate can be stressed to a greater degree. Here, however, machining of the carrier body is necessary.

It is especially preferred for at least one drainage bore to be provided in the carrier body, starting on the side facing away from the cylinder body and opening out between the insert and carrier body; the drainage bore is provided in particular in the region of the control kidney which is exposed to hydraulic fluid under pressure. The drainage bore ensures that hydraulic fluid penetrating between the carrier body and the insert is able to drain off before it builds up a pressure in this region between the insert and the carrier body which could lead to separation of the carrier body and the insert. Especially at those points at which the hydraulic fluid is under pressure, that is, in a hydraulic motor at the inlet kidney and in a hydraulic pump at the outlet kidney, there is sometimes a danger that despite the otherwise relatively good seal, small amounts of hydraulic fluid can penetrate between the insert and the carrier body, which without this measure could have adverse consequences after a certain operating time.

In an especially preferred construction, the insert has a joint running in the circumferential direction, which divides the insert into a radially inner and a radially outer part. The term "joint" is intended here to refer merely to a structural element that separates the radially inner and the radially outer part of the insert from one another. This does not mean, however, that the two parts of the insert have some sort of radial spacing between them. On the contrary, these two parts lie closely side by side. In some extreme examples of stress, it has been shown that the plastics material insert breaks under the effect of these high stresses, and the

fracture point can be monitored only with difficulty. The provision of a joint anticipates, as it were, this fracture point. It has been shown that a control plate having an insert of such a construction operates without problems even under extreme stress. The radial division of the insert can be applied both when the insert passes through the carrier body completely, and when the insert is pressed from one or from both sides into the carrier. In all cases, after the insertion, if desired, machining of the surface of the insert will still be required to achieve the required transition-free smoothness of the sliding surface to the cylinder body.

It is especially preferable for the joint to run right through the control kidneys. The joint need in that case merely bridge the gaps between the two control kidneys, so that the provision of the joint in principle causes no appreciable weakening of the insert.

The invention also relates to a method for the manufacture of a control plate, as described above, in which the insert is inserted as a solid part into the carrier body and the control kidneys are created therein subsequently by machining.

The control kidneys can be created, for example by milling. This measure ensures that, despite the use of an insert, the control kidneys are positioned in relation to the control plate exactly at the position where they are intended to be. When assembling the insert and carrier body, no attention need therefore be paid to assembling them in the correct position. In particular in a construction in which the control kidneys run partly also in the carrier body, it is thus possible to ensure that the transition between the carrier body and the insert for the fluid is smooth, that is, that no undesirable steps are created between the insert and carrier body by the assembly thereof.

The insert is preferably pressed into the carrier body. Pressing produces a relatively firm join, in particular a press fit, which can be achieved with relatively little effort. Pressing can be effected in one operation or, if desired, also several operations.

The insert is preferably shrunk into the carrier body. Such a procedure is advisable in particular in the case of the carrier body that is divided into two rings. For example, first of all the inner steel ring can be shrunk in; prior to insertion in the plastics material ring it is cooled, after which the outer ring is shrunk onto the insert. The outer ring must have been heated prior to this. Of course, the plastics material insert too can be heated before it is shrunk onto the inner steel ring of the carrier body.

An insert having an overdimension in the range from 2 to 8%, especially 3 to 5% of the diameter of the insert in its installed state is preferably used for

that purpose.

The invention is described hereinafter with reference to preferred embodiments and in conjunction with the drawings, in which

- 5 Fig. 1 is a diagrammatic cross-section through a part of a piston engine,
- Fig. 2 shows a first embodiment of a control plate in plan view and in cross-section,
- 10 Fig. 3 shows a second embodiment of a control plate in plan view and in cross-section,
- Fig. 4 shows a third embodiment of a control plate in plan view,
- 15 Fig. 5 shows, in a perspective view, a detail enlargement of the control plate according to Fig. 4, partly in section, and
- 20 Fig. 6 shows a fourth embodiment of a control plate in plan view.

A hydraulic machine has a cylinder body 1 in which at least one cylinder 2 is arranged. A piston 3 is arranged to move up and down in the cylinder 2. The movement of the piston 3 is controlled by way of a swash plate 4 against which the piston 3 lies via the intermediary of a slider shoe 5.

The opposite end face of the cylinder body 1, that is, the side from which the piston does not project, has a contact surface 6 with which the cylinder body 1 lies against a control plate 7, which is here shown only diagrammatically. If the cylinder body 1 is now rotated in the direction of an arrow 8, the contact surface 6 of the cylinder body 1 slides over an opposing contact surface 9 of the control plate 7. On each rotation of the cylinder body 1, an opening 10 in the cylinder 2 comes into register alternately with an inlet opening 11 and an outlet opening 12 in the control plate; these openings are connected to a suction port and a discharge port respectively, not shown more specifically. In this case, the machine is being used as a pump. If the machine is being used as a motor, the inlet opening 11 is connected to a pressure connection while the outlet opening 12 is connected to a tank connection. During an upward movement of the piston 3 in the cylinder 2, hydraulic fluid is consequently conveyed into the cylinder 2, whilst during a downward movement the hydraulic fluid is expelled from the cylinder 2.

So that the hydraulic fluid uses only the allotted route, that is, passes only through the inlet opening 11 and the outlet opening 12, hereinafter referred to as "control kidneys", it is necessary for the remaining regions of the contact surfaces 6, 9 to seal off this fluid path. The cylinder body 1 and the control plate 7 must therefore lie against one another with a certain pressure.

However, this pressure causes the frictional forces in the contact surfaces 6, 9 to increase. To reduce the friction, previously a fluid lubrication was used, with the hydraulic fluid acting as lubricant.

So that hydraulic fluids that have no lubricating properties can be used, control plates as illustrated in Figures 2 to 5 are now used.

A first embodiment of the control plate 7 is illustrated in Fig. 2, Fig 2a being a plan view and Fig. 2b being a section II-II according to Fig. 2a.

The control plate 7 in this case consists of two rings 13, 14 manufactured from stainless steel, between which there is arranged an insert 15 of plastics material. The control plate 7 is manufactured, for example, in that the two steel rings 13, 14 are shrunk with a press fit onto the insert 15. The control kidneys 11, 12 are then created by machining in a manner known per se by milling. To that end, the insert 15 may have an overdimension of between 2 and 8%, in particular in the range from 3 to 5%, of the diameter of the mounted insert. The press fit can be effected in one or, if desired, several operations. In this manner, for example, first of all the inner steel ring 14 can be pressed onto the insert 15 and then the outer steel ring 13 can be pressed onto the insert 15. Manufacture depends, however, on the tools used. It is also possible first of all to cool the inner steel ring 14, so that it contracts, and to insert it into the insert 15. The outer ring 13, which has previously been heated, is then shrunk down onto the insert 15. Of course, the manufacturing process could be effected in the reverse order. The two rings 13, 14 form a carrier body in which the insert 15 is secured.

Materials in particular from the group of high-performance thermoplastic plastics materials on the basis of polyarylether ketones, in particular polyetherether ketones (PEEK), polyamides, polyacetalenes, polyarylethers, polyethylene terephthalates, polyphenylene sulphides, polysulphones, polyethersulphones, polyetherimides, polyamidimides, polyacrylates, phenol resins, such as novolak resins, or similar substances are possibilities as material for the plastics material. Because the cylinder body 1 is normally made of steel, this combination of material, namely, steel and plastics material, enables an excellent frictional behaviour to be achieved, which easily reaches values of oil-lubricated friction surfaces.

The carrier body 13, 14 has a recess 16 with the assistance of which the control plate 7 can be held, safeguarded against rotation, in the machine. A further means preventing rotation 17, for example, a steel pin, is provided, which holds the insert 15 so that it does not rotate relative to the carrier body 13, 14.

On the side facing away from the cylinder body 1, the control plate 7 has two pressure relief channels 18, by which a space 19 on the side of the control plate 7 facing away from the cylinder body 1 is connected to the atmosphere; in the installed state of the control plate this space is further defined by a rear flange, not shown. Hydraulic fluid which may penetrate into this space 19 can flow away through the pressure relief channels 18 without problem.

Fig. 3 shows a second embodiment of a control plate 7', Fig. 3b being a section along the line III-III of Fig. 3a. Parts that correspond to those of Fig. 2 are denoted by the same reference numbers.

The carrier body 20 in the arrangement according to Fig. 3 is of one piece construction. It has a ring-shaped circumferential groove 21 into which the insert 22 is pressed. The two control kidneys 11, 12 are in turn created in the insert 22 by milling.

The pressure relief channel 23 is arranged this time in the carrier body 20.

Furthermore, two drainage bores 24, 25 are provided. These start at the side of the control plate 7' facing away from the cylinder body 1 and open out between the carrier body 20 and the insert 22 into the groove 21. The drainage bores 24, 25 are arranged in the region of the control kidney 11 which is supplied with hydraulic fluid under pressure when the motor is in operation. Hydraulic fluid that penetrates between the insert 22 and the carrier body 20 despite the press fit is able to flow away through the drainage bores 24, 25 without problems and without causing any damage.

Fig. 4 and 5 show a further example of a control plate 7'' in which identical parts are again denoted by the same reference numbers.

In addition to the insert 22, which is already known from the embodiment of Fig. 3, a further insert 27 is provided in the carrier body 26 and is arranged on the side of the control plate 7'' facing away from the cylinder body 1. The carrier body 26 has a circumferential groove 28 on this side to receive the second insert 27. The control plate 7'', which in its mounted state lies with its side facing away from the cylinder body 1 against a rear flange, is sealed better with this insert 27 than it is when it is in direct contact with the carrier body rear flange. The two inserts 22, 27 can consist of the same material. Alternatively, they can consist of different materials, greater importance being attached to the frictional aspect in choosing the material for the insert 22, whereas the material of the insert 27 is selected more from the point of view of its sealing properties. If both inserts 22, 27 are made of the same material, one can also say that

the insert is divided.

Fig. 5 illustrates the manner in which both the insert 22 and the insert 27 project from the carrier body 26, namely, by a distance D. This distance has been shown on an exaggeratedly large scale for the purposes of illustration. In reality, the insert 22 will project from the carrier body 26 only by a few tenths or even a few hundredths of a millimetre. The same applies to the constructions shown in Figs 2 and 3.

The inserts 22, 27 shown in Figs 3 to 5 are also first of all inserted in the carrier bodies 20 and 26, respectively, for example by pressing or shrinking. Only then are the control kidneys 11, 12 created therein by milling. There is consequently no step at the transition from the insert to the carrier body or vice versa.

Fig. 6 shows a fourth embodiment of a control plate 7'', in which the carrier body 29 can be constructed not only as in Fig. 2 but also as in Fig. 3 or 4.

Unlike the constructions according to Figs 2 to 5, the carrier body is divided by a circumferential joint 30 into a radial inner part 31 and a radial outer part 32. The joint passes through the control kidneys 11, 12. In this construction, the insert 31, 32 is also first of all secured to the carrier body 29 with a press fit. The control kidneys 11, 12 are then created by machining, for example, by milling. A surface-finishing of the insert 31, 32 subsequently follows, if desired, even before the control kidneys 11, 12 are produced by milling, in order to achieve a surface that is as smooth, i.e. transition-free, as possible on which the cylinder body is able to slide. At the joint 30 the two parts 31, 32 lie closely side by side. The friction here is great enough to prevent mutual rotation of the two parts 31, 32. If desired, however, a separate means for preventing rotation relative to the rotary body 29 can be provided for each of the two parts 31, 32; if desired a means preventing rotation can be provided between the two parts 31, 32.

Claims

1. A control plate for a hydraulic piston engine, which has a cylinder body rotatable relative to the control plate, the control plate having at least two control kidneys which on rotation of the cylinder body lie in the path of movement of an opening of a cylinder in the cylinder body, characterized in that the control kidneys (11, 12) are formed in at least one insert (15, 22, 27) of plastics material which is secured in a carrier body (13, 14; 20, 26).
2. A control plate according to claim 1, characterized in that the insert (15, 22, 27) projects from the carrier body (13, 14; 20, 26) at least in the direction towards the cylinder body (1).
3. A control plate according to claim 1 or 2, characterized in that the insert (15, 22, 27) is of ring-shaped construction.
4. A control plate according to claim 3, characterized in that a means safeguarding against rotation (17) is provided between the insert (15, 22) and the carrier body (13, 14; 26).
5. A control plate according to one of claims 1 to 4, characterized in that the insert (15, 22, 27) is joined to the carrier body (13, 14; 20, 26) by means of a press fit.
6. A control plate according to one of claims 1 to 5, characterized in that the insert (15, 27) projects from the carrier body (13, 14; 26) also on the side facing away from the cylinder body (1).
7. A control plate according to claim 6, characterized in that a pressure relief channel (18, 23) is provided in the insert (15) or in the carrier body (26) on the side facing away from the cylinder body (1) and is arranged between the control kidneys (11, 12).
8. A control plate according to claim 6 or 7, characterized in that the insert (22, 27) is divided.
9. A control plate according to one of claims 1 to 8, characterized in that the carrier body (13, 14) is formed from two rings which lie adjacent to the insert (15) in a radial direction from the inside and from the outside.
10. A control plate according to one of claims 1 to 8, characterized in that the carrier body (20, 26) has a circumferential annular groove (21, 28) to receive the insert (22, 27).
11. A control plate according to claim 10, characterized in that at least one drainage bore (24, 25) is provided in the carrier body (20), starting on the side facing away from the cylinder body (1) and opening out between the insert (22) and carrier body (20), wherein the drainage bore (24, 25) is provided in particular in the region of the control kidney (11) which is exposed to hydraulic fluid under pressure.
12. A control plate according to one of claims 1 to 11, characterized in that the insert (29) has a joint (30) running in the circumferential direc-

tion, which divides the insert (29) into a radial inner part (31) and a radial outer part (32).

13. A control plate according to claim 12, characterized in that the joint (30) runs through the control kidneys (11, 12). 5
14. A method for the manufacture of a control plate according to one of claims 1 to 13, characterized in that the insert is inserted as a solid part, or as solid parts, into the carrier body and the control kidneys are created therein subsequently by machining. 10
15. A method according to claim 14, characterized in that the insert is pressed into the carrier body. 15
16. A method according to claim 14 or 15, characterized in that the insert is shrunk into the carrier body. 20
17. A method according to one of claims 14 to 16, characterized in that an insert having an over-dimension in the range from 2 to 8%, especially 3 to 5% of the diameter of the insert in its installed state, is used. 25

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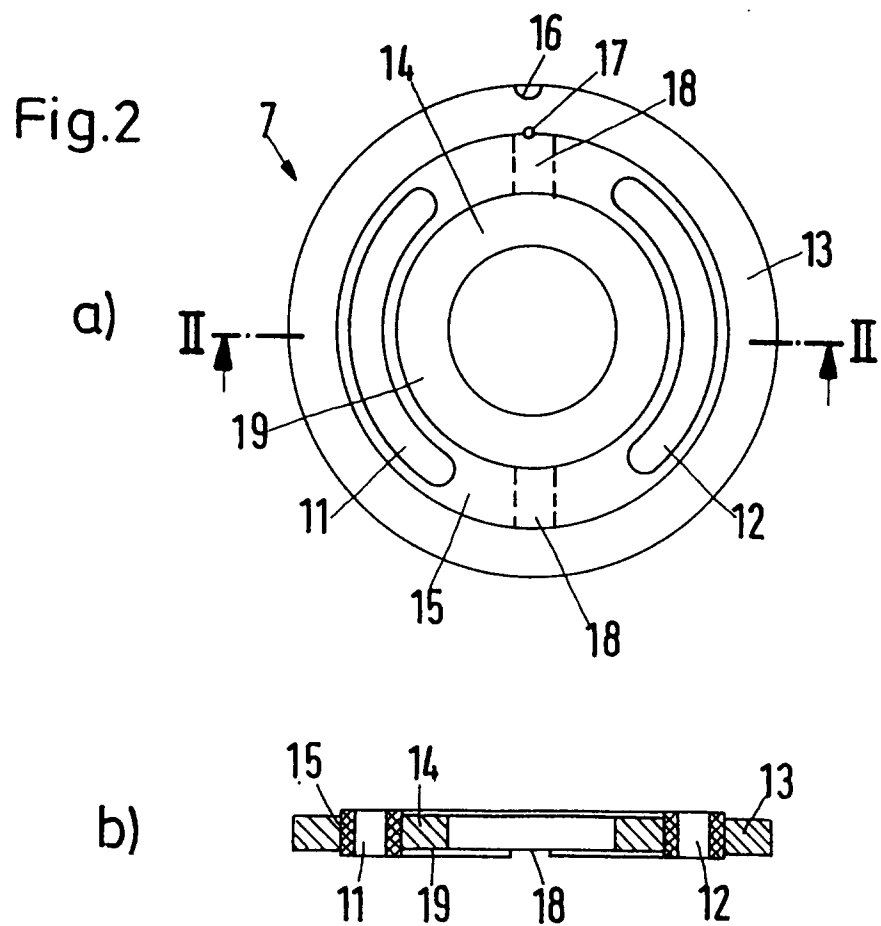
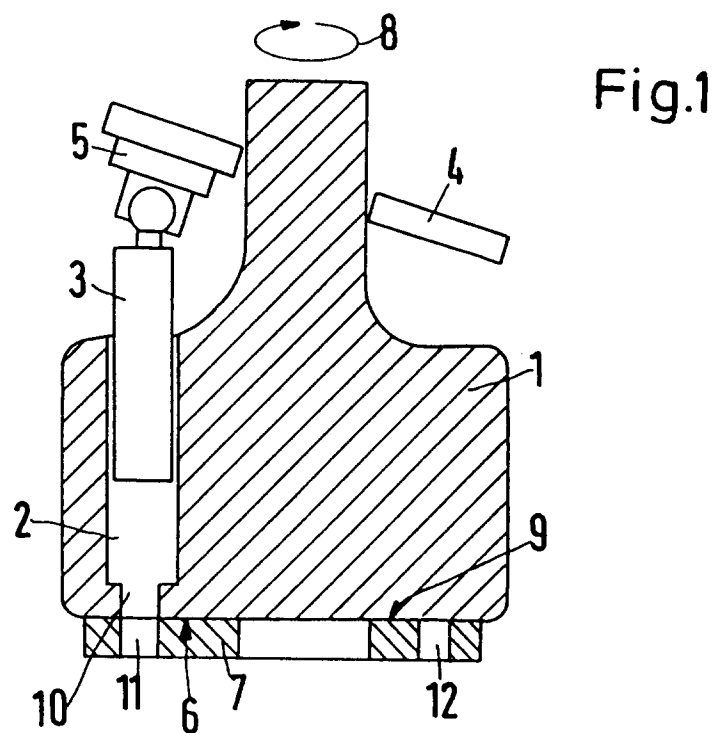


Fig.3

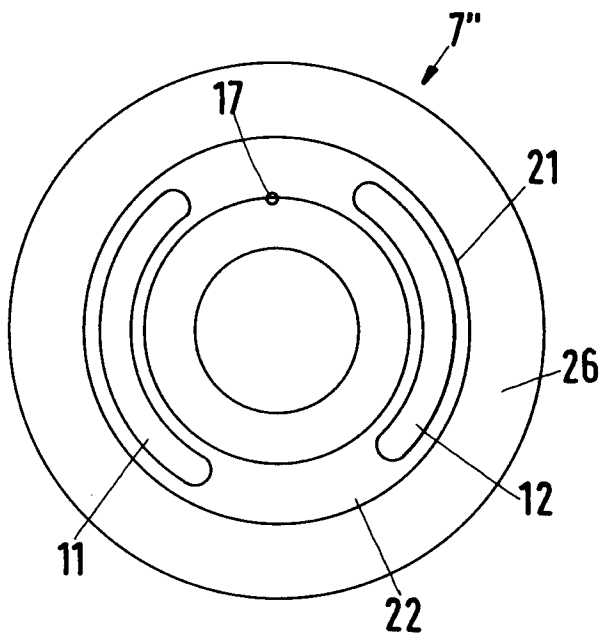
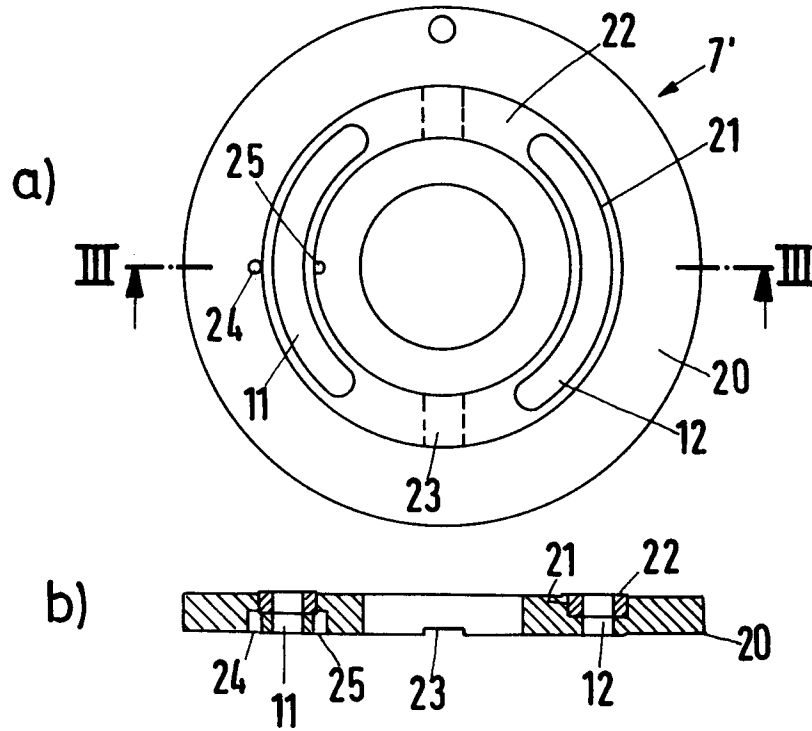


Fig.4

Fig.5

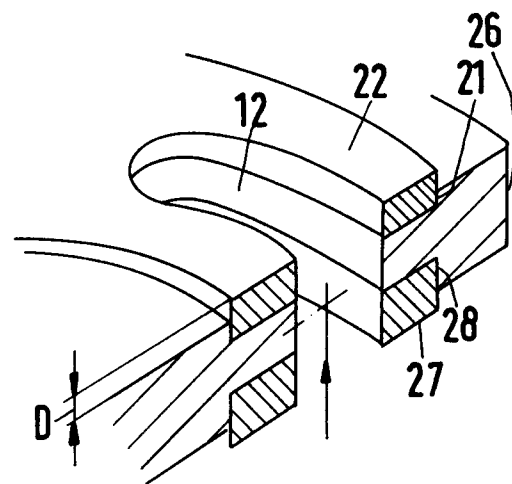
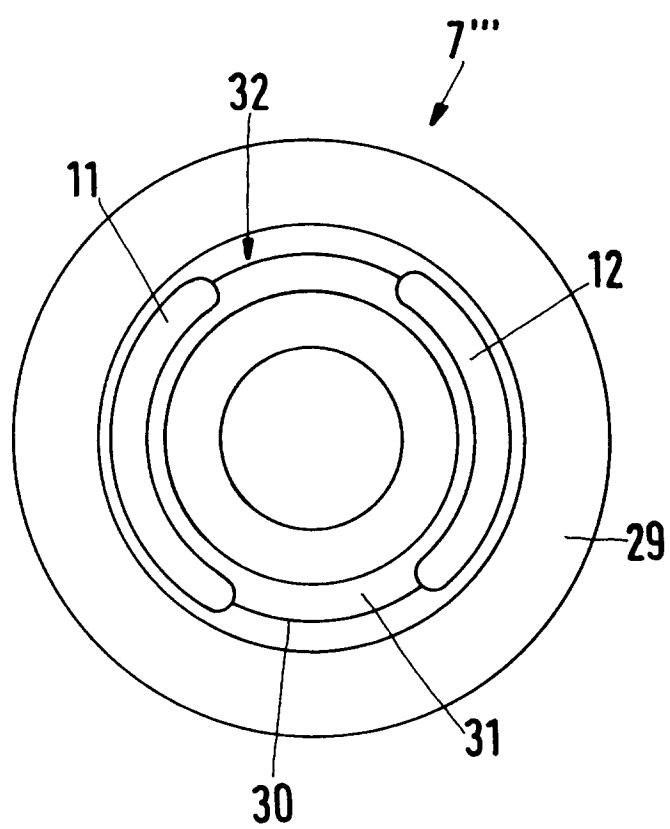


Fig.6





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 94 20 3492

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.6)
X	US-A-3 582 090 (LOEFFLER ET AL.) * the whole document *	1-5, 10	F04B1/20
A	FR-A-1 258 162 (DOWTY HYDRAULIC UNITS) * the whole document *	1	
A	US-A-3 523 678 (WRIGHT)		
A	FR-A-1 346 890 (JOSEPH LUCAS LTD)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F04B F03C F01B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 March 1995	Examiner Von Arx, H
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