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(54) **Title:** A DISPLACEMENT PUMP WITH A BARRIER AGAINST THE FLUID LEAKAGE

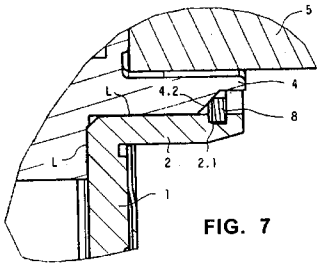


FIG. 7

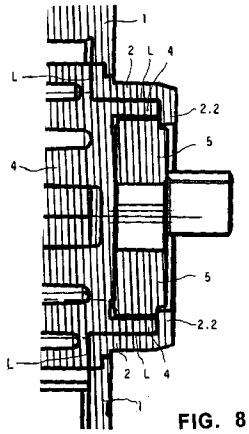


FIG. 8

(57) **Abstract:** A displacement pump driven by a motor, wherein a barrier (4.1; 8; 2.2) suitable for preventing or reducing the fluid leakage is inserted in at least one of the pump regions which are subjected to a leakage between the inner space of the pump and the outside. In one embodiment, in one of two component parts (2,4) subjected to relative movement is formed at least one step (4.1) which determines a limited region of mutual contact between the two component parts (2,4) subjected to relative movement, thus forming a sort of labyrinth which favores the seal against the fluid leakage. As an alternative, on one of the two component parts (2,4) subjected to relative movement is provided an annular inclined area (4.2) located facing a seat (2.1) for an annular sealing element (8) whereby, due to the pressure difference between the inner fluid and the outer fluid, the annular sealing element (8) is biased to contact against the annular inclined area (4.2). Moreover, the sealing barrier (2.2) can be provided in the region wherein there is a coupling joint (5) driving the rotor (4), by forming on the support member (2) a step (2.2) which acts as a closure for the rotor (4) and keeps in position the driving coupling joint (5), the coupling clearance being annulled by the oil penetrating between the parts.

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DESCRIPTION

A DISPLACEMENT PUMP WITH A BARRIER AGAINST THE FLUID LEAKAGE

The subject of this invention is a displacement pump equipped with a barrier against the fluid leakage, intended to prevent or reduce the fluid exchanges between the inner space of the pump and the outside.

From the research of Applicant it has turned out that in the displacement pumps, and mainly in the vacuum pumps for automotive use, one of the essential factors that negatively affect the good pump performance is the leakage of fluid, both from the inner space of the pump towards the outside and from the outside towards the inner space of the pump. The subjects developed in the following find main application in those pumps in which there are provided one or more sliding areas communicating with the outside, or in which a noticeable leakage takes place through the guide region of the shaft or the rotor.

The fluid leakage between the inner space of the pump and the outside affects negatively in direct manner the pump performance mainly because, with reference to a vacuum pump, it involves a re-entry of air or fluids from the outside towards the inner pump space, thus impairing the depression level attained and the time needed for obtaining the same. But the fluid leakage affects negatively the performance even in an indirect manner, because it causes a removal of the oil lubricating the mutually displacing component parts, and in this manner involves an increase of the oil quantity needed for lubricating the pump and therefore an increase of the energy consumed by the device that supplies the lubricating oil, as well as an increases of the strain of the component parts.

In view of the above, the main object of this invention is to noticeably improve the performance of a displacement pump, particularly but not exclusively a vacuum pump, by reducing the performance loss directly and indirectly caused by the fluid leakages between the pump inner space and the outside. Another object of the invention is to attain said object by technically simple means which do not introduce any difficulty in the pump manufacture. Still another object of the invention is to attain the desired objects without noticeably increasing the costs of the pump.

Therefore, in a motor driven displacement pump, the objects of the invention are attained because a barrier, suitable for preventing or reducing the fluid leakage, is inserted in at least one of the pump areas which are subjected to a fluid leakage between the inner space of the pump and the outside.

Said characteristic of the invention can be carried out in different embodiments.

According to a first possible embodiment of the invention, in one of two component parts subjected to relative movement is formed at least one step which determines a limited region of mutual contact between the two component parts subjected to relative movement, thus forming a sort of labyrinth which favores the seal against the fluid leakage.

Preferably said step is provided on the component part that has the higher hardness, whereby during the first periods of operation said step hollows a seat in the component part having the lower hardness, thus providing a particularly effective labyrinth. It is of advantage that to said step is done such a size that, also keeping into account the different thermal expansion coefficients of the component parts, the better operation conditions are attained in the conditions of use in which it is more important that the better seal against the fluid leakage is obtained, said step being in any event sized in such a way that in no operation condition any seize up is generated.

The radial extension of said step may advantageously be sized by taking into account the lubrication conditions. Preferably, in one of said component parts are formed some holes suitable for directing the lubricant to the gliding region of the step.

This first embodiment of the invention, having the whole or a part of the stated features, is of particular advantage in view of its execution being simple and inexpensive.

According to a second possible embodiment, in one of the two component parts subjected to relative movement is provided at least one annular seat, and in this seat is housed an annular sealing element having a low friction coefficient, kept in sealing contact with both the component parts, also due to the different fluid pressure present in the inner space of the pump and outside.

Particularly, in a vacuum pump, the pressure inside the pump being lower than the pressure outside the pump, said sealing element is pushed by

the pressure difference against said seat formed in one of said component parts as well as against the other component part.

It is possible, and it may be suitable, to provide a region of light interference between the annular sealing element and one of the two component parts subjected to a relative movement.

It is of advantage that on one of the two component parts subjected to relative movement is provided an annular inclined area facing said seat for an annular sealing element, whereby, due to the pressure difference between the inner fluid and the outer fluid, the annular sealing element is biased to contact against the annular inclined area.

According to a third possible embodiment, the sealing barrier is provided in the region wherein there is a coupling joint driving the rotor, by forming on the fixed pump portion a step which acts as a closure for the rotor and keeps in position the driving coupling joint, the coupling clearance being annulled by the oil penetrating between the parts.

These and other features, objects and advantages of the subject of the present invention will more clearly appear from the following description of some embodiments, having the character of not limiting examples. with reference to the accompanying drawings, wherein:

Figure 1 represents an axial view of a displacement vane pump, deprived of the cover.

Figure 2 shows on a larger scale a partial section of the pump, taken along a plane which passes through the rotation axis of the rotor and through the contact line between the rotor and the pump body.

Figure 3 shows a region of the pump which is subjected to a fluid leakage, and to this region are referred the following Figures 4 to 7.

Figures 4 to 7 show different embodiments of the sealing against the fluid leakage provided in the pump region of Figure 3.

Figure 8 shows another embodiment of the sealing against the fluid leakage.

The displacement pump according to this invention is particularly suitable for use as a vacuum pump for automotive application, and therefore the following description refers to said application, but it is to be specified that this application is not exclusive, and the pump can be embodied for any application of a displacement pump to the suction or compression of gases or liquids.

With reference to Figures 1 and 2, a displacement vane pump, such as a vacuum pump for automotive application, comprises a body 1 delimiting a chamber 3 wherein is housed a rotor 4, which is rotatably mounted in support members 2 of body 1, and is driven by a motor (not shown) by means of a driving coupling joint 5. The rotor is tangent along a line 6 to the pump body 1, and it carries a vane 7 which, when rotated by the rotor within chamber 3 with its own end portions contacting the wall of body 1, operates the pumping action in a manner which is well known to those skilled in the art.

In a vacuum pump, the area subjected to fluid leakage is mainly represented by the guide members at the motor side. A fluid leakage between the inner pump chamber 3 and the outside may take place, in particular, along the contact surface between the rotor 4 and the support member 2 of body 1; this surface corresponds to line L in the section of Figure 2. The area interested to the fluid leakage, to which refer the different solutions presented within the scope of the invention, is represented in detail in Figure 3.

In several displacement pumps, and in particular the vacuum pumps, some component parts are manufactured of plastics and others of aluminum alloys, because this ensures advantages in terms of costs, weight and balancement of the forces present, but this fact introduces differences in the thermal coefficients of the component parts, and therefore increased difficulties in the design with reference to the clearances, from which depend the fluid leakages in the different temperature fields. This fact makes more urgent the requirement for a reduction of these fluid leakages, that is the object of the invention.

A first embodiment according to the invention, represented at a large scale in Figure 4, involves the provision of at least one step 4.1 protruding in diameter in the guide region. The step 4.1 is provided on the less yielding element, that in this case is the rotor 4, but in general it may be the rotor 4 or the support member 2, in accordance with the materials used in the manufacture of the component parts. The size of the step is chosen in such a way that, in the operating conditions, the coupling is of uncertain type. According to the choice of the materials present in this coupling, different coefficients of thermal expansion may be observed, and therefore, when the coefficient of thermal expansion of the materials is different, the field of the functional clearance varies depending on the operation conditions. For this reason the

step should be sized by keeping into account the operation conditions wherein it is more important that the better condition is attained. In any event, the step should be sized in such a way that in no operation condition any seize up is generated.

During the first periods of operation, the less yielding component part on which the step is provided hollows a seat in the more yielding component part, thus providing a sort of labyrinth which favors the seal against the fluid leakage. The height of the step zone will be sized by taking into account the height of the guide component part and the lubrication conditions.

In order to prevent seize up phenomena, it is suitable to provide some holes arranged for directing the lubricant to the region of relative gliding of the component parts.

The advantage of the solution now described resides in its simple and inexpensive execution. It ensures an effective advantage within the foreseen operation field. In order to carry out this solution, it is only needed that in the working process of the rotor the creation of the sealing step or steps is foreseen.

A second embodiment of the invention is represented in Figure 5. In this case, in the support member 2 at the motor side there is formed a seat 2.1, wherein is housed an annular sealing element 8 having a low friction coefficient. In the rotor 4, the diameter of the corresponding region is chosen in such a way as to favor the accommodation of the sealing element 8. In the application of this solution to a vacuum pump, one should keep into account the fact that the pressure value inside the pump is lower than the outer pressure, whereby the annular sealing element 8 is pushed to contact the seat 2.1 at a side of the support member 2 and to contact the rotor 4.

The third embodiment represented in Figure 6 is a modification of the embodiment of Figure 5. In this case, a region of light interference is provided between the annular sealing element 8 and rotor 4.

Also the fourth embodiment represented in Figure 7 is a modification of the embodiment of Figure 5. In this case, the annular sealing element 8, which is housed in its seat 2.1 formed in the support member 2, rests at the rotor side against an inclined annular region, which is represented in the section by the inclined line 4.2. The component parts remain in mutual contact and, due to the pressure difference between the inner and outer spaces, the

annular sealing element 8 is biased to adapt itself to the annular surface represented by the inclined line 4.2.

In the fifth embodiment represented in Figure 8, the seal against the fluid leakage is obtained by forming a step or flange 2.2 on the support member 2 of the pump. The step 2.2 formed on the support member 2 acts as a closure for rotor 4 and keeps in position the driving joint 5. The clearance is annulled by the oil entering between the joint seat at the motor side and the joint itself.

As it appears from the foregoing, this invention concerns the provision of a barrier in a displacement pump (and specifically in a vacuum pump) as well as the geometry of this barrier, which can be fixed (if formed by machining or molding) or movable (in the case of the insertion of an annular sealing element) and, when provided in correspondence of the region of possible communication between the inner space of the pump and the outside within the rolling region of rotor, contributes to improve the performances of the pump both in the temperature field in which the pump should operate and outside this temperature field.

The advantages of applying the invention are numerous.

The passage of fluid is prevented and therefore, with reference to the vacuum pumps, there is no re-entry of air or fluids from outside towards the inner pump space, with a consequent advantage in the pump performance, both in terms of vacuum level obtained and of time needed for its obtention.

The quantity of oil required for lubricating the pump is reduced, and this allows to dispose of more oil for other motor components or to use a lubrication pump of reduced volume.

The energy absorbed by the lubrication pump is reduced because of its better efficiency and of the reduced oil quantity to be treated by the pump.

The strain of the component parts is reduced because of the lower air and oil quantity to be treated.

Against these advantages, it will appear to those skilled in the art that the application of the invention does not introduce any difficulty or high cost in the industrial manufacture of the pump.

It should be understood that this invention is not limited to the embodiments described and shown as examples. Several possible modifications have been pointed out in the course of the description, and others are within

the ability of those skilled in the art. These modification and others, and any replacement by technically equivalent means, can be made to what has been described and shown, without departing from the scope of the invention as defined by the appended Claims.

CLAIMS

1 . A motor driven displacement pump, characterized in that a barrier (4.1; 8; 2.2) suitable for preventing or reducing the fluid leakage is inserted in at least one of the pump areas which are subjected to a fluid leakage between the inner space of the pump and the outside.

2 . A displacement pump according to Claim 1, characterized in that In one of two component parts (2,4) subjected to relative movement is formed at least one step (4.1) which determines a limited region of mutual contact between the two component parts (2,4) subjected to relative movement, thus forming a sort of labyrinth which favores the seal against the fluid leakage.

3 . A displacement pump according to Claim 2, characterized in that said step (4.1) is provided on the component part (2,4) that has the higher hardness, whereby during the first periods of operation the step hollows a seat in the component part (4,2) having the lower hardness, thus providing a particularly effective labyrinth.

4 . A displacement pump according to Claim 2, characterized in that to said step (4.1) is done such a size that, also keeping into account the different thermal expansion coefficients of the component parts (2,4), the better operation conditions are attained in the conditions of use in which it is more important that the better seal against the fluid leakage is obtained, said step (4,1) being in any event sized in such a way that in no operation condition any seize up is generated.

5 . A displacement pump according to Claim 2, characterized in that the radial extension of said step (4.1) is sized by taking into account the lubrication conditions.

6 . A displacement pump according to Claim 2, characterized in that in one of said component parts (2,4) are formed some holes suitable for directing the lubricant to the gliding region of the step (4.1).

7 . A displacement pump according to Claim 1, characterized in that In one of the two component parts (2,4) subjected to relative movement is provided at least one annular seat (2.1), and in this seat (2.1) is housed an annular sealing element (8) having a low friction coefficient, kept in sealing contact with both the component parts (2,4), also due to the different fluid pressure in the inner space of the pump and in the outside.

8 . A displacement pump according to Claim 7, characterized in that, when the pump is a vacuum pump, the pressure inside the pump being lower than the pressure outside the pump, said sealing element (8) is pushed by the pressure difference against said seat (2.1) formed in one of said component parts (2,4), and against the other component part (4,2).

9 . A displacement pump according to Claim 7, characterized in that a region of light interference is provided between the annular sealing element (8) and one of the two component parts (2,4) subjected to a relative movement.

10 . A displacement pump according to Claim 7, characterized in that on one of the two component parts (2,4) subjected to relative movement is provided an annular inclined area (4.2) located facing said seat (2.1) for an annular sealing element (8), whereby, due to the pressure difference between the inner fluid and the outer fluid, the annular sealing element (8) is biased to contact against the annular inclined area (4.2).

11 . A displacement pump according to Claim 1, characterized in that the sealing barrier (2.2) is provided in the region wherein there is a coupling joint (5) driving the rotor (4), by forming on the support member (2) a step (2.2) which acts as a closure for the rotor (4) and keeps in position the driving coupling joint (5), the coupling clearance being annulled by the oil penetrating between the parts.

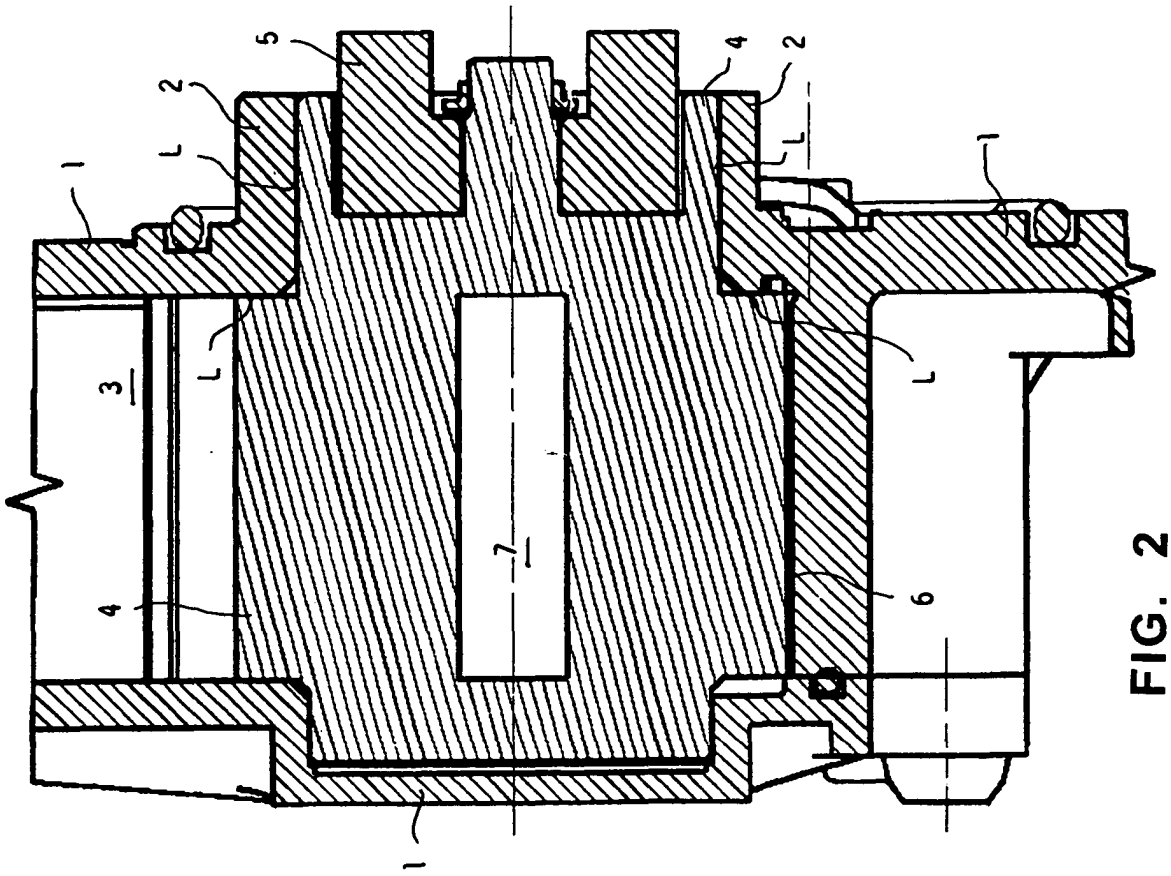


FIG. 2

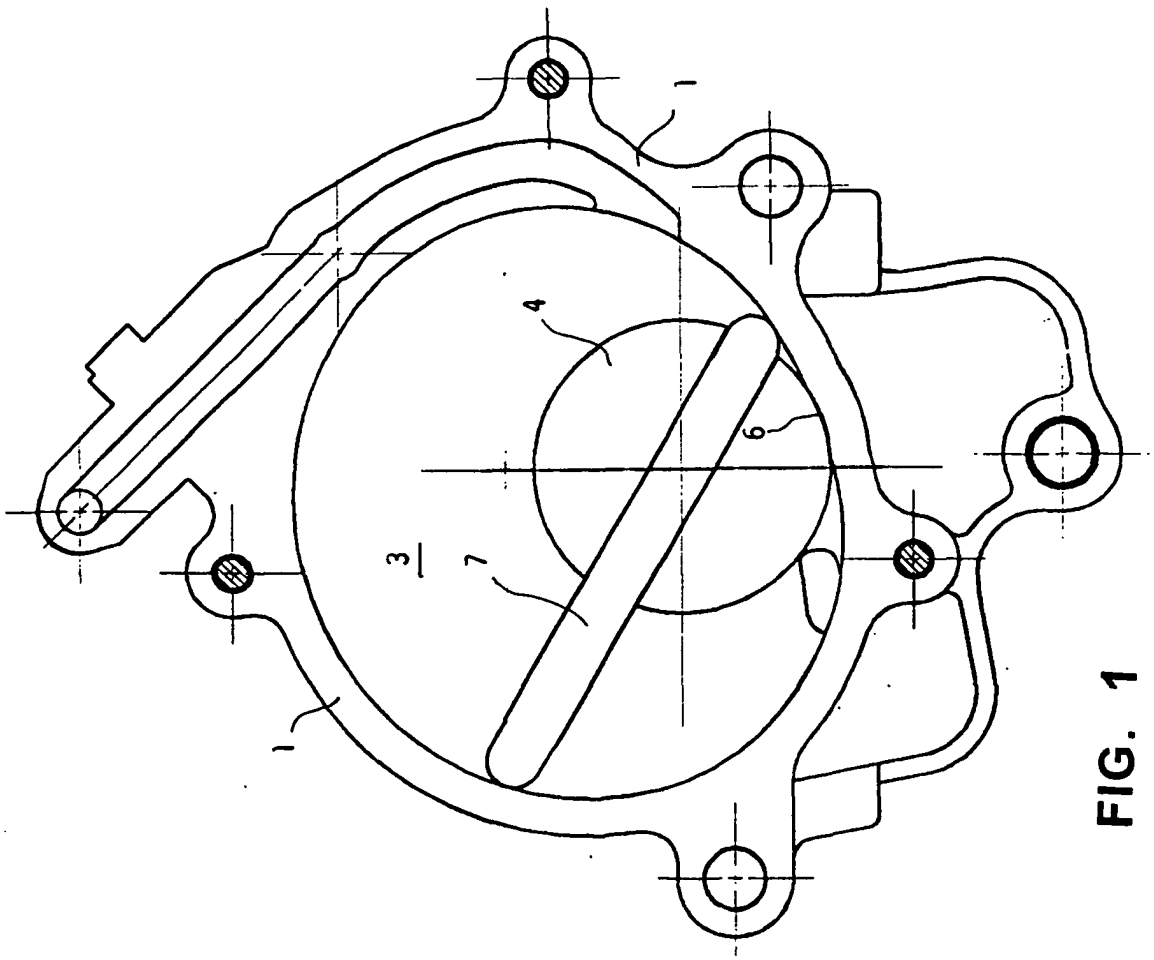


FIG. 1

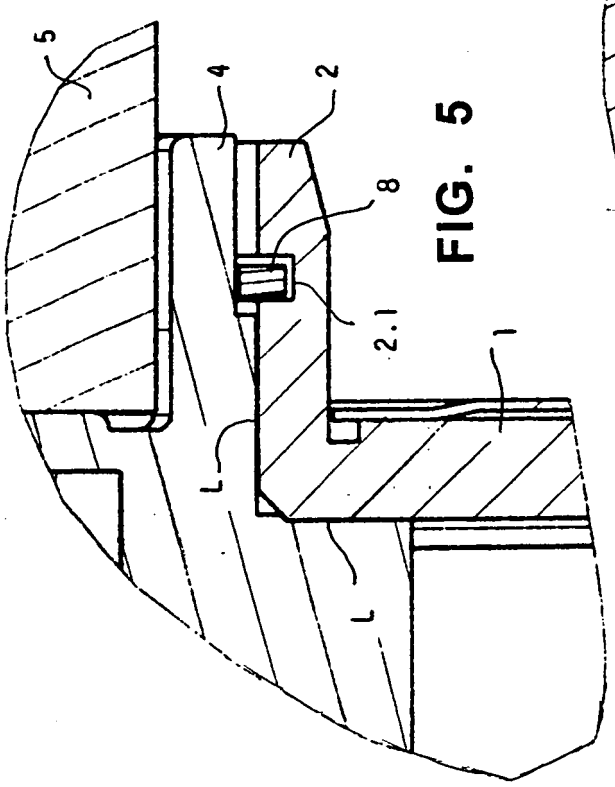


FIG. 5

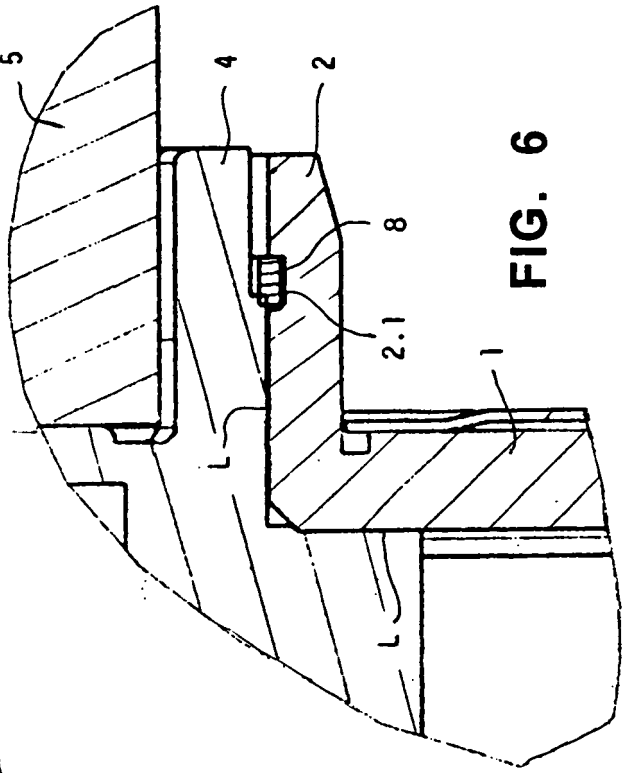


FIG. 6

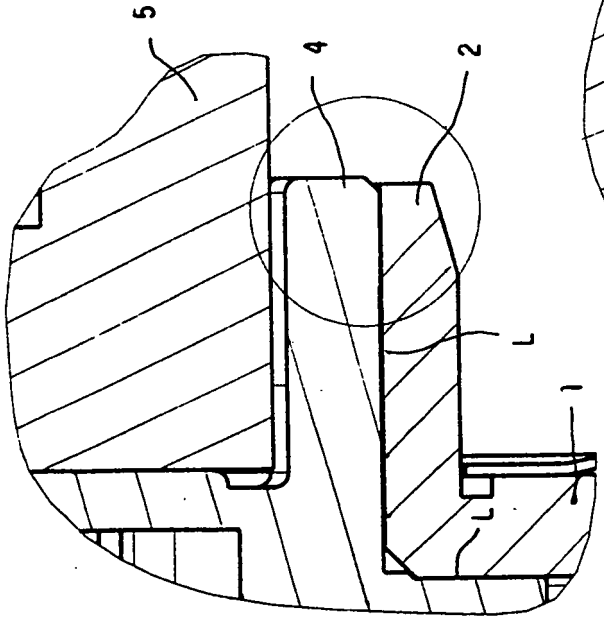


FIG. 3

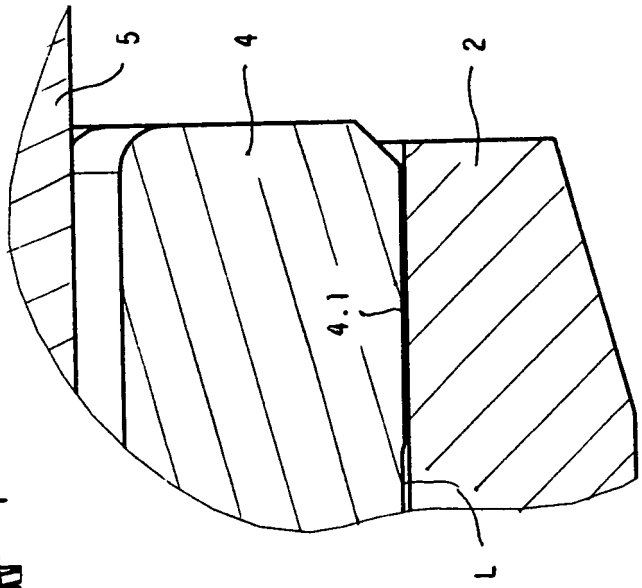


FIG. 4

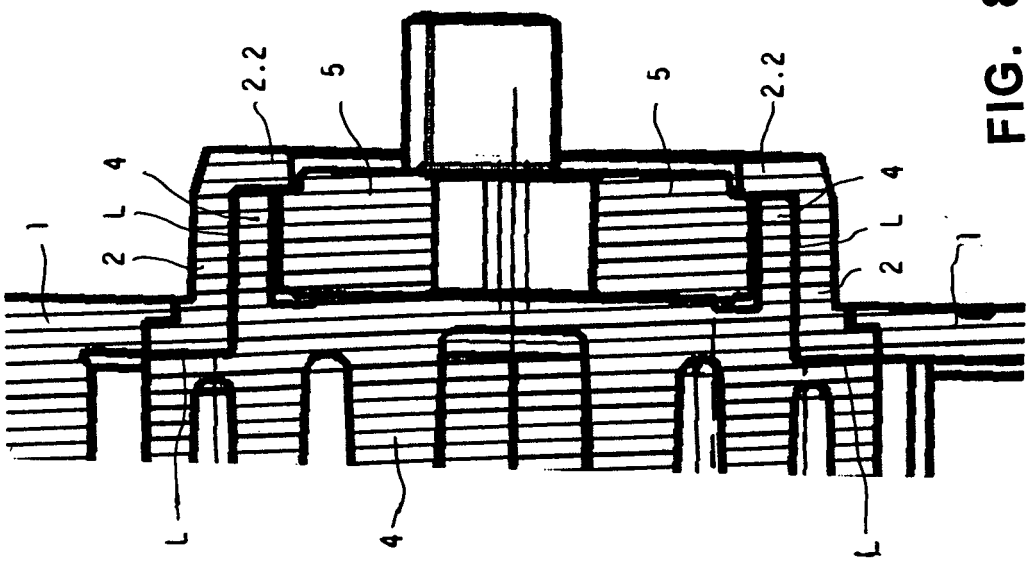


FIG. 8

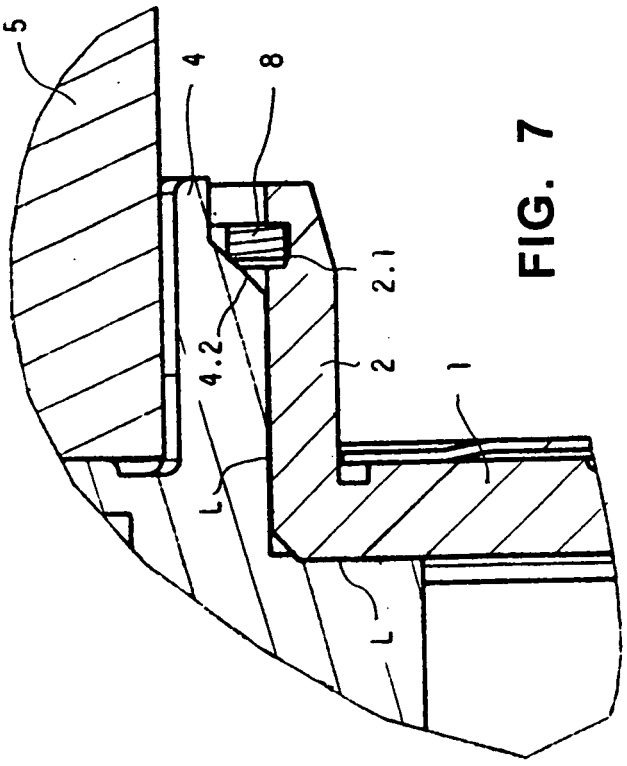


FIG. 7