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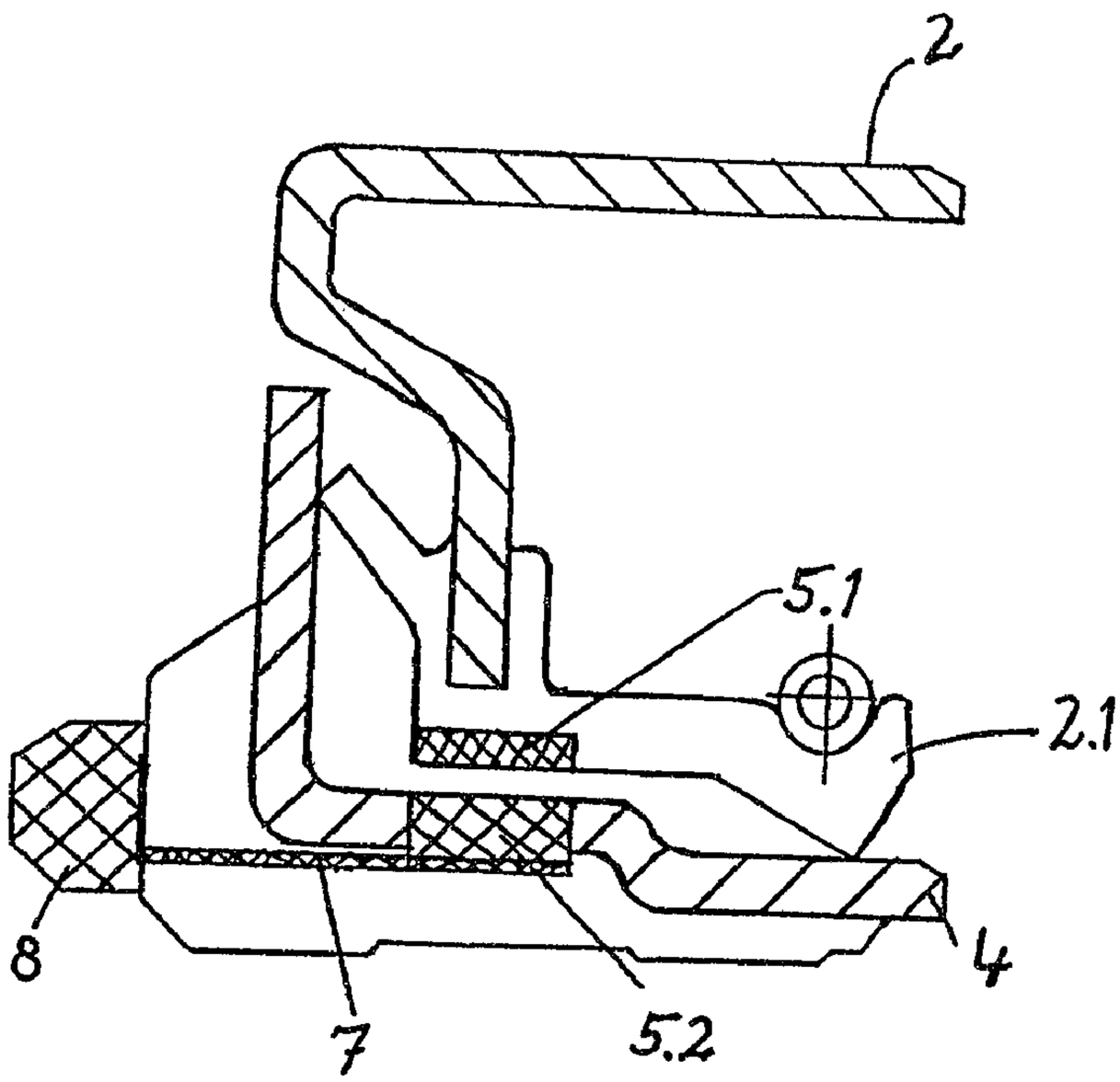

(57) Abrégé/Abstract:
A seal arrangement includes a seal having a polymeric sealing body and a flexible auxiliary member which is rigidly affixed to at least a portion of the sealing body and which is an electrical impulse generator and/or sensor adapted for use in the detection of variable parameters of the seal and its environment. The integration of the auxiliary member into the seal arrangement provides for a miniaturized construction and simple manufacture and, installation and operation at low cost.

ABSTRACT

A seal arrangement includes a seal having a polymeric sealing body and a flexible auxiliary member which is rigidly affixed to at least a portion of the sealing body and which is an electrical impulse generator and/or sensor adapted for use in the detection of variable parameters of the seal and its environment. The integration of the auxiliary member into the seal arrangement provides for a miniaturized construction and simple manufacture and, installation and operation at low cost.

SEAL ARRANGEMENT

The invention relates to seal arrangements including a sealing body of polymeric material and a flexible auxiliary member which is rigidly affixed to at least a portion of the sealing body and is adapted to be used for at least one electrical function.

Such a seal arrangement is known from German Published Application DE-OS4038394. It is used for passing a conductor through the wall of a housing which encloses a liquid and an engine having a sensor mounted thereto. The sensor is connected with a flexible end of the conductor and is used for the detection of selected parameters. The position of the sensor during the intended use is mainly determined by the position of the engine. Therefore, an especially accurate installation of the sensor is required for the achievement of a good measurement accuracy. This is difficult to achieve and results in high installation costs.

It is now an object of the invention to provide a seal arrangement which is easily installed and permits very precise detection of the data of a measuring station such as a sensor.

This object is achieved in accordance with the invention with a seal arrangement including a polymeric sealing body and a flexible auxiliary member rigidly affixed to at least a portion of the sealing body, whereby the flexible auxiliary member is constructed as an electrical impulse generator and/or sensor. This arrangement permits the detection of signals representing, for example, the speed of rotation of the engine, and the temperature, humidity or pressure in the space to be sealed as well as the conversion of those signals to an electrical signal and transmission thereof.

The auxiliary member is preferably either embedded into the polymeric sealing body or adhesively connected to the surface thereof. It is thereby unimportant where the auxiliary member is fixed to the sealing body. The location of the auxiliary member can be selected solely for the purpose of achieving an optimal measurement of the desired parameters. This always results in a very exact positioning of the auxiliary member in relation to the engine.

The seal arrangement is manufactured with known injection molding, press molding or casting tools. Such tools can be manufactured with very high accuracy, for example with variances in the micrometer range only. The flexible auxiliary member is preferably connected with the sealing body by placing the flexible auxiliary member into the empty tool so that it is forced against the wall of the tool by the liquid or viscous material pressed into the tool, and thereby connected with the material. The auxiliary member then exactly follows the shape of the tool and at the same time is permanently connected with the solidified sealing body at a precisely controllable location.

The auxiliary member is preferably connected by way of a flexible conductor with a plug or a measuring arrangement which are at least partly embedded into the sealing body. This allows integration of the impulse generator and/or sensor into the seal arrangement. The sensor or impulse generator is preferably mounted on a flexible circuit board which is electrically connected directly to the plug that functions as an interface between the sensor or impulse generator and further measurement and processing apparatus. Flexible circuit boards allow the installation of a large number of components within a very limited space and due to this flexibility ensure that the mounted components adapt to the finished shape of the seal. When flexible circuit boards are used, no additional conductors are required. This, again results in an especially simple installation of the seal arrangement and reduces possible measurement and detection errors.

In one preferred embodiment, the impulse generator or sensor includes a flexible circuit board of an annular, closed shape. Circumferentially distributed codes are provided on the circuit board for the generation of impulses. The codes are placed on the base material of the flexible circuit board in transverse or longitudinal direction and extend at a selected distance from each other. The result is an impulse generator of simple construction which is acheivable without cost intensive manufacturing and installation steps. The codes used for the impulse generation can be magnetized, if desired. The integration of the impulse generation and detection as well as the transmission functions into the sealing arrangement provides for a miniaturized construction. The complete sealing and signalling system is manufactured at low cost

and is customer friendly. Furthermore, this system allows not only the detection and transmission with high accuracy of information on the speed of rotation of an associated engine, but also of signals representing the temperature, humidity or pressure in the space to be sealed.

Flexible circuit boards used for the impulse generator and the conductive connection between the sensor and the plug are preferably rectangular in shape. With such a construction, no additional adaptation of the circuit boards to the shape of the sealing body and other parts of the seal is required. The circuit board can be easily manufactured and embedded into the material of the sealing body during molding. The adaptation of the circuit board to the shape of the sealing body is automatically achieved.

It is also possible to provide several impulse generators and/or sensors on or in the sealing body for the simultaneous detection of different signals or for the detection of selected parameters with the same seal arrangement in different applications. The auxiliary member can be of annular, closed shape and surround the sealing body in circumferential direction. This allows the detection of the speed of rotation of a machine part in relation to the sealing body. The pressure in the space to be sealed can be detected with an annular auxiliary member which is a piezo element.

Fixing the sensor on the sealing body allows the detection of leakage from the space to be sealed or detection of the temperature of the sealing edge. The sensor used for detection of relative movement is preferably a Hall-effect sensor. In another embodiment, the sensor consists of an electrical circuit with resistor and capacitor. The flexible circuit board carrying the sensor supplies operating power to the sensor and serves as a conductor for the transmission of the signals generated by the sensor.

The preferred auxiliary member for the detection of the temperature in the sealed space includes a thermoelement in connection with a bridge circuit. The integration of these elements into the seal arrangement is made possible without additional auxiliary means by the use of flexible circuit boards.

In a further preferred embodiment which forms a cassette or functional unit, the auxiliary member is combined with a second auxiliary member which is connected with the relatively moveable part of the seal arrangement. Both auxiliary members are

preferably positioned directly opposite to each other along opposing sides which has the advantage that the two auxiliary members are precisely positioned relative to each other.

The seal arrangement here described is an integrated unit which includes a seal, and an impulse generator and/or a sensor. The use of flexible circuit boards and the resulting miniaturized construction allows the gluing or vulcanizing of measuring instruments directly onto the seal arrangement. An exact and simple detection of these signals is thereby made possible. At the same time, different signals can be detected. The production of the above described sealing system does not require any costly constructive assembly steps which reduces the cost for the detection and processing of the signals.

More particularly, in accordance with a first aspect of the invention there is provided a seal comprising: a sealing member made of a polymer; a first flexible auxiliary element part that is immovably affixed to the sealing member, said first auxiliary element part being selected from the group consisting of a pulse generator and a sensor; a machine part that is moveable relative to the sealing member; a second auxiliary element part that is immovably affixed to the machine part, said second auxiliary element part being selected from the group consisting of a pulse generator and a sensor, and wherein the second auxiliary element part is a pulse generator when the first auxiliary element part is a sensor and wherein the second auxiliary element part is a sensor when the first auxiliary element part is a pulse generator; wherein the first auxiliary element part moves with respect to the second auxiliary element part whenever the sealing member moves with respect to the machine part.

In accordance with a second aspect of the invention there is provided a seal comprising: a first inner sealing ring; a second outer sealing ring made of polymer, at least one of said first and second sealing rings being rotatable with respect to the other sealing ring; at least one flexible sensor attached to one of the sealing rings; and at least one flexible signal generator attached to the other of the sealing rings.

Embodiments of the invention will now be described with reference to the accompanying drawings wherein:

Figure 1 shows a functional unit of a seal arrangement with sensor and impulse generator;

Figure 2 shows an impulse generator in the form of a flexible circuit board;

Figure 3 illustrates a sealing body with attached and embedded impulse generators;

Figures 4 and 5 show sealing bodies with attached and embedded sensors; and

Figure 6 illustrates an element which is connectable in series to the seal arrangement and carries an impulse generator

Figure 1 shows a functional seal arrangement including an impulse generator and a sensor as first and second parts of an auxiliary member or element. The seal includes a first seal portion 2 having a sealing body 2.1, which is made of elastomeric material. The seal further includes a second seal portion 4 which is movably relative to the first seal portion 2. The seal also includes an auxiliary member 5 which consists of first and second parts 5.1 and 5.2. First flexible auxiliary member part 5.1 is rigidly affixed to at least a portion of the sealing body 2.1. First auxiliary member part 5.1 is an impulse generator in form of a flexible circuit board, which can be used for at least one electrical function. The second auxiliary member part 5.2 provided in the seal arrangement is a sensor which is separate from the first auxiliary member part 5.1, (the impulse generator in this example). The sensor 5.2 is located on the relatively movable second seal portion 4. The sensor is connected by an electrical conductor 7 with a plug 8. The plug 8 is found at the outer surface of the seal and functions as an interface between the sensor 5.2 and measuring instruments connectable thereto for the processing of the signals detected. The conductor 7 is preferably a flexible circuit board which is used for transmission of the detected signals and/or for supply of operating voltage to the sensor 5.2. The sensor 5.2 and the plug 8 can thereby be conductively connected without the use of further connecting elements.

Figure 2 illustrates the construction of a circuit board which is constructed as an impulse generator. Codes 9 are provided on the base material of the circuit board for the generation of impulses. As is apparent from the drawing, the codes 9 are positioned in longitudinal or transverse direction on the circuit board and at a distance A from each

other, dependent on their location on the sealing body 2.1 (see Figure 2). The codes 9 are preferably made of iron or copper, whereby the iron type is magnetizable. The use of flexible circuit boards as impulse generators allows the impulse generator to be exactly adapted to the shape of the sealing body 2.1. Furthermore, the material of the circuit board allows the vulcanizing or gluing thereof directly onto the polymeric material of the sealing body 2.1 without additional assembly cost. The small size of the impulse generator allows it to be integrated at any desired position. Errors in the signal detection caused by the spacial separation of the impulse generator and the sealing body 2.1 are avoided by fixing the impulse generator directly onto the sealing body. The preferred rectangular shape of the flexible circuit board enhances this effect. The sensor is preferably positioned directly opposite the impulse generator 5.1 (see Figure 1) so that additional errors are prevented. The integration of the sensor 5.2 and the impulse generator 5.1 in the seal arrangement prevents the accumulation of dirt or water on the signal detecting elements thereby eliminating one source of errors.

It is also possible to detect pressure. To this end, the auxiliary member 5.1 is a piezo element. In another possible use, the auxiliary member is a thermoelement for temperature detection.

As shown in Figures 4 and 5, the sensor 5.2 can also be mounted on the sealing body 2.1 together with the conductor 7 and the plug 8. This allows the detection of, for example, dampness and leakage. The sensor can be a Hall-effect sensor or an electrical sensor including an electrical circuit that consists of a capacitor and a resistor.

Figure 6 shows an embodiment wherein the impulse generator is integrated into or mounted on a plastic or metal sling disk 11. Such disks are sometimes used in series with annular, rotating seals. The seal arrangement which consists of an integrated unit including a seal, and a sensor and/or impulse generator as auxiliary members can be used for the detection and transmition of signals representing temperature, humidity, rotation speed or pressure depending on the construction and function of the respective auxiliary member. A simple impulse generation is achieved as well as a miniaturized construction of the signal detecting elements within the seal arrangement, which makes for a cost efficient and simple manufacture.

Changes and modifications in the specifically described embodiments can be carried out without departing from the scope of the invention which is intended to be limited only by the scope of the appended claims.

CLAIMS

1. A seal comprising:

a sealing member made of a polymer;

a first flexible auxiliary element part that is immovably affixed to the sealing member, said first auxiliary element part being selected from the group consisting of a pulse generator and a sensor;

a machine part that is moveable relative to the sealing member;

a second auxiliary element part that is immovably affixed to the machine part, said second auxiliary element part being selected from the group consisting of a pulse generator and a sensor, and wherein the second auxiliary element part is a pulse generator when the first auxiliary element part is a sensor and wherein the second auxiliary element part is a sensor when the first auxiliary element part is a pulse generator;

wherein the first auxiliary element part moves with respect to the second auxiliary element part whenever the sealing member moves with respect to the machine part.

2. The seal according to claim 1, wherein the first auxiliary element part is embedded in the sealing member.

3. The seal according to claim 1, wherein the first auxiliary element part is bonded to the surface of the sealing member.

4. The seal according to claim 1, wherein one of the first and the second auxiliary element parts has a ring shape.

5. The seal according to claim 1, further comprising a flexible conductor that is electrically connected to at least one of the auxiliary element parts so as to provide a means for providing an external electrical connection thereto.

6. The seal according to claim 1 or 4, wherein at least one of the auxiliary element parts is piezoelectric.

7. The seal according to claim 1, wherein at least one of the auxiliary element parts contains a capacitor and a resistor.

8. The seal according to claim 1, wherein at least one of the auxiliary element parts comprises a thermoelement.

9. The seal according to claim 1, wherein the relatively movable machine part and the sealing element are packaged together as a functional unit.

10. The seal according to claim 9, wherein the second auxiliary element part is configured to be located adjacent the first auxiliary element part.

11. A seal comprising:

a first inner sealing ring;

a second outer sealing ring made of polymer, at least one of said first and second sealing rings being rotatable with respect to the other sealing ring;

at least one flexible sensor attached to one of the sealing rings; and

at least one flexible signal generator attached to the other of the sealing rings.

12. A seal as set forth in claim 11, wherein the sensor is bonded to the surface of a sealing ring.

13. A seal as set forth in claim 11, wherein the signal generator is bonded to the surface of a sealing ring.

14. A seal as set forth in claim 11, wherein the sensor is embedded in the surface of a sealing ring.

15. A seal as set forth in claim 11, wherein the signal generator is embedded in the surface of a sealing ring.

16. A seal according to claim 11, wherein the sensor comprises a piezoelectric material.

17. A seal according to claim 11, further comprising a capacitor and resistor circuit to detect the presence of moisture.

18. A seal according to claim 11, wherein the sensor comprises a thermoelement.

19. A seal according to claim 11, wherein the sealing rings, sensor, and signal generator are combined together as a functional unit.

20. A seal according to claim 11, wherein the sensor is in facing relation to the signal generator across a gap.

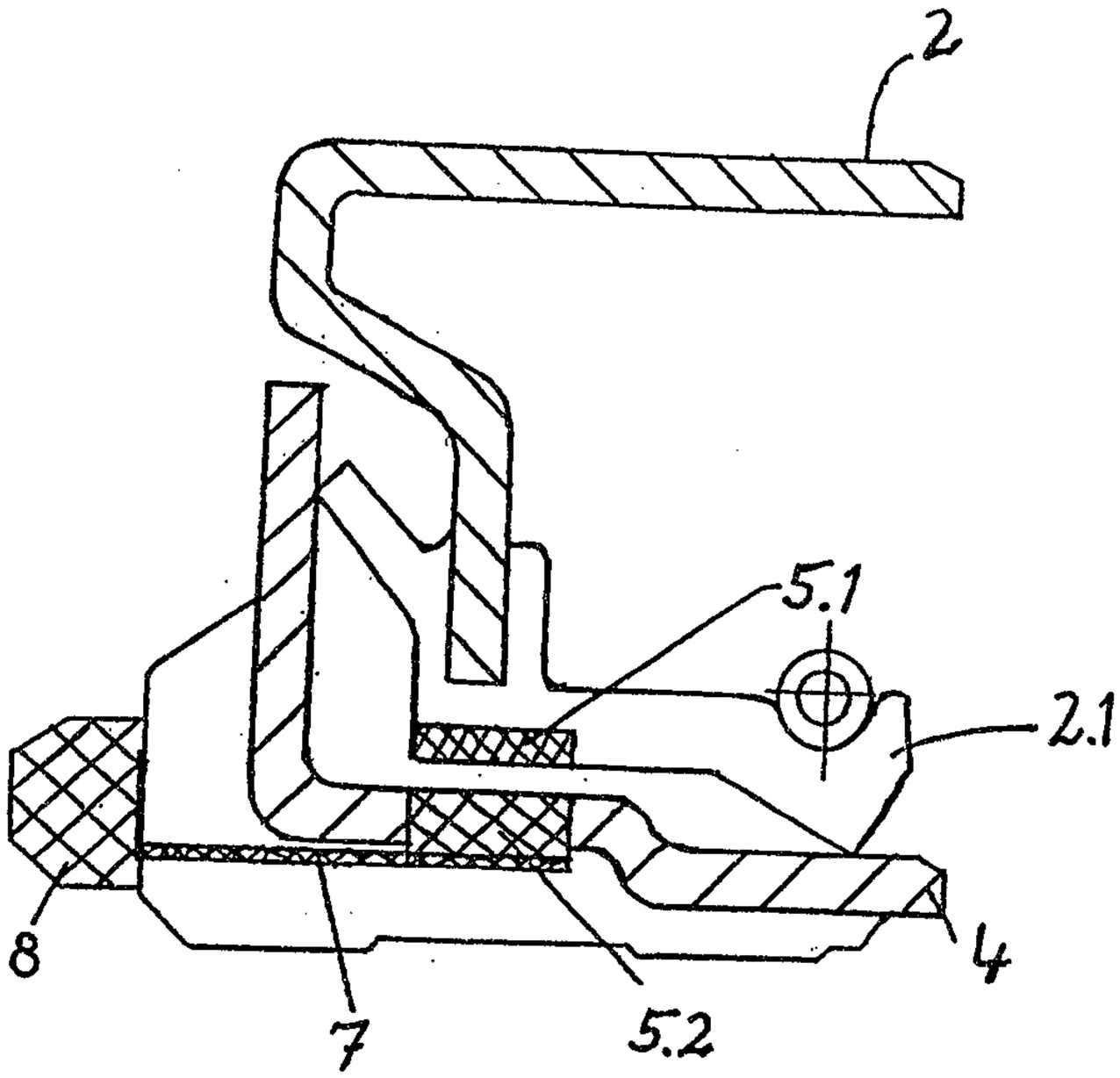

FIG 1

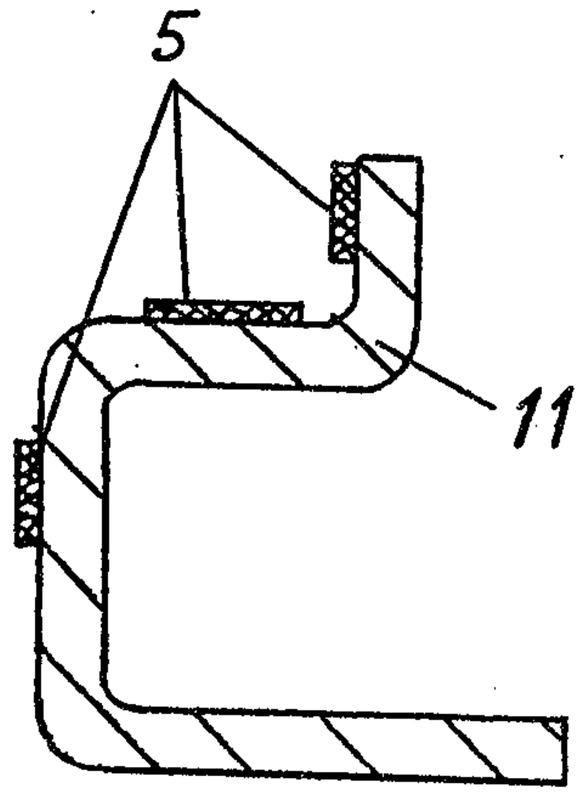

FIG 6

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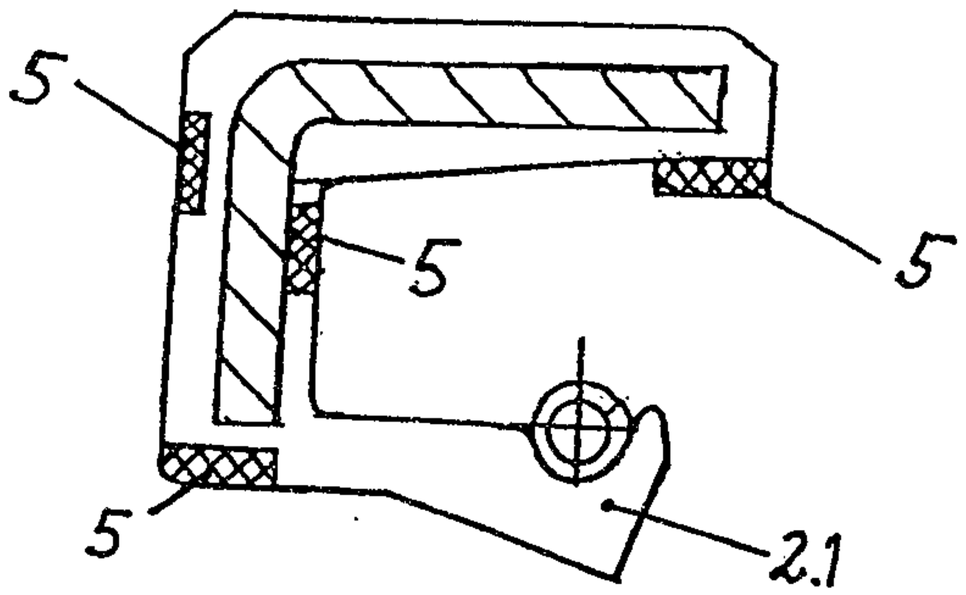

FIG 3

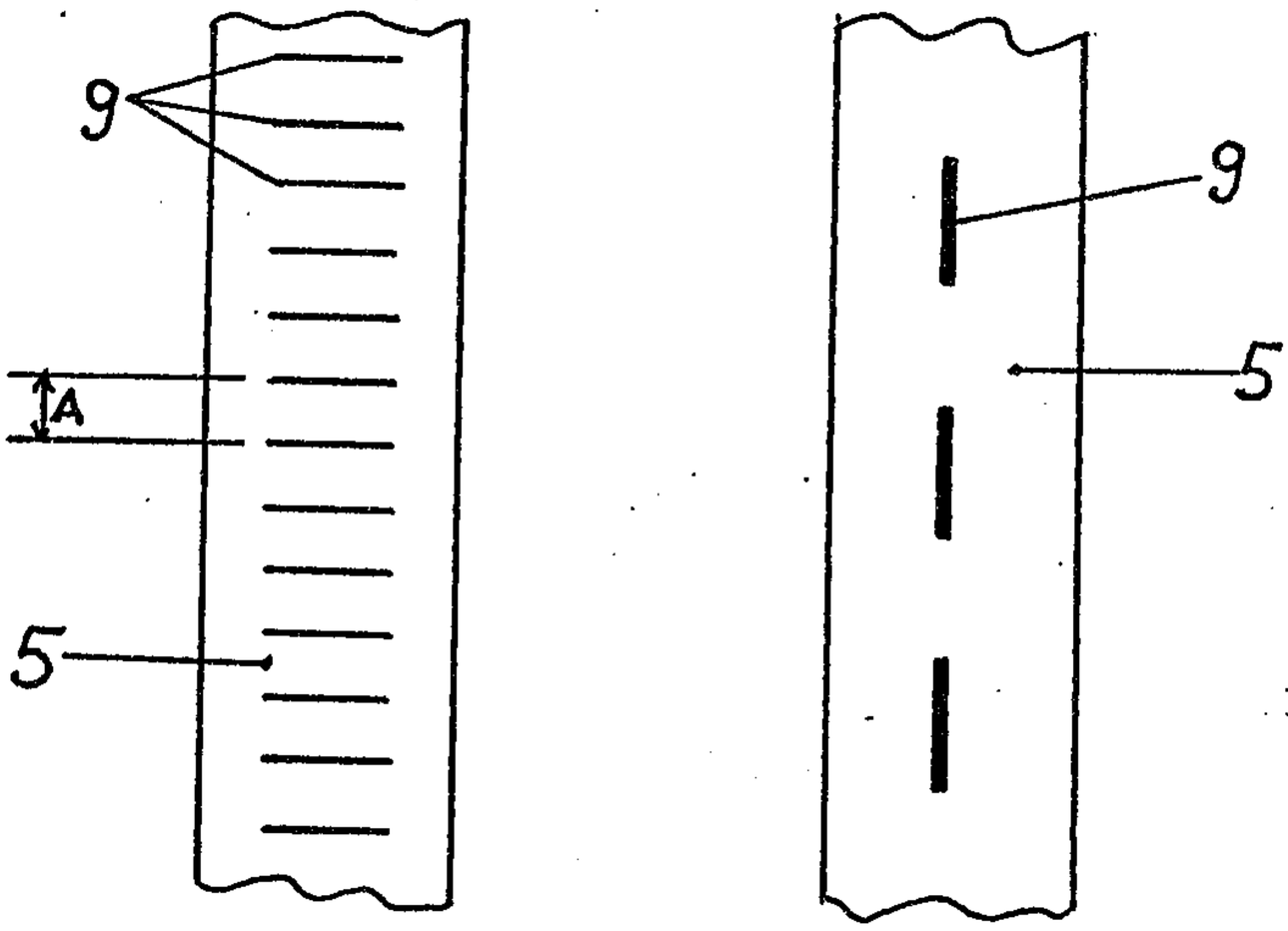

FIG 2

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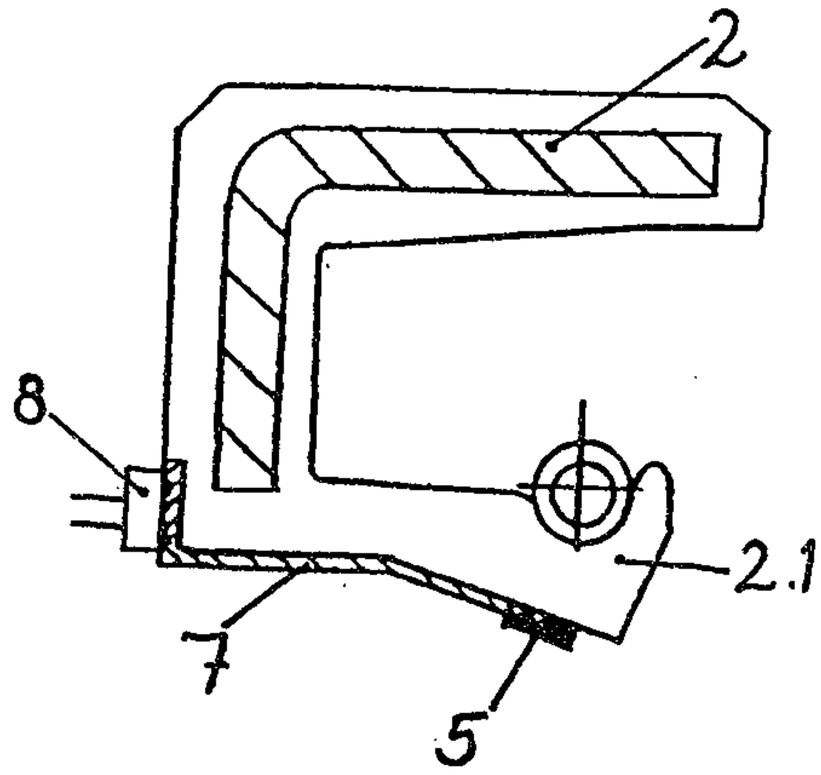

FIG 4

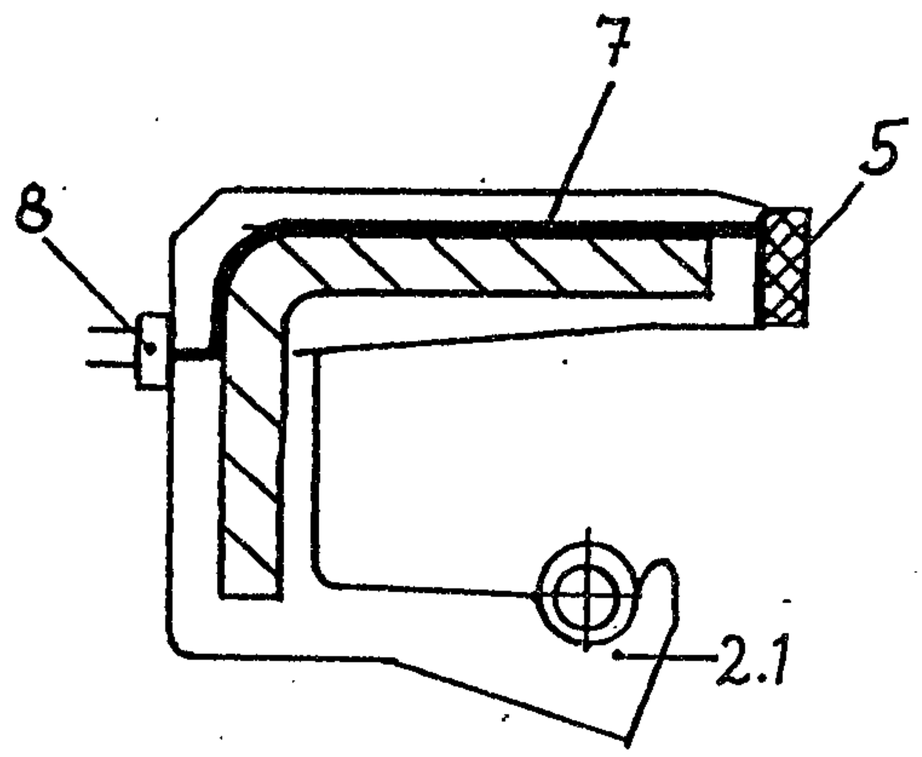

FIG 5

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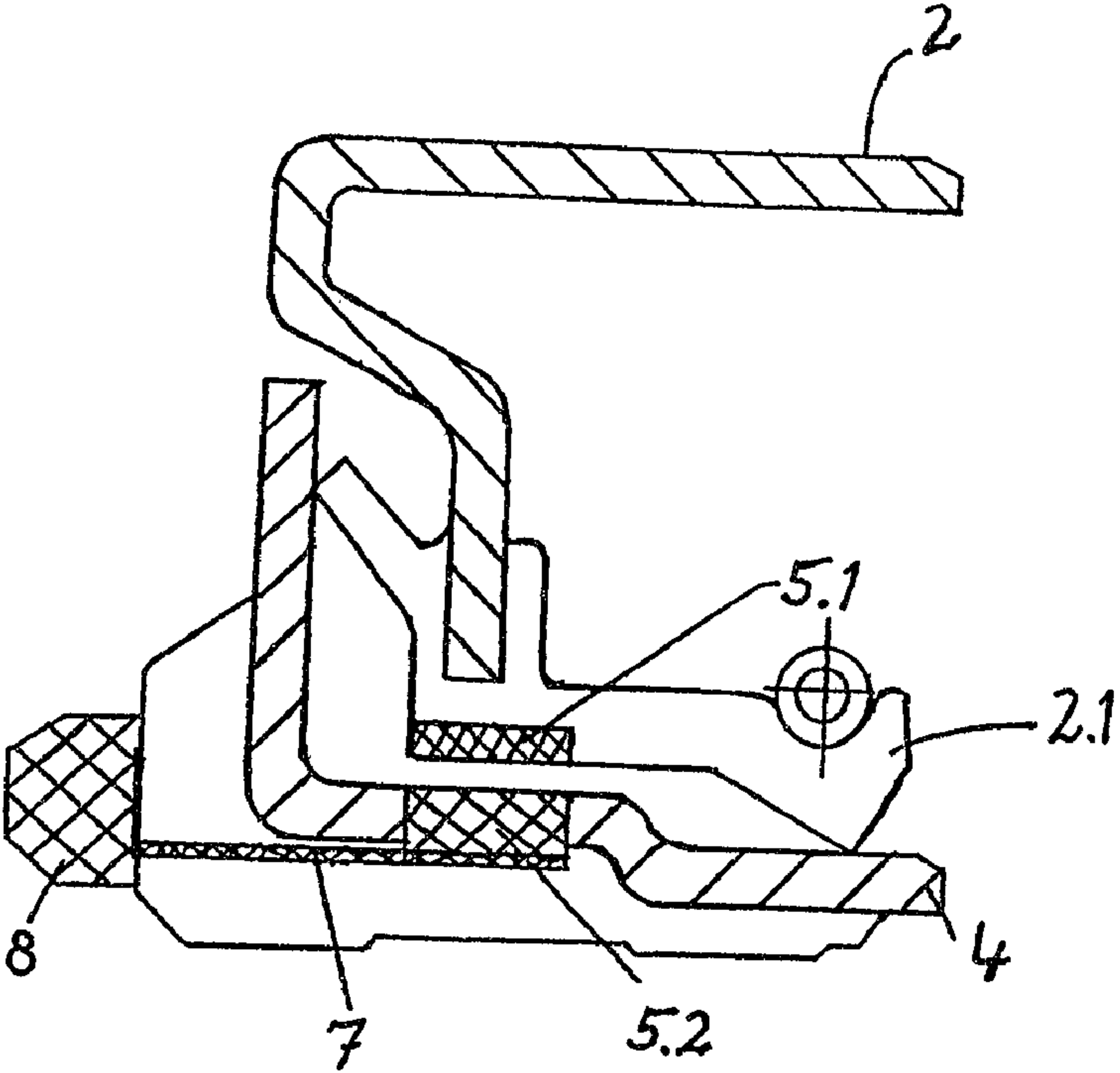
2
5.1
2.1
8
7
5.2
4