



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
07.02.2018 Bulletin 2018/06

(51) Int Cl.:
H01H 35/26 (2006.01) H01H 35/34 (2006.01)

(21) Application number: **17181360.3**

(22) Date of filing: **14.07.2017**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(30) Priority: **04.08.2016 IT 201600082433**

(54) **PRESSURE SENSOR FOR FLUIDS**

(57) Pressure sensor for fluids applicable, for example, to a household appliance, and having: a cavity (2) for receiving a fluid, the cavity (2) being defined by a body (4) and a diaphragm (6) that can be deformed by the fluid pressure; a switch (8) comprising a movable portion (10) that can be switched between a first position and a second position, wherein the deformation of the diaphragm (6) causes the movable portion (10) to be positioned into the first position or into the second position; an elastic means (12) configured for acting upon the diaphragm (6) and the movable portion (10) in order to influence the switching of the movable portion (10) between the first position and the second position.

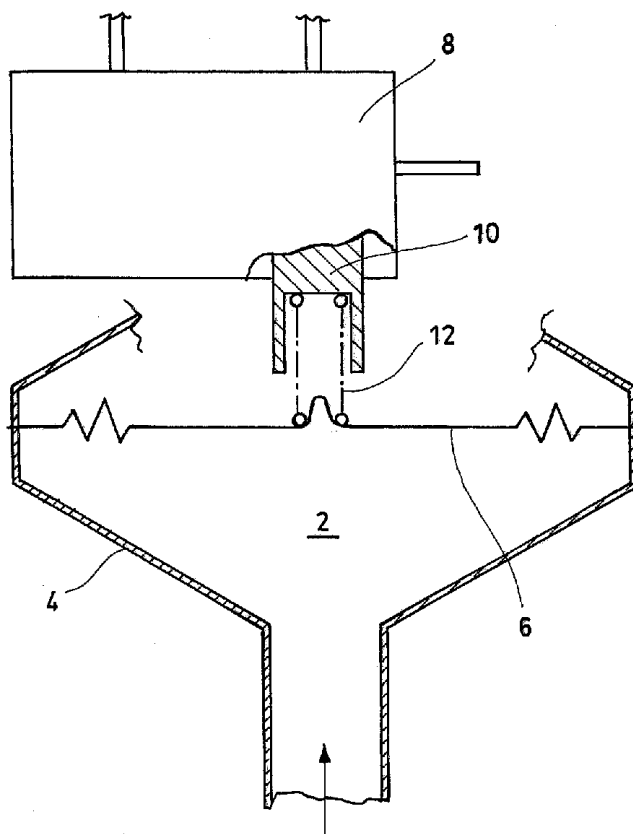
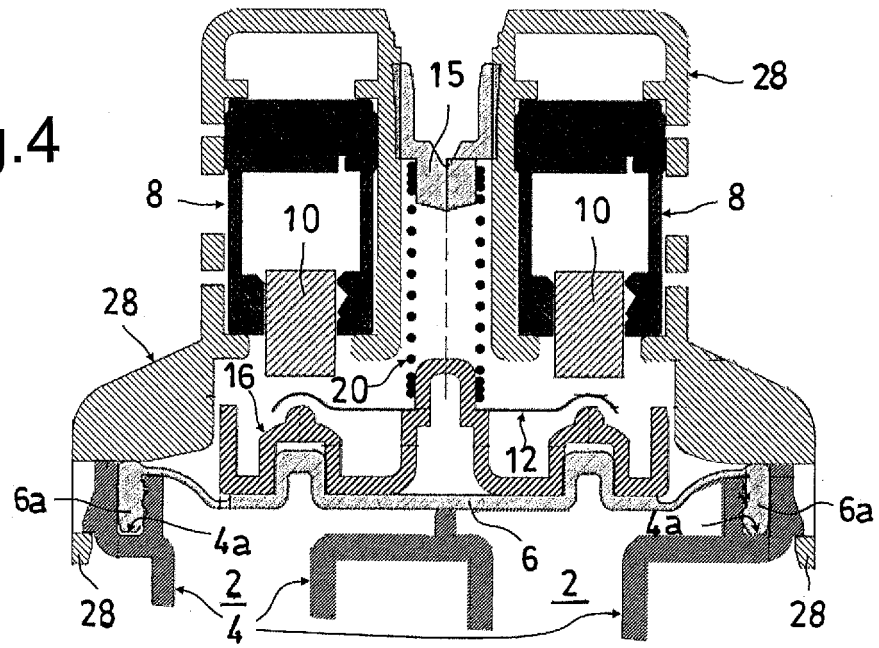


Fig. 1

Fig.4



Description

Technical field

[0001] The present invention relates to a pressure sensor for fluids applicable, for example, to a household appliance.

Background art

[0002] According to the prior art, the switches or microswitches associated with pressure sensors can provide very accurate switching between the two positions (e.g. "ON/OFF"), which typically occurs within a time of the order of tenths of a millimeter or, in some versions, even hundredths of a millimeter.

[0003] However, devices of this type suffer from a few drawbacks.

[0004] One drawback relates to the fact that such high switching accuracy is a problem when the switches or microswitches are used in pressure sensors, because the very narrow difference between the ON and OFF positions would result in too frequent alternations between the two switching positions. This situation may lead to early contact wear, leading to increased risk of burnt sensor components.

Summary of the invention

[0005] It is one object of the present invention to provide a pressure sensor for fluids which can overcome this and other drawbacks of the prior art, while at the same time being simple and economical to manufacture.

[0006] According to the present invention, this and other objects are achieved through a pressure sensor for fluids made in accordance with the appended independent claim.

[0007] It is one object of the present invention to provide a pressure sensor for fluids which can reduce the excessively frequent alternations between the two switching positions.

[0008] It is to be understood that the appended claims are an integral part of the technical teachings provided in the following detailed description of the invention. In particular, the appended dependent claims define some preferred embodiments of the present invention, which include some optional technical features.

Brief description of the drawings

[0009] Further features and advantages of the present invention will become apparent from the following detailed description, which is supplied by way of non-limiting example with reference to the annexed drawings, wherein:

- Figure 1 is a sectional view of a pressure sensor made in accordance with a first exemplary embodiment

ment of the present invention;

- Figure 2 is a sectional view of a pressure sensor made in accordance with a second exemplary embodiment of the present invention;
- Figure 3 is a sectional view of a pressure sensor made in accordance with a third exemplary embodiment of the present invention;
- Figure 4 is a sectional view of a pressure sensor made in accordance with a fourth exemplary embodiment of the present invention;
- Figure 5 is a graph that shows a comparison between a sensor according to the prior art and a sensor according to the present invention.

Detailed description of the invention

[0010] The pressure sensor for fluids, which is applicable, for example, to a household appliance such as a washing machine or a dishwasher, comprises:

- a cavity 2 for receiving a fluid, the cavity 2 being defined by a body 4 and a diaphragm 6 that can be deformed by the fluid pressure,
- a switch 8 comprising a movable portion 10 that can be switched between a first position and a second position, wherein the deformation of the diaphragm 6 causes the movable portion 10 to be positioned into the first position or into the second position,
- an elastic means 12 configured for acting upon the diaphragm 6 and the movable portion 10 in order to influence the switching of the movable portion 10 between the first position and the second position.

[0011] For example, the switch 8 may be a microswitch.

[0012] Therefore, the fluid pressure causes the diaphragm 6 to become deformed, resulting in the movable portion 10 switching into the first or second position. In the example, the increased fluid pressure bends the diaphragms 6 upwards. By way of example, the fluid may be a liquid, e.g. water or a watery mixture, or a gas. The switch 8 and the body 4 can be mutually attached, possibly in a removable manner, through *per se* known fastening means, such as screws, bolts, brackets or other mounting means. In response to the sensor detection, the household appliance will execute specific commands; for instance, it may carry out certain functions or output a signal for the user.

[0013] The elastic means 12 is conveniently a spring, e.g. a coil spring; it is however possible to apply additional *per se* known elastic means or springs. In particular, the movable portion 10 can translate between the first and second positions. In particular, the movable portion 10 depicted in the drawings can translate vertically. For example, in the first position the movable portion 10 is raised, whereas in the second position the movable portion 10 is lowered. Preferably, the movable portion 10 is configured for snapping when switching between the first

position and the second position. The movable portion 10 is movable relative to a main body of the switch 8, e.g. an external casing. In the illustrated examples, the elastic means 12 is coaxial to the sliding axis of the movable portion 10, said sliding axis being, in particular, vertical.

[0014] With reference to the variants shown in Figures 1 and 3, the elastic means 12 is interposed between the movable portion 10 and the diaphragm 6. In particular, in Figure 1 the elastic means 12 is configured for contacting the movable portion 10 and the diaphragm 6. For the purposes of the present description, defining an object as "interposed" between two elements does not necessarily exclude the presence of additional objects between the two elements, and does not necessarily indicate that the object must be in contact with one of the two elements.

[0015] With reference to the variant shown in Figure 2, the elastic means 12 is situated in the cavity 2. The diaphragm 6 is interposed between the movable portion 10 and the elastic means 12. In particular, the diaphragm 6 is configured for contacting the movable portion 10 and the elastic means 12. Optionally, a support surface 13 is present between the diaphragm 6 and the switch 8. This support surface 13 is useful to limit the travel of the diaphragm 6 towards the switch 8. The support surface 13 can be mounted to the switch 8. The support surface 13 preferably has a substantially planar shape.

[0016] Preferably, the sensor comprises adjustment means for adjusting the intensity of the mechanical force exerted by the elastic means 12. In particular, the adjustment means include a sliding element, such as a screw 14 or a grub screw, which can be operated by a user. Said sliding element is configured for compressing or extending the elastic means 12, in particular the spring. In the illustrated examples, the screw 14 is shown abutting against the spring. It is thus possible to adjust the preload of the elastic means 12, in particular the spring. In Figure 2, the grub screw or screw 14 is within the cavity 2 and acts upon the elastic means 12, which is also situated in the cavity 2. In the illustrated examples, the screw 14 or grub screw can translate vertically, when turned, for adjusting the intensity of the mechanical forces exerted by the elastic means 12, in particular for compressing or extending the spring.

[0017] Optionally, a support element 16 is interposed between the diaphragm 6 and the elastic means 12 (in particular, configured for contacting them) in order to distribute the force exerted by the elastic means 12 on a surface of the diaphragm 6. The support element 16 may be, for example, a leaf, a disk, a plate, a conical or truncated conical surface, etc.

[0018] Conveniently, in the cavity 2 there is a guiding structure 18 for guiding the motion of the screw 14, which is, in particular, adapted to translate vertically, thus allowing the fluid to flow to and from the cavity 2.

[0019] With reference to the variant shown in Figure 3, the elastic means 12 is in contact with the movable

portion 10 and the support element 16. The adjustment element, in particular the screw 14 or grub screw, is in the cavity 2. Therefore, the diaphragm 6 is in contact with the support element 16 at the top and with the adjustment element at the bottom.

[0020] In accordance with one particular variant, there is a second elastic means 20 (preferably a spring, e.g. a coil spring) configured for acting upon the diaphragm 6. The second elastic means 20 is preferably interposed between the switch 8 and the diaphragm 6. Conveniently, the second elastic means 20 is coaxial to the elastic means 12. With particular reference to Figure 3, the second elastic means 20 is in contact with the support element 16; as an alternative, the second elastic means 20 rests directly on the diaphragm 6. In general, the second elastic means 20 is interposed between the diaphragm 6 and the support surface 13. Preferably, the second elastic means 20 is also in contact with the support surface 13. At least one adjustment element 22, preferably a pair of adjustment elements 22, is adapted to adjust the distance between the support surface 13 and the switch 8. The movable adjustment element 22, which is preferably a calibration screw, is slidable (in particular vertically) within a guide assembly 24, which 24 may be mounted to the switch 8. Through the adjustment element 22, it is possible to define a pressure for causing the movable portion 10 to switch between the first and second positions. This provides a further option for controlling the switching behaviour, thus making the pressure sensor especially adaptable in use.

[0021] With reference to the variant shown in Figure 4, there is a plurality (in particular, a pair) of switches 8, each switch 8 having a respective movable portion 10. The two movable portions 10 can slide parallel to each other, in particular vertically. The deformation of the diaphragm 6 causes the two movable portions 10 to be positioned into the first position or into the second position. Between the diaphragm 6 and the two movable portions 10 is interposed the support element 16, which in the example supports the elastic means 12. In particular, the elastic means 12 is essentially a leaf, in particular a corrugated leaf. Conveniently, one of the switches 8 is redundant and acts as a safety switch. More in detail, it must be pointed out that the diaphragm 6 is secured to the body 4 by one end 6a of the diaphragm 6 inserted in a recess 4a of the body 4. The end 6a is caught or pressed within the recess 4a so that, if necessary, the diaphragm 6 can be removed from the body 4. In the illustrated example, the elastic means 12 acts upon the movable portions 10 in order to influence the switching positions of the movable portions 10.

[0022] The elastic means 12 is interposed between the movable portions 10 and the diaphragm 6, in particular between the movable portions 10 and the support element 16. In the particular example shown, the elastic means 12 is an elastically deformable leaf or plate. As the fluid pressure increases in the chamber 2, the diaphragm 6 becomes deformed, thereby raising the sup-

port element 16; said support element 16 touches the plate, bringing it in abutment with the movable portions 10 to raise the movable portions 10 and move them towards one of the two switching positions. In the example, a central portion of the leaf (elastic means 12) rests on a central portion, which is, in particular, shaped like a cusp, of the support element 16. Said leaf has two lateral portions adapted to abut or act against the two movable portions 10. In particular, the lateral portions of the leaf are curved and are adapted to rest on respective lateral cusps of the support element 16.

[0023] Conveniently, in a substantially central position between the two switches 8 there is a second elastic means 20, configured for acting upon the diaphragm 6. In the example, the second elastic means 20 rests on the support element 16, or on the leaf (elastic means 12). The second elastic means 20 is preferably a spring, e.g. a coil spring. Said second elastic means 20 is adapted to vary the pressure threshold of the switch 8 by acting upon the diaphragm 6. Optionally, the second elastic means 20 has respective adjustment means operable by a user, such as a screw 15, for adjusting the intensity of the force exerted on the diaphragm 6.

[0024] Preferably, the two switches 8 are housed in a casing 28, which is mounted to the body 4. The casing 28 and the body 4 are assembled in a removable manner, in particular through joining means, e.g. complementary profiles. It is however possible to employ further removable fastening means *per se* known in the art, e.g. complementary threads on the body 4 and casing 28 to allow them to be screwed together, or screws, etc. Also this variant preferably includes adjustment means acting upon the elastic means 12.

[0025] In a *per se* known manner, in the exemplary embodiment illustrated herein the switch 8 comprises a return means (in addition to those previously described and designated by numbers 12, 20), such as an elastic means, configured for selectively bringing the movable portion 10 towards one of the first and second positions. Thus, the movable portion 10 will be monostable, like a push-button. For example, the return means will tend to move the movable portion 10 towards the first position (in which position the movable portion is down); when the fluid pressure increases, the diaphragm 6 becomes deformed, thereby raising the movable portion 10 and bringing it into the second position; when the fluid pressure decreases, the return means will bring the movable portion back into the first position.

[0026] Figure 5 is an experimental graph that shows a comparison between a pressure sensor made in accordance with the prior art (line A) and a pressure sensor made in accordance with the invention (line B). The graph shows the travel of the movable portion 10 (millimeters) on the horizontal axis and the force (expressed, for example, in grams) necessary for actuating the movable portion 10 on the vertical axis. This is therefore a force/displacement graph of the movable portion 10. Each line A, B starts from a respective starting point A1,

B1 of the travel of the movable portion 10 and arrives at a final point A2, B2 of the travel. Each line A, B has a respective outward tract a', b' and a respective return tract a'', b''. Tract a' starts from point A1 and reaches point A2; tract a'' follows the inverse path. Tract b' starts from point B1 and reaches point B2, tract b'' follows the inverse path. As can be seen, the outward tract a', b' does not coincide with the return tract a'', b''.

[0027] With reference to the outwards tracts a' and b', the vertical line S2 indicates the travel position where the movable portion 10 snaps from the first position into the second position, which is shown to be substantially equal for the movable portions 10 of the prior-art pressure sensor (line A) and of the pressure sensor according to the invention (line B). At point S2, the force required to increase the displacement of the movable portion 10 decreases.

[0028] With reference to the return tract a'' (prior art), the vertical line S1-A indicates the position where the movable portion 10 snaps from the second position into the first position. Therefore, "d" designates the distance between the vertical lines S1-A and S2, i.e. the positions where the movable portion 10 switches between the first position and the second position.

[0029] With reference to the return tract b'' (invention), the vertical line S1-B indicates the position where the movable portion 10 snaps from the second position into the first position. Therefore, "D" designates the distance between the vertical lines S1-B and S2, i.e. the positions where the movable portion 10 switches between the first position and the second position.

[0030] As can be seen, $D > d$, resulting in fewer commutations between the first position and the second position when the fluid pressure oscillates around a substantially intermediate value between the values corresponding to the first and second positions.

[0031] Of course, without prejudice to the principle of the invention, the forms of embodiment and the implementation details may be extensively varied from those described and illustrated herein by way of non-limiting example, without however departing from the scope of the invention as set out in the appended claims.

Claims

1. Pressure sensor for fluids, having:

- a cavity (2) for receiving a fluid, the cavity (2) being defined by a body (4) and a diaphragm (6) that can be deformed by the fluid pressure,
 - a switch (8) comprising a movable portion (10) that can be switched between a first position and a second position, wherein the deformation of the diaphragm (6) causes the movable portion (10) to be positioned into the first position or into the second position,
- characterized in that** it comprises an elastic

means (12) configured for acting upon the diaphragm (6) and the movable portion (10) in order to influence the switching of the movable portion (10) between the first position and the second position.

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2. Sensor according to claim 1, wherein the elastic means (12) is interposed between the diaphragm (6) and the movable portion (10). 10
3. Sensor according to claim 1, wherein the elastic means (12) is within the cavity (2).
4. Sensor according to any one of the preceding claims, comprising adjustment means for adjusting the intensity of the mechanical force exerted by the elastic means (12). 15
5. Sensor according to claim 4, wherein the adjustment means include a sliding element, such as a screw (14) or a grub screw, and wherein the elastic means (12) is a spring; said sliding element being configured for compressing or extending the spring. 20
6. Sensor according to any one of the preceding claims, comprising a second elastic means (20) configured for acting upon the diaphragm (6). 25
7. Sensor according to claim 6, comprising: 30
 - a support surface (13) arranged between the diaphragm (6) and the switch (8);
 - an adjustment element (22) for adjusting the distance between the support surface (13) and the switch (8); wherein the second elastic means (20) is interposed between the diaphragm (6) and the support surface (13). 35
8. Sensor according to any one of the preceding claims, comprising a support element (16) interposed between the diaphragm (6) and the elastic means (12) for distributing the force exerted by the elastic means (12) on a surface of the diaphragm (6). 40
9. Sensor according to any one of the preceding claims, comprising a plurality of switches (8), each switch (8) having a respective movable portion (10); wherein the deformation of the diaphragm (6) causes the two movable portions (10) to be positioned into the first position or into the second position. 45 50
10. Sensor according to claims 2 and 9, wherein the elastic means (12) is an elastically deformable leaf or plate. 55

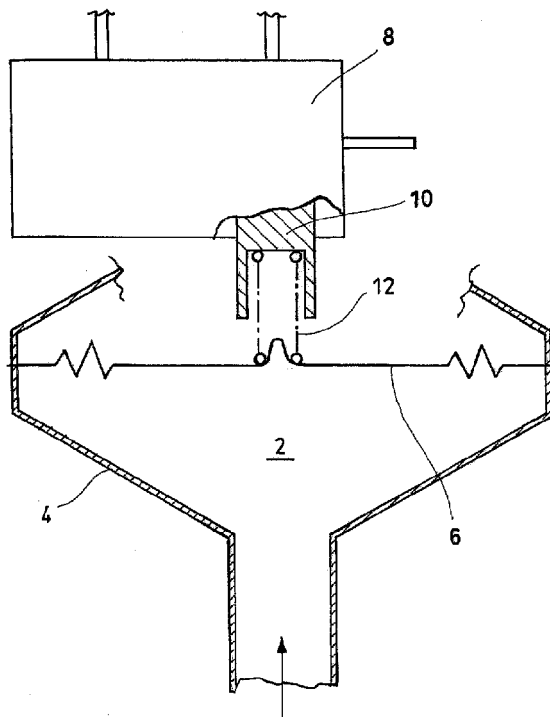


Fig.1

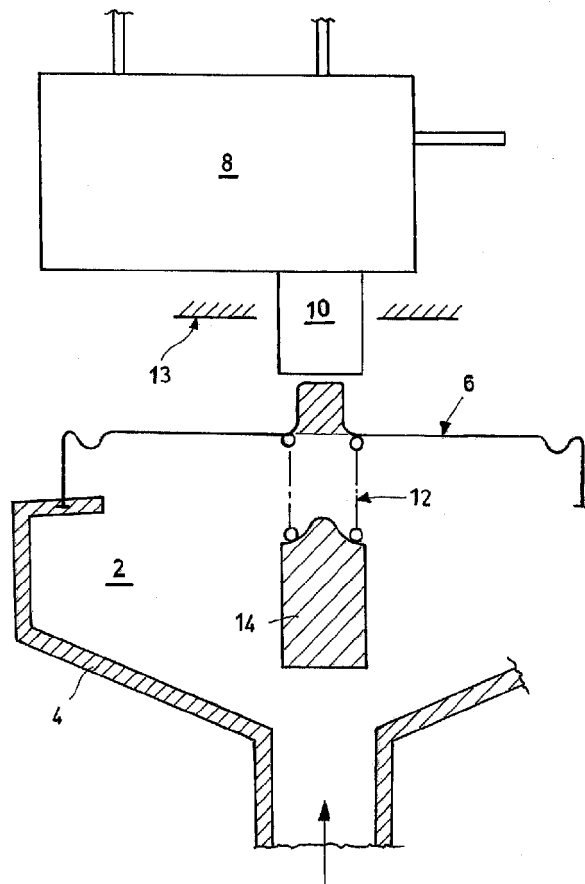


Fig.2

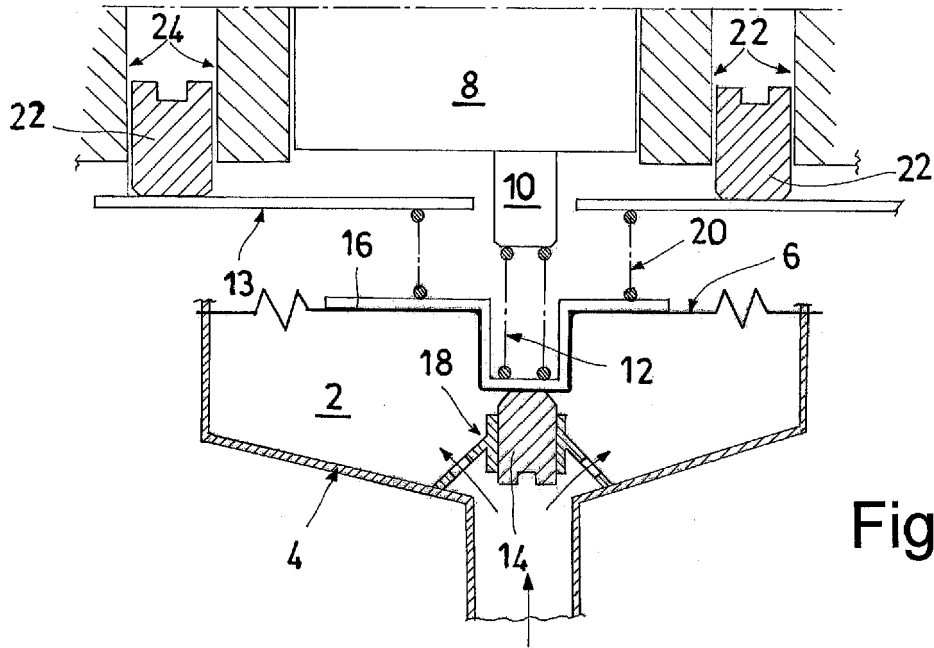


Fig.3

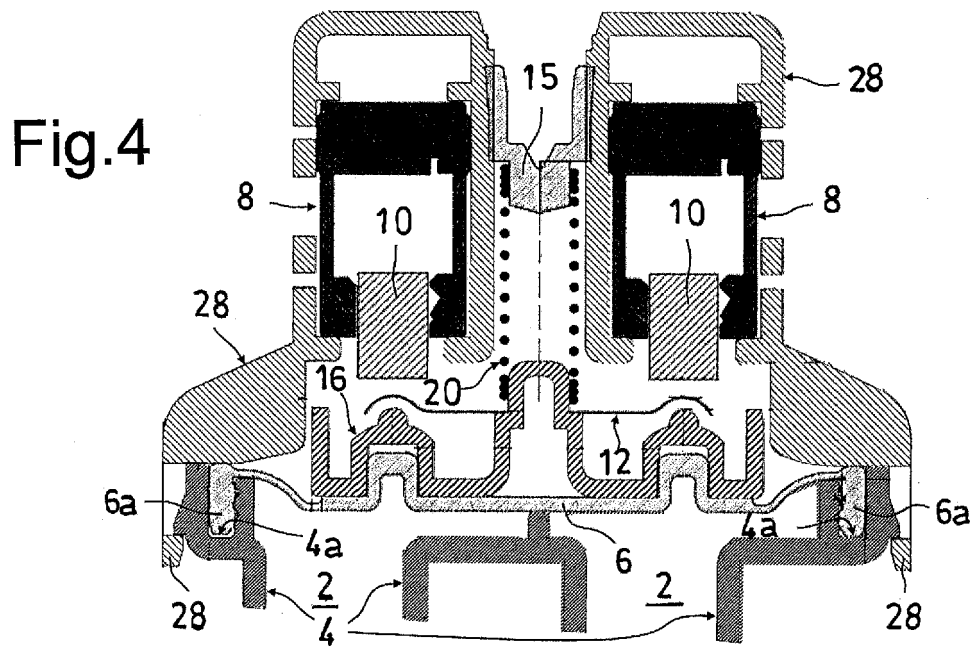


Fig.4

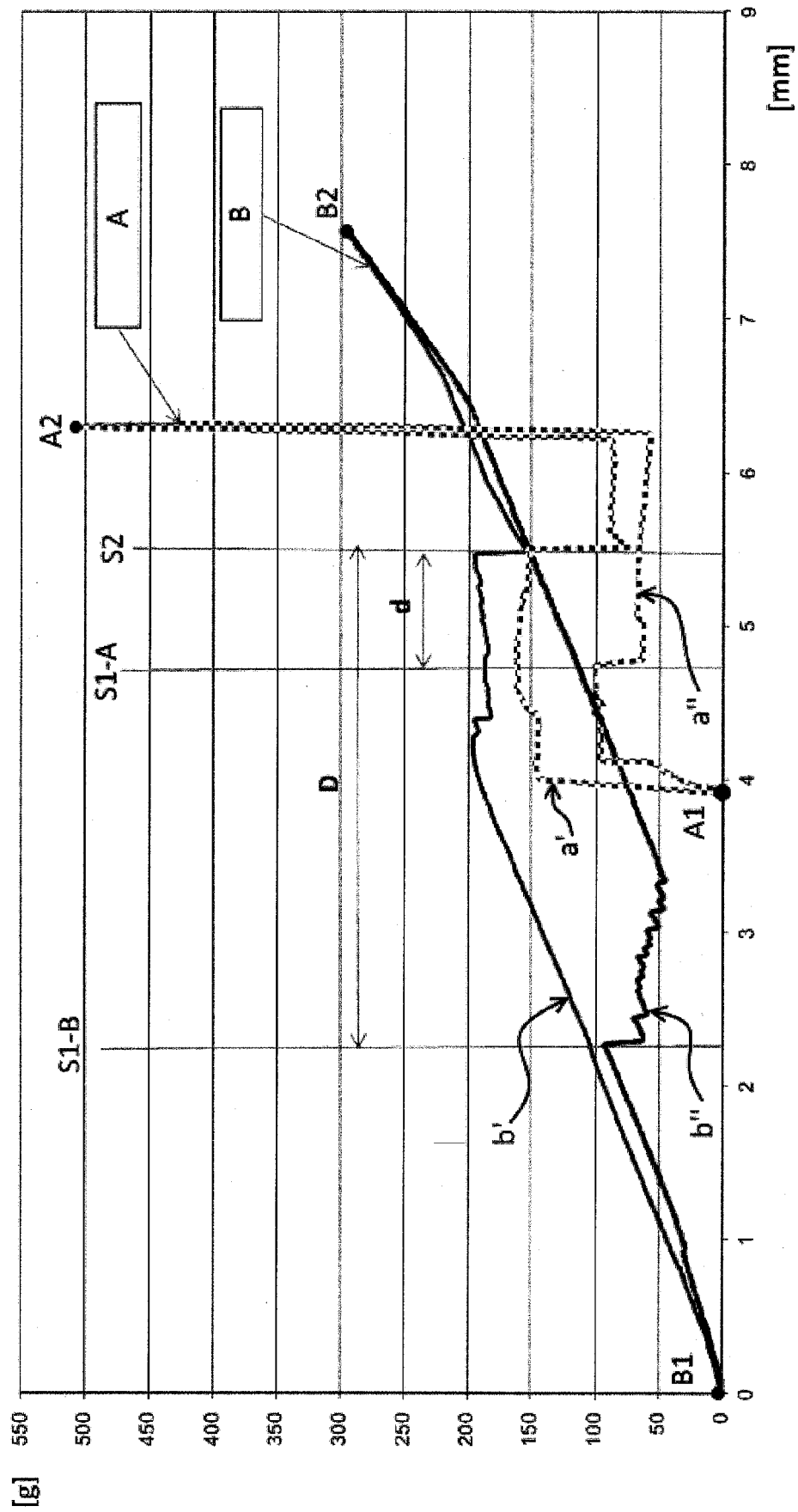


Fig.5



EUROPEAN SEARCH REPORT

Application Number
EP 17 18 1360

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 October 2017	Examiner Schambach, Philip
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