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(54) **ROD THERMOSTAT WITH SAFETY**

(57) A thermostat (100) comprising: a thermostat body (1); a tubular element (24) projecting from said thermostat body (1); a rod (2) with differential thermal expansion, axially inserted in said tubular element (24) and protruding at a proximal end inside said thermostat body (1); a temperature regulation system (19, 20) associated with said rod (2); a safety lever (16) arranged transversally to said rod (2) and configured for a displacement under a thermal expansion action transmitted through said rod (2), said safety lever (16) comprising a first engagement element (16a); a reset element (3) arranged transversally to said rod (2) and sliding under an action of a first bias member (4), said reset element (3) comprising a second engagement element (3a) configured to cooperate with said first engagement element (16a), defining a trip of said reset element (3) between a first operating position and a second safety position wherein said reset element (3) allows a movement of said safety lever (16) to open at least one electric contact (5, 7; 11, 7) upon reaching a safety temperature.

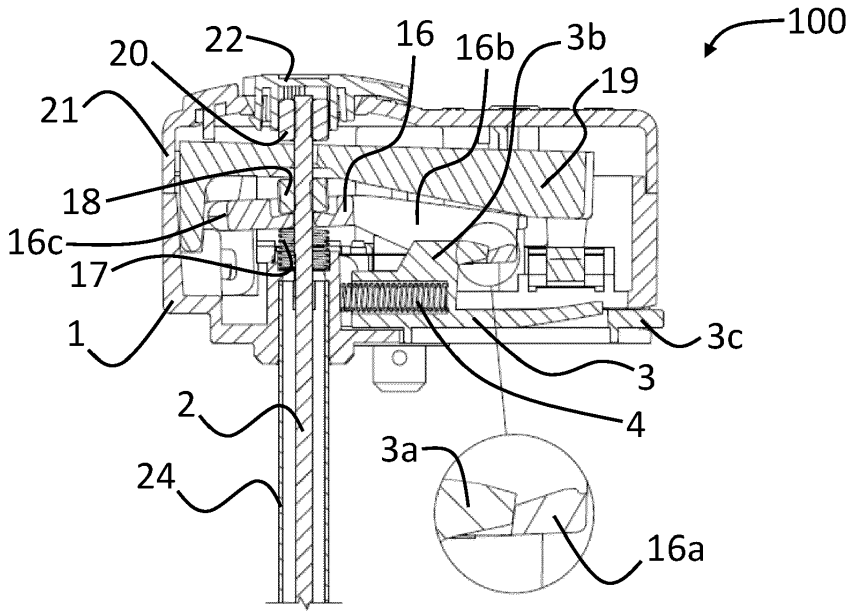

FIG. 5

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Description

Technical field

[0001] The present invention relates to a thermostat, in particular a rod thermostat with safety.

[0002] In general, the present invention finds a preferred, but non-limiting application in the field of rod thermostats, provided for use in electric water heaters and preferably equipped with a bipolar safety.

Prior art

[0003] Rigid rod thermostats are electromechanical devices for keeping a temperature within a specific narrow range, performing opening of an electric power supply circuit of heating means of the apparatus whereon they are mounted upon reaching a specific predetermined temperature and closing of the circuit, when the temperature has lowered by a specific differential.

[0004] Known rigid rod thermostats comprise a safety system, typically a bipolar safety system, which intervenes and performs opening of the electric power supply circuit of the heating means of the apparatus whereon they are mounted upon reaching a second predetermined safety temperature, and closing of the circuit by manual reset. Typically, the safety system is used to avoid reaching excessive heating temperatures, which are potentially dangerous to the user.

[0005] Known types of bipolar safety for rod thermostats involve a bimetallic disc, or a bimetallic rod, or a shape-memory spring.

[0006] Document WO2005119720A1 relates to a thermostat comprising an electromechanical system for temperature control arranged in a pedestal enclosure closed by an casing, wherein the temperature control system is composed of a probe provided with a high-expansion metal tube in which a low-expansion metal rod is arranged, a safety device for opening safety breakers when the temperature exceeds a minimum thermal threshold thereof and a holding device for converting the low-expansion movement of the safety device into a sudden movement for opening the contacts of the elastic blades of each safety switch; the retention device temporarily acts onto a sliding unit which comes into contact with each safety breaker and is connected to the safety device.

[0007] Document EP0749141A1 relates to a thermostat which comprises a plastic base and a metal probe; two contacts attached to the base connect the thermostat in series with the power supply an immersion electrical heater; the conductor blades connect each of the two contacts to a safety breaker; the probe comprises a metal tube housing a rod cooperating with a regulation device; the base is provided with a recess which houses a spring of a shape-memory alloy.

[0008] Document GB2172749A relates to a thermostat having a safety device for cutting off the supply of heat if the temperature increases in an excessive manner, wherein the tube is attached in a bore of a boss of a thermally conductive plate by forcedly fitting a sleeve at the end of the tube; a reversible concave washer is arranged in the plate, which cooperates with a slide block which is capable of cutting off the power supply current when too high a temperature is transmitted to said washer.

[0009] Document WO2002097841A1 relates to an immersion thermostat for water boilers, having an elastic element, pre-compressed by a pressing member and equipped with such an expansion capacity and elastic force as to force the opening of a pair of safety electric contacts, in case the sensors and actuators providing for the good thermostat operation suffer a failure.

[0010] In general, bimetallic-disc safety systems have the disadvantage of operating on air and far from the temperature sensing point. Moreover, bimetallic-disc safety systems are subjected to the effect of external temperature variations, the bimetallic disc being outside the water heater.

[0011] In general, safety systems with a bimetallic rod positioned inside the resistor bulb in contact with the water of the water heater, in view of the very limited increase in temperature by about one degree every 4 minutes, can be subjected to misalignments or pre-bending which damage or cause the contacts which are present on the spring assembly to seize up.

[0012] In general, safety systems with a shape-memory spring involve slow expansions which can cause the contacts which are present on the spring assembly to seize up.

Summary of the invention

[0013] An object of the present invention is to solve drawbacks of the prior art.

[0014] A particular object of the present invention is to provide a safety system with a bimetallic rod which is more reliable.

[0015] A particular object of the present invention is to provide a safety system with a bimetallic rod which is more effective.

[0016] A further particular object of the present invention is to provide a safety system which is less exposed to damages or disservices.

[0017] A further particular object of the present invention is to provide a safety system which prevents the contacts which are present on the spring assembly from seizing up.

[0018] A further particular object of the present invention is to enhance the safety, in particular a bipolar safety, of a rod thermostat.

[0019] These and other objects are achieved by a thermostat according to the features of the attached claims which are an integral part of the present description.

[0020] An idea underlying the present invention is to provide a thermostat with a lever safety, being snap-

openable through a sliding element; the use of a linkage safety system allows the sliding element with manual reset button to be used.

[0021] The thermostat according to the invention comprises: a thermostat body; a tubular element projecting from the thermostat body; a rod with differential thermal expansion, axially inserted in the tubular element and protruding at a proximal end inside the thermostat body.

[0022] The thermostat comprises a temperature regulation system associated with the rod and configured to reversibly open at least one electric contact in the thermostat body upon reaching an operating temperature.

[0023] The thermostat comprises a safety lever arranged transversally to the rod and configured for a displacement under a thermal expansion action transmitted through the rod. The safety lever comprises a first engagement element. The safety lever is configured to open at least one electric contact in the thermostat body upon reaching a safety temperature.

[0024] The thermostat comprises a reset element arranged transversally to the rod and sliding under an action of a first bias member. The reset element comprises a second engagement element configured to cooperate with the first engagement element of the safety lever, defining a trip of the reset element. The reset element trips between a first operating position and a second safety position. In the second safety position the reset element allows a movement of the safety lever to open the at least one electric contact upon reaching the safety temperature.

[0025] Preferably, the safety lever is configured to open two respective electric contacts defining a bipolar safety.

[0026] Preferably, the rigid rod thermostat is formed by a plastic body to which a brass tube containing an INVAR rod is attached.

[0027] Advantageously, the thermostat integrates two functions: a temperature regulation function through a lever which acts onto an electric assembly, and a safety function through a linkage system intervening at a given safety temperature by preferably disconnecting the contacts of both phases at the same time.

[0028] Further features and advantages will be more apparent from the following detailed description of preferred non-limiting embodiments of the present invention, and from the dependent claims which outline preferred and particularly advantageous embodiments of the invention.

Brief description of the drawings

[0029] The invention is illustrated with reference to the following figures, given by way of non-limiting examples, in which:

- Figure 1 illustrates a perspective view of a preferred embodiment of the thermostat according to the present invention.
- Figure 2 illustrates a side view of the thermostat of Figure 1, highlighting two section lines.
- Figure 3 illustrates a first section of the thermostat of Figure 2, in an operating condition.
- Figure 4 illustrates a first section of the thermostat of Figure 2, in a safety condition.
- Figure 5 illustrates a second section of the thermostat of Figure 2, in an operating condition.
- Figure 6 illustrates a second section of the thermostat of Figure 2, in a safety condition.
- Figure 7 illustrates a perspective view of an alternative embodiment of the thermostat body according to the present invention.
- Figure 8 illustrates a section of the thermostat body of Figure 7.
- Figure 9 illustrates an exploded view of a preferred embodiment of the thermostat according to the present invention.

[0030] In different figures, similar elements will be identified by similar reference numbers.

Detailed description

[0031] Figure 1 illustrates a perspective view of a preferred embodiment of the thermostat 100 according to the present invention.

[0032] As it will be further described, the rod thermostat 100 according to the invention comprises a main containment or housing body 1, having a generally circular shape, closed by a plastic lid 21, particularly clipengaged onto the lid.

[0033] The temperature regulation devices and the safety devices, particularly bipolar safety ones, which will be further described, are housed in the thermostat body 1.

[0034] In a preferred embodiment, a brass tube 24 containing an INVAR rod is provided.

[0035] A pair of terminals 8 and 9, equipped in particular with cable clamping screws 23, are attached on the thermostat body 1 for the connection between the main electric circuit and the electric regulation and bipolar safety circuits which are present in the thermostat 100.

[0036] Preferably, the housing of the thermostat body 1, the lid 21 and the internal levers are made of a plastic material which is resistant to temperatures exceeding 100°C.

[0037] Figure 2 illustrates a side view of the thermostat 100, highlighting two section lines I-I and II-II. The thermostat 100 comprises a thermostat body 1 and a tubular element 24 projecting from the thermostat body 1.

[0038] Figure 3 illustrates the section I-I of the thermostat 100 in an operating condition whereas Figure 4 illustrates the section I-I of the thermostat 100 in a safety condition. Likewise, Figure 5 illustrates the second section II-II of the thermostat 100 in an operating condition whereas Figure 6 illustrates the second section II-II of the thermostat 100 in a safety condition.

[0039] Referring to these Figures 3, 4, 5 and 6 the operation of the safety devices of the thermostat 100, and more, will be understood in detail.

[0040] As mentioned, the thermostat 100 comprises a thermostat body 1 and a tubular element 24 projecting from the thermostat body 1.

[0041] The thermostat 100 further comprises a rod 2 with differential thermal expansion, which is axially inserted in the tubular element 24 which is hollow inside. The rod 2 protrudes at a proximal end inside the thermostat body 1.

[0042] Preferably, the tubular element 24 is made of a high-thermal-expansion metal material, preferably of brass, whereas the rod 2 is made of a lowthermal-expansion material, preferably of an INVAR alloy or a Ni-Fe alloy.

[0043] In particular, the rod 2 is distally constrained to the tubular element 24, i.e., in the farthest position of the rod 2 with respect to the thermostat body. It is thereby possible to determine a thermal expansion action transmitted through the rod, which is used for the operation, inter alia, of the safety system, as it will be described.

[0044] The thermostat 100 further comprises a safety lever 16 arranged transversally to the rod 2 and configured for a displacement under a thermal expansion action transmitted through the rod. In particular, as the temperature to which the tubular element 24 is subjected increases, the differential thermal expansion between the rod 2 and the tubular element 24 involves a displacement of the proximal end of the rod 2, due to different thermal expansions of the elements. In particular in the preferred embodiment, with the increase in temperature, the length of the tubular element 24 increases with respect to the length of the rod 2, involving a partial extraction and a lowering (with respect to the direction shown in figure) of the proximal end of the rod 2, which is connected to the safety lever as it will be further described.

[0045] The safety lever 16 comprises a first engagement element 16a, whose function will be described below.

[0046] The safety lever 26 is configured to open at least one electric contact 5, 7 in the thermostat body 1 upon reaching a safety temperature.

[0047] Moreover, the safety lever 16 comprises a safety regulation element 18 constrained to the rod 2 and configured to regulate a position of the safety lever 16 with respect to the safety temperature. Typically, the regulation of the safety temperature by means of the safety regulation element 18 is performed by calibrating the element during manufacturing thereof.

[0048] The safety lever 16 is preferably configured to act onto at least one elongated flexible element 6 to open the at least one electric contact 5, 6. In the preferred embodiment, there is a pair of elongated flexible elements 6 to open two respective electric contacts 5, 7 and 11, 7 thus defining a bipolar safety for the thermostat 100.

[0049] The thermostat 100 further comprises a reset element 3 arranged transversally to the rod 2 and sliding under an action of a first bias member 4, in particular a coil spring 4 but it could be another thrust element or a different spring.

[0050] In fact, the first bias member 4 is configured for a thrust of the reset element 3 in a radially external direction with respect to the thermostat body 1, said first bias member preferably comprising a coil spring.

[0051] Preferably, the safety lever 16 also comprises a second bias member 17, in particular a coil spring 17 or other system, configured to partially counteract the thermal expansion action of the rod.

[0052] The reset element 3 comprises a second engagement element 3a configured to cooperate with the first engagement element 16a of the safety lever 16. The first engagement element 16a and the second engagement element 3a define a trip of the reset element 3 between a first operating position and a second safety position, in said second safety position the reset element 3 allowing a movement of the safety lever 16 to open the at least one electric contact 5,7 upon reaching the safety temperature, as it is exemplified in particular in Figures 4 and 6.

[0053] In particular, the first engagement element 16a and the second engagement element 3a comprise respective front surfaces, configured to abut with each other in the first operating position, see the enlargement in Figure 5, and further configured to overtake each other in the second safety position, see the enlargement in Figure 6, so as to move the first engagement element 16a beyond the second engagement element 3a by tripping.

[0054] Preferably, the respective front surfaces of the first engagement element 16a and second engagement element 3a are slightly tilted, to promote the movement of the safety lever 16 under the modest thermal expansion force exerted by the rod 2.

[0055] In the preferred embodiment, the reset element 3 comprises a hook element 3b having the second engagement element 3a, whereas the safety lever 16 comprises a groove 16b for slidingly housing the hook element 3b at the first engagement element 16a.

[0056] In the preferred embodiment, the reset element 3 further comprises a tab 3c configured to laterally protrude beyond the thermostat body 1 by sliding the reset element 3 in the second safety position. In particular, the tab 3c is adapted to bring the reset element 3 back in the first operating position, i.e., to go from the condition of Figure 6 back to the condition of Figure 5, by mechanically counteracting the action of the first bias member 4 for example by means of a manual pressure of a user onto the tab 3c.

[0057] Advantageously, in the preferred embodiment, the safety lever 16 defines a fulcrum 16c, and the rod 16 itself is interposed between the fulcrum 16c and the first engagement element 16a, thus defining a class-III lever with respect to the thermal expansion action transmitted through the rod 2, so as to amplify a movement of the first engagement element 16a with respect to the second engagement element 3a.

[0058] Preferably, the thermostat 100 further comprises a temperature regulation system associated with the rod 2 and configured to reversibly open at least one electric contact 14, 15 in the thermostat body 1 upon reaching an operating temperature. In particular, the temperature regulation system of the thermostat 100 comprises a regulation lever 19 arranged transversally to the rod 2 and above the safety lever 16 (with respect to the figure direction). In particular, the regulation lever 19 is configured for a displacement under a thermal expansion action of the rod 2. Preferably, the temperature regulation system further comprises a temperature regulation element 20 constrained to the rod 2 and configured to regulate a position of the regulation lever 19 with respect to the operating temperature; in other words, the intervention temperature of the thermostat 100 is settable, also by a user, in particular by acting onto the regulation element 19 via an interface element 22.

[0059] Figure 7 illustrates a perspective view of an alternative embodiment of the thermostat body 1' according to the present invention, whereas Figure 8 illustrates a section of the thermostat body 1'.

[0060] In this alternative embodiment, with respect to the embodiment already described above, the safety lever 16' directly integrates the second bias member, configured to partially counteract the thermal expansion action of the rod 2. In particular, in this alternative embodiment the second bias member provides, instead of a coil spring, a flexible cantilever 16c' at the fulcrum of the safety lever 16', made in particular as a single piece with the thermostat body 1.

[0061] As a complement to the description of the present invention, Figure 9 illustrates an exploded view of the first preferred embodiment of the thermostat according to the present invention, already described with reference to Figures 1 to 6.

[0062] The main components of the thermostat 100 are identified in this exploded view, some of them have already been described above and shown with the same reference number, whereas others are ancillary components identified below for the first time in the description.

1 - Thermostat body

2 - Rod, in particular an INVAR rod

3 - Reset element or reset valve

4 - First bias member, preferably a coil spring

5 - Electric contact

6 - Elongated flexible element or flexible spring for safety

7 - Electric contact

8 - Safety faston

9 - Regulation faston

10 - Internal connection faston

11 - Electric contact

12 - Safety faston (right)

13 - Safety faston (left)

14 - Snap spring

15 - Electric contact

16 - Safety lever

17 - Second bias element, preferably a coil spring

18 - Safety regulation element

19 - Regulation lever

20 - Temperature regulation element

21 - Lid

22 - Interface element or knob

23 - Cable clamping screw

24 - Tubular element, particularly a brass tube

[0063] In summary, advantageously, the present invention allows a thermostat 100 to be manufactured, having a safety system preferably composed of a manually resettable valve 3, two springs and an upper safety lever 16 snap-fixed on the thermostat body 1. A calibration element 18 of the safety intervention temperature is positioned by using an INVAR rod 2.

[0064] With the increase in temperature, the INVAR rod 2 remains fixed and the brass tubular element 24 expands creating a force which lowers the upper lever 16 and trips the lower valve 3 when there is no longer any contact between the tooth 3a which is present on the valve and the portion 16a of the upper lever 16. The trip of the safety valve 3 is instant upon reaching the safety temperature, and trips the two springs 7 opening the electric contacts. The safety is manually resettable after each single intervention, by acting onto the element 3c.

[0065] Considering the description provided herein, the person skilled in the art will be allowed to devise further modifications and alternatives, in order to meet contingent and specific requirements.

[0066] It is evident that, if there are no technical incompatibilities which are apparent to the person skilled in the art, the configurations of specific elements described with reference to some embodiments might be used in other here-described embodiments.

[0067] For example, the specific configuration and mutual shaping of the safety lever and reset element might be modified based on the thermostat model, in particular based on considerations about the overall layout, overall dimensions and space which is available inside the thermostat body.

[0068] The here-described embodiments are therefore to be understood as illustrative and non-limiting examples of the invention.

Claims

1. Thermostat (100) comprising:

- a thermostat body (1);
  - a tubular element (24) projecting from said thermostat body (1);
  - a rod (2) with differential thermal expansion, axially inserted in said tubular element (24) and protruding at a proximal end inside said thermostat body (1);
  - a temperature regulation system (19, 20) associated with said rod (2) and configured to reversibly open at least one electric contact (14, 15) in said thermostat body (1) upon reaching an operating temperature;

characterized in that it further comprises:

- a safety lever (16) arranged transversally to said rod (2) and configured for a displacement under a thermal expansion action transmitted through said rod (2), said safety lever (16) comprising a first engagement element (16a), said safety lever (16) being configured to open at least one electric contact (5, 7; 11, 7) in said thermostat body (1) upon reaching a safety temperature;
- a reset element (3) arranged transversally to said rod (2) and sliding under an action of a first bias member (4), said reset element (3) comprising a second engagement element (3a) configured to cooperate with said first engagement element (16a), defining a trip of said reset element (3) between a first operating position and a second safety position wherein said reset element (3) allows a movement of said safety lever (16) to open said at least one electric contact (5, 7; 11, 7) upon reaching said safety temperature.

2. Thermostat according to claim 1, wherein said first engagement element (16a) and said second engagement element (3a) comprise respective front surfaces configured to abut with each other in said first operating position, and further configured to overtake each other in said second safety position, so as to move said first engagement element (16a) beyond said second engagement element (3a) by means of said trip.

3. Thermostat according to claim 2, wherein said respective front surfaces are tilted in order to favour said movement of said safety lever (16).

4. Thermostat according to any one of claims 1 to 3, wherein said reset element (3) comprises a hook element (3b) having said second engagement element (3a), and wherein said safety lever (16) comprises a groove (16b) for slidingly housing said hook element (3b) at said first engagement element (16a).

5. Thermostat according to any one of claims 1 to 4, wherein said reset element (3) further comprises a tab (3c) configured to laterally protrude beyond said thermostat body (1) by sliding said reset element (3) in said second safety position, said tab (3c) being adapted to bring said reset element (3) back in said first operating position by mechanically counteracting said action of said first bias member (4).

6. Thermostat according to any one of claims 1 to 5, wherein said first bias member (4) is configured for a thrust of said reset element (3) in a radially external direction with respect to said thermostat body (1), said first bias member (4) preferably comprising a coil spring.

7. Thermostat according to any one of claims 1 to 6, wherein said safety lever (16) further comprises a second bias member (17, 16c') configured to partially counteract said thermal expansion action of said rod (2), said second bias member (17) preferably comprising a coil spring (17) or a flexible cantilever (16c').

8. Thermostat according to any one of claims 1 to 7, wherein said safety lever (16) comprises a safety regulation element (18) constrained to said rod (2) and configured to regulate a position of said safety lever (16) with respect to said safety temperature.

9. Thermostat according to any one of claims 1 to 8, wherein said safety lever (16) is configured to act onto at least one elongated flexible element (7) to open said at least one electric contact (5, 7; 11, 7),

preferably a pair of elongated flexible elements (7) to open two respective electric contacts (5, 7; 11, 7) defining a bipolar safety.

10. Thermostat according to any one of claims 1 to 9, wherein said safety lever (16) defines a fulcrum (16c) and wherein said rod (2) is interposed between said fulcrum (16c) and said first engagement element (16a), defining a class-III lever with respect to said thermal expansion action, so as to amplify a movement of said first engagement element (16a) with respect to said second engagement element (3a).

11. Thermostat according to any one of claims 1 to 10, wherein said temperature regulation system comprises a regulation lever (19) arranged transversally to said rod (2) and above said safety lever (16), said regulation lever (19) being configured for a displacement under a thermal expansion action of said rod (2), and it further comprises a temperature regulation element (20) constrained to said rod (2) and configured to regulate a position of said regulation lever (19) with respect to said operating temperature, said temperature regulation element (20) being preferably settable via an interface element (22).

12. Thermostat according to any one of claims 1 to 11, wherein said tubular element (24) is made of a high-thermal-expansion metal material, preferably of brass, and wherein said rod (2) is made of a low-thermal-expansion material, preferably of an INVAR alloy or a Ni-Fe alloy, said rod (2) being distally constrained to said tubular element (24) with respect to said thermostat body (1) so as to determine said thermal expansion action.

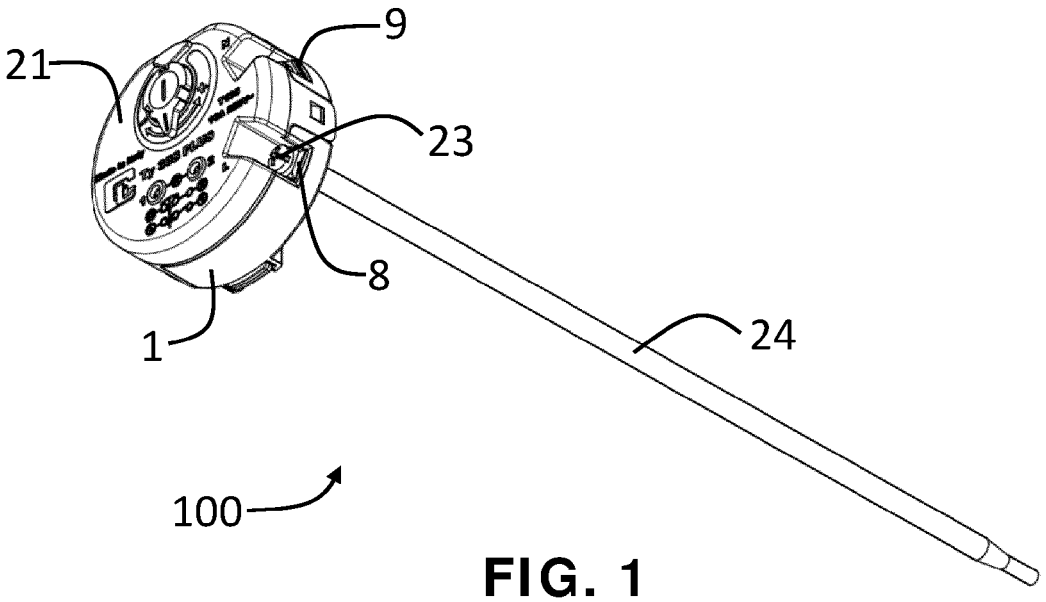


FIG. 1

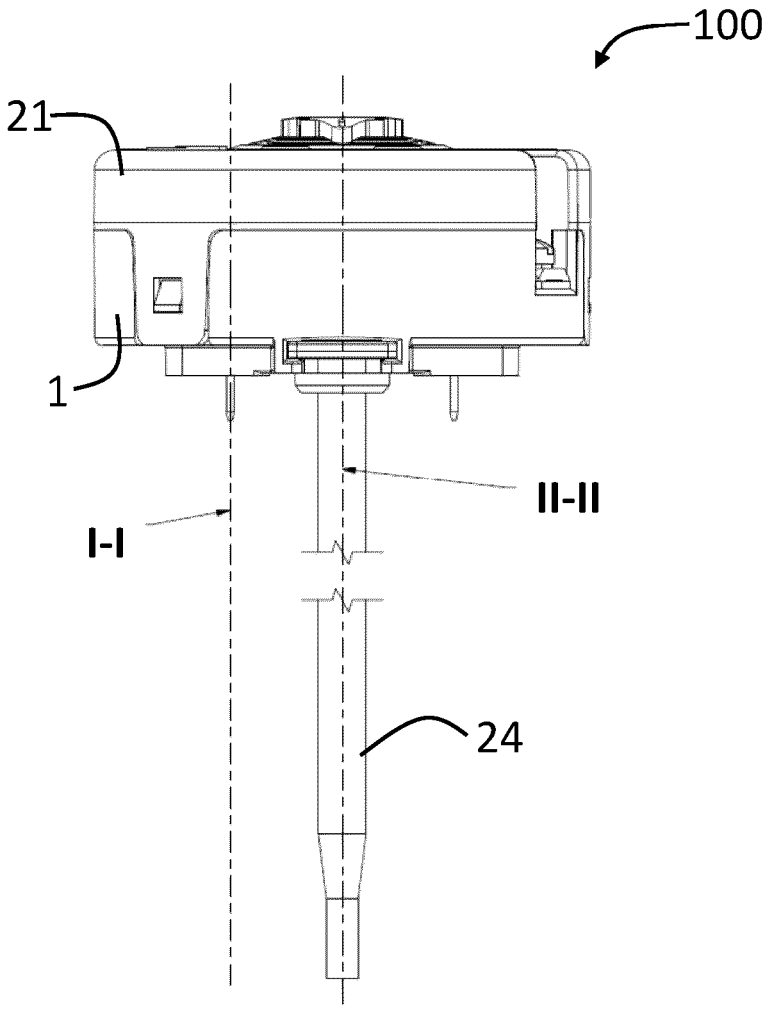
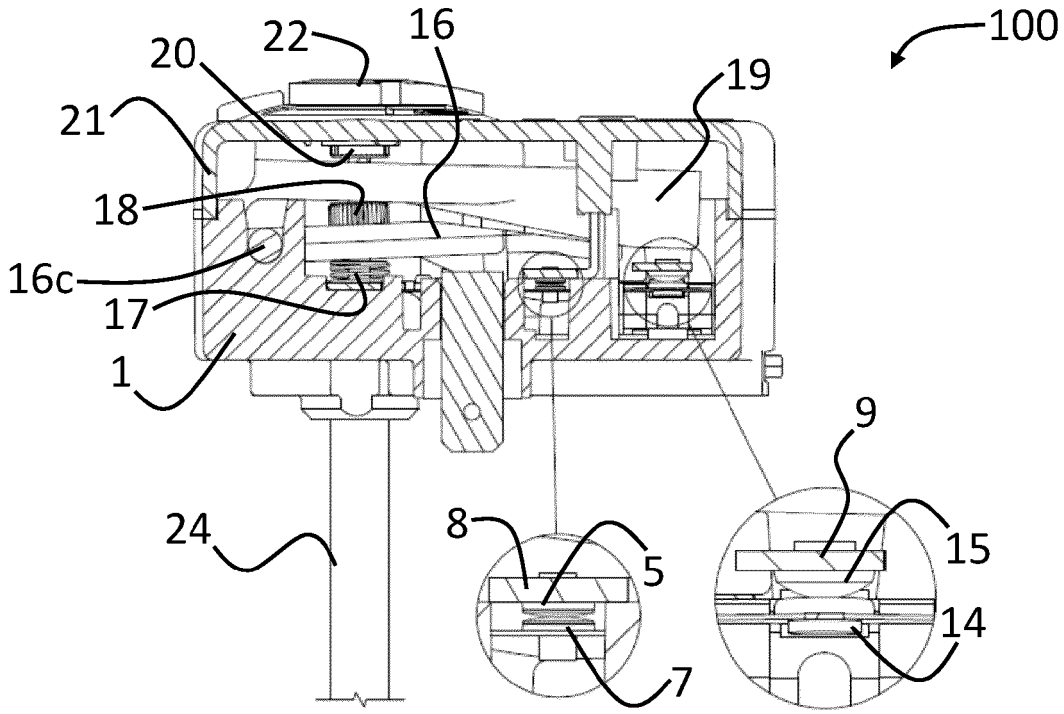
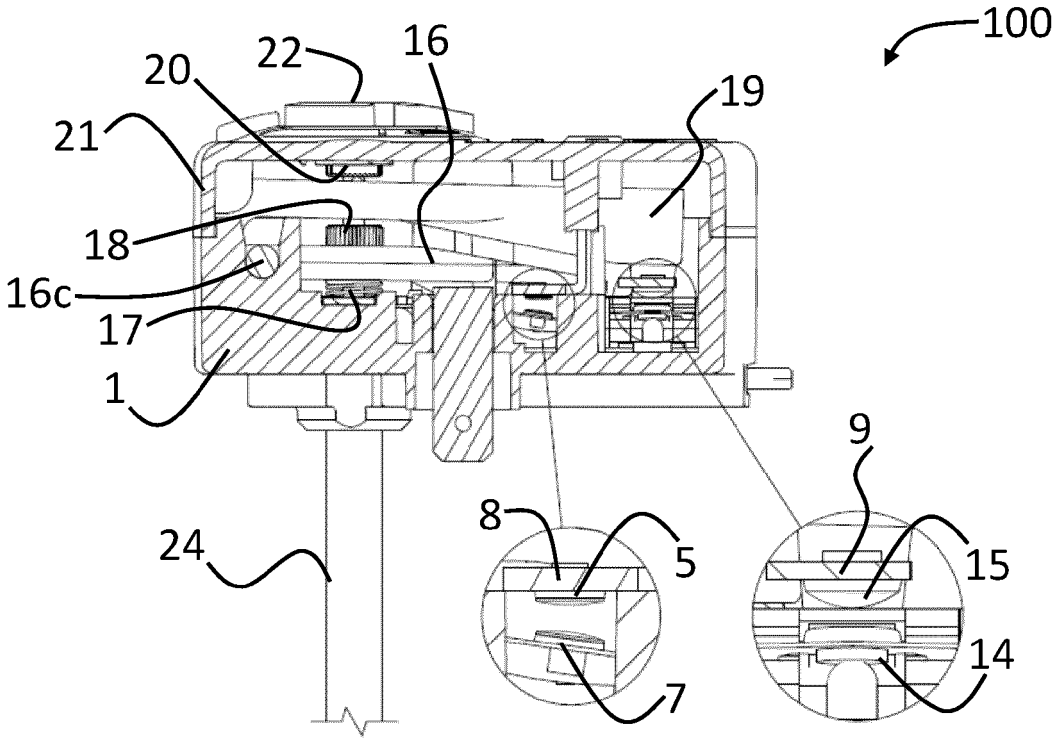


FIG. 2



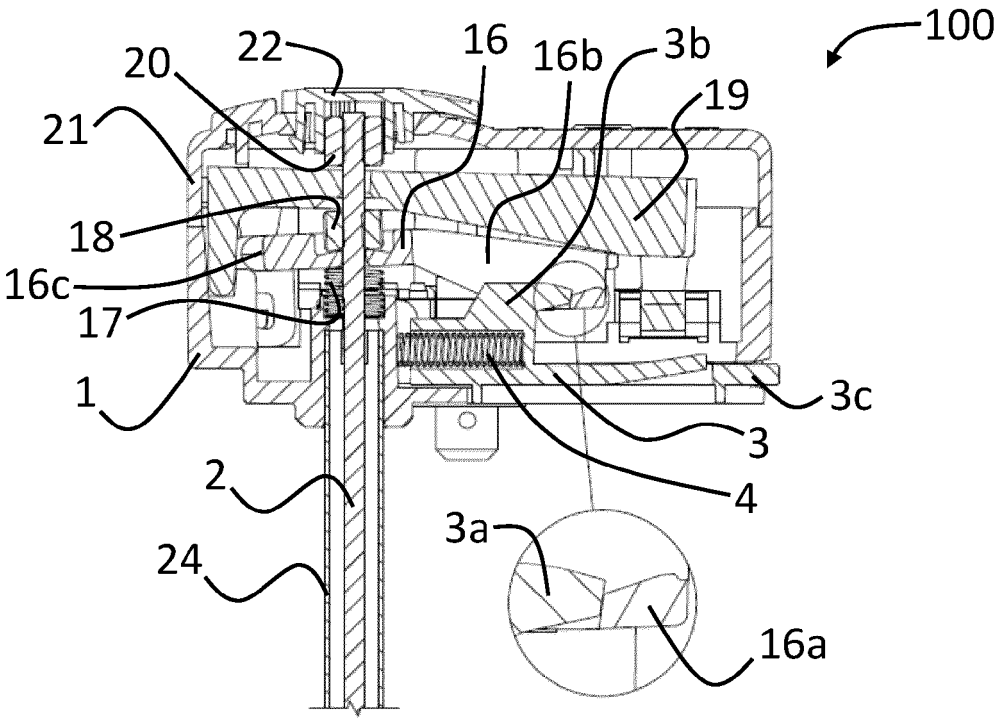
I-I

FIG. 3



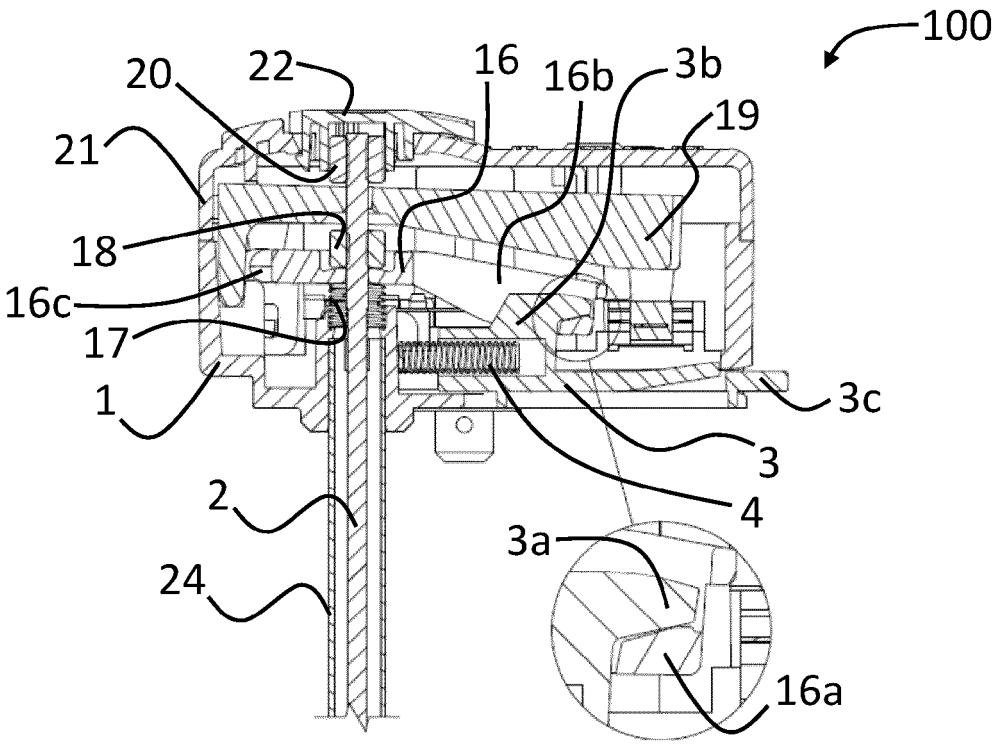
I-I

FIG. 4



II-II

FIG. 5



II-II

FIG. 6

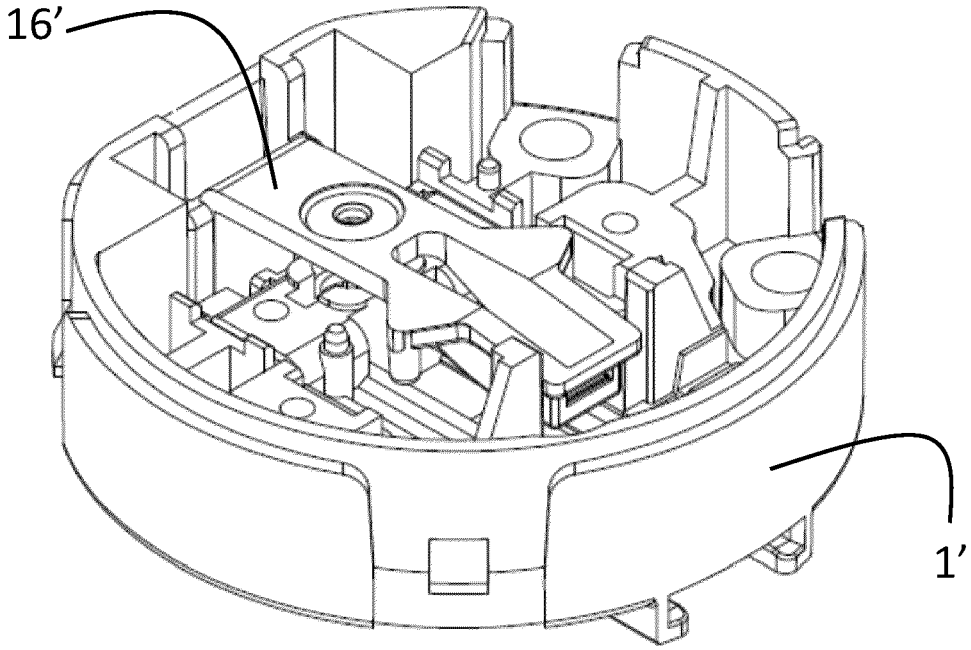


FIG. 7

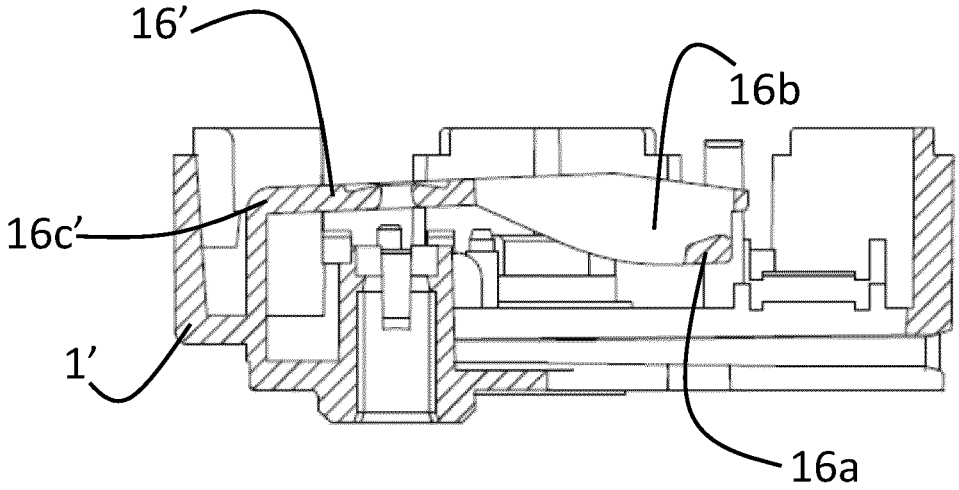


FIG. 8

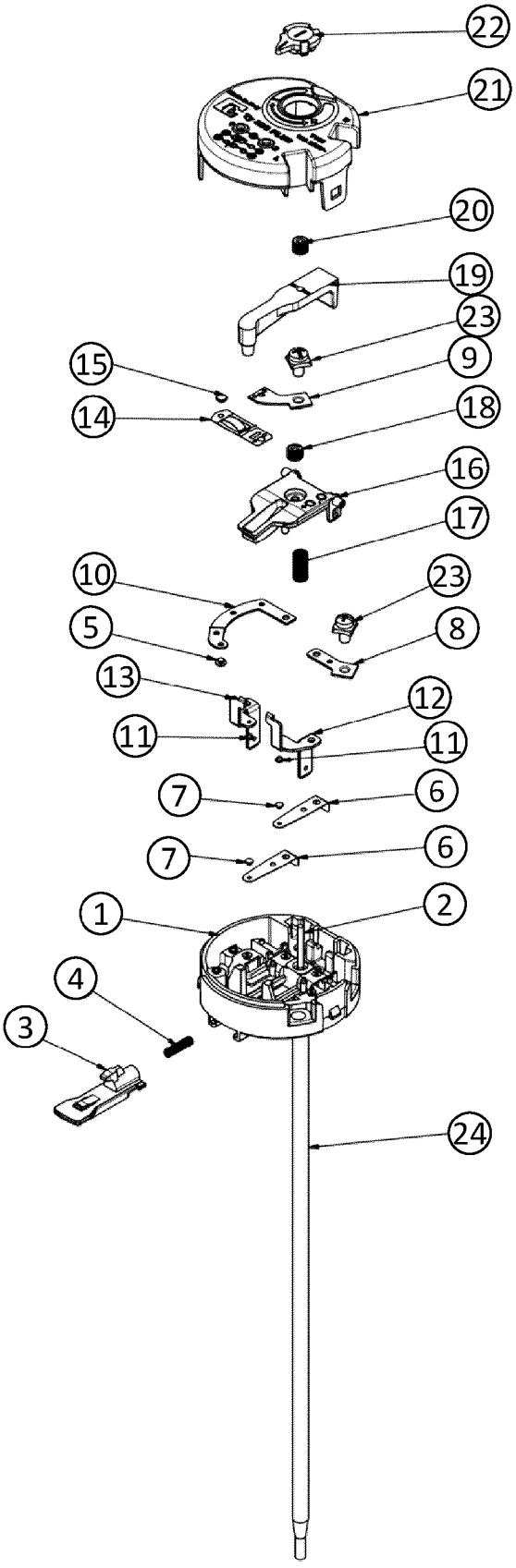


FIG. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 23 18 1396

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	WO 2005/119720 A1 (COTHERM SA [FR]; ROQUES BERNARD [FR]) 15 December 2005 (2005-12-15) * page 6, line 6 - page 7, line 8 * * figures 1-10 *	1-12	INV. H01H37/48 H01H37/00 H01H37/70 ADD. H01H37/22
A,D	EP 0 749 141 A1 (COTHERM SA [FR]) 18 December 1996 (1996-12-18) * column 2, line 32 - column 3, line 31 * * figures 1-4 *	1-12	
A	FR 2 707 424 A3 (LORENZI VASCO SPA [IT]) 13 January 1995 (1995-01-13) * page 5, line 18 - page 7, line 8 * * figures 1-3 *	1-12	
A	GB 2 474 238 A (HEATROD ELEMENTS LTD [GB]) 13 April 2011 (2011-04-13) * page 17, line 19 - page 20, line 29 * * figures 1-4 *	1-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 November 2023	Glaman, C

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