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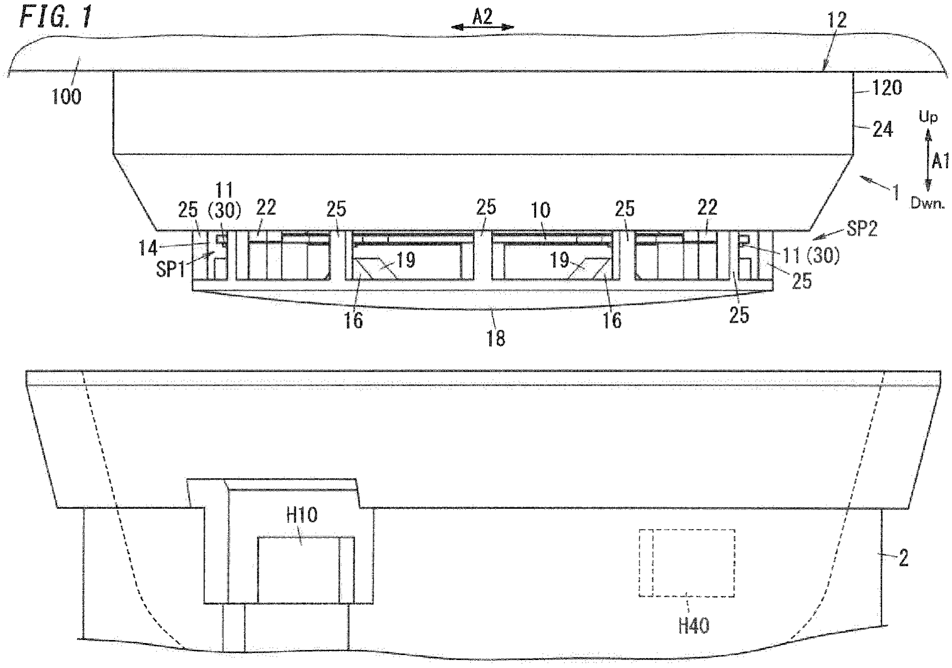
(54) **SENSOR**

(57) The problem to be overcome by the present disclosure is to improve thermal response. A sensor (1) includes a board (10), a heat detecting element (11), a housing (12), and a heat collector (16). The heat detecting element (11) is mounted on the board (10) and detects heat. The housing (12) houses the board (10). The housing (12) has a flow channel (13) and an opening (14). The flow channel (13) is provided in an internal space (SP1) of the housing (12) and allows air to flow therethrough. The opening (14) allows the flow channel (13) to communicate with an external space (SP2) outside of the housing (12). The heat collector (16) is configured to collect hot air toward the heat detecting element (11).

FIG. 1



Description

Technical Field

[0001] The present disclosure generally relates to a sensor and more particularly relates to a sensor for detecting the presence of fire by heat.

Background Art

[0002] JP 2012-14330 A discloses a smoke and heat sensor. The smoke and heat sensor includes a heat sensing means for sensing heat and a smoke sensing unit for sensing smoke that has flowed into a dark box. The smoke and heat sensor houses, inside a housing including a body base and a body case covering an upper part of the body base, a circuit board mounted on the upper surface of the body base, the heat sensing means, and the smoke sensing unit. The heat sensing means includes a plurality of heat sensors provided beside the dark box.

Summary of Invention

[0003] There has been an increasing demand for further improving the thermal response of such a sensor that detects the presence of fire by heat.

[0004] In view of the foregoing background, it is therefore an object of the present disclosure to provide a sensor contributing to improving the thermal response.

[0005] A sensor according to an aspect of the present disclosure includes a board, a heat detecting element, a housing, and a heat collector. The heat detecting element is mounted on the board and detects heat. The housing houses the board. The housing has a flow channel and an opening. The flow channel is provided in an internal space of the housing and allows air to flow therethrough. The opening allows the flow channel to communicate with an external space outside of the housing. The heat collector is configured to collect hot air toward the heat detecting element.

Brief Description of Drawings

[0006]

FIG. 1 illustrates the appearance of a sensor according to a first embodiment with a heating tester;
FIG. 2A is a cross-sectional view of the sensor;
FIG. 2B is a front view of a principal portion thereof as viewed in the direction indicated by the arrow Y in FIG. 2A;
FIG. 3 is an exploded perspective view of the sensor;
FIG. 4 is a perspective view illustrating the sensor with its lower cover removed;
FIG. 5 shows a schematic block configuration for the sensor;
FIG. 6 illustrates the appearance of a heat collector having a triangular shape for use in the sensor;
FIG. 7A is a top view illustrating the sensor and heating tester with the upper cover removed from the sensor;
FIG. 7B is a cross-sectional view thereof taken along the plane X-X shown in FIG. 7A;
FIG. 8 illustrates the appearance of a heat collector of a sensor according to a fourth variation;
FIG. 9 illustrates the appearance of a heat collector of a sensor according to a fifth variation;
FIG. 10 illustrates a heat collector of a sensor according to a sixth variation;
FIG. 11 illustrates guide portions of a sensor according to a seventh variation;
FIG. 12 illustrates guide portions of a sensor according to an eighth variation;
FIG. 13 illustrates guide portions of a sensor according to a ninth variation;
FIG. 14 illustrates guide portions of a sensor according to a tenth variation;
FIG. 15 illustrates the appearance of a sensor according to a second embodiment;
FIG. 16 is a cross-sectional view of the sensor; and
FIG. 17 is a perspective view illustrating the sensor with a lower cover thereof removed.

Description of Embodiments

[0007] Note that the embodiments and their variations to be described below are only exemplary embodiments of the present disclosure and their variations and should not be construed as limiting. Rather, the exemplary embodiments and their variations may be readily modified in various manners depending on a design choice or any other factor without departing from a true spirit and scope of the present disclosure.

(First embodiment)

[0008] A sensor 1 according to a first embodiment will be described with reference to FIGS. 1-7B.

(1) Overview

[0009] A sensor 1 according to a first embodiment may be implemented as, for example, a fire sensor. In the first embodiment, the sensor 1 is supposed to be, for example, a smoke and heat sensor having both the capability of detecting heat generated by a fire, for example, and the capability of detecting smoke produced by a fire, for example. Nevertheless, the sensor 1 does not have to be a smoke and heat sensor and does not have to have the capability of detecting smoke. The sensor 1 is installed on an installation surface 100 such as a ceiling surface or a wall surface of a building as shown in FIG. 2A. In FIG. 2A, the sensor 1 is installed on a ceiling surface.
[0010] As shown in FIG. 1, the sensor 1 according to the first embodiment includes a board 10, at least one heat detecting element 11, a housing 12, and at least one heat collector 16.
[0011] The at least one heat detecting element 11 is mounted on the board 10 to detect heat. In the first embodiment, the heat detecting element 11 may be implemented as, for example, a chip thermistor. The heat detecting element 11 is disposed under the board 10.
[0012] The housing 12 houses the board 10. The housing 12 has: a flow channel 13 (see FIG. 7A) provided in an internal space SP1 of the housing 12 and allowingair to flow therethrough; and at least one opening 14 allowing the flow channel 13 to communicate with an external space SP2 (see FIG. 2) outside of the housing 12.
[0013] The at least one heat collector 16 is configured to collect hot air toward the heat detecting element 11. In the first embodiment, the heat collector 16 may be formed, for example, integrally with a lower cover 120 of the housing 12.
[0014] This configuration includes the heat collector 16, thus achieving the following advantage. Specifically, the hot air flowing into the internal space SP1 of the sensor 1 through the opening 14 flows along the flow channel 13 to reach the heat detecting element 11. As a result, the sensor 1 detects heat. In this case, a gas flow with heat (hereinafter referred to as "hot air") is collected by the heat collector 16 to wrap the heat detecting element 11 mounted on the board 10 and their surroundings, thus causing the heat detecting element 11 to be heated rapidly. Therefore, the heat collector 16 increases the heat detecting rate. Consequently, the sensor 1 achieves the advantage of improving the thermal response.
[0015] Meanwhile, when a test is conducted using a heater-type heating tester 2 (see FIG. 1), the heat source thereof is a localized one compared to a fire, and therefore, the test result tends to be affected by respective heights of the heat source H10 of the heating tester 2 and the height of the board of the sensor. Particularly when the height of the heat source of the heating tester 2 disagrees with the height of the board of the sensor, the hot air does not enter the sensor smoothly, thus causing a decline in thermal response and taking a lot of time to have a test using the heating tester 2 done. In contrast, the sensor 1 according to the first embodiment includes the heat collector 16, thus improving the thermal response not only to the actual presence of a fire but also to the heating tester 2 as well. This achieves the advantage of having the test using the heating tester 2 done in a shorter time.

(2) Configuration

(2.1) Overall configuration

[0016] Next, an overall configuration for the sensor 1 according to the first embodiment will be described in detail. As described above, the sensor 1 may be, for example, a smoke and heat sensor for detecting both smoke and heat.
[0017] In the following description, the vertical arrangement of respective members of the sensor 1 will be described by using the up and down arrows shown in FIG. 1, illustrating a state where the sensor 1 is installed on the installation surface 100 (such as a ceiling surface). Note that these arrows are shown there as just an assistant to description and are insubstantial ones. In addition, these arrows should not be construed as limiting the directions in which the sensor 1 is used.
[0018] As shown in FIGS. 1 and 2, the sensor 1 includes the board 10, a heat detector 3 including a single or a plurality of heat detecting elements 11, a smoke detector 4, a flow channel forming member 7, the heat collector 16, and the housing 12. In addition, the sensor 1 further includes a controller 5 and an indicator 6 as shown in FIG. 5.
[0019] The sensor 1 further includes a disklike attachment base (not shown) to be fixed with screws, for example, onto the installation surface 100. The sensor 1 may be installed onto the installation surface 100 by removably attaching an attachment portion, provided on the upper surface of the housing 12, onto the attachment base.
[0020] In addition, the sensor 1 further includes a communications interface 9 (see FIG. 5). The communications interface 9 transmits, when the sensor 1 detects the presence of fire, a signal alerting to the presence of the fire to an external alarm device, for example, and receives a signal from the alarm device.

[0021] The sensor 1 may be powered by a commercial power supply or a battery provided inside the housing 12, whichever is appropriate.

(2.2) Housing

[0022] The housing 12 houses the board 10, the heat detector 3, the smoke detector 4, the controller 5, the indicator 6, the communications interface 9, and other circuit modules inside.

[0023] The housing 12 is made of a synthetic resin and may be made of flame-retardant ABS resin, for example. The housing 12 is formed in a vertically compressed cylindrical shape as a whole. As shown in FIG. 3, the housing 12 includes a cylindrical lower cover 120 (front cover), one side (e.g., the upper side in the example shown in FIG. 3) of which is open, and a generally disklike upper cover 121 (back cover). The housing 12 is formed by fitting the upper cover 121 into the lower cover 120 through one side thereof that is open. The upper cover 121 is arranged to cover the smoke detector 4 from over the smoke detector 4. The lower cover 120 is disposed under the board 10.

[0024] The housing 12 has a flow channel 13 (see FIG. 7A), which is provided in the internal space SP1 thereof to allow hot air to flow therethrough, and a single or a plurality of (e.g., twelve in this embodiment) openings 14 (lateral holes) that allows the flow channel 13 to communicate with the external space SP2 outside of the sensor 1. In this embodiment, a plurality of openings 14 are provided through the lower cover 120. In other words, the lower cover 120 has a plurality of openings 14 that allows the internal space SP1 to communicate with the external space SP2.

[0025] Specifically, the lower cover 120 includes: a bottom member 18 that forms the bottom of the openings 14; and a cylindrical upper member 24 that forms the side surface of the housing 12. In addition, the lower cover 120 further includes a plurality of (e.g., twelve in this embodiment) beams 25 that couple the bottom member 18 to the upper member 24. The bottom member 18, the upper member 24, and the twelve beams 25 are formed integrally with each other. The twelve beams 25 are arranged at substantially regular intervals along the circumference A3 on the outer peripheral edge 21 of the bottom member 18 and protrude from the outer peripheral edge 21 toward the opened lower edge portion of the upper member 24. The twelve beams 25 are provided to maintain a predetermined gap distance between the upper member 24 and the bottom member 18. Twelve openings 14 are arranged at substantially regular intervals along the circumference of the peripheral wall with such a configuration (corresponding to the circumference A3 of the sensor 1).

[0026] Each of the openings 14 is a generally rectangular through hole, which penetrates radially through the peripheral wall of the lower cover 120 and allows the flow channel 13 to communicate with the external space SP2.

[0027] The bottom member 18 has, on its upper surface, a positioning structure for positioning the board 10. In this embodiment, a cylindrical portion 180 is provided as the positioning structure (see FIG. 2A). In other words, the sensor 1 according to the first embodiment further includes the cylindrical portion 180 arranged to cover the lower surface of the board 10. The cylindrical portion 180 protrudes from the upper surface of the bottom member 18. The upper end surface of the cylindrical portion 180 is in contact with the lower surface of the board 10.

[0028] The upper cover 121 has, on the lower surface, a plurality of connection pieces 123 (see FIG. 3) that protrude downward. The plurality of connection pieces 123 are respectively inserted into a plurality of insert holes 77 (to be described later) provided through the flow channel forming member 7 and respectively fitted into a plurality of fitting holes 32 provided through the board 10. Inserting the plurality of connection pieces 123 into the plurality of insert holes 77 of the flow channel forming member 7 makes the plurality of connection pieces 123 electrically connected to terminals on terminal stages 22, which are arranged adjacent to the insert holes 77. The terminals on the terminal stages 22 are electrically connected to circuit modules provided on the board 10. The upper cover 121 is mechanically connected to a contact portion of the attachment base fixed to the installation surface 100, thereby making the plurality of connection pieces 123 electrically connected to the contact portion. As a result, the circuit modules provided on the board 10 are electrically connected to electric cables (including power cables and signal cables) provided on the backside of the ceiling via the terminal stages 22, the connection pieces 123, the contact portion, and other members.

[0029] In addition, the upper cover 121 further has, on one surface (lower surface) thereof facing the board 10, a housing recess 122 (see FIG. 3) to house an upper portion of the smoke detector 4 mounted on the board 10. The housing recess 122 is formed by making the entire central portion of the upper cover 121 protrude upward. The smoke detector 4 may be positioned stably by the housing recess 122.

[0030] In this embodiment, the sensor 1 further includes gas flow control walls 8 as shown in FIG. 3. In this embodiment, the gas flow control walls 8 may form integral parts of the upper cover 121, for example. The three gas flow control walls 8 are provided on one surface (lower surface), facing the board 10, of the upper cover 121 to be located outward of the housing recess 122. In the first embodiment, the three gas flow control walls 8 are arranged around the smoke detector 4 to reduce non-uniformity in smoke flowability along the circumference A3 of, and with respect to, the smoke detector 4.

(2.3) Board

[0031] The board 10 is configured to mount the smoke detector 4 thereon. In this embodiment, the board 10 may be implemented as, for example, a circuit board. The board 10 may be, for example, a single printed wiring board on which patterned conductor wiring is formed. The board 10 has a pair of engagement holes, which penetrate through the board 10 in the thickness direction. The smoke detector 4 is mounted onto the upper surface of the board 10. In addition, the flow channel forming member 7 is also held by the board 10 as will be described later.

[0032] On the board 10, not only the smoke detector 4 but also the heat detector 3, the controller 5, the indicator 6, the communications interface 9, and other circuit modules are mounted as well. Examples of the other circuit modules include a lighting circuit for turning ON a light source for the indicator 6 and an optical element 401 (see FIG. 5) of the smoke detector 4 and a power supply circuit for generating operating power for various types of circuits based on the power supplied from a commercial power supply, for example.

[0033] As shown in FIGS. 3 and 4, the board 10 is formed in a generally disklike shape as a whole. In the first embodiment, the heat detector 3 includes a single or a plurality of (e.g., six in this embodiment) heat detecting elements 11 and the six heat detecting elements 11 are arranged along an outer peripheral portion 101 of the board 10. The six heat detecting elements 11 are surface-mounted on the lower surface 103 of the board 10. Meanwhile, the smoke detector 4 is mounted on the upper surface 102 of the board 10.

[0034] The controller 5 and a plurality of electronic components forming circuit modules may be mounted on the upper surface 102 or lower surface 103 of the board 10. However, the controller 5 and a plurality of electronic components forming circuit modules do not have to be mounted only on the board 10. Alternatively, another mount board may be provided around the board 10 and some or all of the controller 5 and the electronic components may be mounted on the mount board.

[0035] Next, the structure of the board 10 will be described in detail. As shown in FIG. 3, the board 10 includes a disklike body 104 and a plurality of (e.g., six in the first embodiment) extended portions extended from the edge of the body 104 to go away from the center of the body 104. The smoke detector 4 is disposed in a central area of the upper surface of the body 104.

[0036] These six extended portions are configured as six tongue portions 31. Each of the tongue portions 31 is a portion on which an associated heat detecting element 11 out of the six heat detecting elements 11 is mounted. Each of the tongue portions 31 has an upper surface and a lower surface, which are respectively flush with the upper surface and lower surface of the body 104. When viewed in the upward/downward direction, each of the tongue portions 31 protrudes as an elongate strip plate from the body 104 and has a semicircular tip portion. These six tongue portions 31 are arranged at regular intervals along the circumference A3 of the body 104 to divide the outer peripheral portion 101 of the board 10 into six approximately evenly. Each of the heat detecting elements 11 is mounted on the lower surface of an associated one of the tongue portions 31 to be located around the tip portion thereof. Each of the tongue portions 31 has a through hole 310 having a rectangular opening inside of its associated heat detecting element 11. Providing the through hole 310 beside each heat detecting element 11 may reduce the area of the board 10 around the heat detecting element 11. This may reduce the chances of the heat of the heat detecting element 11 being transmitted through the board 10 to cause some heat loss or the heat generated by other circuit components mounted on the body 104 affecting the heat detecting element 11. That is to say, the through hole 310 improves the thermal insulation properties. The opening area of the through hole 310 is preferably larger than the surface area of the heat detecting element 11 (e.g., the surface area thereof when viewed from over the board 10).

(2.4) Heat detector and smoke detector

[0037] As described above, the heat detector 3 includes the six heat detecting elements 11 which are mounted on the lower surface 103 of the board 10. Note that the six heat detecting elements 11 are shown as a single block in FIG. 5. The number of the heat detecting elements 11 provided is not limited to any particular number but may also be one. Nevertheless, at least two heat detecting elements 11 are suitably provided. In addition, each heat detecting element 11 detects the heat of the hot air that has flowed in through the opening 14 and is surface-mounted on the board 10. In the first embodiment, the heat detecting elements 11 may be implemented as, for example, chip thermistors. Also, in the first embodiment, when viewed along the radius of the lower cover 120, each heat detecting element 11 is provided between two adjacent openings 14 out of the plurality of openings 14.

[0038] The heat detector 3 is electrically connected, via patterned wiring formed on the board 10 and other members, to the controller 5. Each heat detecting element 11 outputs an electrical signal (detection signal) to the controller 5. In other words, the controller 5 monitors, based on the electrical signals provided by the respective heat detecting elements 11, the resistance values, which may vary as the temperature increases, of the respective heat detecting elements 11.

[0039] Optionally, the heat detectors 3 may include not only the heat detecting elements 11 but also an amplifier circuit for amplifying the electrical signals provided by the heat detecting elements 11, a converter circuit for performing analog-to-digital conversion on the electrical signals, and other circuits as well. Alternatively, the amplification and analog-to-digital conversion of the electrical signals provided by the heat detecting elements 11 may be performed by the circuit modules.

[0040] The smoke detector 4 is provided in a central area of the internal space SP1 of the housing 12 and configured to detect smoke. Specifically, the smoke detector 4 is disposed on the upper surface of the body 104 of the board 10 and has an upper portion thereof housed in the housing recess 122 of the upper cover 121. The smoke detector 4 may be a photoelectric sensor for detecting smoke, for example, and may be a scattering light type sensor, in particular.

[0041] As shown in FIG. 5, the smoke detector 4 includes an optical element 401 for emitting light, a photosensitive element 402 for receiving the light emitted from the optical element 401, and a labyrinth structure 403. The optical element 401 may be a light-emitting diode (LED), for example. The photosensitive element 402 may be a photodiode, for example. The labyrinth structure 403 is formed inside a housing having a compressed, generally circular cylindrical shell.

[0042] The optical element 401 and the photosensitive element 402 are arranged inside the labyrinth structure 403 to avoid facing each other. In other words, the optical element 401 and the photosensitive element 402 are arranged such that the photosensitive plane of the photosensitive element 402 is off the optical axis of the light emitted from the optical element 401.

[0043] At the outbreak of a fire, for example, smoke involved with the fire may enter the housing 12 through the openings 14 of the housing 12 and be introduced into the labyrinth structure 403 through an inlet port. If no smoke is present in the labyrinth structure 403, the light emitted from the optical element 401 hardly reaches the photosensitive plane of the photosensitive element 402. On the other hand, if there is any smoke in the labyrinth structure 403, then the light emitted from the optical element 401 is scattered by the smoke and part of the scattered light eventually impinges on the photosensitive plane of the photosensitive element 402. That is to say, the smoke detector 4 makes the photosensitive element 402 receive the light that been emitted from the optical element 401 and scattered by the smoke.

[0044] The photosensitive element 402 of the smoke detector 4 is electrically connected to the controller 5. The smoke detector 4 transmits an electrical signal (detection signal), having a voltage level representing the quantity of light received at the photosensitive element 402, to the controller 5. In response, the controller 5 converts the quantity of the light, represented by the detection signal provided by the smoke detector 4, into a smoke concentration, thereby determining whether or not a fire is actually present. Optionally, the controller 5 may use the quantity of the light as it is to make a decision based on a threshold value. Alternatively, the smoke detector 4 may convert the quantity of light received at the photosensitive element 402 into a smoke concentration and then transmit a detection signal, having a voltage level representing the smoke concentration, to the controller 5.

[0045] The smoke detector 4 may further include an amplifier circuit for amplifying the electrical signal provided by the photosensitive element 402, a converter circuit for performing an analog-to-digital conversion on the electrical signal, and other circuits. Alternatively, the amplification and analog-to-digital conversion of the electrical signal provided by the photosensitive element 402 may be performed by the circuit modules. Also, the number of the optical element 401 for use to detect smoke does not have to be one but may also be plural.

(2.5) Indicator

[0046] The indicator 6 is an indicator lamp notifying an external device of the operating status of the sensor 1. In a normal mode (i.e., in a fire monitoring mode), a lighting circuit of the circuit module turns the light source OFF under the control of the controller 5. On the other hand, when a decision is made that a fire should be present, the lighting circuit of the circuit module starts flickering or lighting the light source under the control of the controller 5. In FIG. 5, illustration of the lighting circuit between the controller 5 and the indicator 6 is omitted.

(2.6) Controller

[0047] The controller 5 may be implemented as a computer system including one or more processors (microprocessors) and one or more memories. In other words, the functions of the controller 5 are performed by making the one or more processors execute a program (application) stored in the one or more memories. In this embodiment, the program is stored in advance in the memory of the controller 5. Alternatively, the program may also be downloaded via a telecommunications line such as the Internet or distributed after having been stored in a non-transitory storage medium such as a memory card.

[0048] The controller 5 is configured to control the communications interface 9 and circuit modules (including the lighting circuit and the power supply circuit).

[0049] In addition, the controller 5 is also configured to receive detection signals from the heat detector 3 and the smoke detector 4 to determine whether or not a fire is actually present. Specifically, the controller 5 monitors the respective detection signals provided by the six heat detecting elements 11 of the heat detector 3 on an individual basis, and decides, on finding at least one heat detecting element 11, of which the signal level (corresponding to a resistance value) included in the detection signal is greater than (or less than) the threshold value, that a fire should be present. In addition, the controller 5 also monitors the detection signal provided by the smoke detector 4 and decides, on finding the signal level included in the detection signal greater than (or less than) a threshold value (indicating that the smoke has reached the smoke detector 4), that a fire should be present.

[0050] On deciding, based on either the signal level of the heat detection or the signal level of the smoke detection, that a fire should be present, the controller 5 makes the communications interface 9 transmit a signal alerting a person to the presence of the fire to a receiver, fire alarm devices, and other devices of an automatic fire alarm system. The communications interface 9 may be implemented as a communications interface for communicating, via cables, for example, with the receiver, the fire alarm devices, and other devices. The communications interface 9 is connected to communicate with the receiver, the fire alarm devices, and other devices via the connection pieces of the mounting member, the connector portion of the attachment base, and the signal cables provided on the backside of the ceiling. In addition, on deciding that a fire should be present, the controller 5 outputs a control signal for flickering or lighting the light source of the indicator (indicator lamp) to the lighting circuit of the circuit module.

(2.7) Flow channel forming member

[0051] The flow channel forming member 7 according to the first embodiment is made of a synthetic resin and may be made of flame-retardant ABS resin, for example. The flow channel forming member 7 has a compressed, generally circular cylindrical shell, of which the upper surface is opened. Specifically, the flow channel forming member 7 includes a ringlike body 70 and a single or a plurality of (e.g., four in this example) terminal stages 22 as shown in FIG. 3. The body 70 has an inner wall 71 and an outer wall 76 surrounding the inner wall 71. The outer wall 76 is provided with a plurality of (e.g., four in this example) outwardly extended portions 73. Each of the extended portions 73 has, at the tip thereof, a downwardly protruding hook 74. The outer wall 76 has a sloped surface 72 as its outer peripheral surface. The sloped surface 72 is sloped up toward the center of the outer wall 76 as the distance to the top of the outer wall 76 decreases. In this example, part of each extended portion 73 is configured to serve as the terminal stage 22. The flow channel forming member 7 has a hole 75 penetrating through a central area thereof in the upward/downward direction. Having each hook 74 hooked on an associated protruding piece 33 of the board 10 allows the flow channel forming member 7 to be fixed onto the board 10. In addition, the outer wall 76 also has the plurality of insert holes 77 mentioned above, into which the connection pieces 123 of the upper cover 121 are inserted.

[0052] Each terminal stage 22 is a structural element having a terminal to be electrically connected to the board 10 and used to secure the board 10 with a screw. The terminals are electrically connected to the conductor pattern on the board 10. The sensor 1 is powered by a commercial power supply from over the installation surface 100 (e.g., the ceiling surface in the first embodiment) and receives or transmits various types of communication signals via the terminals, the connection pieces 123, the attachment base, and other members.

[0053] The smoke detector 4 is installed on the board 10. The inner wall 71 is arranged to surround the smoke detector 4 with a gap left with respect to the smoke detector 4.

[0054] The sloped surface 72 is sloped up, when the smoke detector 4 is viewed in one direction through one of the openings 14, such that its height increases in the vertical direction A1 as the distance to the smoke detector 4 decreases in that direction. The sloped surface 72 forms the outer peripheral surface of the outer wall 76 and the height of the sloped surface 72 corresponds to the height of the outer wall 76. Thus, the flow channel 13 is formed so as to cause the gas (hot air) that has flowed into the internal space SP1 of the housing 12 through one of the openings 14 to flow along the sloped surface 72 and go up toward the top of the smoke detector 4. Specifically, the internal space SP1 is surrounded with the upper cover 121, the flow channel forming member 7, and the smoke detector 4.

(2.8) Heat collector

[0055] Each heat collector 16 is configured to collect the hot air toward its associated heat detecting element 11. The same number of (e.g., six in the first embodiment) heat collectors 16 as that of the heat detecting elements 11 are installed. In other words, the sensor 1 includes six heat collectors 16. In the first embodiment, the respective heat collectors 16 are arranged on, and formed integrally with, the bottom member 18 of the lower cover 120. Specifically, the six heat collectors 16 are provided outside of the cylindrical portion 180 (see FIG. 2A). Each of the heat collectors 16 may be made of, for example, flame-retardant ABS resin.

[0056] In the first embodiment, each heat collector 16 is provided under its associated heat detecting element 11. As shown in FIG. 7A, the heat detecting elements 11 and the heat collectors 16 are arranged to overlap with each other when viewed along the thickness of the board 10. Each heat collector 16 is formed to protrude upward in the vertical direction A1 from the bottom member 18. The respective heat collectors 16 are provided between the board 10 and the bottom member 18 that faces the board 10. FIG. 2A is a cross-sectional view taken along a plane that passes through not only the center of the sensor 1 shown in FIG. 1 as viewed from under the sensor 1 but also two heat detecting elements 11 that face each other diagonally. FIG. 2B is a front view of a principal portion of the sensor 1 shown in FIG. 2A as viewed in the direction indicated by the arrow Y in FIG. 2A. In FIG. 2B, the heat detecting elements 11 is provided to horizontally face a beam 25 that prevents a human from putting his or her on the heat detecting element 11. Specifically, the heat detecting element 11 is provided to horizontally face the beam 25 that is located between two adjacent openings 14 out of the plurality of openings 14. Furthermore, the heat collector 16 is provided under the heat detecting element 11.

[0057] Each heat collector 16 has a circumferentially sloped surface 19 sloped up, along the circumference A3 of the housing 12, toward the heat detecting element 11 so as to increase its height in the vertical direction A1 as the distance to the heat detecting element 11 decreases as shown in FIGS. 1, 2A, 2B, and 6. In addition, the heat collectors 16 and the heat detecting elements 11 overlap with each other along the thickness of the board 10. Thus, in the first embodiment, the heat collectors 16 provided are as many as the heat detecting elements 11 provided. In the first embodiment, when projected onto the board 10 in the vertical direction A1 (i.e., when viewed along the thickness of the board 10), each heat collector 16 has a substantially trapezoidal shape as shown in FIG. 7A. Also, in the first embodiment, each heat collector 16 has a substantially triangular shape when its associated openings 14 are viewed straight from the external space SP2 as shown in FIGS. 2B and the 6. This makes it easier, when hot air has come from both sides of each heat collector 16 along the circumference A3 to the heat collector 16, for example, for the hot air to go up the two circumferentially sloped surfaces 19 of the heat collector 16 and eventually reach the heat detecting element 11. Thus, providing the heat collector 16 enables collecting heat toward the heat detecting element 11 more easily than in a situation where no heat collectors 16 are provided. This enables collecting heat at the outbreak of fire, thus contributing to improving the thermal response. In addition, even when a heating test is conducted using the heating tester 2, for example, enabling collecting heat in this manner contributes to improving the thermal response as well.

(3) Operation

[0058] Next, it will be described how the sensor 1 according to the first embodiment performs the operation of detecting hot air while a heating test is conducted using the heating tester 2.

[0059] FIG. 7A illustrates how the heating tester 2 is attached to cover the sensor 1. The heating tester 2 is attached to the sensor 1 such that the heat source H10 of the heating tester 2 falls just between two adjacent heat detecting elements 11. In this example, the heat source H10 and each of the two adjacent heat detecting elements 11 are supposed to be shifted from each other by approximately 30 degrees. This example will be described on the supposition that the heat source H10 and the heat detecting elements 11 are arranged at worst positions, i.e., at such positions where the heat is detectible least smoothly. However, this is only an example and the heat source H10 and the heat detecting elements 11 may naturally be arranged at other positions.

[0060] If the heat source H10 and each of the two adjacent heat detecting elements 11 are shifted from each other by approximately 30 degrees, then the hot air H30 coming from the heat source H10 collides against the beam 25, the board 10, and other members and thereby separated into hot air H30L flowing to the left as viewed from the beam 25 and hot air H30R flowing to the right as viewed from the beam 25.

[0061] When reaching another beam 25, each of the hot air H30R, H30L flows toward the nearest heat detecting element 11. When reaching the region surrounding the tongue portion 31, each of the hot air H30R, H30L collides against the heat collector 16 and goes up the circumferentially sloped surface 19 of the heat collector 16. Without the heat collector 16, the hot air would pass over or under the board 10. In that case, the heat of the hot air would not be collected easily, and it would take a long time to collect the heat. On the other hand, the sensor 1 according to the first embodiment may catch the hot air and collect its heat due to the presence of the heat collectors 16. FIG. 7B illustrates the distribution of the hot air. FIG. 7B is a cross-sectional view taken along the plane X-X shown in FIG. 7A and passing through one of the heat detecting elements 11 shown in FIG. 7A. The heat detecting element 11 is provided at the tip of the tongue portion 31 and the hot air H20 is collected by the heat collector 16 to wrap the tongue portion 31 having the heat detecting element 11, thereby causing an increase in the heat collecting rate. Thus, a sensor 1 contributing to improving the thermal response may be provided. In addition, the sensor 1 may also contribute to improving the thermal response even when a heating test is conducted using the heating tester 2 with a localized heat source H10.

(4) Advantages

[0062] As can be seen from the foregoing description, a sensor 1 according to the first embodiment includes: a board 10; a heat detecting element 11 mounted on the board 10 to detect heat; a housing 12 that houses the board 10; and a heat collector 16. The housing 12 has a flow channel 13 and an opening 14. The flow channel 13 is provided in an internal space SP1 of the housing 12 and allows hot air to flow therethrough. The opening 14 allows the flow channel 13 to communicate with an external space SP2 outside of the housing 12. The heat detecting element 11 is disposed to fall inside the opening 14 when the opening 14 is viewed straight from the external space SP2. The heat collector 16 is configured to collect the hot air toward the heat detecting element 11.

[0063] According to this configuration, the sensor 1 achieves the advantage of contributing to improving the thermal response. In particular, the improvement of the thermal response allows even the heating tester 2, of which the heat source H10 is a localized one, to achieve the advantage of having the heating test done in a shorter time.

(5) Variations

[0064] Note that the embodiment described above is only an exemplary one of various embodiments of the present disclosure and should not be construed as limiting. Rather, the exemplary embodiment may be readily modified in various manners depending on a design choice or any other factor without departing from the scope of the present disclosure.

[0065] Next, variations of the exemplary embodiment described above will be enumerated one after another. Note that the variations to be described below may be adopted in combination as appropriate. Also, in the following description, the embodiment described above will be hereinafter sometimes referred to as a "basic example."

(5.1) First variation

[0066] In the basic example described above, the sensor 1 includes the gas flow control walls 8. However, the gas flow control walls 8 are not essential constituent elements for the sensor 1 according to the present disclosure but may be omitted as appropriate.

(5.2) Second variation

[0067] In the basic example described above, the number of the gas flow control walls 8 provided is three. However, this is only an example and should not be construed as limiting. Alternatively, the number of the gas flow control walls 8 provided may also be two or even four or more.

(5.3) Third variation

[0068] In the basic example described above, the board 10 on which the smoke detector 4 is mounted is a circuit board on which the controller 5 and other circuit components are also mounted. However, this is only an example and should not be construed as limiting. Alternatively, the board 10 may also be provided separately from the circuit board on which the controller 5 and other circuit components are mounted. Nevertheless, the basic example contributes more effectively to cutting down the number of members required.

(5.4) Fourth variation

[0069] In the basic example described above, the heat collectors 16 each have a triangular shape in front view. However, this is only an example and should not be construed as limiting. Alternatively, the heat collectors 16A may also each have a trapezoidal shape in front view as shown in FIG. 8. The heat collector 16A having such a trapezoidal shape has two circumferentially sloped surfaces 19A and a trapezoidal upper surface 19B as a plane surface. The heat collector 16A with such a shape also allows the hot air coming from around the heat collector 16A to go up the circumferentially sloped surfaces 19A and reach its associated heat detecting element 11. Thus, the heat collector 16A contributes to improving the thermal response as effectively as the heat collector 16 with the triangular shape.

(5.5) Fifth variation

[0070] Each of the heat collectors 16 of the basic example may also be modified to have a radially sloped surface. As shown in FIG. 9, such a heat collector 16C may have a radially sloped surface 20 sloped up, along the radius A2 of the housing 12, toward the heat detecting element 11 so as to increase its height in the vertical direction A1 as the distance to the heat detecting element 11 decreases. In this case, the radius A2 is supposed to be directed from the center of the sensor 1 as viewed from under the sensor 1 toward the outer peripheral edge thereof. Providing such a radially sloped surface 20 makes it even easier for the hot air to go up the heat collector 16C. Thus, the heat collector 16C contributes to improving the thermal response as effectively as the heat collector 16 with the triangular shape.

(5.6) Sixth variation

[0071] In the basic example described above, each heat collector 16 is configured in a triangular shape in front view. However, this configuration is only an example and should not be construed as limiting. Alternatively, the heat collector 16 having the triangular shape in front view may be extended horizontally along the radius A2 of the sensor 1 through the outer peripheral edge 21 of the bottom member 18 of the lower cover 120 as shown in FIG. 10. In that case, the heat collector 16D is provided between the board 10 and the bottom member 18 that forms the bottom of the opening

14 and facing the board 10. When viewed along the thickness of the board 10, the outer peripheral edge 21 of the bottom member 18 and the outer edge of the heat collector 16D are aligned with each other. The heat collector 16D not only produces the heat collecting effect but also serves as a finger guard for preventing a human from putting his or her finger on the heat detecting element 11 through the opening 14. This allows a member that plays the role of the finger guard in a known structure to be omitted.

(5.7) Seventh variation

[0072] The sensor 1 of the basic example may be modified to further include guide portions 17A, each of which guides the hot air flowing in through one of the openings 14 toward its associated heat detecting element 11. As shown in FIG. 11, each guide portion 17A is formed on an associated terminal stage 22 (see FIG. 3) and is sloped from one of the openings 14 toward its associated heat detecting element 11. Specifically, each guide portion 17A is provided on an associated extended portion 73 (see FIG. 3), a part of which serves as the terminal stage 22. As in the first embodiment, each heat detecting element 11 is mounted on the lower surface of an associated tongue portion 31 and provided around a tip of the tongue portion 31. Each guide portion 17A is configured as a terminal stage 22A serving as not only a beam 25 but also a terminal stage 22 as well. As shown in FIG. 11, the terminal stage 22A serving as not only a beam 25 but also a terminal stage 22 has a sloped surface connecting the beam 25 to the terminal stage 22 in top view. In front view, the sloped surface is sloped toward the heat detecting element 11. Thus, the terminal stage 22A (guide portion 17A) guides the hot air toward the heat detecting element 11. The terminal stage 22A is arranged not to overlap with any tongue portion 31 of the board 10. Thus, making the terminal stage 22A also serve as the guide portion 17A allows cutting down the material to use.

(5.8) Eighth variation

[0073] As shown in FIG. 12, the sensor 1 of the basic example may be modified to further include guide portions 17B, each of which guides the hot air flowing in through one of the openings 14 toward its associated heat detecting element 11. As in the first embodiment, each heat detecting element 11 is mounted on the lower surface of an associated tongue portion 31 and provided around a tip of the tongue portion 31. For example, the guide portions 17B are formed on the beams 25 (25A, 25B) as shown in FIG. 12. A beam 25A (guide portion 17B), arranged to face one of the heat detecting elements 11 of the board 10, may have the shape of an equilateral triangle, for example, one vertex of which is provided to face the heat detecting element 11. On the other hand, another beam 25B (guide portion 17B), arranged not to face any heat detecting element 11, is provided between two adjacent heat detecting elements 11 and has a trapezoidal shape. The beam 25B with the trapezoidal cross section is provided to be convex toward the external space SP2. Using these two types of beams 25A, 25B in combination makes it even easier for the hot air flowing in through any of the openings 14 to be separated to the right and to the left by the beams 25B and to be directed toward the heat detecting element 11 by the beams 25A. This contributes to improving the thermal response of the sensor 1. In this variation, the beams 25A, 25B are supposed to be used in combination. Alternatively, either the beams 25A or the beams 25B may be used selectively.

(5.9) Ninth variation

[0074] As shown in FIG. 13, the sensor 1 of the basic example may be modified to further include guide portions 17C, each of which guides the hot air flowing in through one of the openings 14 toward its associated heat detecting element 11. As in the first embodiment, each heat detecting element 11 is mounted on the lower surface of an associated tongue portion 31 and provided around a tip of the tongue portion 31. As shown in FIG. 13, the sensor 1 includes guide portions 17C. Each of the guide portions 17C has the shape of blades 26. Each guide portion 17C is provided for an associated beam 25 and has the blades 26, each of which is sloped from one of the openings 14 toward an associated heat detecting element 11. The guide portions 17C and the beams 25 are formed integrally with the bottom member 18A of the lower cover 120 (see FIG. 3). In other words, the blades 260 of the guide portions 17C and the beams 25 form integral parts of the bottom member 18A. Each of the multiple pairs (e.g., six pairs in the example illustrated in FIG. 13) of blades 26 (guide portions 17C) is spaced from adjacent pairs of blades 26. These pairs of blades 26 are arranged such that a virtual line connecting together two adjacent blades 26 passes by the heat detecting element 11 located between the two adjacent blades 26. In that case, the hot air coming from the heat source H10 of the heating tester 2, for example, will be guided to the heat detecting element 11. Therefore, these guide portions 17C are configured to more smoothly guide the hot air toward the heat detecting elements 11, thus contributing to improving the thermal response.

(5.10) Tenth variation

[0075] As shown in FIG. 14, the sensor 1 of the basic example may be modified to further include guide portions 17D, each of which guides the hot air flowing in through one of the openings 14 toward its associated heat detecting element 11. As in the first embodiment, each heat detecting element 11 is mounted on the lower surface of an associated tongue portion 31 and provided around a tip of the tongue portion 31. The sensor 1 according to this tenth variation includes the upper member 24 (see FIG. 1) and a plurality of (e.g., six in the example illustrated in FIG. 14) beams 25. Each of the guide portions 17D is provided between a pair of beams 25. The bottom member 18B is provided with wall surfaces 28 (guide portions 17D), each of which couples together two adjacent beams 25 out of the plurality of beams 25 and has either a curved shape or a linear shape. In this variation, the wall surfaces 28 are formed on the bottom member 18B. Each wall surface 28 that couples together two adjacent beams 25 and that has either a curved shape or a linear shape is formed to pass by an associated heat detecting element 11. In that case, the hot air coming from the heat source H10 of the heating tester 2, for example, will be guided along the wall surface 28 to the heat detecting element 11. Therefore, these guide portions 17D are configured to more smoothly guide the hot air toward the heat detecting elements 11, thus contributing to improving the thermal response.

(5.11) Eleventh variation

[0076] In the basic example described above, the heat detecting elements 11 and the heat collectors 16 are arranged to overlap with each other when viewed along the thickness of the board 10. However, this configuration is only an example and should not be construed as limiting. Alternatively, the heat detecting elements 11 and triangular heat collectors 16 may also be arranged such that no vertices of each heat collector 16 overlap with any heat detecting element 11 (i.e., the vertices of each heat collector 16 shift from the heat detecting elements 11) when viewed along the thickness of the board 10. In addition, a gap is left between each heat detecting element 11 and its associated heat collector 16 as shown in FIG. 2B. To enable the hot air to pass smoothly, each heat detecting element 11 and its associated heat collector 16 preferably have a gap left between themselves. For example, even if any vertex of a heat collector 16 is located above its associated heat detecting element 11 in the vertical direction A1 but if the vertex of the heat collector 16 and the heat detecting element 11 are shifted from each other, then a gap may still be left between the heat collector 16 and the heat detecting element 11.

(Second embodiment)

[0077] In a second embodiment, the heat detecting elements 11 are implemented as lead thermistors 30 (heat detecting elements 11) instead of chip thermistors, which is a major difference from the first embodiment. The following description of the second embodiment with reference to FIGS. 15-17 will be focused on the differences from the first embodiment. In the following description, any constituent element of this second embodiment, having the same function as a counterpart of the first embodiment described above, will be designated by the same reference numeral as that counterpart's, and description thereof will be omitted as appropriate herein. The drawings to be referred to in the following description of the second embodiment are all schematic representations. That is to say, the ratio of the dimensions (including thicknesses) of respective constituent elements illustrated on the drawings does not always reflect their actual dimensional ratio.

[0078] A sensor 1A according to the second embodiment includes: a board 10A; a heat detecting element 11 mounted on the board 10A to detect heat; a housing 12 that houses the board 10A; and a heat collector 16. The housing 12 has a flow channel 13 provided in an internal space SP1 of the housing 12 and allowing air to flow therethrough and an opening 14 allowing the flow channel 13 to communicate with an external space SP2 outside of the housing 12. The heat detecting element 11 is disposed to fall inside an opening area 15 of the opening 14 when the opening area 15 of the opening 14 is viewed straight from the external space SP2. The heat collector 16 is configured to collect hot air toward the heat detecting element 11.

[0079] The heat detecting elements 11 for use in the second embodiment are lead thermistors 30. In the second embodiment, the lead thermistors 30 are negative thermal coefficient thermistors. That is to say, the lead thermistors 30 are heat detecting elements 11, of which the resistance value decreases as the temperature increases.

[0080] The lead thermistors 30 are connected to the board 10A as shown in FIGS. 15-17. The lead thermistors 30 are provided to protrude downward in the vertical direction A1 from the lower surface of the board 10A. On the lower surface of the board 10A, a single or a plurality of (e.g., four in the second embodiment) lead thermistors 30 are provided. The lead thermistors 30 are arranged at regular intervals (i.e., approximately every 90 degrees). The board 10A is not provided with any tongue portions 31 described for the first embodiment but has a substantially disklike shape.

[0081] The heat collectors 16 are provided between the lead thermistors 30 and the bottom member 18 of the lower cover 120. A gap is left between the heat collectors 16 and the lead thermistors 30. In this embodiment, the heat collectors

16 may have, for example, a triangular shape as shown in FIG. 6.

(Operation)

[0082] Next, it will be described how the sensor 1A according to the second embodiment performs the operation of detecting hot air while a heating test is conducted using the heating tester 2.

[0083] The heating tester 2 is attached to the sensor 1A and hot air coming from the heat source H10 of the heating tester 2 is allowed to flow into the internal space SP1 of the sensor 1A through one of the openings 14 of the sensor 1A. When flowing into the internal space SP1 of the sensor 1A through one of the openings 14, the hot air is obstructed by the rectangular parallelepiped beams 25, which connect the bottom member 18 of the lower cover 120 to the upper member 24 thereof, and the board 10A, for example. Thus, the hot air that has collided against the beams 25, the board 10A, and other members is separated to the right and to the left. Then, the hot air separated to the right and to the left enters the internal space SP1 of the sensor 1A to reach the heat collectors 16 provided on the bottom member 18. The hot air that has reached the heat collector 16 goes up the circumferentially sloped surfaces 19 of the heat collectors 16. Then, the hot air reaches the lead thermistors 30 which are provided over the heat collectors 16 with a gap left between themselves in the vertical direction A1. Without the heat collectors 16, the hot air would pass through the gap between the board 10A and the bottom member 18 and leave the internal space SP1 through an outlet port H40 of the heating tester 2. In contrast, providing the heat collectors 16 makes it easier to collect the hot air around the lead thermistors 30. Consequently, the sensor 1A contributes to improving the thermal response.

(Variations)

[0084] Next, variations will be enumerated one after another. Note that the variations to be described below may be adopted as appropriate in combination with the second embodiment described above.

[0085] In the second embodiment described above, the lead thermistors 30 are supposed to be negative thermal coefficient thermistors. However, this configuration is only an example and should not be construed as limiting. Alternatively, positive thermal coefficient thermistors may also be used.

[0086] In the second embodiment described above, the sensor 1A includes rectangular parallelepiped beams 25. However, this configuration is only an example and should not be construed as limiting. Alternatively, the beams 25 may also include guide portions 17B (see FIG. 12) with beams 25A formed in a triangular pyramid shape or beams 25B formed in a truncated pyramid shape. Providing the guide portions 17B makes it easier for the hot air to flow toward the heat collectors 16, thus contributing to improving the thermal response.

[0087] In the second embodiment described above, the sensor 1A includes rectangular parallelepiped beams 25. However, this configuration is only an example and should not be construed as limiting. Alternatively, the sensor 1A may also include terminal stages 22A as the guide portions 17A and the beams 25 may also be used as the terminal stages 22 (see FIG. 3). This also makes it easier for the hot air to flow toward the heat collectors 16, thus contributing to improving the thermal response.

[0088] In the second embodiment described above, the sensor 1A includes heat collectors 16 having a triangular shape in front view (see FIG. 6). However, this configuration is only an example and should not be construed as limiting. Alternatively, the sensor 1A may include heat collectors 16A having a trapezoidal shape in front view. Still alternatively, heat collectors 16C may also be used as shown in FIG. 9. Each of the heat collectors 16C has a radially sloped surface 20 sloped up, along the radius A2 of the housing 12, toward the heat detecting element 11 so as to increase its height in the vertical direction A1 as the distance to the heat detecting element 11 decreases. In this case, the radius A2 is supposed to be directed from the center of the sensor 1 as viewed from under the sensor 1 toward the outer peripheral edge thereof.

(Recapitulation)

[0089] As can be seen from the foregoing description, a sensor (1, 1A) according to a first aspect includes a board (10, 10A), a heat detecting element (11), a housing (12), and a heat collector (16, 16A, 16C, 16D). The heat detecting element (11) is mounted on the board (10, 10A) and detects heat. The housing (12) houses the board (10, 10A). The housing (12) has a flow channel (13) and an opening (14). The flow channel (13) is provided in an internal space (SP1) of the housing (12) and allows air to flow therethrough. The opening (14) allows the flow channel (13) to communicate with an external space (SP2) outside of the housing (12). The heat collector (16, 16A, 16C, 16D) is configured to collect hot air toward the heat detecting element (11).

[0090] This configuration contributes to improving the thermal response of the sensor (1, 1A).

[0091] In a sensor (1, 1A) according to a second aspect, which may be implemented in conjunction with the first aspect, the heat detecting element (11) is disposed under the board (10, 10A).

[0092] This configuration contributes to improving the thermal response of the sensor (1, 1A) by using the heat detecting element (11) in combination with the heat collector (16, 16A, 16C, 16D).

[0093] In a sensor (1, 1A) according to a third aspect, which may be implemented in conjunction with the first or second aspect, the heat detecting element (11) and the heat collector (16, 16A, 16C, 16D) are arranged to overlap with each other when view along a thickness of the board (10, 10A).

[0094] This configuration allows the heat detecting element (11) to efficiently detect the hot air collected by the heat collector (16, 16A, 16C, 16D), thus contributing to improving the thermal response of the sensor (1, 1A).

[0095] A sensor (1, 1A) according to a fourth aspect, which may be implemented in conjunction with any one of the first to third aspects, further includes a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A). The heat collector (16, 16A, 16C, 16D) is provided between the board (10, 10A) and the bottom member (18, 18A, 18B) and has a circumferentially sloped surface (19) sloped up, along a circumference (A3) of the housing (12), toward the heat detecting element (11) so as to increase its height in a vertical direction (A1) as a distance to the heat detecting element (11) decreases.

[0096] This configuration causes the hot air to go up the circumferentially sloped surface (19), thus making it easier for the heat detecting element (11) to detect the hot air and eventually contributing to improving the thermal response of the sensor (1, 1A).

[0097] In a sensor (1, 1A) according to a fifth aspect, which may be implemented in conjunction with the fourth aspect, the heat collector (16, 16A, 16C, 16D) has either a trapezoidal shape or a triangular shape when the opening (14) is viewed straight from the external space (SP2).

[0098] According to this configuration, the heat collector (16, 16A, 16C, 16D) uses a slope with a trapezoidal or triangular shape as the circumferentially sloped surface (19), thus making it easier for the heat detecting element (11) to detect the hot air and eventually contributing to improving the thermal response of the sensor (1, 1A).

[0099] In a sensor (1, 1A) according to a sixth aspect, which may be implemented in conjunction with any one of the first to fifth aspects, the heat collector (16, 16A, 16C, 16D) is provided between the board (10, 10A) and a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A) and has a radially sloped surface (20) sloped up, along a radius (A2) of the housing (12), from the opening (14) toward the heat detecting element (11) so as to increase its height in a vertical direction (A1) as a distance to the heat detecting element (11) decreases.

[0100] This configuration causes the hot air to go up the radially sloped surface (20) of the heat collector (16, 16A, 16C, 16D), thus making it easier for the heat detecting element (11) to detect the hot air and eventually contributing to improving the thermal response of the sensor (1, 1A).

[0101] In a sensor (1, 1A) according to a seventh aspect, which may be implemented in conjunction with any one of the first to sixth aspects, the heat collector (16, 16A, 16C, 16D) is provided between the board (10, 10A) and a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A). When viewed along a thickness of the board (10, 10A), an outer peripheral edge (21) of the bottom member (18, 18A, 18B) and an outer edge of the heat collector (16, 16A, 16C, 16D) are aligned with each other.

[0102] This configuration allows the heat collector (16, 16A, 16C, 16D) to be also used as, for example, a finger guard preventing a human from putting his or her finger into the sensor (1, 1A), thus allowing the member provided as a finger guard to be omitted.

[0103] A sensor (1, 1A) according to an eighth aspect, which may be implemented in conjunction with any one of the first to seventh aspects, further includes a guide portion (17A, 17B, 17C, 17D) to guide the hot air flowing in through the opening (14) toward the heat detecting element (11).

[0104] According to this configuration, the guide portion (17A, 17B, 17C, 17D) controls the flow channel (13) of the air to direct the hot air toward the heat detecting element (11) and makes it easier for the heat detecting element (11) to detect the hot air, when used in combination with the heat collector (16, 16A, 16C, 16D), thus eventually contributing to improving the thermal response of the sensor (1, 1A).

[0105] In a sensor (1, 1A) according to a ninth aspect, which may be implemented in conjunction with the eighth aspect, the board (10, 10A) further includes a terminal to be electrically connected. The sensor (1, 1A) further includes a flow channel forming member (7). The flow channel forming member (7) includes a terminal stage (22) to hold a base of the terminal. The guide portion (17A) is formed on the terminal stage (22) and is sloped up from the opening (14) toward the heat detecting element (11).

[0106] This configuration allows the guide portion (17A) to integrate the terminal stage (22) and the beam (25) together, thus cutting down the material used for the beams (25).

[0107] A sensor (1, 1A) according to a tenth aspect, which may be implemented in conjunction with the eighth or ninth aspect, further includes: an upper member (24) covering the board (10, 10A) from over the board (10, 10A); and a beam (25) coupling the upper member (24) to a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A). The guide portion (17C) is formed on the beam (25). The guide portion (17C) has blades (26) sloped up from the opening (14) toward the heat detecting element (11).

[0108] This configuration makes it easier for the heat detecting element (11) to detect the hot air when used in combination with the heat collector (16, 16A, 16C, 16D), thus eventually contributing to improving the thermal response of the sensor (1, 1A).

[0109] In a sensor (1, 1A) according to an eleventh aspect, which may be implemented in conjunction with the tenth aspect, the sensor (1, 1A) includes the upper member (24) and a plurality of the beams (25). The guide portion (17D) is provided between the plurality of the beams (25). The bottom member (18B) has a wall surface (28) having a curved or linear shape and coupling together two adjacent beams (25) out of the plurality of the beams (25).

[0110] This configuration makes it easier for the heat detecting element (11) to detect the hot air, thus eventually contributing to improving the thermal response of the sensor (1, 1A).

Reference Signs List

[0111]

1, 1A	Sensor
10, 10A	Board
11	Heat Detecting Element
12	Housing
13	Flow Channel
14	Opening
16, 16A, 16C, 16D	Heat Collector
17A, 17B, 17C, 17D	Guide Portion
18, 18A, 18B	Bottom Member
19	Circumferentially Sloped Surface
20	Radially Sloped Surface
21	Outer Peripheral Edge (of Bottom Member)
22	Terminal Stage
24	Upper Member
25	Beam
26	Blade
28	Wall Surface
A1	Vertical Direction
A2	Radius
A3	Circumference
SP1	Internal Space
SP2	External Space

Claims

1. A sensor (1, 1A) comprising:

a board (10, 10A);
a heat detecting element (11) mounted on the board (10, 10A) and configured to detect heat;
a housing (12) that houses the board (10, 10A); and
a heat collector (16, 16A, 16C, 16D),
the housing (12) having: a flow channel (13) provided in an internal space (SP1) of the housing (12) and allowing air to flow therethrough; and an opening (14) allowing the flow channel (13) to communicate with an external space (SP2) outside of the housing (12),
the heat collector (16, 16A, 16C, 16D) being configured to collect hot air toward the heat detecting element (11).

2. The sensor (1, 1A) of claim 1, wherein
the heat detecting element (11) is disposed under the board (10, 10A).

3. The sensor (1, 1A) of claim 1 or 2, wherein
the heat detecting element (11) and the heat collector (16, 16A, 16C, 16D) are arranged to overlap with each other when view along a thickness of the board (10, 10A).

4. The sensor (1, 1A) of any one of claims 1 to 3, further comprising a bottom member (18, 18A, 18B) forming a bottom

of the opening (14) and facing the board (10, 10A), wherein
the heat collector (16) is provided between the board (10, 10A) and the bottom member (18, 18A, 18B) and has a circumferentially sloped surface (19) sloped up, along a circumference of the housing (12), toward the heat detecting element (11) so as to increase its height in a vertical direction (A1) as a distance to the heat detecting element (11) decreases.

5. The sensor (1, 1A) of claim 4, wherein
the heat collector (16, 16A, 16C, 16D) has either a trapezoidal shape or a triangular shape when the opening (14) is viewed straight from the external space (SP2).

6. The sensor (1, 1A) of any one of claims 1 to 5, wherein
the heat collector (16, 16A, 16C, 16D) is provided between the board (10, 10A) and a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A) and has a radially sloped surface (20) sloped up, along a radius (A2) of the housing (12), from the opening (14) toward the heat detecting element (11) so as to increase its height in a vertical direction (A1) as a distance to the heat detecting element (11) decreases.

7. The sensor (1, 1A) of any one of claims 1 to 6, wherein

the heat collector (16, 16A, 16C, 16D) is provided between the board (10, 10A) and a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A), and
when viewed along a thickness of the board (10, 10A), an outer peripheral edge (21) of the bottom member (18, 18A, 18B) and an outer edge of the heat collector (16, 16A, 16C, 16D) are aligned with each other.

8. The sensor (1, 1A) of any one of claims 1 to 7, further comprising a guide portion (17A, 17B, 17C, 17D) configured to guide the hot air flowing in through the opening (14) toward the heat detecting element (11).

9. The sensor (1, 1A) of claim 8, wherein

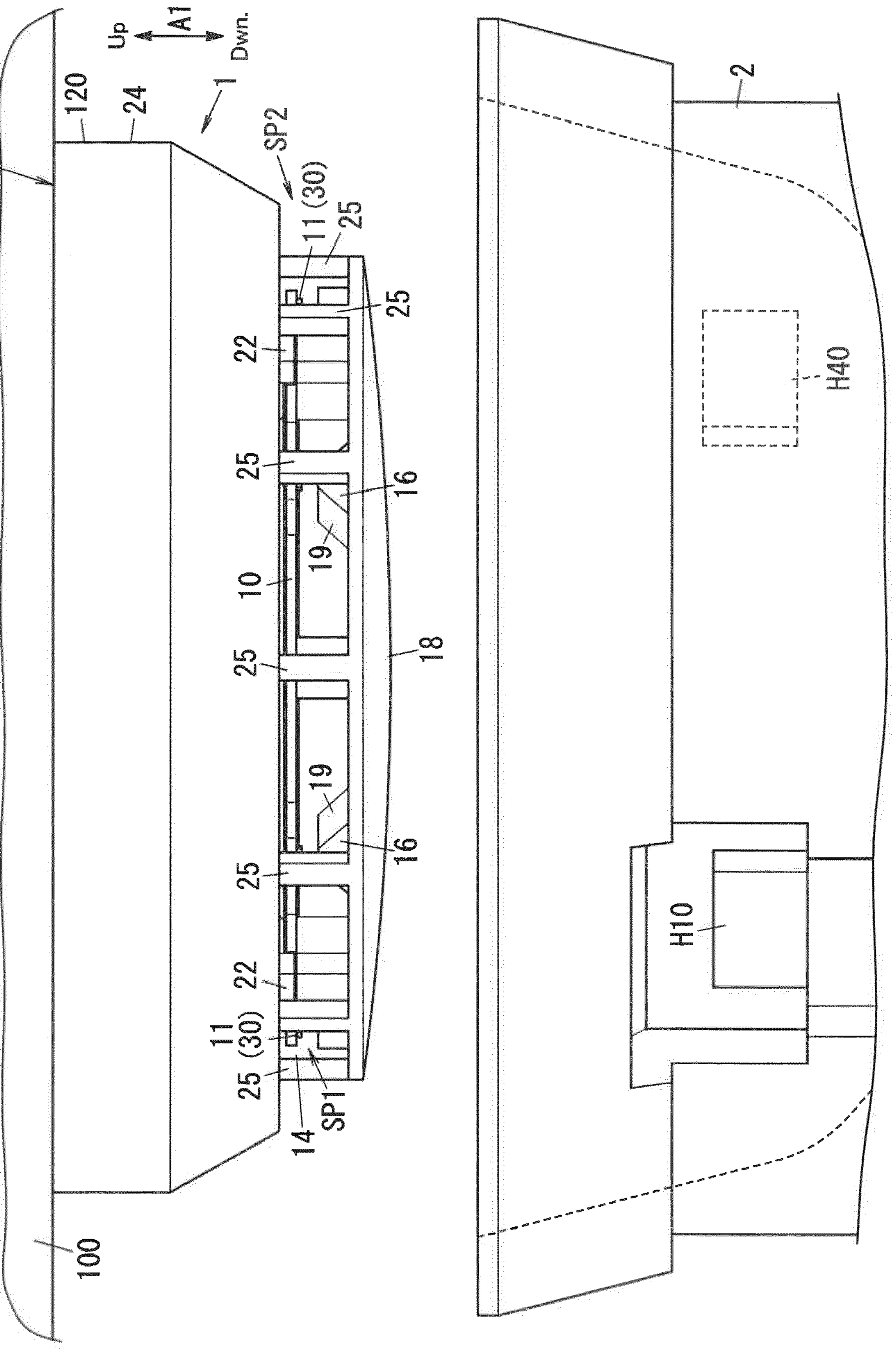
the board (10, 10A) further includes a terminal to be electrically connected,
the sensor (1, 1A) further includes a flow channel forming member (7), the flow channel forming member (7) including a terminal stage (22) to hold a base of the terminal, and
the guide portion (17A, 17B, 17C, 17D) is formed on the terminal stage (22) and is sloped up from the opening (14) toward the heat detecting element (11).

10. The sensor (1, 1A) of claim 8 or 9, further comprising:

an upper member (24) covering the board (10, 10A) from over the board (10, 10A); and
a beam (25) coupling the upper member (24) to a bottom member (18, 18A, 18B) forming a bottom of the opening (14) and facing the board (10, 10A), wherein
the guide portion (17A, 17B, 17C, 17D) is formed on the beam (25), and
the guide portion (17A, 17B,17C, 17D) has blades (26) sloped up from the opening (14) toward the heat detecting element (11).

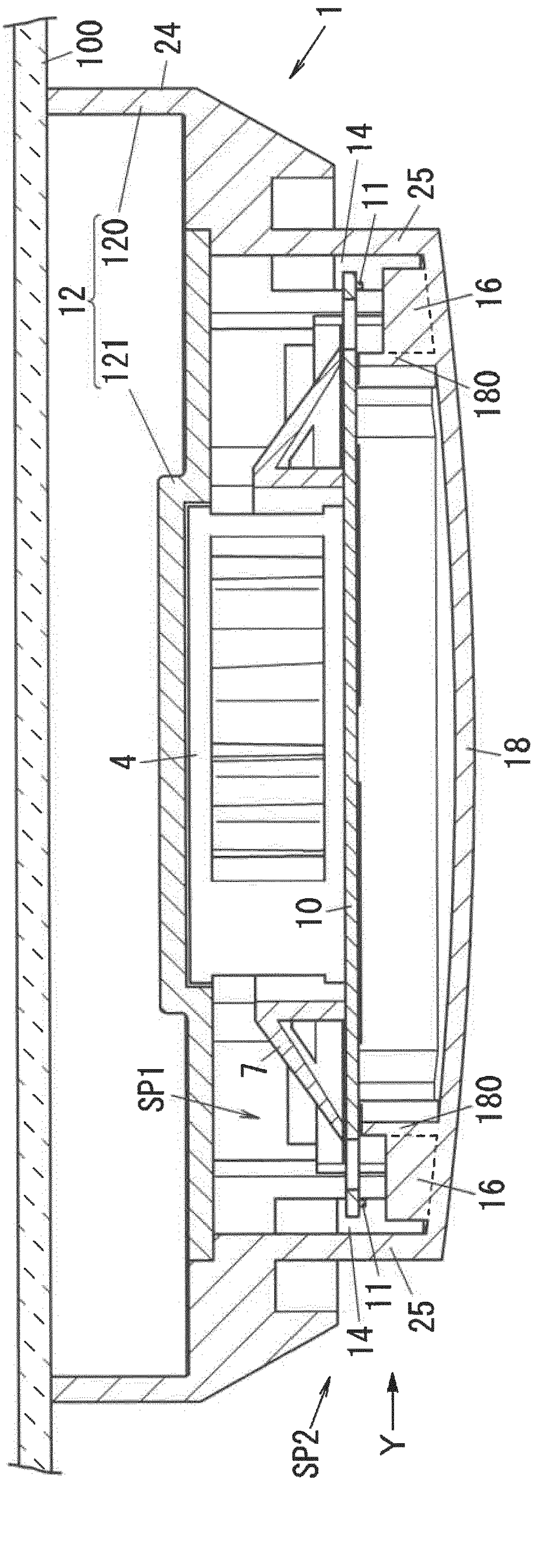
11. The sensor (1, 1A) of claim 1, wherein

the sensor (1, 1A) includes the upper member (24) and a plurality of the beams (25),
the guide portion (17A, 17B, 17C, 17D) is provided between the plurality of the beams (25), and
the bottom member (18, 18A, 18B) has a wall surface (28) having a curved or linear shape and coupling together two adjacent beams (25) out of the plurality of the beams (25).



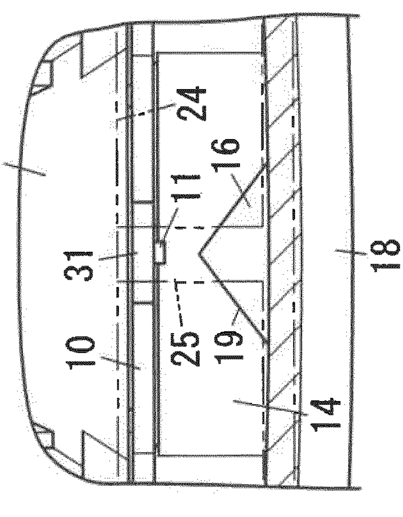
12
120
24
1
Up
Dwn.
A1
SP2
11 (30)
25
22
16
19
10
18
A2
14
SP1
100
2
H40
H10

FIG. 1



1
100
24
120
12
121
14
11
25
16
180
4
18
10
7
SP1
SP2
Y

FIG. 2A



7
24
16
11
31
10
25
19
14
18

FIG. 2B

FIG. 3

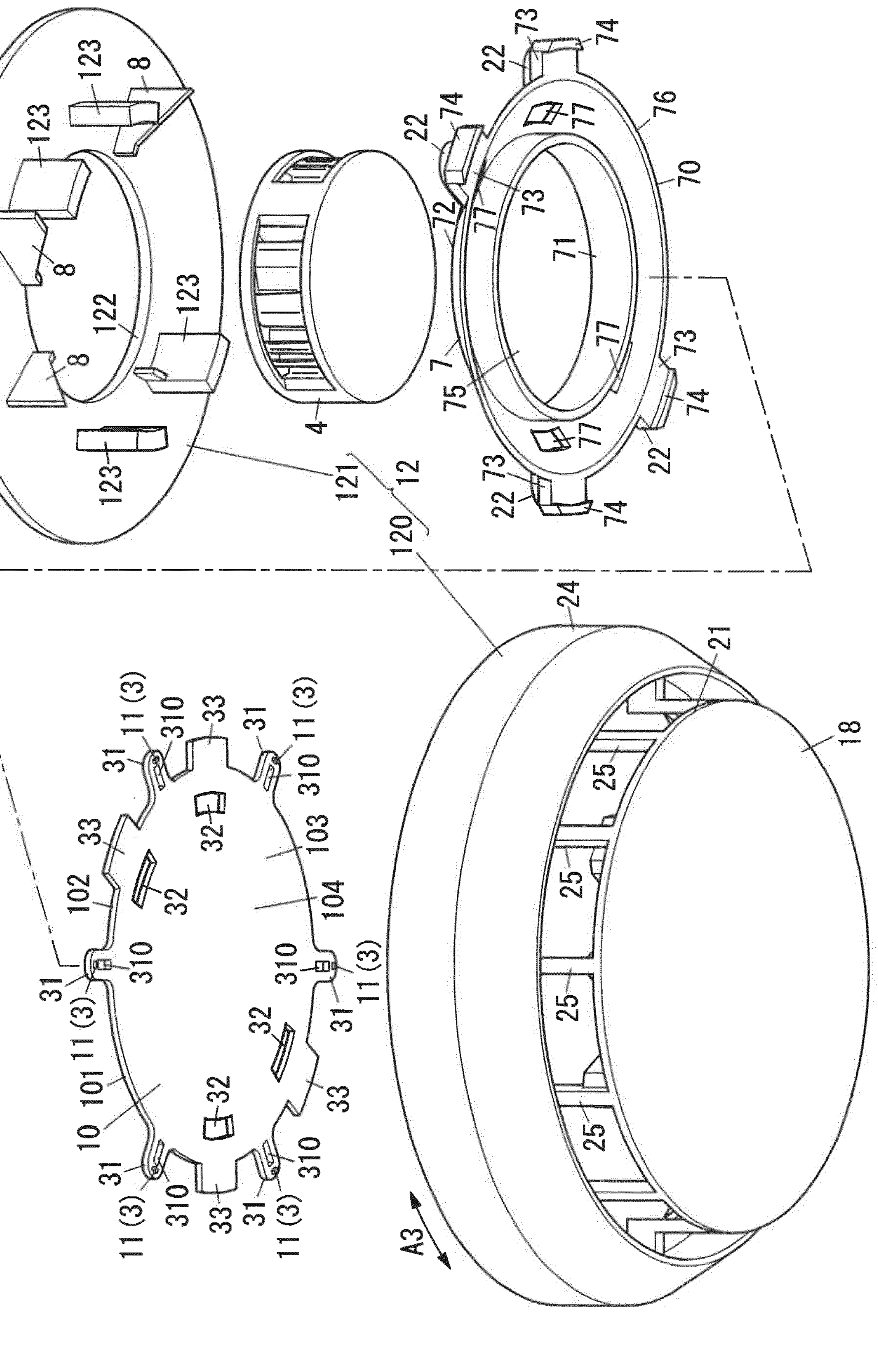
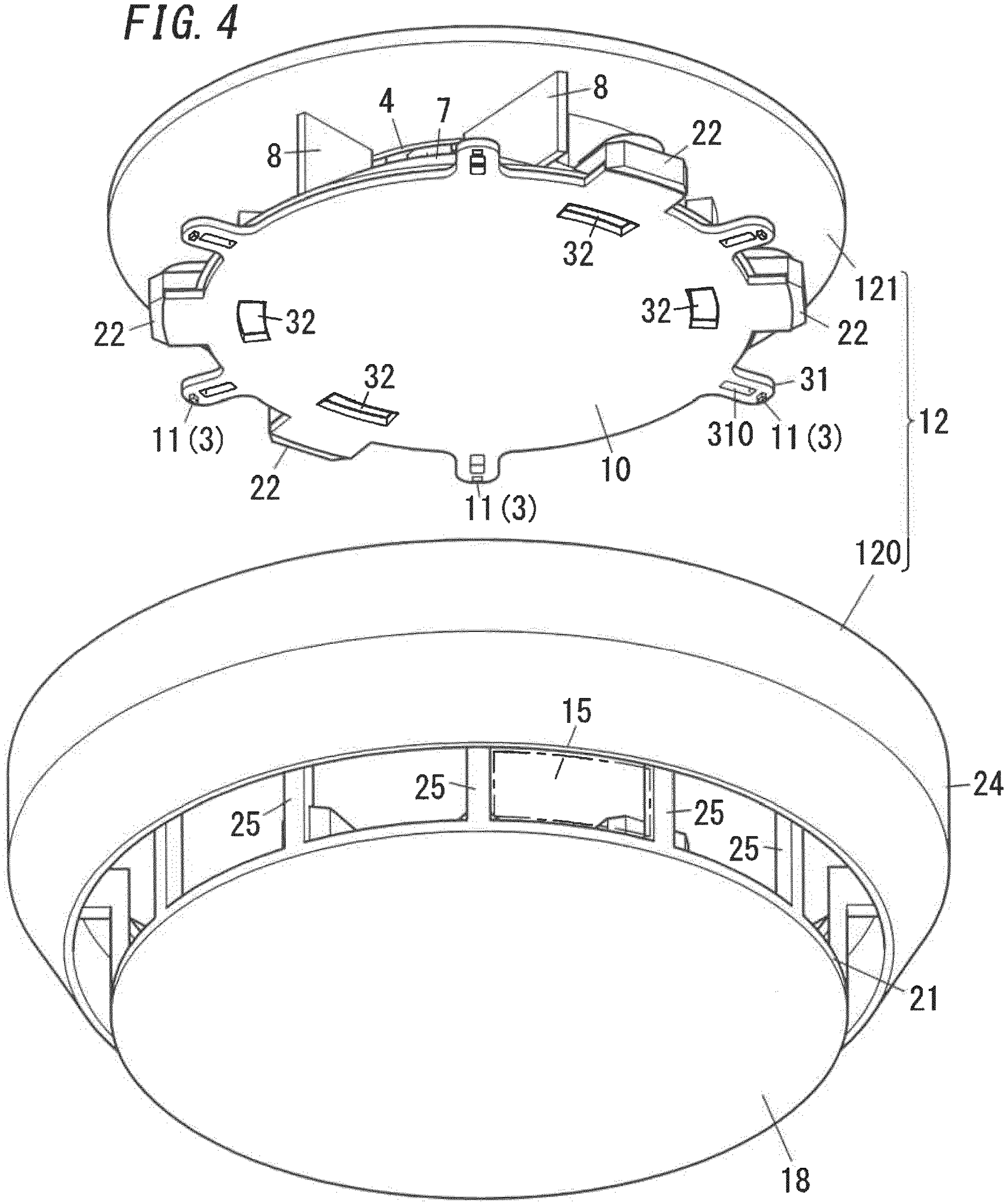

123
8
123
123
8
122
8
123
123
121
12
120
4
22
74
73
74
22
73
77
76
77
73
72
71
70
7
75
77
73
74
22
77
73
22
74
24
21
18
25
25
25
25
25
A3
10
101
102
103
104
11 (3)
31
310
32
33

FIG. 4



8
4
7
8
22
32
121
22
32
32
22
32
31
11 (3)
310
11 (3)
12
22
10
11 (3)
120
15
25
25
25
24
25
21
18

FIG. 5

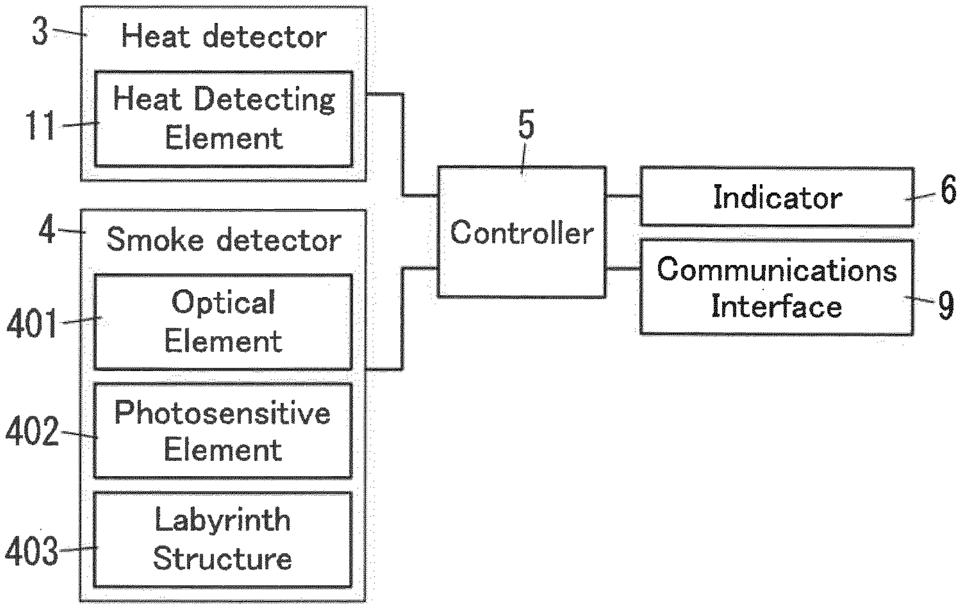

3
Heat detector
11
Heat Detecting Element
4
Smoke detector
401
Optical Element
402
Photosensitive Element
403
Labyrinth Structure
5
Controller
Indicator
6
Communications Interface
9

FIG. 6

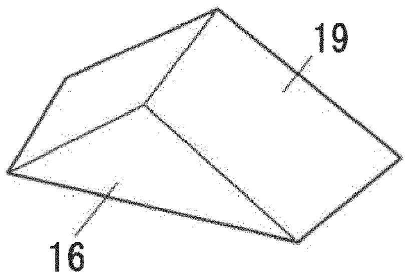


FIG. 7A

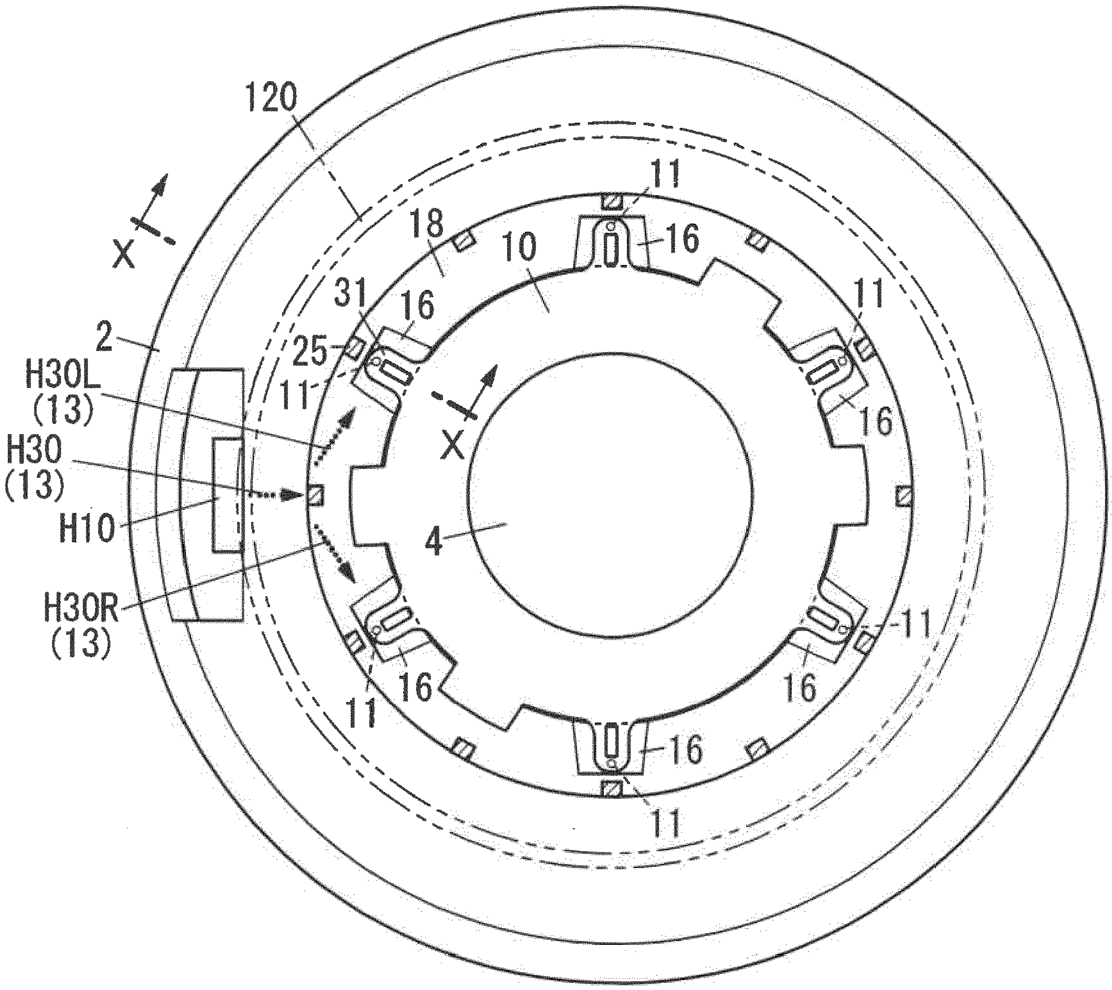

120
11
18
10
16
X
31
16
11
2
25
H30L
(13)
11
H30
(13)
X
16
H10
4
H30R
(13)
11
16
11
16
16
11

FIG. 7B

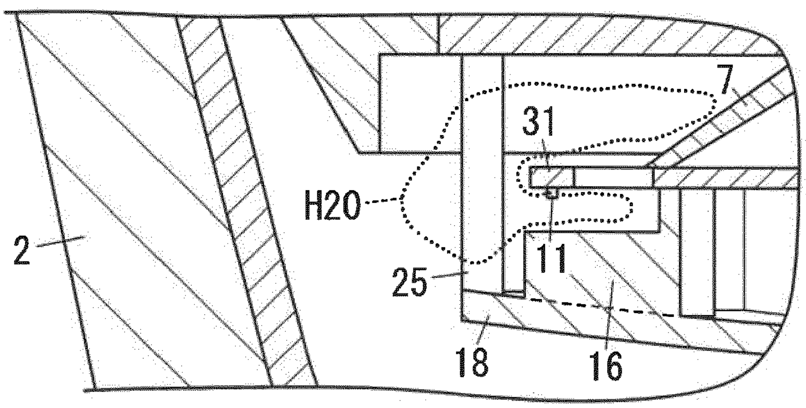

7
31
H20
2
11
25
18
16

FIG. 8

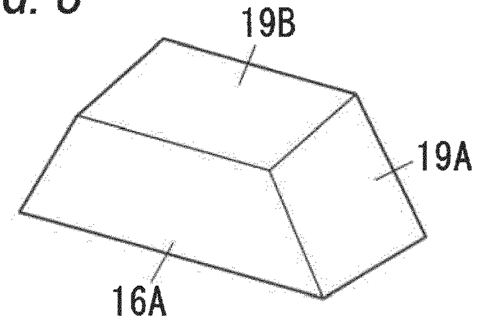


FIG. 9

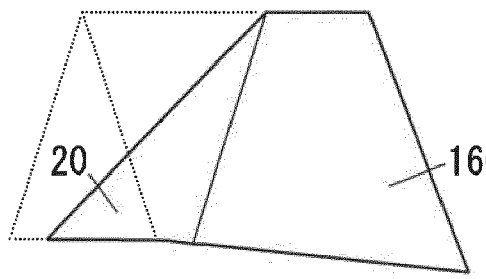


FIG. 10

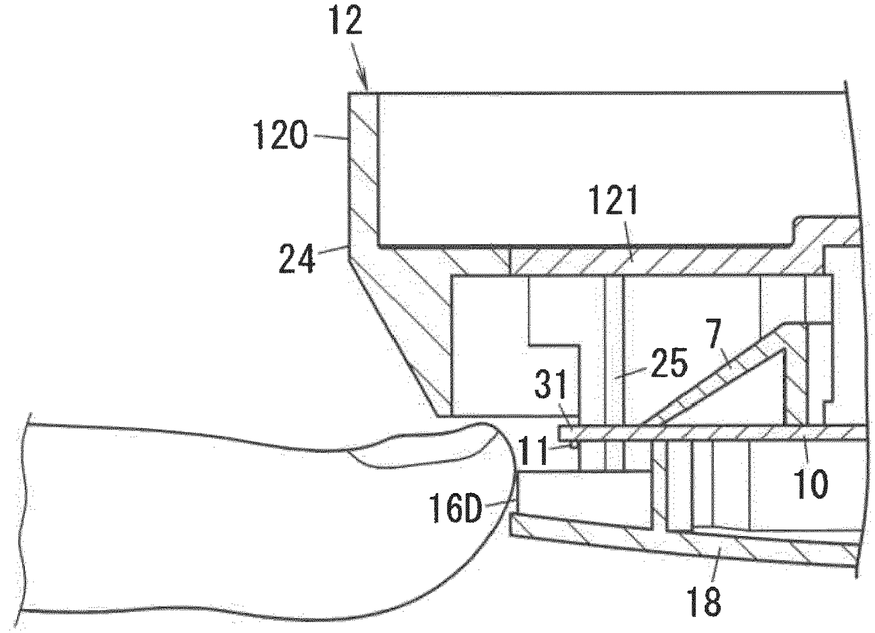


FIG. 11

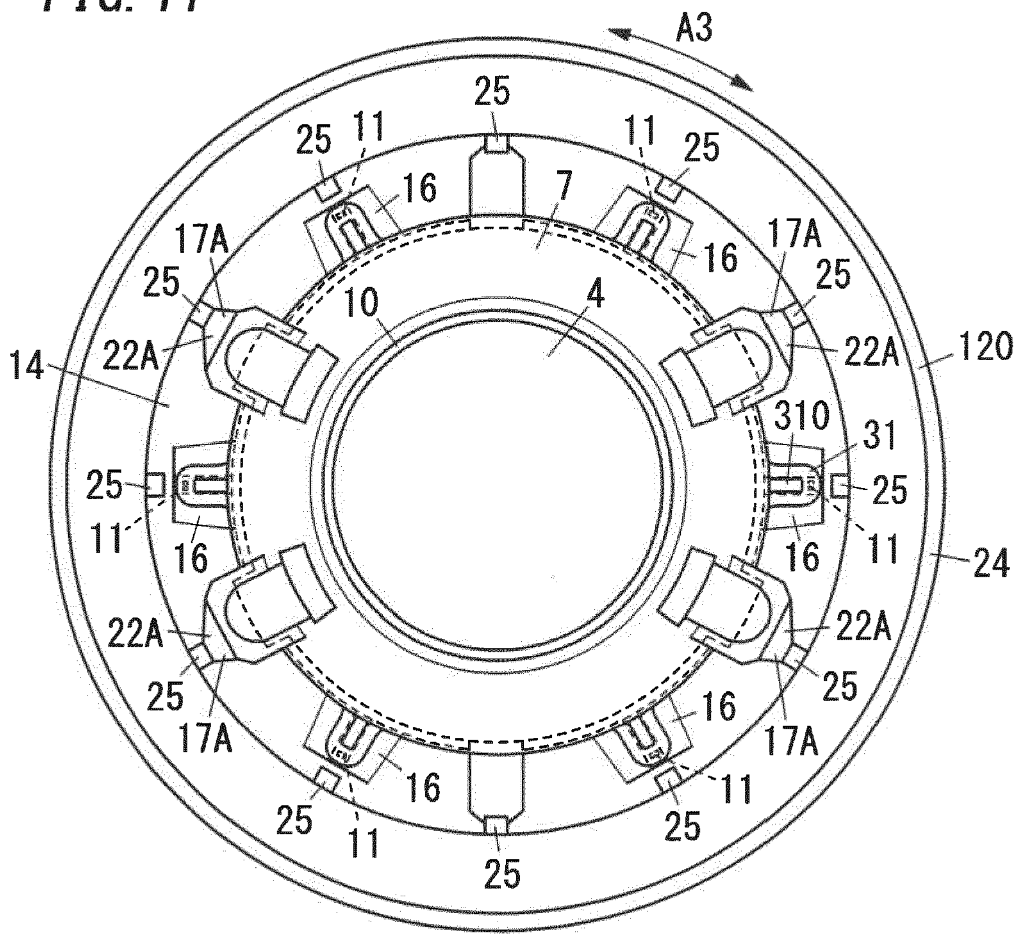

A3
25
11
25
16
7
11
25
16
17A
25
10
4
17A
25
14
22A
22A
120
310
31
25
25
11
16
16
11
24
22A
22A
25
17A
25
17A
16
16
11
25
11
25
25

FIG. 12

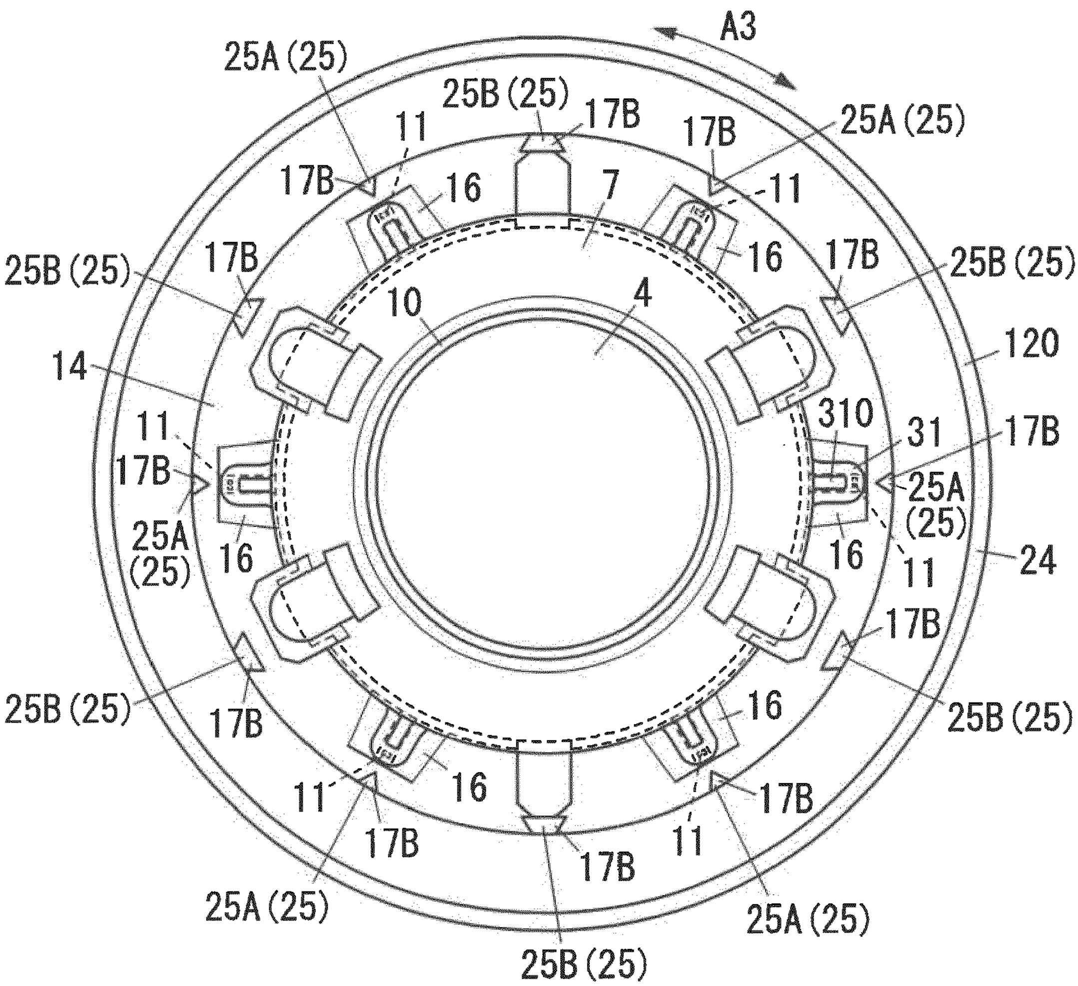

A3
25A (25)
25B (25)
17B
11
17B
25A (25)
17B
16
7
11
16
25B (25)
17B
17B
25B (25)
10
4
14
120
310
31
17B
11
17B
25A
(25)
25A
(25)
16
16
11
24
17B
25B (25)
17B
16
25B (25)
11
16
17B
17B
11
25A (25)
17B
25A (25)
25B (25)

FIG. 13

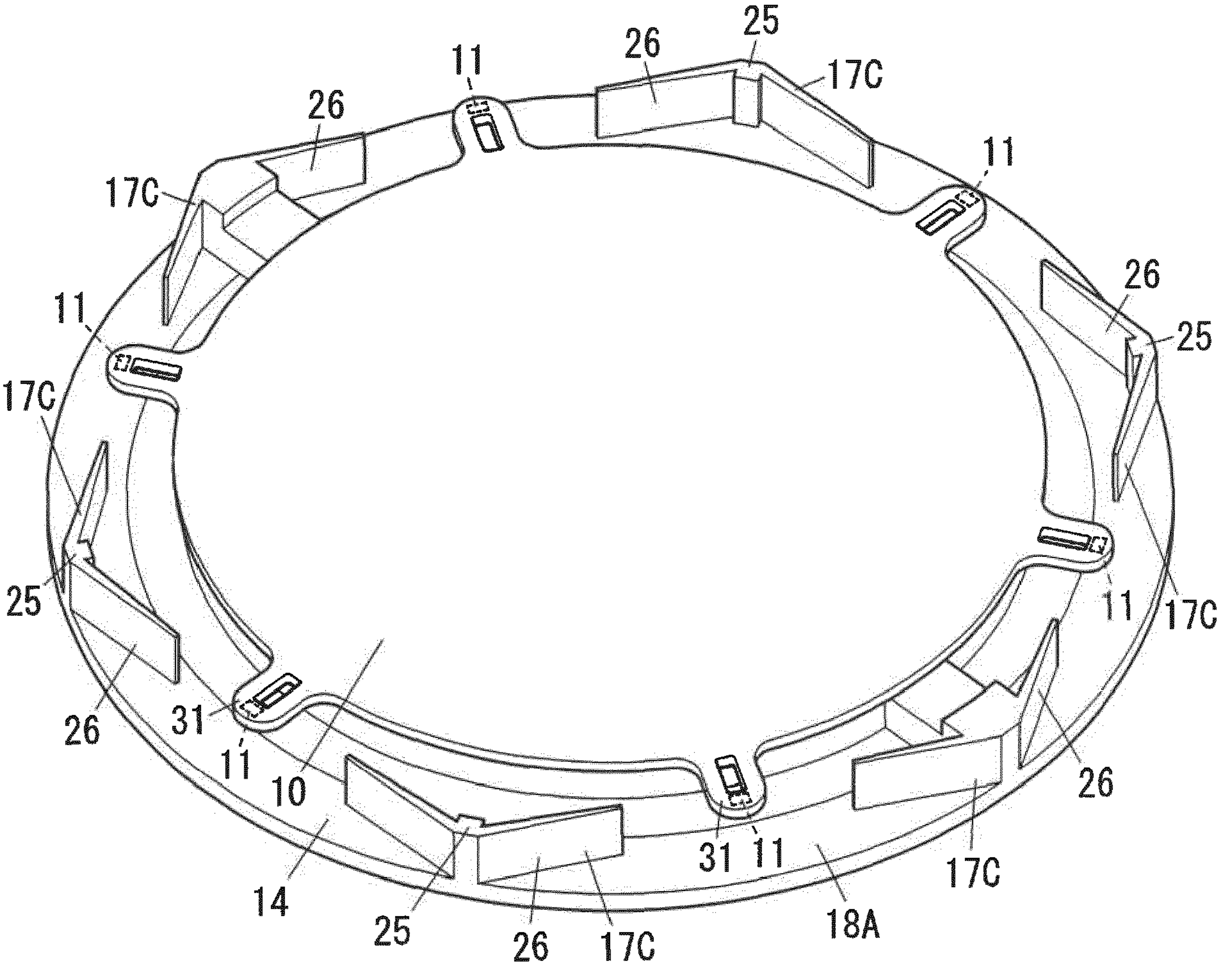

11
26
25
17C
26
17C
11
11
26
25
17C
11
17C
25
26
31
11
10
14
25
26
17C
31
11
18A
17C
26

FIG. 14

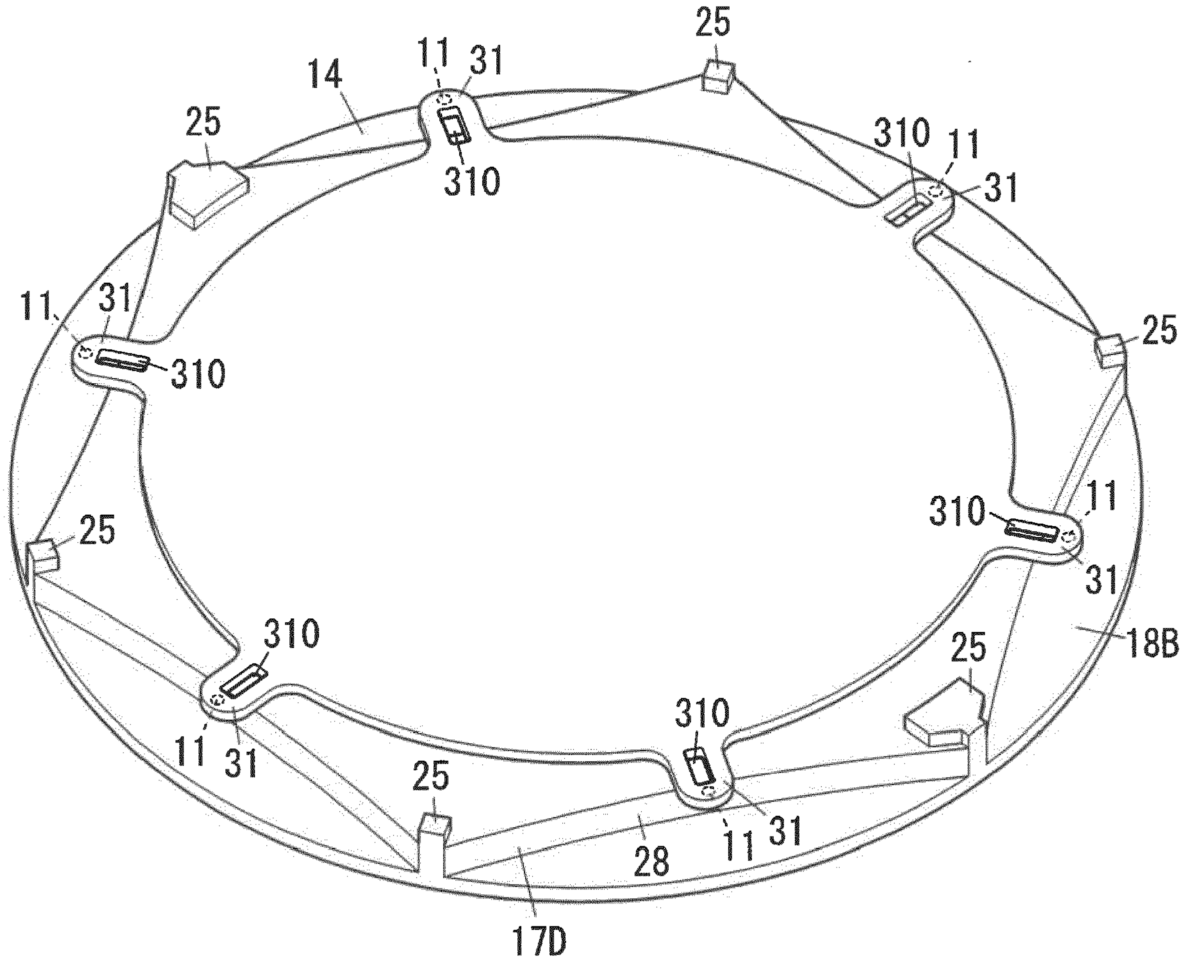

25
11
31
14
25
310
310
11
31
11
31
310
25
310
11
31
25
310
25
310
11
31
25
310
31
11
28
17D
18B

FIG. 15

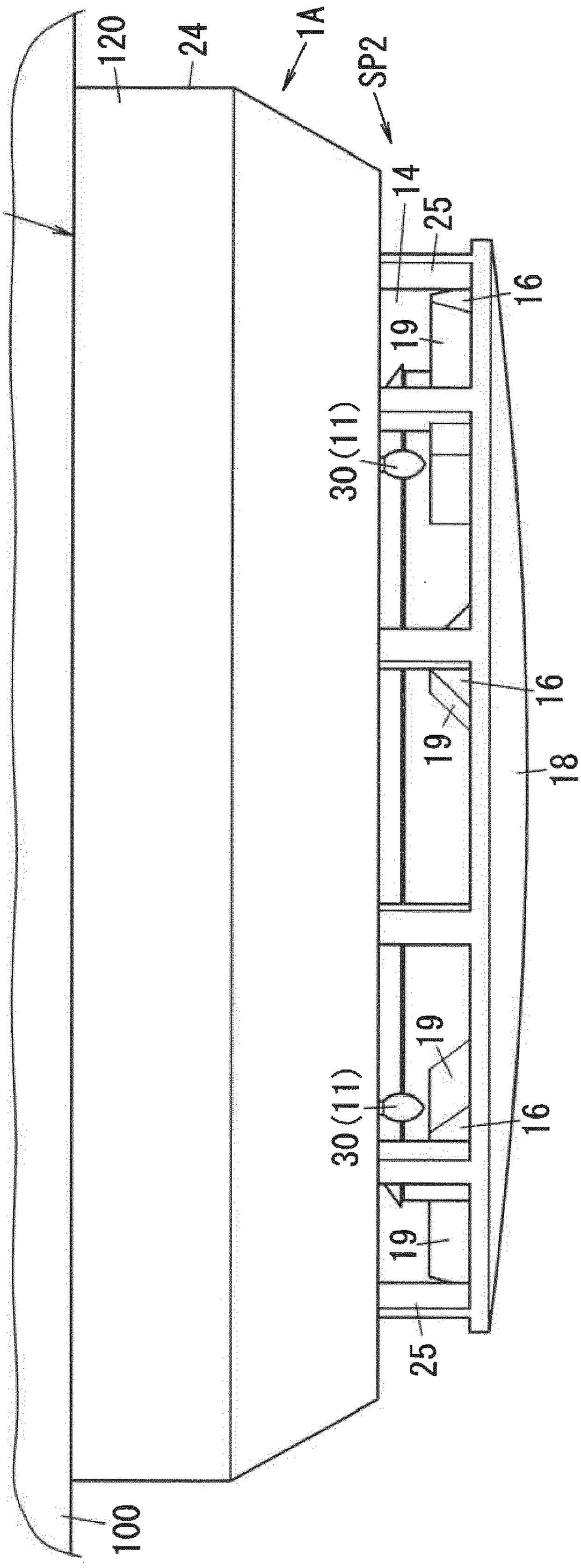


FIG. 16

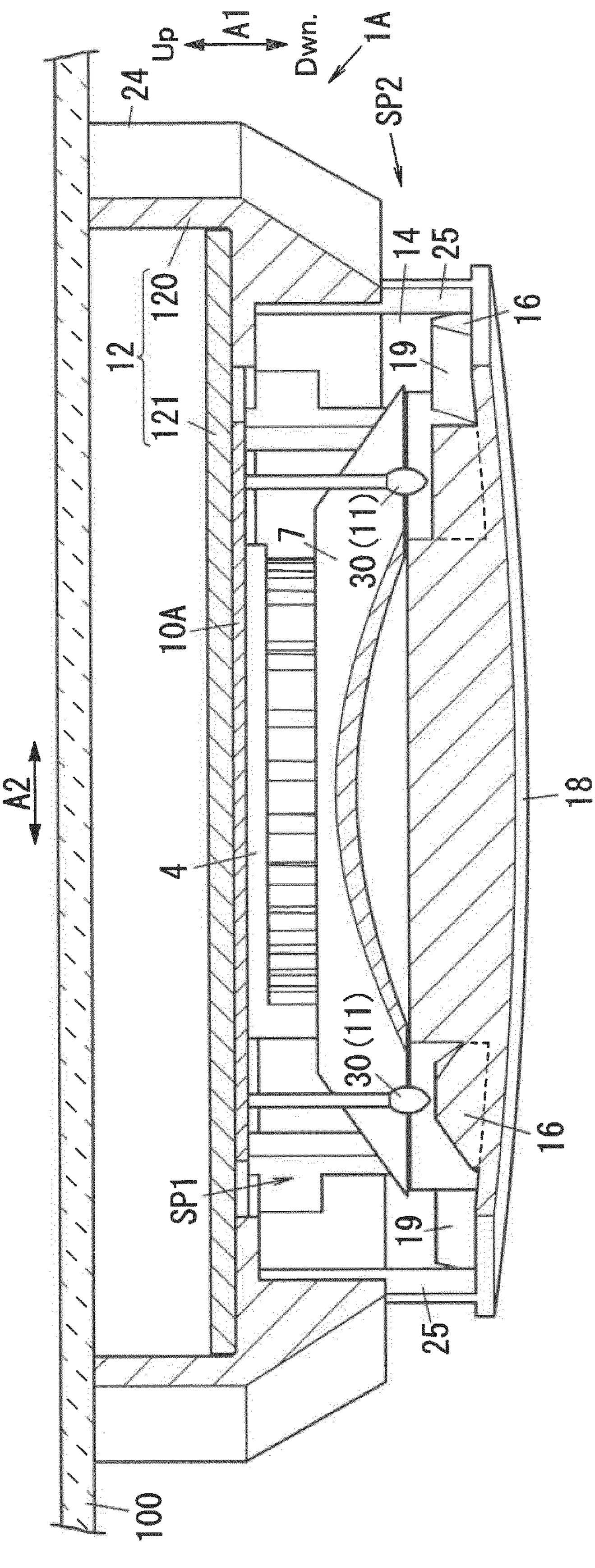
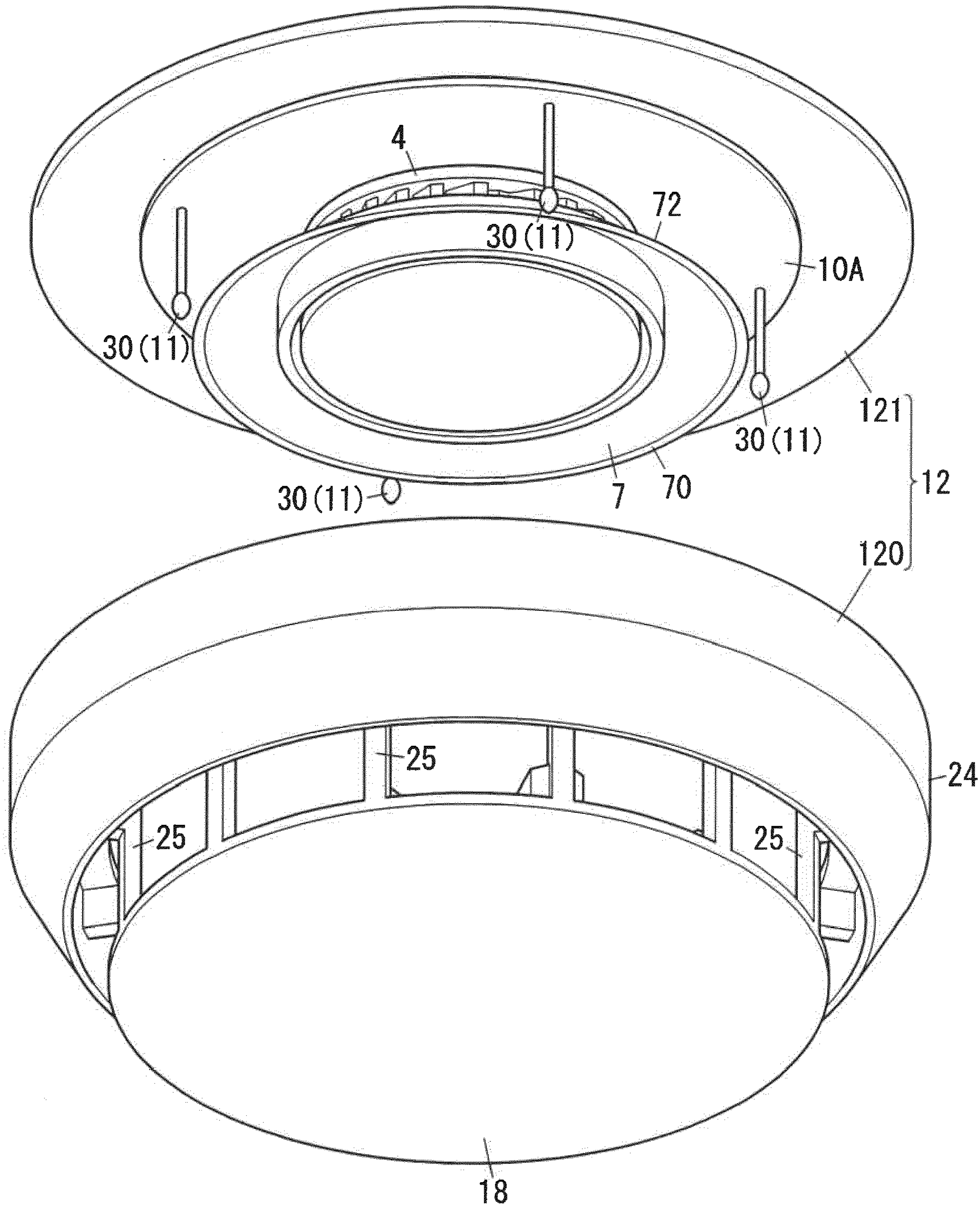

Up
A1
Dwn.
1A
SP2
24
120
12
121
14
25
16
19
30(11)
7
10A
A2
4
18
30(11)
16
SP1
19
25
100

FIG. 17



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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 5417

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2020 204845 A (PANASONIC IP MAN CORP) 24 December 2020 (2020-12-24) * paragraph [0051] - paragraph [0057]; figures 1-4 *	1-11	INV. G08B17/06 G08B17/107
X	GB 2 239 709 A (HOCHIKI CO [JP]) 10 July 1991 (1991-07-10)	1-3,8	
A	* page 7, line 8 - line 20; figures 1,2g * * page 10, line 20 - line 30 *	4-7,9-11	
X	WO 2020/075487 A1 (PANASONIC IP MAN CO LTD [JP]) 16 April 2020 (2020-04-16)	1,2	
A	* paragraph [0031] - paragraph [0034]; figure 3A *	3-11	

TECHNICAL FIELDS SEARCHED (IPC)

G08B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 September 2022	Kurzbauer, Werner

1

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07-09-2022

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		FI 906243 A	26-06-1991
		GB 2239709 A	10-07-1991
WO 2020075487 A1	16-04-2020	NONE	

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- JP 2012014330 A **[0002]**