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(54) Device for manually controlling gas delivery, with means for automatic shut-off if flammable gas is present in the atmosphere.

(57) This invention provides an actuator device for manually opening and closing gas delivery, with means for automatic shut-off if flammable gas is present in the atmosphere, comprising a valve (18) for controlling general gas delivery associated operationally with mechanical energy storage means (20, 20 a) which are activated on opening the valve, and manually operable means (35) for releasing the mechanical energy in order to voluntarily close the delivery valve at the wish of the user.

Electromagnetic means (41, 42) are also provided controlled by a sensor unit for causing the mechanical energy to be released in a dangerous situation to thus close the delivery valve (18), and means (16, 38) for displaying whether the valve is in its manually opened or closed or automatically shut-off state, the actuator device also being provided with means (43) for electrically activating the sensor unit on valve opening.

The sensor unit comprises a gas sensor associated with the relative control electronics, which comprise the sensor electronic operating circuit and the electronic circuit for automatically controlling the actuator device.

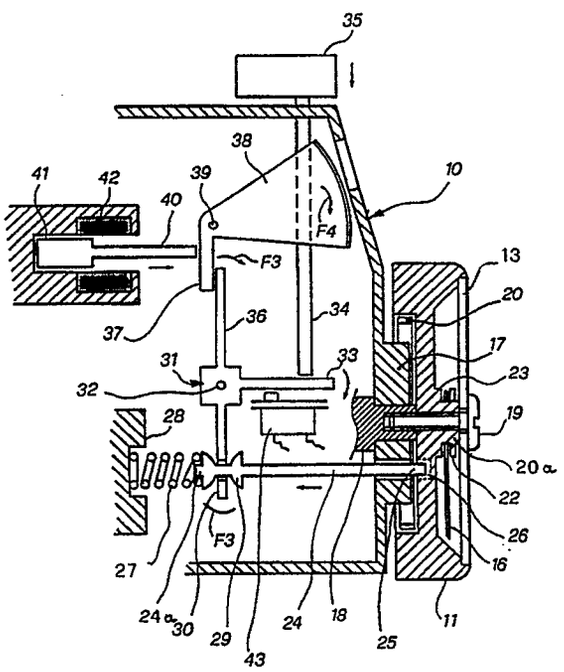

fig. 4

EP 0 410 945 A2

DEVICE FOR MANUALLY CONTROLLING DELIVERY, WITH MEANS FOR AUTOMATIC SHUT-OFF IF FLAMMABLE GAS IS PRESENT IN THE ATMOSPHERE

This invention relates to a manual gas delivery control device with means for automatic shut-off if flammable gas is present in the atmosphere.

More particularly, the invention relates to an actuator device for manually opening and closing gas delivery, with means for automatic shut-off if flammable gas is present in the atmosphere, comprising a valve for controlling general gas delivery associated operationally with mechanical energy storage means which are activated on opening the valve, and manually operable means for releasing the mechanical energy in order to voluntarily close the delivery valve at the wish of the user.

Electromagnetic means are also provided controlled by a sensor unit for causing the mechanical energy to be released in a dangerous situation to thus close the delivery valve, and means for displaying whether the valve is in its manually opened or closed or automatically shut-off state, the actuator device also being provided with means for electrically activating the sensor unit on valve opening.

The sensor unit comprises a gas sensor associated with the relative control electronics, which comprise the sensor electronic operating circuit and the electronic circuit for automatically controlling the actuator device.

Advantageously, the sensor unit comprises a mains power unit and a back-up battery to allow operation in the temporary absence of electricity.

Currently preferred embodiments of the present invention are described hereinafter by way of non-limiting example with reference to the accompanying drawings in which:

Figures 1 a and 1 b are respectively front and side views of the unit housing the gas sensor and the relative control electronics;

Figure 2 shows a schematic block diagram of the arrangement according to the invention;

Figures 3 a 3 b and 3 c are respectively a front view, a side view and a top view of the actuator device of the present invention;

Figure 4 is a simplified sectional view of the actuator device according to the invention taken substantially through the axis of the control knob;

Figure 5 is a sectional view similar to that of Figure 4 showing a second embodiment of the actuator device of the invention; and

Figure 6 shows a modification of the structure of Figure 5 to allow gas delivery to be controlled if the electricity supply is lacking.

The type of gas sensor used in the system according to the present invention is of the tin dioxide N-conductivity semiconduotor type recently developed in Japan and extremely reliable even though of low cost. This type of sensor is particularly convenient as it is designed specifically to detect the presence of methane, propane and butane, i.e. the gases most commonly used by domestic users, plus carbon monoxide and smoke. These sensors are particularly resistant to poisoning in that they are based on the principle of adsorbing oxygen molecules once the sensor is in operation (by being heated to about 250 ° C).

If reducing gases such as the aforesaid gases are present, the previously adsorbed oxygen molecules are removed with consequent increase in the semiconductor conductivity.

The gas concentration in the atmosphere can be determined by measuring the semiconductor conductivity, to thus determine whether the concentration is sufficiently high to cause an explosion.

By way of non-limiting example it has been found particularly appropriate to use a tin dioxide gas sensor of the type marketed by the Japanese firm Figaro with the code TGS 813.

In the following description the electronic circuit for controlling the gas sensor operation is assumed to be known as it is both available to and easily deducible by the expert of the art on the basis of the technical data supplied by the sensor manufacturer.

The power for the electronic circuit is provided by a stabilized voltage direct current power unit which also keeps the back-up battery charged. The electrical connection between the actuator device and the sensor unit and between the actuator device and the electricity mains is by electric cables.

With reference to Figures 1 a and 1 b the sensor unit comprises a casing indicated overall by 1 and provided with two side aperture arrangements 2, of which only one is visible in Figure 1 b , and a top aperture arrangement 3 positioned on the front of the casing 1.

The aperture arrangements 2, 3 are in the form of louvres to reduce passage of dust and grease by gravity and to as far as possible reduce soiling of the gas sensor, not shown, present in the casing 1.

The illustrated arrangement has been chosen to facilitate the formation of convection air currents indicated by the arrows F1, F2 arising by virtue of the presence within the casing 1 of the heat source represented by the gas sensor, which as stated operates at a temperature of about 250 ° C. In the top part of the casing there is an indicator lamp 4 preferably in the form of a green LED which in-

dicates the operating state of the unit contained in the casing 1.

It should be noted that the time required to heat the gas sensor is about 56 seconds if its energy supply lacks for more than 15 minutes, the required time being otherwise shorter the shorter the gap in the sensor energy supply.

The electronic circuit which controls the sensor is designed so that if a predetermined concentration of flammable gas is present in the atmosphere for at least 9 seccnds an actuator is activated to close the valve which delivers gas to the user, as will be seen hereinafter.

The delay of 9 seconds has been fixed to prevent accidental alarms being triggered. For example, when a gas cooker is lit there there is generally an escape of gas before the flame lights, but this escape is generally of short duration and not dangerous. The fixed delay prevents the alarm being triggered and the gas delivery being shut off.

Figure 2 shows a power unit 100 connected at 101 to the electricyty mains. The unit 100 is preferably of the stabilized type to maintain a rechargeable back-up battery 102 charged.

As will be apparent hereinafter, a disconnection delay device 103 is provided cooperating with the gas sensor indicated overall by 104, which is associated with a thermal compensation device 105.

The gas sensor 104 cooperates with a shut-off delay device 106 associated with the actuator 107, which controls an electromagnet 108.

A switch 109 cooperates with the internal mechanism of the gas delivery control device as explained hereinafter.

Figures 3 a , 3 b , 3 c show the external structure of the actuator device, which is operated by the sensor unit if an alarm arises and is operated manually if opening or closure is desired by the user.

The actuator device comprises a casing 10 from which a knob 11 substantially similar to the common knobs of gas taps projects.

In the top part of the casing 10 there is a protected window 12 in which a flap- type element can move, as described hereinafter, to make a word such as "ALARM" appear if the gas sensor operates.

A pushbutton 35 positioned on the top of the casing 10 causes closure of the valve by releasing, as described hereinafter, the mechanical energy stored or loaded by the initial opening of the knob 11.

The valve in question comprises a conventional connector 14 to be screwed into the gas delivery fitting (the gas originating from the meter or from a feeder such as a pressure reduction valve of a self-contained system), and a connector 15 to receive the conventional pipe by which the gas is fed to the user item or items (not shown).

As will be also seen hereinafter, the knob 11 is provided with a swivel flap 16 to expose the word "CLOSED" or "OPEN" provided on the front of said knob 11, so that only the word relative to the particular position of rotation of the knob 11 is visible.

Two different embodiments of the actuator device will now be described with reference to Figures 4 and 5.

With reference firstly to Figure 4, the casing 10 incorporates a block 17 which rotatably supports the shaft of the valve 18 for operating the gas valving member. The knob 11 is mounted on the shaft of the valve 18 and is retained in position by a screw 19.

In the space between the knob 11 and the casing 10 there is a spiral spring 20 fixed between the block 17 and the knob 11 and arranged tc be loaded with elastic energy when the delivery valve is opened by rotating the knob 11 in the direction of the arrow 21 (Figure 3a).

It should be noted that in Figure 4 the knob 11 is shown in the open state and thus with the spring 20 loaded.

As stated, on a projection 20 a of the knob 11 there is mounted the swivel element 16, which is retained freely movable by the retention rings 22, 23 so that said element 16 is able to expose that word which indicates the state of the valve. In this respect, as it is freely mounted, the swivel element 16 will always be positioned downwards.

A disc 13 constructed of transparent polycarbonate protects the print on the knob against soiling and protects the swivel element against damage.

As can be seen from Figure 4, the knob 11 is retained in the open state against the return force of the spring 20 by a pawl rod 24 passing through the casing 10 and comprising an extension 25 which engages a cavity 26 provided in the inwardly facing side of the knob 11.

The pawl rod 24 is permanently urged towards the knob 11 by a spring 27 operating between one end 24a of said pawl rod 24 and a seat 28 associated with the casing 10.

The pawl rod 24 is also provided with a grooved element 29 arranged to cooperate with a fork element 30 provided at the end of a three-arm lever indicated overall by 31 and pivoted at 32. The three-arm lever 31 is provided with an arm 33 arranged to cooperate with a rod 34 associated with a pushbutton located on the outside of the casing 10.

The arm 33 also cooperates with an electric switch 43 arranged to control the supply to the electronic circuit of the gas sensor unit.

The lever 31 is also provided with an arm 36

cooperating with a lug 37 on a flap 38 pivoted at 39, said lug 37 also cooperating with a control rod 40 fixed to the mobile core 41 of a draw-in electromagnet 42.

The operation of the described structure is as follows: as stated, upon opening, the knob 11 is rotated it in the direction of the arrow 21 until the pawl rod 24 penetrates into the cavity 26. In reaching this position, the three-arm lever 31 will have rotated in the opposite direction to the arrows F3 to operate the switch 43 and rotate the flap 38 in the direction of the arrow F4. At this point gas can flow, and the electronic circuit associated with the gas sensor is activated. To manually close the valve it is necessary only to press the pushbutton 35 which by means of the operating rod 34 rotates the three-arm lever 31 in the direction of the arrows F3 to open the switch 43 and displace the pawl rod 24 towards the left against the action of the spring 27, to cause the pawl 25 to leave the cavity

In this manner the spring 20 discharges its previously stored energy to rotate the knob 11 in the opposite direction to that of the arrow 21 (Figure 3 a).

If an alarm condition arises the operational sequence is substantially the same, except that the three-arm lever 31 instead of being operated by the rod 34 is operated by the rod 40 controlled by the core 41 of the electromagnet 42 energized by the power circuits (not shown) associated with the gas sensor electronics. In this latter case the flap 38 is rotated in the opposite direction to the arrow F4, to expose the word "ALARM" (Figure 3 a).

When normal conditions are restored the control electronics cede energizing the electromagnet 42, and the flap 38 returns to its normal position indicating the absence of danger.

In the embodiment shown in Figure 5 parts corresponding to the embodiment of Figure 4 are indicated by the same reference numerals and their description is excluded for simplicity.

As can be seen from Figure 5 the casing 50 houses and supports the previously described elements 11, 13, 16, 17, 18, 19, 20, 20 a , 22, 23.

The pawl rod 24 of Figure 4 is replaced by a pawl rod 51 provided at the end distant from the pawl 25 with a projection 52 cooperating with a thrust spring 53 which rests against a seat 54 on the structure.

The pawl rod 51 is provided with a groove 55 cooperating with a three-arm lever indicated overall by 56 and pivoted at 57. The lever 56 comprises a first arm 58 engaging said groove element 55, a second arm 59 cooperating with one end of an operating rod 60 associated with a pushbutton 35.

The three-arm lever 56 is also provided with an arm 62 on which a flap element 63 rest, pivoted at 64.

In proximity to the seat 54 there is a solenoid electromagnet winding 65 arranged to cooperate with an armature 66 provided with an extension 67 cooperating with the flap 63, and an abutting part 68 cooperating with the projection 52 on the pawl lever 51.

The manual operation of the embodiment shown in Figure 5 is substantially similar to that of the embodiment described with reference to Figure 4.

With regard to its operation under alarm conditions, the solenoid electromagnet is energized to draw into it the armature 66 which by means of its abutting part 68 drags with it the pawl rod 51, to release the knob 11. At the same time the extension 67 of the armature 66 withdraws fro the flap 63, which is free to fall and expose the alarm indication, following rotation of the three-arm lever 56 in the direction of the arrow F5.

When the alarm condition ceases, the spring 53, via the projection 52, urges the armature 66 towards the right so that its extension 67 raises the flap 63.

Figure 6 shows a modification of the structure of Figure 5 for the purpose of enabling gas delivery to be controlled if the electricity supply fails.

As can be seen from this figure the pushbutton 35 a is retained in its rest position by the springs 200, 201 to enable the pushbutton 35 a to be moved in both directions F10 and F11 from its rest position in the figure.

On pushing the pushbutton 35 a in the direction of the arrow F11 the knob 11 a is released. Before operating the lever 57 a by means of the underpart 202 of the pushbutton 35 a the pushbutton 35 a engages the display flap 63 a by means of the angle lever 203, so preventing the display flap 63 a from falling.

In addition, pressing the pushbutton 35 a causes the rod 51 a to move rearwards by means of the arm 58 a of the lever 57 a , which engages the groove 55 a , to overcome the force of the electromagnet 204 so as to release the knob 11 a and close the valve 18 a . On rotating, the shaft of the valve 18 a breaks the electrical feed circuit of the electromagnet 204 via the switch 47. The display flap 63 a remains in position as it is retained by the angle lever 203.

If electrical energy to the electromagnet 204 fails, this ceases to urge the rod 51 a in the direction of the arrow F12 to consequently release the knob 11 a which rotates under the action of the spring 20 a to close the valve 18 a .

In this case, the angle stop lever 203 for the display flap 63 a is inoperative and the flap 63 a is free to fall into the position indicating alarm.

To again open the valve 18 a , notwithstanding the previously indicated situation, the knob 11 a is

rotated anti-clockwise. The shaft of the valve 18 a acts on the switch 47, which reactivates the electrical circuit and thus energizes the electromagnet 204. The shaft of the valve 18 a also returns the display flap 63 a into its normal position via the lever 205.

To open the valve 18 a in the absence of electrical energy (which would normally be prevented only if electrical feed to the electromagnet 204 were present) the pushbutton 35 a is raised in the direction of the arrow F10 to load the spring 206 acting on the arm 59 a of the angle lever 57 a and cause the lever 207 to engage the pushbutton underpart 202.

By completely rotating the knob 11 a anticlockwise, the pawl rod 51 a enters the seat 208 of the knob 11 a and locks it. The lever 207 which engages the pushbutton underpart 202 is constructed with a part 209 in ferromagnetic material, positioned in proximity tc the electromagnet 204.

When the electricity supply returns, the electromagnetic field produced by the electromagnet 204 attracts the ferromagnetic part 209 of the lever 207, which thus release the pushbutton underpart 202.

In other words, the engagement of the pushbutton underpart 202 by the lever 207 is achieved by pulling the pushbutton 35 a upwards. This overcomes the resistance of the end of the lever 207, which moves below the projection on the left of the pushbutton underpart 202, which is thus retained in a position higher than normal, with the spring 206 under tension, and is released only in one of the following ways: either by electricity supply returning to the electromagnet 204, to attract the ferromagnetic end 209 of the lever 207 and release the pushbutton underpart 202; or by pushing the pushbutton 35 a downwards for manual closure due to lack of electrical energy, and overcoming the elastic resistance of the end of the lever 207 so that it passes above the projection on the pushbutton underpart 202.

The pushbutton underpart 202 is provided with a pin 202′ rigid with it and able to undergo a determined path of travel within a slot 202″ in the pushbutton 35 a .

The rest position of the pin 202′ is at the middle of its path of travel within the slot 202″. Two cases can therefore arise:

a) In the case of manual closure of the valve, i.e. pressing the pushbutton 35 a downwards, the pushbutton 35 a during the initial part of its travel displaces the lever 203 into a position such that it prevents the display flap 63 a falling. After the pin 202′ has completed its free travel within the slot 202″ in the pushbutton 35 a , the pushbutton underpart 202 is moved downwards to trigger the closure mechanism, but for which there is no corresponding fall of the display flap 63 a .

b) In the case of "forced" manual opening in the absence of electrical energy, the free travel of the pin 202′ within the slot 202″ in the pushbutton 35 a enables this to remain in its rest position even if the pushbutton underpart 202 is in a higher position than normal because it is engaged by the lever 207.

It should be noted that breaking the circuit for the electronic part when the valve or cock is in its closed state results in an increase in the like of all the components of the electronic circuit and gas sensor, and reduces soiling of the sensor by dust or greasy vapours because when the components are cold there is no convection air flow, to which reference has previously been made.

It should also be noted that, conveniently, the electronics associated with the sensor provide the valve closure releasing electromagnet with an energization which is not of simple pulse type but has a certain duration, in that the release of the energy stored in the elastic element associated with the control knob cannot take place instantaneously because of the viscous friction which is normally present in valves or cocks and prevents instantaneous movement when the closure action is performed.

Claims

1. A manual gas delivery control device with means for automatic shut-off if flammable gas is present in the atmosphere, characterised by comprising an actuator device (107) for manually opening and closing gas delivery, with means for automatic shut-off if flammable gas is present in the atmosphere, comprising a valve (18; 18 a) for controlling general gas delivery associated operationally with mechanical energy storage means (20; 20 a) which are activated on opening the valve, and manually operable means (35; 35 a) for releasing the mechanical energy in order to voluntarily close the delivery valve at the wish of the user, there also being provided electromagnetic means (41, 42; 65, 66; 204, 209) controlled by a sensor unit (104) for causing' the mechanical energy to be released in a dangerous situation to thus close the delivery valve (18; 18 a), and means (16; 38; 63; 63 a) for displaying whether the valve is in its manually opened or closed or automatically shut-off state, the actuator device (107) also being provided with means (43; 47) for electrically activating the sensor unit (104) on valve opening, the sensor unit comprising a gas sensor (104) associated with the relative control electronics, which comprise the sensor electronic operating circuit and the elec-

tronic circuit for automatically controlling the actuator device (107).

2. A device according to claim 1, characterised by comprising delay means (106) for delaying the operation of the shut-off device for a predetermined time from the start of continuous signalling by the sensor (104).

3. A device according to claim 2, characterised in that manually operable means (35; 35 a) are provided to release the mechanical energy for voluntary closure of the delivery valve (18; 18 a) at the wish of the user.

4. A device according to claim 3, characterised in that the valve (18; 18 a) is also provided with means (43; 47) for electrically activating the sensor unit on opening the valve.

5. A device according to one or more of the preceding claims, characterised in that the control electronics comprise delay means (103) for prolonging the energization of the electromagnet means (41, 42; 65, 66; 204, 209) to obtain closure of the delivery valve for a predetermined time sufficient to ensure that the closure action takes effect.

6. A device according to one or more of the preceding claims, characterised in that the mechanical energy storage means activated on opening the valve (18; 18 a) comprise a spiral spring (20; 20a) cooperating with the knob (11; 11 a) and a pawl element (24; 51; 51 a) operating snap-wise to retain the valve control knob in its open position.

7. A device according to claim 6, characterised in that the electrically controlled electromagnet means (41, 42; 65, 66; 204, 209) are arranged to act on the pawl element (24; 51; 51 a) to cause release of the mechanical energy stored in the spring (20; 20 a)

8. A device according to one or more of the preceding claims, characterised in that the delivery valve (18; 18 a) is associated with a flap element (38; 63; 63 a) controlled by the electromagnet means (41, 42; 65, 66; 204, 209) to indicate an alarm condition.

9. A device according to one or more of the preceding claims, characterised in that the sensor unit (104) is provided with an indicator lamp (4) arranged to operate intermittently during an initial time interval and then continuously.

10. A device according to one or more of the preceding claims, characterised in that the sensor unit (104) comprises a casing (1) provided with apertures (2, 3) for facilitating convective movement of the environmental air which penetrates into the casing, the convective movement being caused by the heat developed by the sensor.

11. A device according to one or more of the preceding claims, characterised in that the valve control knob (11; 11 a) comprises a part carrying an indication as to whether it is open or closed, this indication being exposed or covered up by a screening (16) element swivel-mounted on the knob.

12. A device according to one or more of the preceding claims, characterised by comprising a mains power unit (100) and a back-up battery (102) to provide operation during temporary lack of electrical energy.

13. A device according to one or more of the preceding claims, characterised by comprising means for allowing gas delivery to be controlled in the absence of electrical energy, said means being associated with manually operable means (35; 35 a) arranged to be moved into their operating state by an action opposite to that for normal operation when electrical supply is present, the arrangement being such that the manually operable means (35 a) are connected via a pin (202′) and slot (202″) arrangement to allow disengagement of the delivery valve control means (51 a , 57 a).

14. A device according to claim 13, characterised by comprising a lever element (207) constructed with a part (209) of ferromagnetic material positioned in proximity to the electromagnet (204) which controls the device for resetting device operation on restoration of electrical energy.

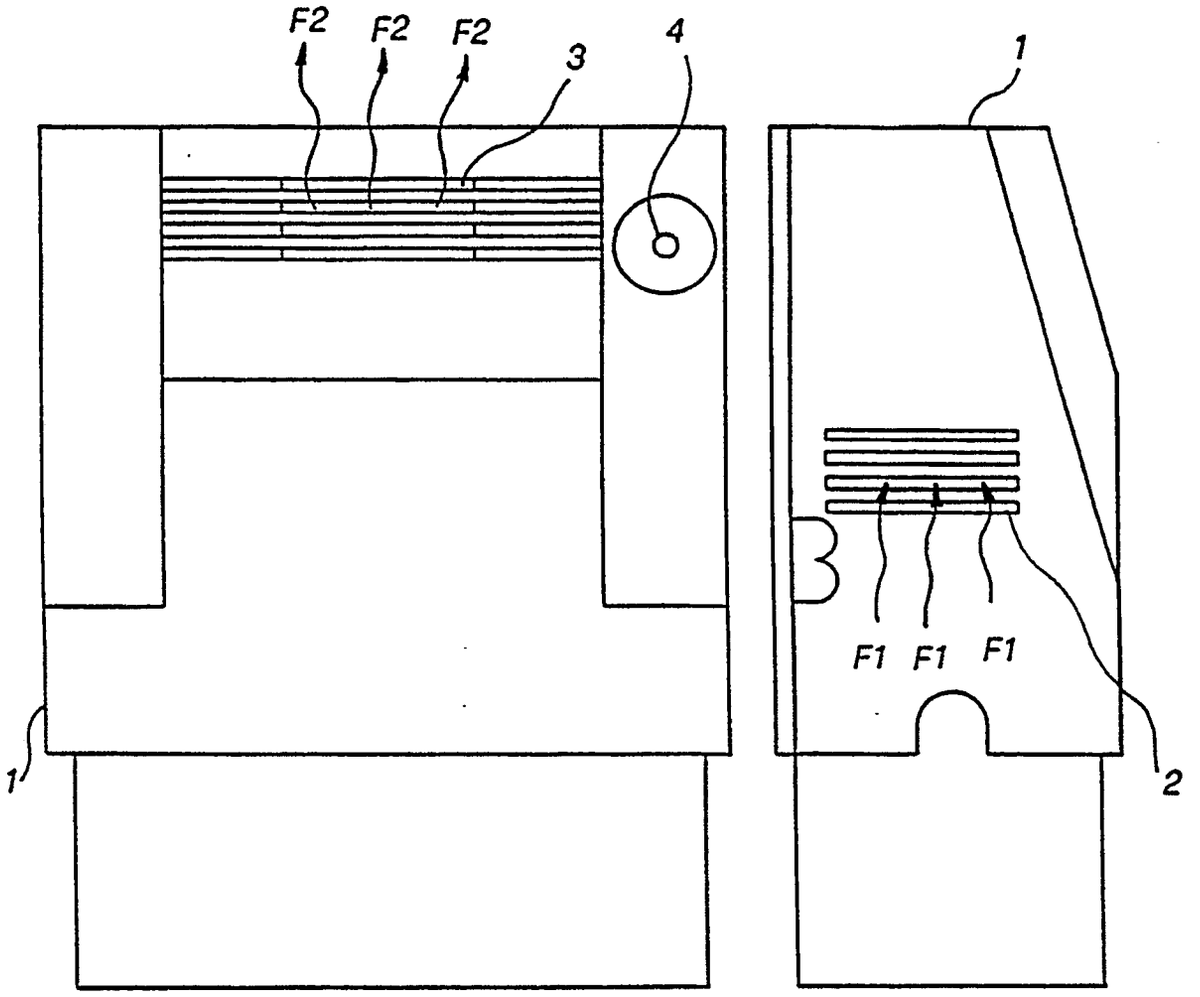

fig.1a

fig.1b

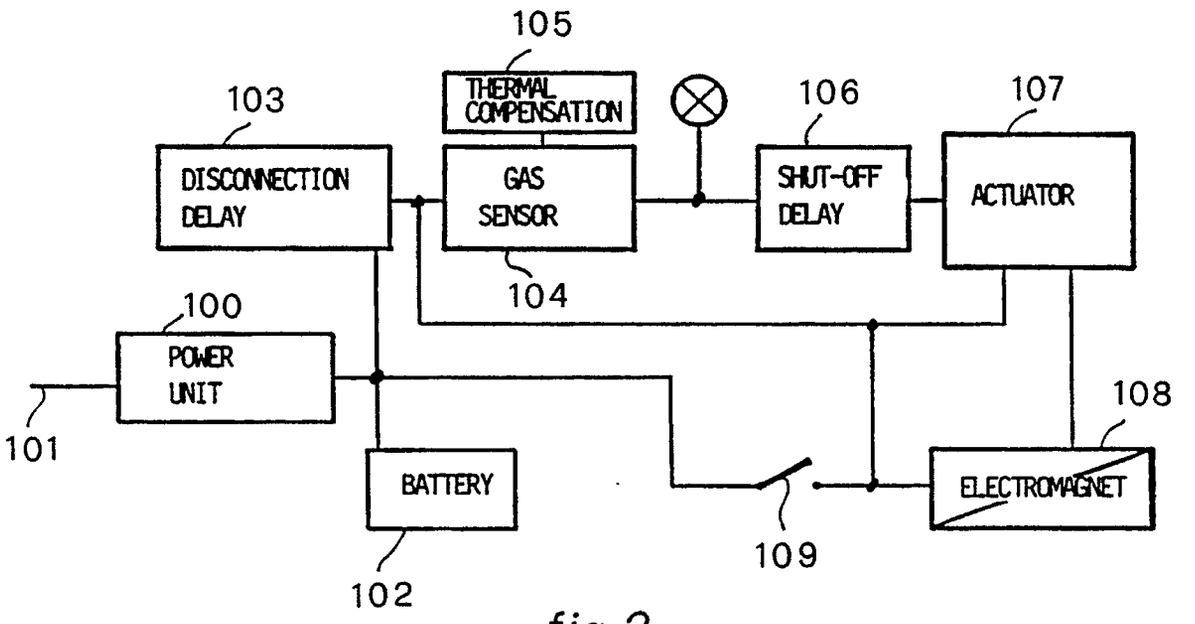

fig.2

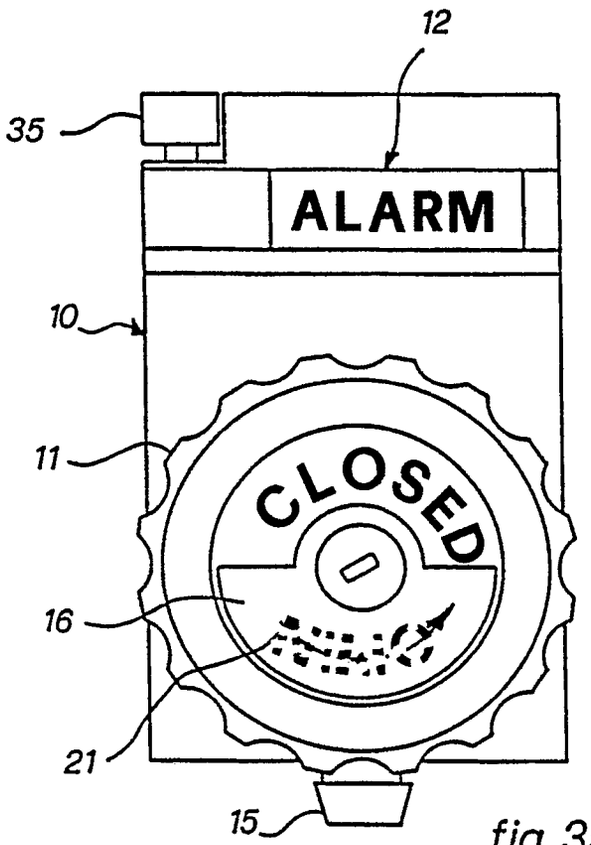

fig. 3a

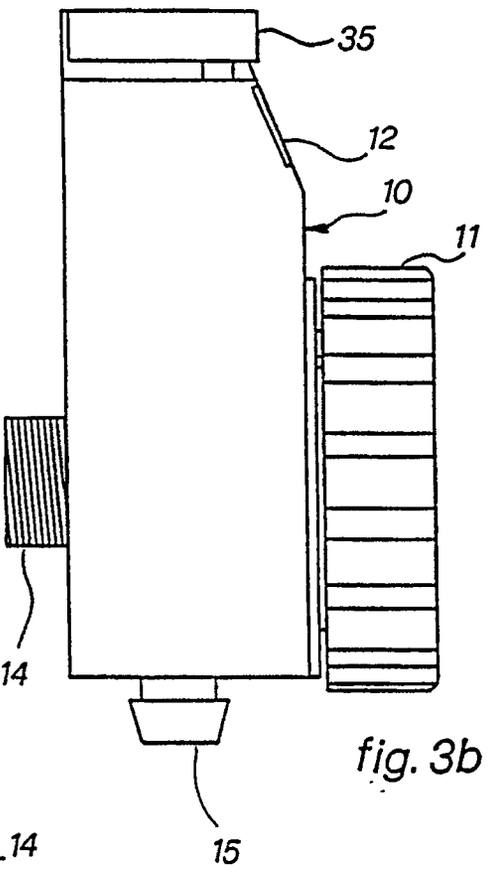

fig. 3b

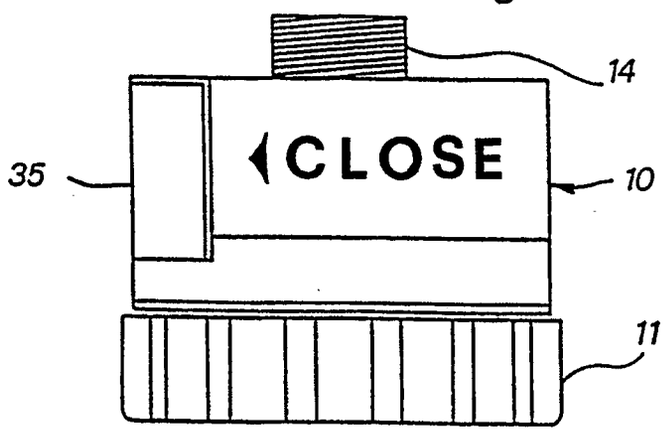

fig. 3c

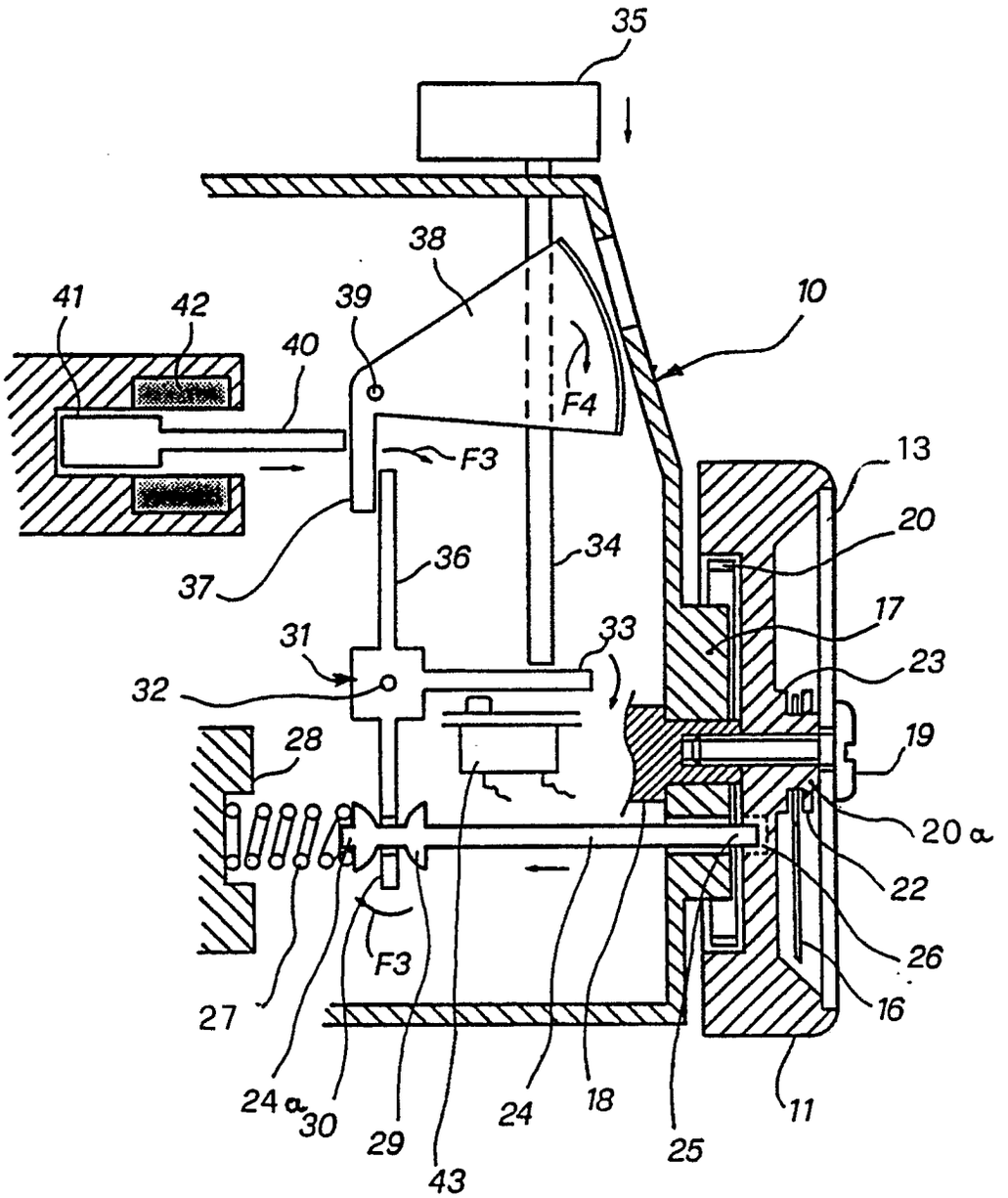
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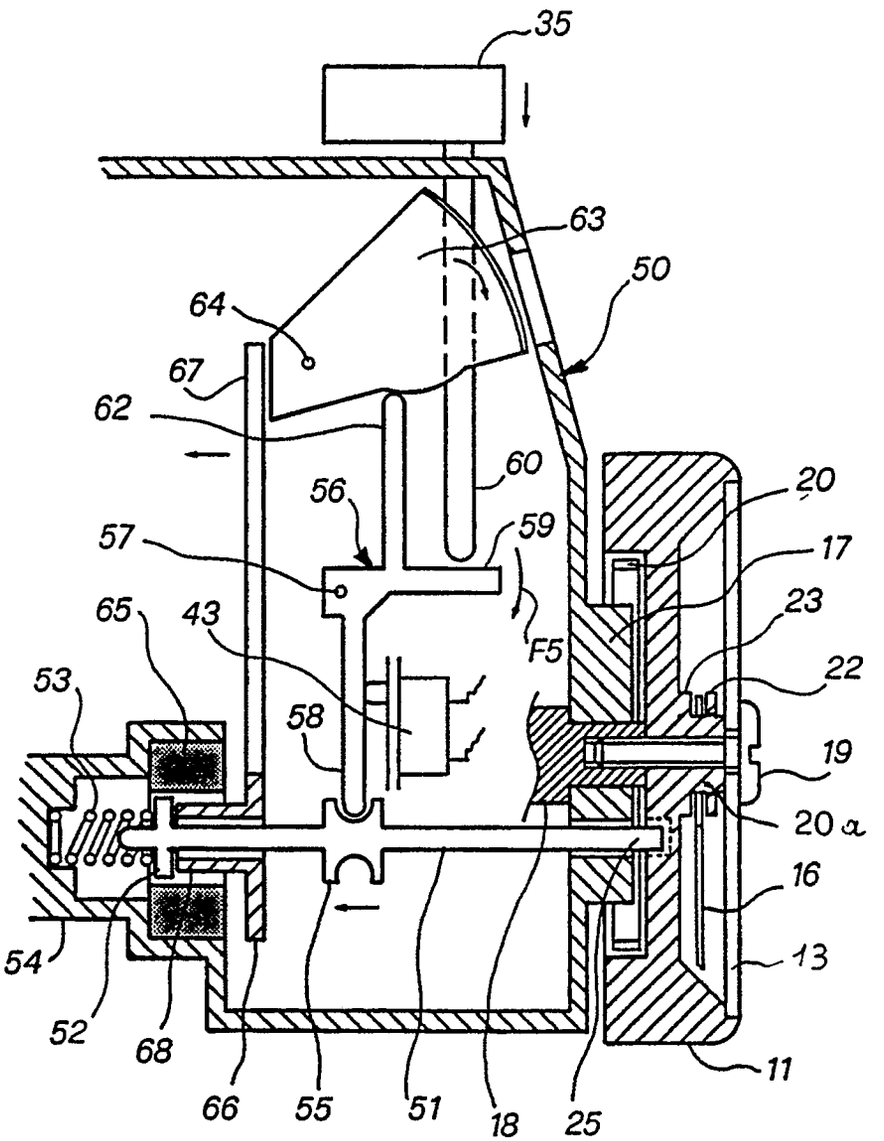
fig. 4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F5
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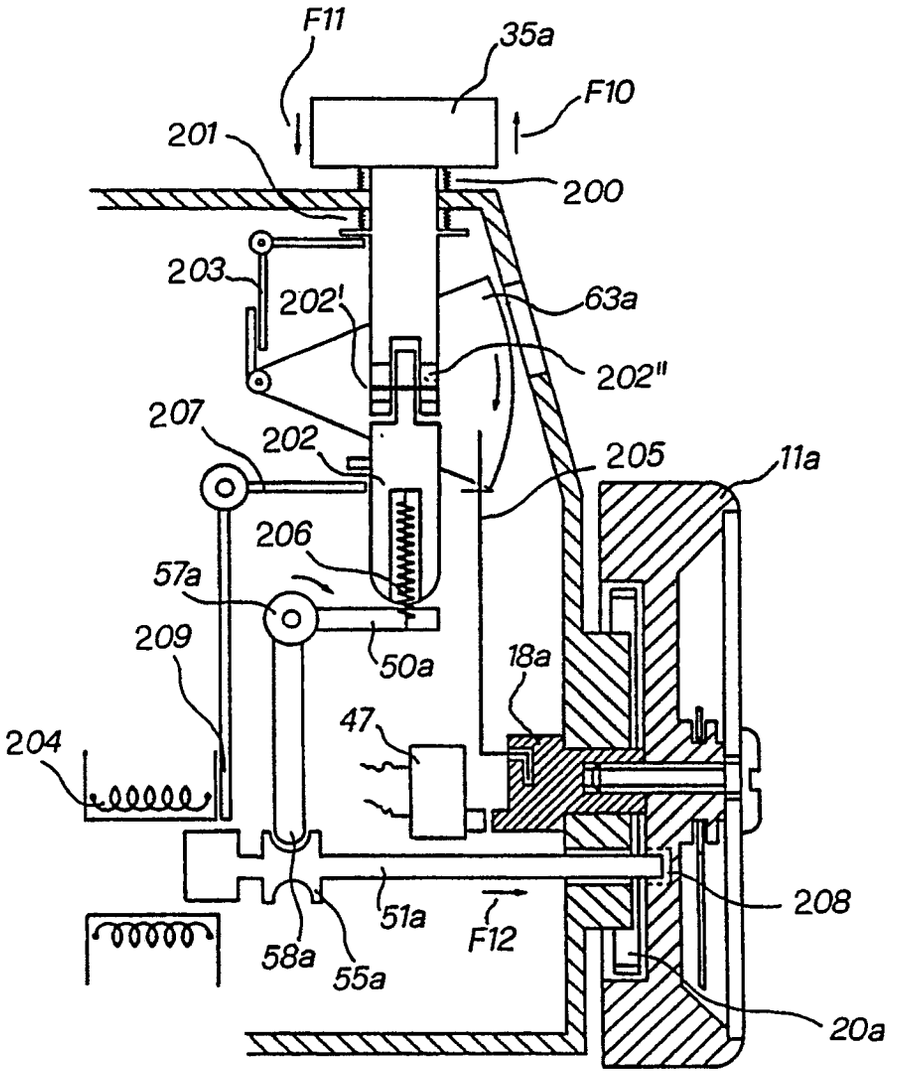
51
18
25
11

fig. 5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202"
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47
204
208
51a
F12
58a
55a
20a

fig. 6