(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 475 128 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
21.03.2012 Bulletin 2012/12

(51) Int Cl.:
A62C 3/02 *(2006.01)*

(21) Application number: **04001631.3**

(22) Date of filing: **27.01.2004**

(54) **Inert gas fire-fighting apparatus and relative method for extinguishing fires**

Inertgasfeuerlöschsystem und Feuerlöschverfahren

Dispositif de lutte contre l'incendie par gaz inerte et méthode de lutte contre l'incendie

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **08.05.2003 IT MI20030925**

(43) Date of publication of application:
10.11.2004 Bulletin 2004/46

(73) Proprietor: **Gastec-Vesta S.r.l.**
20010 Pogliano Milanese MI (IT)

(72) Inventor: **Moscatelli, Filippo**
20017 Rho (Milano) (IT)

(74) Representative: **Petruzziello, Aldo et al**
Racheli S.r.l.
Viale San Michele del Carso, 4
20144 Milano (IT)

(56) References cited:
EP-A- 1 312 392
US-A1- 2002 040 940
US-A1- 2002 139 542
US-B1- 6 257 341

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 475 128 B1

Description

[0001] The present invention refers to an inert gas fire-fighting apparatus and a relative method for extinguishing fires.

[0002] Total flooding technology is based on the introduction of inert gas into the room involved in the fire. The inert gas saturates the environment of the room causing the percentage of oxygen to decrease in such a manner as to cause the self-extinguishing of the fire.

[0003] To extinguish fires in closed environments wherein people are present, such technology presupposes that, after release of the inert gas, a certain percentage of oxygen necessary for people present in the room to breathe is maintained.

[0004] Inert gas fire-fighting apparatuses of the prior art are currently made up of the following items:

- one or more banks of cylinders containing a certain amount of extinguishing gas,
- two or more smoke detectors disposed in the room in which the fire is to be detected, and
- a fire detecting and extinguishing station operatively connected to the smoke detectors and to the banks of cylinders.

[0005] The amount of inert extinguishing gas contained in the cylinders is such as to ensure both that the fire is extinguished and that people can remain in the room. In fact, it is necessary to ensure that, after release of the extinguishing gas contained in the cylinders, a volume percentage of residual oxygen of about 12% is maintained in the room. This percentage of oxygen is sufficient to ensure both that the fire is extinguished and that people present in the room can breathe properly.

[0006] Operation of said apparatuses according to the prior art takes place according to the following procedure:

- a first smoke detector sends a pre-alarm signal to the station,
- in the event of fire, a second smoke detector confirms this event,
- on receiving the confirmation signal, the station begins an extinguishing gas discharge sequence,
- when 20/30 seconds have passed from receipt of the confirmation signal, the station sets actuation means that control discharge by acting on the valve of a pilot cylinder.

[0007] Said actuation means causes total discharge of the extinguishing agent contained in the cylinders until they are completely emptied, without any possibility of intercepting or interrupting release.

[0008] As said previously, the amount of extinguishing agent to be stored in the cylinders must be such as to allow:

- extinguishing of the fire, and
- maintaining a percentage of residual oxygen of about 12% in volume in the room to be protected, to allow people to remain in the room and to ensure an extinguishing concentration for at least 10 minutes from when discharge of the extinguishing agent took place.

[0009] Total flooding fire-fighting apparatuses are conventionally designed and sized taking into account the overall volume of the room, without considering the furnishings and/or the volume of the material to be protected.

[0010] Sometimes the furnishings and the goods to be protected can occupy such a volume as to reduce substantially the gross volume of the room causing, in the event of fire, an excessive concentration of extinguishing agent and, consequently, a reduction in the residual oxygen, which proves insufficient for people present in the room to breathe.

[0011] In some cases, also, the leakage of extinguishing gas due to wear on the seals of casings is such that the amount of extinguishing agent released into the room to be protected is insufficient to extinguish the fire.

[0012] All these factors can have a decisive influence on the percentage of residual oxygen that, on the contrary, should always be constant for the reasons set forth above.

[0013] US 2002/0040940 discloses an inerting apparatus for reducing the risk of and for extinguishing fires in enclosed space which includes a first system for producing the oxygen-expulsion gas or for extracting oxygen from the enclosed space, a second system for rapidly feeding an oxygen-expulsion gas into the space being monitored, a fire detection device, a control unit which sends a base inerting signal to the first system in accordance with the oxygen content in the enclosed space, and which sends a complete inerting signal to the second system in accordance with a detection signal from the fire detection device.

[0014] EP 1312392 discloses a method for extinguishing a fire in a tunnel by isolating the site of the fire by curtains (6,8) upon a fire detection signal to give a zone (14) for action, flooding the zone with an inert gas through flow openings from an external gas supply (31) to reduce the oxygen volume to an inert level, extracting smoke and fumes by suction (25) without affecting the inert level. A control unit (23) is linked to a smoke detector (5) and oxygen monitor (22) to assess the oxygen content in the zone and set the flow of fire extinguishing gas accordingly.

[0015] The object of the present invention is to overcome the drawbacks of the prior art by providing an inert gas fire-fighting apparatus and a relative method for extinguishing fires able to maintain a substantially constant residual percentage of oxygen when the volume to be flooded or the planned concentrations of the extinguishing agent varies.

[0016] This object is achieved in accordance with the

invention with the apparatus and the method according to appended independent claims 1 and 11, respectively.

[0017] Advantageous embodiments of the invention are apparent from the dependent claims.

[0018] The inert gas fire-fighting apparatus according to the invention comprises:

- a plurality of cylinders containing an inert gas of the extinguishing type (such as, for example, nitrogen or argon), connected to a plurality of delivery nozzles suitable to deliver the inert gas into a room, and
- a fire detecting/extinguishing station able to receive control signals indicating a fire alarm and to send accordingly control signals to first actuator means able to actuate discharge of the extinguishing gas from the cylinders towards the deliver nozzles.

[0019] The peculiar characteristic of the invention is represented by the fact that the fire-fighting apparatus further comprises:

- air sensor means able to detect the percentage volume of at least one component of the air inside the room, and
- a station for detection of the concentration of oxygen, of extinguishing gas or of another component of the air able to acquire data indicating the percentage volume of oxygen, of inert gas or of another component of the air detected by the air sensor means and to send accordingly control signals to second actuator means able to open/close the flow of extinguishing gas towards the delivery nozzles.

[0020] In this way, during release of the extinguishing gas, the percentage of oxygen inside the room is maintained above a [first] threshold value ensuring that the air is breathable and below a [second] threshold value ensuring that the fire is extinguished.

[0021] Further characteristics of the invention will be made clearer by the detailed disclosure which follows, referring to a purely exemplary and therefore non-limiting embodiment thereof, illustrated in the appended drawings, in which:

- Figure 1 is a perspective view diagrammatically illustrating a fire-fighting apparatus according to the invention;
- Figure 2 is a block diagram illustrating diagrammatically an oxygen control station connected to an oxygen sensor and to a solenoid actuator, forming part of the fire-fighting apparatus according to the invention; and
- Figure 3 is a diagrammatic view illustrating the connection in cascade of a bank of cylinders of the fire-fighting apparatus according to the invention.

[0022] The fire-fighting device according to the invention is described with the aid of the figures.

[0023] Figure 1 diagrammatically illustrates a fire-fighting apparatus according to the invention, indicated as a whole with reference numeral 100. The fire-fighting apparatus 100 is applied to a room 1, illustrated by way of example as a closed, parallelepiped shaped room. The room 1 is provided with an access door 2 in the front wall and can be provided with windows (not shown) in the side walls.

[0024] Outside the room 1, near a side wall of the room 1, there is disposed a bank of cylinders 10. Each cylinder 10 contains an inert gas, such as argon, for example, able to saturate the air, so as to lower the content of oxygen in order to cause extinguishing of the fire.

[0025] As shown better in Figure 3, at the top of each cylinder 10 there is mounted a fast-opening discharge valve 20, able to open/close the communication between the inside of the cylinder 10 and an exit or discharge mouth 21 thereof. Such a discharge valve 20 is described in detail in European patent application No. 02425312.2 in the name of the same applicant and incorporated herein as a reference.

[0026] Returning to Figure 1, the discharge mouths 21 of each valve 20 are connected to respective flexible hoses 11. The hoses 11 are connected to a manifold 12 which branches off into a plurality of branch pipes or ducts 13 disposed in the roof of the room 1. Connected to the branch pipes 13 there is a plurality of discharge nozzles 14 disposed beneath the roof of the room and able to release the inert gas coming from the cylinders 10 inside the room 1.

[0027] In the manifold 12, downstream of the discharge hoses 11 coming from the cylinders 10, a line switch 15 is installed, which signals the flow of gas towards the discharge nozzles 14 in the event of actuation of the valves 20 of the cylinders.

[0028] A plurality of smoke detectors 6 able to detect the presence of smoke inside the room 1 is applied to the inside facing surface of the roof of the room 1. Even if four smoke detectors 6 are shown in Figure 1, the number of these detectors can vary according to the volume to be controlled.

[0029] The smoke detectors 6 are preferably disposed on the roof in a high position, since the smoke developed by fire tends to rise upwards.

[0030] The smoke detectors 6 are operatively connected to a fire detecting/extinguishing station 7 disposed in a wall of the room 1 and accessible to an operator. The smoke detectors 6 are connected to the detecting/extinguishing station 7 by means of electrical cables 60 able to convey a control signal to the station 7 in response to the detection of smoke by the detectors 6.

[0031] An alarm push-button 8 with an electric/manual switch and an acoustic/optical alarm 9 are connected to the detecting/extinguishing station 7 by means of respective electrical cables 80 and 90.

[0032] The push-button 8 is disposed in a wall of the room 1, in a position accessible to the user. In this manner, in the event of fire the user can operate the push-

button 8 to send a control signal indicating a fire alarm to the station 7 through the electrical line 80.

[0033] The alarm 9 is disposed in a wall of the room 1 in a position visible to the user. In this manner, when the station 7 receives a control signal indicating a fire from the smoke detectors 6 and/or from the alarm push-button 8, it sends a control signal by means of the electrical line 90 to the alarm 9, which gives out an acoustic and/or an optical alarm signal.

[0034] The detecting/extinguishing station 7 is connected, by means of the electrical line 70, to the actuating apparatus of the discharge valves 20 of the cylinders 10 to control discharge of the extinguishing gas.

[0035] In particular, the electrical line 70 coming from the station 7 is connected to a solenoid valve 22 installed in the discharge valve 20 of a pilot cylinder 10, that is to say, of the first cylinder of the bank of cylinders 10. The solenoid valve 22 has an outlet 23 communicating with the inside of the cylinder 10 and a gate pin which opens/closes the outlet 23. This gate pin is moved by a solenoid actuator controlled by a control signal coming from the station 7 through the electrical line 70.

[0036] Inside the room 1 there are installed oxygen sensors 4 able to detect accurately the percentage volume of oxygen contained in the room 1. The oxygen sensors 4 can be three in number, for example, situated in various positions in the room 1.

[0037] The oxygen sensors 4 are connected, by means of an electrical line 40, to an oxygen detection station 3, which is situated in a wall of the room 1. The oxygen detection station 3 is connected, by means of an electrical line 30, to an apparatus for closing the discharge valves 20 of the bank of cylinders.

[0038] In particular, the electrical line 30 sends a control signal from the oxygen detection station 3 to a second solenoid valve 5 installed on the pilot discharge valve 20 of the first cylinder 10 of the bank.

[0039] With reference to Figure 2, the oxygen sensor block 4 comprises:

- a group of LED 41 to signal operation of the sensor 4,
- a power supply 42 to supply the electronics of the sensor 4,
- an interface 43 to exchange signals and data with the oxygen detection station 3,
- an oxygen sensor proper 44 to detect the oxygen concentration in the room 1, and
- a temperature sensor 45 to detect the temperature in the room 1.

[0040] The block of the oxygen detection station 3 comprises:

- a group of LED 31 to signal operation of the station 3,
- a power supply 32 to supply the electronics of the station 3,
- a first interface 33 to exchange signals and data with the oxygen sensors 4,
- a control panel 36 provided with alphanumerical display to display information,
- a second interface 37 to exchange signals with the second solenoid valve 5,
- a CPU 38 to process the data received from the oxygen sensors 4, and
- a memory 39 to store data entered by the operator.

[0041] A minimum threshold value S_{min} pre-set by the operator is stored in the memory 39. The minimum threshold value S_{min} is equal to a minimum percentage volume of oxygen. S_{min} is pre-set to a percentage volume value of oxygen comprised in a range of 12-14%, preferably between 12 - 13%.

[0042] A maximum threshold value S_{max} pre-set by the operator is also optionally stored in the memory 39. The maximum threshold value S_{max} is equal to a maximum percentage volume of oxygen above which saturation of the air suitable to extinguish the flames of a fire cannot be guaranteed. S_{max} is pre-set to a percentage volume value of oxygen comprised in a range of 13 - 15 %, preferably between 13 - 14%.

[0043] Clearly the S_{max} value must be greater than the S_{min} value.

[0044] Furthermore, a time interval T is optionally pre-set in the memory 39, sufficient to ensure that fire is extinguished completely when air saturated with an oxygen percentage of about 12% is maintained. This time interval can be selected in a range from 5 to 15 minutes and preferably it is not less than 10 minutes.

[0045] When discharge of the extinguishing gas is actuated, the oxygen detection station 3 is put into operation and acquires from the sensors 4 in real time, through the line 40, the data indicating the percentage volume of oxygen. The CPU 38 processes the data acquired and compares them in real time with the minimum threshold value S_{min}. If the value for the percentage volume of oxygen falls below S_{min} the CPU 38, through the interface 37 and the line 30, sends a control signal to the second solenoid valve 5 to order closure thereof.

[0046] If in the time interval T starting from closure of the solenoid valve 5 the value for percentage volume of oxygen exceeds the second threshold S_{max}, the CPU 38 sends another control signal to the second solenoid valve 5 through the interface 37 and the line 30 to order reopening thereof.

[0047] Once the time T has passed, the oxygen detection station 3 is reset.

[0048] Clearly, instead of the oxygen sensors 4 air sensors able to measure another component of air, such as nitrogen, carbon dioxide or argon, for example, could be used. Accordingly, said air sensors send the oxygen detection station 3 a signal indicating the air component measured. Thus the oxygen detection station 3 indirectly works out the percentage of oxygen contained in the room 1.

[0049] In this case the oxygen detection station 3 has in its memory 39 a conversion table able to convert the

percentage of the air component detected into a percentage of oxygen.

[0050] The second solenoid valve 5 comprises an inlet 51, an outlet 52 and a gate pin which opens/closes the communication between the inlet 51 and the outlet 52. The gate pin is driven by a solenoid actuator controlled by a control signal coming from the oxygen detection station 3 through the electrical line 30.

[0051] The solenoid valve 5 can be a three-way valve and can therefore provide a third exhaust outlet 53 (Figure 2) that serves for depressurization of the upper chamber of the piston of the discharge valve 20.

[0052] With reference to Figure 3, the discharge valves 20 of the cylinders 10 has a cover 24, at the top of which there is mounted a T-connector 25 communicating with the upper chamber of the plunger/gate pin of the respective discharge valve 20.

[0053] The outlet 52 of the second solenoid valve 5 is connected to the inlet of the T-connector 25 of the pilot valve.

[0054] The outlet of the T-connector 25 of the pilot valve is connected, by means of a hose 27, to the inlet of the T-connector 25 of the second valve and so on, so as to connect all the valves 20 of the bank of cylinders 10 in cascade. The outlet of the T-connector 25 of the last cylinder 10 of the bank is closed by an exhaust valve 26.

[0055] Returning to the pilot discharge valve 20, the outlet of the first solenoid valve 22 is connected by means of a hose 28 to the inlet of a pneumatic actuator 29 installed in the discharge valve 20. The pneumatic actuator 29 has a stem able to break a breakable disk inside the discharge valve 20 to allow the passage of gas inside a duct of the discharge valve 20.

[0056] The outlet of the pneumatic actuator 29 is connected by means of a flexible hose 56 to the inlet 51 of the second solenoid valve 5.

[0057] With reference now in particular to Figures 1 and 3, operation of the fire-fighting apparatus 100 is described.

[0058] Under normal conditions, the first solenoid valve 22 of the pilot discharge valve 20 is normally closed, whilst the second solenoid valve 5 of the pilot discharge valve 20 is normally open.

[0059] When a fire or a fire beginning breaks out in room 1, the smoke detectors 6 detect the presence of smoke and, accordingly, they send an alarm signal to the detecting/extinguishing station 7 through the electrical lines 60. Generally, a first alarm signal is sent from a first detector 6 and a second confirmation alarm signal from a second detector 6.

[0060] As an alternative to or in combination with the alarm signal from the smoke detectors 6, a further alarm signal coming from the alarm push-button 8, operated by a user, can reach the detecting/extinguishing station 7 through the electrical line 80.

[0061] Once the alarm signal and the alarm confirmation signal have been received the detecting/extinguishing station 7, through the electrical line 90, sends a control signal to the acoustic/optical alarm 9 which gives off an acoustic or an optical alarm signal to warn people inside the room 1 of the danger of fire.

[0062] At the same time, the detecting/extinguishing station 7 sends the first solenoid valve 22 of the pilot discharge valve 20 a control signal through the electrical line 70. As a result, the solenoid actuator operates the gate pin of the first solenoid valve 22.

[0063] Then the first solenoid valve 22, which was normally closed, opens and the gas inside the first cylinder 10 passes through the first solenoid valve 22 and the hose 28 and reaches the pneumatic actuator 29. As a result, the gas operates the steam of the pneumatic actuator 29, which breaks the breakable disk inside the discharge valve 20 allowing the passage of gas.

[0064] Consequently, the gas leaves the pneumatic actuator 28 through the hose 56, passes through the second solenoid valve 5 which is normally open and then it passes through the T-connectors 25 and the hoses 27 for connection in cascade, so as to reach the upper chamber of the piston of each valve 20 of the bank of cylinders. As a result the gate pins of all the discharge valves 20 are operated in cascade and discharge of the extinguishing gas from the discharge mouths 21 of all the cylinders of the bank takes place.

[0065] Through the hoses 11, the manifold 12 and the branch ducts 13 the extinguishing gas reaches the discharge nozzles 14 from which it exits, spreading in to the room 1. As a result, as the extinguishing gas spreads in the room 1, there is a gradual saturation of the oxygen contained in the room 1. Thus the percentage volume of oxygen in the room 1 begins to fall.

[0066] During the introduction of inert gas into the room 1, the oxygen sensors 4 continuously detect the percentage volume of oxygen present in the room 1 and, through the electrical line 40, send the oxygen detection station 3 data indicating the oxygen values detected. In the oxygen detection station 3, the data indicating the percentage volume of oxygen coming from the oxygen sensors 4 is compared with the pre-set minimum threshold value S_{min}.

[0067] When a percentage volume of oxygen below about 13-14% is reached in the room 1, the process of extinguishing the fire, which no longer has sufficient oxygen for the combustion process, begins.

[0068] If there is any gas remaining in the cylinders 10, this gas continues to be introduced into the room 1. Thus, as a result, the percentage volume of oxygen continues to fall until the pre-set minimum threshold S_{min} is reached. Accordingly, the oxygen detection station 3 sends a control signal through the electrical line 30 to the solenoid actuator of the second solenoid valve 5.

[0069] Consequently, the second solenoid valve 5, which was normally open, closes, cutting off the flow of gas which reaches the head of the valves 20 of the bank of cylinders through the T-connectors 25 and the hoses 27. Accordingly, the upper chamber of [each] piston of

the discharge valves 20 is no longer pressurized and is depressurized by means of the second outlet 53 of the solenoid valve 5. Thus the discharge valves 20 close in cascade interrupting the discharge of gas. As a result, gas is no longer introduced into the room 1 and thus the percentage volume of oxygen does not fall beneath the minimum threshold value S_{min} avoiding risks for people remaining in the room 1.

[0070] Inside the room 1 there may be several doors or windows, which are not able to ensure a tight seal against the outside environment. Thus, inside the room 1 air can enter from the outside and gas can escape to the outside. Therefore, after delivery of gas has been interrupted, the percentage volume of oxygen in the room 1 can increase to reach a value higher than 14-15%, above which fire could flare up again.

[0071] Thus, if within the preset time T starting from closure of the solenoid valve 5 the oxygen sensors 4 detect a percentage of oxygen in the room 1 which reaches the second pre-set threshold value S_{max}, the oxygen detection station 3 sends a control signal to the solenoid actuator of the solenoid valve 5 which closes the depressurisation outlet 53 and opens again the connection between the inlet 51 and the outlet 52, ordering discharge in cascade of all valves of the cylinders. Extinguishing gas is then introduced into the room 1 again, causing the volume percentage of oxygen to fall again.

[0072] With said apparatus, in the time interval T the volume percentage of oxygen in the room 1 remains at a substantially constant value in the range between S_{min} - S_{max}. In this manner, complete extinguishing of the fire and at the same time maximum safety of the operators breathing the air contained in the room 1 is ensured.

[0073] Once time T has passed from closure of the solenoid valve 5, the oxygen detection station 3 is re-set to be ready for a new operating cycle.

[0074] It should be noted that with the fire-fighting apparatus according to the invention, it is not necessary to carry out a precise calibration of the cylinders according to the volume of the room to be controlled. In fact the bank of cylinders 10 can safely be oversized with the addition of reserve cylinders that will be actuated only in case of necessity, that is to say, for example, when there is leakage from the doors or the windows of the room to be controlled.

[0075] Furthermore, the fire-fighting apparatus according to the invention proves particularly suitable to be applied to rooms destined to hold particularly bulky objects, apparatuses and furniture that considerably affect the volume of air contained in the room with respect to an empty room.

[0076] In the present detailed description, the fire detecting/extinguishing station 7 and the oxygen detection station 3 are connected to the respective detector means (6, 4) and to the respective actuator means (22, 5) by means of electrical wiring. However, instead of an electrical wiring, a wireless type connection can be provided.

[0077] Furthermore, the particular embodiment has been illustrated in which the first solenoid valve 22 is installed in the pilot discharge valve 20 and the second solenoid valve 5 is mounted on top of the pilot valve. However, the first solenoid valve 22 can be replaced with generic actuator means able to actuate discharge of the gas contained in the cylinders 10 and the second solenoid valve can be replaced with generic actuator means able to open/close the flow of gas from the cylinders 10 to the discharge nozzles 14.

[0078] Numerous changes and modifications of detail within the reach of a person skilled in the art can be made to the present invention without thereby departing from the scope of the invention as set forth in the appended claims.

Claims

1. An inert gas fire-fighting apparatus (100) comprising:

- a plurality of cylinders (10) containing an inert gas of the extinguishing type, connected to a plurality of delivery nozzles (14) able to deliver the inert gas into a room (1), and
- a fire detecting/extinguishing station (7) able to receive control signals indicating a fire alarm and accordingly to send control signals to first actuator means (22) able to actuate the discharge of extinguishing gas from the cylinders (10) towards the delivery nozzles (14),
- air sensor means (4) able to detect the percentage volume of at least one component of the air in said room (1), and
- an oxygen detection station (3) able to acquire data indicating the percentage volume of a component of air detected by the air sensor means (4) to calculate the percentage of oxygen contained in the room (1) and accordingly to send control signals to second actuator means (5) able to close/open the flow of extinguishing gas towards said delivery nozzles (14),

characterised in that

said air sensor means (4) comprise oxygen sensors able to detect the volume percentage of oxygen in the room (1), said oxygen sensor means (4) comprising a power supply (42), an oxygen sensor (44), a temperature sensor (45) and an output interface (43) operationally connected to a respective acquisition interface (33) of said oxygen detection station (3).

2. An apparatus according to claim 1 **characterised in that** said oxygen detection station (3) comprises:

- a memory (39) to store at least a threshold value (S_{min} , S_{max}) pre-set by the user, indicating a value for the percentage volume of oxygen

and
- a CPU (38) to compare the value of the percentage volume of oxygen detected directly or indirectly by the air sensor means (4) with said at least one pre-set threshold value.

3. An apparatus according to claim 1 or 2, **characterised in that** said oxygen detection station (3) comprises a power supply (32), a control panel (36) and an output interface (37) operatively connected to said second actuator means (5).

4. An apparatus according to any one of the preceding claims **characterised in that** said oxygen sensor means (4) and/or said oxygen detection station (3) comprise optical signalling means (41, 31) to signal their operation.

5. An apparatus according to any one of the preceding claims, **characterised in that** said second actuator means comprise a solenoid valve (5) provided with a solenoid actuator.

6. An apparatus according to claim 5, **characterised in that** said solenoid valve (5) is mounted on top of a pilot discharge valve (20) of a bank of cylinders (10) connected in cascade.

7. An apparatus according to any one of the preceding claims, **characterised in that** said first actuator means comprise a solenoid valve (22) provided with a solenoid actuator mounted in a pilot discharge valve (20) of a bank of cylinders (10) connected in cascade.

8. An apparatus according to any one of the preceding claims, **characterised in that** it comprises smoke detection means (6) able to detect the presence of fire in said room (1) and operatively connected to said detecting/extinguishing station (7).

9. A fire extinguishing method implemented by using the apparatus (100) as defined in any one of the preceding claims comprising the following steps:

- sending a fire alarm signal to a fire detecting/extinguishing station (7), and
- in compliance with receipt of the alarm signal, sending by the fire detecting/extinguishing station (7) of a control signal to first actuator means (22) to actuate discharge of the extinguishing gas inside a room (1),
- detecting continuously the percentage volume of oxygen contained in the room (1) by means of oxygen sensor means (4) as defined in any one of the preceding claims,
- comparing the detected percentage volume of oxygen with at least one pre-set threshold value (S_{min}, S_{max}), and
- according to the result of the comparison, sending of a control signal to second actuator means (5) to open/close the discharge of extinguishing gas inside said room (1)

10. A method according to claim 9, **characterised in that** said comparison step comprises comparison of the detected value for the percentage volume of oxygen with a pre-set minimum threshold value (S_{min}) so that, if the detected value for the percentage volume of oxygen is equal to or less than said pre-set minimum threshold value (S_{min}), a control signal is sent to said second actuator means (5) to shut off the discharge of extinguishing gas.

11. A method according to claim 10, **characterised in that** said pre-set minimum threshold value (S_{min}) is comprised in the range between 12- 14.

12. A method according to claim 11, **characterised in that** said pre-set minimum threshold value (S_{min}) is comprised in the range between 12- 13%.

13. A method according to any one of claims 9 to 12, **characterised in that** said comparison step comprises comparison of the detected value for the percentage volume of oxygen with a pre-set maximum threshold value (S_{max}), so that if the detected value for the percentage volume of oxygen is equal to or greater than said pre-set maximum threshold value (S_{max}), a control signal is sent to said second actuator means (5) to open the discharge of extinguishing gas again.

14. A method according to claim 13, **characterised in that** said pre-set maximum threshold value (S_{max}) is comprised in the range between 13-15

15. A method according to claim 14, **characterised in that** said pre-set maximum threshold value (S_{max}) is comprised in the range between 13-14%.

16. A method according to any one of claims 9 to 15, **characterised in that** said comparison step is performed for a pre-set time interval (T) apt to ensure that the fire is completely extinguished.

17. A method according to claim 16, **characterised in that** said pre-set time interval (T) is comprised in the range between 5-15 minutes.

18. A method according to claim 17, **characterised in that** said pre-set time interval (T) is greater than 10 minutes.

Patentansprüche

1. Inertgasfeuerlöschsystem (100), umfassend:

   - mehrere Zylinder (10), die ein Inertgas zum Löschen enthalten und mit mehreren Abgabedüsen (14) verbunden sind, welche dazu imstande sind, das Inertgas in einen Raum (1) abzugeben, und
   - eine Feuererkennungs-/-löschstation (7), die dazu imstande ist, Steuersignale zu empfangen, welche einen Feueralarm anzeigen, und entsprechend Steuersignale an erste Betätigungsmittel (22) zu senden, die dazu imstande sind, den Austritt von Löschgas aus den Zylindern (10) zu den Abgabedüsen (14) hin auszulösen,
   - Luftsensormittel (4), die dazu imstande sind, den prozentualen Volumenanteil von zumindest einer Komponente der Luft in dem Raum (1) zu erkennen, und
   - eine Sauerstofferkennungsstation (3), die dazu imstande ist, Daten, die den prozentualen Volumenanteil einer Luftkomponente, der durch das Luftsensormittel (4) erkannt ist, zum Berechnen des prozentualen Anteils von Sauerstoff, der in dem Raum (1) enthalten ist, zu erfassen und entsprechend Steuersignale an zweite Betätigungsmittel (5) zu senden, die dazu imstande sind, den Löschgasstrom zu den Abgabedüsen (14) hin zu schließen/zu öffnen,

   dadurch gekennzeichnet, dass
   die Luftsensormittel (4) Sauerstoffsensoren umfassen, die dazu imstande sind, den prozentualen Volumenanteil von Sauerstoff in dem Raum (1) zu erkennen, wobei die Sauerstoffsensormittel (4) eine Stromversorgung (42), einen Sauerstoffsensor (44), einen Temperatursensor (45) und eine Ausgabeschnittstelle (43) umfassen, welche betriebsfähig mit einer jeweiligen Erfassungsschnittstelle (33) der Sauerstofferkennungsstation (3) verbunden ist.

2. System nach Anspruch 1, **dadurch gekennzeichnet, dass** die Sauerstofferkennungsstation (3) Folgendes umfasst:

   - einen Speicher (39) zum Speichern von zumindest einem Schwellenwert (S_{min}, S_{max}); der vom Benutzer voreingestellt ist und einen Wert für den prozentualen Volumenanteil von Sauerstoff angibt; und
   - eine CPU (38) zum Vergleichen des Werts des prozentualen Anteils von Sauerstoff, der direkt oder indirekt durch die Luftsensormittel (4) erkannt ist, mit dem zumindest einen voreingestellten Schwellenwert.

3. System nach einem der Ansprüche 1 oder 2, **dadurch gekennzeichnet, dass** die Sauerstofferkennungsstation (3) eine Stromversorgung (32), eine Steuerkonsole (36) und eine Ausgabeschnittstelle (37) umfasst, die betriebsfähig mit den zweiten Betätigungsmitteln (5) verbunden ist.

4. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Sauerstoffsensormittel (4) und/oder die Sauerstofferkennungsstation (3) optische Signalmittel (41, 31) zum Signalisieren ihres Betriebs umfassen.

5. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die zweiten Betätigungsmittel ein Magnetventil (5) umfassen, das mit einem Magnetantrieb versehen ist.

6. System nach Anspruch 5, **dadurch gekennzeichnet, dass** das Magnetventil (5) auf einem Pilotauslassventil (20) einer Zylinderreihe (10) in Kaskadenverbindung angebracht ist.

7. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die ersten Betätigungsmittel ein Magnetventil (22) umfassen, das mit einem Magnetantrieb versehen ist, welcher auf einem Pilotauslassventil (20) einer Zylinderreihe (10) in Kaskadenverbindung angebracht ist.

8. System nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es Raucherkennungsmittel (6) umfasst, die dazu imstande sind, das Vorhandensein von Feuer in dem Raum (1) zu erkennen, und die betriebsfähig mit der Erkennung-/- löschstation (7) verbunden sind.

9. Feuerlöschverfahren, das unter Benutzung des Systems (100) wie in einem der vorhergehenden Ansprüche definiert umgesetzt ist, folgende Schritte umfassend:

   - Senden eines Feueralarmsignals an eine Feuererkennungs-/-löschstation (7), und
   - in Übereinstimmung mit dem Empfang des Alarmsignals, Senden eines Steuersignals durch die Feuererkennungs-/-löschstation (7) an erste Betätigungsmittel (22) zum Auslösen des Austritts des Löschgases innerhalb eines Raums (1),
   - fortlaufendes Erkennen des prozentualen Volumenanteils von Sauerstoff, der in dem Raum (1) enthalten ist, mithilfe von Sauerstoffsensormitteln (4) wie in einem der vorhergehenden Ansprüche definiert,
   - Vergleichen des erkannten prozentualen Volumenanteils von Sauerstoff mit zumindest einem voreingestellten Schwellenwert (S_{min}, S_{max}), und

- entsprechend dem Ergebnis des Vergleichs, Senden eines Steuersignals an zweite Betätigungsmittel (5) zum Öffnen/Schließen des Austritts von Löschgas innerhalb des Raums (1).

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** der Vergleichsschritt den Vergleich des erkannten Werts für den prozentualen Volumenanteil von Sauerstoff mit einem voreingestellten Mindestschwellenwert (S_{min}) umfasst, sodass, wenn der erkannte Wert für den prozentualen Volumenanteil von Sauerstoff gleich dem oder kleiner als der voreingestellte Mindestschwellenwert (S_{min}) ist, ein Steuersignal zum Abschalten des Austritts von Löschgas an die zweiten Betätigungsmittel (5) gesendet wird.

11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** sich der voreingestellte Mindestschwellenwert (S_{min}) im Bereich zwischen 12 und 14 befindet.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** sich der voreingestellte Mindestschwellenwert (S_{min}) im Bereich zwischen 12 und 13% befindet.

13. Verfahren nach einem der Ansprüche 9 bis 12, **dadurch gekennzeichnet, dass** der Vergleichsschritt den Vergleich des erkannten Werts für den prozentualen Volumenanteil von Sauerstoff mit einem voreingestellten Höchstschwellenwert (S_{max}) umfasst, sodass, wenn der erkannte Wert für den prozentualen Volumenanteil von Sauerstoff gleich dem oder größer als der voreingestellte Höchstschwellenwert (S_{max}) ist, ein Steuersignal zum erneuten Öffnen des Austritts von Löschgas an die zweiten Betätigungsmittel (5) gesendet wird.

14. Verfahren nach Anspruch 13, **dadurch gekennzeichnet, dass** sich der voreingestellte Höchstschwellenwert (S_{max}) im Bereich zwischen 13 und 15 befindet.

15. Verfahren nach Anspruch 14, **dadurch gekennzeichnet, dass** sich der voreingestellte Höchstschwellenwert (S_{max}) im Bereich zwischen 13 und 14% befindet.

16. Verfahren nach einem der Ansprüche 9 bis 15, **dadurch gekennzeichnet, dass** der Vergleichsschritt für einen voreingestellten Zeitraum (T) ausgeführt wird, der zu gewährleisten geeignet ist, dass das Feuer vollständig gelöscht wird.

17. Verfahren nach Anspruch 16, **dadurch gekennzeichnet, dass** sich der voreingestellte Zeitraum (T) im Bereich zwischen 5 bis 15 Minuten befindet.

18. Verfahren nach Anspruch 17, **dadurch gekennzeichnet, dass** der voreingestellte Zeitraum (T) größer als 10 Minuten ist.

Revendications

1. Un dispositif de lutte contre l'incendie par gaz inerte (100) comprenant :

- une pluralité de bouteilles (10) contenant un gaz inerte de type extincteur, raccordée à une pluralité de buses de décharge (14) capables de délivrer le gaz inerte dans un local (1), et
- un poste de détection/ lutte contre l'incendie (7) capable de recevoir des signaux de commande indiquant une alarme d'incendie et de ce fait d'envoyer des signaux de commande à un premier élément d'actionneur (22) capable d'actionner la décharge du gaz extincteur depuis les bouteilles (10) vers les buses de décharge (14),
- un élément de capteur d'air (4) capable de détecter le pourcentage de volume d'au moins un composant de l'air dans ledit local (1), et
- un poste de détection d'oxygène (3) capable d'acquérir des données indiquant le pourcentage de volume d'un composant de l'air détecté par l'élément de capteur d'air (4) pour calculer le pourcentage d'oxygène contenu dans le local (1) et de ce fait d'envoyer des signaux de commande au deuxième élément d'actionneur (5) capable de fermer/d'ouvrir l'écoulement du gaz extincteur vers lesdites buses de décharge (14),

caractérisé en ce que
lesdits éléments de capteur d'air (4) comprennent des capteurs d'oxygène capables de détecter le pourcentage de volume d'oxygène dans le local (1), lesdits éléments de capteur d'oxygène (4) comprenant une alimentation électrique (42), un capteur d'oxygène (44), un capteur de température (45) et une interface de sortie (43) connectée de façon fonctionnelle à une interface d'acquisition respective (33) dudit poste de détection d'oxygène (3).

2. Un dispositif selon la revendication 1 **caractérisé en ce que** ledit poste de détection d'oxygène (3) comprend :

- une mémoire (39) pour mémoriser au moins une valeur seuil (S_{min}, S_{max}) prédéfinie par l'utilisateur, indiquant une valeur pour le pourcentage de volume d'oxygène et
- une CPU (38) pour comparer la valeur du pourcentage de volume d'oxygène détecté directement ou indirectement par l'élément de capteur d'air (4) avec au moins une dite valeur de seuil prédéfinie.

3. Un dispositif selon la revendication 1 ou 2 **caractérisé en ce que** ledit poste de détection d'oxygène (3) comprend une alimentation électrique (32), un tableau de commande (36) et une interface de sortie (37) raccordés de façon fonctionnelle audit deuxième élément d'actionneur (5).

4. Un dispositif selon l'une des revendications précédentes **caractérisé en ce que** ledit élément capteur d'oxygène (4) et/ou ledit poste de détection d'oxygène (3) comprennent des moyens de signalisation optiques (41, 31) pour signaler leur fonctionnement.

5. Un dispositif selon l'une des revendications précédentes **caractérisé en ce que** ledit deuxième élément d'actionneur comprend une électrovanne (5) munie d'un actionneur à solénoïde.

6. Un dispositif selon la revendication 5 **caractérisé en ce que** ladite électrovanne (5) est montée sur le haut d'une soupape de décharge pilotée (20) d'une rangée de bouteilles (10) raccordées en cascade.

7. Un dispositif selon l'une des revendications précédentes **caractérisé en ce que** ledit premier élément d'actionneur comprend une électrovanne (22) munie d'un actionneur à solénoïde monté dans une soupape de décharge pilotée (20) d'une rangée de bouteilles (10) raccordées en cascade.

8. Un dispositif selon l'une des revendications précédentes **caractérisé en ce qu'**il comprend des moyens de détection de fumées (6) capables de détecter la présence de feu dans ledit local (1) et raccordés de façon fonctionnelle audit poste de détection/de lutte contre l'incendie (7).

9. Une méthode de lutte contre l'incendie mise en oeuvre en utilisant le dispositif (100) tel qu'il est défini dans une des revendications précédentes, comprenant les étapes suivantes :

- envoi d'un signal d'alarme d'incendie à un poste de détection/de lutte contre l'incendie (7) et
- conformément à la réception du signal d'alarme, envoi par le poste de détection/de lutte contre l'incendie (7) d'un signal de commande au premier élément d'actionneur (22) pour actionner la décharge du gaz extincteur à l'intérieur du local (1),
- détection en continu d'un pourcentage du volume d'oxygène contenu dans le local (1) au moyen d'un élément de capteur d'oxygène (4) tel que défini dans une des revendications précédentes,
- comparaison du pourcentage de volume d'oxygène avec au moins une valeur de seuil (S_{min}, S_{max}) prédéfinie, et
- selon le résultat de la comparaison, envoi d'un signal de commande au deuxième élément d'actionneur (5) pour ouvrir/fermer la décharge du gaz extincteur à l'intérieur dudit local (1).

10. Une méthode selon la revendication 9 **caractérisée en ce que** ladite phase de comparaison comprend la comparaison de la valeur détectée pour le pourcentage de volume d'oxygène à la valeur de seuil minimum (S_{min}) prédéfinie de sorte que, si la valeur détectée pour le pourcentage de volume d'oxygène est égale ou inférieure à ladite valeur de seuil minimum (S_{min}) prédéfinie, un signal de commande est envoyé audit deuxième élément d'actionneur (5) pour arrêter la décharge de gaz extincteur.

11. Une méthode selon la revendication 10 **caractérisée en ce que** ladite valeur de seuil minimum (S_{min}) prédéfinie est comprise dans la gamme de 12 - 14.

12. Une méthode selon la revendication 11 **caractérisée en ce que** ladite valeur de seuil minimum (S_{min}) prédéfinie est comprise dans la gamme de 12 - 13 %.

13. Une méthode selon l'une des revendications 9 à 12 **caractérisée en ce que** ladite phase de comparaison comprend la comparaison de la valeur détectée pour le pourcentage de volume d'oxygène à la valeur de seuil maximum (S_{max}) prédéfinie de sorte que si la valeur détectée du pourcentage de volume d'oxygène est égale ou supérieure à ladite valeur seuil maximum (S_{max}) prédéfinie, un signal de commande est envoyé audit deuxième élément d'actionneur (5) pour ouvrir à nouveau la décharge de gaz extincteur.

14. Une méthode selon la revendication 13 **caractérisée en ce que** ladite valeur de seuil maximum (S_{max}) prédéfinie est comprise dans la gamme de 13-15.

15. Une méthode selon la revendication 14 **caractérisée en ce que** ladite valeur de seuil maximum (S_{max}) prédéfinie est comprise dans la gamme de 13 -14 %.

16. Une méthode selon l'une des revendications 9 à 15 **caractérisée en ce que** ladite phase de comparaison est effectuée pendant un intervalle de temps (T) prédéfini de nature à assurer que l'incendie est complètement éteint.

17. Une méthode selon la revendication 16 **caractérisée en ce que** ledit intervalle de temps (T) prédéfini est compris dans la gamme de 5 - 15 minutes.

18. Une méthode selon la revendication 17 **caractérisée en ce que** ledit intervalle de temps (T) prédéfini est supérieur à 10 minutes.

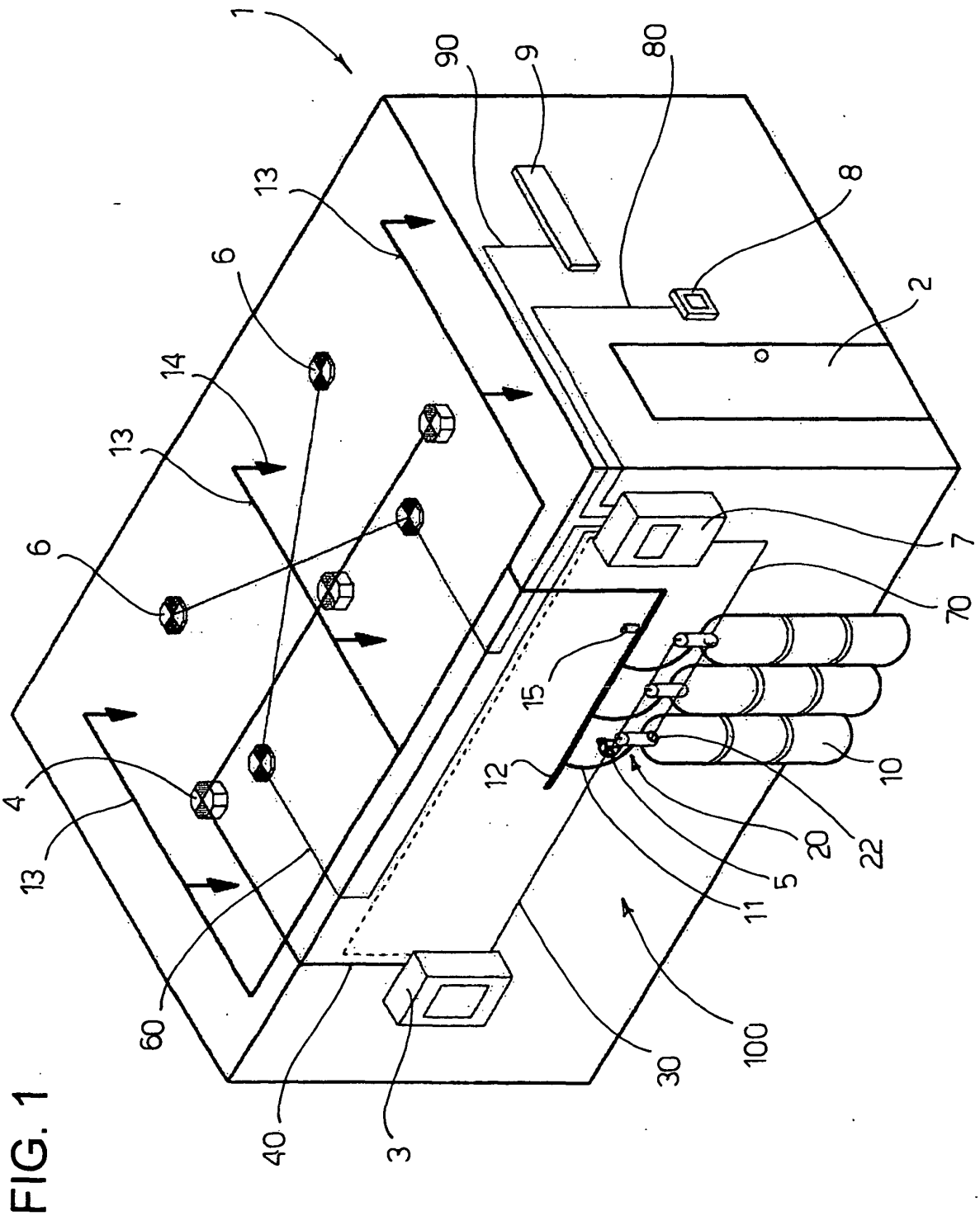


FIG. 1

FIG. 2

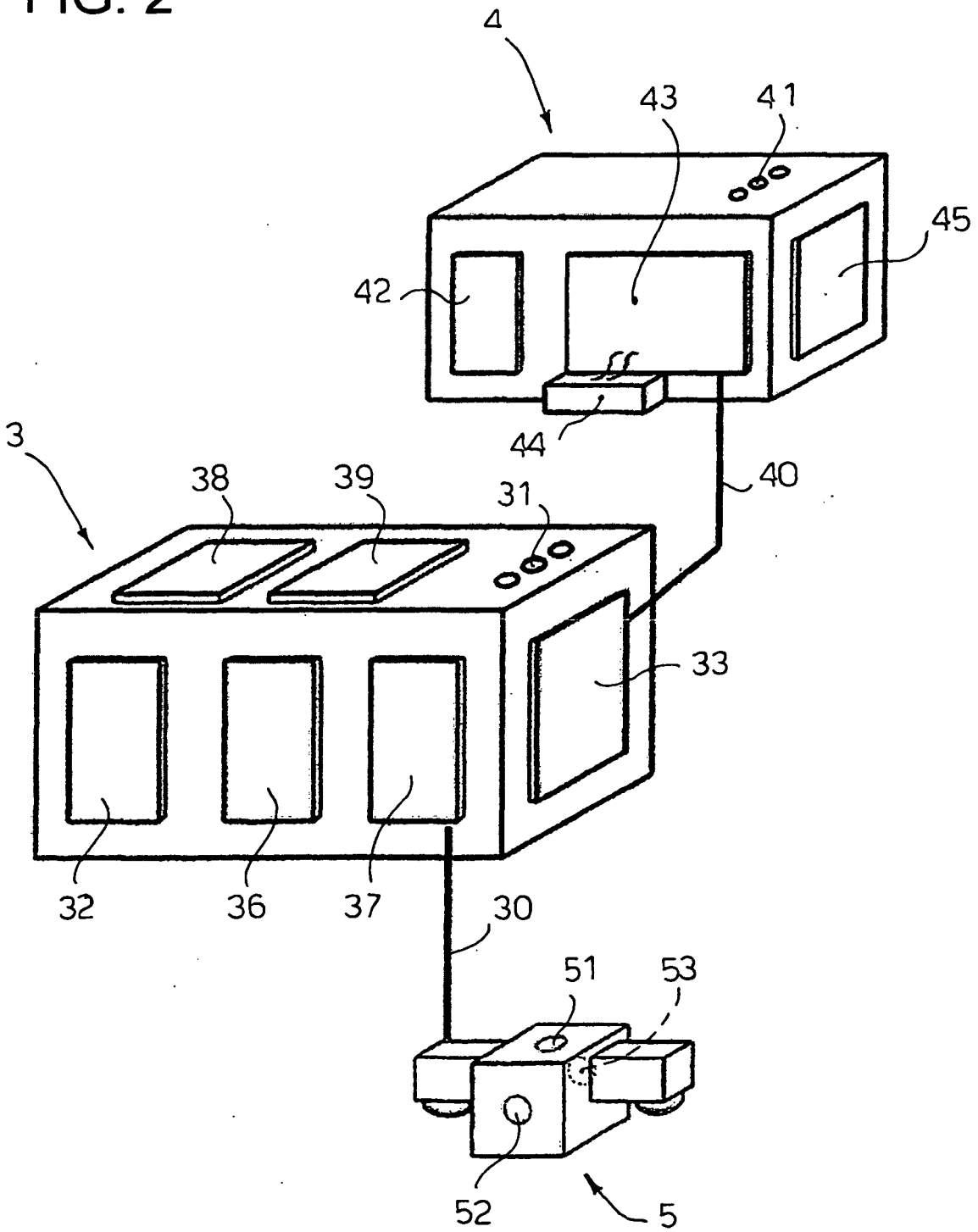
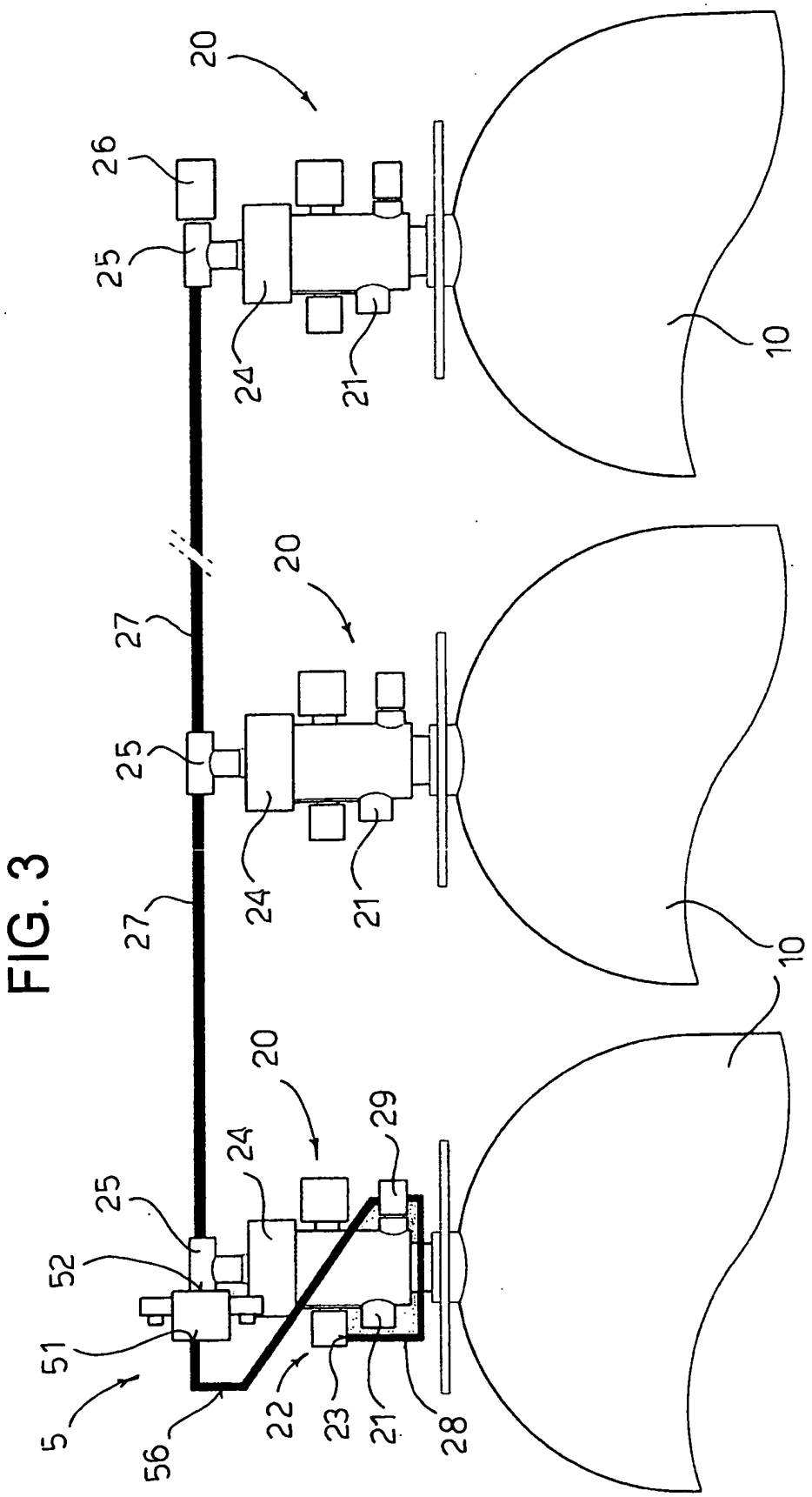


FIG. 3


20
26
25
24
21
10
20
27
25
24
21
27
10
20
24
29
25
52
51
5
56
22
23
21
28
10

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20020040940 A **[0013]**
- EP 1312392 A **[0014]**
- EP 02425312 A **[0025]**