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

(11) **EP 4 245 944 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
04.09.2024 Bulletin 2024/36

(21) Application number: **23161132.8**

(22) Date of filing: **10.03.2023**

(51) International Patent Classification (IPC):
E04F 17/04 *(2006.01)* ***E04F 17/02*** *(2006.01)*
F24F 11/30 *(2018.01)* ***F24F 11/50*** *(2018.01)*
F24F 13/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E04F 17/04; E04F 17/02; F24F 7/06; F24F 11/33; F24F 11/34

(54) **PRESSURIZATION SYSTEM FOR A STAIRWELL**

DRUCKBEAUFSCHLAGUNGSSYSTEM FÜR EIN TREPPENHAUS

SYSTÈME DE MISE SOUS PRESSION POUR UN PUITS D'ESCALIER

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

(30) Priority: **17.03.2022 IT 202200005258**

(43) Date of publication of application:
20.09.2023 Bulletin 2023/38

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EP 4 245 944 B1

Description

Technical field of the Invention

[0001] The present invention relates to an innovative system for pressurizing a predetermined environment in order to limit the spread of smoke in the event of a fire. In particular, the system object of the present invention is capable of preventing the smoke released during a fire from invading areas considered protected, such as for example stairwells.

Background art

[0002] As is known, and in a nutshell, pressurization systems for stairwells are one of the most advantageous solutions for facilitating escape in the event of a fire. Indeed, in the event of a fire in a building, the smoke released by combustion represents a serious danger not only for people fleeing to a safe place but also for rescue teams. From this point of view, pressurization systems are extremely important for active protection in the event of fire: they favor the outflow of the occupants, they represent additional protection for rescuers against combustion products, even at high temperatures, they guarantee clear visibility and facilitate the identification of the fire source. From this point of view, pressurization systems have become a valid option for guaranteeing adequate safety conditions in multi-store buildings, being able to maintain sustainable conditions in protected spaces, such as escape routes, access routes for the fire brigade intervention teams, lobbies, stairways and other areas that need to be kept smoke-free.

[0003] Currently the UNI EN 12101-6: 2005 standard defines the specifications of these systems based on the type of control to be carried out and according to the fire safety objectives established in the general design of the building. The standard takes into consideration different classes of the pressurization system based on the structure, the intended use and the subdivision characteristics of the building, which are subordinate to the objective to be achieved (protection from exodus or the intervention of the fire brigade fire) and the type of exodus envisaged (protection in place, simultaneous or phased exodus).

[0004] Pressurization systems for stairwells are known in the state of the art, such systems in accordance with the UNI EN 12101-6: 2005 standard, however they present criticalities due to the possible malfunctioning of the components of the system itself. EP3542870A2 shows a pressurisation system for a stairwell according to the preamble of claim 1.

[0005] Infact, the known pressurization systems for stairwells cannot be completely reliable, in terms of speed and stability in the intervention.

[0006] This is due to the fact that the systems commonly used for the pressurization of environments, in particular stairwells, often do not have calibrated, highly accurate and highly reliable adjustment elements, which allow the situations present to be reconciled quickly and stably in case of fire.

[0007] Therefore, there is a need to create an innovative, extremely reliable stairwell pressurization system to limit the spread of smoke in the event of a fire.

Summary of the Invention

[0008] The present invention has the objective of realizing an extremely efficient stairwell pressurization system capable of reducing the risks due to a fire as much as possible. This objective, which is the main object of the present invention, is achieved by optimizing the regulating elements of the system, their calibration, precision and above all their reliability.

[0009] This is why the main components of the pressurization system object of the present invention have been engineered with functional safety components certified as "Safety Integrity Level" 2 (SIL2) according to the IEC 61508 standard. The safety integrity levels (SIL) are defined as a quantitative measure of risk reduction, the meaning of SIL can therefore be traced back to the measure that indicates the degree of reliability that a safety system must achieve in order to reduce the risk of an accident during its use. The safety integrity level (SIL) is a number indicating the value of the probability that a system correctly performs an instrumental safety function within a pre-established period of time, i.e. it is the quantification of the reliability (or degree of reliability) achieved by any object that performs a safety-related function. The greater its reliability, the greater its ability to perform critical functions for the safety or for the availability of machines or systems.

[0010] The SIL is assigned to each individual independent safety function (SIF), implemented by one or more Safety Instrumented Systems (SIS).

[0011] The main components of the system, object of the present invention, are therefore designed to comply with the SIL2 level. This level of security is therefore able to ensure that the system continues to operate with higher availability than traditional systems currently on the market.

[0012] Therefore, the pressurization system of a stairwell object of the present invention is configured to be extremely safe and reliable, by means of a suitable combination of equally reliable and redundant components, as specified in the attached independent system claim.

[0013] Advantageously an analysis of the reliability of the system and the certification of its components in accordance with the IEC 61508 has been performed, being internationally recognized to guarantee and demonstrate the level of reliability of a device, system or installation having safety implications, i.e. with risks for man, the environment, things.

[0014] Further preferred and/or particularly advantageous embodiments of the invention are described according to the characteristics set out in the attached dependent claims.

Brief Description of the Drawings

[0015] The invention will now be described with reference to the attached drawings, which illustrate some non-limiting examples of embodiment, in which:

- figure 1 illustrates a scheme of the pressurization system of a stairwell, according to the present invention;
- figure 2 illustrates a detail of the system of Fig. 1, in a front view,
- figure 3 illustrates the system of Fig. 1, equipped with a channel for the extraction of hot fumes.

Detailed Description

[0016] With reference to Figures 1 and 2, they schematically illustrate a pressurization system 100 of a stairwell to limit the spread of smoke, in the event of a fire, in this area, according to an embodiment of the present invention. The pressurization of the stairwell is achieved by introducing fresh air and thus providing a positive pressure differential which prevents smoke from entering the protected area.

[0017] The system 100 comprises: a ventilating casing 1 for the introduction of air from the external environment, positioned above the building and in correspondence with the stairwell which must be pressurized, a duct 2 preferably made of sheet metal, connected to the ventilating casing 1, having an external portion 2' for the supply of air comprising at least one smoke sensor 20 and an internal portion 2" for the delivery of air passing through an internal wall of the stairwell and covering its entire height, at least one high precision pressure sensor 4.

[0018] Advantageously, the pressure sensors 4 are three in number and are positioned on different floors of the stairwell. In the non-limiting example in Figure 1, the three pressure sensors 4 are positioned on the second, sixth and top floor of the stairwell. In a further example illustrated in Figure 2, these pressure sensors 4 are in a closer position and in any case on nonconsecutive planes of the stairwell.

[0019] The internal portion 2" of the duct 2 has an adjustable outlet 3 on each floor. A programmable logic controller (PLC), inserted in the control panel 5 positioned in a safe area, is electrically connected to the ventilating casing 1, to the pressure sensors 4, to at least one smoke sensor 20 of the system 100. A manual control panel 6 is positioned on the ground floor of the stairwell, so as to be usable by the emergency teams in manual mode (start/stop system with key selector and push-button panel for firefighters).

[0020] The ventilating casing 1 comprises a plurality of fans 10 with electronically commutated (EC) motors.

[0021] Advantageously, each fan 10 is equipped with an inverter on the motor, for the regulation of the flow rate/speed, this allows to avoid the insertion of the inverters necessary for the standard fans in the control panel 5 (reducing spaces and costs).

[0022] The control panel 5 of the system manages the alarms, the start-up and/or regulation of the ventilating box 1, and includes:

- a battery power supply unit, certified EN12101-10, to guarantee power supply to the control equipment in the event of a failure in the electrical network;
- a safety PLC (SIL2), for the control and command of the EC motors on the plurality of fans 10 positioned in the ventilating casing 1;
- motor protection switches and power contactors for the plurality of fans 10 located in the ventilating casing 1;
- an interface with a building management system (BMS) with the possibility of remote teleassistance and automatically programmed function tests as required by current legislation.

[0023] Advantageously, the flow rate of the ventilating casing 1 for introducing air into the stairwell is defined by a regulatory calculation and the air can be introduced alternatively either from the bottom or from the top of the stairwell.

[0024] The ventilating casing 1 object of the present system comprises a plurality of fans 10 so that the air flow reaches the required flow rate and is characterized by a redundancy in the number of such fans 10, in order to be of the SIL2 type. In fact, the EN12101-6 and prEN12101-13 standards establish that such systems have an additional ventilating casing as a backup, precisely because there is a need for absolute certainty that the system can always operate in the event of a fire. In the case of the present invention, the presence of an additional ventilating casing is not necessary since the plurality of fans 10 causes the ventilating casing 1 to assume a SIL2 reliability, demonstrated by the relative calculation.

[0025] Advantageously, the ventilating casing 1 has, for example, a flow rate equal to 30,000 m3/h given by the presence of two fans 10 and a further additional fan 10 in redundancy. Advantageously, in the event of a malfunction or breakdown of one of the two fans 10 of the ventilating casing 1, in order to continue to obtain the correct flow rate, the further fan 10 automatically takes over which guarantees the redundancy function.

[0026] Furthermore, the adjustable vents 3 positioned on the various floors of the stairwell also ensure an adequate flow rate and correct balancing of the system, for example according to what is described in the Applicant's Italian patent No. 102019000020868.

[0027] The pressure sensors 4, the system management control panel 5 and the fan box have SIL2 reliability. This, as already said, allows to guarantee the maximum reliability of the system. This reliability is given by the fact that, in addition to the plant modifications described above, the calculation was carried out according to the series of standards EN 61508 (Functional safety of Elec-

tric/Electronic/Programmable Electronic systems) which demonstrates the reliability of the system object of the present invention as SIL2.

[0028] In fact, the legislation prescribes the methods for determining the PFD ("Probability of Failure on Demand") or PFH ("Probability of Failure per Hour"), or the SIL, or the definition of the reliability of components, equipment and systems used in safety applications.

[0029] The safety systems considered are generally made up of:

- sensors and transducers (pressure sensors 4),
- "Logic Solver" (with any safety software - PLC 5),
- final elements (actuators / drives of the safety function - fan).

[0030] The PFD (or PFH) value represents the probability that a device or system is unable to provide the required safety function: this probability corresponds to a SIL level, which is an integer number (from a minimum of 1 to a maximum of 4) to express the safety integrity level of the safety device/system in question. The analysis of the reliability of an installation and the certification of its components in accordance with IEC 61508 is therefore an effective and internationally accepted method to guarantee and demonstrate the level of reliability of a device, system or installation with safety implications, i.e. with risks for man, the environment, things.

[0031] Advantageously, the control panel 5 ensures that the desired pressure value is maintained in the stairwell. Through the control panel 5 the pressure is constantly measured through the pressure sensors 4 in real time and compared with a set-point value.

[0032] The operating speed of the fan 1 is therefore managed by the control panel 5 in order to have a precise introduction of air into the stairwell. In fact, excessively high pressures could make it difficult to open the doors, it is therefore essential that the speed of the air passing through an opening must be between 0.75m/s and 2m/s.

[0033] For buildings with a height of less than 11 m, a single air intake point is allowed in the pressurized area; for taller buildings it will be necessary to insert an air entry point at least every three floors, for example by using diffusers and an air duct along the entire staircase.

[0034] Advantageously, as illustrated in Figure 3, a possible duct 7 can be installed for the extraction of hot fumes, downstream of which there is at least one suction fan 8, the duct is directly connected to the external environment. In this way the pressurization of the stairwell which prevents the fumes from penetrating inside it is further assisted by the hot fume extraction duct 7 to the full benefit of the safety of the system.

[0035] The correct functioning of the pressurization system 100 also depends on the regulation of the system. It is essential that the system 100 includes calibrated adjustment elements, such as the adjustable vents 3, with high precision and reliability, which allow the present situations to be reconciled quickly and stably in the event of a fire. It is for this reason that the pressurization system object of the present invention includes components with high functional safety, certified SIL2.

[0036] Advantageously, the control panel 5, in addition to satisfying the most stringent certification requirements, simplifies the installer's work.

[0037] In addition to the embodiment of the invention, as described above, it is to be understood that numerous other variants exist. It is also to be understood that such embodiments are exemplary only and limit neither the scope of the invention, nor its applications, nor its possible configurations. On the contrary, although the above description allows the skilled person to carry out the present invention at least according to an exemplary embodiment thereof, it must be understood that many variants of the components described are possible, without thereby departing from the scope of the invention as defined in the attached claims.

Claims

1. Pressurization system (100) for a stairwell comprising a ventilating casing (1) for supplying air from the external environment provided with a duct (2) connected to the ventilating casing (1), having an external portion (2') for supplying air comprising at least one smoke sensor (20) and an internal portion (2") for supplying air through an internal wall of the stairwell, a pressure sensor (4), a control panel (5) electrically connected to the ventilating casing (1), the pressure sensor (4), the at least one smoke sensor (20) and a manual control panel (6),

whereby the control panel (5) comprises

- a programmable logic controller for the control and command of electronically commutated motors of the plurality of fans (10) positioned in the ventilating casing (1);

said system (100) being **characterised by** the fact that the system (100) comprises at least three pressure sensors (4), to which the control panel (5) is electrically connected, and by the fact that the control panel (5) in turn comprises

- a battery power supply unit
- corresponding motor protectors and power contactors for the plurality of fans (10) positioned in the ventilating casing (1);
- an interface with a building management system,

and by the fact that
the ventilating casing (1) comprises one or more additional fans (10) providing the redundancy function.

2. System (100) according to claim 1, wherein the ventilating casing (1) is positioned above the building and in correspondence with the stairwell to be pressurized.

3. System (100) according to claim 1 or 2, wherein the pressure sensors (4) are two in number and are positioned on different floors of the stairwell.

4. System (100) according to any one of claims 1 to 3, wherein the inner portion (2") of the ducting (2) comprises an adjustable vent (3) at each floor of the stairwell.

5. System (100) according to any one of the preceding claims **characterised in that** it comprises a duct (7) for extracting hot fumes, downstream of which there is at least one suction fan (8).

Patentansprüche

1. Druckbeaufschlagungssystem (100) für ein Treppenhaus, umfassend ein Lüftungsgehäuse (1) zur Zufuhr von Luft aus der Außenumgebung, das mit einem Kanal (2) versehen ist, der mit dem Lüftungsgehäuse (1) verbunden ist, mit einem äußeren Teil (2') zur Zufuhr von Luft, der mindestens einen Rauchsensor (20) umfasst, und einem inneren Teil (2") zur Zufuhr von Luft durch eine Innenwand des Treppenhauses, einem Drucksensor (4), einem Bedienfeld (5), das elektrisch mit dem Lüftungsgehäuse (1) verbunden ist, dem Drucksensor (4), dem mindestens einen Rauchsensor (20) und einem manuellen Bedienfeld (6), wobei das Bedienfeld (5) eine speicherprogrammierbare Steuerung zur Steuerung und Steuerung elektronisch kommutierter Motoren der Vielzahl von Ventilatoren (10) umfasst, die in dem Lüftungsgehäuse (1) angeordnet sind; wobei das System (100) **dadurch gekennzeichnet ist, dass** das System (100) mindestens drei Drucksensor (4) umfasst, mit denen das Bedienfeld (5) elektrisch verbunden ist, und dadurch, dass das Bedienfeld (5) wiederum umfasst

   - eine Batteriestromversorgungseinheit
   - entsprechende Motorschutzschalter und Leistungsschütze für die Vielzahl von Lüftern (10), die im Lüftungsgehäuse (1) angeordnet sind;
   - eine Schnittstelle zu einem Gebäudemanagementsystem,

   und dadurch, dass
   das Lüftungsgehäuse (1) einen oder mehrere zusätzliche Lüfter (10) umfasst, die die Redundanzfunktion bereitstellen.

2. System (100) nach Anspruch 1, wobei das Lüftungsgehäuse (1) über dem Gebäude und in Übereinstimmung mit dem zu druckbeaufschlagenden Treppenhaus positioniert ist.

3. System (100) nach Anspruch 1 oder 2, wobei die Drucksensor (4) zwei an der Zahl sind und auf verschiedenen Etagen des Treppenhauses positioniert sind.

4. System (100) nach einem der Ansprüche 1 bis 3, wobei der innere Teil (2") der Kanal (2) eine einstellbare Entlüftung (3) auf jeder Etage des Treppenhauses umfasst.

5. System (100) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es einen Kanal (7) zum Absaugen heißer Dämpfe umfasst, hinter dem sich mindestens ein Saugventilator (8) befindet.

Revendications

1. Système de pressurisation (100) pour cage d'escalier comprenant un caisson de ventilation (1) pour amener de l'air du milieu extérieur muni d'un conduit (2) relié au caisson de ventilation (1), présentant une partie externe (2') pour amener air comprenant au moins un capteur de fumée (20) et une partie interne (2") pour amener de l'air à travers une paroi interne de la cage d'escalier, un capteur de pression (4), un panneau de commande (5) connecté électriquement au caisson de ventilation (1), le capteur de pression (4), le au moins un capteur de fumée (20) et un panneau de commande manuel (6), le panneau de commande (5) comprenant

   un contrôleur logique programmable pour le contrôle et la commande des moteurs à commutation électronique de la pluralité de ventilateurs (10) positionnés dans le boîtier de ventilation (1); ledit système (100) étant **caractérisé par le fait que** le système (100) comprend au moins trois capteurs de pression (4), auxquels le panneau de commande (5) est connecté électriquement, et **par le fait que** le panneau de commande (5) en le tour comprend

   - un bloc d'alimentation par batterie,
   - des protecteurs de moteur et des contacteurs de puissance correspondants pour la pluralité de ventilateurs (10) positionnés dans le caisson de ventilation (1);
   - une interface avec un système de gestion technique du bâtiment,

   et **par le fait que**
   le caisson de ventilation (1) comprend un ou plu-

sieurs ventilateurs supplémentaires (10) assurant la fonction de redondance.

2. Système (100) selon la revendication 1, dans lequel le caisson de ventilation (1) est positionné au-dessus du bâtiment et en correspondance avec la cage d'escalier à pressuriser.

3. Système (100) selon la revendication 1 ou 2, dans lequel les capteurs de pression (4) sont au nombre de deux et sont positionnés à des étages différents de la cage d'escalier.

4. Système (100) selon l'une quelconque des revendications 1 à 3, dans lequel la partie interne (2") du conduit (2) comprend un évent réglable (3) à chaque étage de la cage d'escalier.

5. Système (100) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend un conduit (7) d'extraction des fumées chaudes, en aval duquel se trouve au moins un ventilateur aspirant (8).

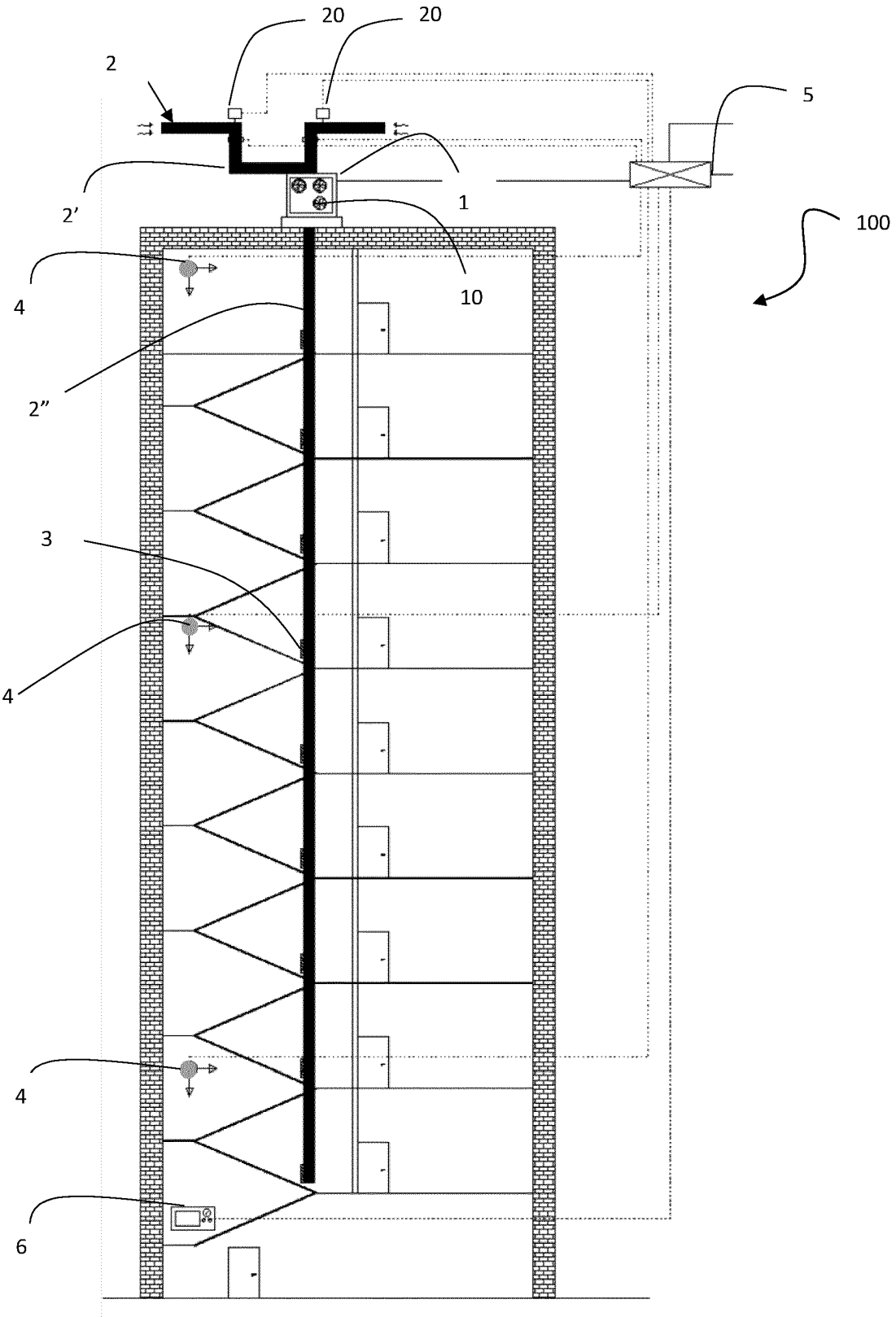
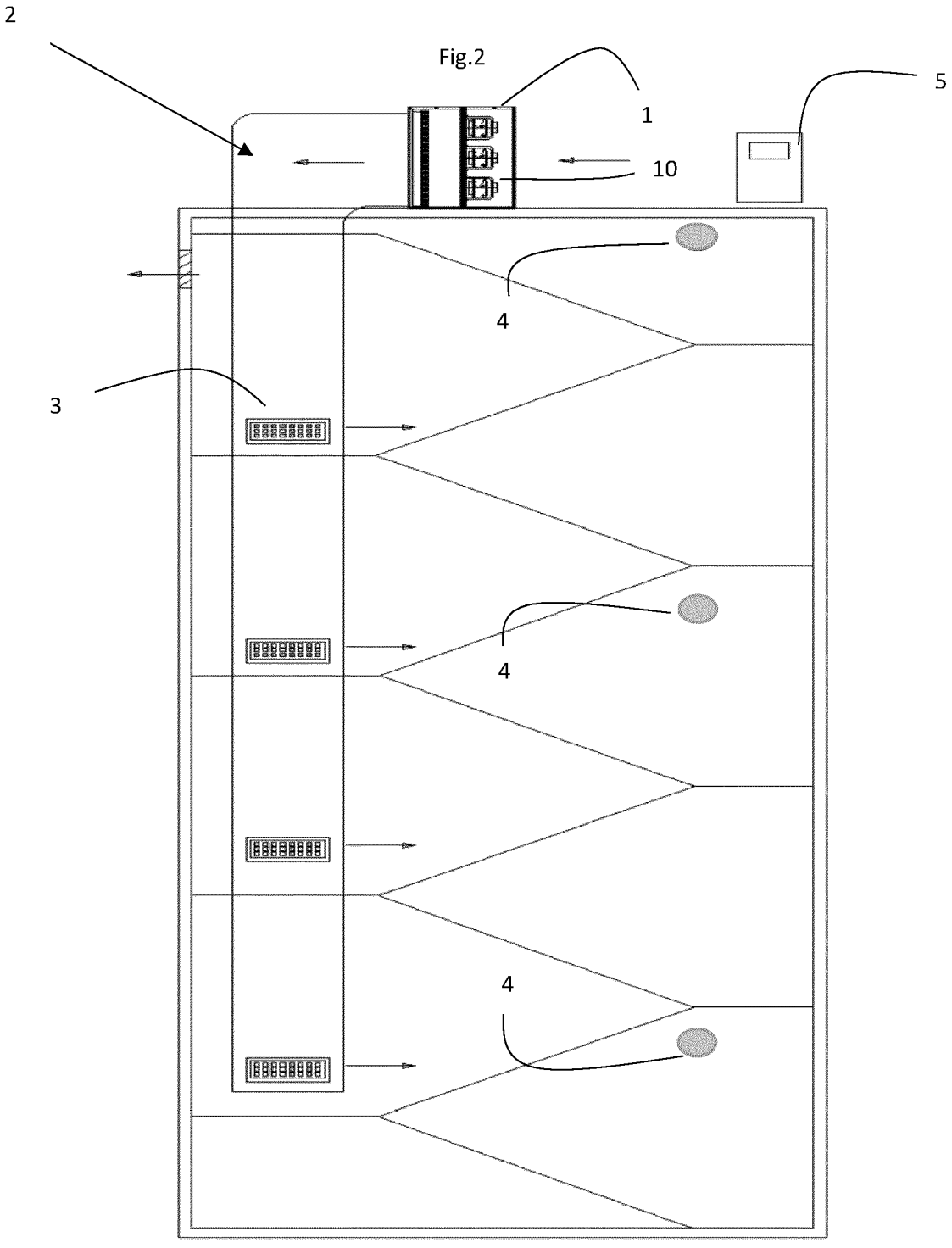


Fig.1

Fig.2



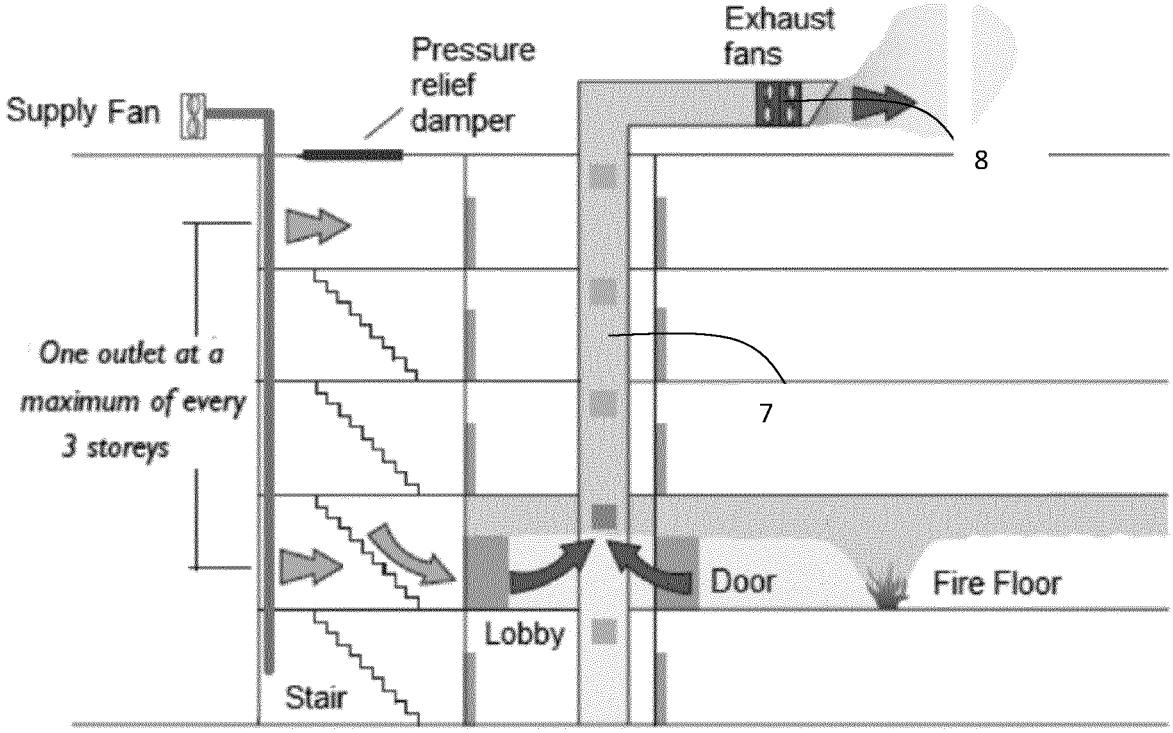

Exhaust fans
Pressure relief damper
Supply Fan
8
One outlet at a maximum of every 3 storeys
7
Door
Fire Floor
Lobby
Stair

Fig.3

REFERENCES CITED IN THE DESCRIPTION

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