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Lacombe

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[54] **FIRE DOOR STRUCTURE AND FIRE SAFETY INSTALLATION INCLUDING SAID DOOR STRUCTURE**

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[52] **U.S. Cl.** ..... **49/7;** 49/3; 49/4; 160/1; 98/33 R

[51] **Int. Cl.²** **E05F 15/20**

[58] **Field of Search** ..... 49/1–7, 168–170; 160/1; 98/33 R

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Primary Examiner—Kenneth Downey
Attorney, Agent, or Firm—Holman & Stern

[57] **ABSTRACT**

Fire door structure in which the door, which is resiliently biased to the closing position, defines an opening allowing passage through the door structure when the door is closed. A movable flap normally closes this opening. First spring means bias the flap to the closing position and second spring means bias the flap to the opening position. The second spring means are stronger than the first spring means. Locking means normally hold the flap in the closing position of the flap and are released upon outbreak of a fire so as to allow the second spring means to open the flap. When a given temperature created by the heat of the fire is reached, fusible means render the second spring means inoperative so that the first spring means can cause the flap to close the opening.

9 Claims, 11 Drawing Figures

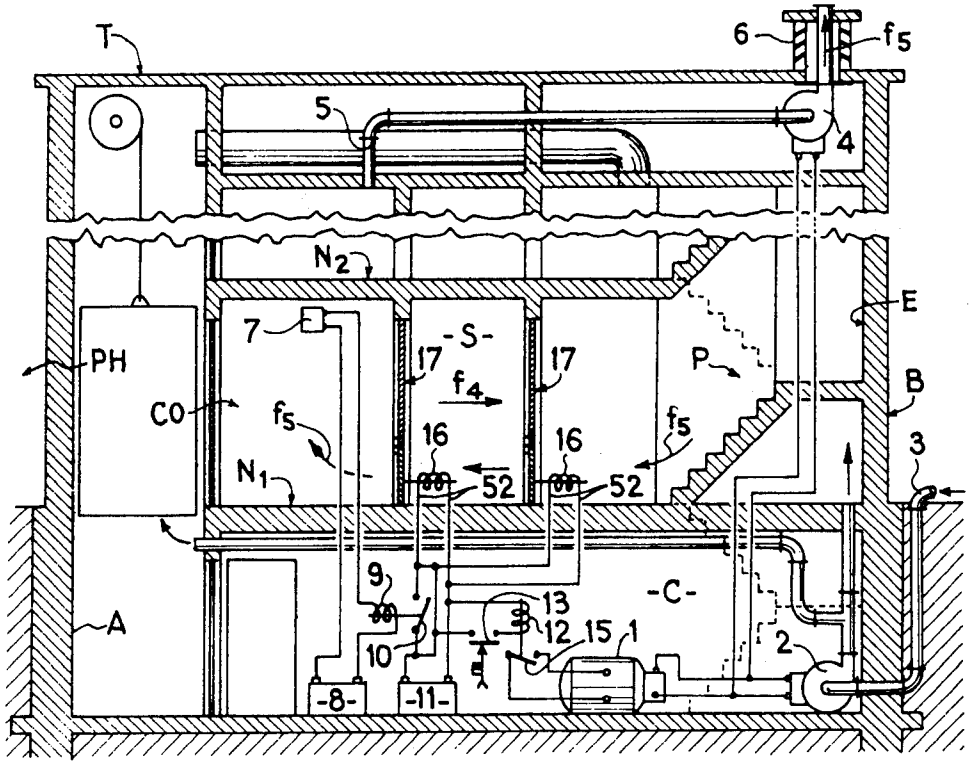
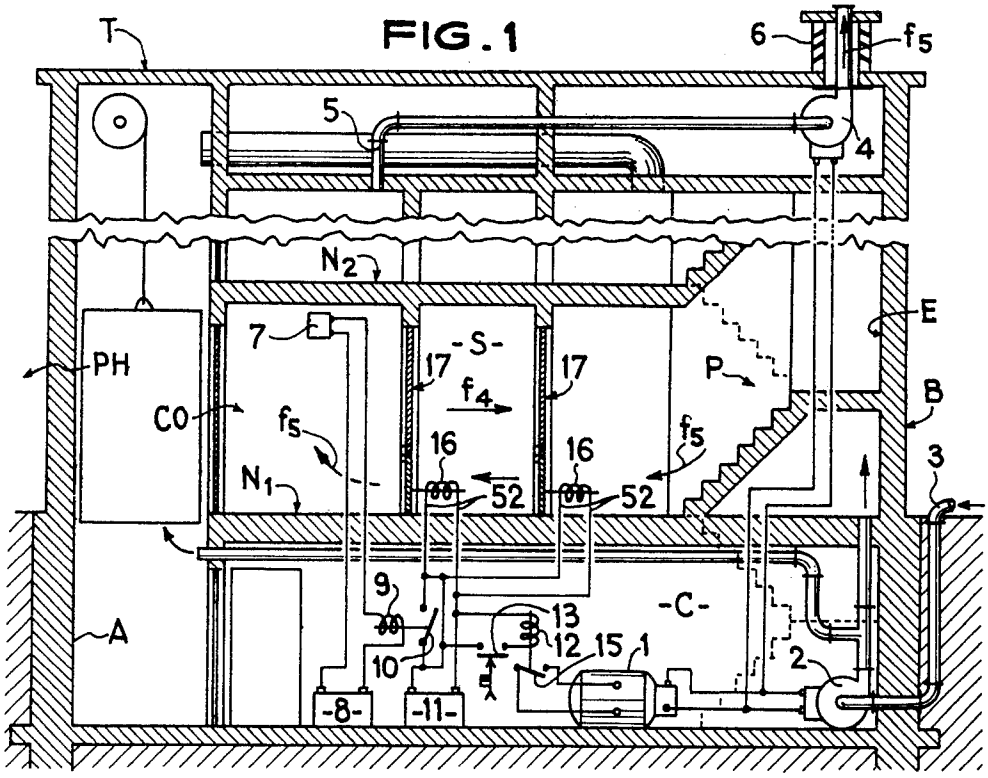


FIG. 1


T
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f5
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FIG. 2

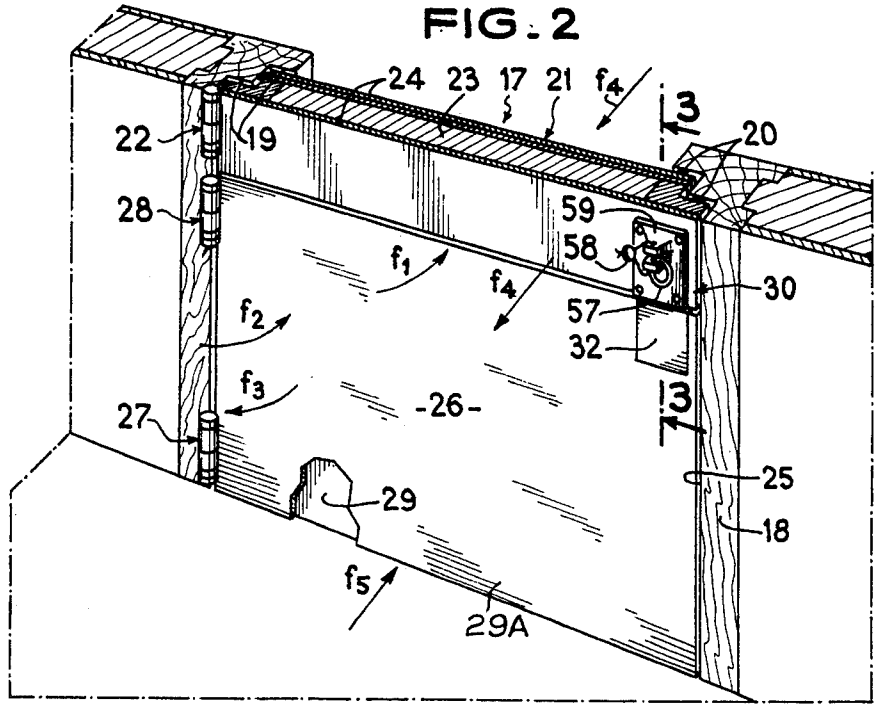
24
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FIG. 3

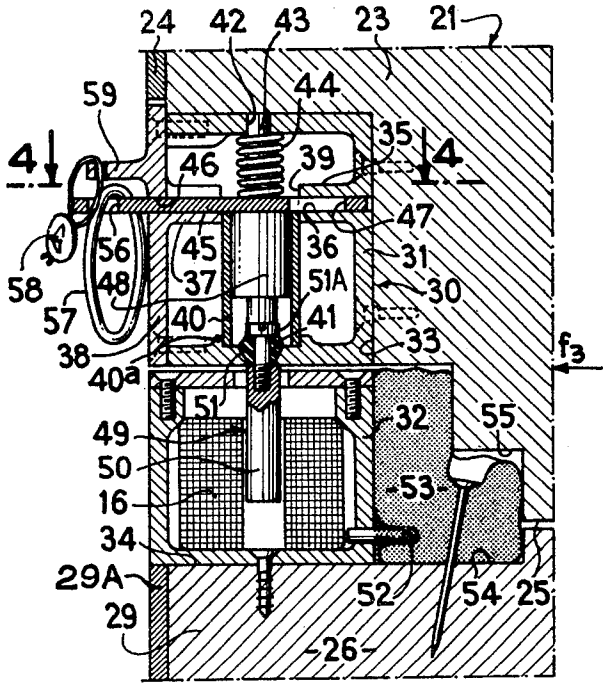

FIG. 5

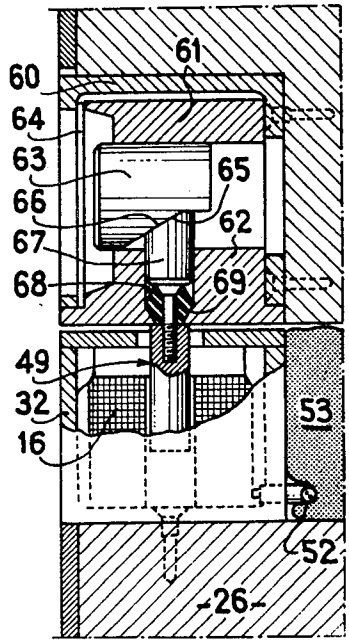

FIG. 4

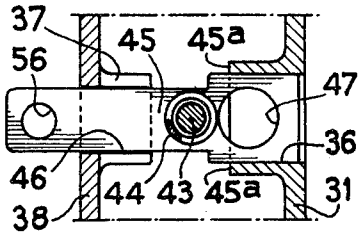

FIG. 7

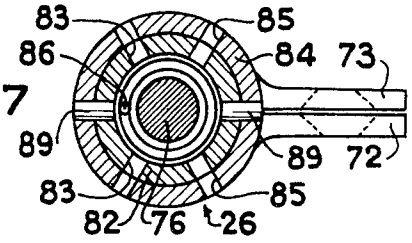
83
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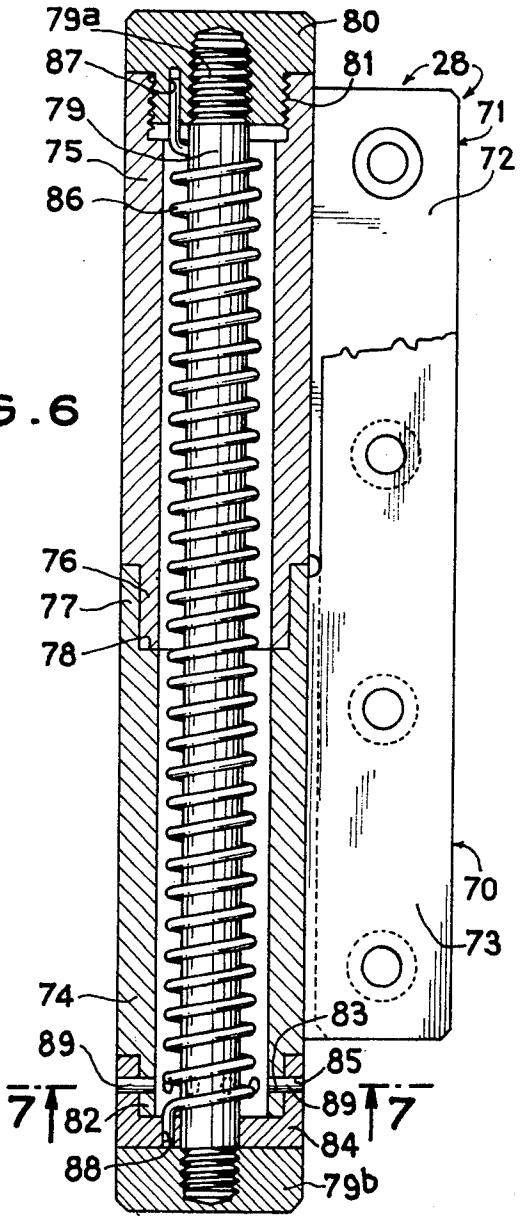
FIG. 6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79b

FIG. 8A

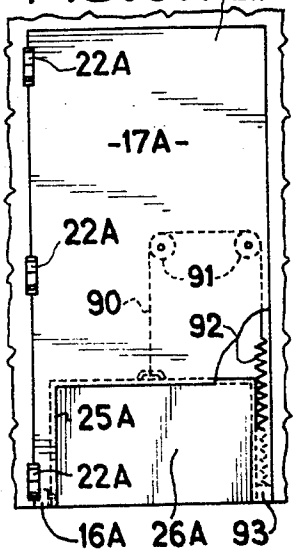


FIG. 8B

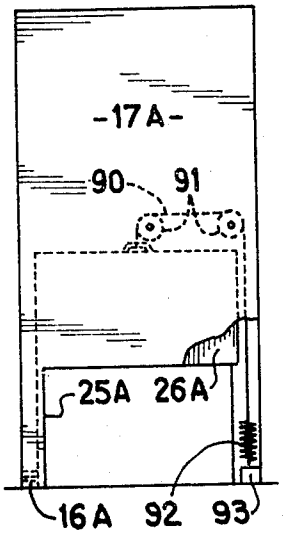


FIG. 8C

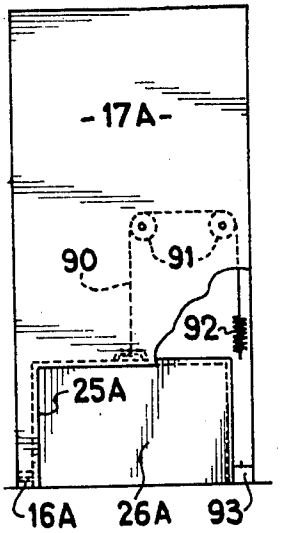
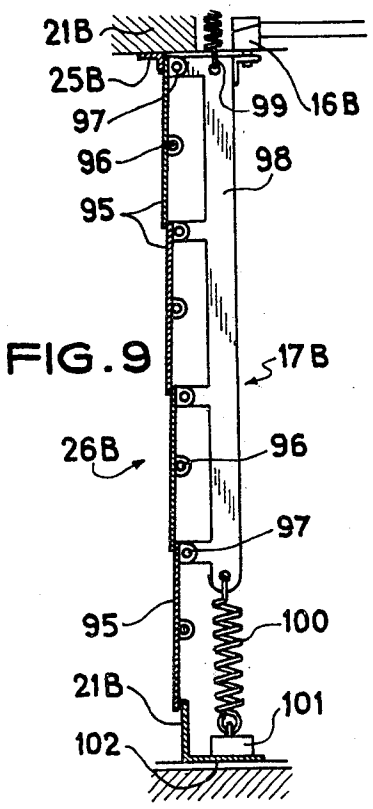


FIG. 9



FIRE DOOR STRUCTURE AND FIRE SAFETY INSTALLATION INCLUDING SAID DOOR STRUCTURE

BACKGROUND OF THE INVENTION

The present invention relates to a fire door structure adapted to facilitate the evacuation of persons from a damaged part of a building in the event of a fire. It also relates to a fire safety installation including this door structure.

In the fire protection of buildings employed for living quarters and/or commercial activities, the present-day tendency requires a separate protection of the levels or floors of this building by isolating them from each other during a limited period of time following on the outbreak of the fire. This is the case of high buildings for example.

It is therefore necessary to provide between the levels or floors of a building a fire-proof device for preventing the fire from spreading from one level to the other before help and fire-fighting means arrive on the scene of the fire.

It should be understood that the isolation of the levels from each other must not hinder the evacuation of the persons from the level on fire and this is why provision of means have been envisaged whereby, for at least a period of time, the level on fire and the escape paths for the persons may be ventilated so as to evacuate as far as possible the smoke produced by the fire.

The escape path thus leads from the level on fire to common stairs whereas ventilating means are provided which send a draft of air in the direction away from the common stairs through the level on fire and to the exterior.

The fire door structures which are interposed between the stairs and the levels of the building must perform several functions and in particular the following:

a. An emergency exit door in the case of fire.
b. An isolating element which is fire proof during a sufficient period of time after the beginning of the fire.
c. A closing element which does not hinder the free circulation of ventilating air between the common parts of the building and the levels.
d. Permit, notwithstanding the fire isolating function, introduction of fire-fighting means and in particular fire hoses.

PRIOR ART

Now, heretofore, these functions have usually been disassociated. Solid and isolating fire door structures have been provided with, in association, separate ventilating means, such as special ducts with valves controlled specially for this purpose and enabling the fire door structure to be by-passed so as to ensure the circulation of the air. Such an arrangement presents many drawbacks among which may be mentioned the necessity to provide special ducts and associated particular valves which one does not know where to place and are inaesthetic for the premises and require reinforcements in the framework of the building.

The fire door structure according to the invention overcomes these drawbacks.

SUMMARY OF THE INVENTION

The invention provides a fire door structure comprising a door which is resiliently biased in a direction to close the door and has an opening closed by a movable flap, locking means for normally securing the flap to the door and capable of releasing the flap from the door in the event of a start of a fire so as to permit the opening of said opening, first resilient means biasing said flap to the closing position of the flap, second resilient means which are more powerful than the first resilient means for biasing said flap to the opening position of the flap and fusible means for, when a given temperature is reached, rendering said second resilient means inoperative and allowing operation of said first resilient means for closing said opening.

With such a fire door structure, it is possible to temporarily partially open the fire door structure so as to allow a ventilation through the door structure while allowing escape of persons, which opening is closed after a given period of time so as to recreate an isolation against fire of the regions disposed on each side of the door structure.

Further features and advantages of the invention will be apparent from the ensuing description with reference to the accompanying drawings. In the drawings

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial diagrammatic elevational view of a building comprising a fire safety installation including fire door structures according to the invention;

FIG. 2 is a partial perspective view of a fire door structure according to a first embodiment of the invention;

FIG. 3 is a sectional view, to an enlarged scale, of a first embodiment of locking means for locking together the door and flap of the door structure shown in FIG. 2;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 2;

FIG. 5 is a sectional view, similar to that of FIG. 3, of a second embodiment of the locking means;

FIG. 6 is an elevational view, partly in section, of second resilient means provided in the flap shown in FIG. 2;

FIG. 7 is a sectional view taken on line 7—7 of FIG. 6;

FIGS. 8A, 8B and 8C are elevational views, to a reduced scale, of a second embodiment of a door structure according to the invention, and

FIG. 9 is a vertical sectional view, to an enlarged scale, of the lower part of a fire door structure according to a third embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows diagrammatically a building B having several levels or floors N_1, N_2 . . . etc, with only the lower level N_1 having been shown in full at least as concerns its parts related to the invention. Provided in this building are a lift cage A, a stairway E and a basement C, whereas each level has a corridor CO, a landing P and a chamber S which places the corridor and the landing in communication with each other. Further, the corridor CO gives onto the living quarters or the offices PH which have not been shown in the drawing.

Each level N_1, N_2 . . . etc. of the building is isolated from the other levels, with the separating or partition walls being fire-proof for a period of time which may be as much as two hours or more, depending on the fire regulations. The sole communications between the levels are the lift cage or cages and the stairway or stairways, the latter being separated from the levels by the chambers S.

Such a chamber comprises two fire door structures according to the invention although a single door structure may be satisfactory in some cases.

It must be understood that the description of the building just given has been given merely by way of example, since the invention may be applied to any type of building whose internal arrangement may be of any type.

In the basement C of the illustrated building B, an emergency electricity generating unit **1** of any conventional type is coupled to an internal combustion engine (not shown) for example. This generator supplies electrical power in particular to a main fan **2** which draws from the exterior of the building B air by way of a duct **3** which opens to the exterior at a distance from the fan (**8** meters for example). The fan **2** delivers air to the stairway E. The generating unit **1** also supplies power to an auxiliary fan **4** which has its inlet in communication with the corridors CO of all the levels N_1, N_2 . . . etc through a duct **5** and has its outlet communicating with the exterior. A skylight **6** placed above the stars is provided preferably with flaps, the inclination of which is adjustable as to adjust the flow of air in accordance with the discharge from the building B.

One or more fire detectors, diagrammatically represented by the rectangle **7**, are provided at each level N_1, N_2 . . . etc. They are all connected to a detecting battery **8** disposed in the basement C and individually connected to a relay **9** in series. The relay **9** comprises a movable contact **10** inserted in a control circuit which is supplied with power by a battery **11**. The control circuit comprises a first relay assembly **12** which is connected in parallel and includes preferably a time delay contact **13** which has a delayed closure. The relay **12** controls the operation of the generator unit **1** through a movable contact **15**.

The control circuit which is supplied with power by the battery **11** also includes control coils **16** of two electromagnets incorporated in the fire door structures **17** defining the chamber S at each level. Note that in order to simplify the diagram shown in FIG. **1**, only the control circuit of level N_1 has been shown, whereas each level, of course, includes its own control circuit actuated by its own fire detector or group of fire detectors. It is indeed considered that the construction of such a control circuit is within the knowledge of one skilled in the art and no further description is necessary. The control circuit may also include a central signalling device which is located in a supervising or fire-watching station of the building B.

With reference to the fire door structures, FIG. **2** shows in perspective the lower part of such a structure. The fire door structure comprises a door frame **18** of any material which resists fire during the period of time laid down by the fire regulations. This frame **18** has a double recess **19** provided with two sealing elements **20** preferably of asbestos.

The door **21** of this fire door structure includes hinges **22** (only one of which is shown in the drawing) and is biased to the closing position, and therefore in the direction of arrow f_1, for example by a well-known resiliently yieldable device (not shown). The door **21** has a core **23** covered with facings **24** on both sides, it being understood that some other arrangement may also be adopted.

At the base of the door **21**, there is provided a hatch or opening **25** which is closed in the illustrated embodiment by a flap **26** pivoted on two hinges **27** and **28** with which is combined a resiliently yieldable device.

The hinge **27** is of conventional type and has a torsion spring (not shown in the drawing) which biases the flap **26** to the closing position (arrow f_2). The hinge **28** is of special design for the invention and will be described in detail with reference to FIGS. **6** and **7**. It is merely necessary to mention here that it biases the flap **26** to the opening position (arrow f_3) and that the power of its resiliently yieldable device is higher than that of the resiliently yieldable device of the hinge **27**.

In the same way as the door **21**, the flap **26** includes a core **29** on both sides of which are provided protective facings **29A**.

The flap **26** is normally secured to the door **21** by a locking mechanism **30**, two embodiments of which will now be described with reference to FIGS. **3–5**.

The first embodiment comprises two cases **31** and **32** which are one above the other and respectively screwed to the cores **23** and **29** of the door **21** and flap **26** in cavities **33** and **34** formed therein.

A projecting portion **35** is formed on the bottom of the case **31** and includes a guide slot **36** and defines with an opposite projecting portion **37** of a detachable cover **38**, a center space **39** in which is maintained the upper edge of a guide sleeve **40**. The latter is maintained at its base by a flange **40***a* which projects from the lower wall of the case **31**. This wall includes a conical aperture **41** which is upwardly divergent and coaxial with the sleeve **40**.

The upper wall of the case **31** also has an aperture **42** in alignment with the aperture **41** and a guide rod **43** extends coaxially downwardly therethrough. Around this rod there is disposed a coil spring **44** which is stressed between the upper wall of the case **31** and a horizontal pull-member **45**. The latter is guided in the slot **36** and in a rectangular opening **46** in the cover **38**. It has at the rear an aperture **47** which has such diameter that it is capable of allowing the passage of the spring **44** when it is placed in alignment with the latter.

A cylindrical push-member **48** is disposed in the sleeve **40** and bears on a plunger **49** composed of a cylindrical rod **50**, a conical retaining washer **51** and a screw **51A** holding the latter to the rod **50**. The washer **51** is of deformable material and is received in the complementary conical aperture **41** of the case **31** and thus retains the plunger **49** in the position shown in FIG. **3**.

The lower end portion of the plunger **49** extends into an electromagnet coil which is the coil **16** shown in FIG. **1**. This coil is disposed in the lower case **32** and supplied with current by a cable or line **52** which extends from the locking mechanism **30** to the frame **18** so as to be connected to the battery **11**, as shown in FIG. **1**. The cable **52** is protected by a sealing element **53** of fire-proof material, as asbestos wool, which is fixed in a horizontal recess **54** formed in the flap **26**. The sealing element bears against a double complementary horizontal recess **55** provided in the bottom edge of the door **21**.

The pull-member **45** extends out of the case **38** and includes at its outer end an aperture **56** for receiving a ring **57**, and a wire **58** which passes through an aperture formed in an outer projection portion **59** of the cover **38** and may be sealed as shown.

The two cases **31**, **32** are preferably composed of molded material.

In the illustrated position, the plunger **49** secures the flap **26** to the door **21** so that they open together when the door is pushed in the direction of arrow f_3.

The interconnection of the two door elements can be destroyed or eliminated in two ways:

1. By energizing the coil **16** so that the plunger **41** is caused to descend and urge the conical washer **51** through the aperture **41.**
2. By breaking the sealed wire **58** by means of the ring **57** so that the pull-member **45** is pulled out of the case until the aperture **47** coincides with the spring **44.** The latter is then released and, in urging the push-member **48** downwardly, forces the deformable washer **51** through the conical aperture **41.**

Note that the pull-member **45** has at the rear two shoulders **45***a* which retain it in the case **31** owing to the presence of the projecting portion **37.**

In the modification shown in FIG. **5,** the lower case is identical to the case shown in FIGS. **3** and **4,** but the upper case **60** is slightly different. It can be seen that it includes a guide **61** in which is formed a horizontal cylindrical aperture **62** receiving a button **63.** The latter is disposed behind a glass window **64** which must be broken to shift or depress the button.

The button **63** includes in its lower part an oblique surface **65** which co-operates with a complementary oblique surface **66** of a push-member **67** which is guided in an aperture **68** provided in the guide and perpendicular to the aperture **62** and coaxial with the plunger **49** of the case **32.**

The aperture **68** is conical and converges downwardly and receives a deformable bi-conical washer **69,** the function of which is identical to that of the washer **51** shown in FIG. **3.**

It will be understood that the connection normally established between the door **21** and the flap **26** may be broken or eliminated either by energizing the coil **16** or by actutating the button **63** after breaking the window **64.**

The hinge **28** of the flap **26** (FIG. **1**) will now be described with reference to FIGS. **6** and **7.**

This hinge comprises two elements **70** and **71** which are respectively fixed to the frame **18** and to the flap **26** through hinge strips **72** and **73.**

The hinge strip **72** is integral with a knuckle **74** in the form of a sleeve whereas the hinge strip **73** comprises a knuckle **75** which has a reduced portion **76** received in the upper enlarged end **77** of the bore of the knuckle **74** and bears on a shoulder **78.**

A hinge pin **79** extends through the hinge assembly and includes a screwthreaded upper end portion **79***a* on which a nut **80** is screwed. The nut is connected to the knuckle **75** by a screwthread **81.**

The knuckle **74** comprises a reduced lower end portion **82** in which are formed radial apertures **83** and is capped by a cup **84** which is also provided with radial apertures **85.** The latter are capable of coming into alignment with the apertures **82** by relative rotation of the cup **84** and knuckle **74.**

A torsion or coil spring **86,** one end portion of which is received in an axially extending aperture **87** of the nut **81,** is under stress around the pin **79,** with its opposite end portion being fixed in an axially extending aperture **88** in the cup **84.** The force exerted by the spring **86** may be adjusted as desired by turning the cup **84** with respect to the knuckle **74** and fixing it in the adjusted position by fusible or meltable pins **89** which are respectively introduced into pairs of apertures **83, 85** which come into coincidence when the necessary force is reached.

A lock-nut **79***b* may be screwed on the lower screwthreaded end portion of the pin **79** so as to oppose or cancel out the force of the spring **86,** for example in the course of transportation of the fire door structure **17.**

The spring **86** may be released by fusion or melting of the pins **89,** that is to say beyond a certain dangerous temperature created by the fire. Indeed, when heating occurs beyond this temperature, the pins **89** shear and this disconnects the spring **86** from the lower knuckle **74** of the hinge.

The fire protection installation operates in the following manner:

When a fire breaks out at level N_1, the detector **7** is actuated and causes the energization of the electromagnets **16** and, after a certain delay produced by the contact **13,** the current generator unit **1** is started up. The detector **7** may also actuate any useful sound, light or other alarm signal to warn the persons within the parts PH of the level N_1. These persons may escape by passing from the corridor CO through the chamber S to the stairway E (arrow f_4).

The delay produced by the contact **13** produces the actuation of the electromagnet **16** and consequently the opening of the flaps **26** under the action of the spring **86** provided in their upper hinge **28,** before the fans **2** and **4** are started up. Thus there is no hindering pressure differential on each side of the chamber S and the persons would experience no difficulty in opening the fire door structure **17.** If the flaps did not open, there would indeed exist a pressure differential (positive in the stairway E with respect to the pressure of the corridor CO) on each side of the chamber S which would render the opening of the door structures **17** very difficult.

The fans **2** and **4** having been started up, the smoke produced in the common parts of the level N_1 is evacuated through the duct **5** by way of the openings **25** of the fire door structures **17** (arrow f_5).

The doors **21** can therefore be opened without difficulty in the direction of arrows f_4.

Moreover, fire-fighting means (hoses and nozzles) may be passed through the openings **25** for fighting the fire.

When the latter spreads to the chamber S, the resulting heating will cause the fusible pins **89** of the hinges **28** to melt. The flaps **26** are then closed under the action of the resiliently yieldable mechanisms provided in the hinges **27** and the level N_1 is once again completely isolated from the other levels of the building.

It should be mentioned that it is possible to provide an opening (not shown) at the base of each fire door structure **17** for facilitating the establishment of the circulation of air as soon as the fire starts. In this case, it is possible to omit the contact **13** which has a delayed closure.

If the detector **7** is incapable of energizing the electromagnet **16,** for example, owing to some deterioration of the electrical circuits, the connection between the door **21** and the flap **26** can still be broken manually as explained hereinbefore with reference to FIGS. **3–5.**

The modification shown in FIGS. **8A–8C** comprises a fire door structure **17A** having an opening **25A** which may be closed by a guillotine type flap **26A.** The door

21A of this door structure has hinges 22A at least one of which is provided with a resiliently yieldable closing device.

The flap 26A is slidably mounted in the frame 21A by means of guides (not shown) and may be vertically displaced by means of a cable 90 and a set of pulleys 91, with the cable 90 being hooked to a spring 92. The latter is under tension between the flap 26A and a fixed point 93 provided with suitable means (not shown) which melt as soon as a certain temperature is reached so as to break the connection between the spring 92 and the fixed point 93. In this modification, the weight of the flap 26A performs the function of the resiliently yieldable mechanism which was provided in the hinge 27 shown in FIG. 2.

The plunger of an electromagnet 16A normally retains the flap 26A in its lower position (FIG. 8A) in opposition to the action of the spring 92.

In the event of fire, the electromagnet 16A is energized in the same way as described with reference to FIGS. 1–7 and releases the flap 26A which is therefore raised under the action of the spring 92 and allows a free passage for the circulation of air (FIG. 8B). At the approach of the critical temperature produced by the heat of the fire, the fusible means attaching the spring 92 to the fixed point 93 melt so that the flap 26A falls under the action of the force of gravity (FIG. 8C).

The modification shown in FIG. 9 shows a flap 26B in the form of a Venetian shutter which is mounted in a door 21B of a fire door structure 17B, only the lower part of which is shown in vertical section in the drawing. The flap 26B is mounted in an opening or hatch 25B of the door and includes strips 95 which are pivotably mounted on horizontal rods 96 disposed across the opening 25B. The strips 95 are respectively articulated by a lug 97 to a vertical rod 98 which is hooked to two springs 99 and 100, with the spring 100 being stronger than the spring 99. The spring 100 is hooked to fusible means 101 fixed to an L-section member 102 which defines the lower edge of the opening 25B. The spring 99 is hooked to a fixed point (not shown) of the door 21B.

An electromagnet 16B normally holds the rod 98 in its illustrated position so that the lugs 97 cannot move rearwardly.

When a fire breaks out, the electromagnet 16B is energized and releases the rod 98 so that the strips 95 pivot and open the opening 95B under the action of the spring 100. When the heat of the fire produces the melting of the fusible means 101, the spring 100 loses its lower hooking point and the spring 99 can come into operation and close the opening 25B.

In the modification of the locking means shown in FIG. 5, there is provided a bi-conical deformable washer 69 so as to permit a re-arming of the locking means after their actuation. It is sufficient for this purpose to reverse the current in the electromagnet 16 so as to cause the plunger 49 to rise to its initial position.

It will be observed that the fire door structure according to the invention can also be mounted in a corridor in which it is maintained permanently opened, for example, by an electromagnetic locking device. In the event of fire, the locking device can then release the door which, in closing, performs its fire isolating function, with the window 25 being simultaneously opened.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A fire door structure comprising a door frame, a door movably mounted on said frame, means for resiliently biasing the door in a direction to close the door, the door having an opening therein allowing passage through the door structure, a movable flap for selectively opening and closing the opening, locking means for normally securing the flap to the door in the closed position of the flap and sensitive to a remote fire detection means for releasing the flap from the door in the event of a start of a fire so as to permit the flat to open said opening and to evacuate smoke therethrough, first resiliently yieldable means for biasing said flap to the closing position of the flap, second resiliently yieldable means which are more powerful than the first resiliently yieldable means for biasing the flap to the opening position of the flap, and fuisible means proximate the door thereby allowing said second resiliently yieldable means to open the flap under the control of said remote fire detection means and said first resiliently yieldable means to close the flap when the second resiliently yieldable means is disabled as the temperature close to the door rises to a predetermined level so as to isolate both sides of the door with respect to fire propagation.

2. The fire door structure as claimed in claim 1, comprising hinges having a substantially vertical pivot axis for pivotally connecting the flap to the door frame.

3. The fire door structure as claimed in claim 2, wherein said first and second resiliently yieldable means are associated with said hinges and comprise two torsion springs having different strengths.

4. The fire door structure as claimed in claim 3, wherein a hinge associated with the spring of higher strength comprises two knuckles, two hinge strips respectively connecting the two knuckles to the frame and the flap, a rotary member attaching the higher strength spring to one of the knuckles and defining first radial orifices, second radial orifices in said one knuckle, said first orifices and second orifices being capable of being put into radial alignment upon rotation of the cup relative to said one knuckle, said fusible means comprising a fusible pin extending through a first orifice and a second orifice which are radially aligned for securing the cup to said one knuckle.

5. The fire door structure as claimed in claim 1, wherein said locking means comprise means defining a first aperture in the door and means defining a second aperture in the flap, the first aperture and second aperture being in alignment in the closing position of the flap, a withdrawable locking member normally extending through the first aperture and second aperture in the closing position of the flap, an electromagnet associated with the locking member and a manually actuatable device associated with the locking member for withdrawing the locking member selectively electrically and manually.

6. The fire door structure as claimed in claim 5, further comprising breakable means which are associated with the manually actuatable device and require to be broken before permitting actuation of the manually actuatable device.

7. The fire door structure as claimed in claim 5, comprising a first case mounted in the door and including means defining said first aperture, a second case mounted in the flap and including means defining said second aperture, the cases being in superimposed relation, the aperture associated with the upper case of the superimposed cases having a downwardly convergent face, a deformable washer combined with the locking member and having a downwardly convergent face

matching the downwardly convergent face of the aperture of the upper case, the electromagnet being disposed in the lower case, and the manually actuatable device being mounted in the upper case and associated with the locking member to urge the locking member downwardly in case of fire by forcing the deformable washer through the aperture having a downwardly convergent face.

8. A fire door structure comprising a door frame, a door movably mounted on said frame, means for resiliently biasing the door in a direction to close the door, the door having an opening therein allowing passage through the door structure, a movable flap for selectively opening and closing the opening, locking means for normally securing the flap to the door in the closed position of the flap and sensitive to a remote fire detection means for releasing the flap from the door in the event of a start of fire so as to permit the flap to open said opening and to evacuate smoke therethrough, said flap being of the guillotine type and so arranged as to be biased by gravity in its closing position, said structure further comprising a cable and pulley arrangement and a resiliently yieldable means for biasing said flap to the open position, said resiliently yieldable means being capable to overcome the weight of said flap, and fusible means proximate the door thereby allowing said resiliently yieldable means to open said flap under the control of said remote fire detection means, while allowing to close said flap by virtue of gravity when said resiliently yieldable means is disable by said fusible means as the temperature close to the door rises to a predetermined level so as to isolate both sides of the door with respect to fire propagation.

9. The fire door structure as claimed in claim **1**, wherein the flap is of the Venetian shutter type and combined with the second resiliently yieldable means so as to be opened by the second resiliently yieldable means and combined with the first resiliently yieldable means so as to be closed by the first resiliently yieldable means.

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