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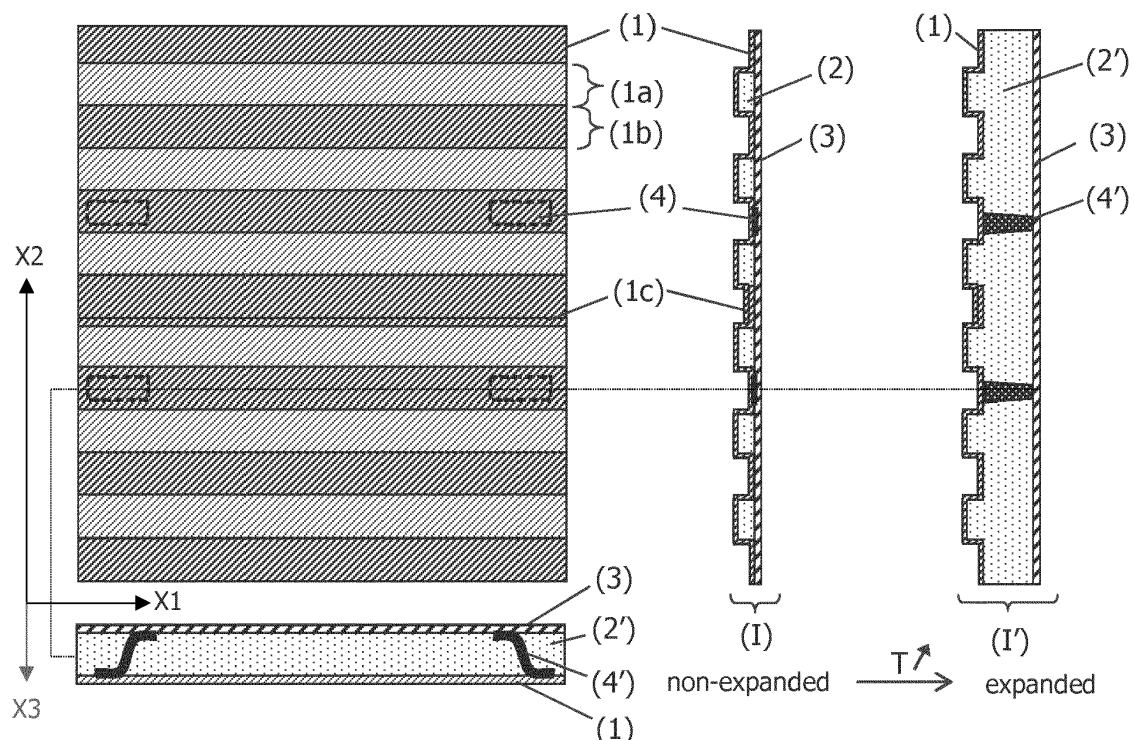
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(54) **Corrugated fire-retardant shutter**

(57) The present invention relates to a cost effective and a relatively lightweight fire-retardant shutter for smoke redirection and damping applications in air ducts, buildings and building industry. In particular, it concerns a fire-retardant shutter comprising at least one layer of a

corrugated fire-resistant material and an intumescent material, wherein the intumescent material is positioned at least partially inside the concave surfaces formed by the corrugations of the fire-resistant material.

Figure 4



Description

Technical Field

[0001] The present invention relates to a cost effective and a relatively lightweight fire-retardant shutter for smoke redirection and damping applications in air ducts, buildings and building industry. In particular, the invention concerns a fire-retardant shutter comprising at least one layer of a corrugated fire-resistant material and an intumescent material, wherein the intumescent material is positioned at least partially inside the concave surfaces formed by the corrugations of the fire-resistant material.

Background for the invention

[0002] It is a well-known fact that in case of fire in a building, timing is everything. Fire spreads upwards in a matter of seconds and sideways in the matter of minutes. While spreading, it generates hazardous fumes that can render people disoriented or even unconscious. Therefore, a quick intervention to cut the advancing smoke off and delay the progression of fire is key in saving lives, especially in complex buildings like large offices or schools, wherein the nearest fire-exit can be corridors or even staircases away.

[0003] For these reasons, there is a constant need for the development of quickly reacting and relatively durable fire barriers, capable of buying as much time as possible and ensuring safest escape route possible for the affected fire victims.

[0004] Consequently, nowadays there exist numerous fire protection solutions with different advantages and drawbacks. For protection of air ducts or ventilation shafts there are two most common types of barriers. The first one provides a broad category of passive perforated intumescent plugs or grilles in which the intumescent component expands in response to heat or fire, fusing the grille into a solid block which, for a certain time, will hold the fire from spreading. Another category comprises fire-resistant fire and smoke dampers that can close quickly in response to heat. The purely intumescent barriers in general have better insulating properties but are much slower in closing and therefore tend to allow some smoke to pass. On the other hand, the closing dampers are more effective against smoke but, being largely made of metal, they transfer heat much faster which leads to quick elevation of temperatures on the other side of the damper. Hybrid solutions, that combine both the fire resistant material with the intumescent exist but are usually composed of multiple layers and hence are bulky, tending to limit air passage through air ducts, shafts, or even small windows or narrow corridors.

[0005] An example of one solution is provided in EP2520338, which discloses a curtain comprising two parallel flat layers of the fire-resistant material encasing powdery or doughy intumescent material. The design appears simple, however it suffers from major manufactur-

ing complications to prevent the loose intumescent from falling out from between the two parallel sheets. To do so, the sheets are first joined by a plurality of bracing slats perpendicular to the surface of the fire resistant sheets, then the intumescent is packaged in discrete bags that are then, inserted between the shelves formed by the bracing slats.

[0006] Similarly, NL2010146 discloses a relatively thick double-walled and hollow-cored segmented rollable curtain with complex multichamber bags encasing intumescent powder. Consequently, the curtain not only appears dimensionally not suitable for smaller openings like air ducts, but also it is complicated to manufacture due to its numerous components.

[0007] Other prior art documents such as WO02053679 or US2013255893, disclose curtains of heavy knitted fire-resistant fabric, wherein the intumescent material particles are either glued onto the surface of the fabric or woven into it, respectively. Although these solutions could be sufficiently lightweight, they do not allow incorporation of intumescent layers sufficiently thick to achieve a longer lasting thermal barrier.

[0008] In spite of the promising combination of the intumescent and fire-resistant elements, the above listed shutters are either complex to manufacture or provide insufficiently satisfying characteristics including the extent of intumescent char expansion and thus also the time they can withstand the fire.

[0009] In view of the above, it appears that there remains a need in the art for a low-cost, quickly-closing and durable fire-retardant shutter that can easily be fitted to air ducts, ventilation shafts as well as architectural openings such as doors, corridors or even windows. The present invention provides a solution to this and other problems.

Summary of the invention

[0010] The present invention is defined in the appended independent claims. Preferred embodiments are defined in the dependent claims. In particular, the present invention concerns a fire-retardant shutter or for applications in air ducts, shafts, and architectural openings, the shutter comprising:

- a layer made of a fire-resistant material that is corrugated i.e. comprising furrows forming a concave surface and ridges forming a convex surface in an alternate and parallel pattern, and
- an intumescent material (2) positioned at least partially inside the concave surface of at least one furrow (1 a).

[0011] A shutter of such design can be easily manufactured at relatively low costs and, most importantly, possesses increased stiffness in the direction parallel to the direction in which the corrugations are extending, and at the same time increased bending ability or rollability

along the direction perpendicular to the direction of the corrugations. These properties make the shutter of the present invention particularly advantageous for manufacturing of relatively light-weight and small fire-barriers or smoke evacuators that could be discretely mounted e.g. in a form of a curtain or a roller-blind in air ducts, shafts, building corridors and like, and then swiftly extended or unrolled in case of a fire or smoke. The increased stiffness along the direction of corrugations minimizes occurrence of deformations that could impede or slow down the unrolling or opening of the shutter, and furthermore ensures even covering of the opening and thus forming a better barrier. On the other hand, the presence of corrugations provides natural casing for various forms of intumescent materials that, once the shutter is exposed to heat, undergo phase transition and swell delaying increase in temperature on the other side of the shutter and, further, forming an effective seal against the passage of fire and smoke.

[0012] In a preferred embodiment, the shutter of present invention is sufficiently flexible to roll around at least a portion of a rotating drum.

[0013] In another embodiment, the fire retardant shutter of the invention further comprises at least one additional layer that is coupled to its first layer of the fire resistant material, such as to form a closed space encasing the intumescent material, and thus keep it in place. This is necessary for intumescent materials that are provided as a suspension of loose particles or a paste, which otherwise would not remain in the furrows of the corrugated shutter.

[0014] In alternative embodiments the additional, or second, layer can be attached to the first layer by welding or means of an adhesive or glue, or can advantageously be coupled to the first layer by means of coupling bridges, such as rivets or a scored portion formed in one of the layers and attached to the second one.

[0015] In an embodiment according to the latter embodiment, which is particularly advantageous in case looser forms of intumescent material are used, the coupling bridges allow the distance between the first layer and the additional layer to be increased upon expansion of the intumescent material encased between them. Examples of such bridges include but are not limited to strips of easily bendable metal, springs, etc. Advantageously, the strips of easily bendable material can be formed as a score portion formed in one of the layers, preferably being the additional layer. The score portion may for example comprise 3 edges formed by score lines, two of which are parallel to one another and perpendicular to the third one being the edge adjacent to the part of the score portion that is fixedly attached to the corrugated layer of the shutter via e.g. welding or another attachment means such as a screw or a rivet. In such instance, as the intumescent material expands pushing the two shutter layers away from one another, the score portion bends along its two parallel edges forming a bend line that is perpendicular to these edges and parallel to the edge

attached to the corrugated layer. The additional layer of the shutter preferably has a certain degree of flexibility sufficient not to hinder rolling of the shutter, and, in the particular case of the previously described embodiment, also not to interfere with the bending of the score portion. Therefore, in a preferred embodiment, the additional layer is made of a flexible material or a film.

[0016] In another preferred embodiment, the additional layer is also made of a fire-resistant material, which potentially is advantageous in for shutters positioned between two rooms that are under similar risk of fire.

[0017] Preferred fire-resistant materials for the application in the shutter according to the invention are the ones that do not degrade at 300°C for at least 30 minutes. With prejudice to layer thickness and exact content, examples of suitable material groups include inox (stainless steel), aluminium, fabric of aramid, calcium silicate, or various mixes thereof.

[0018] Thus, in a preferred embodiment of the present shutter, the fire-resistant material of the first corrugated layer is selected from a group comprising inox, aluminium, fabric of aramid, calcium silicate, or a mix thereof.

[0019] Similarly, in an alternative embodiment, whether or not combined with the previous one, the fire-resistant material of the additional layer is also selected from a group comprising inox, aluminum, fabric of aramid, calcium silicate, or a mix thereof.

[0020] Another important component of the shutter of the present invention is the intumescent material. As stated before, an intumescent is a substance which swells as a result of heat exposure, thus increasing in volume and decreasing in density. Most known materials expand in response to heat but the intumescent materials do so via a chemical reaction, usually elimination of a water molecule. The remaining substance is called char and becomes expanded ("foams") as the eliminated water undergoes a phase transition, which additionally also decreases temperature of the material, and leaves the material as vapour. The remaining char is a poor conductor of heat, and depending on the form and amount of the char, as well as the strength or pressure of its expansion, intumescent materials can be classified as soft char or hard char materials, the latter being characterised by higher expansion pressure. In general embodiments, the fire retardant shutter of present invention can comprise any intumescent material selected from a group comprising soft char materials or hard char materials, or mixes thereof, and preferably comprises hard char material comprising graphite, sodium silicate or other sodium salt, or vermiculite. Commercial examples of currently sold intumescent mixes, suitable for use with present invention, include Rf-Expand EX607 and Rf-Expand EX147, as commercialised by RF Technologies, or e.g. products like Favuseal, Palusol, or Kerafix etc. Because the division of intumescent materials is not clear-cut and many commercial compositions are known, it can be assumed for the purposes of the present invention that a suitable intumescent shall be understood as any material or ma-

terial mixture expanding in response to heat and capable of reaching a volumetric expansion ratio of at least 2, preferably 4, or most preferably 8 or higher, wherein said ratio is defined as the ratio of the final volume of the material expanded under standard fire conditions, as given in ISO 834 (1975), to its initial volume under STP (expanding ratio $ER = \text{final volume}/\text{initial volume}$).

[0021] Therefore, in a preferred embodiment in accordance with other embodiments, the intumescent material is a material reaching a volumetric expansion ratio of at least 2, preferably 4, or most preferably 8 or higher under standard fire conditions.

[0022] The shutter of the present invention can further advantageously be coupled to an elongated mandrel in such way the alternate furrows ridges are parallel to the elongated surface of the mandrel as to allow retracting or extending of the shutter by winding or unwinding around said mandrel, thus forming a roller blind. In an embodiment of said embodiment, the roller blind may further comprise means for mounting it in a special housing or directly in an air duct or an architectural opening.

[0023] In a further aspect, the present invention also provides a fire-retardant shutter assembly for closing an area defined by a first direction, X1, and a second direction, X2, said assembly comprising:

(a) a shutter according to any of the claims 1-10, said shutter further defined as comprising

- a leading edge extending along the second direction, X2, and parallel to the first direction, X1, in one direction to close the area and in the opposite direction to open said area, and
- two lateral edges separated by the leading edge;

(b) a housing for accommodating said shutter and capable of being installed in the area defined by directions X1 and X2, said housing comprising

- at least one shutter-adjacent profile, that is a profile parallel to the first direction, X1, and the profile closest to the shutter's leading edge when the shutter is in a non-extended position, and
- at least two side profiles that are connected and perpendicular to the shutter-adjacent profile and parallel to the second direction, X2; and

(c) means for extending the shutter leading edge along the second direction, X2, as to close said area.

[0024] As it will be appreciated by any skilled person, the means of extending said shutter shall comprise any of the different arrangements, manual or automated alike, known in the art that are capable of setting the shutter into motion as to close or open the defined area in response to a trigger. The trigger can be any an internal or external signal relayed from an initiating device either integrated in the assembly, or nearby, or more distant.

Examples of initiating devices are also well known in the art and are not within the scope of the present invention, they include e.g. pull stations, break-glass stations, heat detectors, fusible links, smoke detectors, flame detectors, water-flow detectors, cameras etc.

[0025] In a further embodiment, the housing of the fire-retardant shutter assembly shall further comprise a guiding system, such as guide rails or guiding cables, for guiding at least one lateral edge of the shutter, preferably both lateral edges of the shutter.

[0026] In another embodiment of the present invention, any of the housing, or the guiding system, or the shutter can comprise at least one sealing strip for better sealing of the extended shutter against the housing.

[0027] In a preferred embodiment of the fire-retardant shutter assembly of the invention, the shutter is coupled to a mandrel and the means for extending said shutter is rotational motion of said mandrel in the housing, thus forming a roller blind assembly.

[0028] In a possible embodiment of the previous embodiment, particularly advantageous where access to the shutter is difficult in high not easily accessible openings such as the ones of air ducts, the mandrel can be positioned in the lowest profile of the housing and the shutter extends upwards on a guiding system.

Brief description of the Figures

[0029] For a fuller understanding of the nature of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 shows vertical cross sections of three alternative embodiments of the shutter according to the present invention, said embodiments differing with respect to the shape of corrugations;

Figure 2 shows vertical cross sections of two alternative embodiments of the shutter further comprising the additional layer;

Figure 3 shows an exploded view of one embodiment of the shutter;

Figure 4 shows frontal view of one embodiment of the shutter (left panel), vertical cross sections of one embodiment of the shutter material prior (I) and after volumetric expansion (I') (right panel), and a horizontal cross section of the same expanded embodiment (bottom left panel) along the zone of the shutter comprising coupling bridges (4).

Figure 5 shows vertical cross sections of an embodiment of the shutter rolled in two different ways around a cylindrical mandrel (II);

Figure 6 shows vertical cross sections of three al-

ternative embodiments of a shutter further comprising more elements;

Figure 7 shows different views of a simplified model of an embodiment of a housing of a fire-retardant rolling-shutter assembly according to the invention;

Detailed description of the invention

[0030] The present invention provides a corrugated fire-retardant shutter for closing an area defined by a first direction, X1, and a second direction, X2. With regard to the movement of shutter, it can be defined as having a leading edge and two side lateral edges separated by and perpendicular to the leading edge. As the shutter moves, the leading edge extends along the second direction, X2, and moves parallel to the first direction, X1, in one direction to close the area and in the opposite direction to open said area. The fire-retardant shutter of the present invention comprises

(a) a layer made of at least one sheet of a fire-resistant material (1) defined as a material non-degrading at 300°C for at least 30 minutes, having a corrugated structure, i.e. having a structure comprising furrows (1a) forming a concave surface and ridges (1b) forming a convex surface, said furrows and ridges extending along the first direction, X1, and alternating along the second direction, X2, and

(b) an intumescent material (2), positioned at least partially inside the concave surface of at least one furrow (1a).

[0031] As used herein, the term "fire-retardant" should be understood as intended for delaying the spread of flame, smoke, and/or fumes.

[0032] Figure 1 schematically illustrates three examples of the material (1) forming the fire-retardant shutter of the invention, showing different possible corrugation patterns in the fire-resistant material (1). Furrow (1a) and ridge (1b) sections are indicated. The presented shapes only serve illustrative purposes as many other corrugation types can be envisaged and obtained by methods known in the art, such as roll-forming, cold-rolling, various pressing or extrusion techniques, or processing in special corrugation machines, or other ways of sheet profiling or potentially even welding.

[0033] The unidirectional parallel corrugations of the shutter of the invention serve two major roles. Firstly, they confer the desirable physical properties as increased rigidity in the dimension perpendicular to the direction of the corrugations (or parallel to the direction in which the furrows and ridges that form the corrugations extend), X2, and higher bendability in the direction parallel to the corrugations (or perpendicular to the direction in which the furrows and ridges extend), X1, which together counteract bending of the shutter in any direction

different than along the corrugations. And secondly, the concave surfaces inside the furrows provide natural support for accommodating the intumescent material (2).

[0034] Once the fire-resistant layer is profiled, it suffices to pour the intumescent powder or granulates into the furrows and then secure the thus obtained product with an additional layer, or simply attach solid rods of the intumescent material into the concave surfaces by means of an adhesive. Such shutter can readily be positioned upright without further complicated manufacturing procedures for ensuring the intumescent does not dislocate.

[0035] As used herein, the term "intumescent material" is to be understood as a material swelling or expanding under conditions of exposure to fire or heat, typically by the expulsion of water vapour. In preferred embodiments of present invention, the intumescent material is capable of reaching a volumetric expansion ratio at least 2, preferably 4, or most preferably 8 or higher, wherein said ratio is defined as the ratio of the final volume of the material expanded under standard fire conditions, as given in ISO 834 (1975), to its initial volume under standard conditions for temperature and pressure (STP). The expansion ratio x is given by the formula:

$$x = V_{final}/V_{initial}.$$

[0036] The degree to which the intumescent material expands is important during a fire event, as the expanding char will have to fill the space it is designed to occupy and must do so at a rapid rate. The higher the expansion ratio, the better the isolation properties and the probability the intumescent will expand firmly against the periphery of the area to be sealed, thereby providing an effective seal against the passage of fire and smoke. There exists many types of intumescent materials suitable to be used in the shutter of the present invention. Most types are graphite-based or based on various silicas such as sodium-silicate, mica or vermiculite. Examples of commercial intumescent materials include various mixes including Rf-Expand, Palusol, Favuseal or Kerafix, some of which can attain expansion ratio of 50 or even higher. Further examples of intumescent compositions can be found in e.g. patent documents US5476891, US4273879, or WO201060421.

[0037] In a preferred embodiment, the intumescent material (2) is positioned at least partially inside the concave surfaces of a plurality of furrows (1a) on at least one side of the corrugated fire-resistant material (1); but in certain embodiments, it can be positioned at least partially inside the concave surfaces of a plurality of furrows (1a) on both sides of the corrugated fire-resistant material (1) (cf. Figure 6, middle pane). In a particularly preferred embodiment, the intumescent material (2) is positioned at least partially inside the concave surfaces of a plurality of furrows (1a) on only one side of the corrugated fire-resistant material (1).

[0038] Commercial intumescent materials are usually supplied in powder, pellet, or pasteous form, but may be processed to other form by extrusion, compression-moulding or injection-moulding. Because of high friability and looseness of the majority of the currently-available intumescent materials, in advantageous embodiments of the present invention, the corrugated shutter further comprises an additional layer of material (3) such as to form a closed space encasing the intumescent material (3). Two examples of such solution are illustrated in Figures 2. The additional layer (3) is preferably flat and preferably coupled to the corrugated or first layer (1) by e.g. an adhesive, welding with or without an adhesive, or by coupling bridges (4) such as rivets, nails, or screws. By application of the additional second layer (3) even the free-flowing intumescent materials (3) may be stored as distinguishable layers enclosed inside of the furrows formed in the corrugated fire-resistant sheet, as symbolically represented in Figure 3.

[0039] Figure 4 shows a preferred embodiment of the shutter according to the invention, wherein two (or more) corrugated fire-resistant sheets (1) overlap (1c). However, in alternative embodiments, two or more fire-resistant sheets (1) may be coupled to the continuous additional layer (3) without being directly connected to each other.

[0040] As further illustrated in Figure 4, the shutter of the present invention may advantageously be configured to allow increasing of the distance between the first (corrugated) layer (1) and the additional layer (3) upon expansion of the intumescent material (2') encased between them. Such effect can be achieved by means of extendible coupling bridges that either elongate or bend (4') as the additional layer (3) is pushed away from the first fire-resistant corrugated layer (1) by the expanding intumescent (2'). Examples of such extendible coupling bridges include but are not limited to springs or flexible metal slabs, provided as separate components or formed in one of the layers a scored portions.

[0041] As discussed before and with prejudice to materials used, parallel corrugations have the advantage of ensuring that the shutter of the present invention is bendable and rollable in only one direction, said direction, X2, being the direction perpendicular to the direction wherein the furrows and ridges of the corrugations are extending, X1. Figure 5 schematically illustrates two different modes of rolling or bending of the shutter material (I) around a rotating drum or mandrel (II).

[0042] In a preferred embodiment, the shutter of the present invention is provided in a form of a flexible roller blind, wherein the corrugated shutter material (I) is coupled to the elongated profile of a mandrel (II) in a way allowing to retract or extend the shutter material (I) by moving the shutter leading edge along the direction perpendicular to the longitudinal axis of the mandrel (II), X2, by means of rotational movement exerted by the mandrel (II).

[0043] Therefore, in preferred embodiments of present invention, the composite material (I) of the shutter is suf-

ficiently flexible to roll around at least a portion of a rotating mandrel (II). Along these lines, examples of fire resistant materials suitable for either the first corrugated layer (1) or the additional layer include but are not limited to inox, aluminum, woven aramid, calcium silicate, mixes thereof, or various alloys thereof.

[0044] In one embodiment, the corrugated first layer (1) is preferably made of inox.

[0045] In another embodiment, nonexclusive with the previous embodiment, the additional layer (3) is also preferably made of inox.

[0046] In an alternative embodiment, the additional layer (3) can be selected from any flexible material or film, e.g. including woven or non-woven fabrics, hydroentangled materials, a spunbond materials, or a meltblown materials, enameled cloths, meshes, a monofilament fabrics, aluminized glass cloths, perforated films, adhesive layers, a glue webs, or a glue films.

[0047] As will be obvious to one skilled in the art, a curtain of present invention may comprise a plurality of more additional layers, e.g. it can comprise two opposing layers of the corrugated fire-resistant material (1'), or additional layers directly coupled (3') or non-directly coupled (3'') to the corrugated layer of the fire-resistant material (1), as schematically illustrated in Figure 6.

[0048] Similarly, any of the layers, external layers in particular, may comprise additional coating or a top decorative layer facing ambient such as a paint layer or a wallpaper. Advantageously, such layers can be made of any of a fire retarded or fire resistant cellulosic material, melamine, veneer, high pressure laminates etc., and combinations thereof.

[0049] For the safety and ease of installation purposes, the present invention further provides a fire-retardant shutter assembly configured to be installed in and close an area defined by a first direction, X1, and a second direction, X2. The fire-retardant shutter assembly according to the invention comprises:

(a) a shutter according to any of the claims 1-10, said shutter defined as comprising

- a leading edge extending along the second direction, X2, and parallel to the first direction, X1, in one direction to close the area and in the opposite direction to open said area, and
- two lateral edges separated by the leading edge;

(b) a housing for accommodating said shutter and capable of being installed in the area defined by directions X1 and X2, said housing comprising

- at least one shutter-adjacent profile, that is a profile parallel to the first direction, X1, and the profile closest to the shutter's leading edge when the shutter is in a non-extended position, and
- at least two side profiles that are connected and perpendicular to the shutter-adjacent profile and

parallel to the second direction, X2; and

(c) means for extending the shutter leading edge along the second direction, X2, as to close the area.

[0050] In a preferred embodiment, the area in which the housing and thus the fire-retardant shutter assembly can be installed is the area defined by an opening, such as an opening of an air duct, a shaft, or an architectural opening such as an opening in a wall, a window, a door, or a corridor etc.

[0051] In a preferred embodiment, the housing of the assembly according to the invention comprises four profiles, i.e. comprises an additional profile parallel to the shutter-adjacent profile, and connected and perpendicular to the two side profiles, wherein all four profiles define a generally rectangular opening as schematically illustrated in Figure 7.

[0052] In a particularly preferred embodiment, the housing further comprises a guiding system for guiding at least one lateral edge, preferably both lateral edges, of the shutter during the movement of the leading edge.

[0053] Non-limiting examples of guiding systems comprise guiding rails or guiding lines, which, when coupled to a motor, can actively contribute to closing of the shutter.

[0054] In another embodiment, the housing profile that is farthest to the shutter-adjacent profile may comprise a locking system for locking and fixing the leading edge of the shutter once it is fully extended.

[0055] In further embodiments the leading edge of the shutter may comprise an extension compatible with said locking system for ensuring more efficient locking.

[0056] In an alternative embodiment but compatible with the above embodiment, the leading edge of the shutter may further comprise a counterweight aiding in gravitational lowering of the shutter and/or closing against the housing.

[0057] In another preferred embodiment according to the previous embodiments, the fire-retardant shutter assembly is a roller-blind assembly wherein the shutter is coupled to a mandrel (II) and is sufficiently flexible to wound and unwound around said mandrel and wherein the means for extending said shutter is the mandrel's rotational motion. A very schematic example of such shutter assembly with a roller blind and housing was presented in Figure 7.

[0058] In an advantageous embodiment according to the previous embodiment, the mandrel (II) is positioned in the lowest profile of the housing and the shutter extends upwards by means of the guiding system.

[0059] The means for extending the shutter, can be any of the known manual or motorized means capable of triggering and maintaining the movement of the shutter leading edge until the assembly of the present invention is fully closed. For example, the assembly may comprise and be activated by an integrated thermal element which melts at temperatures higher than ambient but low

enough to indicate the presence of a fire, allowing an assembly of springs to release the shutter.

[0060] In certain embodiments, a fire-retardant shutter assembly of the invention may further comprise means for retracting the shutter, which can be advantageous for reusing the assembly in case the shutter was closed due to a false alarm or during a fire drill exercise.

[0061] In advantageous embodiments, the fire-retardant shutter assembly of the invention is configured to stop fire progression through an opening smaller than or equal to 2 m², preferably 1.5 m², for at least 60 to 120 minutes.

Claims

1. A fire-retardant shutter comprising:

- a layer made of a fire-resistant material (1) comprising furrows (1 a) forming a concave surface and ridges (1 b) forming a convex surface in an alternate and parallel pattern, and
- an intumescent material (2) positioned at least partially inside the concave surface of at least one furrow (1a).

2. Fire retardant shutter according to claim 1, further comprising at least one additional layer (3) coupled to the first layer of the fire-resistant material (1), such as to form a closed space encasing the intumescent material (2).

3. Fire retardant shutter according to claim 2, wherein the additional layer (3) is coupled to the first layer by means of coupling bridges (4).

4. Fire retardant shutter according to claim 3, wherein the coupling bridges (4) allow the distance between the first layer (1) and the additional layer (3) to be increased upon expansion of the intumescent material (2) encased between them.

5. Fire retardant shutter according to any of the preceding claims, wherein the additional layer (3) is made of a flexible material or a film.

6. Fire retardant shutter according to claims 2 to 5, wherein the additional layer (3) is made of a fire-resistant material.

7. Fire retardant shutter according to any of the preceding claims, wherein the fire-resistant material of the first layer (1) is selected from a group comprising inox, aluminium, fabric of aramid, calcium silicate, or a mix thereof.

8. Fire retardant shutter according to any of the claims 2 to 7, wherein the fire-resistant material of the additional layer (3) is selected from a group comprising

inox, aluminium, fabric of aramid, calcium silicate, or a mix thereof.

9. Fire retardant shutter according to any of the preceding claims, wherein the intumescent material (2) is selected from a group comprising soft char materials or hard char materials or a mix thereof, and preferably is a hard char material comprising graphite, sodium silicate, or vermiculite. 5
10. Fire retardant shutter according to any of the preceding claims, further comprising at least one lateral sealing strip (III). 10
11. A fire-retardant shutter assembly for closing an area defined by a first direction, X1, and a second direction, X2, said assembly comprising 15
- (a) a shutter according to any of the claims 1-10, said shutter defined as comprising 20
- a leading edge extending along the second direction, X2, and parallel to the first direction, X1, in one direction to close the area and in the opposite direction to open said area, and 25
 - two lateral edges separated by the leading edge;
- (b) a housing for accommodating said shutter and capable of being installed in the area defined by directions X1 and X2, said housing comprising 30
- at least one shutter-adjacent profile, that is a profile parallel to the first direction, X1, and the profile closest to the shutter's leading edge when the shutter is in a non-extended position, and 35
 - at least two side profiles that are connected and perpendicular to the shutter-adjacent profile and parallel to the second direction, X2; and 40
- (c) means for extending the shutter leading edge along the second direction, X2. 45
12. A fire-retardant shutter assembly according to claim 11, wherein the housing comprises a guiding system for guiding at least one lateral edge, preferably both, of the shutter. 50
13. A fire-retardant shutter assembly according to claim 12, wherein the housing or the guiding system further comprises at least one lateral sealing strip (III). 55
14. A fire-retardant shutter assembly according to any of the claims 12-13, wherein the shutter is coupled

to a mandrel (II) and wherein the means for extending said shutter is rotational motion.

15. A fire-retardant shutter assembly according to claim 14, wherein the mandrel (II) is positioned in the lowest profile of the housing and wherein the shutter extends upwards by means of the guiding system.

Figure 1

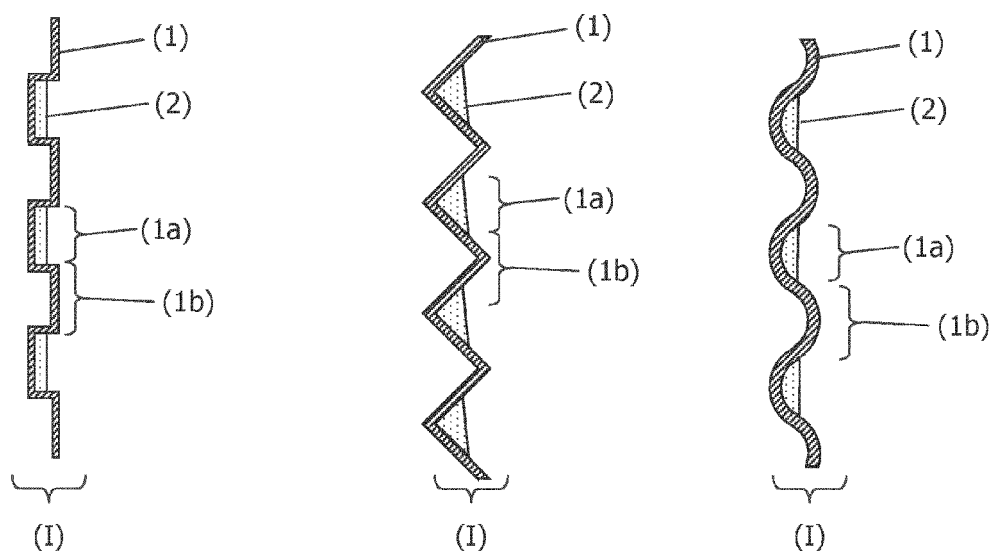


Figure 2

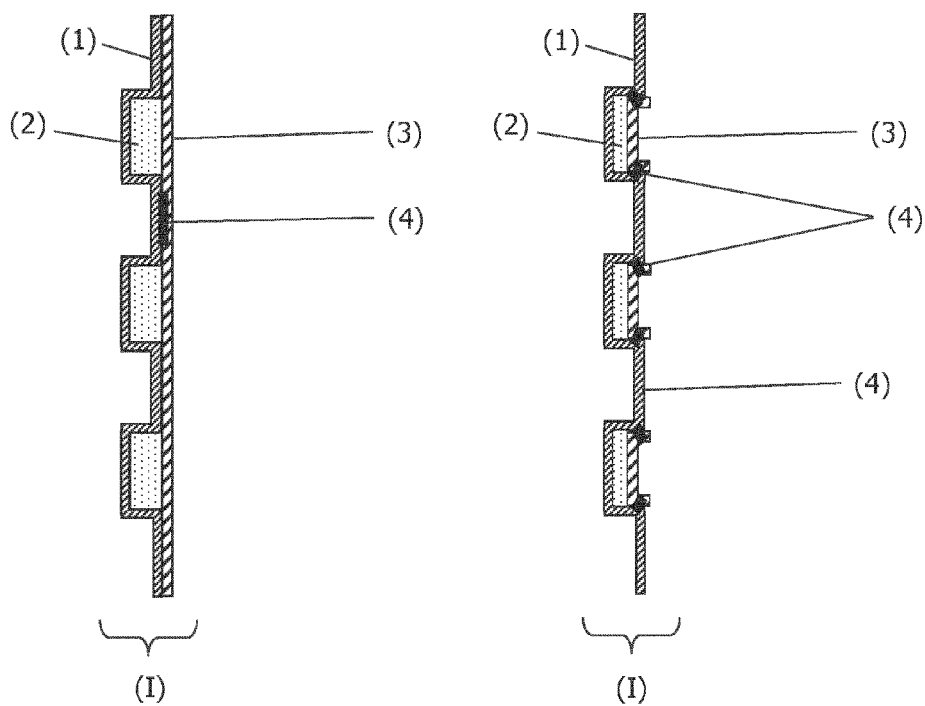


Figure 3

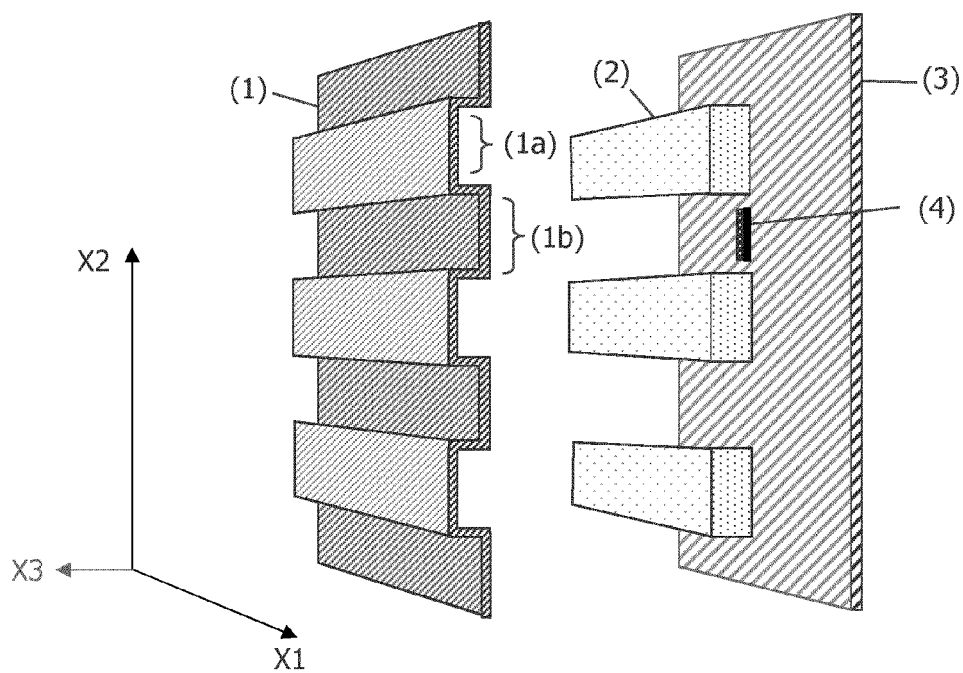


Figure 4

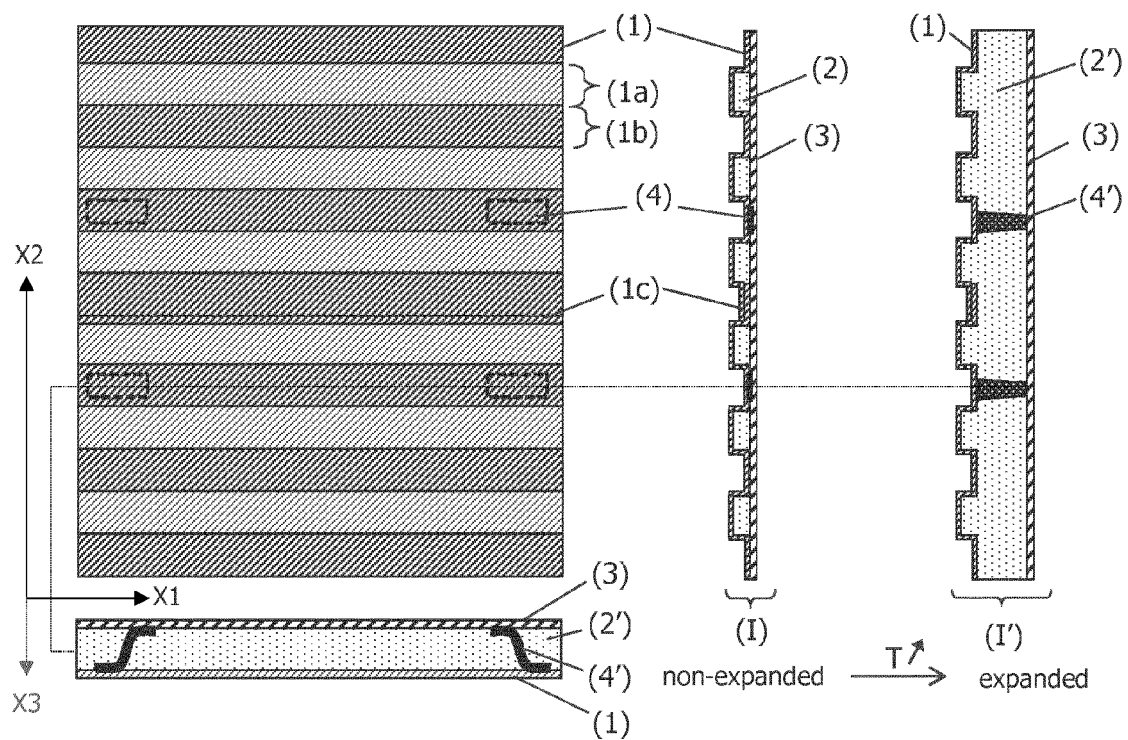


Figure 5

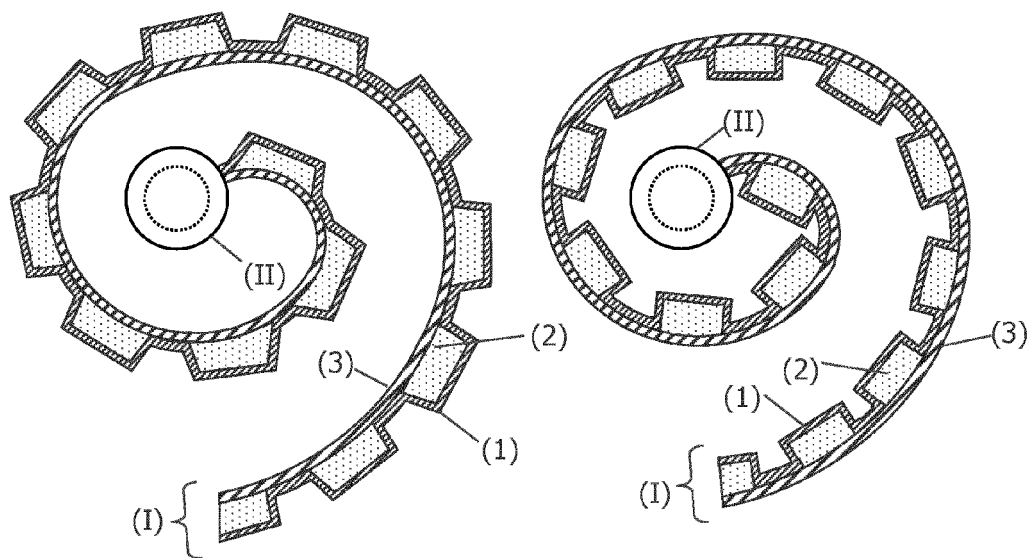


Figure 6

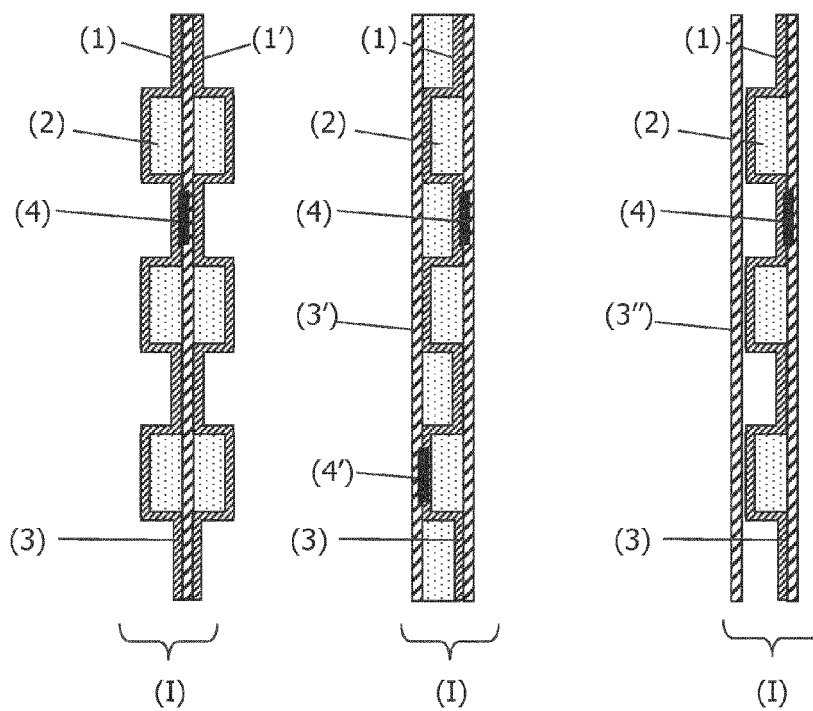
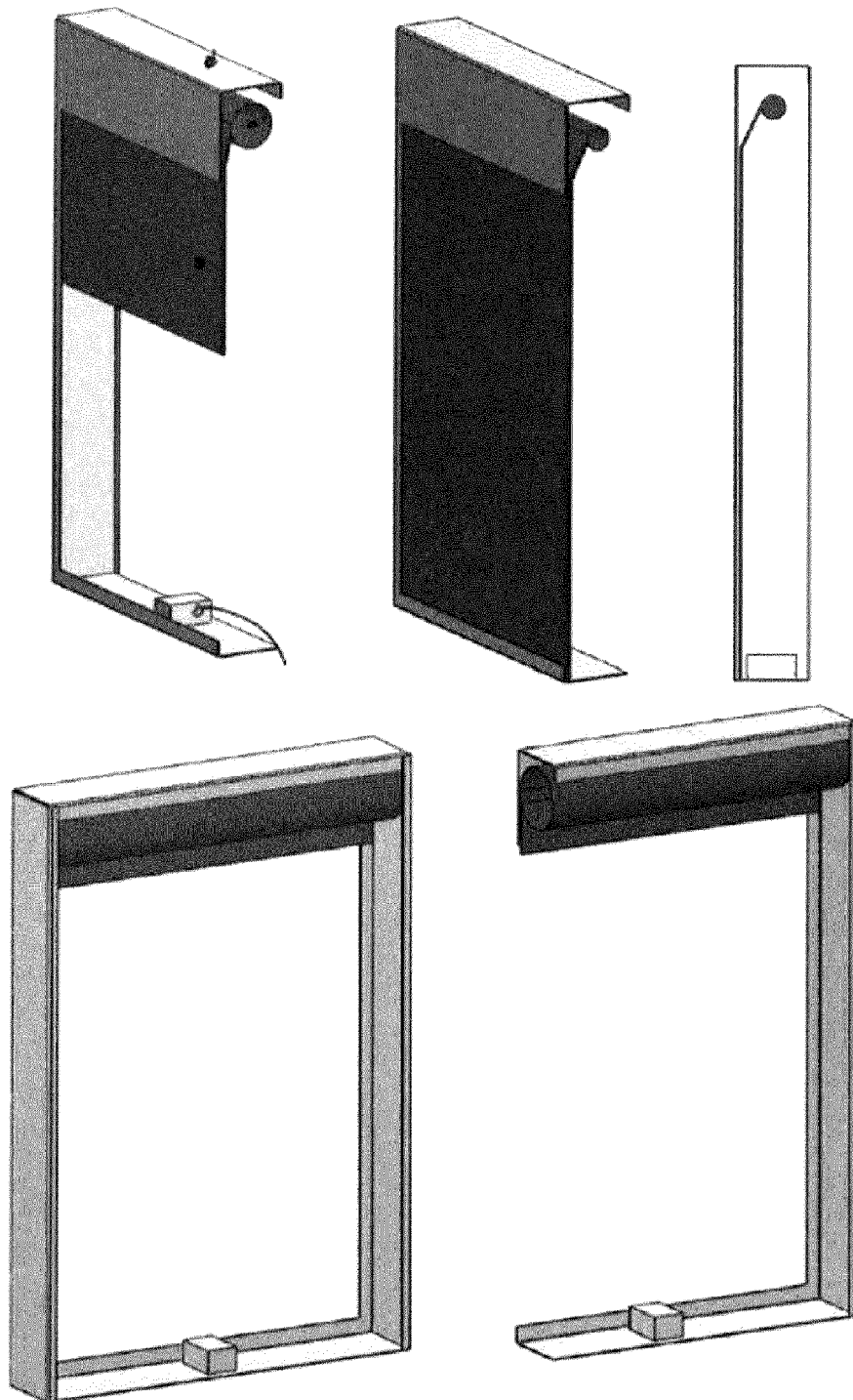


Figure 7





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Application Number
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