

①⑨



Europäisches Patentamt
European Patent Office
Office européen des brevets

①⑪ Publication number:

**0 123 255
B1**

①⑫

EUROPEAN PATENT SPECIFICATION

④⑤ Date of publication of patent specification: **20.07.88**

⑤① Int. Cl.⁴: **E 04 B 1/94**

②① Application number: **84104296.3**

②② Date of filing: **16.04.84**

⑤④ **Fire protective structural component.**

③⑧ Priority: **18.04.83 US 485608**

④③ Date of publication of application:
31.10.84 Bulletin 84/44

④⑤ Publication of the grant of the patent:
20.07.88 Bulletin 88/29

⑧④ Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

⑤⑧ References cited:
**CH-A- 542 697
DE-A-2 613 938
DE-A-3 234 021
GB-A-2 072 046
US-A-4 292 358**

⑦③ Proprietor: **American Vamag Company,
Incorporated
1061 Linden Avenue
Ridgefield New Jersey 07657 (US)**

⑦② Inventor: **Radovic, Paul
60 Elizabeth Avenue
Teaneck New Jersey 07666 (US)**

⑦④ Representative: **Türk, Gille, Hrabal
Bruckner Strasse 20
D-4000 Düsseldorf 13 (DE)**

EP 0 123 255 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Courier Press, Leamington Spa, England.

Description

A continuing need exists to find new, better and/or more economical means to improve the resistance to fire of buildings, their contents, and other structures and objects which can be damaged by fire. These include ships, mobile homes, electrical circuits, shipping containers, record protective equipment and the like. While the fire itself, i.e., combustion (pyrolysis) is obviously the primary danger, the heat transfer from a fire already in progress to areas which at that given moment might not be directly subjected to flames, is in many situations equally cause of great concern.

There are many types of fires and their progress may differ in many ways, but they all have three basic elements in common. These three elements are indispensable for practically all fires: (a) fuel (subject to combustion); (b) heat sufficient to start the ignition and support combustion of the given fuel; (c) oxygen. If any of the above indispensable elements is cut off, a fire stops because, in principle, the process of combustion cannot continue. Most, if not all methods of suppression of fire are based on this premise.

However, confining, or even extinguishing a fire does not eliminate the danger in many situations because heat from the fire might have been transferred to adjoining areas, and reached a temperature at which materials start to burn, or at which an explosion can occur.

The invention of this application makes possible great improvements in both of the above aspects, in many applications: it prevents or reduces spread of fire, and reduces thermal conductivity and transfer of heat, thus contributing to the safety of life and property in cases of fire.

Efforts to provide fire resistant materials are in many situations mandated by the building codes and other authorities having jurisdiction, as well as by insurance and legal considerations. Many known materials and means of fire protection which presently satisfy existing regulations and requirements, provide less than optimal protection. For instance, fire doors, which are often used to safeguard escape routes such as fire stairs, are sources of considerable potential danger. Typically, if one side of a metal fire door is exposed to fire, the unexposed side of the door may become very hot, even red hot, thus generating considerable radiant heat, which not only might ignite combustible materials on the unexposed side, but might make corridors or stairways so hot that they are unusable as escape routes. Due to the present limitation in the "state-of-the-art", our Building Codes and testing standards either do not require the measurements of temperatures on the unexposed side of fire doors, or, for most severe applications, the temperatures on the unexposed side are measured only during the first 30 minutes of the test of such fire door. This is due to the fact that building codes can require no better than the "state-of-the-art" technology. Generally, the requirements are that the temperature rise on the unexposed side of the door does not exceed 232°C (450°F) and for most critical fire doors the temperature rise does not exceed 121°C (250°F) during the first thirty minutes. There is, therefore, a need for substantial improvements in developing fire resistant materials which, preferably, should provide also a lower thermal conductivity in case of fire.

Various means of protection against the effects of fire are high temperatures have been attempted. In one approach, liquid fire retardants are applied as coatings to wooden doors and the like. But the benefit of this approach is very limited if such door is subjected to the test in accordance with the ASTM E—152 Standard (UL 10B). (American Society for Testing Materials, Standard E—152 (corresponding to test UL 10B of Underwriter Laboratories Inc.)). A study by the National Bureau of Standards ("Doors as Barriers to Fire and Smoke", H. Shoub and D. Gross, Building Science Series 3, NBS, 1966) shows that a hollow door with hardboard facings, coated with two coats of an intumescent fire retardant coating will burn through in 11 minutes and 15 seconds. An identical door coated with a gloss enamel (not fire retardant) will burn through in 5 minutes, 10 seconds.

Intumescent liquids have also been applied to metal and other lattices, as described in Fryer, et al. Patent No. US—A—4,292,358. These coated lattices are usually used singly or in multiples, to protect objects from a distance. The Fryer patent discloses the concept of using coated lattices on the inside of a door, but this technique has not met with commercial acceptance due to its obvious deficiencies: it produces a door of only quite limited fire endurance, and the cost of producing such lattices and fitting them into fire doors is extremely high. Also, the meshes tend not to absorb sound, so that a mesh insulated door is a poor noise insulator and, therefore, an inadequate door. The concept of using intumescent coated, temperature resistance glass lattices in walls is disclosed in Billing, et al. Patent No. US—A—4,069,075.

Another previous fire protective approach has been to insulate fire doors and other objects with an inorganic material such as "rock wool". However, this approach provides less than desired protection since the thermal conductivities of "rock wool" and similar materials, although less than those of metals, are, nevertheless, considerable. Moreover, when such insulating materials are low density and/or fibrous and porous, like "rock wool", heat travels readily through the insulation to the unexposed side of the object.

The invention provides a material which, though inexpensive and of light weight, imparts substantially improved fire and heat resistance properties to structural and other components in which it is used. In particular, use of the material of the invention results in a drastic decrease in heat transmitted, as reflected in lower temperatures and a lower rate of increase in temperature on the side of the material which is not exposed to fire.

The invention comprises a fire protective structural component comprising a fire protective material which consists of a porous, non-metallic carrier material and an intumescent fire retarding substance and which is sandwiched between two surfaces of said structural component (known from US—A—4292358),

wherein the porous carrier material is inorganic and has a thickness of at least 5 mm and consists of rock wool or aluminium silicate in fibrous form; the porous carrier material contains the intumescent material evenly dispersed throughout the pores of the carrier material; and the intumescent material serves as a binder for the fibers. The material of the invention is sandwiched between two faces of a component structure, e.g., the front and back surfaces of a door. Upon exposure to elevated temperatures, the coating substance in the crevices of the fibrous material (or in the pores) intumesces and fills voids, pores and crevices with an intumescent char. The low heat conductivity and the closed cell structure of the intumescent material reduces the passage of oxygen and of heat. That is, heat conduction is impeded by filling up of the air space in the fibrous and/or porous material with the intumescent cellular structure, which is of very low thermal conductivity.

The inorganic material serves as a carrier body for the intumescent substance and as an insulator. That is, it fills the hollow area of the structure (e.g. a door) so that the structure can continue to function to insulate against heat, cold and noise. The combination of the insulation carrier and the intumescent material is an advantageous one in that the solid, inorganic, non-metallic insulator protects rearwardly disposed portions of the intumescent material from the effects of heat. It is believed that the outstanding fire and heat protective characteristics of the invention result in part from the fact that the rearward portions of the intumescent material protected by the rock wool (or other material of the invention) are available to resist fire and heat if they persist through the forward aspects of, for example, the door.

The usefulness of the material of the invention is not limited to doors. For example, as mentioned above, the material of the invention can be used in construction of fire resistant record protection equipment. Magnetic tapes, floppy discs and related computer records can be ruined if exposed to the temperatures above 52°C (125°F). The material of the invention can be used to line portable boxes which protect against destruction of the discs by such temperature increase, and yet can be carried from desk to desk.

Another advantageous use of the material of the invention can occur in attics and the like, where flexible fire insulation material is needed. In many localities, the building codes or local laws require that attics be subdivided with a material which affords fire protection. Because of the irregular shapes of attic ceilings, it may be advantageous to use the flexible treated rock wool or other material prepared according to the invention which can be readily adapted to irregular shapes. Similar advantages and uses can be found in ships, boats and other vessels, mobile homes, transportation containers, storage structures for storage of heat sensitive or hazardous materials, and the like. A large number of other applications are possible, including filing cabinets, safes, elevators, floors, ceilings and walls, wall partitions, electrical circuits, etc.

For a more complete understanding of the above and other features and advantages of the invention, reference should be made to the following detailed description of the preferred embodiments and to the accompanying drawing.

Fig. 1 is a cross section of a door insulated with the fire protective material of the invention.

The preferred embodiment comprises a door 12, which is insulated in accordance with the invention. The door comprises a wooden base 14 and a wooden upper portion 16. The upper portion meets and is coextensive with the metal fire stop (the rebat) on the door frame (not shown). The door has two wooden panels, a first panel 18 and a second panel 20. Within the panels is an area 22 which is hollow prior to insertion of the material of the invention. The area 22 is filled with a sheet 24 of rock wool treated with an intumescent liquid such as Albert DS-Clear® available from the American Vamag Company, of 1061 Linden Avenue, Ridgefield, New Jersey 07657. Typical dimensions for the door would be a total thickness of 44 mm (1½ inches) and a thickness of 3.2 mm (⅛ inch) each for panels 18 and 20. As may be necessary when a non-self-supporting material, such as rock wool, is employed, the treated sheet is secured at its top and sides by stapling (not shown), so that if one part of the sheet loses its integrity, the rest of the sheet remains in position. Other means to secure the sheet will, of course, be apparent to one skilled in the art.

Upon exposure to elevated temperatures, the intumescent material foams up. As a result of the presence of the inorganic carrier material and the intumescent material, the heat conductance of the door is dramatically less than otherwise and the door greatly resists the passage of heat, flame and smoke.

The carrier material of the invention is impregnated with the intumescent material. Preferably, the carrier material is substantially or completely impregnated. Many techniques for treating the carrier material with intumescent substance, such as coating, spraying, dipping, soaking, may be used.

It is important that the intumescent substance be applied to the carrier material itself (as distinguished from adjacent walls, etc.) in order to achieve the maximum effect of the invention. According to the invention, the carrier material is impregnated in such a way that the intumescent material is more or less evenly dispersed throughout the pores and/or crevices of the carrier material. It is particularly preferred in this respect to obtain a regular dispersal of a substantial amount of the intumescent substance within the carrier material by impregnating the carrier material with the intumescent substance.

Impregnation of the carrier material in accordance with the invention can be accomplished in several ways. One way is to dip the carrier material into liquid intumescent material and permit it to soak until it is impregnated. A second approach, which can be used where the carrier material is sufficiently flexible, is to coat the surface of the carrier material with the intumescent substance and compress the carrier material. The compressed portion of the carrier material is then released, thereby drawing the intumescent liquid

into the carrier material, as with a sponge. The intumescent material may also be deposited on the fibers (rock wool, for instance), prior to manufacture of a blanket or batt. Rock wool and similar fibrous inorganic materials are usually sold in blankets or batts. To keep the fibers together, a certain amount of binding resin is generally used during manufacture of the batt or blanket. The intumescent substance may be deposited
 5 on the fibers prior to manufacture of the batt, etc. instead of the binding resin, thereby fulfilling the dual role of intumescent and binder.

It is important, for impregnation, that the carrier material be fibrous, as well as porous, like rock wool. Rock wool is particularly preferred because it is light and inexpensive. By "porous" it is meant that the material is capable of absorbing liquids. The term "porous" includes fibrous material capable of absorbing
 10 liquid. Other carrier materials suitable for utilization in accordance with the invention are aluminum silicate blankets. Appropriate thickness for the carrier material is at least 5 millimeters, preferably 10 millimeters and most suitably 25 millimeters and could range up to 76 or 102 mm (3 or 4 inches) or more.

The fact that the instant carrier material is porous and/or fibrous distinguishes the material of the invention from lattices, such as those described in the Fryer and Billing patents, mentioned above.
 15 Moreover, lattices and other materials having large voids do not provide adequate insulation and intumescent protective effects.

The material of the invention is sandwiched between two faces of the structural or protective component of which it is a part. Suitable structural components in which the invention may be used include doors (including metal and wooden doors), walls, ceilings, floors, and airplane parts. Rock wool as flexible
 20 lightweight fibrous non-metallic inorganic carrier is used with particular advantage in airplanes where it is important to minimize the weight of components, and in doors where flexibility and compressibility of the carrier material permits the construction of lighter weight and greatly improved fire resistant material. Indeed, some previous insulated doors, particularly in Europe, were thicker than the standard door, thereby requiring that other components, e.g., the door frame, be custom-made at considerable expense to
 25 conform to the thickness of the fire door. In contrast, two 25 mm (1 inch) thick sheets of treated rock wool prepared in accordance with the invention fit conveniently within a hollow wooden door of standard 44 mm (1½ inch) total thickness to provide exceptional fire preventive characteristics.

While the invention involves sandwiching the carrier material between two surfaces of the component, e.g., the door, the treated carrier material may be self-supporting in certain circumstances. It may be
 30 particularly appropriate for the carrier material to be self-supporting where the material is inherently rigid, e.g., a board.

Protective components for which the material of the invention would be useful include elevators, safes, safe deposit boxes and filing cabinets.

The intumescent material must be such that at elevated temperatures it foams up. The foamed material
 35 must have a low heat conductance. Together with the non-metallic, inorganic, carrier material, the foamed material impedes for substantial periods of time the passage of heat and/or flame through the component. Known intumescent materials useful in the practice of the invention include, but are not limited to, the products classified and tested by Underwriters' Laboratories under the names DS-Clear, PR-Clear, PR-White and DS-11 Clear (product designations) which are available from the American Vamag Company,
 40 1061 Linden Avenue, Ridgefield, New Jersey 07657.

Example

Two insulated wooden doors (Door A and Door B) were constructed and tested in accordance with ASTM standard E—152. Each door comprised a front and a back standard Lauan plywood panel 3.2 mm
 45 (⅛ inch) thick, having a hollow area in-between. The hollow area of each door was filled, as described below. The total thickness of each door was the standard 44 mm (1½ inches). The doors were both mounted on steel frames.

A sheet of rock wool having a thickness slightly in excess of 38 mm (1½ inches) and impregnated according to the invention with "PR White" intumescent liquid was squeezed into the hollow of Door A, thereby filling it. The hollow Door B was similarly filled with a 38 mm (1½ inch) thick sheet of rock wool,
 50 except that the rock wool was not treated with an intumescent substance. Thus, the two door assemblies were identical, except that Door A contained treated rock wool in accordance with the invention, whereas Door B contained untreated rock wool and, therefore, was not prepared in accordance with the invention. The doors were both sealed with plywood and mounted on steel frames.

Each test assembly was positioned against the face of the furnace. Two thermocouples were
 55 positioned on the unexposed face of each door to measure the temperature rise there. The burners were ignited and the temperatures within the furnace were made to follow the temperature-time curve of ASTM standard E—119.

The results are as follows:

60

65

O 123 255

	Elapsed Time (minutes)	Avg Furnace Temp**	Average Temp (2 Thermocouples) Unexposed Side Door A	Average Temp (2 Thermocouples) Unexposed Side Door B
5	5	538°C (1000°F)		
	15	759°C (1399°F)	51°C (123°F)	211°C (412°F*)
10	18			Flames Burn through (Test Halted)
	30	843°C (1550°F)	70°C (158°F)	
15	40	878°C (1613°F)	76°C (168°F)	
	45	892°C (1638°F)	92°C (198°F)	
	50	905°C (1661°F)	75°C (167°F)	
20	55	916°C (1681°F)	75°C (166°F)	
	57		79°C (174°F)	
25	58		***	
	60	927°C (1700°F)		

* Flames begin to burn through

** Exact furnace temperatures are for test of Door A. Temperatures for test of Door B were comparable and also in accordance with ASTM Standard E—119.

*** Test halted due to failure of glue holding the plywood together, *not* due to burn-through. Note that at 57 minutes, before the failure, the temperature of the unexposed side was 79°C (174°F) which is far less than the 211°C (412°F) temperature prior to burn-through of Door B.

As is evident from this comparative test, use of the material of the invention results in drastically improved protection from the affects of heat and fire. This is reflected in two critical features: (1) the time it takes for fire breakthrough to occur is markedly extended from 18 minutes in Door B to at least 57 minutes in Door A and (2) the rate of temperature rise over this period of time is quite low.

The extension of the period of protection to 57 minutes with the relatively inexpensive material of the invention is exceptional. Indeed, the period can easily be extended (by better gluing) to 60 minutes. In fact, it is believed that protection of 90 minutes or more are achievable. This will be apparent in view of the low temperature for the unexposed side of Door A at 57 minutes which, of course, is substantially less than the temperature at which flames began to burn through the untreated rock wool Door B.

The low temperature increases revealed by the test of Door A over a period of almost one hour are no less remarkable. The average temperature increase in 57 minutes (assuming initial room temperature of 22°C (72°F)) is only 39°C (102°F). It will be noted that at 45 minutes the average temperature unexposed side of Door A was 92°C (198°F) but at 50 minutes the temperature was 75°C (167°F). It is believed that this decrease in temperature is due to the effect mentioned earlier, wherein forward aspects of the coated rock wool protected the rearward aspects from high temperature, so that eventually when elevated temperatures reach the rearward portions, the intumescent liquid will still be available to foam and provide protection.

It should be understood, of course, that the specific form of the invention herein illustrated and described is intended to be representative only, as certain changes may be made therein without departing from the clear teachings of the claims.

The amount of intumescent material with which the carrier material is impregnated should be sufficient that upon exposure to elevated temperatures in case of fire the intumescent material foams up and fills the voids, pores and crevices with an intumescent char.

Claims

1. A fire protective structural component (12) comprising a fire protective material (24) which consists of a porous, non-metallic carrier material and an intumescent fire retarding substance and which is sandwiched between two surfaces (18, 20) of said structural component, characterized in that the porous

0 123 255

-carrier material (24) is inorganic and has a thickness of at least 5 mm and consists of rock wool or aluminium silicate in fibrous form; the porous carrier material contains the intumescent material evenly dispersed throughout the pores of the carrier material; and the intumescent material serves as a binder for the fibers.

5 2. The fire protective structural component (12) of claim 1, characterized in that the porous carrier material (24) has a thickness of at least 25 mm, preferably of at least 50 mm, and of at most 100 mm, preferably of at most 75 mm.

3. The fire protective structural component (12) of any of claims 1 to 2, characterized in that the porous carrier material (24) is in the form of a batt or of a blanket.

10 4. The fire protective structural component (12) of any of claims 1 to 3, wherein the component (12) is a door (12) and said surfaces are the front and rear surfaces of said door (12).

Patentansprüche

15 1. Feuerschutzbauteil (12), welches ein vor Feuer schützendes Material (24) enthält, das aus einem porösen, nicht-metallischen Trägermaterial und einem bei Hitze aufschäumenden Brandschutzmittel besteht, und das zwischen zwei Oberflächen (18, 20) des genannten Bauteils sandwichartig angeordnet ist, dadurch gekennzeichnet, daß das poröse Trägermaterial (24) anorganisch ist, eine Dicke von mindestens 5 mm hat und aus Steinwolle oder Aluminiumsilikat in faseriger Form besteht; das poröse Trägermaterial
20 enthält des bei Hitze aufschäumende Material gleichmäßig in den Poren des Trägermaterials verteilt; und das bei Hitze aufschäumende Material dient als Binder für die Fasern.

2. Feuerschutzbauteil (12) nach Anspruch 1, dadurch gekennzeichnet, daß das poröse Trägermaterial (24) eine Dicke von mindestens 25 mm, vorzugsweise mindestens 50 mm, und höchstens 100 mm, vorzugsweise höchstens 75 mm hat.

25 3. Feuerschutzbauteil (12) nach jedem der Ansprüche 1 bis 2, dadurch gekennzeichnet, daß das poröse Trägermaterial (24) die Form von Watte oder einer Matte hat.

4. Feuerschutzbauteil (12) nach jedem der Ansprüche 1 bis 3, worin das Bauteil (12) eine Tür (12) ist und genannte Oberflächen die Vorder- und die Rückseite der genannten Tür (12) sind.

30 Revendications

1. Composant structurel de protection contre l'incendie (12) comportant un matériau (24) de protection contre l'incendie qui est constitué d'un matériau support, poreux, non métallique, et d'une substance intumescente retardatrice du feu et qui est pris en sandwich entre deux surfaces (18, 20) dudit composant
35 structurel, caractérisé en ce que le matériau support poreux (24) est inorganique, a une épaisseur d'au moins 5 mm et est constitué de laine de roche ou de silicate d'aluminium sous forme fibreuse; en ce que le matériau support poreux contient le matériau intumescent régulièrement dispersé à travers les pores du matériau support; et en ce que le matériau intumescent sert de liant pour les fibres.

2. Composant structurel de protection contre l'incendie (12) selon la revendication 1, caractérisé en ce
40 que le matériau support poreux (24) a une épaisseur d'au moins 25 mm, de préférence d'au moins 50 mm, et d'au plus 100 mm, de préférence au plus 75 mm.

3. Composant structurel de protection contre l'incendie (12) selon l'une quelconque des revendications 1 à 2, caractérisé en ce que le matériau support poreux (24) se présente sous la forme d'une laize ou d'une couverture.

45 4. Composant structurel de protection contre l'incendie (12) selon l'une quelconque des revendications 1 à 3, dans lequel le composant (12) est une porte (12) et dans lequel lesdites surfaces sont des surfaces avant et arrière de ladite porte (12).

50

55

60

65

