FIRE RESISTING DOORS HAVING METALLIC OUTER LAYERS

Filed Dec. 20, 1968

INVENTORS:
RUDOLF GAETH
FRITZ STASTNY
BERNHARD SCHMITT
RUDOLF BREU
FRIEDHELM GAERTNER

By

C. Marzolf, Johnston & Coolish, Att'ys
FIRE RESISTING DOORS HAVING METALLIC OUTER LAYERS

Rudolf Gaeth, Limburgerhof, Fritz Stastny, Ludwigshafen, Bernhard Schmitt, Heidelberg, Rudolf Breu, Lambrecht, and Friedrich Gaertner, Schauernheim, Germany, assignors to Badische Anilin- & Soda-Fabrik Aktiengesellschaft, Ludwigshafen (Rhine), Germany

Filed Dec. 28, 1968, Ser. No. 785,703

Claims priority, applied Germany, Dec. 28, 1967, P 16 59 608.0

Int. Cl. E04c 2/24; E06b 3/70

U.S. Cl. 52—232

6 Claims

ABSTRACT OF THE DISCLOSURE

A fire-resisting door having stiffening members inside a door frame. Both the frame and the stiffening members are covered with an insulating layer and a metallic outer layer, the layers being joined in such a way that the union is destroyed by the action of heat.

Commercial fire resisting steel doors consist essentially of two metal sheets having a thickness of 1.5 mm. which are folded together to form a door casing having a total thickness of not less than about 48 mm. A layer of insulating material, for example of mineral fibers or calcined diatomaceous earth, is arranged in the door casing. Upon the action of high temperatures, such as occur in the event of fire, it is found that such doors offer adequate resistance, except at the edges where appreciable openings form between the door and the surrounding frame owing to the marked distortion of the door casing. Heat, flames and smoke pass through these openings into the adjoining room thus contributing to the spread of the fire. In this way the surface of the door away from the fire becomes strongly heated in a short time. This disadvantage is particularly evident when the hinge side of a door is exposed to fire.

The construction of a fire resisting door made from metallic materials which does not distort under the action of heat provides a problem which has not yet been solved. The present invention has for its object to provide fire resisting doors having metallic outer layers which practically do not distort under the action of heat.

We have found that the said object is achieved in fire resisting doors having metallic outer layers by providing stiffening members inside a door frame and covering the frame and the stiffening members with at least one thermally insulating layer and then with the metallic outer layer, the outer layer being joined with the adjacent inner layer in such a way that the minor is destroyed by the action of heat.

Sheet steel or sheet aluminium may be used for the metallic outer layers. The framework of the door preferably consists of a non-combustible material, for example strips of cement bound asbestos. The stiffening members may be conventional honeycombs and the like, consisting for example of hardboard or wood-base materials, such as are used in plywood doors. The insulating layers should advantageously have good mechanical strength in addition to their insulating effect. Boards of asbestos bound with cement as obtainable commercially are particularly suitable for this purpose. A combination of such cement bound asbestos boards with known alkali metal silicate boards containing fibers and water is especially suitable. These alkali metal silicate boards have the property of expanding at temperatures above 250° C. to form an mechanically stable layer which provides an outstanding thermal insulating effect. These boards contain 0.5 to 60% by weight of fibers and 20 to 70% by weight of water with reference to the anhydrous alkali metal silicate contained therein. Staple glass fibers are particularly suitable as fibrous material.

The union between the outer and inner layers is designed in accordance with this invention to be destroyed by the action of heat. Practically all organic based adhesives may be used for the purpose provided they become plastic under the action of heat or lose their bonding properties by thermal decomposition, e.g. at temperatures of 60 to 400° C. Organic high polymers or curable reactive compounds are suitable, epoxide resins, polyacrylates, polyvinyl acetate, copolymers of ethylene and vinyl acetate, and/or acrylic esters being particularly preferred.

Instead of with an adhesive, the layers may also be joined together mechanically, for example with screws, rivets and the like. In this case the screws and rivets are made from materials of low melting point, e.g. from 60 to 670° C., for example metals such as Wood's metal, aluminum, or from organic material which will melt under the action of heat, e.g. at temperatures from 60 to 670° C., for example from a polyamide, polyethylene, rigid polyvinyl chloride, or which are destroyed at these temperatures, e.g. wood.

In the event of fire, it is only the metal layer facing the fire which becomes distorted in the case of metal doors according to this invention, the remainder of the door being only insignificantly distorted so that heat and flames cannot penetrate to the side of the door away from the fire.

A door in accordance with this invention is illustrated in FIGS. 1 and 2 of the drawing by way of example. FIG. 1 is a vertical section and FIG. 2 is a horizontal section of a door on section plane 2—2 of FIG. 1 and of the door frame adjoining the same. The same parts are indicated by the same reference numerals in both figures.

The framework 1 of the door may be made from cement bound asbestos. Within the framework there is provided a stiffening member 2 consisting of criss-crossed strips of hardboard. A lock reinforcement 3 and a horizontal rail 4 are prepared from the same material as the framework. The framework and the stiffening member are covered by a thermally insulating cover plate 5 for example of cement bound asbestos and a board 6 of alkali metal silicate containing fibers and water. A sheet steel cover plate 7 is secured to the board 6 by means of an adhesive which decomposes when heated. The edges of the door are covered with a U-shaped section 8 for example of aluminum. The door is mounted in a door frame 9 provided with an L-shaped section 10 of metal. A fillet 11 consisting of a plurality of plies of strips of aluminum and alkali metal silicate containing fibers and water which have been stuck together is stuck in the section 10. The gap between the door and the doorframe is closed in the event of fire by the expansion of the alkali metal silicate so that heat and smoke cannot penetrate into the room away from the fire.

The board 6 may be reinforced by an embedded wire netting 12. The boards 6 may be attached to the framework of the door by staples 13. The outer sheet steel cover plate 7 may be secured to the underlying board 6 by screws or rivets 14 made of a material having a melting point of 60 to 670° C. instead of by the aforesaid adhesive.

The invention is illustrated by the following example.

EXAMPLE

A door has a total thickness of about 40 mm., a height of 1960 mm. and a width of 968 mm. The framework having a thickness of 20 mm. and a width of 70 mm. which consists of cement bound asbestos is provided with a lock reinforcement and a horizontal rail of the same material. The stiffening member consists of strips of
hardboard having a thickness of 4 mm. and a width of 20 mm. arranged crosswise 70 mm. apart.

The framework and stiffening member are covered on both sides with a board 6 mm. in thickness of cement bound asbestos and a board 1.5 mm. in thickness of sodium silicate. The sodium silicate board has a water content of 30% by weight and the ratio of Na₂O to SiO₂ is 1:3.3; it also contains 120 g./m.² of staple glass fiber and 50 g./m.² of cane sugar. It is reinforced by an embedded wire netting having a wire thickness of 0.5 mm. and 25 mm. apertures. The two covering boards are fixed in the framework with wire staples. Over these on both sides there is provided a sheet of steel having a thickness of 0.5 mm. which is firmly bonded to the sodium silicate by means of an epoxide resin. The stiffening boards are also bonded with this adhesive.

The edges of the door are covered with a U-shaped section of aluminum (length of each arm 25 mm., width of base about 40 mm., thickness of section 1 mm.). The gap between the section and the sheet steel is sealed with silicon rubber.

A sheet metal casing is placed in a recess in the door and a simple mortise lock is mounted therein. The door is also fitted with two hinges. These consist of a two limbed mounting into which the door is inserted. Both limbs are held by three screws each passing through the door.

The frame surrounding the door may be a commercial frame of sheet steel having a rabbit depth of 41 mm. An L-shaped iron section is welded in the frame rabbit and in the recess formed a fillet consisting of three strips (each 40 mm. in width and 1.5 mm. in thickness) of sodium silicate whose composition corresponds to that of the boards described above.

The fire test according to DIN 4102, sheet 2 (September 1965) by exposing the hinge side of the door to a flame, following results are obtained in dependence on the duration of the test:

<table>
<thead>
<tr>
<th>Duration of test, min.</th>
<th>Temperature on side of door not exposed to flame, °C.</th>
<th>Temperature in fire chamber, °C.</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>10..................</td>
<td>650</td>
<td></td>
<td>20 Sheet steel on side exposed to flame distorts.</td>
</tr>
<tr>
<td>20..................</td>
<td>860</td>
<td></td>
<td>30 Door distorted about 0.8 cm. between hinges.</td>
</tr>
<tr>
<td>30..................</td>
<td>850</td>
<td>55</td>
<td>10 to 30 minutes—the gases formed by decomposition of epoxide resin penetrate into fire chamber— fireproofing strips do not open between door and frame.</td>
</tr>
<tr>
<td>45..................</td>
<td>870</td>
<td>55</td>
<td>Maximum distortion of door: 2 cm.</td>
</tr>
<tr>
<td>60..................</td>
<td>930</td>
<td>95</td>
<td>The side of the door not exposed to flame becomes slightly buckled.</td>
</tr>
<tr>
<td>95..................</td>
<td>1,020</td>
<td>100</td>
<td>Glare of fire at the upper corner on the lock side—end of test.</td>
</tr>
</tbody>
</table>

We claim:

1. A fire resisting door comprising a framework with stiffening members inside the framework, at least one thermally insulating inner layer covering each face of the framework and stiffening members, and an outer metallic layer covering each adjacent insulating inner layer, the outer metallic layer being secured to the adjacent inner layer solely by heat-destructive securing means whereby the union of said outer layer to said adjacent inner layer is destroyed by the action of heat.

2. A fire resisting door as claimed in claim 1 wherein the outer metallic layer is a layer of sheet steel or aluminum.

3. A fire resisting door as claimed in claim 1 wherein the insulating inner layers are made of cement bound asbestos or alkali silicate boards containing fibers and water.

4. A fire resisting door as claimed in claim 1 wherein the outer metallic layer is secured to the adjacent inner layer by means of an organic adhesive which loses its bonding properties under the action of temperatures of 60 to 400 °C.

5. A fire resisting door as claimed in claim 1 wherein the outer metallic layer is secured to the adjacent inner layer by an epoxide resin, a polyacrylate, a polyvinyl acetate, a copolymer of ethylene and vinyl acetate and/or an acrylic ester.

6. A fire resisting door as claimed in claim 1 wherein the outer metallic layer is secured to the adjacent inner layer by screws or rivets made of a material having a melting point of 60 to 70 °C.

References Cited

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Patent No.</th>
<th>Date</th>
<th>Inventor</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,233,711</td>
<td>3/1941</td>
<td>Pasquier</td>
<td>52—615</td>
</tr>
<tr>
<td>2,542,490</td>
<td>2/1944</td>
<td>Pretot</td>
<td>52—615</td>
</tr>
<tr>
<td>2,458,152</td>
<td>1/1949</td>
<td>Eakins</td>
<td>85—37</td>
</tr>
<tr>
<td>2,593,050</td>
<td>4/1952</td>
<td>Paul et al.</td>
<td>52—232</td>
</tr>
<tr>
<td>2,662,043</td>
<td>12/1953</td>
<td>Clements</td>
<td>52—615</td>
</tr>
<tr>
<td>2,787,345</td>
<td>4/1957</td>
<td>Soubier et al.</td>
<td>52—232</td>
</tr>
<tr>
<td>3,426,491</td>
<td>2/1969</td>
<td>Gaeth et al.</td>
<td>52—615</td>
</tr>
</tbody>
</table>

FOREIGN PATENTS

<table>
<thead>
<tr>
<th>Patent No.</th>
<th>Date</th>
<th>Inventor</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>310,446</td>
<td>12/1955</td>
<td>Switzerland</td>
<td>52—615</td>
</tr>
</tbody>
</table>

HENRY C. SUTHERLAND, Primary Examiner
J. L. RIDGILL, Jr., Assistant Examiner

U.S. Cl. X.R.

52—456, 615