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(19)

(54) LIGHT-TRANSMITTING FIRE-SCREENING PANELS

(71) We, BFG GLASSGROUP, Rue Caumartin 43, Paris, France, a Groupement d'Interet Economique, established under the laws of France (French Ordinance dated 23rd September 1967) do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a method of bonding a solid layer of intumescent material carried by a support to a second sheet of material to form a light-transmitting laminate. The invention also relates to a laminate made by said method.

In the construction of buildings, light-transmitting panels have sometimes to be used in e.g. interior walls to form partitions, and such partitions have occasionally to satisfy certain standards of fire resistance. For example when a panel is exposed to a particular temperature cycle for a specified time, such standards may require that the panel should retain its strength without breaking, that it should be completely flame proof, that it should act as an infra-red radiation screening barrier and that the side thereof furthest from the source of heat should not become so hot as to involve serious risk of burning a person who touches it.

Clearly an ordinary glass sheet will not satisfy these requirements for any significant length of time, and it has accordingly been proposed to use laminated panels in which a layer of intumescent material is sandwiched between two sheets of glass. Such panels have been made by depositing a layer of intumescent material onto a first glass sheet, drying such layer, and bonding the layer to a second glass sheet by means of a layer of plastics material such as polyvinylbutyral. Although this has gone a long way towards meeting the standards referred to above for sufficiently long periods of exposure to fire, this panel manufacturing method does suffer from certain disadvantages, in particular as regards the cost and inconvenience of using a sheet of polyvinyl butyral.

In order to enhance the fire screening properties of light-transmitting panels it has been proposed to provide a panel comprising a layer of hydrated alkali metal silicate as an intumescent material sandwiched between light transmitting sheets, for example of glass or plastics. In order to form such sandwich into a laminate, it has been proposed to form the silicate layer on one sheet and bond it to the other using a layer of adhesive. As adhesives, the following materials have been suggested: a sodium silicate solution having a commercial concentration, a mixture of talc with a 35 to 48% by weight sodium silicate solution in the ratio by weight of from 1:2 to 1:3 with reference to the total weight, and epoxide resin mixtures.

It has now been found that it is not necessary to make use of a distinct adhesive layer which bonds to the intumescent layer and to the second sheet in order to effect lamination, and that all that is required is to activate the surface of the intumescent layer so that it can bond directly to the second sheet.

Accordingly, the present invention as broadly defined provides a method of bonding a solid layer of intumescent material carried by a support to a second sheet of material to form a light-transmitting laminate, characterised in that the sheet and layer are united to form the laminate without using an interposed layer of adhesive material after wetting at least one of the surfaces which are to be brought into contact with an inorganic solvent for said intumescent material so that such solvent is present at the time of such contact and

activates the intumescent layer so that it bonds directly to said sheet.

This is a very convenient bonding method for use in a stage of the process of manufacturing laminated fire-screening panels which eliminates the need to use a separate adhesive. At least in preferred embodiments of the method, advantages of decreased cost and increased transparency may be afforded. The support may for example be a temporary support for the layer such as a mould in which the layer is formed. Preferably the support and/or said sheet comprise(s) a vitreous sheet.

The word "vitreous" is used herein to denote articles made from glass or vitro-crystalline material. Vitro-crystalline materials can be made by subjecting glass to a heat treatment so as to induce the formation of one or more crystalline phases therein. Vitreous sheets can impart structural strength to a said laminate without significantly impairing its light transmitting properties.

A said layer is preferably formed by applying intumescent material in wet state and drying such material, since this has been found most convenient in practice.

Advantageously such drying is continued until the intumescent material forms a cohesive solid layer. This feature facilitates handling of the material during the manufacturing process.

In preferred embodiments of the invention at least the surface of a said layer is wetted using said solvent.

Wetting of the surface of the layer of intumescent material has the advantage of removing gaseous inclusions and other surface irregularities thereof, and this is highly advantageous as regards the transparency of the panel.

Preferably both surfaces which are to be brought into contact are wetted before such contact, since this promotes a firm bond.

Preferably, said second sheet comprises a layer of said intumescent material. This is a very simple and convenient way of obtaining a layer of intumescent material of increased thickness in a finished panel.

Preferably said intumescent material comprises an hydrated metal salt. Advantageously, said hydrated metal salt is selected from: alkali metal silicates e.g. sodium silicate, aluminates, plumbates, stannates, alums, borates and phosphates.

Preferably said layer of intumescent material is a transparent solid layer at ambient temperature; preferably such layer is between 0.1mm and 8mm thick, and optimally between 0.1mm and 3mm, e.g. 0.8mm to 1mm.

Advantageously, the intumescent material is applied to said support as an aqueous solution. When using sodium silicate it is prefered to use a solution in which the weight ratio $SiO_2:Na_2O$ is from 3.3:1 to 3.4:1 and whose density is from 37° to 40° Baumé.

The intumescent material may be applied in wet state by poring, dipping or spraying, and it may be applied as a single layer, or it may be built up by applying, to a said sheet, a succession of strata each of which is dried before the next stratum is applied.

A said layer of intumescent material is suitably dried by placing it in a current of warm air of controlled temperature and humidity, e.g. air at 35°C and 50% relative humidity. Such warm air current may e.g. be directed by a fan.

When using sodium silicate as said intumescent material, it is preferred to dry the layer until it contains between 30% and 40% by weight of water. Is should be borne in mind that the cohesiveness of the layer will be greater with reduced amounts of water, but that the more water is present, the more efficacious will the layer be as an intumescent fire-screening barrier.

The solvent used for wetting the second sheet or the exposed surface of said layer of intumescent material is preferably water.

Preferably, said surfaces are brought into mutual contact by sliding one over the other to bring the support and sheet into register. This helps to exclude the possibility of bodies of air being trapped between the surfaces.

In the most preferred embodiment of the invention, said surfaces are wetted and washed by a process which includes immersing them in a bath of said solvent. This is found to be a very simple way of facilitating substantially uniform wetting of said surfaces. The bath may conveniently be ambient temperature.

Preferably, said surfaces are brought into mutual contact while they are still immersed in said bath. This has been found to improve the quality of the finished product.

It is particularly advantageous to leave the sheets immersed in the bath after they have been brought into mutual contact. If the sheets are left immersed for say 3 to 24 hours after assembly into the panel, it will be found that the layer of intumescent material has been dissolved away around the periphery of the panel. This leaves a groove which may conveniently be used to accommodates a sealing compound to protect the intumescent material from the effects of contact with the atmosphere.

Whether of not said groove is present, it is preferred that sealing material is applied around the edges of the panel after assembly and drying in order to seal the layer of intumescent material from the atmosphere.

It is possible for such a groove to be for-

the groove is continous around the periphery of the panel.

Advantageously at least one and preferably each face of a vitreous ply arranged for contact with a said layer of intumescent material incorporates a protective stratum composed of a substance selected so as to inhibit interaction between such face and the intumescent material. Such stratum is preferably a coating which comprises an anhydrous metal compound.

Preferably, said intumescent material is selected from alums, borates and alkali metal silicates, and a said anhydrous metal compound for forming a protective coating is selected from zirconium oxide and anhydrous aluminium phosphate, but in alternative preferred embodiments, said intumescent material comprises hydrated aluminium phosphate and a said anhydrous metal compound for forming a protective coating is selected from: titanium oxide, zirconium oxide, tin oxide and anhydrous aluminium phosphate. Advantageously, a said protective coating is formed to a thickness of between 100 and 1000 Angstrom units.

The invention will now be described by way of example with reference to the accompanying diagrammatic drawings in which:

Figure 1 is an edge elevation of a fire-screening panel in course of assembly; and

Figures 2 to 4 are detail edge elevations of fire-screening panels.

Example

A fire-screening panel was made as shown in Figure 1. This panel comprises two sheets of glass 1, 2 each 3mm thick to the first of which a layer 3 of intumescent material 2.5mm thick has been applied.

In order to form the layer 3, hydrated sodium aluminium sulphate was applied in a aqueous solution.

This solution was applied to a face of the first glass sheet while it was substantially horizontal and at a temperature of 20°C. The solution was allowed to spread out over the sheet and was dried by directing a current of warm air across the sheet using a fan. When the layer had become dry it was sprayed with water, and the second glass sheet 2 was slidden across the layer as shown in the drawing until it was in face to face registry.

The panel was then allowed to dry so that the two glass sheets were bonded together by means of the sandwiched layer, to form a panel having an edge as shown in Figure 2. In order to hasten such drying, the panel can be heated, but care must be taken to ensure that such heating is not sufficient to cause the hydrated sodium aluminium sulphate to intumesce.

A groove may be cut in the edge of the panel by removing the hydrated sodium aluminium sulphate over a marginal zone 4 leading around the panel, as is illustrated in Figure 3.

In a variant of the Example, the applied layer of hydrated sodium aluminium sulphate was dried as before and the thus coated sheet was then immersed in a bath of water. The second sheet 2 was then slidden into registry and the thus assembled panel was left in the bath for a sufficient time for the marginal zone 4 of the sandwiched layer to have been dissolved away as shown in Figure 4.

In a further variant, the face of each of the sheets of glass which was to be interior of the panel was protected from direct contact with the intumescent material by applying thereto a protective coating of anhydrous aluminium phosphate 500 Angstrom units thick.

Such a coating can be formed as follows. A solution in alcohol containing one mole of anhydrous aluminium trichloride and one mole of anhydrous phosphoric acid is prepared. This can be applied to the upper faces of horizontally laid sheets of glass and allowed to spread out to form a uniform covering. The sheets are dried and placed in a furnace heated to 400°C. This gives a strongly adherent coating of anhydrous aluminium phosphate.

Attention is directed to our copending application No 26873/76 which has been divided from this application.

WHAT WE CLAIM IS:

1. A method of bonding a solid layer of intumescent material carried by a support to a second sheet of material to form a light-transmitting laminate, characterised in that the sheet and layer are united to form the laminate without using an interposed layer of adhesive material after wetting at least one of the surfaces which are to be brought into contact with an inorganic solvent for said intumescent material so that such solvent is present at the time of such contact and activates the intumescent layer so that it bonds directly to said second sheet.

2. A method according to claim 1, characterised in that the support and/or said sheet comprise(s) a vitreous sheet.

3. A method according to claim 1 or 2, characterised in that a said layer is formed by applying intumescent material in wet state and drying such material.

4. A method according to claim 3, characterised in that such drying is continued until the intumescent material forms a cohesive solid layer.

5. A method according to any preceding claim, characterised in that said layer is wetted using said solvent.

6. A method according to any preceding claim, characterised in that both sur-

faces which are to be brought into contact are wetted before such contact.

7. A method according to any preceding claim, characterised in that said second sheet comprises a layer of said intumescent material.

8. A method according to any preceding claim, characterised in that said intumescent material comprises an hydrated metal salt.

9. A method according to claim 8, characterised in that said hydrated metal salt is selected from: alkali metal silicates e.g. sodium silicate, aluminates, plumbates, stannates, alums, borates and phosphates.

10. A method according to any preceding claim, characterised in that said layer of intumescent material is a transparent solid layer at ambient temperature.

11. A method according to any preceding claim, characterised in that the intumescent material is applied to said support as an aqueous solution.

12. A method according to claim 9, characterised in that said layer of intumescent material is formed using a solution of sodium silicate in which the weight ratio $SiO_2:Na_2O$ is from 3.3:1 to 3.4:1 and whose density is from 37° to 40° Baumé.

13. A method according to claim 12, characterised in that said layer is dried until it contains between 30% and 40% by weight of water.

14. A method according to any preceding claim, characterised in that said solvent is water.

15. A method according to any preceding claim, characterised in that said surfaces are brought into mutual contact by sliding one over the other to bring the support and sheet into register.

16. A method according to any preceding claim, characterised in that said surfaces are wetted by a process which includes immersing them in a bath of said solvent.

17. A method according to claim 16, characterised in that said surfaces are brought into mutual contact while they are still immersed in said bath.

18. A method according to claim 17, characterised in that the sheets are left immersed in the bath after they have been brought into mutual contact.

19. A method according to claim 18, characterised in that the sheets are left immersed for between 3 and 24 hours after assembly into the panel whereby a layer of intumescent material is dissolved away around the edge of the panel to leave a peripheral groove.

20. A method according to any preceding claim, characterised in that sealing material is applied around the edges of the panel after assembly and drying in order to seal the layer of intumescent material from the atmosphere.

21. A method of manufacturing a laminated fire-screening panel substantially as described in the Example herein set forth.

22. A laminated fire-screening panel manufactured by a method according to any one of the preceding claims.

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1562791 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

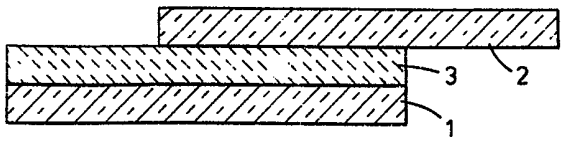

FIG. 1

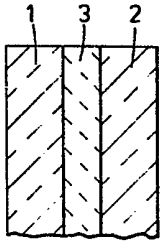

FIG. 2

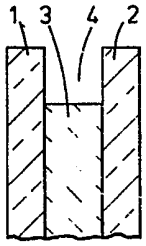

FIG. 3

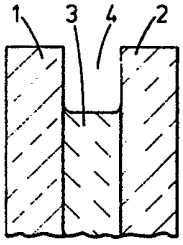

FIG. 4