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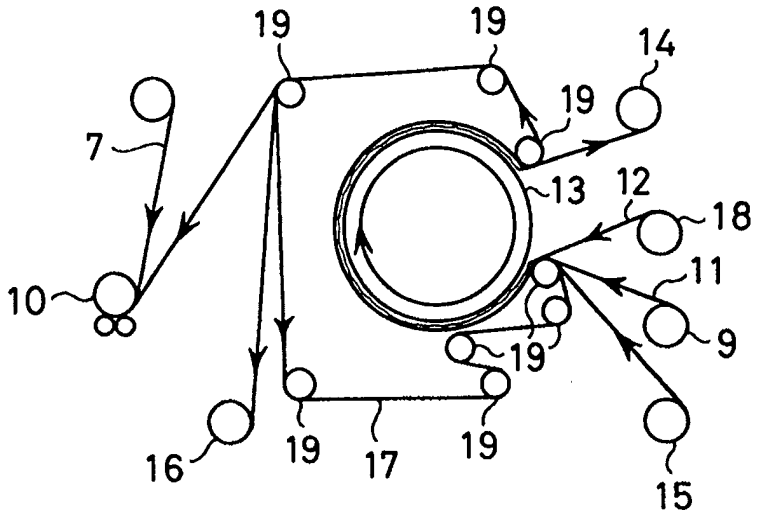
(54) Title: FIRE RESISTANT SANDWICH BOARD

(57) Abstract

A coil of liner for a fire resistant sandwich board is manufactured by providing a continuous web of steel plate (11) coated on one side with a layer of polyester with embedded polyamide spheres, providing a continuous web of transfer material (12) printed with indicia in a sublimable dye, bringing said webs in surface–to–surface contact and running them around part of the circumference of a heated roller (13) to effect printing of the web of steel plate by a sublimation process. The liner has a pleasant appearance and the board manufactured according to the invention shows excellent performance in fire tests.



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FIRE RESISTANT SANDWICH BOARD

The present invention relates to fire resistant sandwich boards intended for use as wall panels or ceilings in interiors of rooms subject to stringent fire codes, e.g. interiors on board ships, oil platforms or inside certain types of building structures. The invention further relates to methods of manufacturing such sandwich boards or intermediate products for this use.

Various requirements put on wall panels and ceilings for such applications e.g. related to cost, weight, heat insulation, sound insulation, resistance to wear, resistance to chemicals, aesthetic value in addition to fire hazard considerations have led to the introduction of sandwich boards in various forms. A sandwich board of relevance in the present context comprises a core of mineral wool with steel plate liners on both sides. For structural considerations the mineral wool core must be arranged with the fibres extending crosswise and the liners adhered to the core by adhesive. Some examples of this kind of sandwich board are explained in Danish patent application 3526/75 filed 4th August 1975.

For reasons of aesthetic value it is commonly used to laminate the steel liners with plastic or covered with PVC foil. A PVC foil of a thickness 0.150 mm can be coloured and textured to provide an attractive appearance. Although a product of this kind satisfies most of the codes presently applied, the plastic laminate inevitably is a source of heat release and a source of harmful and poisonous gases when exposed to open fire.

It has been suggested to cover the steel liners with a very thin layer of polymer material, e.g. a layer with a surface thickness of 0.030 mm in order to minimise heat release and gas release under fire exposure. However, such products have failed to gain acceptance on the market because of the lack of aesthetic value offered.

The publication WO 95/30 552 contains the suggestion of building a sandwich wall panel with a metal liner with a decorative colouring, e.g. a reproduction of a photograph or of a piece of art. According to this publication the board panel is manufactured by stacking together various components among which metal foil and a transfer paper and by heat pressing the stack for a time period of 5 to 30 minutes whereby the dye transfers to the plate surface.

EP-A 00 72 461 contains a suggestion for continuous printing of a steel plate of a thickness of 0.75 mm by a transfer process which takes place between a double band press.

DE-C 26 42 350 and DE-C 29 14 704 offer various suggestions for dyes and printing methods related to transfer printing of textiles.

The solutions suggested in the prior art do not seem to have gained any share of the market in fireproof panels, presumably because the manufacturing methods are too cumbersome or costly or perhaps because they failed to come up with products which can truly meet all the applicable requirements.

The invention provides a method as recited in claim 1.

This provides a highly efficient manufacturing method adapted for outputting a liner by means of which it is possible to manufacture a sandwich board which satisfies all the requirements mentioned above and which exhibits a performance during fire tests superior to the majority of boards on the market today. The liner is imprinted by way of a transfer process which permits a large variety of colours and patterns. The surface finish is highly resistant to wear and the product may be shipped with a protective covering which may stay in place preserving the surface finish until one of the last stages of room finishing.

The invention further provides a method of manufacturing a fire resistant sandwich board as recited in claim 8.

This provides the manufacturing of a sandwich board capable of meeting the strictest fire requirements and capable of meeting also the multitude of other requirements referred to above. The board can be manufactured at comparatively low cost.

The invention further provides a sandwich board as recited in claim 9.

This board meets all requirements relevant to a board for use as interior wall panel or ceiling as explained above.

Preferred embodiments appear from the dependent claims.

Further features and advantages of the invention will appear from the detailed description given below with reference to the appended drawings, on which

Fig. 1 illustrates schematically a transfer printing station used according to the method according to the invention,

Fig. 2 shows a transverse section through a portion of the board according to the invention, and

Fig. 3 shows a planar view of a board according to the invention.

All the drawings are schematic and not necessarily to scale and illustrate only parts essential to facilitate understanding the invention, other parts being omitted from the drawings for the sake of clarity. Throughout the drawings identical references are used to designate identical of similar items.

Reference is first made to fig. 1 for a brief explanation of the transfer printing process as applied according to the invention. In the station illustrated in fig. 1 steel plate web 11 unrolled from the coil 9 is brought together with transfer material web 12 unrolled from the transfer take-off roller 18 in surface-to-surface contact while passing around a guide roller 19 to enter into contact with the surface of heated roller 13.

Backing paper unrolled from backing paper take-off roller 15 is placed on the outside of the steel plate web 11 and the layers are held into surface contact with the cylindrical surface of heated roller 13 by means of the pressure applied by blanket 17 which follows an endless loop and which is tensioned to the extent of applying a radial surface pressure onto the webs sufficient to

prevent any slippage between the transfer material and the steel plate.

In a preferred embodiment of the invention a pressure within the range from 2 to 4 Bars has been found effective.

The diameter of the heated roller may be 500 mm and the roller is preferably kept to a temperature of 210°C. The transfer material web and the steel plate web pass around approximately 80% of the roller periphery to leave the heated roller by making a turn around another guide roller 19.

At the guide roller where the webs leave the heated roller the transfer material web is separated from the steel plate web to be wound on transfer take-up roller 14.

The speed of revolution of the heated roller is tuned to achieve a contact time for every point on the web in the order of 20 to 30 seconds which has been found sufficient to ensure a satisfactory transfer printing by sublimation. In the preferred embodiment the equivalent speed of web motion will be in the range 3 to 5 meters per minute.

For other embodiments featuring larger diameter rollers, e.g. up to 2,000 mm, the speed of revolution is set to correspondingly lower values in order to maintain a contact time in the order of 20 to 30 seconds.

The density of dye applied in the sublimation process is estimated to be in the range of 1 to 5 g/m^2, preferably 1 to 2 g/m^2.

Having been separated from the spent transfer material the hot steel plate web 11 passes two more guide rollers and is separated from the backing paper and from the blanket. Following a straight pass the steel plate web is wound onto coil 10 together with an interlayered web of foil 7.

In the preferred embodiment foil 7 comprises a polyethylene foil of a thickness of approximately 20 microns. The polyethylene foil is surface treated on the side facing the print on the steel plate web with adhesive. This kind of foil has been found to provide adequate protection of the liner and it can easily be peeled off when desired without tearing. Other embodiments aimed for sturdy protection may feature heavier grade foils.

The steel plate web 11 leaves the heated roller with a temperature about 210°C and cools down in the air to a temperature in the range approximately 60 to 70°C at the point of winding on the liner coil 10. The remanent heat of the steel plate web furthers the adhesion of the protective foil.

The coil of steel plate 9 used in this process comprises a steel plate of a thickness in the range of 0.5 to 0.7 mm, the steel plate having been pre-treated with a surface coating. This surface coating, which is applied in a set-up not illustrated in the drawings, comprises a polyester based material with embedded spheres of polyamide. In the preferred embodiment a base layer of polyester material is applied to the steel plate and cured, and a top layer of polyester with suspended polyamide spheres is subsequently applied and cured.

The base layer comprises approximately 15 grams per square meter of polyester based material, while the top layer comprises an additional approximately 15 grams per square meter of polyester based material with 3 to 4 grams per square meter polyamide spheres. By this method the polyamide spheres are arranged predominantly in the top surface where they serve to produce an attractive appearance and to ensure wear resistance while the polyester material can fulfil the purposes of securing the spheres, protecting the steel surface and nesting the dye applied in the transfer printing.

Reference is now made to fig. 2 illustrating a cross sectional view through a portion of the board manufactured according to the invention. The sandwich board 1 comprises core 3 sandwiched between liners 2. In the preferred embodiment the core comprises mineral wool wherein the fibres are oriented to extend mainly in directions transverse to the liners. The liners comprise steel plates manufactured in the process explained above and adhered to the core by a glue 6 on polyurethane basis.

Each liner comprises on the side facing away from the core the coating 4, the print indicia 5 and the protective foil 7.

Fig. 2 also illustrates the board edge 8 wherein a border region of each liner is angled to strengthen and protect the board edges and the core is notched so as to permit insertion of fixture means.

Fig. 3 illustrates a sandwich board 1 according to the invention in a planar view to illustrate just one example of print indicia 5.

The sandwich board 1 according to the invention is manufactured in a process line where the liner coil in unwound, treated with polyurethane adhesive and cut into sections of a suitable format. As the sandwich board is preferably manufactured with similar or identical opposite sides it is preferred to cut pairs of identical liner blanks.

A board of mineral wool oriented so that the fibres extend generally crosswise and cut into a suitable format is placed on one liner blank of the pair while the other blank is inverted and placed on top. The assembly is heat pressed to cure the polyurethane adhesive and the edges are finished.

Boards according to the invention are manufactured in widths ranging from 100 mm to 1,250 mm and lengths from 800 mm to 10,000 mm. The thickness of the sandwich boards manufactured according to the invention generally range from 25 mm to 100 mm, the bulk comprising thicknesses of 25 mm or 50 mm. Other dimensions can be manufactured by similar methods.

In fire tests according to the Nordtest method NT Fire 025 and ISO/DIS 9705 sandwich boards according to the invention and comparable boards covered with 0.150 mm of PVC foil have been exposed to gas flames. Among the results of the these tests were noted a heat release from the boards according to the invention of 0.6 to 0.9 MJ/m^2 compared to 5 MJ/m^2 for the PVC foil covered boards. The release of HCl from the inventive boards was about 0.6% of the values noted for the PVC boards. Values for release of

other gasses and smoke were all substantially lower for the inventive boards.

Although specific embodiments of the invention have been explained in more detail above this is not intended to exclude that the invention could be practised in other ways within the scope of the appended patent claims.

Patent Claims

1. A method of manufacturing a coil of liner for a fire resistant sandwich board said method comprising the steps of

providing a continuous web of steel plate coated on one side with a layer of polyester with embedded polyamide spheres,

providing a continuous web of transfer material printed with indicia in a sublimable dye,

bringing said webs in surface-to-surface contact and running them around part of the circumference of a heated roller while urging said webs against the surface of the roller by running a blanket around said roller in overlying relationship with said webs, the blanket being tensioned to apply a surface pressure sufficient to substantially prevent any slippage between the webs,

the extent of circumference covered by the webs, the speed of revolution of the roller, and the temperature of the roller being selected to ensure printing of the web of steel plate by a sublimation process,

separating the webs after printing and winding spent transfer material on a transfer take-up roll,

air cooling the web of printed steel plate until the print has cured,

bringing a web of protective polymer foil in adhesive surface-to-surface contact with the surface of the web of steel plate, and

winding the web of steel plate together with the foil on a liner take-up roll.

2. The method according to claim 1, c h a r a c t e r i z e d in that the step of bringing the protective foil into contact with the steel plate is carried out at a

stage where the steel plate is warm enough to soften the protective foil to enhance the adhesion.

3. The method according to claim 1, c h a r a c t e r i z e d in that the steel plate has a thickness of at least 0.3 mm and preferably at least 0.5 mm.

4. The method according to claim 1, c h a r a c t e r i z e d in that the speed of the webs during the printing is tuned to keep the roller contact time in the range of 20 to 30 seconds.

5. The method according to claim 1, c h a r a c t e r i z e d in that the roller temperature is kept in the range of 150 to 240°C and preferably in the range of 200 to 220°C.

6. The method according to claim 1, c h a r a c t e r i z e d in that the thickness of the polyester coating is kept to be below 50 microns and preferably below 40 microns while the density of the dye applied by the printing is kept below 5 grams per square meter.

7. The method according to claim 1, c h a r a c t e r i z e d in that the protective foil provided comprises a polyethylene based material of a thickness sufficient to allow peel-off substantially without tearing.

8. A method of manufacturing a fire resistant sandwich board comprising the steps of

forming a web by unwinding a coil of fire resistant liner manufactured according to any of the preceding claims,

treating the unprinted side of the web with a layer of adhesive,

cutting the web into paired sections,

applying onto one section of each pair a board of mineral wool,

inverting the other section of each pair and applying it on top of the mineral board to form a sandwich,

subjecting the sandwich to pressure and heat in order to cure the adhesive, and

finishing the edges.

9. A fire resistant sandwich board comprising a mineral wool board core and a pair of steel plate liners adhered onto respective sides of the core, each of the steel plate liners being surface treated on the side facing away from the core with a coating comprising polyester with embedded polyamide spheres and provided on top of the coating with a decorative pattern applied by way of sublimation process.

10. The board according to claim 9, c h a r a c t e r i z e d in that the coating comprises a layer of a thickness of no more than 50 microns and preferably no more than 40 microns.

11. The board according to claim 9, c h a r a c t e r i z e d in that the steel plate liners comprise steel plates of a thickness of at least 0.3 mm and preferably at least 0.5 mm.

12. The board according to claim 9, c h a r a c t e r i z e d in that it is provided with removable foil

coatings on both sides in order to protect the liner surface.

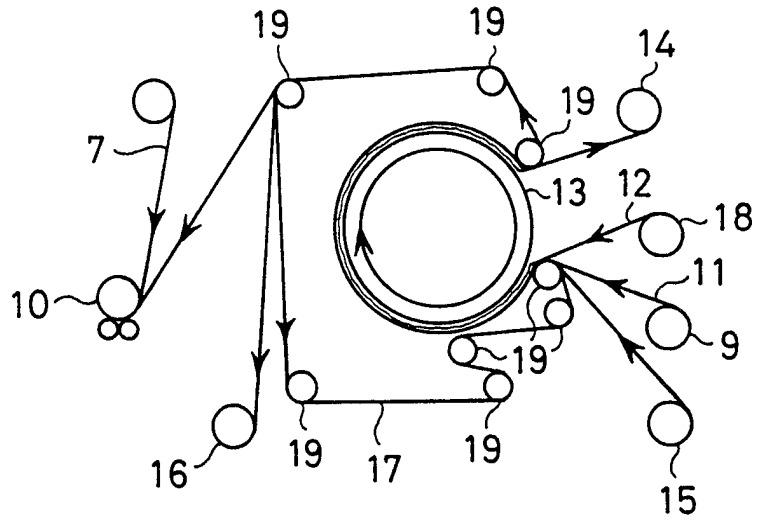

Fig. 1

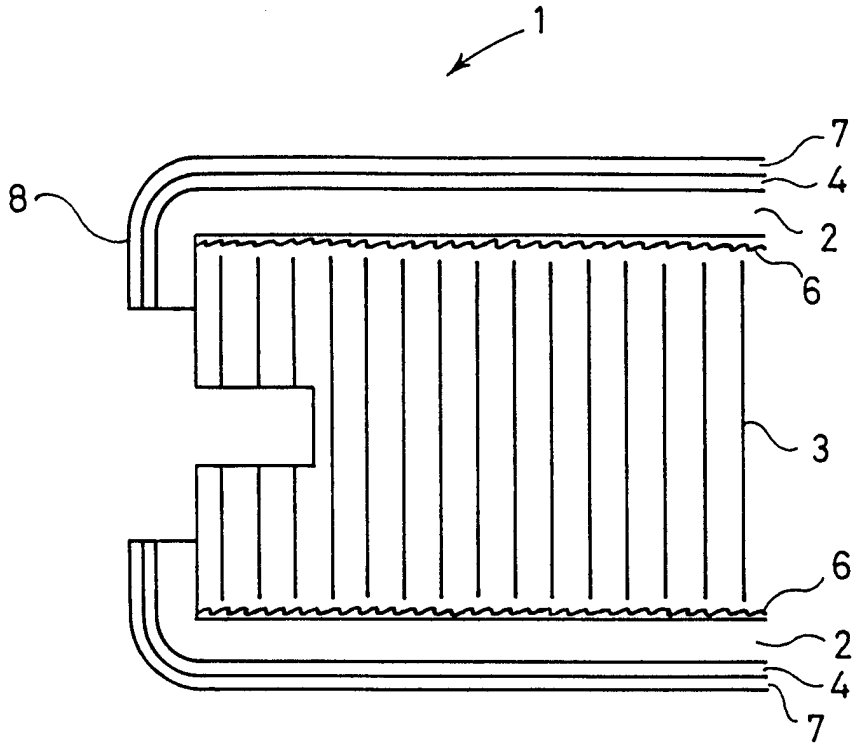

Fig. 2

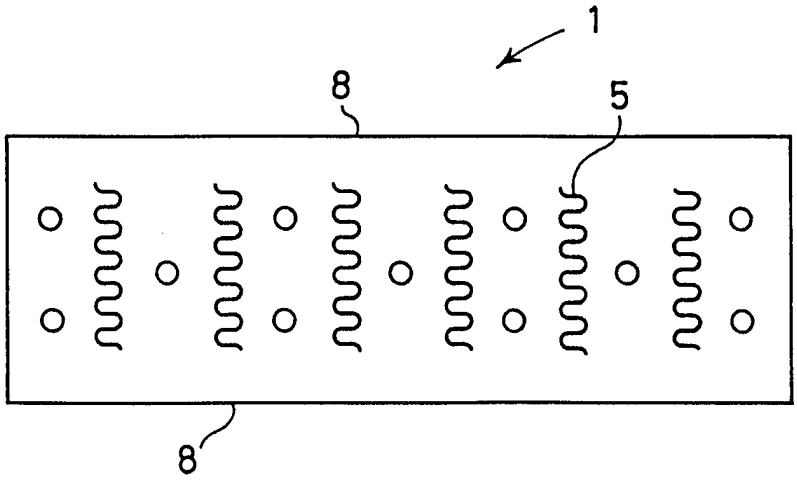

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00507

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B44C 5/04, B41M 1/30, B41M 5/035, B32B 15/08, E04B 1/94, E04C 2/292
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B44C, B41M, B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0060107 A2 (BRITISH STEEL CORPORATION), 15 Sept 1982 (15.09.82), see the whole document --	1-7
A	EP 0072461 A1 (HERBERTS GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG), 23 February 1983 (23.02.83), page 3, abstract --	1-7
A	File WPI, Derwent accession no. 96-283682, Dainippon Ink & Chem Inc et al: "Coating material for prepn. of decorative metal plates - comprising polyester resin or acrylic resin and polyamide particles", JP,A,8120201, 960514, DW9629 --	1

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2151983 A (MORTEO SOPREFIN SPA), 31 July 1985 (31.07.85), page 1, line 71 - line 88, abstract -- --------	9-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

01/07/97

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0060107 A2	15/09/82	SE 0060107 T3	
		AU 8103982 A	16/09/82
		CA 1184067 A	19/03/85
		GB 2094230 A,B	15/09/82
		US 4411667 A	25/10/83
EP 0072461 A1	23/02/83	DE 3132693 A	17/03/83
GB 2151983 A	31/07/85	DE 3445777 A	31/10/85
		FR 2557610 A,B	05/07/85