(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 988 429 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
21.08.2002 Bulletin 2002/34

(21) Application number: **98929556.3**

(22) Date of filing: **15.06.1998**

(51) Int Cl.[7]: **E04B 1/94**

(86) International application number:
PCT/GB98/01733

(87) International publication number:
WO 98/057000 (17.12.1998 Gazette 1998/50)

(54) FIRE STOPS FOR USE IN BUILDINGS

FEUERSCHUTZABSCHLÜSSE FÜR GEBÄUDE

ELEMENTS COUPE-FEU DESTINES A ETRE UTILISES DANS DES BATIMENTS

(84) Designated Contracting States:
AT BE DE DK GB NL

(30) Priority: **13.06.1997 EP 97304156**

(43) Date of publication of application:
29.03.2000 Bulletin 2000/13

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EP 0 988 429 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to fire stops for installation in cavities in buildings, for instance between an access floor and a wall, or between two leaves of a cavity wall.

[0002] It is known to use cavity fire stops consisting of strips or elongate element of mineral wool to form fire stops in cavities within buildings. Such cavities may be between the cladding or curtain walling and a structural element, such as a concrete floor slab, to be fire stopped. The fire stops can be used in both vertical and horizontal plains. The strips of mineral fibre material are generally fitted with a slight compression in the direction perpendicular to the leaves of the cavity being stopped. In a vertical cavity, the strips are usually held in place by the use of brackets protruding horizontally from the first leaf to be constructed. Where the cavity to be fire stopped is longer than the length of slab as supplied, two slabs are used end to end, generally with fire stopping performance being improved by the use of stepped or rebated ends which interlock with one another. The mineral wool elements may have integral foil smoke barrier facings, used in an orientation such that the foil barrier lies perpendicular to the sides of the cavity being fire stopped.

[0003] One product which is commercially available under the trade name Lamatherm and described in GB-A-2262228 is supplied as a rectangular precursor slab which is formed from mineral fibre lamellae oriented so as to provide suitable bending resistance to the fire stop product. The rectangular slab is cut on site to elements of the desired width, depending on the depth of cavity to be closed, and fixed in position using the usual brackets. The rectangular slab is provided with a foil barrier and the cut elongate elements are oriented in the cavity with the foil perpendicular to the leaves. Whilst this product has good flexibility, to provide resilient fixing under compression within the cavity, the production process for such slabs, requiring the cutting and orientation and adhesion of lamellae, is complex and expensive.

[0004] The present invention seeks to provide a product having performance as good as the Lamatherm product described above, including the desired resilience to compression with longitudinal stiffness, but using more simple production techniques.

[0005] Many processes are known in which, during the production of mineral fibre web, a loosely compacted mineral fibre web is subjected to longitudinal and, optionally, height compression. For instance such processes are described in CH-A-679161, EP-A-0560878, WO-A-95/20708, WO-A-94/16162, WO-A-88/00265, US-A-2409066, WO-A-95/20707 and CH-A-620861. A feature of the products produced by the prior art processes is that the web produced tends to have inadequate bending resistance, especially for webs having a final density of lower than 100 kg/m^3.

[0006] WO-A-88/00265 and WO-A-92/13150, each describe a process in which length compressed mineral fibre web is split into two continuous strips, height compressing one of the strips and feeding it back on to the other web. In WO-A-95/20707, an insulating mat formed of mineral fibre for instance made using a process involving longitudinal compression, for use as an insulation panel, has an air permeable covering over one or both of the two main surfaces of the web. The air permeable covering is, for instance, formed of perforated foils, including a layer of metal foil. The air permeability of the foil is measured in air resistant units, and the air resistance is less than 100 mm water column. The density of the mineral fibre web is in the range 15 to 60 kg/m^3, where the mineral fibre is rockwool.

[0007] In the invention there is provided a new use of an elongate rectangular cylindrical element having a rectangular cylindrical rockwool core, a first dimension of the rectangle being in the range 60 to 150mm, and an air impermeable fire-resistant foil bonded to and substantially covering the surface of two opposite longitudinal faces, whereby the thickness between the foil covered faces is said first dimension whereby it is in the said range 60-150 mm, to form a fire stop in a cavity bounded on at least two opposite sides in a building where the foil covered faces span the cavity and the element is resiliently compressed between the said opposite sides of the cavity, characterised in that the core is formed of a single ply mat and has a density of more than 60 kg/$m^{3,}$ the fibres of the core being oriented substantially perpendicularly to the faces to which the foil is bonded by being arranged in a pleated pattern, in which the pleats propagate perpendicularly to the longitudinal axis of the element.

[0008] The rockwool core of the element used in the invention is preferably made by a process in which the web is subjected to length compression during production. This length compression is preferably such as to orient fibres predominantly in a plane substantially perpendicular to the machine direction and to the cross direction of the line on which the web is produced. This has the effect of making the wool resilient to compressive forces applied parallel to the machine direction.

[0009] Preferably the foil is applied to the web, and adhered using a suitable adhesive, after curing of resin impregnated in the length compressed wool in an oven, by application to the two faces of the cured web in line. The elongate element is preferably cut so that its longitudinal axis lies perpendicular to the machine direction. Consequently in the product of the invention, the fibres of the core are oriented predominantly in a plane substantially perpendicular to the surfaces to which the foil is bonded. The length compression step has conferred resilience upon application of a compressive force between the two longitudinal faces to which foil is not bonded. This results in a tight fit upon being compressed in a building cavity.

[0010] In the invention the impermeable fire-resistant

foil preferably comprises a continuous non-perforated sheet of metal, preferably of aluminium. A suitable thickness for the aluminium sheet is 20 μm. It may be a laminate of aluminium with a reinforcing layer, for instance formed of fibre glass scrim e.g. 80-120g/m^2 weight and a continuous or discontinuous surface lamina of a thermoplastic material to act as adhesive.

[0011] Where the adhesive is a thermoplastic material, the foil can be adhered to the mineral wool web by heating the adhesive to a temperature above the melting temperature, contacting it with the web and allowing the adhesive to cool and solidify, for instance by the use of heated rollers to apply simultaneous heat and pressure.

[0012] The element of the invention is preferably retained in the cavity required to be fire stopped under compression. Consequently the element is resilient under pressure applied between the two non-foil covered longitudinal faces (that is in the plane parallel to the foil covered faces and perpendicular to the longitudinal axis of the element). As describe above this resilience is a feature of longitudinally compressed mineral fibre web which is utilised when the element is cut in the orientation described above. The mineral fibre core has a pleated pattern as a result of being produced by a suitable longitudinal compression process. The longitudinal compression process may be carried out as described in any of the above mentioned patent specifications. The element is preferably cut so that its longitudinal axis is perpendicular to the direction of propogation of the pleats (or parallel to the pleats themselves).

[0013] It is generally the case that the product formed by longitudinal compression, especially product having a generally pleated pattern of mineral fibres, and with a density of less than 120 or 100 kg/m^3, has inadequate self-deflection properties, for elements cut from the web which are elongate in the machine direction of the web. However, in the present invention, it has been found that the application of a foil so that two opposite longitudinal faces are bonded to the foil provides the element with a surprising level of resistance to self-deflection, when the element is oriented with the foil in either horizontal or vertical direction.

[0014] Self-deflection in an elongate element can be measured by a method in which the element is positioned horizontally, supported under each end, in the desired orientation (eg with foil covered surfaces arranged vertically or horizontally). The degree of vertical deflection in the centre provides a measure of the self-deflection.

[0015] Preferably the density of the mineral fibre core is in the range 60 to 120 kg/m^3, more preferably in the range 90 to 100 kg/m^3. The higher the density, the better the fire performance (the longer the barrier performs in a fire test). It is generally found that, for a wall cavity fire stop a density of 80-100kg/m^3 is desirable, whilst for an access floor the density can be lower, for instance about 60-70kg/m^3.

[0016] The element of the invention preferably has a length in the range 500 to 1500 mm, most conveniently in the range 750 to 1000 mm. Preferably the thickness of the element between the foil covered faces is in the range 75 to 120 mm. The height of the element between the longitudinal non-foil covered faces is preferably in the range 50 to 1000 mm, more preferably 60 to 750 mm, most preferably 75 to 100 mm.

[0017] The cavity in which the fire-stop is used is preferably a cavity between a floor slab and a real floor or a wall, or between two leaves of a cavity wall.

[0018] It is particularly convenient for the longitudinal elements to be cut on site to the desired shape. It is convenient for a precursor of the element to be provided as a rectangular slab having foil covered major faces. The slab is generally cut into longitudinal elements by cutting parallel slices from the slab. A fire stop is generally required to be longer than a single element and the fire stop is therefore formed by arranging several elements end to end.

[0019] In order to improve the fire barrier properties still further, the ends of the elements are rebated or otherwise cut, so as to provide overlapping steps, to minimise the effect of a break, especially in the foil, which may allow transmission of smoke. Preferably the precursor slab is provided with appropriate shaping, for instance rebating, at opposite edges of the generally rectangular slab, so that each slice, which forms an element, has shaped ends to provide that overlap.

[0020] The invention is conveniently put into effect by providing a precursor slab in conjunction with appropriate fixing brackets comprising metal clips having a first end capable of impaling into the non-foil covered side of an element cut from the slab and a second end suitable for fixing horizontally in a wall, as a kit for use on site. In a building method according to the invention, a fire stop is provided in a cavity, and in the method fixing brackets are fixed into a wall forming the first side of a cavity with impaling ends extending substantially perpendicularly from the wall to a distance of at least 50%, preferably about 75% of the eventual width of the cavity, an elongate element which has a height between non foil covered faces of about 1 to 5 mm more than the desired width of the cavity, is impaled through a non foil covered face on the fixing brackets, and the second side of the cavity is subsequently built with the elongate element being subjected to compression during said building.

[0021] In an alternative method, a fire stop is provided in a preformed cavity. In this method, an elongate element having a distance between non foil covered faces which is in the range 1 to 5 mm greater than the width of the cavity is compressed between the non foil covered faces so that the height between those faces is less than the width of the cavity and is inserted into the cavity and allowed to expand in the cavity into contact with the walls, whereby it is retained in position by friction between the non foil covered faces and the sides of the cavity.

[0022] In the methods, it is convenient for the elements to be cut on site from a rectangular precursor slab. Thus the distance between non-foil covered faces can be adapted as desired to the width of the cavity. The precursor slab is suitably provided with instructions to ensure it is cut in the appropriate direction to take advantage of the resilience afforded by the length compression of the mineral wool, as described above.

[0023] In the methods of the invention, it is preferred for a single fire stop to be formed of several elongate elements abutted end to end, in which the abutting ends of the elements are rebated and interlock with each other in the fire stop.

[0024] Where the fire stop is installed in the cavity of a wall, it is generally arranged in a horizontal orientation. In such an arrangement the cavity is preferably provided with a damp proof course built into the cavity above the fire stop in order to avoid collection of moisture on the upper impermeable foil covered surface of the fire stop.

[0025] The invention is further illustrated in the accompanying drawings in which:

Figure 1 shows a perspective view of one end of an elongate element according to the invention;
Figure 2 shows a perspective view of a precursor slab with one elongate element sliced from the slab;
Figure 3 is a plan view of a firestep in the cavity between an access floor and a cavity wall; and
Figure 4 is a section along line IV-IV in Figure 3.

[0026] In Figure 1 there is shown one end of an elongate element 1 comprising a mineral fibre core 2 and air impermeable metal foils 3 and 4 covering opposite longitudinal faces of the element 1. The end of the element is rebated by cutting a step generally shown at 5 as indicated. At the opposite end of the element there will be a similar step allowing for co-operation with an abutting element to form a fire stop which is longer than the element itself.

[0027] The mineral wool core is formed of rockwool, in this case having the density of around 90 kg/m^3. The element has a thickness t in the range 60 to 150 mm, preferably 75 to 120 mm. The width w between the longitudinal non foil covered faces 6 and 7 is in the range 50 to 500 mm, more preferably 80 to 400 mm. The length of the element is preferably in the range 500 to 1500 mm, more preferably 750 to 1000 mm.

[0028] Foils 3 and 4 are preferably formed of a laminate including a layer of aluminium foil of thickness 25 μm. The laminate includes surface layers of fibreglass scrim reinforcement of weight 93g/m^2 and polyethylene adhesive at 25 g/m^2. The foils are attached to the core 2 by passing the length compressed cured slab between a set of heated rollers, with polyethylene side-facing the rockwool, at a temperature high enough to melt the polyethylene and under a suitable pressure. It may be desirable to apply additional adhesive to the inner face of the foils 3 and 4 and/or to the surface of the mineral wool core, or to adhere a non-precoated laminate using such adhesive.

[0029] As is shown in Figure 1, the mineral fibre core 2 is formed of fibres 8, whose orientation is generally perpendicular to the foil (3, 4) covered faces. This orientation is achieved by the use of length compression during manufacture of the mineral fibre web.

[0030] Length compression is achieved in known fashion by the use of sequential series of conveyor rollers or belts with decreasing speed. The difference in speed between the conveyor components at the start of the length compression unit as compared to the end of the length compression unit may be around 3:1. Using a suitable arrangement of conveyors the mineral wool is effectively pleated so as to provide the desired orientation of fibres. The fibre orientation provides good resistance to compression in the direction between the foil (3, 4) covered faces and between the non foil covered faces 6, 7, whilst the adhesion of foils 3 and 4 provide the elongate element 1 with appropriate resistance to self-deflection.

[0031] Figure 2 illustrates how a rectangular precursor slab 9 having continuous foil sheets 13 and 14 covering respectively lower and upper surfaces and having a step 15 cut at each end, is sliced along lines 16, 17 and 18 to form a series of elongate elements 1.

[0032] Figures 3 and 4 show how a fire stop is provided in a preformed void between a floor formed of concrete floor slabs 20 and a curtain wall 19. The cavity between the floor and the curtain wall is w' in depth, w' being between 1 and 5 mm less than the width w of the elongate element 1. A fire stop is formed of several elongate elements, including 1 and 1' arranged with rebated ends 5 overlapping one another.

[0033] Each element 1, 1', cut for a snug fit to width w is impaled onto metal brackets 21, 22, each of which has a cranked shape shown better in Figure 4. The brackets, spaced apart at distances in the range 400-500mm, are impaled into the elongate element 1, each bracket extending through more than half (about 75%) the width w of the element. The element is then fitted in to the void, with adjacent elements being tightly butted to one another. The protruding ends of the brackets, now lying on the floor slab 20, can subsequently be mechanically fixed to the floor using appropriate means. Since the width w' of the cavity is less than the width w of the uncompressed elongate element, the element is held in the cavity under compression.

[0034] Where the elements are to be fitted in masonry wall cavities, the brackets are built into the bed joints of the internal leaf at spacings of about 400-500mm. After the next lift of masonry is completed, the elements are impaled onto the protruding ends of the brackets after which the outerleaf can be continued with suitable damp proof course being built in as necessary above a horizontal fire stop or vertically externally of a vertical fire stop.

Claims

1. Use of an elongate rectangular cylindrical element (1) having a rectangular cylindrical rockwool core (2) one dimension of the rectangle being in the range 60 to 150 mm and an air impermeable fire resistant foil (13, 14) bonded and substantially covering the surface of two opposite longitudinal faces (3, 4) of the core whereby the thickness between the foil covered faces is said first dimension whereby it is in the said range 60-150 mm to form a fire stop in a cavity bounded on at least two opposite sides in a building where the foil covered faces span the cavity and the element is resiliently compressed between the said opposite sides of the cavity, **characterised in that** the core is formed of a single ply mat and has a density of more than 60 kg/m^3 the fibres (8) of which are oriented substantially perpendicular to the faces to which the foil is bounded by being arranged in a pleated pattern, in which the pleats propagate perpendicular to the longitudinal axis of the element.

2. Use according to claim 1 in which the foil comprises an imperforate continuous sheet of aluminium.

3. Use according to claim 2 in which the aluminium sheet is about 20 micron thick.

4. Use according to any preceding claim in which the element has a length in the range 500 to 1500 mm.

5. Use according to claim 4 in which the element has a length in the range 750 to 1000 mm.

6. Use according to any preceding claim in which the element has a thickness between the foil covered faces in the range 75 to 120 mm.

7. Use according to any preceding claim in which the height between the longitudinal non-foil covered faces of the element is in the range 50 to 500 mm.

8. Use according to claim 7 in which the said height is in the range 80 to 400 mm.

9. Use according to any preceding claim in which the cavity is between an access floor and a real floor or wall or between two leaves of a cavity wall.

10. Use according to any preceding claim in which two or more elements are arranged end to end in the cavity and in which each element has rebated ends mating with corresponding rebated ends of an adjacent element.

11. Use according to any preceding claim in which fixing brackets comprising metal clips are fixed into a wall forming the first side of the cavity, a series of clips being substantially aligned with one another and each having a portion extending into the wall and impaling ends extending substantially perpendicularly from the wall to a distance from the said wall of at least 50% of the eventual width of the cavity, an elongate element having a height between non-foil-covered longitudinal faces of about 1 to 5 mm more than the desired width of the cavity, is impaled through a non foil covered face on the fixing brackets and the wall forming the second side of the cavity is then built with the elongate element being compressed by the said second wall to form a cavity of the desired width.

12. Use according to any preceding claims in which the element is installed generally horizontally between vertical walls and in which a damp proof course is built into the cavity above the element.

Patentansprüche

1. Verwendung eines länglichen, rechteckigen, zylindrischen Elements (1) mit einem rechteckigen, zylindrischen Steinwollkern (2), wobei eine Abmessung des Rechtecks im Bereich von 60 bis 150 mm liegt, und einer luftundurchlässigen, feuerbeständigen Folie (13, 14), die mit der Oberfläche von zwei gegenüberliegenden Längsaußenseiten (3, 4) des Kerns verbunden ist und diese im wesentlichen bedeckt, wobei die Dicke zwischen den mit Folie bedeckten Außenseiten die genannte erste Abmessung ist, wobei sie im genannten Bereich von 60 bis 150 mm liegt, zur Gestaltung eines Brandschutzes in einem durch mindestens zwei gegenüberliegende Seiten begrenzten Hohlraum in einem Bauwerk, wobei die mit Folie bedeckten Außenseiten den Hohlraum überbrücken und das Element zwischen den genannten gegenüberliegenden Seiten des Hohlraums in elastischer Weise zusammengedrückt ist, **dadurch gekennzeichnet, daß** der Kern aus einer einlagigen Matte gebildet ist und eine Dichte von mehr als 60 kg/m^3 aufweist, wobei deren Fasern (8) im wesentlichen senkrecht zu den Außenseiten, mit denen die Folie verbunden ist, orientiert sind, indem sie in einer gefalteten Ausführung angeordnet sind, in der sich die Falten senkrecht zur Längsachse des Elements fortpflanzen.

2. Verwendung nach Anspruch 1, worin die Folie eine nicht perforierte, zusammenhängende Aluminiumfolie umfaßt.

3. Verwendung nach Anspruch 2, worin die Aluminiumfolie eine Dicke von etwa 20 Mikron aufweist.

4. Verwendung nach irgendeinem vorhergehenden

Anspruch, worin das Element eine Länge im Bereich von 500 bis 1.500 mm aufweist.

5. Verwendung nach Anspruch 4, worin das Element eine Länge im Bereich von 750 bis 1.000 mm aufweist.

6. Verwendung nach irgendeinem vorhergehenden Anspruch, in welcher das Element eine Dicke zwischen den mit Folien bedeckten Außenseiten im Bereich von 75 bis 120 mm aufweist.

7. Verwendung nach irgendeinem vorhergehenden Anspruch, in welcher die Höhe zwischen den Längsaußenseiten des Elements, die nicht mit Folie bedeckt sind, im Bereich von 50 bis 500 mm liegt.

8. Verwendung nach Anspruch 7, in welcher die Höhe im Bereich von 80 bis 400 mm liegt.

9. Verwendung nach irgendeinem vorhergehenden Anspruch, in welcher sich der Hohlraum zwischen einem zugänglichen Boden und einem tatsächlichen Boden oder einer Wand oder zwischen zwei Blättern einer Hohlraumwand befindet.

10. Verwendung nach irgendeinem vorhergehenden Anspruch, in welcher zwei oder mehr Elemente mit den Enden aneinanderstoßend im Hohlraum angeordnet sind und in welcher jedes Element gefalzte Enden aufweist, die in die entsprechenden gefalzten Enden eines benachbarten Elements passen.

11. Verwendung nach irgendeinem vorhergehenden Anspruch, in welcher Befestigungshalterungen, die Metallhalter umfassen, an einer Wand befestigt sind, die die erste Seite des Hohlraums bildet, wobei eine Reihe von Haltern im wesentlichen in einer Linie angeordnet sind und jeweils einen Bereich, der sich in die Wand erstreckt, und durchbohrende Enden, die sich im wesentlichen senkrecht von der Wand bis zu einem Abstand von der Wand von mindestens 50% der tatsächlichen Breite des Hohlraums erstrecken, aufweisen, ein längliches Element mit einer Höhe zwischen den Längsaußenseiten, die nicht mit Folie bedeckt sind, von etwa 1 bis 5 mm mehr als die gewünschte Breite des Hohlraums über eine Außenseite, die nicht mit Folie bedeckt ist, auf die Befestigungshalterungen aufgespießt wird und die Wand, die die zweite Seite des Hohlraums bildet, dann gebaut wird, wobei das längliche Element durch die zweite Wand zusammengedrückt wird, um einen Hohlraum der gewünschten Breite zu bilden.

12. Venwendung nach irgendeinem der vorhergehenden Ansprüche, in welcher das Element im allgemeinen horizontal zwischen senkrechten Wänden installiert wird und in welcher eine Feuchtigkeitsisolierschicht in den Hohlraum über dem Element eingebaut wird.

Revendications

1. Utilisation d'un élément (1) cylindrique, rectangulaire, allongé ayant une partie centrale (2) rectangulaire, cylindrique, en laine de roche, une dimension du rectangle se situant dans l'intervalle de 60 à 150 mm, et une feuille (13, 14) imperméable à l'air, résistant au feu, liée à et recouvrant sensiblement la surface de deux faces (3, 4) longitudinales opposées de la partie centrale, l'épaisseur entre les faces recouvertes d'une feuille étant la dite première dimension qui se situe dans le dit intervalle de 60 - 150 mm pour former un coupe-feu dans une cavité fermée sur au moins deux côtés opposés, dans une construction, les faces recouvertes d'une feuille enjambant la cavité, et l'élément étant comprimé de manière élastique entre les dits côtés opposés de la cavité, **caractérisée en ce que** la partie centrale est formée d'un mat à couche unique, et présente une densité de plus de 60 kg/m^3, dont les fibres (8) sont orientées essentiellement perpendiculairement aux faces auxquelles la feuille est liée, en étant disposées selon un motif plissé, les plis se propageant perpendiculairement à l'axe longitudinal de l'élément.

2. Utilisation selon la revendication 1, dans laquelle la feuille comprend une feuille en aluminium continue, sans perforation.

3. Utilisation selon la revendication 2, dans laquelle la feuille en aluminium a une épaisseur d'environ 20 microns.

4. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'élément a une longueur dans l'intervalle de 500 à 1500 mm.

5. Utilisation selon la revendication 4, dans laquelle l'élément a une longueur dans l'intervalle de 750 à 1000 mm.

6. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'élément a une épaisseur entre les faces recouvertes d'une feuille, dans l'intervalle de 75 à 120 mm.

7. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle la hauteur entre les faces longitudinales de l'élément non recouvertes d'une feuille se situe dans l'intervalle de 50 à 500 mm.

8. Utilisation selon la revendication 7, dans laquelle la dite hauteur se situe dans l'intervalle de 80 à 400 mm.

9. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle la cavité se trouve entre un plancher d'accès et un plancher ou une paroi réelle, ou entre les deux feuillets d'une paroi creuse.

10. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle deux éléments ou davantage sont disposés bout à bout dans la cavité, et dans laquelle chaque élément présente des extrémités rainurées s'adaptant à des extrémités rainurées correspondantes d'un élément adjacent.

11. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle des pattes de fixation comprenant des agrafes métalliques sont fixées dans une paroi formant le premier côté de la cavité, une série d'agrafes étant essentiellement alignées l'une par rapport à l'autre et présentant chacune une partie se prolongeant dans la paroi et des extrémités d'empalement se prolongeant essentiellement perpendiculairement à partir de la paroi jusqu'à une distance de la dite paroi d'au moins 50% de la largeur finale de la cavité, un élément allongé ayant une hauteur entre faces longitudinales non recouvertes d'une feuille, d'environ 1 à 5 mm de plus que la largeur souhaitée de la cavité, est empalé par une face non recouverte d'une feuille, sur les pattes de fixation, et la paroi formant le second côté de la cavité est alors construit avec l'élément allongé en état de compression par la dite seconde paroi, pour former une cavité de la largeur souhaitée.

12. Utilisation selon l'une quelconque des revendications précédentes, dans laquelle l'élément est installé généralement horizontalement entre des parois verticales, et dans laquelle une assise hydrofuge est construite dans la cavité, au-dessus de l'élément.

Fig.1.

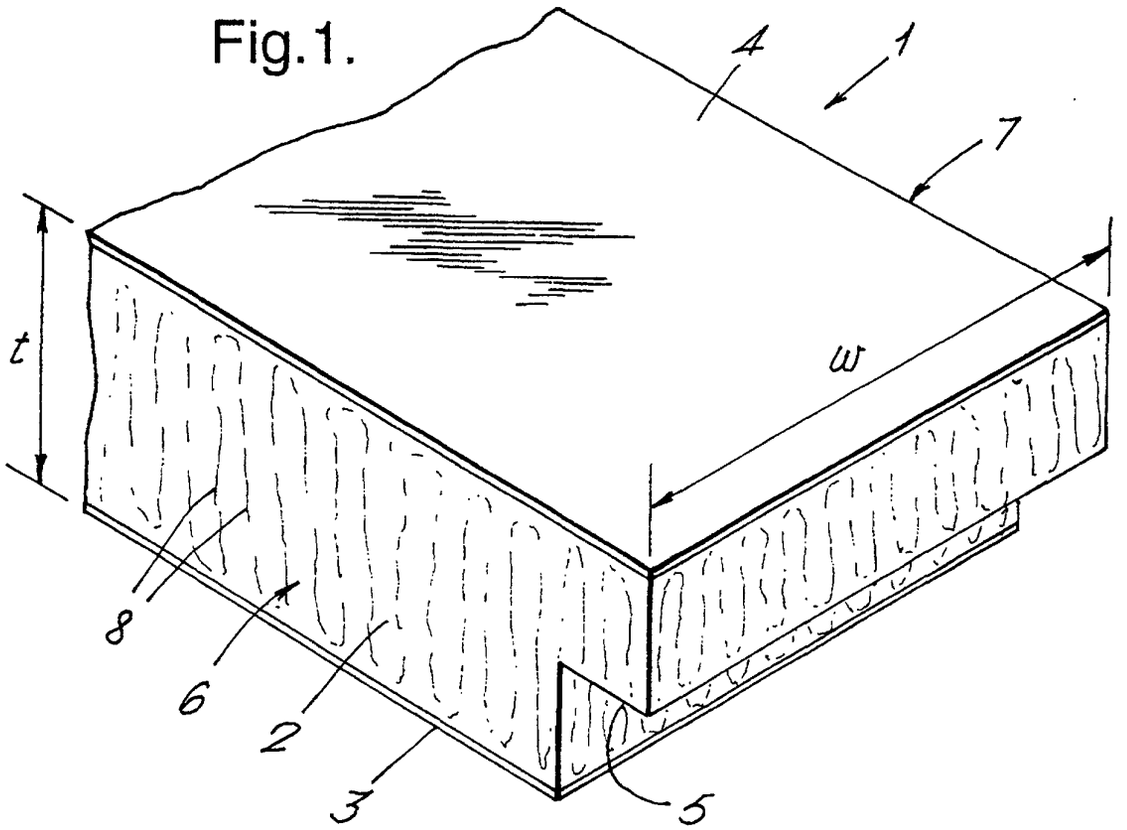

Fig.2.

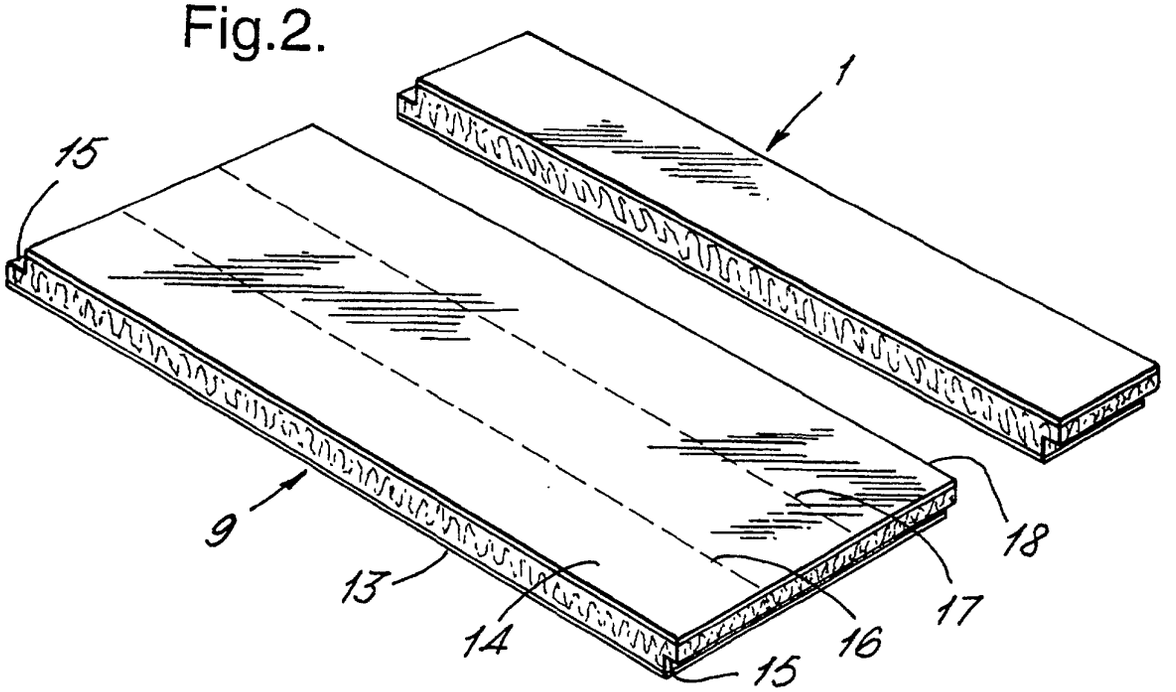

Fig.3.

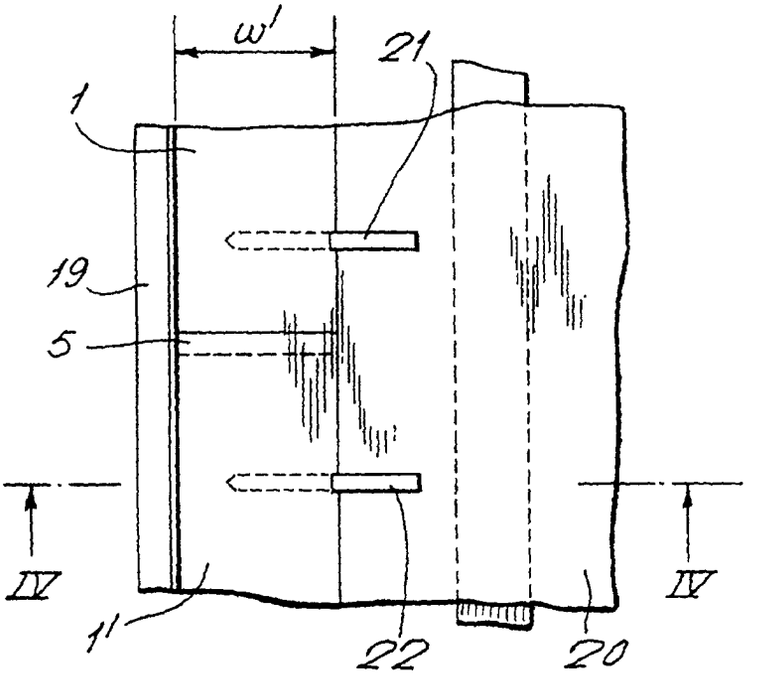

Fig.4.