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

(11) Publication number: **0 228 296**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **86310166.3**

(51) Int. Cl.⁴: **E 04 D 1/20**

(22) Date of filing: **29.12.86**

(30) Priority: **30.12.85 GB 8531840**
10.07.86 GB 8616831

(43) Date of publication of application: **08.07.87**
Bulletin 87/28

(84) Designated Contracting States: **AT BE CH DE ES FR GB GR IT LI NL SE**

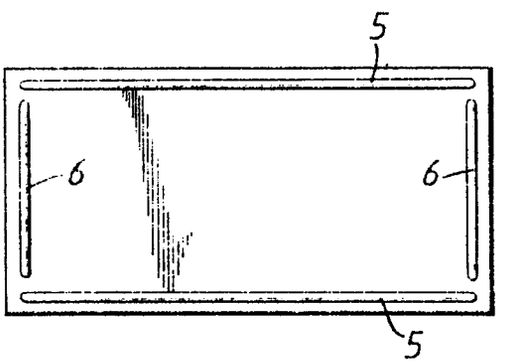
(71) Applicant: **PBT INTERNATIONAL LIMITED, 3F Second Avenue Westfield Trading Estate, Midsomer Norton Bath England BA3 4BH (GB)**

(72) Inventor: **Thompson, Peter Brian, Nordrach Blagdon, Bristol BS18 6XW (GB)**

(74) Representative: **Bardo, Julian Eason et al, Abel & Imray Northumberland House 303-306 High Holborn, London, WC1V 7LH (GB)**

(54) Roofing panel.

(57) A roofing panel suitable for use on a flat or shallow angled roof is of substantially lamellar form, is made of plastics material and has an edge portion which extends substantially in a plane parallel to the plane of the panel body. Means (5, 6) for accommodating expansion or contraction of the panel relative to a substrate on which it is placed are provided. The means extends across a major part of the panel in two mutually transverse directions, is formed as an integral part of the panel and comprises at least one portion which projects out of the plane of the panel body.



EP 0 228 296 A2

Roofing Panel

This invention relates to a roofing panel, to a roof including a plurality of such panels and to a method of laying roofing panels to form a roof. The invention is particularly, but not exclusively, concerned with what are hereinafter referred to as flat roofs, that is roofs which are horizontal or slope at a shallow angle, typically less than 15^{o} to the horizontal.

In a roofing structure employing roofing panels of a substantially inextensible kind, and particularly a structure having a large area, there is a need to accommodate relative variations in the dimensions of the panels and the support structure on which they rest due for example to temperature changes.

One form of roofing deck for such roofs has been corrugated metal sheets which are laid across spaced apart supports. Between the supports the sheets are unsupported and the corrugations in the sheets impart the necessary structural strength to the sheet to enable it to span the supports. U.S. 3,310,925 describes an arrangement in which sheets are laid with their side edges overlapping and have corrugations which are referred to as expansion or contraction crimps. This arrangement might also be used in forming a roofing deck but would not seem suitable for use as a roofing panel as it would not be a simple matter to make it waterproof

particularly at sites where four panels meet at their corners. In structures other than roofs it has also been proposed to provide metal panels with corrugations which accommodate dimensional variations in the panels.

In addition to the form of roofing panel described above, roofing panels are also known which are intended to be laid on a substantially continuous substrate. A roofing panel of this kind does not require significant structural strength and its purpose is to provide a waterproof skin to a roof. Commonly such panels are made of plastics material. The same need to accommodate relative dimensional variations between the panel and the supporting substrate arises with these panels and in this case there is the added difficulty that the plastics materials suitable for such panels, for example glass reinforced plastics material, are not as ductile as metal. Previous solutions to this problem have involved providing for the dimensional variation at the edges of adjacent panels by providing a special expansion joint between adjacent panels or by oversized fixing holes. An example of such a design is shown in GB 2,115,346.

According to the invention there is provided a roofing panel suitable for use on a flat or gently sloping roof, the panel being of substantially lamellar form, being made of plastics material and having an edge portion which extends substantially in a plane parallel

to the plane of the panel body, wherein means for accommodating expansion or contraction of the panel relative to a substrate on which it is placed are provided, said means extending across a major part of the panel in two transverse directions, being formed as an integral part of the panel and comprising at least one portion which projects out of the plane of the panel body.

The panel of the present invention incorporates as an integral part of the panel an arrangement for accommodating expansion or contraction of the panel relative to the substrate on which it is laid. By arranging for the means for accommodating expansion or contraction to extend across a major part of the panel in two transverse directions, expansion or contraction of the panel in any direction can be accommodated. Thus the need for separate expansion joints is eliminated and the construction of a roof simplified.

The means for accommodating expansion or contraction may be spaced from the extreme edge of the panel. This ensures that it cannot interfere with joints between adjacent panels. In the case where it does extend to the edge it may be necessary for a corresponding means for accommodating expansion or contraction to be provided on the adjoining edge of an adjacent panel to enable a watertight joint to be provided between them.

The means for accommodating expansion or contraction preferably terminates adjacent the extreme edges of the panel. Preferably the point at which the expansion or contraction accommodating means terminates is at least five times closer to the edge of the panel than to the centre of the panel. This ensures that expansion or contraction is accommodated over substantially the whole of the width or length of the panel.

According to the invention there is also provided a roofing panel suitable for use on a flat or gently sloping roof, the panel being of substantially lamellar form, being made of plastics material and having an edge portion which extends substantially in a plane parallel to the plane of the panel body, wherein means for accommodating expansion or contraction of the panel relative to a substrate on which it is placed are provided, said means extending across a major part of the width or length of the panel, being formed as an integral part of the panel and comprising at least one portion which is spaced from the extreme edge of the panel and projects out of the plane of the panel body.

Preferably the edge portion of the panel is flat. This facilitates joining of adjacent panels.

The edge portion may be contiguous and coplanar with the panel body.

The preferred means for accommodating expansion or contraction of the panel relative to a substrate on which it is placed, comprises one or more ridges for accommodating expansion or contraction transverse to the ridge or ridges, but it is possible for other formations to be provided. For example the panel may be provided with a number of discrete raised portions extending in a line across the panel to form what might be described as a discontinuous ridge; the raised portions need not however be aligned with one another and may be distributed in other ways over the area of the panel.

Preferably the panel is of rectangular shape, although other shapes such as hexagons or triangles could be used.

The one or more ridges may be positioned in a variety of ways on the panel. A ridge may be provided along the length of the panel approximately equidistant from the opposite sides thereof and/or a pair of ridges may be provided extending along the length of the panel and positioned along opposite sides of the centre of the panel. Alternatively a ridge may be provided along one or both diagonals of the panel.

In addition or instead of ridges along the length of the panel, a ridge may be provided across the width of the panel approximately equidistant from the ends thereof and/or a pair of ridges extending across the width of the panel and positioned on opposite sides of a transverse

centre line of the panel may be provided.

It may be advantageous to provide one or more ridges adjacent one or more edges of the panel since in that position the ridges can provide not only a means for accommodating expansion or contraction, but also a border to a seam formed between adjacent panels. In a particularly preferred arrangement, one or more ridges are provided adjacent each edge of the panel.

A ridge may simply comprise two walls steeply inclined to the plane of the panel body and joined together by a top wall parallel to the plane of the panel body. The ridge may, however, include three or more walls steeply inclined to the plane of the panel body, such forms of ridges being described below with reference to the accompanying drawings. The greater number of steeply inclined walls that are provided in a ridge the greater its capacity for accommodating expansion or contraction. Also, the closer the inclination of a wall is to the perpendicular and the taller the wall is the greater its capacity for accommodating expansion or contraction.

Preferably the one or more ridges project outside the plane of the panel body to one side only. The panel would normally be laid with that one side as the upper side. In such a case the panel can lie in contact with a supporting substrate over the whole of its surface apart from where the one or more ridges are provided.

The plastics material from which the panel is made is preferably a polyester resin material. Other

suitable rigid or semi-rigid plastics materials could be used. The plastics material preferably incorporates reinforcement which may comprise fibres or strands and may be glass, polyester, nylon, polythene, metal or carbon.

It may be advantageous for the means for accommodating expansion or contraction to be made of a plastics material different from the plastics material from which the panel body is made. For example, the accommodating means may be made of a more flexible material than the rest of the panel body. In such a case the accommodating means would still be an integral part of the panel body.

According to another aspect of the invention there is provided a roof including a plurality of panels, each as defined above, laid on a substrate, wherein the orientation of the panels is varied over the area of the roof such that a straight line coincident with a boundary line between adjacent panels intersects a panel having means for accommodating expansion or contraction along that straight line.

By laying panels in the unconventional arrangement described above it is ensured that even though a single panel may only be able to accommodate expansion or contraction in one direction, along a given line coincident with a boundary line between adjacent panels there is one panel able to accommodate

expansion or contraction along that line.

According to a further aspect of the invention there is provided a roof including a plurality of panels, each as defined above, laid on a substrate, in which the panels are rectangular and are laid with the ends of the panels adjacent the sides of other panels. Again, this unconventional arrangement for laying the panels enables expansion or contraction of the panels in any direction to be accommodated.

In a preferred embodiment of the invention, the length of each panel is twice its width and panels orientated in the same way are laid alongside one another with the ends of the panels spaced apart from each other by the width of each panel and adjoining sides of panels that are orientated perpendicular thereto.

According to a further aspect of the invention there is provided a roof including a plurality of panels laid on a substrate, each panel including means for accommodating expansion or contraction of the panel in a given direction, wherein the orientation of the panels is varied over the area of the roof such that a straight line coincident with a boundary line between adjacent panels is intersected by a panel that includes means for accommodating expansion or contraction in a direction transverse to the straight line.

According to yet another aspect of the invention there is provided a method of laying panels on a substrate

to form a roof in which each panel includes means for accommodating expansion or contraction of the panel in a given direction and the panels are laid with their orientation varying over the area of the roof such that a straight line coincident with a boundary line between adjacent panels is intersected by a panel that includes means for accommodating expansion or contraction in a direction transverse to the straight line.

By way of example certain illustrative embodiments of the invention will now be described with reference to the accompanying drawings, of which:

Fig. 1A is a plan view of a roof panel,

Fig. 1B is a sectional view along the lines I - I in Fig. 1A of the panel,

Figs. 2 to 5, 6A and 6B illustrate schematically alternative forms of panel to that shown in Fig. 1A,

Fig. 7 is a diagrammatic view of a roof structure made up of a plurality of panels of the form shown in Fig. 1A and illustrates a preferred pattern of laying of the panels of Fig. 1A.

Referring first to Figs. 1A and 1B, the panel 1 shown is made in one piece of glass reinforced polyester (GRP), is of rectangular shape and is of generally lamellar form apart from a ridge 2 extending down the longitudinal centre line of the panel along substantially the whole length thereof. As can be seen in Fig. 1B the ridge 2 is formed from two steeply inclined walls 3 which merge into a curved top wall 4. The walls 3 are inclined

at an angle b to the plane of the panel body (in this case b is about 90°) and the top of the ridge 2 is a height a above the plane of the panel body. In the case of the panel shown in Fig. 1 dimension a will be at least 1 cm. The ridge 2 terminates just before the edge of the panel 1 in order that the whole of the border of the panel should lie in a common plane so that it can be laid in contact with a flat substrate around the whole of its periphery.

In this example of the invention the panel 1 has a length which is twice its width and its length is 8 ft (2.44 m).

Fig. 2 shows an alternative form of panel having a pair of ridges 5 extending along the length of the panel and positioned on opposite sides of its longitudinal centre line towards the opposite side edges of the panel, and a pair of ridges 6 extending across the width of the panel and positioned on opposite sides of its transverse centre line towards the opposite ends of the panel. The ridges 5 and 6 terminate adjacent one another. It is advantageous that they do not join as this prevents pools of water forming on the panel.

Fig. 3 shows an alternative form of panel having a single diagonal ridge 7.

Fig. 4 shows an alternative form of panel having a pair of diagonal ridges 7, 8. In this illustrated embodiment the ridges 7, 8 intersect one another but, if

desired, one or both ridges may have a discontinuity at the centre of the panel so that pools of rain water will not form on the panel.

Fig. 5 shows an alternative form of panel having a pair of longitudinal ridges 5 as in Fig. 2 and a single transverse ridge 9 across the centre of the panel between the ridges 5.

Figs. 6A and 6B illustrate a panel broadly similar to the panel 1 of Fig. 1 but with a different form of ridge. In this case the ridge is shown as made up of three separate portions 10, 11 and 12 formed between four steeply inclined wall portions. While in the illustrated embodiment the portions 10 and 12 project to one side of the panel body while the portion 11 projects to the other side, it will be understood that a ridge could also be made up from a number of portions all projecting on one side of the panel body thereby enabling the other side of the panel body to be laid on a flat substrate.

It should be understood that the ridge configurations described above are examples only and other configurations, including other combinations of the illustrated configurations, could be employed.

Fig. 7 shows a preferred pattern in which the panels 1 of Figs. 1A and 1B may be laid. It will be seen that half the panels are laid in one orientation and half in a perpendicular orientation and that adjacent panels

orientated in the same way are arranged with their ends spaced apart from each other by the width of a panel, which is half the length of a panel. All the panels are laid with their ridges 2 uppermost.

It will be understood that in order to form a roof of rectangular configuration a number of half size panels are required around the edges of the roof. Suitable edging pieces will also be required and these may include one or more expansion ridges running at right angles to the roof edge line.

The panels 1 are laid on a continuous flat substrate (not shown), which may be the deck material or an insulation board or other suitable even surface, and are secured at their edges to the substrate or to deck material beneath the substrate by any suitable means which may comprise nails, screws, drill-screws, cavity or plug fastenings, spring or flexible fastenings or adhesives of various types.

If a panel 1 expands or contracts relative to the substrate on which it is laid, for example as a result of a change in temperature, then any such expansion or contraction across the width of the panel is absorbed by deformation of the ridge 2 in the panel. Expansion or contraction along the length of the panel is not however accommodated by the ridge 2 in that panel (in the case of the panel of Figs. 1A and 1B) and has to be accommodated by slight movement in the fastening to the substrate or

in the substrate itself. In practice it is found that the movement required to allow for such expansion and contraction of a single panel is small and can be accommodated but that the combined total expansion or contraction of a row of panels laid end to end requires a much greater movement of the ends of the row of panels which cannot be accommodated. However, by adopting the pattern of laying shown in Fig. 7, a ridge 2 is provided every one and a half panel lengths in both perpendicular directions along the roof and thus the movement required to be accommodated in the fastening of the panel edge to the substrate is kept to a small amount that can be tolerated. Also the length of any one straight join between panels is limited to one and a half panel lengths.

While the pattern of laying shown in Fig. 7 has been described with particular reference to the panels shown in Figs. 1A and 1B, it should be understood that any of the panels shown in Figs. 2 to 5, 6A and 6B may also be laid in this way. Although the panel shown in Fig. 2 for example is provided with both transverse and longitudinal ridges, it may still be advantageous to lay the panels in the pattern shown in Fig. 7.

While the present invention obviates the need for expansion joints in typical cases, it is within the scope of the invention to use the panels of the invention in conjunction with expansion joints. This may be useful if

unusually large movements are to be accommodated, for example where two separate buildings or roofing decks are joined.

Some particular examples of methods of making and laying the panels will now be given in Examples 1 to 5 below.

Example 1

Using a suitable male mould to the pattern required, the mould is covered with liquid polyester resin, for example that sold by Cray Valley Products under the trademark SYNOLAC, suitably catyalyzed, by means of a brush, pouring or spraying or other convenient method. The catalyzed resin is overlaid before it has cured with a reinforcing layer and this sequence is repeated as necessary before or after previous layers are fully cured to build the required thickness of panel. The surface to be exposed directly to the weather will normally be finally coated with a gel-coat or colour coat to give improved surface finish and/or resistance to exposure to weather and light. If in this example a female mould were used to form the panels, the sequence of coatings would be reversed. The panels so formed should then be suitably cured either at room temperature or at an elevated temperature.

Panels will then be laid as shown in Fig. 7 on a substrate edge to edge, either overlapping, edges butting

or with strips of any suitable material under the joints to improve joint smoothness or rigidity. Dependent upon weather conditions mastic may be used to temporarily seal edges (seams) before the final seaming operation.

Next the panel edges are fastened to the substrate by one of the methods described above. Such fastening should be of a type and number sufficient to withstand wind uplift requirements.

The seams are then coated with liquid polyester resin, suitably catalyzed, and then reinforced with suitable fibre. This sequence may be repeated as necessary to achieve a suitable laminate.

Before the lamination is carried out, surfaces to be seamed may be roughened or cleaned with a suitable solvent so as to improve or facilitate good intercoat adhesion.

Finally a layer of clear or colour pigmented polyester gel-coat may be applied to the seams and/or the panels.

Example 2

Using a suitable mould to the pattern required, a liquid compound including the suitably catalyzed polyester resin and chopped glass fibres providing inbuilt reinforcement, is coated on the mould surface. When partially cured or when cured or hardened, further layers of such reinforcement-containing liquid compound

may be further overcoated.

Panels so formed will then be suitably cured and fixed to a roof substrate as described in Example 1.

Example 3

A suitable quantity of mix containing catalyzed polyester resin, reinforcement fibres and a percentage of inert filler in a sheet form, known in the industry as SMC (sheet moulding compound) may be placed in a suitable male/female mould and subjected to high pressure and with heat applied for a suitable time.

Panels so formed will then be suitably fixed to a roof substrate in combination as described in Example 1.

Example 4

A suitable quantity of mix containing catalyzed polyester resin, reinforcement fibres and inert filler, known in the industry as DMC (dough moulding compound) is placed in a suitable male/female mould and subjected to high pressure and with heat applied for a suitable time.

Panels so formed will then be suitably fixed to a roof substrate in combination as described in Example 1.

Example 5

A panel formed as in Examples 1 to 4 is overcoated with a layer of flexible polyisocyanurate resin to provide additional surface protection. Such

coating may be applied by spray, brush or roller. Some examples of alternative overcoatings are rigid polyisocyanurate resins, acrylates and silicone rubbers.

While in the examples described the panel seams are coated with polyester resins and suitable reinforcement, mastic material may be used instead of or in addition to the polyester resin.

Claims:

1. A roofing panel suitable for use on a flat or gently sloping roof, the panel being of substantially lamellar form, being made of plastics material and having an edge portion which extends substantially in a plane parallel to the plane of the panel body, wherein means for accommodating expansion or contraction of the panel relative to a substrate on which it is placed are provided, said means extending across a major part of the panel in two mutually transverse directions, being formed as an integral part of the panel and comprising at least one portion which projects out of the plane of the panel body.

2. A panel as claimed in claim 1 in which the means for accommodating expansion or contraction is spaced from the extreme edge of the panel.

3. A panel as claimed in claim 2 in which the means for accommodating expansion or contraction terminates adjacent the extreme edges of the panel.

4. A panel as claimed in claim 3 in which the point at which the expansion or contraction accommodating means terminates is at least five times closer to the edge of the panel than to the centre of the panel.

5. A roofing panel suitable for use on a flat or gently sloping roof, the panel being of substantially lamellar form, being made of plastics material and having an edge portion which extends substantially in a plane

parallel to the plane of the panel body, wherein means for accommodating expansion or contraction of the panel relative to a substrate on which it is placed are provided, said means extending across a major part of the width or length of the panel, being formed as an integral part of the panel and comprising at least one portion which is spaced from the extreme edge of the panel and projects out of the plane of the panel body.

6. A panel as claimed in any preceding claim in which the edge portion is flat.

7. A panel as claimed in any preceding claim in which the edge portion is contiguous and coplanar with the panel body.

8. A panel as claimed in any preceding claim in which the means for accommodating expansion or contraction of the panel comprises one or more ridges for accommodating expansion or contraction transverse to the ridge or ridges.

9. A panel as claimed in claim 8 in which the panel is of rectangular shape.

10. A panel as claimed in claim 9 in which a pair of ridges extending along the length of the panel and positioned on opposite sides of a longitudinal centre line of the panel are provided.

11. A panel as claimed in claim 9 to 10 in which a pair of ridges extending across the width of the panel and positioned on opposite sides of a transverse centre

line of the panel are provided.

12. A panel as claimed in any of claim 8 to 11 in which a ridge includes two walls steeply inclined to the plane of the panel body.

13. A panel as claimed in any of claims 8 to 12 in which the one or more ridges project outside the plane of the panel body to one side only.

14. A roof including a plurality of panels laid on a substrate, each as claimed in any preceding claim, wherein the orientation of the panels is varied over the area of the roof such that a straight line coincident with a boundary line between adjacent panels intersects a panel having means for accommodating expansion or contraction along that straight line.

15. A roof including a plurality of panels laid on a substrate, each as claimed in any of claims 1 to 13, in which the panels are rectangular and are laid with the ends of panels adjacent the sides of other panels.

16. A roof including a plurality of panels laid on a substrate, each panel including means for accommodating expansion or contraction of the panel in a given direction, wherein the orientation of the panels is varied over the area of the roof such that a straight line coincident with a boundary line between adjacent panels is intersected by a panel that includes means for accommodating expansion or contraction in a direction transverse to the straight line.

17. A method of laying panels on a substrate to form a roof in which each panel includes means for accommodating expansion or contraction of the panel in a given direction and the panels are laid with their orientation varying over the area of the roof such that a straight line coincident with a boundary line between adjacent panels is intersected by a panel that includes means for accommodating expansion or contraction in a direction transverse to the straight line.

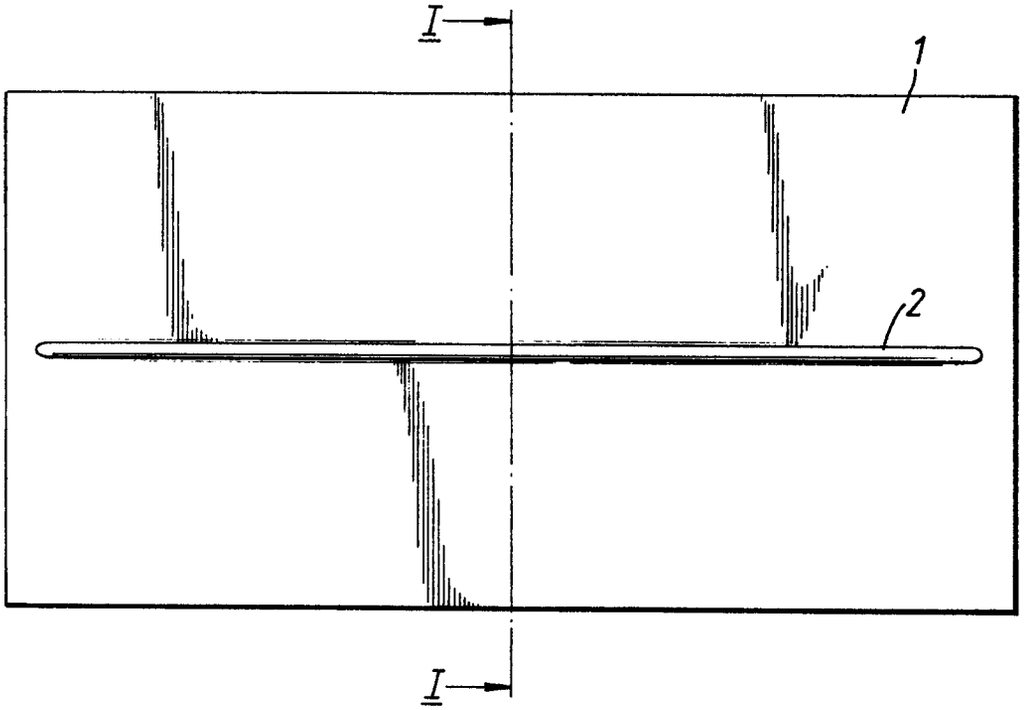


FIG. 1a.

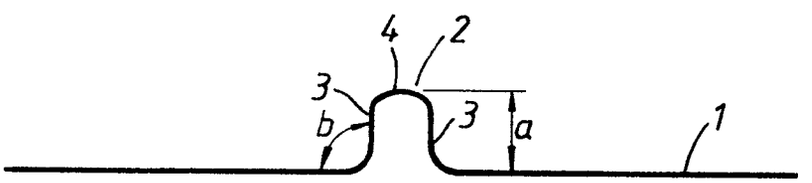


FIG. 1b.

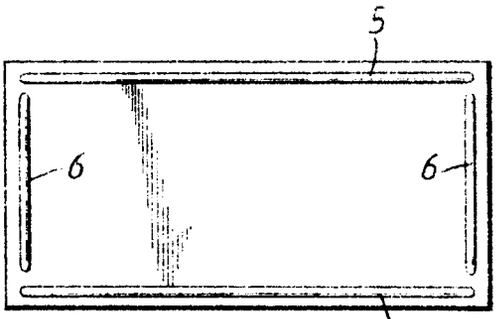


FIG. 2.

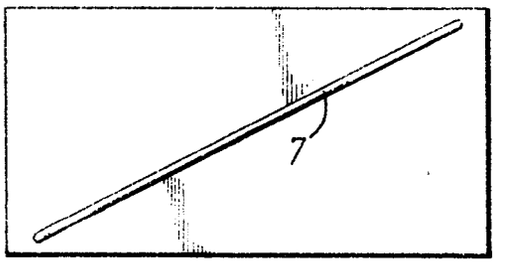


FIG. 3.

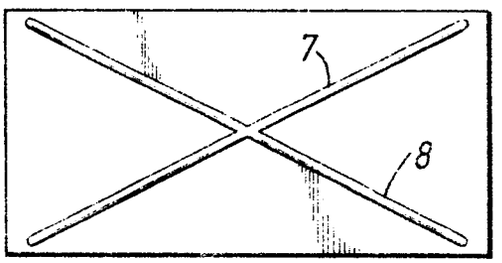


FIG. 4.

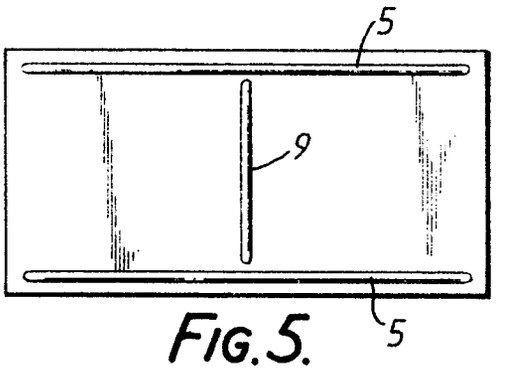


FIG. 5.

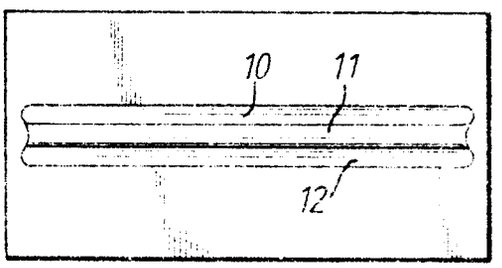


FIG. 6b.

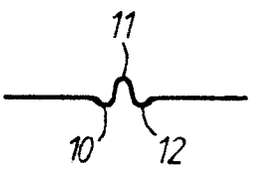


FIG. 6a.

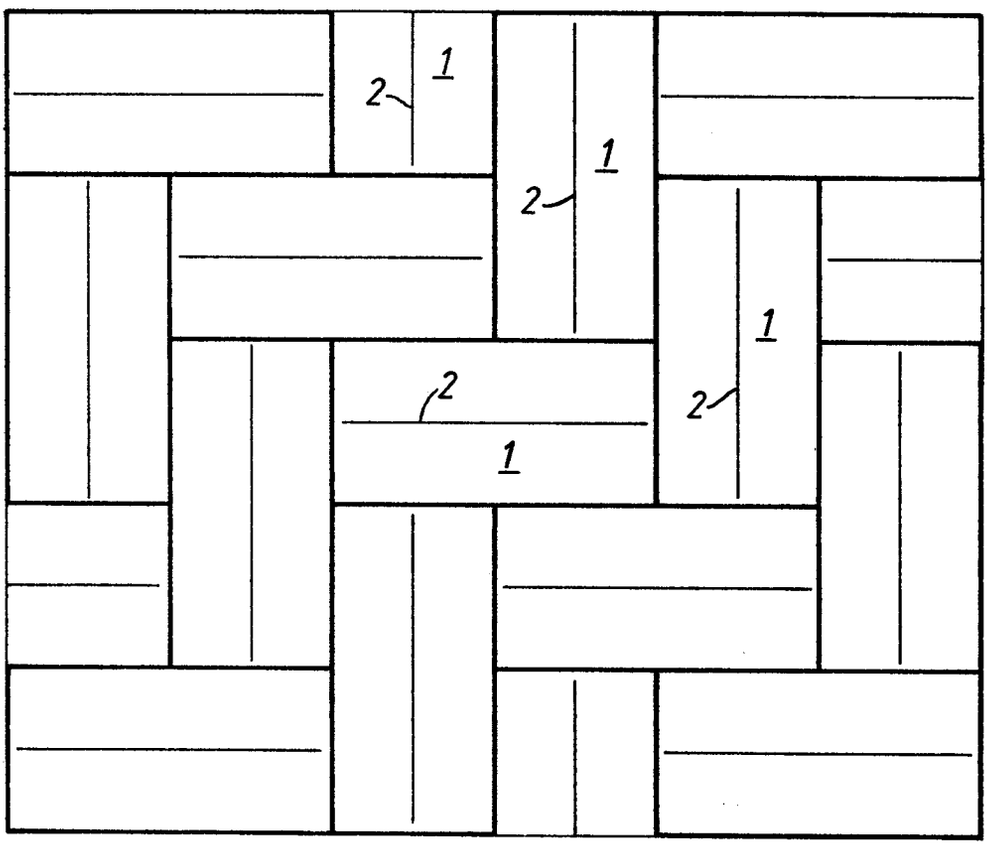


FIG. 7.