OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) **Demande-Application**

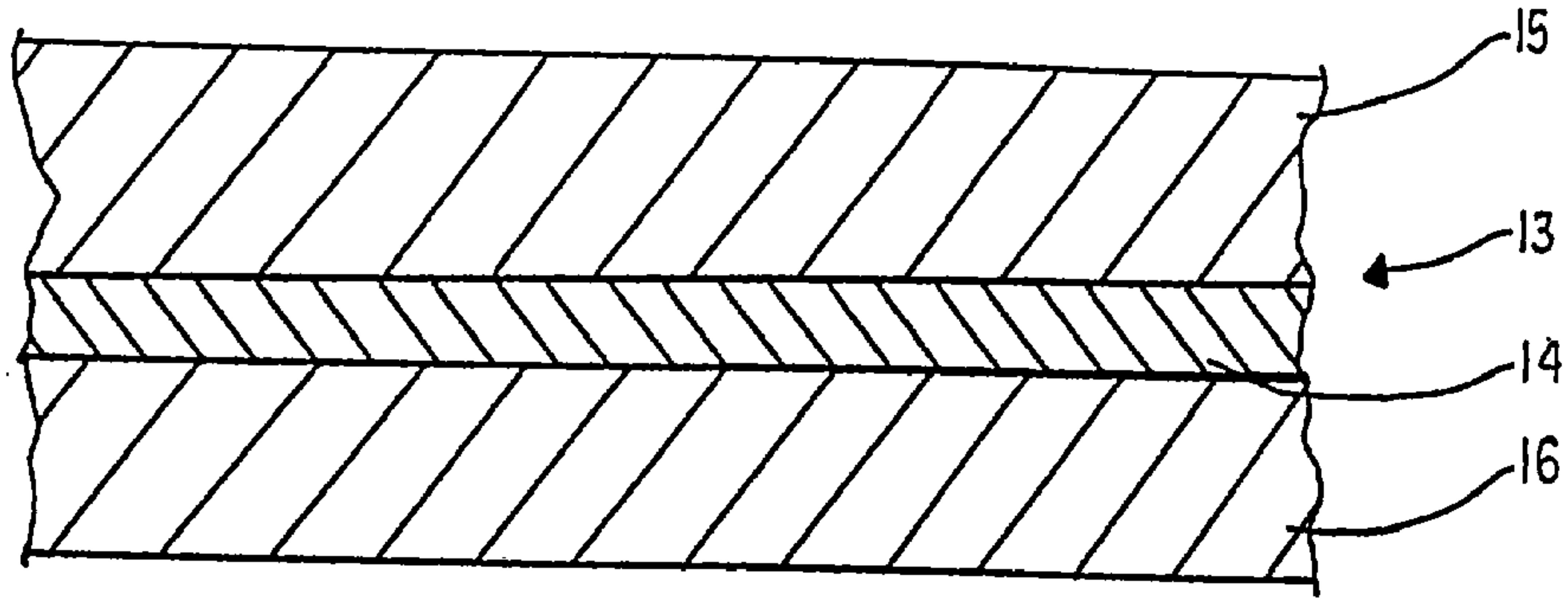
(21) (A1) **2,280,255**
(22) 1999/08/11
(43) 2000/02/24

(72) GRÖNE, HORST-DITMAR, DE
(72) HEAP, ANTHONY J. D., DE
(71) LINPAC INC., US

(51) Int.Cl.[6] B32B 5/18, B32B 27/32
(30) 1998/08/24 (09/138,801) US

(54) **ISOLANT COMPOSITE / SOUS-COUCHE ET METHODE SERVANT A SA FORMATION**

(54) **COMPOSITE INSULATION/UNDERLAYMENT SHEET AND METHOD OF FORMING THE SAME**



(57) A composite insulation and/or underlayment sheet is provided by continuously extruding a pair of cover laminae comprising a styrenic polymer, and simultaneously extruding between the freshly extruded cover laminae an inner lamina of a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene, formed with or without discontinuities, the cover laminae being bonded immediately to the inner lamina.

METHOD OF MANUFACTURING COMPOSITE SHEET MATERIALS

ABSTRACT OF THE DISCLOSURE

A composite insulation and/or underlayment sheet is provided by continuously extruding a pair of cover laminae comprising a styrenic polymer, and simultaneously extruding between the freshly extruded cover laminae an inner lamina of a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene, formed with or without discontinuities, the cover laminae being bonded immediately to the inner lamina.

G0011397

COMPOSITE INSULATION/UNDERLAYMENT SHEET AND METHOD OF FORMING THE SAME

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to composite insulation and/or underlayment sheet, and more particularly, to a laminated sheet having a pair of outer layers or cover laminae of foamed plastic, such as styrenic polymer foam, enclosing an inner layer or lamina of a relatively tough and flexible material such as high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers or the like. The invention also relates to a method of manufacturing such sheets.

Related Art

Laminated, relatively rigid foam panels are widely used in building construction for thermal and sound insulation and as non-loadbearing structural members because of their smooth surfaces and wind-barrier properties. They are customarily provided in a sheet of substantial length relative to its width. The sheet is scored transversely of its long dimension at equal intervals to define the panels. The sheet is then fan-folded about the scorelines to provide a stack one panel wide for shipping and for transportation to the construction site.

Foamed plastic is notoriously brittle, and therefore measures must be taken to prevent the sheet from fracturing and separating at the scorelines when folded, and from shattering, crumbling, and breaking up at the construction site during handling and when nailed or stapled in place.

Sheet insulation and/or underlayment known in the prior art is shown in FIG. 1. The known sheet 10 comprises a substrate or first lamina 11 of virgin or recycled styrenic polymer foam. A thinner coating or second lamina 12 is permanently adhered or bonded to one side of the first lamina 11 throughout its full extent. The second lamina 12 comprises a material which is much tougher and much more flexible than styrenic polymer foam—high-impact polystyrene or acid copolymers of polyethylene, for example—whereby to maintain the integrity of the sheet during folding, handling, and nailing or stapling.

Sheets of styrenic polymer foam structure are conventionally formed by extrusion, as by continuously extruding a cylinder or tube of styrenic polymer, expanding the tube under internal gas pressure, and slitting the expanded tube or "balloon" at one side and rolling it out to form a sheet of single thickness, or slitting it at opposite sides to form a pair of sheets. It is also known to form a laminate of styrenic polymer foam structure by simply introducing the extruded tube between a pair of rolls to press it flat, and then continuously trimming the lateral edges from the flattened tube. Just such a technique is disclosed in German Patent Specification No. 2,946,867, published October 27, 1983 in the names of T. Komori et al.

Though plastics, and in particular foamed plastics, are employed in great quantities for insulating purposes, efforts are being made increasingly to reuse these materials; that is, to recycle them, in view of environmental concerns. Plastics are particularly well suited for reuse in general.

With these considerations as a starting point, the invention addresses the problem of providing sheet insulation and/or underlayment that will meet or exceed thermal and strength requirements, afford improved ease of handling and, where desired, the use of recycled materials, and that may be manufactured by a simple, effective, and economical method.

SUMMARY OF THE INVENTION

The invention provides a composite insulation and/or underlayment sheet comprising a pair of cover laminae formed of styrenic polymer foam enclosing a relatively tough and flexible inner lamina of a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene. Such a sheet is brittle and easily fractured at the cover laminae, but the tough and flexible inner lamina acts to maintain the integrity of the sheet in a construction analogous to the familiar shatter-resistant laminated window glass commonly employed in automotive vehicles.

The invention also provides a method of forming a composite insulation and/or underlayment sheet by extruding a pair of cover laminae from styrenic polymer to form a styrenic polymer foam structure, simultaneously extruding a relatively tough and flexible inner lamina of a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene, promptly drawing and enclosing the inner lamina between the freshly extruded cover laminae, and immediately bonding the cover laminae to the inner lamina. To form a good bond, the cover laminae are kept as close to the melting point as possible by preferably bringing them together with the inner lamina as soon as possible after they are formed, or alternatively, by heating them before they meet with the inner lamina. The preferred technique for doing so is to control the distance from the extruder dies at which the lamination occurs.

More particularly, the method is carried out by continuously extruding a tube of styrenic polymer to form a stryrenic polymer foam structure, and slitting the tube at opposite sides thereof to provide the freshly extruded cover laminae. The laminae thus have outer surfaces and confronting inner surfaces in spaced relationship to each other, and the inner lamina is introduced between the confronting surfaces and conducted by them in the direction of travel of the cover laminae. The inner lamina is promptly engaged between the freshly extruded cover laminae, and the confronting surfaces are immediately bonded about and to the inner lamina. Either recycled or virgin styrenic polymer foam may be employed.

Other objects, features and advantages of the invention will be apparent from the ensuing description in conjunction with the accompanying drawings.

THE DRAWINGS

In the drawings:

FIG. 1 is an enlarged partial cross-sectional view of sheet insulation and/or underlayment known in the prior art;

FIG. 2 is an enlarged partial cross-sectional view of insulation and/or underlayment sheet formed according to the invention; and

FIG. 3 is a schematic representation of a manufacturing method according to the invention, which is adapted to form the insulation and/or underlayment sheet of FIG. 2.

DETAILED DESCRIPTION

FIG. 2 shows laminated insulation and/or underlayment sheet formed according to the invention and suitable for use in the construction or rehabilitation of buildings. The outer or cover laminae of the sheet comprise foamed plastic, specifically styrenic polymer foam, adjacent to an inner lamina of supporting material, the thickness of which is greatly exaggerated in FIG. 2 for illustrative purposes.

Ideally, the supporting material should be tough, strong, and flexible, while adhering well to the styrenic polymer foam forming the cover laminae, and it should offer low resistance to the passage of moisture, much in the manner of the styrenic polymer foam. A preferred material, then, is high-impact polystyrene, which is tough and flexible at room temperatures. It has a melting point in the range of about 70° to 105°C. Further, high-impact polystyrene is preferred because it is a good electrical insulator. Other suitable materials include butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene.

More particularly, a three-layer insulation and/or underlayment material 13 is shown in FIG. 2 and includes a thin inner lamina 14 between two thicker cover laminae 15 and 16 to form the laminate. The cover laminae 15, 16 are formed of foamed plastic, virgin or recycled, while the inner lamina 14, which provides a bonding and supporting layer, preferably comprises high-impact polystyrene, but it may comprise any of the other supporting materials identified above. If laminae 15, 16 are formed of recycled styrenic polymer foam or a mixture of virgin and recycled styrenic polymer foam, resources may be conserved and the overall cost of production reduced.

The inner lamina 14, being clad on both sides by the cover laminae 15 and 16, the insulation and/or underlayment sheet 13 is more tear-resistant making it more durable and easier to use. For example, either side of the sheet may be placed in contact with a concrete wall or a stud wall. As shown in FIG. 2, the cover laminae 15 and 16 of the insulation and/or underlayment sheet 13 are approximately of equal thickness and are bonded to the inner lamina 14 across the full width thereof. Each cover lamina 15, 16 is approximately 100 to 250 mils thick, while the inner lamina 14 is preferably 0.5 mil to 3.0 mils thick, and most preferably approximately 1.0 mil thick. Of course, these thicknesses may be increased or reduced as required for a particular application. Further, it is not essential that any two or more of the laminae be of equal thickness.

FIG. 3 shows one method of manufacture of the insulation and/or underlayment sheet 13 of FIG. 2. The two cover laminae 15 and 16 are formed continuously and simultaneously by extrusion. More particularly a film balloon 23 is created from an extruder by way of an extruder die 22, the balloon being conducted to a cooling mandrel 24 and then slit on opposite sides to be separated into two halves. Each of these halves, initially still rounded or domed in the balloon configuration, is rolled out or flattened in order to form the two flat cover laminae 15 and 16. The method thus far is conventional.

The inner lamina 14, in the form of extruded viscoelastic melt, is continuously introduced from an extruder by way of an extruder die 25 directly between the cover laminae 15 and 16 formed from the balloon, which adhere to it and draw it with them in their common direction of travel. The inner lamina is fed from the extruder die at a rate that will cause it to be drawn down to the desired thickness between the cover laminae.

The bonding of the cover laminae 15 and 16 with the inner lamina 14 is carried out across the full widths of the three laminae. As stated above, the cover laminae are kept as close to the melting point as possible by preferably bringing them together with the inner lamina as soon as possible after they are formed, or alternatively, by heating them before they meet with the inner lamina. The inner lamina 14 exits the extruder die 25 in the form of a hot melt at a temperature in the range of approximately 180° to 230°C. It is immediately engaged by the confronting surfaces of the cover laminae and is drawn with them. As this occurs, the hot melt releases heat to the cover laminae, causing them to melt at the adjacent surfaces since they have already been close to their melt temperature. At the same time, this transfer of heat from the inner lamina to the cover laminae causes it to cool and eventually to achieve its solid state, bonding securely to the melted surfaces of the cover laminae as they too cool and revert to their solid state. On the other hand, if the cover laminae become overheated, they will blister.

Thus, it will be seen that the locations of the two extruder dies22 and 25 relative to each other and the distance between them are of critical importance and should be adjusted as necessary to provide a secure bond without blistering of the cover laminae.

A suitable gap 27 is formed between a pair of joining rolls 26, which complete the lamination and assist in determining the thickness of the finished sheet.

While the foregoing method is preferred, other methods of forming the insulation and/or underlayment sheet of the invention may be substituted. For example, the sheet has also been formed successfully by coextrusion of the laminae.

If in the preferred method the residual heat from the extrusion process is inadequate to provide acceptable bonding between the cover laminae 15 and 16 and the inner lamina 14, the confronting surfaces of the cover laminae adjoining the inner lamina may be heated before lamination. Such heating may be provided by heat radiators (not shown); i.e., radiant heat; by heating chucks (not shown) in contact with the confronting surfaces of the cover laminae 15 and 16; i.e., conductive heat; or preferably, by forced convection; i.e., convective heat. In any case, the heating is carried out across the full width of the lamina so treated.

Referring to FIG. 3, in the preferred form of such heating, just before the cover laminae 15 and 16 are brought together with the inner lamina 14, the confronting surfaces to be bonded to the inner lamina are exposed to heat from two opposed banks of heaters 35, 35*a*. These heaters are preferably of a type which continuously discharge heated gases directly upon the surfaces to be heated, the source of heat being electrical heating elements or gas-combustion (neither shown), as preferred. Moreover, heater controls are preferably provided and situated conveniently for manual adjustment by an operator to regulate the temperature of the heated surfaces. For simplicity, only one such control 36 is represented in FIG. 6, though in actuality each bank of heaters 35, 35*a* is provided with individual controls.

Here again, bonding is carried out across the full widths of adjacent laminae. It is also important to point out that if heat is so applied it should in every case be carried out across the full width of each lamina so treated.

The inner lamina 14 may be formed in known manner with discontinuities such as perforations or apertures of various sizes, thereby effecting a saving of resources and establishing or enhancing moisture transmission characteristics in the sheet. This may be carried out on the finished sheet 13 by perforating one or both of the cover laminae 15 and 16 and the inner lamina 14. Alternatively, apertures may be formed in the inner lamina at the extruder die in controlled fashion, much in the manner in which extruded plastic webbing is manufactured for example. In either case, moisture transmission may be varied by varying the size and density of the perforations or apertures.

While the invention has been specifically described in connection with certain specific embodiments thereof, it is to be understood that this is by way of illustration and not of limitation, and the scope of the appended claims should be construed as broadly as the prior art will permit.

CLAIMS

What is claimed is:

1. A composite insulation and/or underlayment sheet having a pair of cover laminae, each of the cover laminae comprising a styrenic polymer foam structure, an inner lamina enclosed between the cover laminae, the inner lamina comprising a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene.

2. A composite insulation and/or underlayment sheet according to claim 1, wherein the cover laminae are bonded to the inner lamina.

3. A composite insulation and/or underlayment sheet according to claim 1, wherein the inner lamina is formed with discontinuities therein.

4. A composite insulation and/or underlayment sheet according to claim 1, wherein the material of the inner lamina comprises high-impact polystyrene.

5. A composite insulation and/or underlayment sheet according to claim 1, wherein the material of the inner lamina comprises butadiene polystyrene.

6. A composite insulation and/or underlayment sheet according to claim 1, wherein the material of the inner lamina comprises a metallocene-catalyzed polymer.

7. A composite insulation sheet according to claim 1, wherein the material of the inner lamina comprises an acid copolymer of ethylene.

8. A method of making a composite insulation and/or underlayment sheet, comprising the steps of extruding a pair of cover laminae from styrenic polymer to form a styrenic polymer foam structure, extruding an inner

lamina formed of a material selected from the group consisting of high-impact polystyrene, butadiene styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene, and promptly enclosing the inner lamina between the freshly extruded cover laminae.

9. A method according to claim 8, including the step of bonding the cover laminae to the inner lamina immediately as the inner lamina is enclosed between the cover laminae.

10. A method according to claim 8, including the steps of applying heat to the freshly extruded cover laminae immediately before enclosing the inner lamina between the cover laminae so heated, and bonding the cover laminae to the inner lamina immediately as the inner lamina is enclosed between the cover laminae.

11. A method according to claim 10, wherein the step of applying heat is carried out across the full widths of the cover laminae.

12. A method according to claim 8, including the step of forming discontinuities in the inner lamina material.

13. A method according to claim 12, wherein the step of forming discontinuities in the inner lamina is carried out by perforating at least one of the cover lamina and the inner lamina.

14. A method according to claim 12, wherein the step of forming discontinuities in the inner lamina is carried out during the step of extruding the inner lamina.

15. A method of making a composite insulation and/or underlayment sheet, comprising the steps of continuously extruding a styrenic polymer in a tube from a first extruder die to form a styrenic polymer foam structure, slitting the first tube at opposite sides thereof to form a spaced pair of cover laminae having confronting surfaces, continuously extruding from a second extruder die a material selected from the group consisting of high-impact polystyrene, butadiene

styrene, metallocene-catalyzed polymers, and acid copolymers of ethylene to form an inner lamina, introducing the inner lamina between the confronting surfaces of the spaced cover laminae, promptly engaging the freshly extruded lamina between the confronting surfaces laminae to conduct the inner lamina in the direction of travel of the cover laminae, and immediately bonding the inner lamina to the confronting surfaces of the cover laminae.

16. A method according to claim 15, including the step of applying heat to at least one of the confronting surfaces immediately before engaging the inner lamina between the confronting surfaces of the cover laminae.

17. A method according to claim 15, including the step of applying heat to both of the confronting surfaces immediately before engaging the inner lamina between the confronting surfaces of the cover laminae.

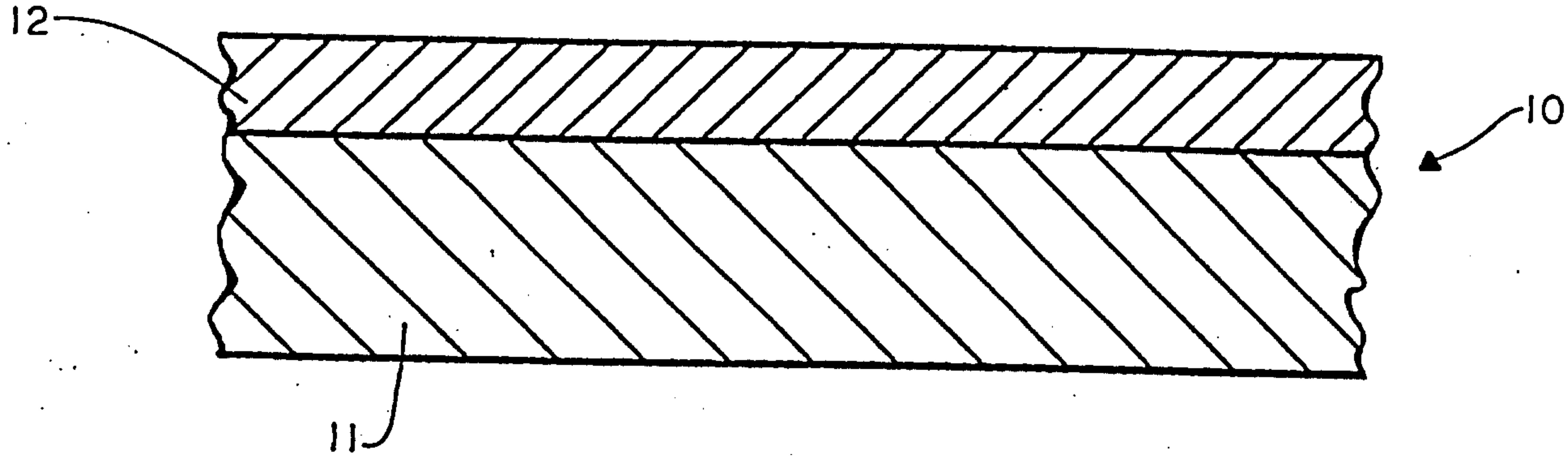


FIG. 1 (PRIOR ART)

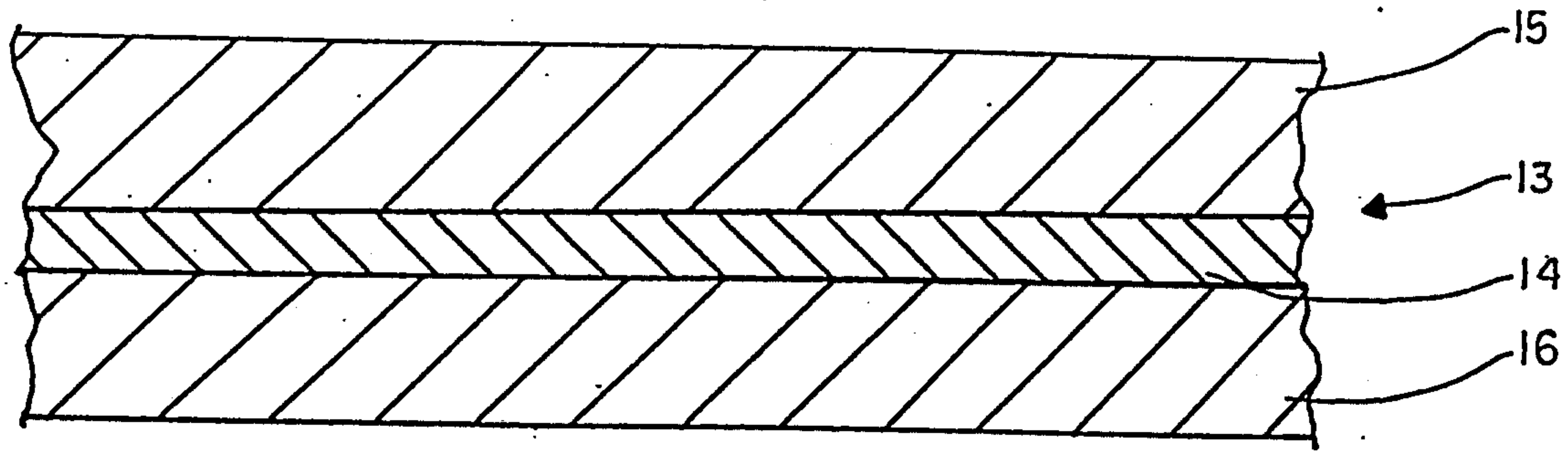


FIG. 2

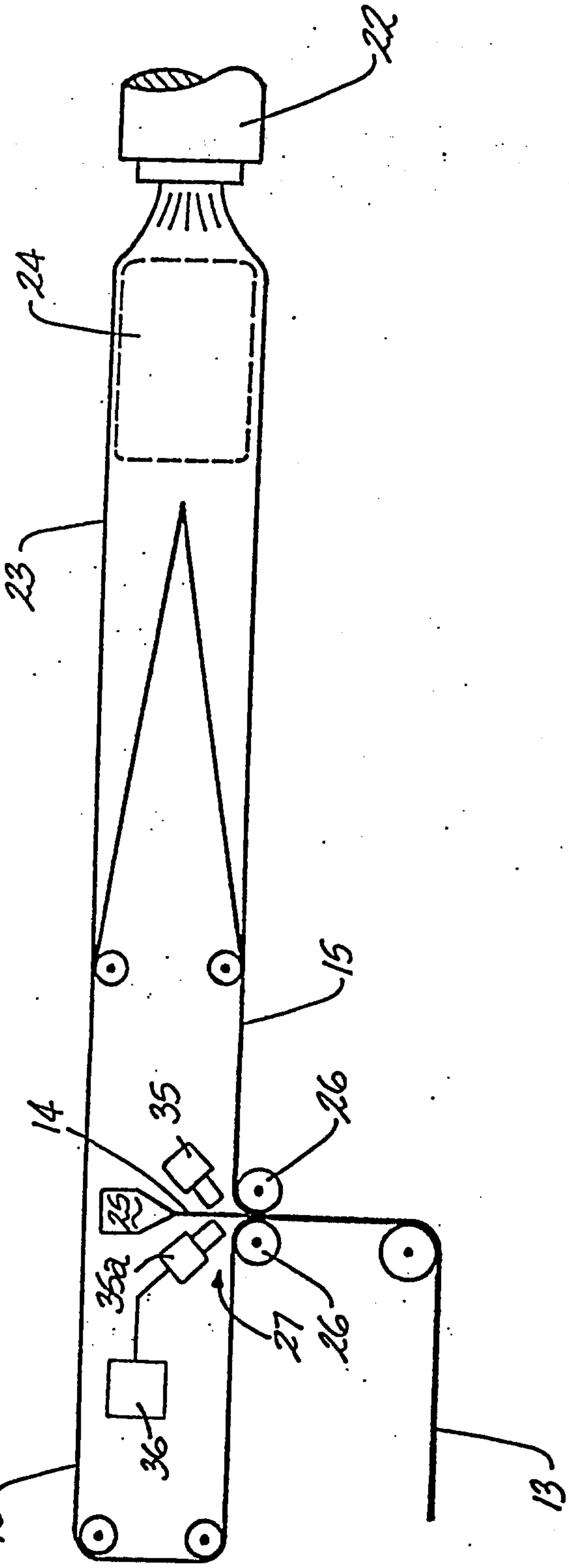


FIG. 3