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# (54) Laminating Process and Apparatus

(57) A process for forming a panel from two or more thermoplastics sheets comprising the steps of separately feeding the sheet simultaneously through a controlled temperature furnace so as to cause expansion thereof, heating at least opposed surfaces of adjacent sheets to be further heated to their melting temperature and then causing said sheets to converge together until they abut one another whereupon the opposed surfaces which have been further heated fuse or weld together, the panel thus formed then being calibrated and cooled.

The invention also relates to an apparatus comprising various means for carrying out such a process and to a panel thus produced.

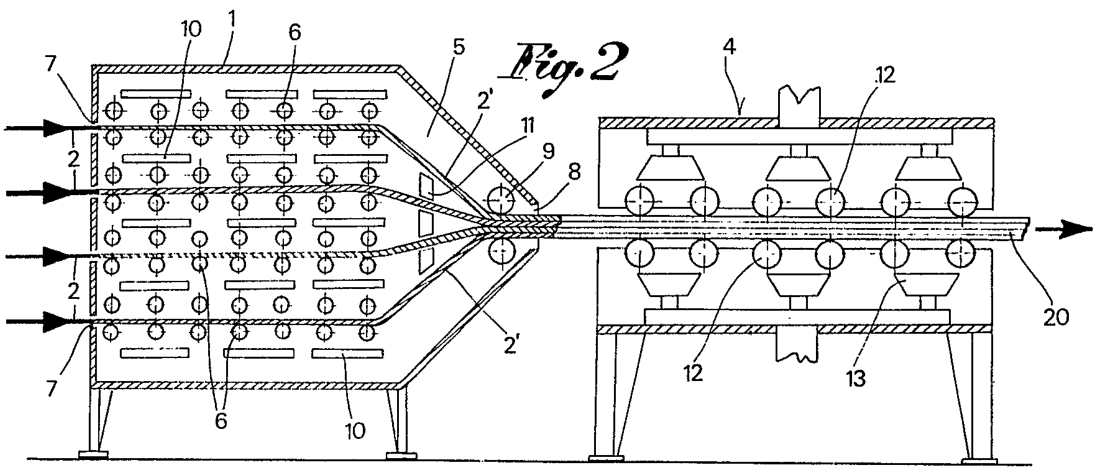


Fig. 2

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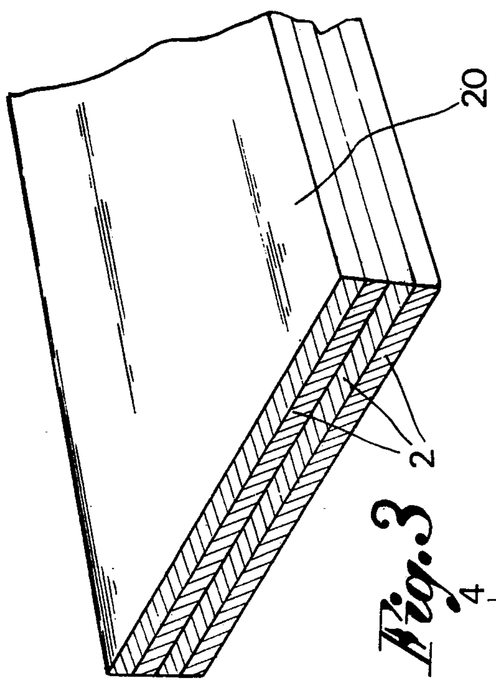


Fig. 3

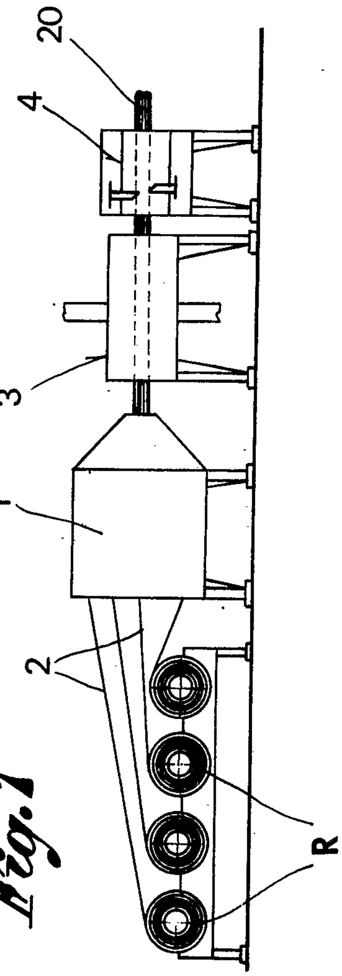


Fig. 1

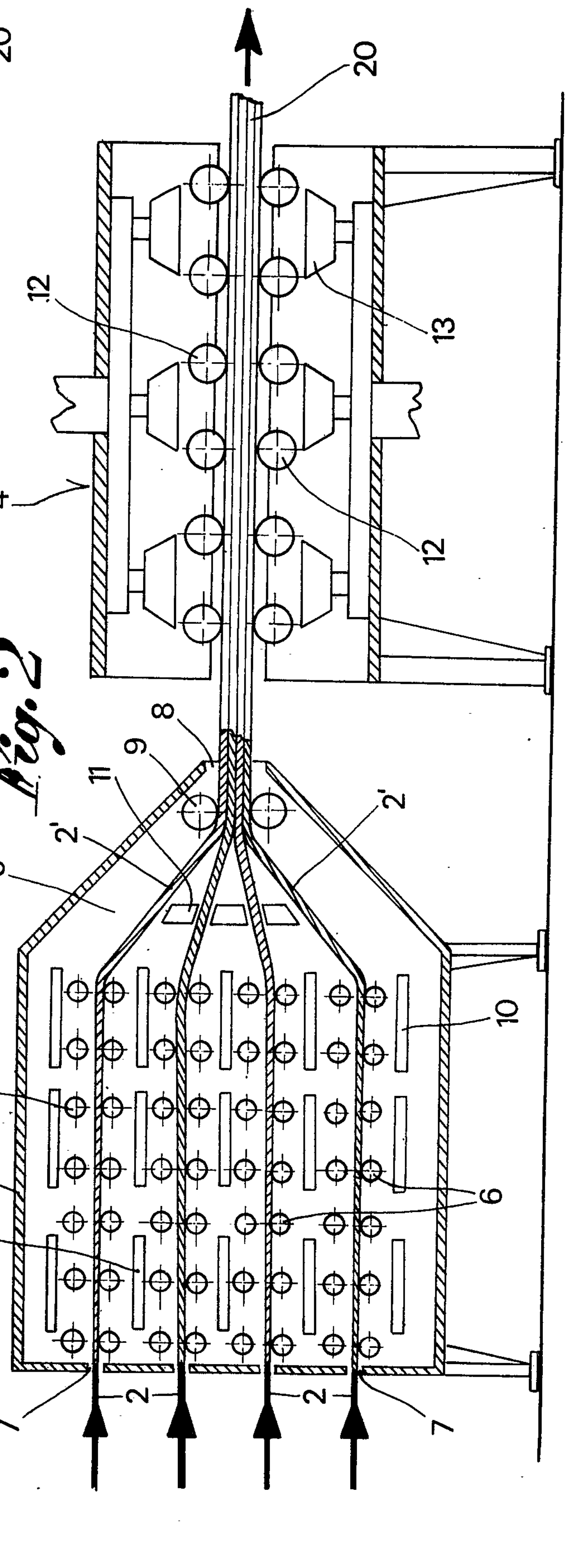


Fig. 2

SPECIFICATION

## A Process and Apparatus for Connecting Sheets of Expanded Thermoplastic, Resin and a Composite Panel Produced Thereby

The present invention relates to a process for connecting a plurality of sheets of expanded thermoplastic resin together to form a multi-layer panel, to an apparatus suitable for carrying out the method and to composite panel thus produced.

In the field of treating thermoplastic resins, the obtention of single-layer sheets or panels having a pre-determined thickness is well known, the process depending on the intended use of the finished product. However, the most common process used hitherto can only be used to obtain products having a relatively high density. In practice, therefore, such a method has to be carried out at relatively high temperatures which necessitates that the extruded expanded panels must be subjected to long periods of calibration and cooling before they can be used. Panels produced in this manner also require adequate seasoning at a monitored temperature, which, in view of the voluminous nature of the material, necessitates the use of large chambers. This has a seriously disadvantageous affect both on plant operating and production costs.

The present invention therefore seeks to provide a process and an apparatus which permit the production of panels of expanded thermoplastic material from sheets or strips, which strips have previously been extruded and seasoned.

According to the present invention there is provided a process for connecting two or more pre-formed, seasoned sheets of expanded thermoplastic resin having a pre-determined density comprising the steps of separately conveying each sheet at a monitored speed, through a furnace, the interior of which is maintained at a monitored temperature so as to cause expansion of said sheets to pre-determined thickness, heating at least opposed surfaces of adjacent sheets in a region adjacent the outlet of said furnace, causing said sheets to converge together until they are superposed in abutment with one another, such abutment causing fusion or welding together of said opposed adjacent heated surfaces, removing the thus connected sheets from the furnace through a single outlet and conveying them to and through a calibrating and cooling station. The sheets may be made of fibrous material, the fibres of which may be disposed randomly or parallel to one another.

Also according to the present invention, there is provided a panel of extruded expanded thermoplastic resin when produced by such a process, said panel having a thickness equal to the sum of the thicknesses of the sheets from which it is produced after expansion of said sheets and a density less than the composite density of the sheets prior to treatment in the furnace but equal to the composite density of such sheets after expansion.

Still further according to the present invention there is provided an apparatus for connecting two or more sheets of pre-formed seasoned thermoplastic resin comprising a heating furnace defining a heating chamber, said furnace having a plurality of inlet passages, one for each sheet and, in an opposite wall of said furnace, a single outlet passage for the connected sheets, means for continuous supporting and conveying each sheet individually through said furnace, first heat generating means for maintaining a monitored temperature within said chamber so as to cause the sheets to undergo expansion until the sheet acquires pre-determined density, guide means for causing said sheets to converge towards and approach one another, second heating means for further heating at least the opposed surfaces of adjacent sheets to the melting temperature of the thermoplastic material, means for causing said further heated portions of adjacent sheets to abut one another whereby fusion or welding together of the sheets occurs and means for calibrating and cooling the thus connected sheets.

This makes it possible to obtain, at relatively low temperatures, multi-layer panels having a density less than that of the individual sheets or strips utilised as the starting materials, and which is less than that which may be achieved if a panel is formed as a single layer of equivalent thickness. Such process also eliminates the necessity of seasoning the panels thus produced which reduces production cost and speedsup production.

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

Fig. 1 shows a schematic side view of an apparatus in accordance with the present invention,

Fig. 2 shows part of the apparatus in cross-section and

Fig. 3 shows a cross-section through the resulting composite panel.

In the drawings there is shown a furnace utilised for simultaneously heating two or more sheets 2 of expanded thermoplastic material to be connected together, a calibrating and cooling station 3 for the sheets when connected together and a station 4 utilised for subsequent printing and cutting of the product into panels.

The furnace 1 comprises a chamber 5 in which support and conveying means for each sheet are mounted, the conveying means allowing each individual sheet 2 to be continuously moved through the furnace. These conveying means may be in the form, as shown, of rollers 6 defining paths for the sheets. Alternatively, the conveying means may be by endless belts or chains or, indeed, any other suitable devices capable of individually and separately transporting the sheets 2.

The support and conveying means 6 are aligned with corresponding inlet passages 7 in one wall of the furnace 1. The sheets 2 are extruded and seasoned and are then wound on rolls R. The sheets are drawn from the rolls R and enter the furnace 1 through the passages 7. As shown, these passages 7 are formed in one of the end walls of the furnace 1.

It should, however, be noted that the sheets of expanded material may be fed either horizontally or vertically without adversely affecting the treatment thereof. The guide means 6 for the sheets are therefore mounted accordingly.

In either case, in the wall of the furnace opposite that having the inlet passages 7 formed therein, a single outlet passage 8 for all the sheets 2 is provided. Within the furnace 1, adjacent the outlet passage 8, at least one pair of adjustable guide rollers 9 are mounted for causing the sheets 2 to converge and approach one another so as to become closely superposed.

For heating the sheets of extruded, expanded material 2, as they pass through the furnace 1, heating means 10, such as electrical resistance heating panels are disposed between the support and conveying means 6 for the sheets 2, which heating panels maintain the furnace chamber at a preselected temperature so as to produce a predetermined expansion of each individual sheet. It will be readily appreciated that expansion of the sheet causes a reduction in its density.

Furthermore, in the region adjacent the outlet 8 of the furnace 1 where the sheets 2' are converging towards the pair of guide rollers 9, further heating elements 11 are provided for heating the opposing surface regions of adjacent sheets to their melting temperature. Such melting permits the adjacent sheets to adhere or fuse together as they pass between the rollers 9. This is true irrespective of whether the surfaces of the sheets are smooth or whether they have been subjected to a prior mechanical pre-treatment.

Thus, during their passage through the furnace 1, the sheets 2 may be treated at any suitable desired temperature for a pre-selected length of time. During such treatment they undergo an expansion additional to that at the beginning, thus making it possible to reduce the density of the sheet to a desired value. After the additional expansion, the surfaces to be adhered together are subjected to the action of the heating elements 11 so that at least their surface regions are heated to their melting temperature. Accordingly, when they pass between the guide rollers 9, the sheets are welded together forming a single panel 20 having a number of layers corresponding to the number of sheets utilised the thickness of the panel being equal to the sum of the thicknesses of the sheets employed and a density which is dependent upon the densities of the sheets employed.

Depending upon the nature of the thermoplastic material from which the sheets are formed, the temperature within the furnace may vary from 100°C to 200°C, and the speed at which the sheets are conveyed through the furnace may be from 4 to 15 meters. By using these parameters, it is possible to achieve a reduction in density from 60 to 70 gr/l in the starting sheets to 22 gr/l in the finished product.

In other words, the process and apparatus of the present invention permits the volume of the starting sheet to be substantially increased without causing any major technical difficulties.

The multi-layer panel thus produced is then conducted to and through a calibrating and cooling station 3 in which the physical characteristics of the finished product are fixed. This station 3 comprises, as shown in Fig. 2, two sets of adjustable rollers 12 which face one another, so as to define therebetween a guide path along which the panel 20 must pass. During its passage between the rollers, the sheet is cooled by, for example, air issuing through openings 13 disposed above and below the rollers 12 and by water.

After cooling, the product is ready to be subjected to subsequent printing and cutting to size. This is effected in the treatment station 4.

Using the above described process it is possible to form panels from any extruded, expanded thermoplastic material the sheets which make up the panel optionally including additives such as fire-retardant materials and colouring matter. If the sheets are made of fibrous material, the fibres may be orientated or randomly distributed.

During the process, it is also possible to apply to one or both outer surfaces of the finished products, plastic laminates or ordinary or bituminous paper in order to obtain a final product of the desired structure and having the desired characteristics.

Finally, in a simple and economic manner, a multi-layer product is obtained which has the density, thermal insulation, mechanical strength, low moisture-absorbence, high resistance to diffusion of water vapour therethrough and dimensional stability equivalent to similar products obtained directly by extrusion as a single layer structure.

**Claims**

1. A process for connecting two or more preformed, seasoned sheets of expanded thermoplastic resin having a predetermined density comprising the steps of separately conveying each sheet at a monitored speed, through a furnace, the interior of which is maintained at a monitored temperature so as to cause expansion of said sheets to a predetermined thickness, heating at least opposed surfaces of adjacent sheets in a region adjacent the outlet of said furnace, causing said sheets to converge together until they are superposed in abutment with one another, such abutment causing fusion or welding together of said opposed adjacent heated surfaces, removing the thus connected sheets from the furnace through a single outlet and conveying them to and through a calibrating and cooling station.

2. A process as claimed in claim 1, wherein the connected sheets are printed and cut after

passing through the calibrating and cooling station.

3. A process as claimed in claim 1 or 2, wherein the thermoplastic material is fibrous, said fibres being arranged in parallel.

4. A process as claimed in claim 1 or 2, wherein the thermoplastic material is fibrous, said fibres being randomly arranged.

5. A process as claimed in any preceding claim, wherein during passage of said thermoplastic sheets through said furnace sheets of plastic material, laminates, paper or bituminous paper are applied thereto.

6. A process as claimed in claim 1, substantially as hereinbefore described.

7. A panel of extruded expanded thermoplastic resin when produced by a process as claimed in any preceding claim, said panel having a thickness equal to the sum of the thicknesses of the sheets from which it is produced after expansion of said sheets, and a density less than the composite density of the sheets prior to treatment in the furnace but equal to the composite density of such sheets after expansion.

8. An apparatus for connecting two or more sheets of pre-formed seasoned thermoplastic resin comprising a heating furnace defining a heating chamber said furnace having a plurality of inlet passages, one for each sheet and, in an opposite wall of said furnace, a single outlet passage for the connected sheets, means for continuous supporting and conveying each sheet individually through said furnace, first heat generating means for maintaining a monitored temperature within said chamber so as to cause the sheets to undergo expansion until the sheet acquires predetermined density, guide means for causing said sheets to converge towards and approach one another, second heating means for further heating at least the opposed surfaces of adjacent sheets to the melting temperature of the thermoplastic material, means for causing said further heated portions of adjacent sheets to abut one another whereby fusion or welding together of the sheets occurs and means for calibrating and cooling the thus connected sheets.

9. An apparatus as claimed in claim 8, additionally comprising means for printing the thus connected sheets and means for cutting the sheets.

10. An apparatus as claimed in claim 8 or 9, wherein said support conveying means comprises opposed pairs of rollers, conveyor belts or endless chains.

11. An apparatus as claimed in any one of claims 8 to 10, wherein said guide means comprise a pair of adjustable rollers disposed adjacent the outlet passage of the furnace.

12. An apparatus as claimed in any one of claims 8 to 11, wherein said heat generating means are electrically actuated.

13. An apparatus as claimed in any one of claims 8 to 12, wherein said calibrating means comprise two sets of opposed rollers defining therebetween a travel path for the connected sheets.

14. An apparatus as claimed in claim 13, wherein said cooling means comprise air diffusion nozzles disposed above and below the sets of rollers forming the calibrating means.

15. An apparatus for connecting together two or more sheets of thermoplastic resin constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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