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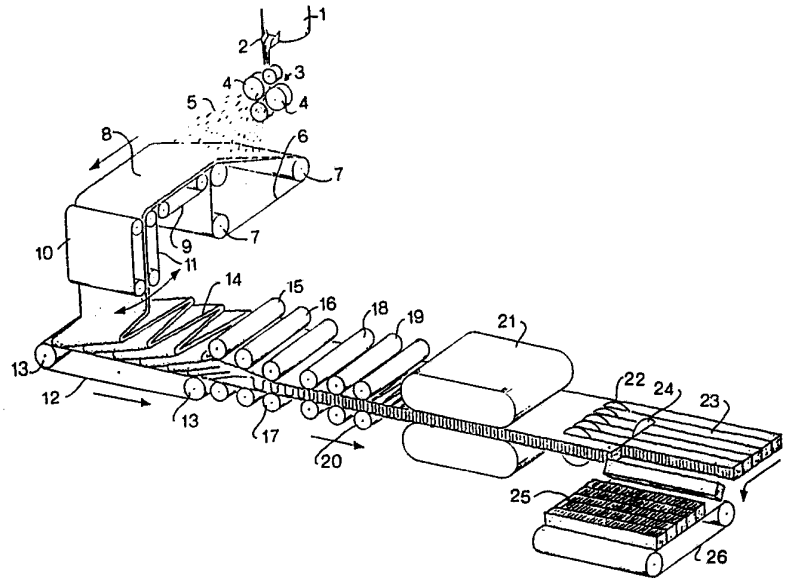
(54) Title: METHOD OF MANUFACTURING INSULATING BOARDS COMPOSED OF INTERCONNECTED ROD-SHAPED MINERAL FIBRE ELEMENTS



(57) Abstract

A method of manufacturing insulating board elements composed of interconnected mineral fibre lamellae comprising converting a melt of mineral fibre forming starting material into fibres, supplying a binder to said fibres, causing the fibres to form a fibre web, cutting the fibre web in the longitudinal direction to form lamellae, cutting said lamellae into desired lengths, turning the lamellae 90° about their longitudinal axis and bonding the fibres together to form boards, the lamellae having been subjected to a surface compression followed by a longitudinal compression either before or after the fibre web is cut into lamellae.

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+ DESIGNATIONS OF "SU"

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Method of manufacturing insulating boards composed of interconnected rod-shaped mineral fibre elements

This invention relates to a method of manufacturing insulating boards composed of interconnected rod-shaped mineral fibre elements (in the following referred to as lamellae) comprising converting a melt of a mineral fibre forming starting material into fibres, supplying a binder to said fibres, causing the fibres to form a fibre web, cutting the fibre web in the longitudinal direction to form lamellae, cutting said lamellae into desired lengths, turning the lamellae 90° about their longitudinal axis and bonding them together to form boards.

A method of the type defined above is disclosed in DE patent publication No. 2307577 C3. In this prior art method the melt is converted into fine mineral fibres by being thrown out from one or more rapidly rotating spinning wheels under the simultaneous supply of a binder capable of being cured, and the fibres thus formed are caught on an endless belt in the form of a fibre web wherein the fibres predominantly are oriented parallel to the surface of the web. In this prior art method the fibre web is cut longitudinally into lamellae and the lamellae thus formed are turned 90° about their longitudinal axis whereafter the lamellae thus oriented are bonded together to form a web-like product which is then cut into desired lengths to form board elements. Due to the turning of the lamellae the fibres of the finished boards will predominantly be oriented in a plane perpendicular to the surfaces of the boards and as a result thereof boards having a considerable stiffness and strength perpendicularly to the surfaces of the boards are obtained.

Boards produced by the method described above are suitable for many applications, but for certain applications, e.g. exterior insulation of roofs and/or building fronts and insulation of floors, the boards possess an insufficient stiffness or strength and/or insulating property.

It has now been found that these properties can be considerably improved so as to allow the boards to be used for purposes for which the prior art boards are not suitable by using lamellae which have

been subjected to a compression in a plane perpendicular to the main surfaces of the web (in the following referred to as surface compression) followed by a longitudinal compression either before or after the fibre web is cut into lamellae.

By using lamella made from a fibre web which has been subjected to a surface compression and a longitudinal compression it has been possible to increase the area strength of up to 60% compared to lamella boards made from fibre webs which have not been subjected to such a treatment.

The invention is based on the discovery that a compression in the longitudinal direction of a fibre web, in which the fibres are predominantly oriented parallel to the surface of the web, produces an inner fold structure in the fibre web, the folds extending perpendicularly to the longitudinal direction of the fibre web.

When such a web is cut longitudinally into lamellae and the lamellae are turned 90° and bonded together to form a lamella board, each lamella will exhibit a folded layer structure, the folds extending perpendicularly to the main surfaces of the lamella board and thereby imparting a greater stiffness and strength (area strength) to the lamella board than in the case where a lamella board is composed of rectilinear layers.

Instead of increasing the strength it may be desirable to reduce the density as this may cause an increase in the insulating capacity. Thus, it is well known that boards of rock wool made from lamellae having a content of pearls of about 30%, the pearls being greater than 63 μm, have an optimum insulating capacity at a density of about 40 kg/m^3.

It is well known that a relatively thick mineral fibre web can be formed directly, viz. by collecting the fibres made from the melt on a conveyor belt, see DE patent publication No. 2307577. It is also well known that a fibre web can be produced by initially producing a relatively thin primary web and subsequently doubling the primary web to form a secondary relatively thick fibre web comprising partially overlapping layers of the primary web, see DE patent

publication No. 3501897.

In a fibre web which is formed directly on a conveyor belt the fibres have varying directions of orientation, but by subjecting such a web to a surface compression the fibres will be partially re-arranged so as to be predominantly oriented in a direction which is parallel to the surface of the web.

When a fibre web is doubled the fibres are collected on a high-velocity conveyor belt, e.g. running with a velocity of 130 m/min, in the form of a thin fibre layer, e.g. having a weight of 0.3 kg/m^2. When collected in this manner, the fibres will be deposited on the conveyor belt in directions parallel to the surface of the web and predominantly parallel to the direction of movement of the belt. As a result thereof the fibre web will obtain a tensile strenght which is about twice as high in the longitudinal direction of the fibre web as in the transverse direction. The secondary fibre web is formed by laying by means of pendulum belts the thin primary web in a number of layers, e.g. 20, preferably transversely to the longitudinal direction of the secondary web, the number of layers being determined by the desired area weight of the secondary web.

In the doubled web the fibres are predominantly oriented transversely to the web when the layers of the primary web extend transversely to the secondary web.

The purpose of doubling a fibre web is ordinarily to obtain a secondary web having a relatively great thickness and having a small variation in density in the longitudinal direction.

In the method according to the invention lamellae made from a doubled fibre web comprising from 4 to 25 layers and having a surface weight of from 1 to 8 kg/m^2 are preferably used.

A particularly high compression stiffness is obtained with boards made from lamellae obtained by cutting a secondary web longitudinally and subsequently turning them 90° about their longitudinal axis because the fibres being predominantly oriented transversely to the secondary web will be positioned perpendicularly

to the plane of the board.

By compressing the fibre web longitudinally before turning the lamellae 90°, the compressive strength of the finished lamellae is increased and the above mentioned increase in stiffness and the increase in compression strength appear to support one another, which is evidenced by the fact that the two measures apparently produce a total effect which is greater than the sum of effects produced by the measures separately.

Methods for longitudinally compressing fibre webs are known per se. In a preferred prior art method, cf. CH patent specification No. 620861, a mineral fibre web is introduced into the space between two parallel conveyor belts which travel with a velocity V_1 and subsequently into the space between two further conveyor belts which travel with a velocity V_2, which is lower than V_1. Depending on the relationship between V_1 and V_2, the fibre web is more or less compressed longitudinally. The relationsship between V_1 and V_2 is selected so that folds are formed by the longitudinal compression, said folds extending transversely to the longitudinal direction of the web. In another preferred method, cf. US patent specification No. 2,500,690, the longitudinal compression is effected by means of a row of roller sets, said rollers rotating with a velocity which decreases in the longitudinal direction of the fibre web.

It is preferred to compress the fibre web longitudinally before cutting it into lamellae but the longitudinal compression may also be effected when the web has been cut into lamellae..

For use in the method according to the invention lamellae made from fibre webs which have been compressed longitudinally in a ratio of from 1.5:1 to 4:1 are preferred.

As mentioned above, the longitudinal compression should be effected following the vertical compression and when using a heat curable binder, the said longitudinal compression is effected before the fibre web is introduced into a curing furnace.

Methods for subjecting a fibre web to a surface compression are also

well known. In such a prior art method the fibre web to be compressed is introduced into the space between the rollers in a series of roller sets, the spacing between the rollers in the roller sets decreasing in the direction of movement of the fibre web.

For use in the method according to the invention lamellae made from a fibre web which has been surface compressed in a ratio of from 3:1 to 6:1 are preferred.

The cutting of the fibre web to form lamellae is preferably effected by means of saws which may have the form of compass saws, cf. DE patent publication No. 2307577, or circular saws, cf. SE published patent application No. 441764 and DE patent publication No. 2032624.

In a preferred embodiment of the method according to the invention the rod-shaped fibre elements are cut into desired lengths before being turned 90° and combined into lamella boards. Such turning may e.g. be effected in connection with the transfer of the cut lamellae from one conveyor belt upon which they are advanced in the longitudinal direction of the lamellae onto another conveyor belt moving perpendicularly to the first belt and upon which the lamellae are conveyed in a direction perpendicularly to their longitudinal direction.

This embodiment is advantageous in that the apparatus used for such turning of the lamellae requires little space.

Alternatively the turning of the lamellae can be effected during the cutting of the web into lamellae, e.g. as described in DE patent publication No. 2307577 or DE 2032624.

The properly oriented lamellae which are to form a lamella board can be glued together, preferably by means of a binder which is applied to the upper side of the fibre web and optionally to the lower side thereof, and preferably before the web is cut into lamellae.

However, it is not necessary to add an additional binder as the binder which is supplied to the fibres in connection with their formation is also present at the surfaces of the lamellae and it may

be sufficient to bond together the lamellae if they are pressed intimately together during the curing of the binder in the curing furnace, cf. DK patent application No. 3526/75.

If a heat curable binder has been supplied to the fibres in connection with their formation and if a heat curable binder is also used for bonding together the lamellae, the binders can be cured in one step by conveying the properly oriented and combined lamellae through a curing furnace in which they are heated to curing temperature, which is preferably between 210 and 260°C when phenol formaldehyd resin is used as a binder.

However, the binder for bonding together the lamellae may also be supplied after the fibre web/lamellae have been heated in a curing furnace to cure the binder supplied to the fibres in connection with their formation.

By supplying binder after the curing furnace other binders than heat curable binders can be used.

The invention will now be described in further detail with reference to the drawing which schematically shows a plant for carrying out the method according to th invention.

In the drawing 1 designates a furnace for manufacturing a mineral fibre forming melt which is supplied to a spinner 3 having four rapidly rotating spinning wheels 4 via a melt outlet 2. Simultaneously with the introduction of melt onto the outer surfaces of the spinning wheels and binder is sprayed, a strong gas stream is passed across the surfaces of the spinning wheels in the axial direction, thereby causing the formation of fibres 5 which are collected on an endless perforated conveyor belt 6 which is supported by three rollers 7, one of which is driven by driving means (not shown). As a result thereof a fibre web 8 (the primary web) is formed and this web is introduced into the space between two pendulum belts 10 and 11 by means of a further endless conveyor belt 9. The lower ends of the pendulum belts are located pivotally in a direction perpendicularly to the direction of movement of a further endless conveyor belt 12 which is supported by two rollers 13, one

of which is driven by driving means (not shown).

The amplitude of the oscillation of the lower part of the pendulum belts 10 and 11 corresponds to the width of the conveyor belt 12 and a doubled fibre web 14 of partially overlapping fibre layers 8 is thus formed on the belt 12.

The fibre web 14 is subsequently introduced into a surface compression section consisting of three sets of co-operating rollers 15, 16 and 17, the spacing between the rollers in the roller sets decreasing in the longitudinal direction of the fibre web. Subsequently the fibre web 14 is introduced into the longitudinal compression section which also consists of three roller sets 18, 19 and 20, the rollers of the latter sets of rollers rotating with the same velocity, which velocity is lower than that of the sets of rollers 15, 16 and 17.

The fibre web which has been compressed longitudinally is then introduced into a curing furnace 21 in which it is heated to a temperature which is sufficiently high to cure the binder and to fix the fibres relatively to one another.

After having passed the curing furnace the heat treated fibre web 14 is cut in the longitudinal direction by means of saws 22 so as to form lamellae 23 which are subsequently cut transversely by means of a transverse saw 24. The lamellae 23 thus cut are then turned 90° and combined to form a board element 25 on a conveyor belt 26 and at the same time a binder is applied to the contact surfaces by means of an application apparatus (not shown) to bond together the lamellae 23.

As indicated in the drawing the fibre layers formed from the primary web 8 extend substantially perpendicularly to the surface of the finished board element, and as they are also folded they are highly resistant against compression.

Instead of being bonded together the lamellae can be joined together by means of e.g. strips, strings, vlies or paper on one side or both sides of the boards.

Patent claims

1. A method of manufacturing insulating board elements composed of interconnected rod-shaped mineral fibre elements comprising converting a melt of a mineral fibre forming starting material into fibres, supplying a binder to said fibres, causing the fibres to form a fibre web, cutting the fibre web in the longitudinal direction to form lamellae, cutting said lamellae into desired lengths, turning the lamellae 90° about their longitudinal axis and bonding them together to form boards, characterized in using lamellae which have been subjected to a surface compression followed by a longitudinal compression either before or after the fibre web is cut into lamellae.

2. A method according to claim 1, characterized in using lamellae made from a doubled fibre web.

3. A method according to claims 1 or 2, characterized in using lamellae which have been compressed longitudinally in a ratio of from 1.5:1 to 4:1.

4. A method according to claims 1, 2 or 3, characterized in using lamellae which have been subjected to a surface compression in a ratio of from 3:1 to 6:1.

5. A method according to any of the claims 1-4, characterized in that the fibre web is cut into lamellae having desired lengths before being turned 90° and combined into lamella boards.

6. A method according to any of the claims 1-5 and comprising supplying to the fibres a heat curable binder, characterized in that the surface compression and the longitudinal compression are effected before the fibre web is subjected to a heat treatment to cure the binder.

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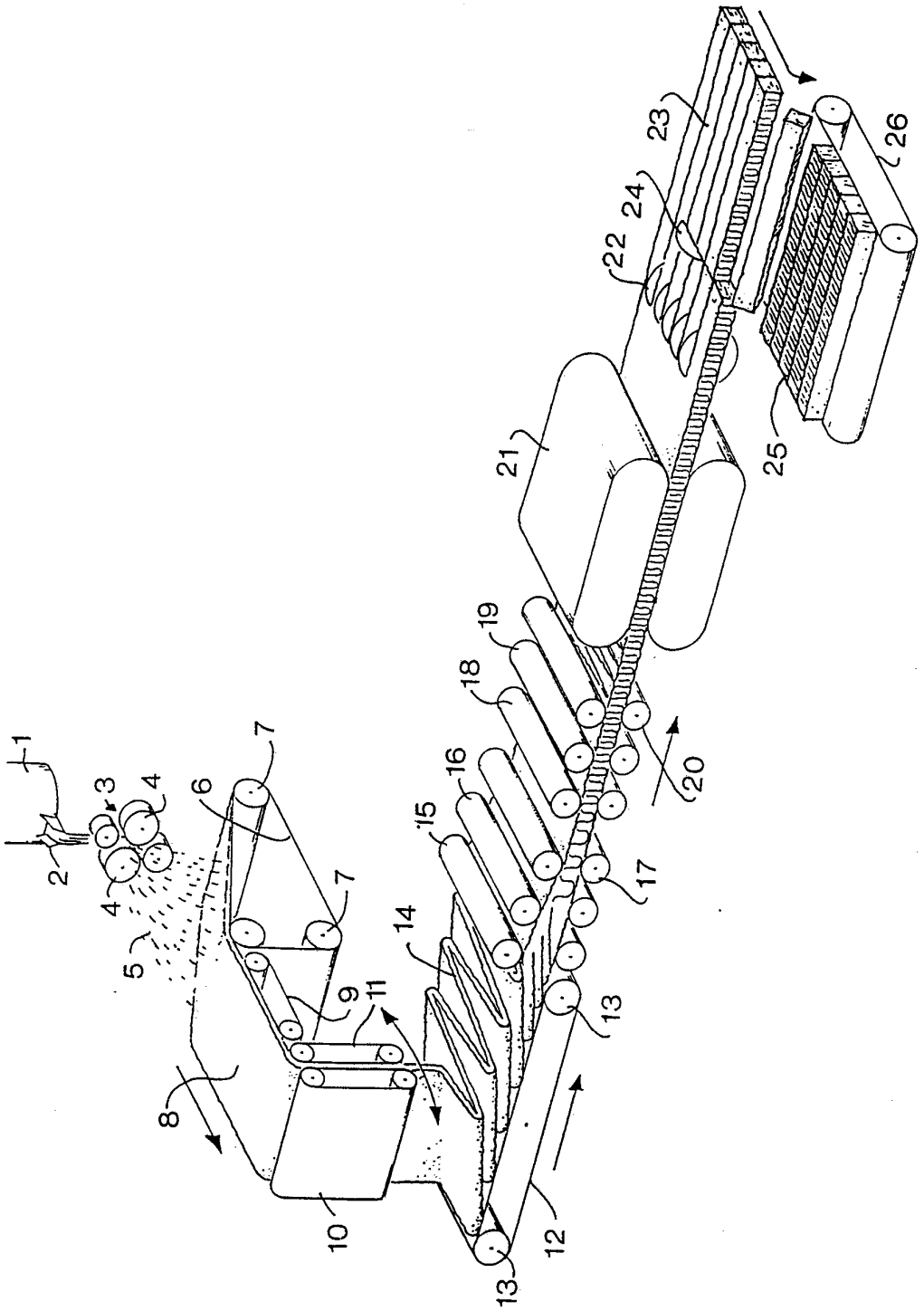

INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 91/00383

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: D 04 H 1/70

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	D 04 H; B 32 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	US, A, 3493452 (P.M. COLE) 3 February 1970, see page 1, line 61; page 2, line 51 - line 54 --	1-6
Y	DE, A1, 3501897 (BAYER AG) 24 July 1986, see figure 2 --	1-6
Y	SE, B, 441764 (GULLFIBER AB) 4 November 1985, see page 4, line 16 - line 20 --	5
A	CA, A, 1209893 (CAMERON, NEIL M.) 19 August 1986, see the whole document --	1-6

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12th March 1992	1992 -03- 16
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Nils Ekström

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
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Y	SE, B, 366729 (ROCKWOOL AB) 6 May 1974, see page 3, line 25 - line 28 --	6

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/DK 91/00383

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 01/02/92 The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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