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(54) METHOD AND APPARATUS FOR PRODUCING FIBROUS MATERIAL BATTS

VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG VON FASERIGEN VLIESSTOFFEN

PROCEDE ET APPAREIL POUR LA PRODUCTION DES PANNEAUX DE MATERIAU FIBREUX

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- **DATABASE WPI Section Ch, Week 8929, Derwent Publications Ltd., London, GB; Class A60, AN 89-210665 & JP,A,1 148 206 (ASAHI GLASS KK) 9 June 1989**

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Description

[0001] This invention relates to the manufacture of fibrous material mats or batts, in particular but not solely to low density batts for thermal insulation or padding. The invention also relates to other properties of these batts, such as fire resistance and resilience to crushing.

[0002] A method of forming resin impregnated fibre batts is disclosed in US Patent No. 4,678,822, on which the two-part form of claim 1 is based. The resin is an acrylic self crosslinking polymer containing fire and smoke retardants and a pesticide. The fibres may be natural and/or synthetic in origin and are often waste materials.

[0003] The materials are randomly dispersed in a sliver which is sprayed with the resin during a continuous folding process known as lapping. The sliver is lapped up to a required thickness on a moving conveyer, and the resulting mat is cured at around 150°C and cut into batts having a density of around 25 kg/m^3.

[0004] This method and other similar methods now in use have high production costs due to the quantities of materials required and the conditions under which manufacturing takes place. The relatively high density batts also give an undesirably high thermal conductivity for a given thickness. Lower density products would be cheaper and less conductive but are not yet available from existing sources.

[0005] The textile industry incorporates various natural and/or synthetic fibre materials in a wide range of products. These materials are often treated for fire resistance by absorption of inorganic salts such as borates and phosphates from aqueous solution, and/or by spraying with resin compositions which contain these salts or other chemicals such as metal oxides or halogenated organic compounds.

[0006] A variety of natural and synthetic resins are available. By themselves most are dangerously flammable until the various salts and other compounds are admixed in solution to form water/resin emulsions. The final compositions may then impart fire, insect, fungus and rodent resistance as well as resilience, cohesion and strength to the fibrous materials. They should also be stable and non-toxic.

[0007] Boric acid (H_3BO_3) and sodium tetraborate or borax ($Na_2B_4O_7$)impart many of the desired properties to the fibres and to the resins with boron being the important component. However, their use has been unsatisfactory to some extent due to problems with high pH and low solubility in water. Generally both the aqueous solutions in which the material is immersed and the resin compositions with which they are sprayed cannot contain sufficient concentrations of boron. They have also been unsatisfactory with regard to stiffness of the treated materials.

[0008] It is an object of the present invention to provide for manufacture of fibrous material butts having improved physical properties, or at least provide the public with a useful choice.

[0009] According to a first aspect of the present invention, there is provided a method of manufacturing fibrous material batts comprising: forming a sliver of dispersed fibrous material, lapping the sliver into a moving multilayer mat, spraying the sliver with a fibre bonding agent during lapping, curing the bonding agent on the moving mat, and cutting the mat to form batts of required dimensions and density, characterised in that alternate sides of the sliver are sprayed by a pair of spray booms which oscillate with the sliver during lapping to produce an even distribution of the bonding agent in the mat.

[0010] According to a second aspect of the present invention, there is provided apparatus for manufacturing fibrous material batts comprising: lapping means which form a sliver of fibrous material into a moving multilayer mat, spraying means which oscillate with the sliver and deliver a fibre bonding agent onto the sliver during lapping, curing means which heats the bonding agent on the moving mat, after lapping of the sliver and cutting means which severs the mat into batts of required dimensions and density, characterised in that alternate sides of the sliver are sprayed during lapping to produce an even distribution of the bonding agent in the mat.

[0011] The hereinafter described embodiment of the invention involves several aspects relating to production of the improved batts. A fragile sliver of fibrous material is continuously formed from a mass of natural and/or synthetic fibres such as found in waste wool. The sliver is lapped into a lightweight mat which is carried on a moving conveyor.

[0012] A bonding agent and optionally other substances are sprayed onto the sliver in a fine mist as lapping takes place back and forth across the conveyor. Although control may be excerted over the thickness of the mat by varying the lapping and conveying speeds, a further step of compression is normally required before the structure of the mat is fixed by curing.

[0013] This enables precise control over the eventual density of batts into which the mat will be cut. It is generally desired that the batts have a density of less than 15 kg/m$_3$, and preferably 8 to 12 kg/m^3.

[0014] The bonding agent which is sprayed onto the sliver is typically a resin emulsion containing the optional substances in an aqueous solution. Batts being manufactured for thermal insulation must be fire resistant and one of the optical substances should be octaborate salt having a concentration of up to around 30% by weight.

[0015] A preferred embodiment will be described as an example of the invention with reference to the drawings of which:

Figure 1 schematically shows apparatus for manufacturing fibrous material batts, from one side;

Figure 2 shows the apparatus from above with an exaggerated indication of the lapping operation; and
Figure 3a and 3b show end views of the lapping and spraying operations.

[0016] Referring to these drawings it will be evident that the invention can be employed when making mats and batts from a range of natural and synthetic materials, including animal or plant fibres and acrylics, polyesters or polyamide. Natural wool is preferred due to its ready availability and lofting characteristics. It will also be appreciated that the fibrous material products can be put to a wide range of uses including thermal insulation and stuffing for various objects.

[0017] Figure 1 shows sliver 10 of fibrous material passing downwards through a lapping device 11. The sliver is formed continuously from wool or a wool/synthetic mix, preferably at least 50% by weight of wool, which may be scoured or cleaned by a commercial process and possibly pretreated for fire resistance. Processes for treating the bulk material and forming the sliver are well known and will be not be described further. The sliver itself has a fragile structure up to around 1 cm thick and perhaps 2 m in width.

[0018] The lapping device includes sliver control elements 30 and spray booms 31 which will be described later. The device oscillates back and forth across a moving conveyor 12 onto which the sliver is folded, to create a continuous mat 13 of fibrous material. The fibre bonding agent sprayed onto the sliver from booms 31 thoroughly impregnates the mat, which is typically 10 to 20 cm thick. The conveyor passes through a bath 14 which removes any oversprayed bonding agent.

[0019] Figure 2 shows mat 13 from above, with an exaggerated zigzag structure caused by the relative motion of the lapping device 11 and conveyor 12. In practice the zigzag is very much finer due to the lapping device moving rather more quickly than the conveyor in the directions indicated. The multilayer structure of the mat has also been considerably exaggerated in Figure 1.

[0020] As shown in both Figures 1 and 2 the mat 13 is carried from conveyor 12 to a space 15 between parallel conveyors 16 and 17. The space is adjustable, by lowering or raising conveyor 16, so that the mat can be compressed to a greater or lesser degree in obtaining a required thickness. The conveyors contact the mat, still wet from the spraying operation, through a non-sticking mesh surface.

[0021] Conveyors 16 and 17 carry the mat into an oven 20 which circulates hot air as indicated to dry and cure the bonding agent. A heater/fan 21 blows hot air up through conveyor 17 and out of the oven through an exhaust 22. Heat is exchanged to incoming air which passes down through conveyor 16 from inlet 23. The upwards moving air is typically at a temperature of up to 120°C and preferably heats the mat to a temperature of between 70 and 100°C. The downwards moving air has a temperature of between 50 to 60°C.

[0022] The mat 13 is finally cut at a guillotine device 25 after curing and drying. This creates batts of a required thickness and low density according to various parameters which may be varied during the overall manufacturing process. For example, to create batts having a density of 10 kg/m^3 from a sliver formed at 50 kg/hr, a 1 m wide mat may be conveyed at 50 m/hr, and compressed to a thickness of 10 cm.

[0023] Surprisingly good insulative properties have been obtained from batts having a density less than 15 kg/m^3 and preferably between about 8 and 12 kg/m^3. This represents an optimum volume ratio of air to fibre. At higher densities fibre and resin consumption are unnecessarily high and the insulation is also reduced. A comparison of one sample with the example in US 4,678,822 is as follows.

Thickness mm	Density kg/m^3	Insulation "R" value M^2°C/W	Thermal Conductivity W/M°C
90	8.2	1.71	0.052
54	25	1.34	0.040

[0024] From these results it can be seen that a thickish mat of low density according to the invention gives better insulation than a conventional mat of high density. As the thickness was less than double while the density was less than one third a considerable saving in production materials can be made.

[0025] Figures 3a and 3b show the lapper in more detail to have a pair of control booms 30 and a pair of spray booms 31. It moves from side to side as indicated and both sides of the sliver 10 are sprayed with a resin to hold the structure of the mat, and other substances to provide certain properties of resilience and retardance. The spray booms are alternately switched off for brief periods when the sliver is closest, to obtain economic and even distribution of resin.

[0026] Spraying takes place preferably with the resin at a temperature up to about 50°C and generally between about 25 and 40°C. This assists evaporation of moisture prior to curing and avoids need of elaborate radiative or other drying means which have been proposed previously.

[0027] Curing takes place in the oven preferably at a temperature less than about 120°C and generally between about 70 and 100°C. Higher curing temperatures are usually of no advantage and may be detrimental to some fibres and resins.

[0028] The resin emulsion normally includes various fire and smoke retardants, pesticides, fungicides and the like in the form of an aqueous solution. A surfactant such as sold by Eastman Chemicals Ltd of the United States, under the trade mark TEXANOL, may also be added. Resins suitable for the low temperature curing are preferably acrylic polymer emulsion types with low film forming properties during spraying and high self crosslinking properties during curing.

[0029] One especially advantageous addition to the fibre bonding agents has been found in a range of inorganic octaborate salts, particularly sodium octaborate ($Na_2B_8O_{13}$). A sodium octaborate product (tetrahydrate) is marketed by United States Borax and Chemical Corporation under the trade marks TIMBOR and F-BOR. These have been used exclusively for preservation of timber in the past.

[0030] A suitable resin is marketed by A C Hatrick (NZ) Limited under the trade mark ACROCRYL. It has not been used successfully with boric acid or borax in the past and compositions of this kind have been disregarded due to the unfavourable chemical reactions which occur. Other salts and resins may also be suitable but those mentioned are the most cheaply and widely available at present.

[0031] A composition of TIMBOR dissolved in water and ACROCRYL forms an emulsion which gives surprisingly good fire resistance and resilience to treated materials. There are no problems with pH or low solubility as occurs with other well known boron chemicals which have been tried in the past. It also covers and adheres to fibre surfaces particularly well, and has a marked shelf life stability so need not be used immediately after preparation. The resin is an acrylic cross-linked variety which is cured at around 70 to 100°C once applied.

[0032] Preferred mixtures for spraying onto a fibrous material sliver during lapping have been found to comprise a resin emulsion with up to 30% by weight of resin solids and up to 30% by weight of an octaborate salt. Most preferably 15 to 25% by weight of resin solids and 10 to 25% of sodium octaborate tetrahydrate.

[0033] A comparison of technical data on boric acid, borax and sodium octaborate indicates rather better water solubility characteristics for octaborate compounds (1/19, 1/16 and 1/11 g/ml respectively). Further, the pH of an octaborate solution drops to near neutral as concentration increases and no unfavourable reactions occur with the materials or resins. This allows a high concentration of boron in purely aqueous solutions for immersion of materials, and in resin emulsions which may be sprayed onto the materials.

[0034] Outstanding results have been achieved in experiments conducted to date using resin compositions on woollen webs or blocks for insulation. An emulsion comprising 20% ACROCRYL, 18% TIMBOR and the balance water by weight was sprayed onto woollen fibres which were then lofted and cured. The resulting webs were effectively fire resistant with desirable qualities of high stiffness and low toxicity with fungicidal and insecticidal properties also.

Claims

1. A method of manufacturing fibrous material batts comprising:

forming a sliver (10) of dispersed fibrous material,
lapping the sliver into a moving multilayer mat (13),
spraying the sliver (10) with a fibre bonding agent during lapping,
curing the bonding agent on the moving mat (13), and
cutting the mat to form batts of required dimensions and density,

characterised in that alternate sides of the sliver (10) are sprayed by a pair of spray booms which oscillate with the sliver (10) during lapping to produce an even distribution of the bonding agent in the mat.

2. A method according to claim 1, further comprising compressing the moving mat to a required thickness while curing.

3. A method according to claim 1 or 2, wherein the spray booms (31) direct spray in generally opposed directions towards the sliver (10).

4. A method according to any one of the preceding claims, wherein heated air is blown upward through the mat to cause curing.

5. A method according to any one of the preceding claims, wherein the fibrous material comprises at least 50% by weight of wool.

6. A method according to any one of the preceding claims, wherein the batts have a density of less than 15 kg/m^3.

7. A method according to claim 6, wherein the batts have a density of between 8 and 12 kg/m^3.

8. A method according to any one of the preceding claims, wherein the fibre bonding agent comprises a resin containing an octaborate salt.

9. A method according to any one of the preceding claims, wherein the fibre bonding agent comprises a resin having from 10 to 25% by weight of sodium octaborate tetrahydrate.

10. A fibrous material mat or batt formed according to the method of any one of the preceding claims, and having a density of less than 15 kg/m^3.

11. A fibrous material mat or batt formed according to the method of any one of claims 1 to 9, and having a bonding agent incorporating an octaborate salt.

12. Apparatus for manufacturing fibrous material batts comprising:

    lapping means (11) which form a sliver (10) of fibrous material into a moving multilayer mat (13),
    spraying means (31) which oscillate with the sliver (10) and deliver a fibre bonding agent onto the sliver (10) during lapping,
    curing means (20) which heats the bonding agent on the moving mat (13), after lapping of the sliver (10), and
    cutting means (25) which severs the mat (13) into batts of required dimensions and density,

    characterised in that alternate sides of the sliver (10) are sprayed during lapping to produce an even distribution of the bonding agent in the mat (13).

13. Apparatus according to claim 12, further comprising compressing means (16,17) which together with the curing means (20) reduces the moving mat (13) to a required thickness.

14. Apparatus according to claim 12 or 13, wherein the spraying means (30) comprises spray booms on either side of the sliver which direct the bonding agent generally toward the sliver (10) before the sliver is lapped onto the mat (13).

15. Apparatus according to any one of claims 12 to 14, wherein the curing means (20) blow heated air upwards through the moving mat (13).

Patentansprüche

1. Verfahren zum Herstellen von Faserstoff-Vliesen, umfassend die Schritte:

    Ausbilden eines Bandes (10) aus verteiltem Fasermaterial,
    Zusammenlegen der Bahn zu einer sich bewegenden mehrlagigen Matte (13),
    Besprühen der Bahn (10) mit einem Faserbindemittel während des Zusammenlegens,
    Aushärten des Bindemittels an der sich bewegenden Matte (13), und
    Abschneiden der Matte zur Herstellung von Vliesen in den erforderlichen Abmessungen mit der gewünschten Dichte,

    dadurch gekennzeichnet, daß abwechselnde Seiten der Bahn (10) durch ein Paar von Sprühleisten besprüht werden, die mit der Bahn (10) bei dem Zusammenlegen schwingen, um eine gleichmäßige Verteilung des Bindemittels in der Matte zu erreichen.

2. Verfahren nach Anspruch 1, bei dem die sich bewegende Matte während des Aushärtens auf die gewünschte Dicke komprimiert wird.

3. Verfahren nach Anspruch 1 oder 2, bei dem die Sprühleisten (31) in im wesentlichen entgegengesetzte Richtungen auf die Bahn (10) hin sprühen.

4. Verfahren nach einem der vorhergehenden Ansprüche, bei dem durch die Matte zum Fördern der Aushärtung

erhitzte Luft nach oben geblasen wird.

5. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das Fasermaterial mindestens 50 Gew.-% Wolle enthält.

6. Verfahren nach einem der vorhergehenden Ansprüche, bei dem die Vliese eine Dichte von weniger als 15 kg/m^3 besitzen.

7. Verfahren nach Anspruch 6, bei dem die Vliese eine Dichte zwischen 8 und 12 kg/m^3 besitzen.

8. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das Faserbindemittel ein Oktaboratsalz enthaltendes Harz aufweist.

9. Verfahren nach einem der vorhergehenden Ansprüche, bei dem das Faserbindemittel ein Harz mit 10 bis 25 Gew.-% Natriumoktaborat-Tetrahydrat aufweist.

10. Fasermaterialmatte oder -vlies, hergestellt nach dem Verfahren gemäß einem der vorhergehenden Ansprüche, mit einer Dichte von weniger als 15 kg/m^3.

11. Fasermaterialmatte oder -vlies, hergestellt nach dem Verfahren gemäß einem der Ansprüche 1 bis 9, mit einem ein Oktaboratsalz beinhaltenden Bindemittel.

12. Vorrichtung zum Herstellen von Fasermaterialvliesen, umfassend:

eine Zusammenlegeeinrichtung (11), die eine Bahn (10) aus Fasermaterial zu einer sich bewegenden mehrlagigen Matte (13) zusammenlegt,
eine Sprüheinrichtung (31), die mit der Bahn (10) schwingt und auf die Bahn (10) während des Zusammenlegens ein Faserbindemittel aufbringt,
eine Aushärteeinrichtung (20), die das Bindemittel an der sich bewegenden Matte (13) nach dem Zusammenlegen der Bahn (10) erhitzt, und
eine Schneideinrichtung (25), welche die Matte (13) zu Vliesen mit den gewünschten Abmessungen und der gewünschten Dichte schneidet,

dadurch gekennzeichnet, daß abwechselnde Seiten der Bahn (10) während des Zusammenlegens besprüht werden, um eine gleichmäßige Verteilung des Bindemittels in der Matte (13) zu erreichen.

13. Vorrichtung nach Anspruch 12, umfassend eine Komprimiereinrichtung (16, 17), die im Verein mit der Aushärteeinrichtung (20) die sich bewegende Matte (13) auf die gewünschte Dicke reduziert.

14. Vorrichtung nach Anspruch 12 oder 13, bei der die Sprüheinrichtung (30) Sprühleisten auf jeder Seite der Bahn aufweist, die das Bindemittel etwa in Richtung auf die Bahn (10) lenken, bevor die Bahn zu der Matte (13) zusammengelegt wird.

15. Vorrichtung nach einem der Ansprüche 12 bis 14, bei der die Aushärteeinrichtung (20) heiße Luft nach oben durch die sich bewegende Matte (13) bläst.

Revendications

1. Procédé de fabrication de feuilles continues de matière fibreuse comprenant les étapes qui consistent à :

former un ruban (10) de matière fibreuse dispersée,
plier le ruban en formant un mat multicouche mobile (13),
pulvériser un liant de fibres sur le ruban (10) au cours du pliage,
faire durcir le liant sur le mat mobile (13), et à
découper le mat pour former des feuilles continues de masse volumique et de dimensions requises,

caractérisé en ce que l'on effectue une pulvérisation sur les faces alternantes du ruban (10) au moyen d'une paire de bras de pulvérisation qui oscillent avec le ruban (10) au cours du pliage de manière à obtenir une distribution uniforme du liant dans le mat.

2. Procédé selon la revendication 1, comprenant en outre la compression du mat mobile jusqu'à une épaisseur requise tout en le faisant durcir.

3. Procédé selon la revendication 1 ou 2, dans lequel les bras de pulvérisation (31) dirigent un jet pulvérisé dans des directions généralement opposées vers le ruban (10).

4. Procédé selon l'une quelconque des précédentes revendications, dans lequel l'air chauffé est soufflé de bas en haut à travers le mat pour le faire durcir.

5. Procédé selon l'une quelconque des précédentes revendications, dans lequel la matière fibreuse comprend au moins 50 % en poids de laine.

6. Procédé selon l'une quelconque des précédentes revendications, dans lequel les feuilles continues présentent une masse volumique inférieure à 15 kg/m^3.

7. Procédé selon la revendication 6, dans lequel les feuilles continues présentent une masse volumique allant de 8 à 12 kg/m^3.

8. Procédé selon l'une quelconque des précédentes revendications, dans lequel le liant de fibres comprend une résine contenant un sel de type octaborate.

9. Procédé selon l'une quelconque des précédentes revendications, dans lequel le liant de fibres comprend une résine présentant de 10 à 25 % en poids d'octaborate de sodium tétrahydraté.

10. Mat ou feuille continue de matière fibreuse formé selon le procédé de l'une quelconque des précédentes revendications, et présentant une masse volumique inférieure à 15 kg/m^3.

11. Mat ou feuille continue de matière fibreuse formé selon le procédé de l'une quelconque des revendications 1 à 9, et présentant un liant qui comprend un sel de type octaborate.

12. Appareil pour fabriquer des feuilles continues de matière fibreuse comprenant :

un moyen de pliage (11) qui plie un ruban (10) de matière fibreuse en formant un mat multicouche mobile (13),
un moyen de pulvérisation (31) qui oscille avec le ruban (10) et distribue un liant de fibres sur le ruban (10) au cours du pliage,
un moyen de durcissement (20) qui chauffe le liant sur le mat mobile (13) après le pliage du ruban (10), et
un moyen de découpage (25) qui sépare le mat (13) en feuilles continues de masse volumique et de dimensions requises,

caractérisé en ce que l'on soumet à une pulvérisation les faces alternantes du ruban (10) au cours du pliage de manière à obtenir une distribution uniforme du liant dans le mat (13).

13. Appareil selon la revendication 12, comprenant en outre un moyen de compression (16, 17) qui réduit, avec le moyen de durcissement (20), l'épaisseur du mat mobile (13) jusqu'à une épaisseur requise.

14. Appareil selon la revendication 12 ou 13, dans lequel le moyen de pulvérisation (30) comprend des bras de pulvérisation pour une pulvérisation sur chaque face du ruban, qui dirigent généralement le liant vers le ruban (10) avant que le ruban ne soit plié en formant un mat (13).

15. Appareil selon l'une quelconque des revendications 12 à 14, dans lequel le moyen de durcissement (20) souffle de l'air chauffé de bas en haut à travers le mat mobile (13).

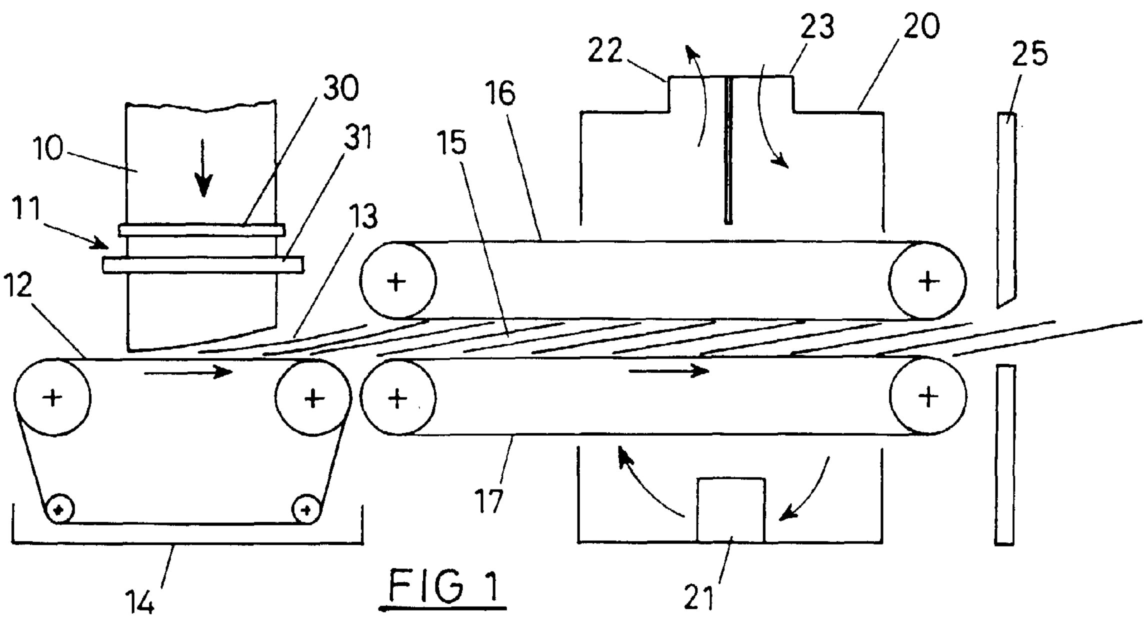

FIG 1

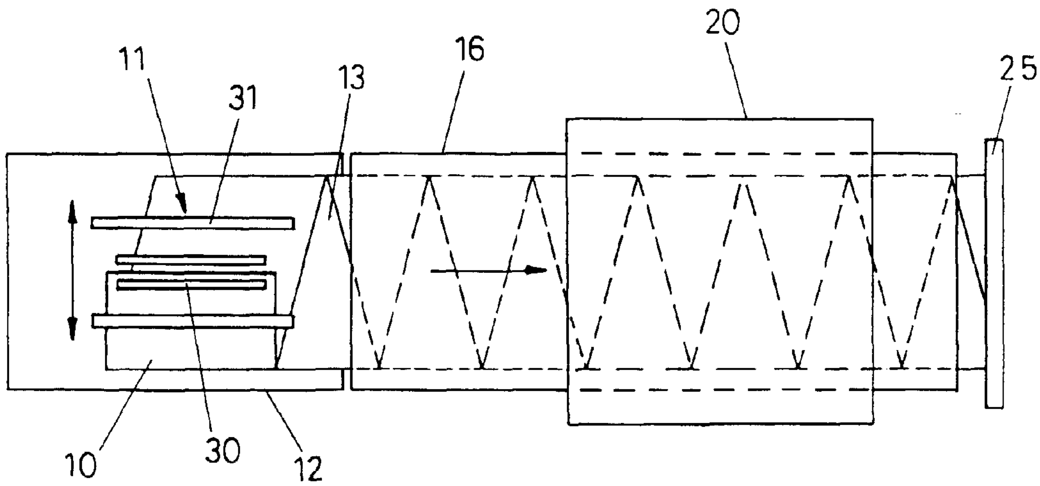

FIG 2

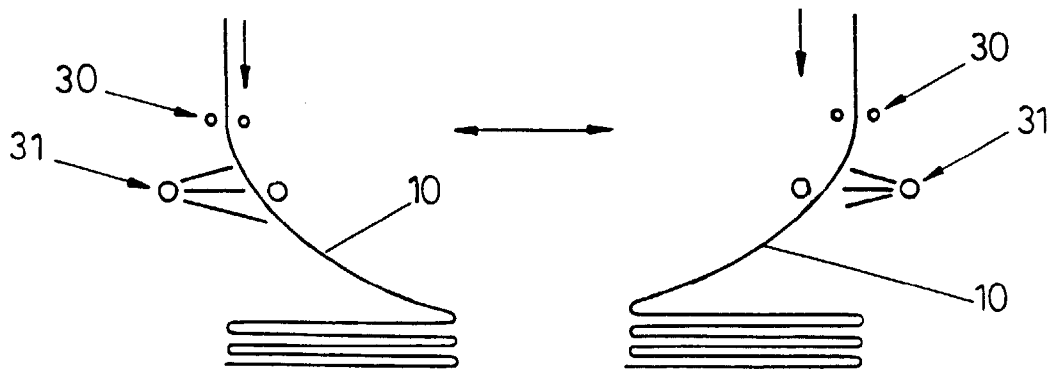

FIG 3a

FIG 3b