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(74) Agent: MUSIL, Dobroslav; Cejl 38, 602 00 Brno (CZ).

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(71) Applicant (for all designated States except US): EL-MARCO, S.R.O. [CZ/CZ]; V Horkách 76, 460 07 Liberec (CZ).

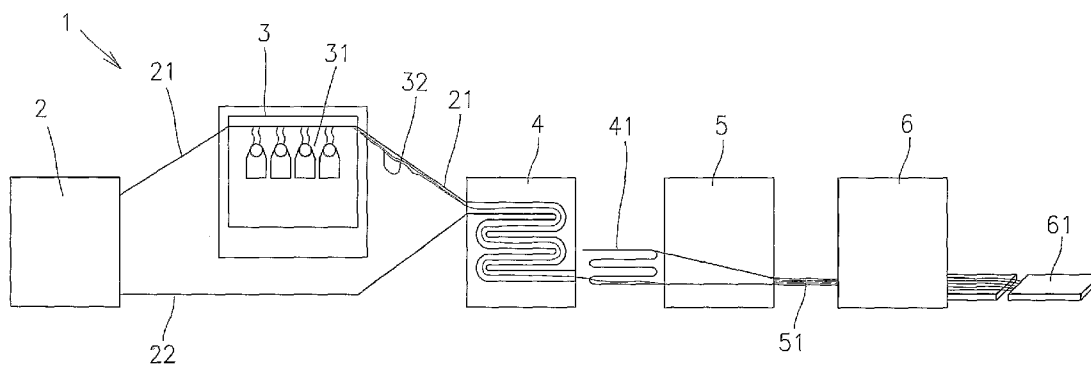
(72) Inventors; and

(75) Inventors/Applicants (for US only): STRÁNSKÁ, Denisa [CZ/CZ]; Havlickova 2252, 470 01 Česká Lipa (CZ). MARES, Ladislav [CZ/CZ]; Srámkova 22, 460 10 Liberec (CZ). JIRSÁK, Oldrich [CZ/CZ]; Srámkova 151, 460 10 Liberec (CZ). KALINOVÁ, Klára [CZ/CZ]; Mozartova 6, 466 04 Jablonec nad Nisou (CZ).

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(54) Title: PRODUCTION METHOD OF LAYERED SOUND ABSORPTIVE NON-WOVEN FABRIC



(57) Abstract: Production method of layered sound absorptive non-woven fabric (51), which comprises a resonance membrane which is positioned between two layers (21, 22) of the card fibrous web, while both layers (21, 22) of the card fibrous web are produced simultaneously in carding machine (2), from which each layer (21,22) of the card fibrous web is separately brought into the device (3) for production of nanofibres through electrostatic spinning, in which to the side of at least one layer (21) of the card fibrous web adjacent to the remaining layer (22) of the card fibrous web a layer (32) of nanofibres is applied, after then both layers (21, 22) of the card fibrous web near to one another until their adjacent sides sit down one on another, they are laid one on another in a selected quantity of layers and the layers join mutually.

WO 2008/083637 A1

Production method of layered sound absorptive non-woven fabric

Technical field

The invention relates to the production method of layered sound absorptive non-woven fabric, which comprises a resonance membrane formed by a layer of nanofibres having diameter to 600 nanometers and basis weight of 0,1 to 5 gm⁻², which is positioned between two layers of the card fibrous web.

Background art

The CZ PV 2005-226 discloses a layered sound absorptive non-woven fabric containing a resonance membrane and at least one another layer of fibrous material. The resonance membrane is formed by a layer of nanofibres having diameter to 600 nanometers and basis weight of 0,1 to 5 gm⁻² and the resultant fabric is formed by a cross laying to the required thickness and weight.

In an advantageous embodiment the layer of card fibrous web here forms the bearing layer on which during electrostatic spinning the layer of produced nanofibres is being deposited, and consequently both layers join together in a known manner at the specified temperature in the hot air chamber.

To increase the efficiency, according to the mentioned document another layer of card fibrous web may be applied on the fabric, namely from the originally disposable side of nanofibrous layer. Possibly there may be another layer, the double or triple one.

Nevertheless the background art for such three- and more layered fabric requires that at least one fibrous web is prepared separately and the same after then is joined to the nanofibrous layer of already produced two-layer fabric. This complicates the production and makes it more expensive.

The goal of the invention is to eliminate the shortcomings of the known solutions or to restrict them considerably.

The principle of invention

The goal of the invention has been reached by a production method of layered sound absorptive non-woven fabric containing a resonance membrane formed by a layer of nanofibres, which is positioned between two layers of card fibrous web according to the invention, whose principle consists in that, both layers of card fibrous web are produced simultaneously in carding machine from which at least one layer of card fibrous web is brought into the device for production of nanofibres through electrostatic spinning, in which to the side of this layer of card fibrous web adjacent to the remaining layer the layer of nanofibres is applied, after then after exiting the device for production of nanofibres through electrostatic spinning, both layers of card fibrous web near to one another until their adjacent parts, out of which at least on one there is applied a layer of nanofibres forming the resonance membrane, touch one another.

From the point of view of spatial complexity and arrangement of individual elements of the device for production of nanofibres through electrostatic spinning it is advantageous if the layer of nanofibres is being applied only on one of layers of the card fibrous web, while the lower layer of card fibrous web also passes the device for production of nanofibres through electrostatic spinning, nevertheless outside its spinning compartment.

In case the structure of the device for production of nanofibres does not enable passage of a layer of card fibrous web on which the layer of nanofibres is not applied outside the spinning compartment, this layer is guided totally outside the device for production of nanofibres through electrostatic spinning, and to the layer of card fibrous web passing through the spinning compartment it is nearing only after the device for production of nanofibres through electrostatic spinning.

According to the claim 3 it is advantageous if both layers of card fibrous web are guided separately into the device for production of nanofibres through electrostatic spinning, while at least one layer of the card fibrous web passes through the spinning compartment of this device and to the side of this

layer of the card fibrous web adjacent to the second layer the layer of nanofibres is applied.

Guiding of the second layer of the card fibrous web enables its passage outside the spinning compartment of the device for production of nanofibres through electrostatic spinning.

In embodiment according to the claim 5 both layers of the card fibrous web are guided through the spinning compartment of the device for production of nanofibres through electrostatic spinning, in which one, the upper, layer of nanofibres is applied on the side of the first layer of the card fibrous web adjacent to the second layer of the card fibrous web, and the second, the lower, layer of nanofibres is applied on the side of the second, the lower, layer of the card fibrous web reverse to the first, the upper, layer of the card fibrous web. This embodiment achieves a higher sound absorption capacity as it contains two resonance membranes formed by layers of nanofibres, while each of these membranes may absorb a different range of sound waves.

Another increasing of absorption capacity may be achieved according to the claim 6 by that, to the layer of nanofibres applied on the side of lower layer of the card fibrous web there is joined at least one another layer of the card fibrous web with a layer of nanofibres applied on the reverse side of this another layer of the card fibrous web.

At the same time it is advantageous especially from the point of view of costs, if this further layer of the card fibrous web is produced on the same carding machine as the upper and lower layer of the card fibrous web.

Or it may be advantageous if this further layer of the card fibrous web is produced in another carding machine than the upper and lower layer of the card fibrous web. This embodiment is rather more expensive, but it allows adding of another one up to three further layers of the card fibrous web.

Especially due to protection of lower layer of nanofibres it is advantageous if to the layer of nanofibres applied on the outer side of lower layer of the card fibrous web reverse to the previous layer of the card fibrous web an auxiliary layer of the card fibrous web is joined.

The auxiliary layer of the card fibrous web may be produced on the same carding machine as the upper and lower layer of the card fibrous web or on another carding machine.

5 The advantage of another variant of solution according to the invention consists in that both layers of card fibrous web are guided through the spinning compartment of the device for production of nanofibres through electrostatic spinning, in which to the mutually adjacent sides of both layers of the card fibrous web there is applied always one layer of nanofibres.

10 In this method it is possible to produce a layered fabric with combination of nanofibrous layers of a different thickness, possibly of a different nanofibrous material and so to reach a broader spectra of the sound being absorbed.

At the same time it is advantageous, if after exiting the device for production of nanofibres through electrostatic spinning the fabric containing at least two layers of the card fibrous web, in between of which there is arranged at least one layer of nanofibres is formed by means of cross laying into layers.

Or according to the claim 14 the fabric containing at least two layers of the card fibrous web, in between of which there is arranged at least one layer of nanofibres, after exiting the device for production of nanofibres through electrostatic spinning may be guided into the laying device in which it is laid into layers.

In this manner it is possible to produce a continuous stripe of layered fabric of a constant composition and specified thickness, which after then, as the need may be, is divided into panels of desired dimensions.

25 Further it is advantageous if layers of the fabric are mutually joined by heating to the temperature of melting the material with the lowest melting temperature, which is contained in layers of the fabric.

Through this method it is possible to choose between which layers of the final layered product the joint will be created by means of mutual smelting of adjacent surfaces.

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Description of the drawing

The embodiments of production lines for performance of the production method according to the invention are schematically shown on the drawing, where the Fig. 1 represents the production line with passage of one card fibrous web outside the device for production of nanofibres through electrostatic spinning, the Fig. 2 a section of the production line with passage of both card fibrous webs through the device for production of nanofibres through electrostatic spinning, while one of them is passing outside the spinning compartment, the Fig. 3 and 4 a section of the production line, in which the nanofibres are applied on both layers of the card fibrous web, while according to the Fig. 3 after exiting the spinning device there is only one layer of nanofibres between the two layers of card fibrous web, while according to the Fig. 4 there are after exiting the spinning device both layers of nanofibres positioned together between the two layers of the card fibrous web. The Fig. 5 represents a section of the production line, in which the layers of nanofibres are applied on four layers of the card fibrous web and the Fig. 6 a section of the production line according to the Fig. 3, at which on the carding machine simultaneously three layers of the card fibrous web are being produced, while the third layer forms the auxiliary covering layer.

Examples of embodiment

The Fig. 1 schematically represents the production line 1 for performance of the production method of layered sound absorptive non-woven fabric, known e.g. from the patent application CZ PV 2005-226, according to the invention.

At the beginning of the production line 1 there is arranged the known carding machine 2, which in a known manner prepares the upper layer 21 of the card fibrous web and the lower layer 22 of the card fibrous web for production of layered sound absorptive non-woven fabric. The layers 21, 22 of

the card fibrous web may be produced from staple bicomponent fibres of the type core-coating or of another suitable material.

After exiting from the carding machine the upper layer 21 of the card fibrous web is guided into the device 3 for production of nanofibres through electrostatic spinning, which is for example the device for production of nanofibres through electrostatic spinning of polymer solutions according to the patent application CZ PV 2005-360. The lower layer 22 of the card fibrous web is guided outside the device 3 for production of nanofibres through electrostatic spinning.

The upper layer 21 of the card fibrous web in the device 3 for production of nanofibres is brought in between the pair of electrodes arranged in the spinning compartment 31 of the device 3 for production of nanofibres through electrostatic spinning. After bringing the high voltage of opposite polarity to these electrodes an electric field with a high intensity is created, which through its action of force to the polymer solution in electrostatic field, e.g. on surface of one of the electrodes from this polymer solution creates the polymer nanofibres. The created polymer nanofibres after their creation are deposited on the lower side of upper layer 21 of the card fibrous web and they create a layer 32 of nanofibres, which is adjacent to the lower layer 22 of the card fibrous web.

After applying the layer 32 of polymer nanofibres of desired thickness and/or desired basis weight, the upper layer 21 of the card fibrous web with deposited layer 32 of nanofibres is exiting the device 3 for production of nanofibres through electrostatic spinning. The upper layer 21 of the card fibrous web with deposited layer 32 of nanofibres is after then brought to the lower layer 22 of the card fibrous web passing outside the device 3 for production of nanofibres through electrostatic spinning and both layers 21, 22 are then together brought into the cross laying device 4 positioned after the device 3 for production of nanofibres. In the cross laying device 4 there is performed a known continuous cross laying of layers 21, 22, which contain a layer 32 of nanofibres, and the non-reinforced layered sound absorptive fabric 41 is produced.

The non-reinforced layered sound absorptive fabric 41 is from the cross laying device 4 brought into the hot-air chamber 5, where through the effect of streaming hot air the upper layer 21 containing the card fibrous web and the nanofibres are joined with the lower layer 22 of the card web, and so the layered sound absorptive non-woven fabric 51 is produced.

After the hot-air chamber 5 in the production line 1 there is arranged the cutting device 6, which from the sound absorptive non-woven fabric 51 produces panels 61 of desired dimensions.

The cross laying device 4 may be replaced by any suitable laying device, which is able to lay the continuously brought layers 21, 22, which contain a layer 32 of nanofibres one on another and thus to produce the non-reinforced layered sound absorptive fabric.

Variant of embodiment according to the invention, in which the lower layer 22 of the card fibrous web is guided through the device 3 for production of nanofibres through electrostatic spinning outside the spinning compartment 31 is represented in the Fig. 2. The device 3 for production of nanofibres through electrostatic spinning here forms a compact unit serving to guide also the lower layer 22 of the card fibrous web.

In another variants of method according to the invention the layer of nanofibres 30 is applied not only on the upper layer 21 of the card fibrous web, but also on the lower layer 22 of the card fibrous web, possibly only on the lower layer 22 of the card fibrous web.

In the variant according to the invention represented in the Fig. 3 the device 3 for production of nanofibres through electrostatic spinning comprises a spinning compartment 31, possibly two separated spinning compartments 311, 312. Upon passage of upper and lower layer 21, 22 of the card fibrous web the nanofibres are here applied on lower surfaces of both layers 21, 22. When the layers 21, 22 comprising always the card fibrous web and the layer 32 of nanofibres enter the cross laying device 4, one layer 32 of nanofibres is to be found between the layers 21, 22 of the card fibrous web and the second layer 32 of nanofibres is to be found on the lower surface of the lower layer 22.

Exemplary embodiment according to the Fig. 3 may be added by another layers of the card fibrous web with applied layer of nanofibres. In embodiment according to the Fig. 5 the device 3 for production of nanofibres through electrostatic spinning of polymer solutions comprises four spinning
5 compartments 311, 312, 313, 314, into which there are brought four layers of the card fibrous web 21, 22, 23, 24 from two carding machines. Upon passage of layers 21, 22, 23, 24 of the card fibrous web the nanofibres are applied on the lower surface of layers 21, 22, 23, 24. When the layers 21, 22, 23, 24 of the card fibrous web containing the layer 32 of nanofibres enter the laying
10 device 40 the layers 21, 22, 23, 24 are nearing one to another until their contact occurs, while between the layers 21, 22, 23, 24 of the card fibrous web there is always one layer 32 of nanofibres. On the bottom surface of the lower layer 22 of the card fibrous web there is also a layer of 32 of nanofibres. By this layer 32 of nanofibres the lower layer 22 of the card fibrous web is laid in
15 the laying device on the upper layer 24 of already applied layers of the card fibrous web 21, 22, 23, 24. The disadvantage of this solution is a fact, that one of the outer layers of the resultant layered sound absorptive non-woven fabric 51 is the layer 32 of nanofibres deposited on the utmost lower layer 22 of the card fibrous web, which is a part of the layered sound absorptive non-woven
20 fabric 51. This problem is solved by exemplary embodiments according to the Fig. 4 and 6.

According to the Fig. 6 the carding machine 2 according to the Fig. 3 provided by means for creation of three layers 21, 22, 25 of the card fibrous web, out of which the layers 21, 22 are brought into the spinning
25 compartments 311, 312 of the device 3 for production of nanofibres through electrostatic spinning of polymer solutions, and the layer 25 of the card fibrous web is guided outside the spinning compartments or also outside the device 3 for spinning and to the layers 21, 22 on which in the spinning compartments 311, 312 of the device 3 for spinning there were applied layers 32 of
30 nanofibres, it joins before entering or on entry into the laying device 40 and so it creates the auxiliary layer 25 of the card fibrous web serving for protection of nanofibrous layer applied on the lower layer 22 of the card fibrous web.

Also the device according to the Fig. 5 may be provided by an auxiliary layer 25.

Also in a variant represented in the Fig. 4 the device 3 for production of nanofibres through electrostatic spinning comprises the spinning compartment 31, possibly two separated spinning compartments 311, 312, as it is described at the embodiment according to the Fig. 3. Nevertheless the nanofibres are here applied on layers 21, 22 so that the applied layers 32 of nanofibres are positioned on mutually adjacent surfaces of layers 21, 22 of the card fibrous web. The method of application of nanofibres down from top on the upper surface of the carrying layer is described e.g. in the CZ 294274. Here the polymer solution is filled into a closed vessel, out of which the polymer solution is brought to the surface of the charged electrode, while with the polymer solution there is wetted e.g. the upper section of circumference of the cylinder, which from the vessel carries out on its circumference the necessary quantity of polymer solution.

In all variants represented in the Fig. 2 to 6 the production procedure of layered sound absorptive non-woven fabric 51, possibly of it created panels 61 proceeds in a manner shown in the first embodiment variant of the production line 1 according to the invention, while for the purpose of the invention it is not important which laying device 40 was applied.

It is obvious, that alternatives of embodiment of the production line 1 enable to reach various inner arrangements of the sound absorptive non-woven fabric 51 and to fulfil in a variable manner the requirements as to properties of means absorbing the sound. Especially it is possible to each layer 21, 22, 23, 24 of the card fibrous web to apply a layer 32 of nanofibres of different properties, at the same time under the different properties it is primarily understood the different material, out of which the nanofibres are produced, the different thickness of the layer 32 of nanofibres, the different diameter and/or length of nanofibres and other properties influencing absorbing of the sound.

The described examples of embodiment permit to create further combinations, which are not described in a detail as they are quite obvious for an average specialist.

List of referential markings

- | | | |
|----|-----|--|
| | 1 | production line |
| 5 | 2 | carding machine |
| | 21 | upper layer of the card fibrous web |
| | 22 | lower layer of the card fibrous web |
| | 3 | device for production of nanofibres through electrostatic spinning |
| 10 | 31 | spinning compartment |
| | 311 | upper section of spinning compartment |
| | 312 | lower section of spinning compartment |
| | 32 | layer of nanofibres |
| 15 | 4 | cross laying device |
| | 41 | non-reinforced layered sound absorptive fabric |
| | 5 | hot-air chamber |
| | 51 | layered sound absorptive non-woven fabric |
| 20 | 6 | cutting device |
| | 61 | panel |

12
CLAIMS

1. Production method of layered sound absorptive non-woven fabric, which comprises a resonance membrane formed by a layer of nanofibres having diameter to 600 nanometers and basis weight of 0,1 to 5 gm⁻², which is positioned between two layers of the card fibrous web, **characterised by that** both layers (21,22) of the card fibrous web are produced simultaneously in carding machine (2), from which at least one layer (21) of the card fibrous web is brought into the device (3) for production of nanofibres through electrostatic spinning, in which to the side of this layer (21) of the card fibrous web adjacent to the remaining layer (22) the layer (32) of nanofibres is applied, after then after exiting the device (3) for production of nanofibres through electrostatic spinning both layers (21,22) of the card fibrous web near one to another until their adjacent parts, out of which at least on one there is applied a layer (32) of nanofibres forming the resonance membrane, sit down one on another.

2. The method according to the claim 1, **characterised by that the** lower layer (22) of the card fibrous web is passing outside the device (3) for production of nanofibres through electrostatic spinning.

3. The method according to the claim 1, **characterised by that both** layers (21,22) of the card fibrous web are guided separately into the device (3) for production of nanofibres through electrostatic spinning, while at least the upper layer (21) of the card fibrous web is passing through the spinning compartment (31) of this device (3) and to the side of this upper layer (21) of the card fibrous web adjacent to the lower layer (22) the layer (32) of nanofibres is applied.

4. The method according to the claim 3, **characterised by that the** lower layer (22) of the card fibrous web is passing outside the spinning compartment (31) of the device (3) for production of nanofibres through electrostatic spinning.

5. The method according to the claim 1 or 3, **characterised by that** both layers (21, 22) of the card fibrous web are guided through the spinning

compartments (31) of the device (3) for production of nanofibres through electrostatic spinning, in which one layer (32) of nanofibres is applied to the side of the upper layer (21) of the card fibrous web adjacent to the lower layer (22) of the card fibrous web and the second layer (32) of nanofibres is being applied to the side of lower layer (22) of the card fibrous web reverse to the upper layer (21) of the card fibrous web.

6. The method according to the claim 5, **characterised by that** to the layer (32) of nanofibres applied to the side of lower layer (22) of the card fibrous web reverse to the first layer (21) of the card fibrous web there is joined at least one another layer (23, 24) of the card fibrous web with a layer (32) of nanofibres applied on the reverse side of this another layer (23, 24) of the card fibrous web.

7. The method according to the claim 6, **characterised by that** further layer (23, 24) of the card fibrous web is produced on the same carding machine (2) as the upper and lower layer (21, 22) of the card fibrous web.

8. The method according to the claim 6, **characterised by that** this further layer (23, 24) of the card fibrous web is produced on another carding machine (20) than the upper and lower layer (21, 22) of the card fibrous web.

9. The method according to any of the claims 5 to 8, **characterised by that** to the layer (32) of nanofibres applied on outer side of lower layer of the card fibrous web reverse to the previous layer of the card fibrous web an auxiliary layer (25) of the card fibrous web is joined.

10. The method according to the claim 9, **characterised by that the** auxiliary layer (25) of the card fibrous web is produced on the same carding machine (2) as the upper and lower layer (21, 22) of the card fibrous web.

11. The method according to the claim 9, **characterised by that the** auxiliary layer (25) of the card fibrous web is produced on another carding machine (20) than the upper and lower layer (21, 22) of the card fibrous web.

12. The method according to the claim 1 or 3, **characterised by that** both layers (21, 22) of the card fibrous web are guided through the spinning compartment (31) of the device (3) for production of nanofibres through

electrostatic spinning, in which to the mutually adjacent sides of both layers (21, 22) of the card fibrous web there is applied always one layer (32) of nanofibres.

13. The method according to any of the previous claims, **characterised**
5 **by that** after exiting the device (3) for production of nanofibres through electrostatic spinning the fabric containing at least two layers (21,22) of the card fibrous web, in between of which there is arranged at least one layer (32) of nanofibres, is formed by means of cross laying into layers.

14. The method according to any of the claims 1 to 12, **characterised**
10 **by that** after exiting the device (3) for production of nanofibres through electrostatic spinning the fabric containing at least two layers (21, 22) of the card fibrous web, in between of which there is arranged at least one layer (32) of nanofibres, is guided into the laying device (40) in which it is laid into layers.

15. The method according to any of the previous claims, **characterised**
15 **by that** the layers of the fabric are mutually joined by heating to the temperature of melting the material with the lowest melting temperature, which is contained in layers of the fabric.

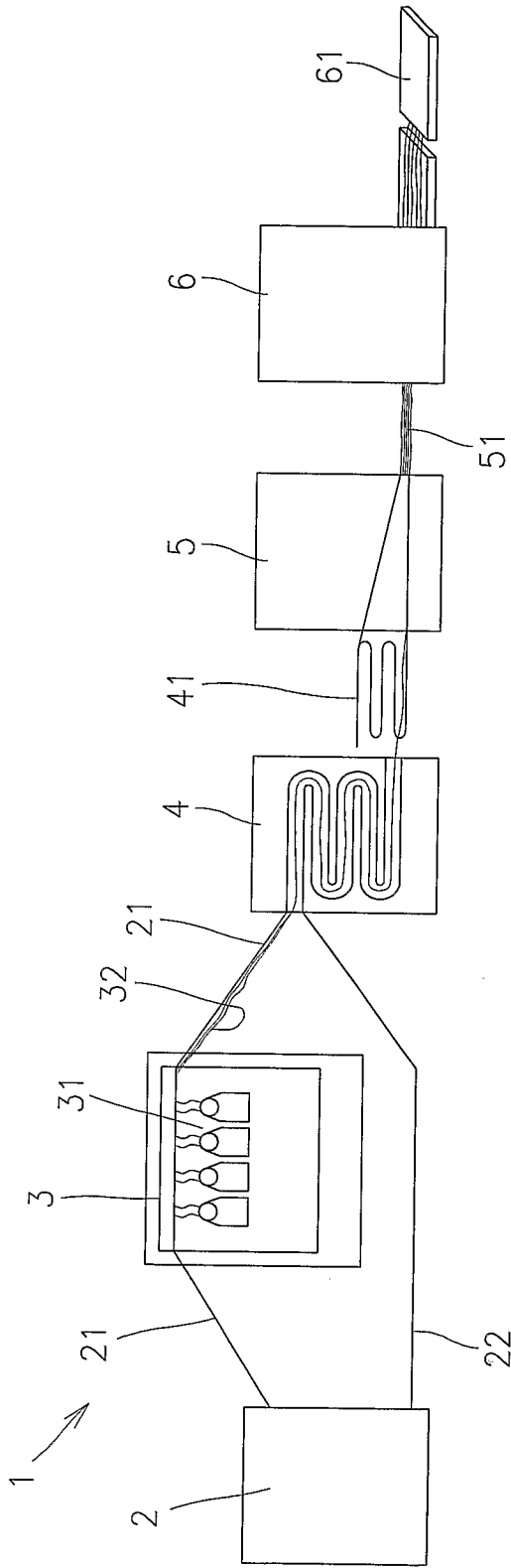


Fig. 1

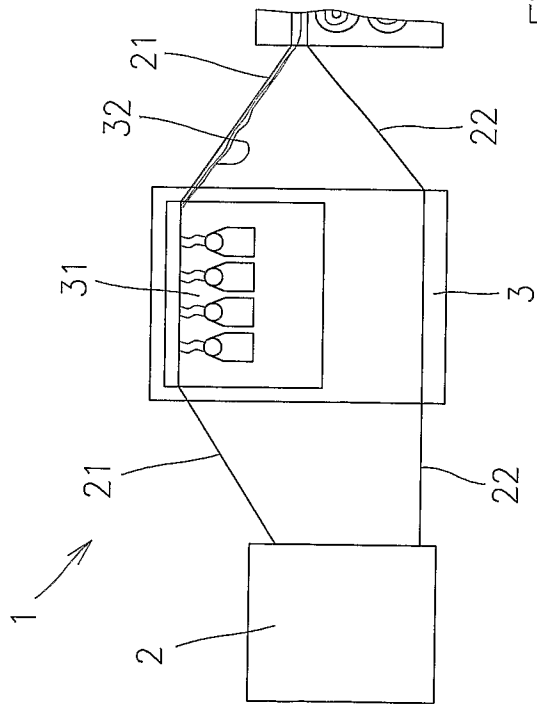
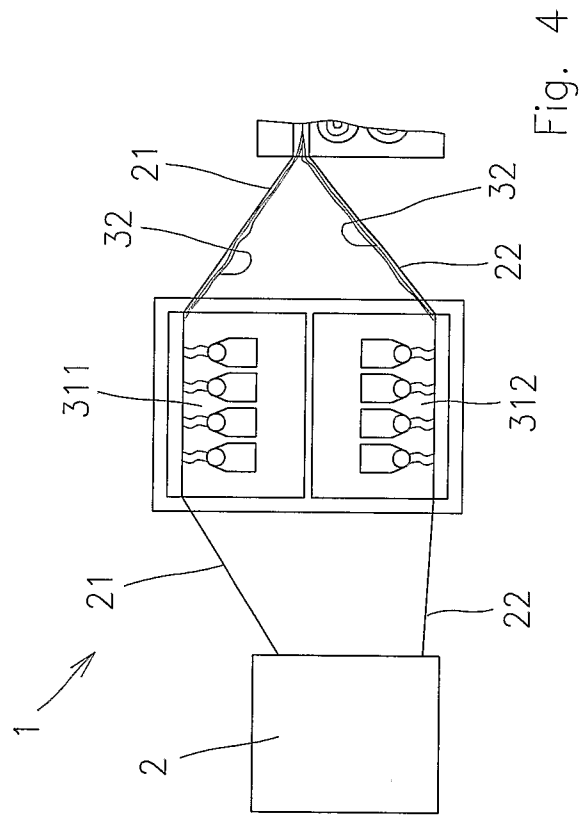
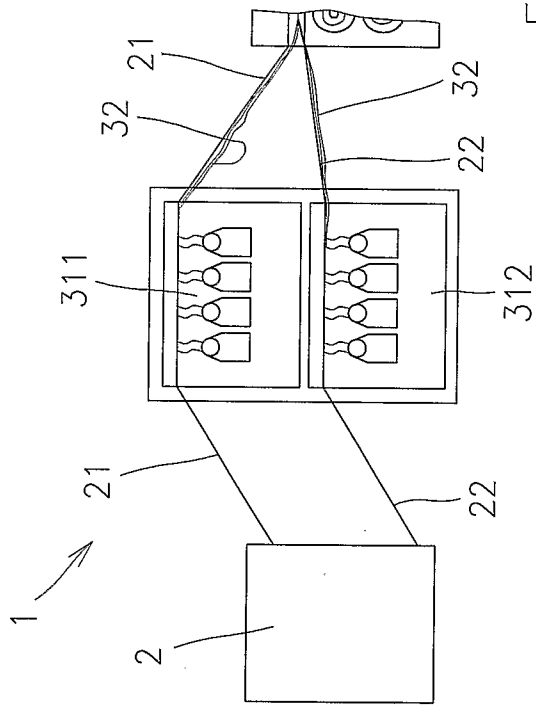


Fig. 2



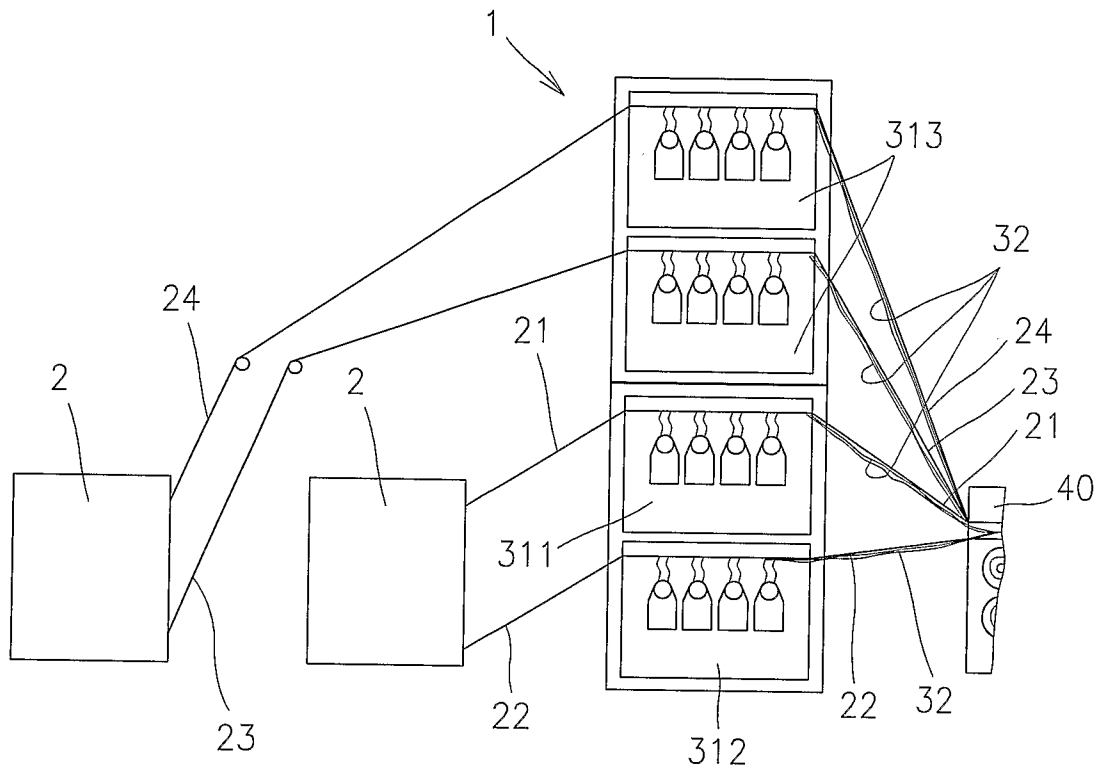


Fig. 5

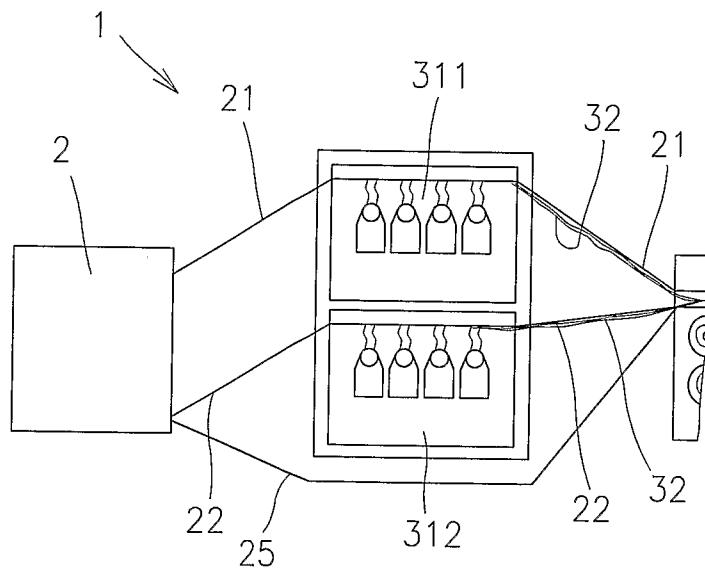


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV., D04H13/00 D04H1/74 G10K11/162 G10K11/168

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D04H B32B G10K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	EP 1 900 863 A (ASSELIN THIBEAU [FR]) 19 March 2008 (2008-03-19) claims; figure 1	1-4, 13, 14
A	WO 2006/108363 A (ELMARCO S R O [CZ]; KALINOVA KLARA [CZ]; SANETRIK FILIP [CZ]; JIRSAK) 19 October 2006 (2006-10-19) cited in the application the whole document	1-15
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Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA/

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NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Barathe, Rainier

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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