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MENETELMÄ HIOMAHUOVAN VALMISTAMISEKSI

METHOD FOR MANUFACTURING NON-WOVEN ABRASIVE ARTICLE

METHOD FOR MANUFACTURING NON-WOVEN ABRASIVE ARTICLE

Description

The invention relates to a method for manufacturing a non-woven abrasive article.

EP 0 912 294 B1 describes the usual method steps for manufacturing a non-woven abrasive article. Materials such as nylon, polyester or mixtures thereof serve as the starting material for such non-woven abrasive articles. The starting material is first subjected to forming a non-woven web and then consolidating said non-woven web. At the end of these steps, the non-woven web is a pre-bonded non-woven web that does not yet comprise abrasive particles. The non-woven web is then passed through an adhesive coater and then a particle coater, in order to apply the abrasive particles. A suitable artificial resin, which cures in a heat stage and then binds the abrasive particles to the starting material, serves as the adhesive.

When passing through the adhesive coater and the particle coater, it is often difficult to always manufacture the coating in the same manner. Accordingly, one problem with the manufacturing method described is to manufacture the non-woven abrasive article with properties that are as homogeneous and reproducible as possible.

US 5,811,186 A describes a process for manufacturing filaments from melt-extruded, melt-bonded thermoplastic fibers. Abrasive particles may subsequently be applied from these filaments.

DE 21 02 786 A describes a method and a device for manufacturing a filament coated with abrasives, with which a filament is coated on its outer surface with an abrasive consisting of individual abrasive grains, wherein the inherent rigidity of the filament is so low that, for example as the bristle of a brush, it runs from the fastening point in the roller and under the effect of gravity approximately in an arc and then vertically downwards.

US 2014/0259960 A1 describes a non-woven web with which a binder material can bond the fibers at crossing points. An abrasive product can be formed from such non-woven web.

US 4,227,350 A also describes the manufacture of an non-woven abrasive article, with which a suitable non-woven web is initially formed from filaments, which is then provided with abrasive particles and a further coating.

US 3,817,004 A describes the manufacture of a wiping mob, with which individual
5 cords or filaments are coated and subsequently picked up at a pickup or headband in such a manner that they hang down to form the wiping mob.

Therefore, it is the object of the invention to improve both the homogeneity and the reproducibility of the manufactured non-woven abrasive article.

This object is achieved by the features of patent claim 1.

10 Preferred embodiments are indicated by subclaims 2 - 11.

The method according to the invention is a method for manufacturing a non-woven abrasive article, wherein non-woven fibers made of a certain starting material are subjected to the method steps of forming a non-woven web then consolidating said non-woven web, whereby, prior to said method step of forming a non-woven
15 web and/or prior to said method step of consolidating said non-woven web, said non-woven fibers are coated with abrasive grains in such a manner that said abrasive grains adhere to said starting material.

Thus, a key finding of the invention is to apply the abrasive grains to the non-woven fibers prior to forming a non-woven web and/or prior to final consolidating of
20 said non-woven web. It has been shown that this allows the abrasive grains to be applied to the non-woven fibers much more uniformly, since the non-woven fibers are still accessible in a separated state.

According to a preferred embodiment, the non-woven fibers are made of a polyamide and/or a polyamide mixture and/or nylon.

25 According to a further preferred embodiment, said formation of a non-woven web is carried out using a carding process and/or using an aerodynamic process.

According to a further preferred embodiment, said consolidation of said non-woven web is carried out using a turbulence process, for example, a water jet turbulence.

Since, according to the invention, abrasive grains have already been added to the material fed to the consolidation of said non-woven web, there is a risk that the tools used in the consolidation of said non-woven web will wear out quickly. In this connection, water jet turbulence has the particular advantage that there is hardly
5 any need to intervene in the non-woven material. The same advantages may also be achieved with consolidation of said non-woven web using a thermal process, for example ultrasonic consolidation. Particularly preferably, turbulence processes and thermal processes may also be used in combination during consolidation of said non-woven web.

- 10 In principle, it is possible in the method according to the invention for the abrasive grains to be applied directly to the abrasive fibers that have not yet fully cured. According to another preferred embodiment, the non-woven fibers are coated with an artificial resin prior to coating with the abrasive grains, which ensures adhesion between the abrasive grains and the non-woven fibers. Preferably, the artificial
15 resin used is a light-curing artificial resin.

- According to a further preferred embodiment, the non-woven fibers are coated continuously. However, it is also conceivable that the non-woven fibers are coated intermittently. Intermittent coating can be particularly advantageous if the average
20 diameter of the abrasive grains is within the range of or greater than the average diameter of the abrasive fibers, such that it is expedient to provide controlled spacing along the non-woven fiber between the abrasive grains.

Further details and advantages of the invention are explained with reference to the following figures. In the figures:

Fig. 1 shows the general view of a plant for manufacturing abrasive yarn,

- 25 Fig. 2 shows a detailed view of the bundling unit 107 of Fig. 1,

Fig. 3 shows a detailed view of the coating unit 109 of Fig. 1,

Fig. 4 shows a detailed view of the non-woven web consolidation unit 115 of Fig. 1,

Fig. 5 shows a first variant of the plant from Fig. 1,

Fig. 6 shows a second variant of the plant from Fig. 1, and

Fig. 7 shows a third variant of the plant from Fig. 1.

Fig. 1 shows a general view of a plant for the manufacturing of abrasive yarn.

According to its basic design, the plant consists of a mixing unit 101, an extruder
5 103, a spinning nozzle 105, a bundling unit 107, a coating unit 109 and a non-
woven web consolidation unit 115.

The mixing unit 101 is connected to the extruder 103 via the connecting flange
102. Various granules may be mixed in the mixing unit and then fed in a mixed
form to the extruder 103.

10 Of course, it is also possible for only one component to be prepared in the mixing
unit and fed to the extruder. For example, polyesters or polyamides, such as nylon
(PA 6.6 with the chemical name polyhexamethylene adipic acid amide), may be
used as granules. Examples of other polyamides include:

- PA 69 (hexamethylenediamine/azelaic acid)
- 15 • PA 612 (hexamethylenediamine/dodecanedioic acid)
- PA 11 (11-aminoundecanoic acid)
- PA 12 (lauric lactam or ω -aminododecanoic acid)
- PA 46 (tetramethylenediamine/adipic acid)
- PA 1212 (dodecanediamine/dodecanedioic acid)
- 20 • PA 6/12 (caprolactam/laurinlactam)

In the extruder 103, the pellets are compressed under high pressure and made to
melt. The melted granules are then fed to the spinning nozzle 105 via the melt
channel 104.

The spinning nozzle 105 is maintained at the necessary spinning temperature (for
25 example, 290 °C for nylon) by a heating unit (not shown further). The spinning
nozzle 105 has a plurality of spinning opening of suitable diameter, as a function of

the viscosity of the melt, in order to allow continuous filaments to be spun. For nylon, for example, the diameter per spinning opening is 0.4 mm. The number of spinning openings can vary greatly as a function of the required strength and diameter of the abrasive yarn, starting from a single spinning opening up to some 100 spinning openings. The spinning opening itself can also be shaped differently. In addition to a circular opening, a star-shaped opening is also conceivable, for example, in order to, in this manner, improve the surface adhesion of the artificial resin or binder.

The filaments spun by the spinning nozzle are then combined at the inlet of the bundling unit 107, where they are mixed together and stretched to form a cohesive yarn 108. A detailed description of the bundling unit 107 is provided below with reference to Fig. 2.

Below the bundling unit 107, a first process interface is marked A. The first process interface A is intended to indicate that there are various options for further processing the yarn 108 at such point. One option is in the manner shown according to Fig. 1, i.e., direct further processing in the coating unit 109. A further option is to wind the yarn 108 onto bobbins at the first process interface A and store such bobbins until further processing.

The yarn 108 bundled by the bundling unit 107 is then fed to a coating unit 109, in which the yarn 108 is encased with a resin and assembled with abrasive grains. A detailed description of the coating unit 109 is provided below with reference to Fig. 3.

Below the coating unit 109, a second process interface is marked B. The second process interface B is in term intended to indicate that there are also various options for further processing the abrasive yarn 112 at such point.

One option is in the manner shown according to Fig. 1; i.e., the abrasive yarn 112 is deposited for direct further processing, for example, on a conveyor belt 110. The drive 111 of the conveyor belt 110 can be used to influence the belt velocity v and thus the density of the deposited material 113. Using the known methods of non-woven processing, the deposited material 113 can then be further processed, for example, into a non-woven abrasive article.

Another option for further processing the abrasive yarn 112 at the second process interface B is to wind the abrasive yarn 112 and then use a weaving process to further process it into a fabric abrasive.

In principle, therefore, further processing of the abrasive yarn into abrasives of any
5 kind is conceivable at the process interface B.

The material 113 deposited on the conveyor belt 110 is then fed to a non-woven web consolidation unit 115, in which the loose fibers are consolidated to form a cohesive non-woven abrasive article. A detailed description of the non-woven web consolidation unit 115 is provided below with reference to Fig. 4.

10 A third process interface is marked C upstream of the non-woven web consolidation unit 115. The third process interface C is in turn intended to indicate that there are also various options for consolidating the deposited material 113 at such point. The main options are chemical consolidation, thermal consolidation, water jet consolidation and needling. All options can also be combined by
15 connecting them in series.

Foam and liquid application are used in chemical consolidation. Slight pre-consolidation is possible with water jet technology. Dewatering of the non-woven is achieved by suction of the foam application. This is followed by drying with cylinder dryers and flow-through dryers.

20 Thermal consolidation is carried out with rotary furnaces. Thereby, the non-woven fibers are consolidated by means of hot air. The flow-through drying process is based on a combination of a screen drum and a radial fan. The fan sucks the air out of the screen drum and returns it to the outside of the drum via heating elements. This creates a suction draft on the drum surface, which holds the non-
25 woven on the drum and simultaneously flows through it. In this process, multiple drums may also be connected in series.

In addition to the central consolidation unit with multiple water beams, the water jet consolidation also comprises downstream spunlace drums and a compacting and dewatering system.

Needling machines for non-woven web consolidation may be of single-board or double-board design. Both may be used with needling from top to bottom or from bottom to top. For some applications, a tandem machine, with one board working from above and one board from below, is also conceivable.

- 5 After the non-woven web consolidation unit 115, a fourth process interface is marked D. At the fourth process interface D, the finished non-woven abrasive article is available for packaging. The finished non-woven abrasive products can then be shipped.

The main control unit 114 is connected to the described components in the
10 manner shown, in order to measure and control the relevant process parameters.

Fig. 2 shows a detailed view of the bundling unit 107 of Fig. 1. At the inlet of the bundling unit 107, the freshly spun filaments are initially combined at the ring opening 201. A further function of the ring opening 201 is to center the combined filaments with respect to the downstream suction jet unit 202. For this purpose, the
15 ring opening 201 can be adjusted in the plane perpendicular to the direction of transport of the combined filaments by a positioning device (not shown in more detail).

The suction jet unit 202 consists of a longitudinal guide unit 203, an air injector unit 204 and a compressed air port 205. The inner diameter of the longitudinal guide
20 unit 203 is slightly smaller (for example, 2 mm) than the inner diameter of the air injector unit 204 (for example, 3 mm). Compressed air at a pressure of, for example, 7 kg/cm² is connected to the compressed air port 205, such that the compressed air follows the indicated path according to the arrows 206. In this manner, a suction jet with high velocity is created in the air injector unit 204. The
25 flow velocity in the middle of the channel can be several kilometers / minute. For example, a typical flow velocity in the center of the channel is 3000 m/min.

The suction jet repels the freshly spun filaments 106 and at the same time causes the filaments to curl among themselves in an irregular and random manner.

Since the velocity of the yarn has a certain slip compared to the flow velocity of the
30 air (for example 10 %), the velocity of the yarn is correspondingly lower (for

example, 2700 m/min) than that of the air flow (as mentioned above, for example, 3000 m/min).

Within the air injector unit 204, flow vortices and turbulence form around the semi-solid filaments, causing the semi-solid filaments to mix, cure and thereby form a cohesive yarn. In addition, the air flow within the air injector unit 204 exerts a suction effect on the yarn, such that the yarn is further transported, tapered and oriented, and in this manner ultimately exits the bundling unit 107 as a cohesive yarn 108.

Fig. 3 shows a detailed view of the coating unit 109 of Fig. 1. In principle, the coating unit 109 comprises a pull-off roller unit 301, a dancer roller unit 302, a primer coating nozzle 303, an abrasive coating nozzle 304, a UV irradiation unit 307 and a control measuring unit 308.

Further transport of the yarn 108 leaving the bundling unit 107 is provided by the pull-off roller unit 301. The velocity of the pull-off rollers 301 is controlled in such a manner that a loose yarn tension is set within the yarn 108 at the entrance of the coating unit 109 in the direction of transport. To compensate for variations in transport velocity, a dancer roller unit 302 is provided in the known manner.

The primer coating nozzle 303 includes a primer or adhesive 305, such that an adhesive layer is formed on the yarn 108 as the yarn 108 passes through the primer coating nozzle 303. The adhesive layer improves the adhesion and adherence of the subsequent coating in the abrasive coating nozzle 304. The thickness of the adhesive layer can be adjusted by the feed rate of the adhesive 305 and also, if necessary, by an adjustable diameter of the primer coating nozzle 303.

The yarn 108 with the adhesive layer is then passed through the abrasive coating nozzle 304, which contains a mixture 306 consisting of a photo-curable resin, abrasive grains and a filler material. The mixture 306 adheres to the adhesive layer, such that the desired abrasive layer in the outer diameter is created. The thickness of the abrasive layer can be adjusted by the feed rate of the mixture 306 and also, if necessary, by an adjustable diameter of the abrasive coating nozzle 304.

At such point, a further variant to the above described coating of the yarn is described: In addition to continuous coating with the primer, the artificial resin and the abrasive grains, it is also possible to carry out the coating intermittently, i.e. with certain interruptions. One reason for this can be, for example, that continuous
5 coating gives the yarn too much bending stiffness. In contrast, the desired flexibility and elasticity of the abrasive yarn could therefore be set very precisely and reproducibly with an intermittent coating.

To implement the intermittent coating, it is conceivable that the primer coating nozzle 303 and the abrasive coating nozzle 304 each have controllable closures
10 that retain or release the coating material in the desired manner. In this manner, the abrasive coating nozzle 304 alone, or the primer coating nozzle 303 and the abrasive coating nozzle 304 together, may be actuated in a uniform cycle, or even in accordance with a specific cycle pattern, in order to selectively apply an intermittent coating to the abrasive yarn.

15 The yarn 108 enters the UV irradiation unit 307 behind the abrasive coating nozzle 304, such that the light-curing resin cures and holds the abrasive grains together. The wavelength of the UV light from the UV irradiation unit 307 depends on the particular artificial resin and can be in the range of, for example, 200 nm to 500 nm. Usually, the curing of the artificial resins used here takes place in a wave
20 range of 315 - 380 nm.

Finally, the abrasive yarn formed in this manner passes through the control measuring unit 308, which measures the outer diameter of the abrasive yarn.

The coating control unit 309 is connected to the described components in the manner shown, in order to measure and control the relevant process parameters.
25 Most importantly, the outer diameter measured by the control measuring unit 308 is evaluated such that the parameters of the primer coating nozzle 303 and the abrasive coating nozzle 306 may be readjusted based on this evaluation.

The atmosphere within the coating unit 109 can additionally consist of nitrogen or an oxygen-reduced gas, in order to achieve stable polymerization of the light-
30 curable resin.

By using the light-curing resin, the yarn 108 can be produced at very high velocities. In principle, velocities of multiple 100 meters/minute to several kilometers/minute are possible, such that the production velocity in the coating unit 109 can be adapted to the velocity of the yarn exiting the bundling unit 107.

- 5 A possible composition of the mixture 306 is described in further detail below:

Any suitable material that is capable of increasing the mechanical strength or abrasion resistance of the light-curing artificial resin, without adversely affecting the curing process, can be used as a filler material. The filler material thus exerts a kind of support function on the abrasive grains.

- 10 In particular, other abrasive grains with a smaller mean diameter than the previously mentioned abrasive grains may thus also be used as filler material. However, powders consisting of metal oxide, metal carbide or non-metal oxide or carbide or of metals can also be advantageous, depending on the application.

Particularly preferably, fine abrasive grains with an average diameter of about

- 15 2 μm to 10 μm may be used as filler material.

The abrasive grains may be made of aluminum oxide or alumina, silicon carbide, CBN, diamond, zirconia alumina, etc., and the average diameter of the grains can be selected as a function of the abrasive application. For example, the abrasive grains may have an average diameter of 20 μm to 200 μm , which in the abrasive

20 range would correspond to a grain size in the range of approximately P800 to P80.

The abrasive grains are added at approximately 5 percent by volume of the light-curing artificial resin liquid and may be wetted with a small amount of ethyl alcohol beforehand.

- For example, the light-curing artificial resin liquid can be an acrylate prepolymer
- 25 (an oligomer or a monomer) with 1 % by weight of an acetophenone derivative mixed in as a photoinitiator.

As mentioned above, the light-curing artificial resin liquid is based on radical polymerization, whereby the radical polymerization of the oligomer or monomer is induced by a free radical generated by the photoinitiator irradiated by the

ultraviolet light. However, the oligomer, monomer and photoinitiator are not limited to these. Similarly, an unsaturated polyester can be used as the oligomer and styrene can be used as the monomer.

For example, polyester acrylate, polyether acrylate, acrylic oligomer acrylate, epoxy acrylate, polybutadiene acrylate, silicone acrylate or polyurethane acrylates may also be used for the oligomer. For example, N-vinyl pyrrolidone, vinyl acetate, monofunctional acrylate, bifunctional acrylate or trifunctional acrylate may also be used for the monomer. For the polymerization initiator, for example, an acetophenone derivative, such as acetophenone or trichloroacetophenone, benzoin ether, benzophenone or xanthone may be used.

In addition, a light addition polymerization design, a light cationic polymerization design or an acid-drying or acid-curing design may be used for the light-curing artificial resin instead of the radical polymerization design.

Fig. 4 shows a detailed view of the non-woven web consolidation unit 115 of Fig.

1. The aim of non-woven web consolidation is to turn a voluminous, soft non-woven into a thinner and stronger sheet. First, non-woven web formation into a non-woven material 113 is performed by depositing the abrasive yarn 112 onto the conveyor belt 110 as shown in Fig. 1. The non-woven material 113 formed in this manner leaves the conveyor belt 110 horizontally and is fed on the following conveyor belt 401 to the non-woven web consolidation process via a further belt and roller system 402.

In the following, the non-woven web consolidation is described in more detail on the basis of needling technology. In the needling machine shown in Fig. 4, the kinematics of the vertical needle movement is implemented by a crank mechanism 403 consisting of eccentrics and connecting rods and via straight guides. With each revolution of the crankshaft, the needle bar 404 continuously performs a rectilinear up and down movement, which movement runs approximately sinusoidally over time. Such oscillating double stroke movements occur at a specific stroke frequency and amplitude, whereby the stroke frequency and amplitude can be set via the control unit 114. Numerous needles are lined up parallel to one another in the so-called needle boards according to an

arrangement scheme orthogonal to the board plane. The needle board itself is fastened to the needle bar 404, which extends as a rigid beam across the working width.

For the passage of the non-woven web inside the needling machine, parallel
5 perforated plates are arranged horizontally. When the needles pierce the non-woven web from above, it supports the lower perforated plate as a so-called stitch plate 406 against puncture forces from above. The perforated plate arranged parallel above it, the so-called blank holder 407, wipes it off against the retraction forces of the needles. The surfaces of the stitch plate and blank holder are
10 smooth, guide the non-woven web and form the space for the throughput via their settable distance. A pair of pull-off rollers 405 frictionally drives the needled non-woven web via a clamp gap and imprints the pull-off velocity on it. However, as long as the needles are engaged, the throughput of non-woven web in the needle zone is stopped.

15 With reference to the second process interface B according to Fig. 1, the depositing and non-woven web formation on the conveyor belt will now be explained in more detail. In order to be able to deposit the abrasive yarn 112 over the entire width of the conveyor belt 110, a device (not shown in more detail) is provided, which can position the abrasive yarn 112 perpendicular to the direction
20 of movement v prior to depositing. For this purpose, the abrasive yarn 112 can be guided at the second process interface B, for example, by an eyelet that is moved back and forth along a traverse perpendicular to the direction of movement v . Similarly, it is also possible for the entire coating unit 109 or, conversely, the conveyor belt 110 to be moved back and forth accordingly. Additionally or
25 alternatively, an air flow unit can be used in order to deposit the abrasive yarn 112 on different positions of the conveyor belt 110 by means of a selectively varying air flow.

As an alternative to forming a single abrasive yarn 112, it is further possible to provide multiple spinning nozzles 105 or a spin bar having multiple spinning
30 nozzles perpendicular to the direction of movement. Fig. 5 shows a first variant of the plant from Fig. 1. The reference signs in Fig. 5 correspond to the reference signs in Fig. 1, such that reference can be made to the description of Fig. 1 with

regard to the description of the components. In contrast to Fig. 1, however, multiple spinning nozzles 105a, 105b, 105c are now provided perpendicular to the direction of movement v , which may be of identical or different design, and in such a manner that the desired deposit of the abrasive yarn 112 is formed over the
5 entire width of the conveyor belt 110. The spinning nozzles may produce identical or different filament diameters.

Fig. 6 shows a second variant of the plant of Fig. 1 with a stretching unit 601, with a finishing unit 602 and with a consolidation unit 605. The process interfaces A, B, C and D correspond in principle to the process interfaces A, B, C and D of Fig. 1,
10 but different variants are conceivable with regard to the stretching unit 601 and the finishing unit 602, which are explained in more detail here.

First, the stretching unit 601 can be of the same design as the bundling unit 107, as shown in detail in Fig. 2. Similarly, the finishing unit 602 can be of the same design as the coating unit 109, as shown in detail in Fig. 3. The same applies to
15 the consolidation unit 605, which can be designed in accordance with the non-woven web consolidation unit 115 shown in detail in Fig. 4.

However, as a variant to the coating unit 109, it is conceivable, for example, that the artificial resin and the primer are dispensed with entirely in the finishing unit 602 and the abrasive grains are applied directly to the yarn that has not yet been
20 fully cured or the yarn surface that has been made plastic again. A coating nozzle can in turn be used for coating, as described in accordance with abrasive coating nozzle 304 in Fig. 3. In addition or as an alternative, it is also possible to bring the abrasive grains into contact with the yarn electrostatically, similar to what is also done with flat abrasives on a backing.

25 In a further variant, drying or curing of the artificial resin occurs after the abrasive yarn has been deposited on the conveyor belt 603. Curing can take place by UV radiation or by conventional thermal drying or other drying methods. To indicate this situation, a thermal drying unit 604 is shown above the conveyor belt 603 as an example in Fig. 6. The basic idea of this variant is that the state of the not yet
30 completely cured abrasive yarn is exploited in order to immediately bring about a certain consolidation when it is deposited on the conveyor belt 603.

Fig. 7 shows a third variant of the plant of Fig. 1 with a stretching unit 701, with a finishing unit 702 and with a consolidation unit 705. The process interfaces A, C and D correspond in principle to the process interfaces A, C and D of Fig. 1, such that the stretching unit 701 can be designed like the bundling unit 107, as shown in detail in Fig. 2. The same applies to the consolidation unit 705, which may be designed in accordance with the non-woven web consolidation unit 115 shown in detail in Fig. 4.

However, according to the variant shown in Fig. 7, the yarn is now already deposited on the conveyor belt 703 downstream of the first process interface A.

10 Once the deposited yarn passes the finishing unit 702, the abrasive grain 706 is sprinkled or sprayed onto the deposited yarn. This is followed by drying or curing with the drying unit 704 along with consolidation with the consolidation unit 705.

MENETELMÄ HIOMAHUOVAN VALMISTAMISEKSI

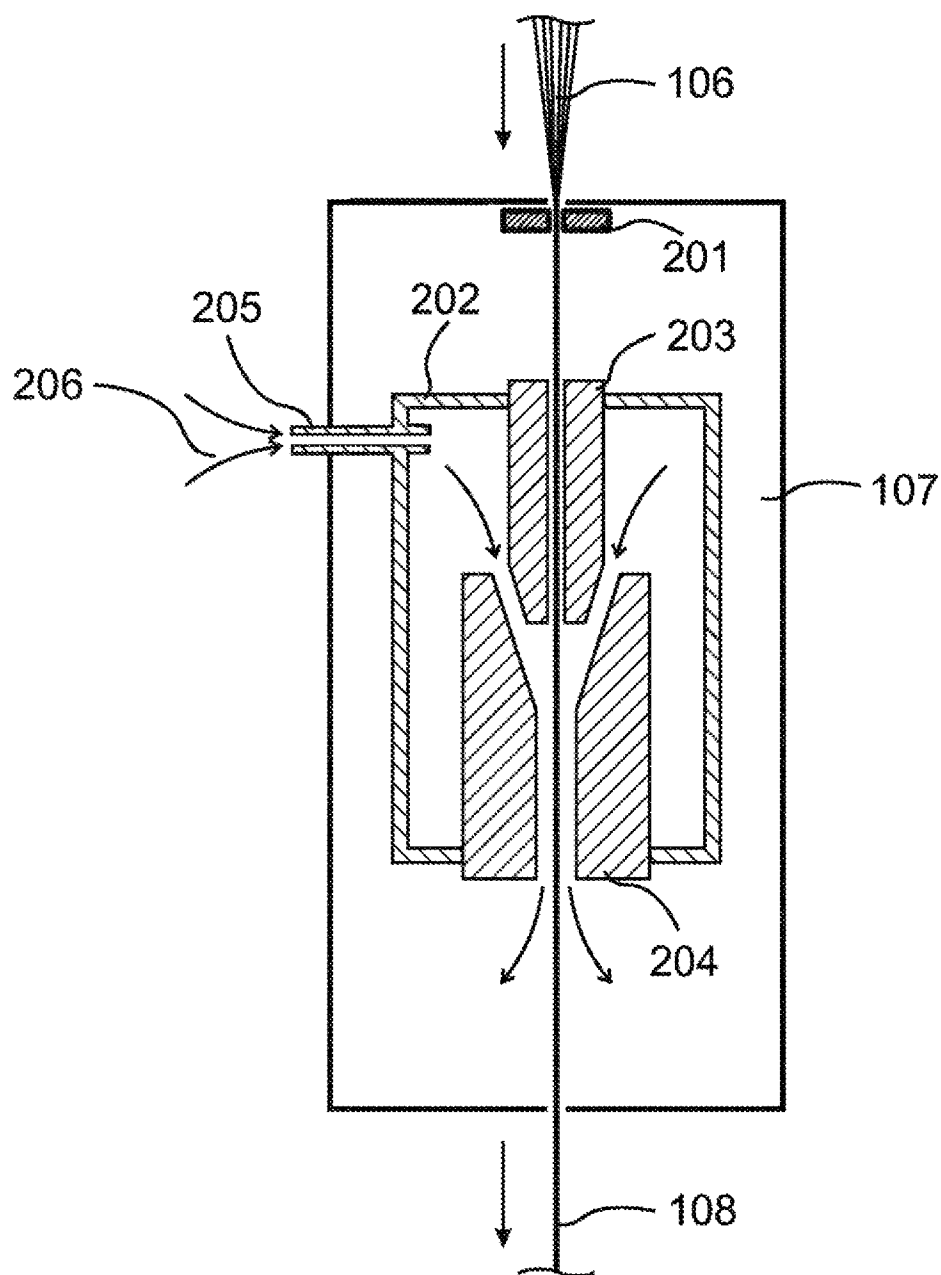
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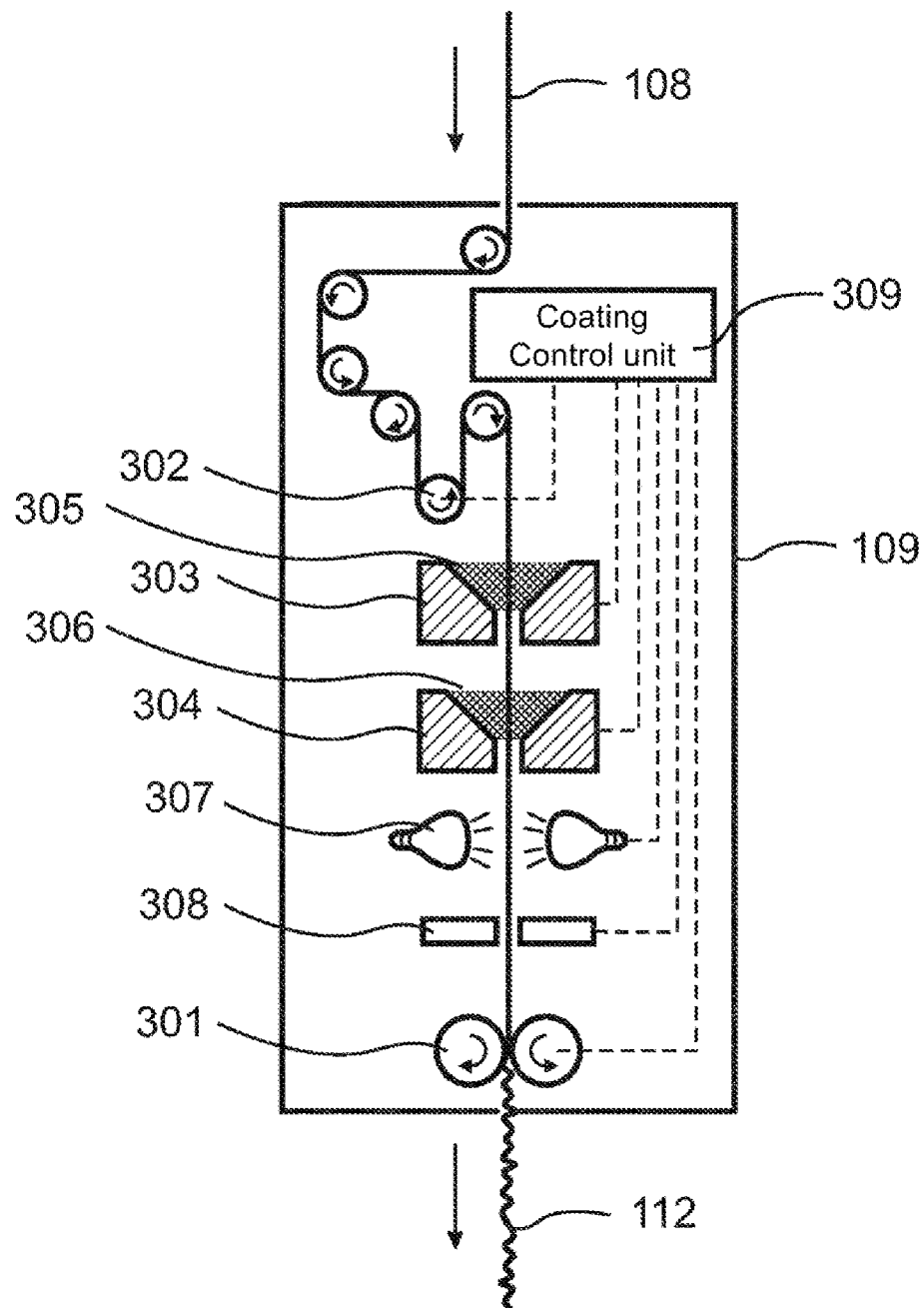
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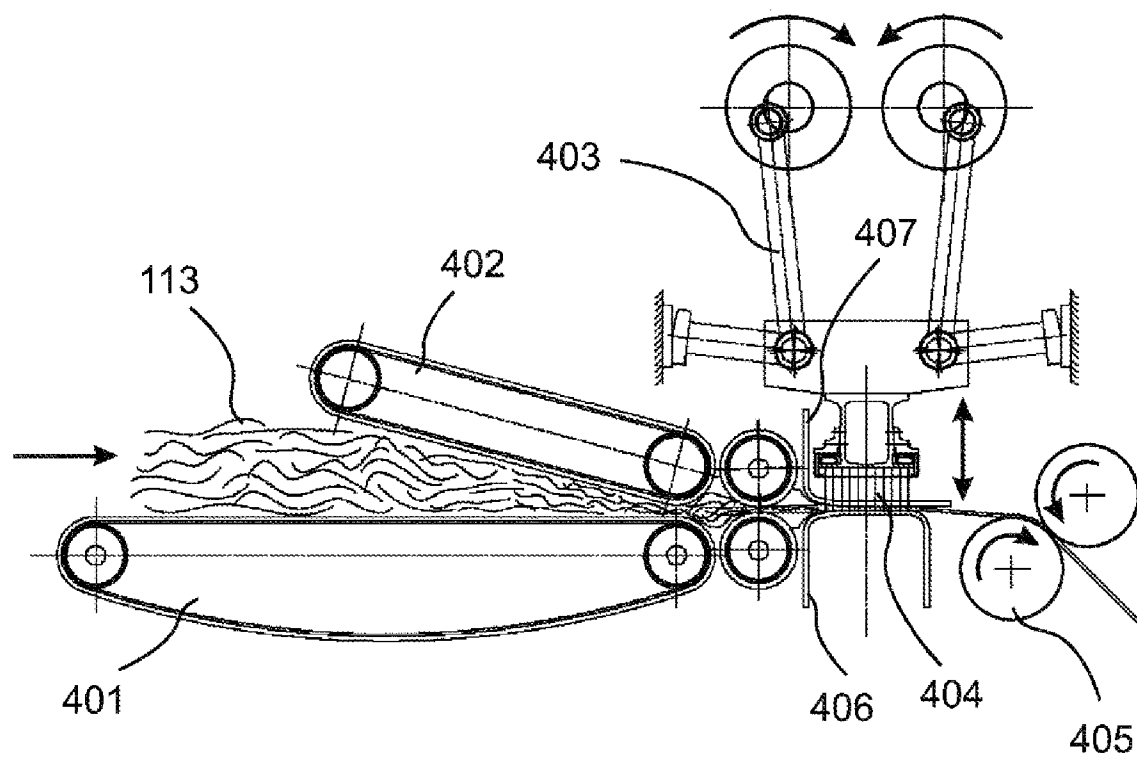
jossa tietyn lähtömateriaalin huopakuituja (108) altistetaan
5 huovanmuodostuksen menetelmävaiheille ja sen jälkeiselle huovankovetukselle,

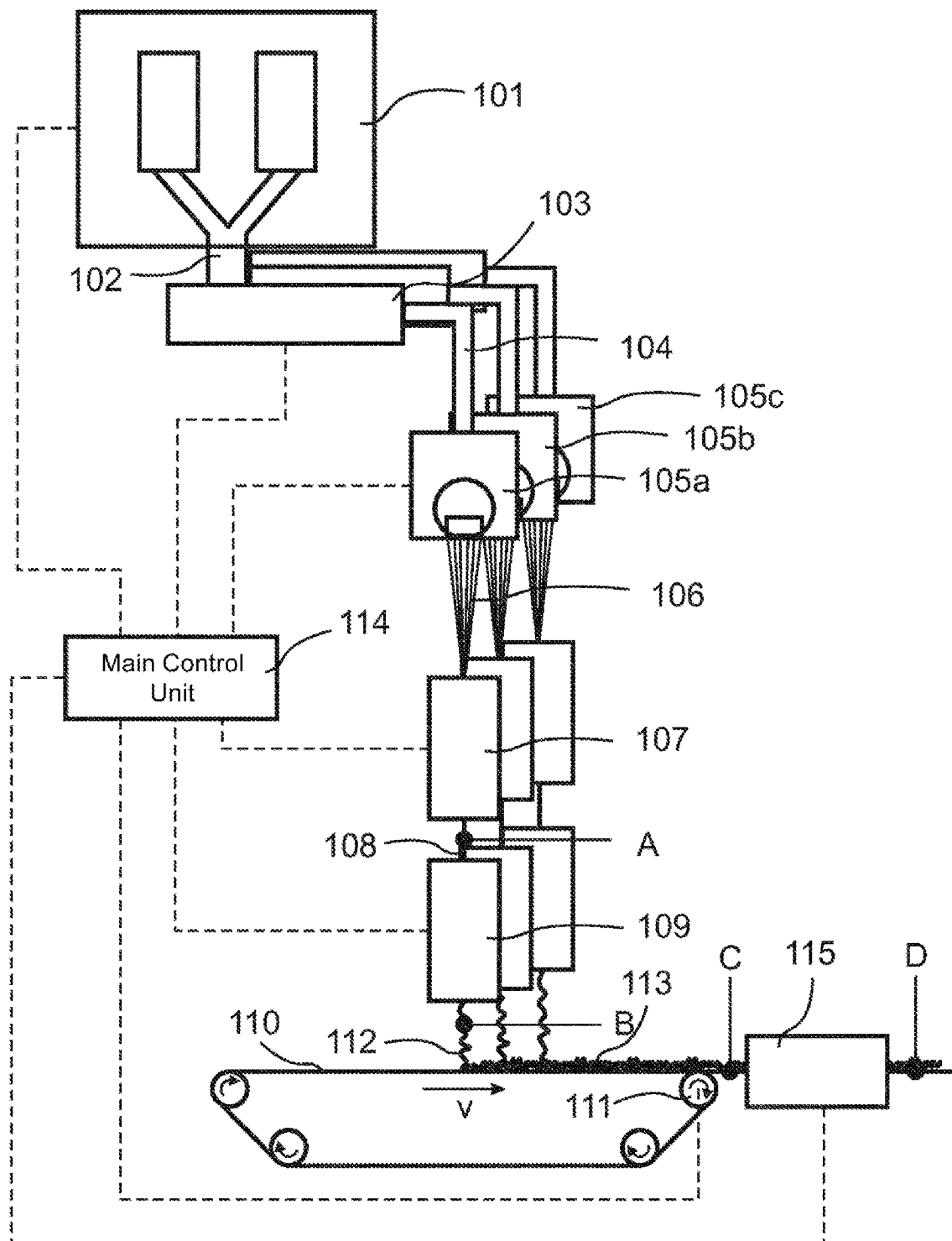
jolloin huopakuidut (108) päällystetään hiomarakeilla ennen
huovanmuodostuksen menetelmävaihetta ja/tai ennen huovankovetuksen
menetelmävaihetta siten, että hiomarakeet tarttuvat lähtömateriaaliin.
2. Patenttivaatimuksen 1 mukainen menetelmä, jolloin huopakuidut (108)
10 koostuvat polyamidista tai polyamidiseoksesta.
3. Patenttivaatimuksen 1 mukainen menetelmä, jolloin huopakuidut (108)
koostuvat nailonista.
4. Jonkin patenttivaatimuksista 1–3 mukainen menetelmä, jolloin huopa
muodostetaan karstausmenetelmällä.
- 15 5. Jonkin patenttivaatimuksista 1–4 mukainen menetelmä, jolloin huopa
muodostetaan aerodynaamisella menetelmällä.
6. Jonkin patenttivaatimuksista 1–5 mukainen menetelmä, jolloin huopa
kovetetaan turbulenssimenetelmällä, esimerkiksi vesisuihkuturbulenssilla.
7. Jonkin patenttivaatimuksista 1–6 mukainen menetelmä, jolloin huopa
20 kovetetaan lämpömenetelmällä, esimerkiksi ultraäänikovetuksella.
8. Jonkin patenttivaatimuksista 1–7 mukainen menetelmä, jolloin huopakuidut
(108) päällystetään synteettisellä hartsilla ennen hiomarakeilla päällystämistä.
9. Patenttivaatimuksen 8 mukainen menetelmä, jolloin synteettisenä
hartsina käytetään valokovettuvaa synteettistä hartsia.
- 25 10. Jonkin patenttivaatimuksista 1–9 mukainen menetelmä, jolloin
huopakuidut (108) päällystetään jatkuvasti.

11. Jonkin patenttivaatimuksista 1–9 mukainen menetelmä, jolloin huopakuidut (108) päällystetään jaksottaisesti.

**Fig. 2**

**Fig. 3**

**Fig. 4**

**Fig. 5**

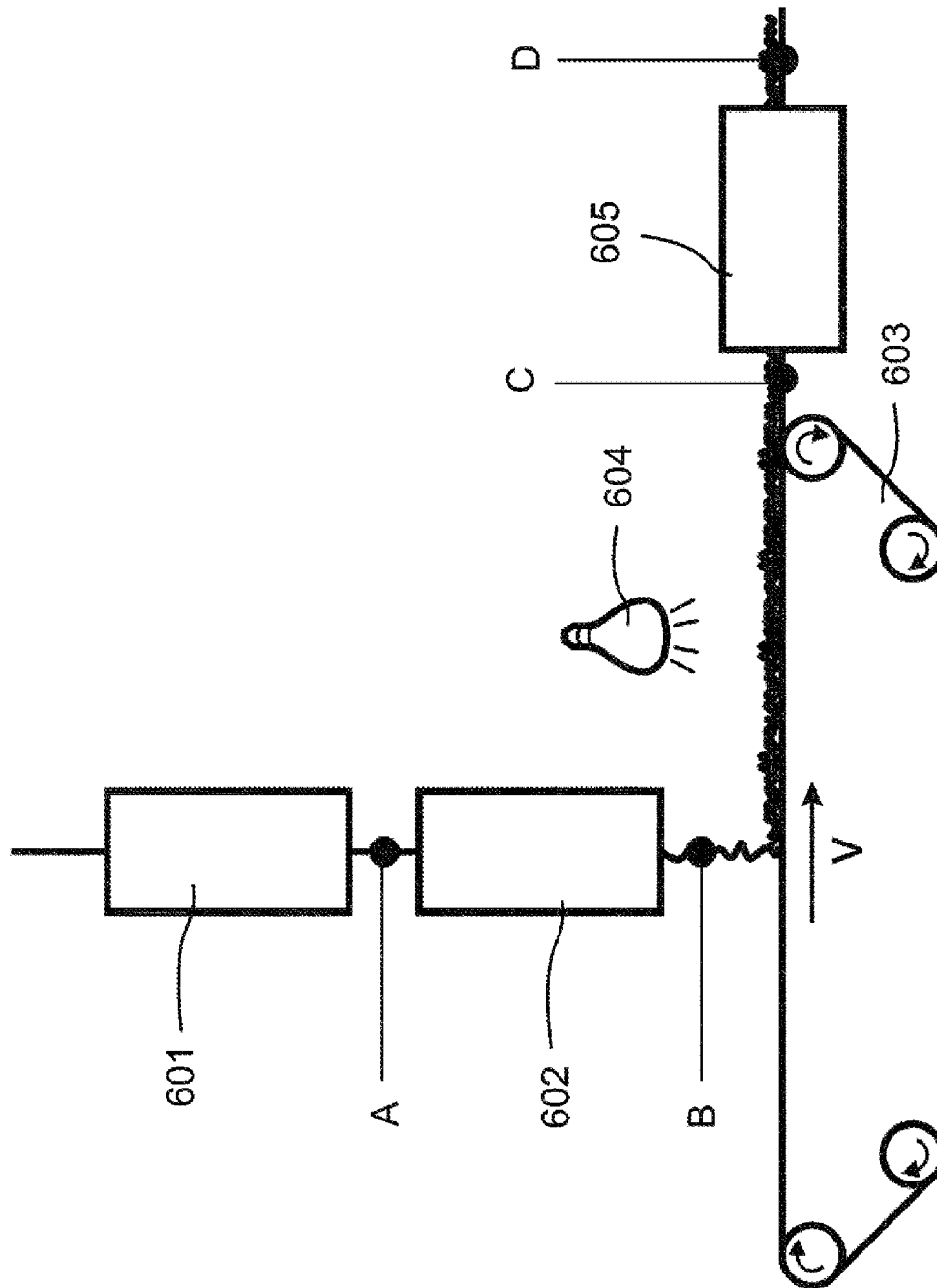


Fig. 6

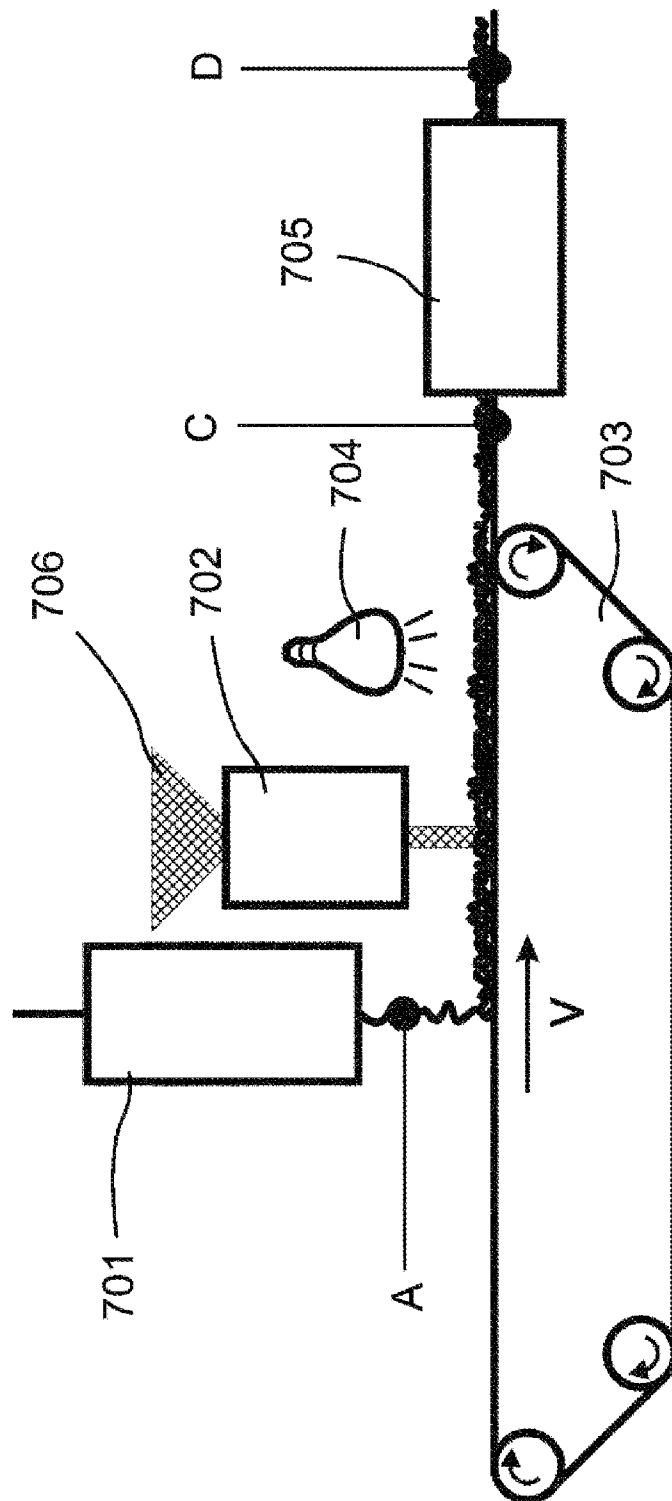


Fig. 7