



(11) **EP 2 530 189 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.12.2012 Bulletin 2012/49

(51) Int Cl.:
D01F 11/00 (2006.01) **D01D 5/00** (2006.01)
D06M 23/08 (2006.01) **B32B 5/26** (2006.01)

(21) Application number: **12168226.4**

(22) Date of filing: **16.05.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **01.06.2011 CZ 20110328**

(71) Applicant: **Technická Univerzita V Liberci**
461 17 Liberec 1 (CZ)

(72) Inventors:
• **Pokorný, Pavel**
46401 Frýdlant v Cechách (CZ)
• **Louda, Petr**
46341 Dlouhý most (CZ)
• **Lukás, David**
46006 Liberec (CZ)

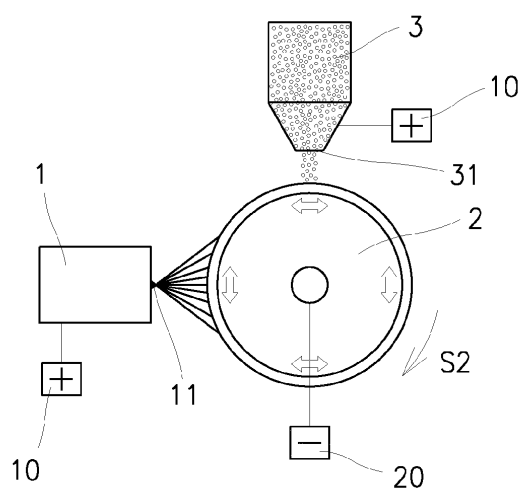
- **Mikes, Petr**
46331 Mnísek u Liberce (CZ)
- **Vyslouzilová, Lucie**
79811 Prostejov (CZ)
- **Chvojka, Jirí**
40747 Varnsdorf (CZ)
- **Hégrová, Božena**
46001 Liberec (CZ)
- **Lukás, Richard**
46322 Mnísek u Liberce (CZ)
- **Amler, Evžen**
17000 Praha (CZ)
- **Buzgo, Matej**
Turna nad Bodvou (SK)

(74) Representative: **Musil, Dobroslav**
Cejl 38
602 00 Brno (CZ)

(54) **Method of production of functional nanofiber layer and device for carrying out the method**

(57) The invention is related to a method for producing a functional nanofiber layer comprising particles of solid and liquid matter by means of electrostatic spinning of a solution or melt of a polymer, at which the produced nanofibers are laid up between a spinning electrode (1, 12) and a collecting electrode (2, 13, 14) onto a base which is the surface of the collecting electrode (2) or a carrying material (8). Thereat, the particles of the solid or liquid matter are brought between the nanofibers of a nanofibrous layer in a direction opposite to the base and laid up in the gaps between the nanofibers.

The invention also relates to a device for carrying out the method.



Obr. 1

EP 2 530 189 A1

Description

Technical field

[0001] A method for producing a functional nanofiber layer comprising particles of solid and liquid matter by means of electrostatic spinning of a solution or melt of a polymer, at which the produced nanofibers are laid up between a spinning electrode and a collecting electrode onto a base which is the surface of the collecting electrode or a carrying material.

[0002] A device for producing a functional nanofiber layer comprising particles of a solid or liquid matter by means of electrostatic spinning of a solution or melt of a polymer between a spinning electrode and a collecting electrode, at which the nanofibers being produced are laid up between the spinning electrode and the collecting electrode onto a base which is the surface of the collecting electrode or a carrying material.

Background art

[0003] The production of nanofibrous layers is usually carried out by means of electrostatic spinning or other well-known methods (usually by means of melt-blowing, drawing or centrifugation). Thereat, small particles are brought into a polymer solution or melt, where they are dispersed. Subsequently, the substance being obtained that way is spun. The second method is based on utilizing the so called coaxial electrostatic spinning. Thereat, a material gets incorporated into the fiber cores, which does not need to be spinnable itself. Among others, liquid dispersions of particles of a solid matter or globules of liquid of a suitable size can be used for the purpose.

[0004] The objective of such solutions is the production of nanofibers obtaining the requested qualities by the incorporation of given particles. By means of subsequent leaching, the material of the particles can also be removed from the fibers, porous fibers with nano-cavities occurring after the material has been washed out being obtained.

[0005] CN 101586256 A solves a method for the production of porous electrospun fibers with nano-salt equally dispersed in a polymer solution, a component fiber (polymer + nano salt) being obtained by means of electrospinning. By means of subsequent leaching of the saline solution the salt is separated, openings are created and the final porous fiber is produced.

[0006] Biologically activated carbon fiber for medical purposes and its production is proposed by CN 101736441 A. Electrostatic spinning and high-temperature sintering is carried out to obtain nanoparticles of calcium phosphate with biological activity in the carbon fibers. The diameter of the carbon fibers varies from 50 to 500 nm; the size of nanometric particles of calcium phosphate varies from 10 to 100 nm; the percentage by weight is between 1 and 10 %. Dispersed nanoparticles of calcium phosphate strengthen the bio-bond between the

carbon nanofiber and the bone tissue and usually improve the ability of induced bone development.

[0007] The objective of KR 20090058155 A is the production of antibacteriological, aseptic and at the same time biologically degradable wrapping paper as a means for filtering air or water. The paper is highly temperature-resistant and mechanically strong. It is made of nanofibers produced by means of electrostatic spinning of a solution having antibacteriological and antiseptic qualities. It contains metallic particles and biodegradable fiber-forming polymer.

[0008] A part of the WO 2008077372 file deals with the method and device for the production of composite fibrous material. At first, fibers of non-ionic polymer are sulphonated. Sulphonated, and thus anionically behaving fibers mix with a polyamide solution in the next step, to make their behaviour cation-active. Finally, the fibers are brought into contact with an anionic dispersion of particles, by means of which the particles get bound to the surface area of the fibers and a fiber-particle composite is produced.

[0009] CZ 300797 B6 relates to a textile comprising at least one layer of polymeric nanofibers obtained by electrostatic spinning from a polymer solution, the polymeric nanofibers comprising particles of a low-molecular matter. The nanofibers of the low-molecular matter are products of a chemical reaction of the low-molecular matter antecedent dissolved in a polymeric solution and a chemical agent applied onto the nanofibers after their spinning. The polymer solution for spinning contains a low-molecular matter antecedent. At spinning, the low-molecular matter antecedent together with the polymer are pulled into the nanofibers being produced. After spinning, a suitable chemical agent is used to act on the antecedent contained in the nanofibers, by means of which the low-molecular matter antecedent transforms into a low-molecular matter.

[0010] CZ 297774 B6 solves the method of the production of photocatalytically active TiO₂. The production starts from a very cheap raw material - alkaline titanate, which is the by-product of the production of titanium white. The titanate is acted upon by glycol while being heated up and the mixture is then processed by sulphuric acid. The product is photocatalytically active TiO₂ of nanofibrous morphology.

[0011] According to CZ 300805 B6, a bio-material based on nanofibrous layers consists of at least two nanofibrous layers, covered by living cells growing on their both sides interconnecting those layers. The nanofibrous layers are unwoven and are composed of synthetic polymers or copolymers of monomers selected from a group comprising methacrylic acid esters, methacrylic acid amides, urethanes, vinyl alcohol and monomers derived from lactic acid and its derivatives, and the method of its preparation. At spinning, the cells are sown on an unwoven layer of nanofibers.

[0012] CZ 2008-241 A3 makes a wrapping agent public, which is namely a wrapping agent comprising woven

or unwoven textile comprising nanofibers and evaporative corrosion inhibitors.

[0013] CZ20096-148 makes an electrostatic spinning device public, containing two serial separated spinning apparatuses. The first of them generates a supporting layer of nanofibers, microfibers and/or liquid nanoparticles containing polyisobutylene on the carrying material. The second spinning device lays the actual functional layer of nanofibers onto the base. The double device is expensive, actually solving only the perfection of the bond of certain functional nanofiber layers to the carrying material and having only an indirect influence on the qualities of the functional nanofiber layer.

[0014] The methods and devices according to the prior art are particularly complicated, not dealing with continuous manufacturing of the final composite product, which in the case is a system of nanofibers with particle material invested. Moreover, the quality of the products depends on the required synchronization of the individual steps of its production. The objective of the invention is to relieve the shortages of the prior art or to reduce them to a significant extent and to propose a reasonably priced method of production of a nanofibrous layer allowing to influence its functional qualities by means of adding powdery particle material.

Principle of the invention

[0015] The objective of the invention is achieved by means of a method for producing a functional nanofibrous layer comprising particles of either a solid or a liquid matter, the goal of which is that the particles of the solid or liquid matter are brought between the nanofibers of the nanofibrous layer, being directed opposite to the base and laid up in the gaps between the nanofibers. That allows for the production of a nanofibrous layer also comprising matters that are not spinnable themselves.

[0016] Solid or liquid particles are brought into the nanofibrous layer immediately after its production. Incorporated particles are evenly distributed in the layer and are safely anchored in it.

[0017] It is advantageous to lay at least one more nanofibrous layer onto the original nanofibrous layer after bringing the particles into it. That way, sandwich structures having the required qualities can be produced.

[0018] The particles are brought into the nanofibrous layer by means of a mechanical method. The mobile means used for the purpose can be simple, cheap and reliable at the same time.

[0019] It is also advantageous to bring the particles into the nanofibrous layer by virtue of gravitation. That usually provides for the simplicity of the batching device.

[0020] Electric wind and electrostatic energy are used to bring the particles into the nanofibrous layer. It is also advantageous to bring the particles into the nanofibrous layer using a current of air. That way, the batching accuracy can be increased and the particles can be transported into a certain area of the nanofibrous layer being pro-

duced.

[0021] To bring the particles in, electrospaying can also be employed. As the output nozzle of the spraying device is not particularly space-demanding, the spraying can advantageously be carried out in a joint step with the electrostatic spinning onto a common area of the base.

[0022] The electrostatic spinning and bringing the particles into the nanofibrous layer is advantageously carried out in a common closed area, which excludes possible undesirable influence of the ambient, resulting in e.g. clogging of the device by impurities or unsuitable ambient temperature.

[0023] The objective of the invention is also achieved by means of a device for the production of a functional nanofibrous layer comprising solid or liquid matter particles, the principle of which is based on placing at least one device for batching the solid or liquid matter particles after the place and/or at the place of laying up the nanofibers opposite to the base. That allows to bring virtually any suitable particles into the nanofibrous layer and to provide for their accurate batching and placing into a suitable area of the nanofibrous layer produced using different means.

[0024] The means for batching solid or liquid matter particles includes a tank with a port, which facilitates the batching and allows to employ gravitational force acting upon the particles brought in for their transport onto the base.

[0025] It is advantageous, when the port of the tank is coupled with a skid plate equipped with a sharp edge at its end facing the base, the skid plate is connected to a high voltage power supply. That allows to produce a narrow current of electric wind directed away from the sharp edge, which facilitates the transport of suitably sized particles into the wind current and further to the desired place.

[0026] It is also advantageous the means for batching the solid and/or liquid particles to be an electrospaying system. The electrospaying device allows to import the particles straight into the area where the fibers making up the nanofibrous layer are laid up simultaneously. The composite nanofibrous material is thus simultaneously produced in one area of the base material.

[0027] The base consists of a rotating collecting electrode. That allows to select the thickness of the nanofibrous layer with invested particles or to produce sandwich structures.

[0028] The base may consist of carrying material. Thereat it is advantageous, if the base is planar-ordered, at least two collecting electrodes are placed below it, a spinning electrode is placed above at least the first collecting electrode and a means for batching the particles is placed above at least one more collecting electrode. The device placed into a longer spinning chamber allows to distribute nanofibers and bring particles of solid or liquid matters into their layer continually onto a band of carrying unwound material. Moreover, the operating sequence can be carried out by means of numerous suc-

cessive spinning electrodes coupled with numerous tanks of wound particles and collecting electrodes assigned to them.

[0029] From the point of view of the surface requirements of the emerging product and the production of a compact layered band, it can be advantageous to place another pair comprising a spinning electrode and a respective collecting electrode after the last means for batching the particles.

Description of the drawing

[0030] The device according to the invention is schematically represented in the drawing, where Fig. 1 shows the basic design, Fig. 2 shows a design comprising two particle tanks, Fig. 3 shows a device using the effect of the electric wind and Coulomb forces to incorporate the particles, Fig. 4 shows a device using the effect of an electro spraying system to incorporate the particles and Fig. 5 and 6 show a continuously operating device processing two types of nanofibers and two types of incorporated particles.

Examples of embodiment

[0031] An exemplary embodiment of the device for incorporating solid or liquid matter particles into a nanofibrous layer at electrostatic spinning comprises a spinning electrode 1 equipped with an output nozzle 11 for importing the processed polymer into an electrostatic field between a spinning electrode 1 connected to the positive pole 10 of a high voltage power supply and a collecting electrode 2 comprising a rotating collector connected to the negative pole 20 of a high voltage power supply. The cylindrical or other surface of the collecting electrode 2 is either covered in a non-represented carrying material or makes up a surface onto which the nanofibers are laid up directly, being removed after finishing the production of the respective layer. Above the collecting electrode 2 a tank 3 is placed, being filled with fine particles of material, which are meant to be incorporated into the final composite nanofibrous material. In the exemplary embodiment, the tank 3 is advantageously connected to the positive pole 10 of the high voltage power supply. In a different embodiment, the tank 3 can be gravitational. In an advantageous embodiment, the tank is coupled with a non-represented vibrational device. The tank 3 is equipped with a lockable outlet 31.

[0032] The embodiment according to the invention represented in Fig. 2 is supplemented by another tank 4 for particles having qualities different from those deposited in tank 3.

[0033] In Fig. 3, a tank 5 for particles is placed, the lower part of which is connected to a bottom comprising a skid plate 6, having a sharp edge 61 neighbouring the collecting electrode 2 and the outlet nozzle 11 of the spinning electrode 1. The edge 61 is connected to the positive pole of the power supply. The wall of the tank 5 finishes

in a lockable outlet 51 in its lowest place. In an advantageous embodiment, the skid plate 6 is connected to an outlet member of a non-represented vibrator.

[0034] In Fig. 4 the device according to the invention is represented, the tank for particles of which is made up of an electro spraying system 7 with a reservoir 71 for the spraying liquid, the outlet tube 72 of which is brought close to the collecting electrode 2 and the outlet nozzle 11 of the spinning electrode 1. The electro spraying nozzle 73 is directed into the area of the collecting electrode 2, onto which the nozzle 11 of the spinning electrode 1 is directed as well. The outlet tube 72 is connected to the positive pole 10 of the high voltage power supply. In a non-represented embodiment, there is a tank for solid particles instead of a reservoir 71 for the spraying liquid.

[0035] In a non-represented embodiment, there are devices included, comprising electrical means for the atomization of particles and their transport towards the surface of the collecting electrode, which are represented in Fig. 3 and 4, is supplemented by supportive pneumatic means. Those comprise a compressed air feeding pipeline the outlet nozzle of which neighbours the outlet opening 51 of the tank 5 of particles or the outlet tube 72 orifice directed towards the surface of the collecting electrode 2.

[0036] In another non-represented embodiment, the device is not equipped with a means for transporting particles to form an electric field. The production of particles and their transport to the surface of the collecting electrode is provided solely by the aerodynamic effect commonly known in relation to pneumatic means.

[0037] In Fig. 5, a device according to the invention is represented, intended for a continuous production of a nanofibrous layer with incorporated particles. In contrast to the embodiment according to Fig. 1 to 4, a part of the collecting electrode 2 is belted with a band of carrying material 8, led by a pair 81 of intake rollers before the collecting electrode 2 and by a pair 82 of off-take rollers after the collecting electrode 2. In the vicinity of the part of the collecting electrode 2 circuit opposite to the spinning electrode 1 another spinning electrode 12 is placed.

[0038] In Fig. 6, another embodiment of the device according to the invention is represented, intended for a continuous production of a nanofibrous layer with incorporated particles. The motion of the carrying material 8 band in the S1 direction is mediated by means of a pair 83 of feed rollers and a pair 84 of detaching rollers. In the spinning chamber 9, the spinning electrode 1, the tank 4 for particles, the spinning electrode 12 and the tank 4 for particles are placed gradually in the S1 direction of the carrying material 8 band's motion above the carrying material 8. Below the band of carrying material 8, two collecting electrodes 13 are placed under the spinning electrodes 1, 10 and two collecting electrodes 14 are placed under the tanks 3, 4. In a non-represented embodiment, two spinning electrodes 1, 12 are placed in a row, having tanks 4 and 3 for particles in a row after them.

[0039] A layer of nanofibers distributed in a commonly

known way (Fig. 1), comes under the outlet opening 31 of the tank 3 for particles after the collector 2 has been turned in the S2 direction. After the outlet opening 31 has been opened, the particles are poured into a layer of nanofibers by means of gravitation and/or the effect of the voltage difference occurring between the tank 3 for particles and the collecting electrode 2. Thereat, the collecting electrode 2 can perform several revolutions when producing a single fibrous film, whereupon sandwich material gets produced, in the layers of nanofibers of which the poured particles are incorporated in the gaps between the nanofibers.

[0040] With the device according to Fig. 2, two kinds of particles from tanks 4 and 3 get gradually laid up after the distribution of the nanofibers.

[0041] In the exemplary embodiment according to Fig. 3, the tank 5 for particles is placed as close as possible to the spinning electrode 1 or its outlet nozzle 11. After the outlet opening 51 of the tank 5 has been opened to pour the particles, the particles lying directly on the skid plate 6 are moved through the outlet opening 51 towards the edge 61 of the skid plate 6. Such movement of particles may be facilitated by vibrations of the skid plate 6. The sharp edge 61 connected to the positive pole 10 of the efficient high voltage power supply charges the powdery particles electrically. Ionization of the gaseous environment occurs and electric wind is formed. The current of electric wind in the S3 direction away from the edge 61 is very narrow (forming a so called stream); that is why quick flux occurs in the vicinity of it, helping transport suitably sized particles into the current and further to a required place, i.e. to the surface area of the collecting electrode 2 virtually simultaneously with the stream of nanofibers leaving the outlet nozzle 11 of the spinning electrode 1. Hereat, the like electric charge obtained by the particles contacting the charged edge 61 is utilized. The like charged particles then repel each other and obstruct the bunching of minute particles. At the same time, those charged particles are gravitated towards the collecting electrode by Coulomb forces, which also supports their motion.

[0042] The electro spraying system according to Fig. 4 uses a strong electric field to transport the particles. By means of it, the surface level of the spraying liquid transported through the outlet tube 72 from the reservoir 71 for the spraying liquid gets unbalanced, whereupon small droplets occur through so called electro spraying. Those droplets occurring after a contact with the charged edge of the nozzle 73 of the outlet tube 72 get seized by the current of the electric wind and transported to a required place. In this case, that is straight into the area where the fibers making up the nanofibrous layer are laid up simultaneously. The composite nanofibrous material is simultaneously produced in one place of the base material.

[0043] After using the atomizing device according to the invention, it is not necessarily needed to use the oppositely charged counter-electrode as the potential of the

charged edge forming the electric wind is related to the ground consisting in e.g. the frame of the machine, the floor of the room etc.

[0044] An analogical electro spraying system may also be using already existing particular materials sputtered electrostatically onto the surface of the collecting electrode virtually simultaneously with the nanofibers.

[0045] With the non-represented devices described above, electrostatic forces and aerodynamic effects of the air current lead from the respective source of compressed air are used for transporting the particles to the surface of the collecting electrode or for atomizing the liquid. The compressed air is used to support the effects of the electric field or, with devices not utilizing the electric field to transport particles, the aerodynamic effect of the compressed air is the only driving agent of the particles distributed into the nanofibrous layer.

[0046] Methods commonly known so far can also be used for the transport of particles and their batching. With one of those, the particles are transported by means of rotating or otherwise moving brushes. A device utilized with another commonly known method, comprises a surface-structured rotating roller, carrying the particles in cavities made on its surface and pouring them into the nanofibrous layer being formed.

[0047] The embodiments represented in Fig. 1 to 4 and their modifications related to the mutual arrangement of the spinning electrodes and tanks for particles allow to produce extensive sandwich material of a required thickness, which may comprise layers of nanofibers of different kinds, by means of multiple rotations of the collecting electrode 2 in the S2 direction.

[0048] The collecting electrode 2 of the device according to Fig. 5 is partly banded with a carrying material 8 band. Its continuous motion in the S4 direction is derived from the rotation of the collecting electrode 2 in the S2 direction or the interaction of the pair 81 of the input rollers and the pair 82 of the off-take rollers, which are linked to non-represented driving means. In the exemplary embodiment, a layer of nanofibers produced by the spinning electrode 1 is primarily produced, followed by the particles from tanks 4, 3 being gradually incorporated into that layer and overlayed by a layer of nanofibers produced by the spinning electrode 12 afterwards. The band of carrying material 8 covered in a multicomponent nanofibrous layer is taken off by means of a pair 82 of off-take rollers for storing purposes or further processing.

[0049] With the device for continuous production of nanofibrous material, represented in Fig. 6, a band of carrying material 8 is lead through a lengthwise arranged spinning chamber 9 virtually horizontally in the S1 direction, being driven by means of a pair 83 of feed rollers supported by a pair 84 of detaching rollers. After the band of carrying material 8 has entered the spinning chamber 9 the first nanofibrous layer, the first kind of particles, the second nanofibrous layer and the second kind of particles are gradually distributed onto it. The produced multicomponent nanofibrous material is detached from the spin-

ning chamber **9** by means of a pair **84** of detaching rollers. The resulting multicomponent nanofibrous material can be modified through changing the order of spinning electrodes **1**, **12** and tanks **4**, **3**. That way, a second layer of nanofibers produced by means of spinning electrode **12** can be added to the first layer of nanofibers produced by means of spinning electrode **1** and the first kind of particles from tank **4** and subsequently the second kind of particles from tank **3** can be poured.

[0050] The represented and described embodiments according to the invention are not of a limiting effect. Their arrangements and modes of operation can be modified within the range of the patent claims, e.g. in terms of the direction of the nanofibers being fed in relation to the motion of the base which they are distributed on. The places where incorporated particles get bound to the nanofibrous layer can change similarly. Different kinds of particles can, for instance, be brought into virtually the same place of the nanofibrous layer based on current needs.

List of reference marks

[0051]

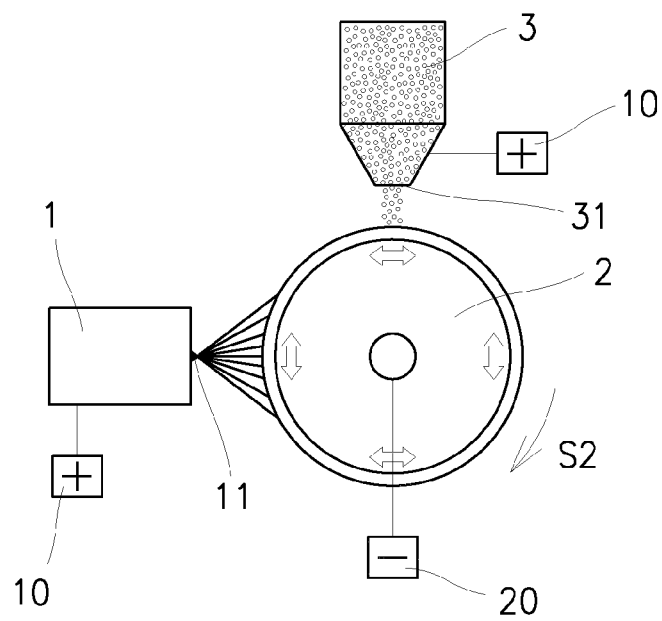
- 1 spinning electrode
- 10 positive pole (of the HV power supply)
- 11 outlet nozzle (of the spinning electrode)
- 12 spinning electrode
- 13 collecting electrode
- 14 collecting electrode
- 2 collecting electrode
- 20 negative pole (of the HV power supply)
- 3 tank
- 31 outlet opening (of the tank)
- 4 tank
- 5 tank (including the skid plate)
- 51 outlet opening (of the tank with the skid plate)
- 6 skid plate
- 61 edge (of the skid plate)
- 7 electrospaying system
- 71 reservoir (for the spraying liquid)
- 72 outlet tube (of the spraying liquid)
- 73 electrospaying system
- 8 carrying material
- 81 pair of input rollers
- 82 pair of off-take rollers
- 83 pair of feed rollers
- 84 pair of detaching rollers
- 9 spinning chamber
- S1 direction of the carrying band motion (in chamber 9)
- S2 direction of the rotation of the collector
- S3 direction of the electric wind streaming
- S4 direction of the carrying band motion

Claims

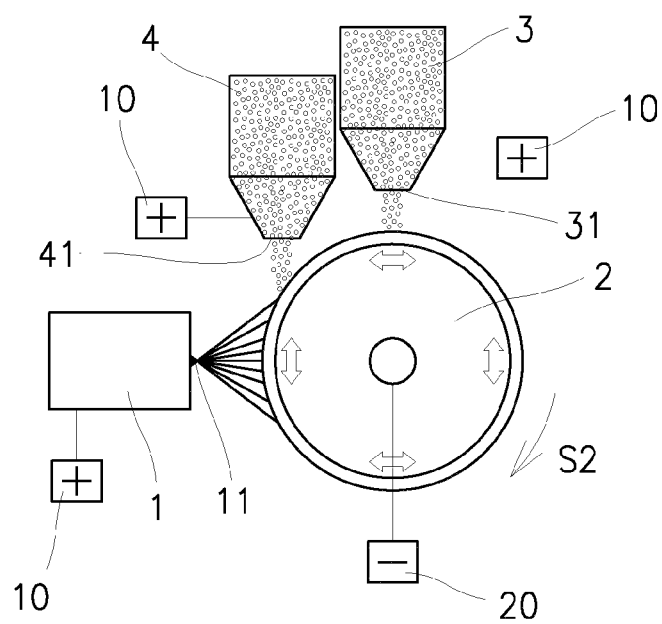
1. A method for producing functional nanofibrous layers comprising particles of a solid or liquid matter by means of electrostatic spinning of a solution or a melt of a polymer, with which the produced nanofibers are laid up between the spinning electrode (1) and the collecting electrode (2, 13, 14) onto a base which is the surface of the collecting electrode (2) or a carrying material (8), **characterized in that**, the particles of the solid or liquid matter are brought between the nanofibers of the nanofibrous layer in a direction opposite to the base and are laid up in the gaps between the nanofibers.
2. A method according to claim 1, **characterized in that**, the particles of the solid or liquid matter are brought into the nanofibrous layer immediately after its production.
3. A method according to claims 1 or 2, **characterized in that**, at least one more nanofibrous layer is laid up onto the original nanofibrous layer after the particles have been brought into the latter.
4. A method according to any of the claims previously mentioned, **characterized in that**, the bringing the particles into the nanofibrous layer is performed by means of a mechanical method.
5. A method according to claim 4 **characterized in that**, the bringing the particles into the nanofibrous layer is performed by virtue of gravitational effects.
6. A method according to claims 4 or 5, **characterized in that**, for bringing the particles into the nanofibrous layer there are used an electric wind and electrostatic forces.
7. A method according to any of the claims 4 to 6, **characterized in that**, for bringing the particles into the nanofibrous layer there is used a current of air.
8. A method according to claim 4 **characterized in that**, the bringing the particles is performed by means of electrospaying.
9. A method according to claim 8 **characterized in that**, the spraying is performed in a joint step with electrostatic spinning onto a common area of the base.
10. A method according to any of the claims previously mentioned, **characterized in that**, the electrostatic spinning and bringing the particles into the nanofibrous layer are performed in a shared closed area.
11. A device for producing functional nanofibrous layers

comprising particles of a solid or liquid matter by means of electrostatic spinning of a solution or melt of a polymer between a spinning electrode (1, 12) and a collecting electrode (2, 13, 14), with which the produced nanofibers are laid up between the spinning electrode (1, 12) and the collecting electrode (2, 13, 14) onto a base which is the surface of the collecting electrode (2) or a carrying material (8), **characterized in that**, after the place and/or at the place of laying up the nanofibers there is placed opposite to the base at least one means for batching the particles of the solid or liquid matter.

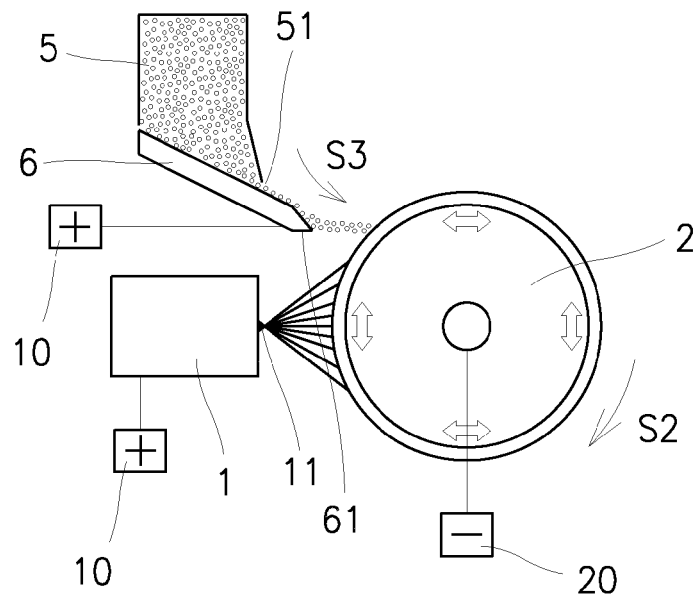
12. A device according to claim 11 **characterized in that**, the means for batching the particles of the solid or liquid matter comprises a tank (3, 4, 5) with an outlet opening (31, 41, 51).
13. A device according to claim 12 **characterized in that**, the outlet opening (51) of the tank (5) is coupled with the skid plate (6) equipped with a sharp edge (61) at its end neighbouring the base, whereas the skid plate (6) is connected to a high voltage power supply.
14. A device according to claim 11 **characterized in that**, the means for batching the particles of the solid and/or liquid matter is an electrospraying system (7).
15. A device according to any of the claims 11 to 14, **characterized in that**, the base is formed by a rotating collecting electrode (2).
16. A device according to any of the claims 11 to 14, **characterized in that**, the base is formed by carrying material (8).
17. A device according to claim 16 **characterized in that**, the base is positioned in a plane, under which at least two collecting electrodes (13, 14) are placed, whereas at least above the first collecting electrode (13) there is placed a spinning electrode (1, 12) and at least above one more collecting electrode (14) there is placed a means for batching the particles.
18. A device according to any of the claims 11 to 17, **characterized in that**, after the last means for batching the particles there is placed a spinning electrode (1, 12).



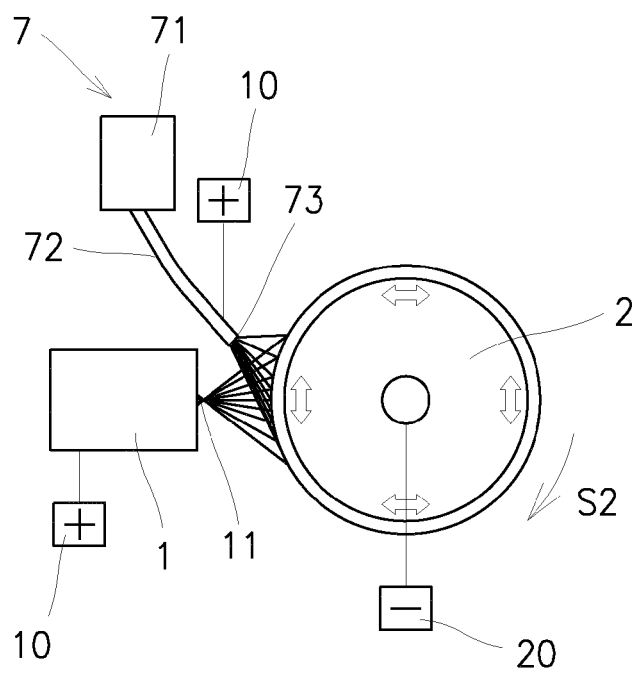
Obr. 1



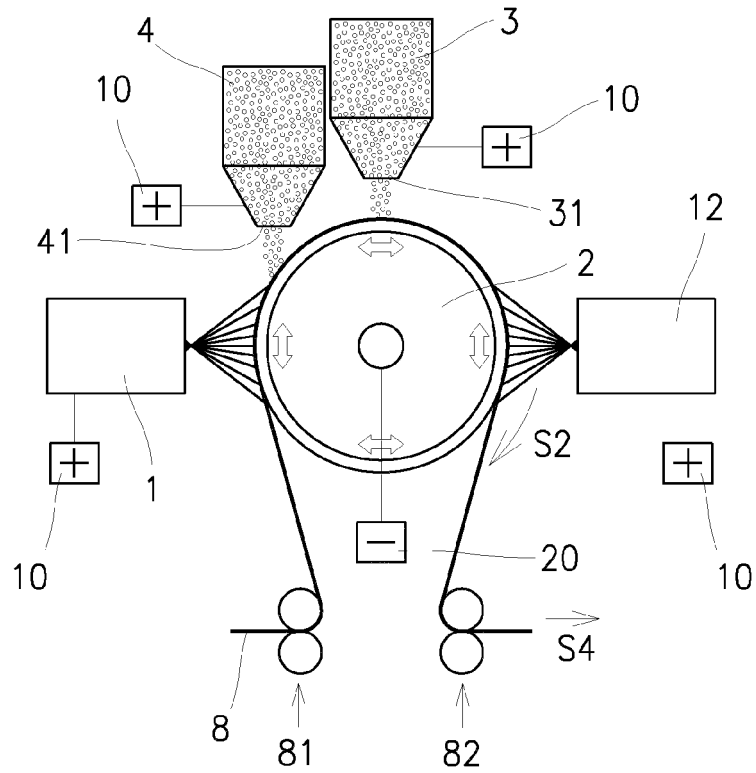
Obr. 2



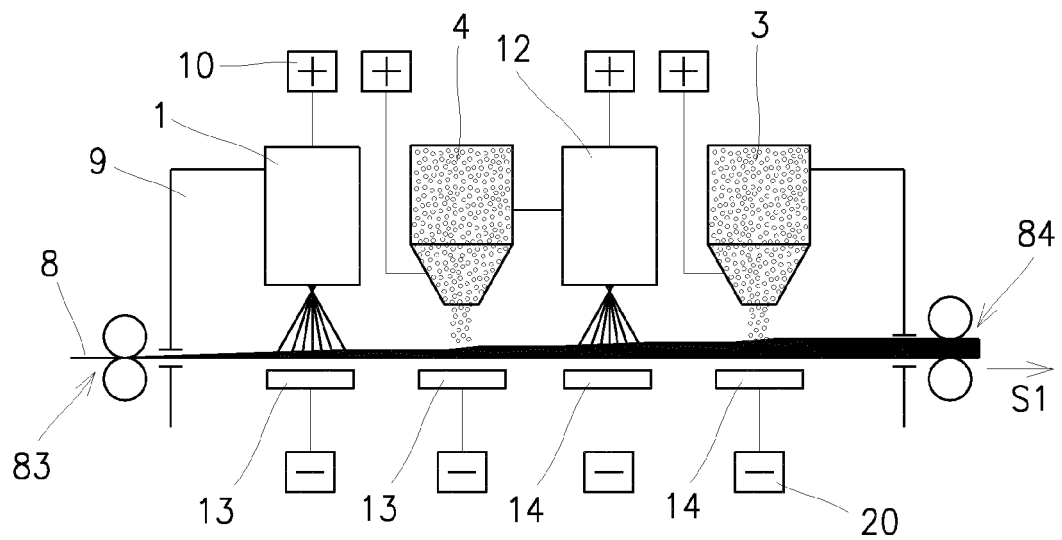
Obr. 3



Obr. 4



Obr. 5



Obr. 6



EUROPEAN SEARCH REPORT

Application Number
EP 12 16 8226

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 2008 285793 A (JAPAN VILENE CO LTD) 27 November 2008 (2008-11-27) * abstract * * paragraph [0044] - paragraph [0046] * * paragraph [0059] * * paragraph [0071] * * paragraph [0074] * * paragraph [0090] * * figure 5 *	1-6, 8-12, 14-18	INV. D01F11/00 D01D5/00 D06M23/08 B32B5/26
X	----- KR 2007 0097936 A (AMOMEDI CO LTD [KR]) 5 October 2007 (2007-10-05) * abstract * * paragraph [0001] * * figure 1 *	1-6, 8-12, 14-17	
X	----- CN 101 947 415 A (UNIV DONGHUA) 19 January 2011 (2011-01-19) * abstract * * examples *	1,2,4,6, 8,10-12, 14-16	TECHNICAL FIELDS SEARCHED (IPC)
X	----- US 2003/069369 A1 (BELENKAYA BRONISLAVA G [US] ET AL) 10 April 2003 (2003-04-10) * paragraph [0021] * * claims 11,12 * * figure 2 *	1,2,4,7, 9-12	D01F D01D D06M B32B D04H
X	----- EP 1 264 804 A1 (JAPAN VILENE CO LTD [JP]) 11 December 2002 (2002-12-11) * paragraph [0047] * * figure 1 *	1,2,4,5, 7,10-12, 15,16	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 5 October 2012	Examiner Fiocco, Marco
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 16 8226

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

05-10-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2008285793 A	27-11-2008	NONE	

KR 20070097936 A	05-10-2007	NONE	

CN 101947415 A	19-01-2011	NONE	

US 2003069369 A1	10-04-2003	US 2003069369 A1	10-04-2003
		US 2009137936 A1	28-05-2009
		US 2011076250 A1	31-03-2011

EP 1264804 A1	11-12-2002	DE 60210165 T2	10-08-2006
		EP 1264804 A1	11-12-2002
		EP 1577274 A2	21-09-2005
		US 2003005723 A1	09-01-2003
		US 2004214497 A1	28-10-2004

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 101586256 A [0005]
- CN 101736441 A [0006]
- KR 20090058155 A [0007]
- WO 2008077372 A [0008]
- CZ 300797 B6 [0009]
- CZ 297774 B6 [0010]
- CZ 300805 B6 [0011]
- CZ 2008241 A3 [0012]
- CZ 20096148 [0013]