(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 April 2016 (07.04.2016)

WIPO | PCT

(10) International Publication Number
WO 2016/050922 A1

(51) International Patent Classification:
B21G 1/08 (2006.01) *B21D 41/04* (2006.01)
A61M 5/32 (2006.01)

(21) International Application Number:
PCT/EP2015/072716

(22) International Filing Date:
1 October 2015 (01.10.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
14187633.4 3 October 2014 (03.10.2014) EP

(71) Applicant: **NOVO NORDISK A/S** [DK/DK]; Novo Allé, 2880 Bagsværd (DK).

(72) Inventor: **KRISTENSEN, Leif, Engmann**; Novo Nordisk A/S, Novo Allé, 2880 Bagsværd (DK).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: METHOD OF FORMING INJECTION NEEDLES

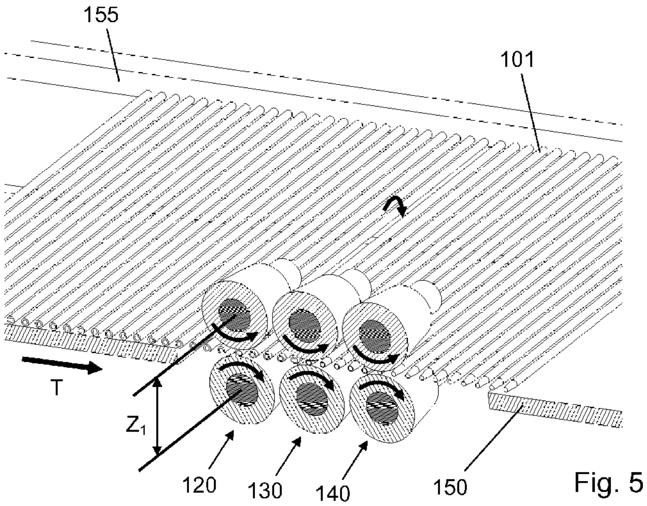

Fig. 5

(57) Abstract: The present invention provides a method of forming injection needles, the method comprising: (i) placing a needle tube portion of a first needle tube extending along and rotating about a first needle axis in a first location between a first pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a first minimum distance as a smallest distance between the first pair of opposing shaping surfaces, the first minimum distance being smaller than a diameter of the needle tube portion, (ii) transporting the needle tube portion of the first needle tube to a second location between a second pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a second minimum distance as a smallest distance between the second pair of opposing shaping surfaces, the second minimum distance being smaller than the first minimum distance, and (iii) simultaneously with or subsequent to (ii) placing a needle tube portion of a second needle tube in the first location, the second needle tube extending along and rotating about a second needle axis.

WO 2016/050922 A1

METHOD OF FORMING INJECTION NEEDLES

FIELD OF THE INVENTION

The present invention relates to medical needles for conveying medication to a body site. Specifically, the invention relates to a forming of such needles to provide a desired needle shape.

BACKGROUND OF THE INVENTION

Injection needles are widely used in the medical area to deliver medicaments to specific body sites. For example, within the treatment of diabetes mellitus pen needle assemblies are oftentimes used with injection pens for subcutaneous administration of various glucose regulating agents. A pen needle assembly includes an injection needle and a needle hub having means for attachment to an injection pen. The injection needle is typically fixed to the needle hub so as to enable skin penetration by the one needle end and penetration of a cartridge septum by the other needle end.

Two important characteristics of an injection needle are the needle gauge and the resistance to flow through the needle lumen. The higher the needle gauge the smaller the outer diameter of the injection needle, and the smaller the outer diameter of the injection needle the lower the frequency of painful injections. A high needle gauge is thus attractive from a comfort perspective.

However, the resistance to laminar flow of a liquid with constant viscosity, η, through a straight tube of length, L, and with an inner diameter, d, can be expressed according to Poiseuille as

$$R \propto \frac{\eta L}{d^4}$$

i.e. as proportional to the length of the needle tube and inversely proportional to the inner diameter to the fourth power. This means that the higher the needle gauge and the longer the needle the greater the force needed to convey a medicament through the needle lumen. A high needle gauge is thus not attractive from an effort perspective.

Some injection needles have a straight lumen and a tapering outer diameter around the needle end portion to provide for a smaller exterior dimension of the invading body and thereby a reduced risk of nociception. The needle gauge measured at the tip is thereby increased in comparison with the needle gauge of a corresponding conventionally formed injection needle, but the flow resistance remains unchanged. An example of such an injection needle is disclosed in WO 02/076540 (Novo Nordisk A/S; Nipro Corporation).

To also obtain a reduction of the flow resistance the injection needle may additionally be formed with a tapering inner diameter at the needle end portion. This enables the provision of a larger lumen over a significant portion of the needle length. An injection needle with tapering inner and outer diameters is e.g. disclosed in EP 1 188 456 (Terumo Kabushiki Kaisha).

WO 2011/033102 (Novo Nordisk A/S) discloses a metal etching process for increasing the inner diameter of a needle tube. The process is suitable for use in a mass production setup but may require special safety measures as it involves pressurisation and transport of a metal etching liquid.

SUMMARY OF THE INVENTION

It is an object of the invention to eliminate or reduce at least one drawback of the prior art, or to provide a useful alternative to prior art solutions.

In particular, it is an object of the invention to provide a simple and inexpensive method of forming needle tubes which is not based on chemical etching.

It is a further object of the invention to provide a method of forming needle tubes which is suitable for mass production.

In the disclosure of the present invention, aspects and embodiments will be described which will address one or more of the above objects and/or which will address objects apparent from the following text.

A method embodying the principles of the invention produces a formed injection needle by a) subjecting a needle tube portion of a needle tube extending along and rotating about a central axis to impact from two opposing surfaces being inclined with respect to the central axis so as to provide a wedge configuration, the two opposing surfaces being at least intermittently in a first relative position which defines a first smallest distance between the two, the first smallest distance being smaller than a diameter of the needle tube portion, and b) subsequent to a) subjecting the needle tube portion to impact from two opposing surfaces being inclined with respect to the central axis so as to provide a wedge configuration, the two opposing surfaces being at least intermittently in a second relative position which defines a second smallest distance between the two, the second smallest distance being smaller than the first smallest distance.

Such a method gradually decreases the smallest distance between the impacting surfaces and thereby gradually deforms the needle tube portion to a desired tapering configuration by simple and inexpensive mechanical processing. The method further enables an attractive mass production setup, as will be clear from the following.

It is noted that the two opposing surfaces mentioned in step b) may be the same as the two opposing surfaces mentioned in step a), or they may be different therefrom. In case of the former in order to reach the conditions of step b) e.g. any amplitude of motion of the respective opposing surfaces perpendicular to the central axis may be increased. In case of the latter prior to step b) the needle tube is moved from a first site where the needle tube portion is arranged between the two opposing surfaces of step a) to a second site where the needle tube portion is arranged between the two opposing surfaces of step b).

Thus, in a first aspect of the invention a method of forming injection needles is provided, the method comprising:

(a) placing a needle tube portion of a first needle tube extending along and rotating about a first needle axis in a first location between a first pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a first minimum distance as a smallest distance between the first pair of opposing shaping surfaces, the first minimum distance being smaller than a diameter of the needle tube portion,

(b) transporting the needle tube portion of the first needle tube to a second location between a second pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a second minimum distance as a smallest distance between the second pair of opposing shaping surfaces, the second minimum distance being smaller than the first minimum distance, and

(c) simultaneously with or subsequent to (b) placing a needle tube portion of a second needle tube in the first location, the second needle tube extending along and rotating about a second needle axis.

A needle tube portion of an injection needle in preparation thus undergoes a gradual deformation towards a desired configuration during the respective swaging in the first location and the second location, and after, e.g. as, it leaves the first location another needle tube portion takes its place. This provides for a simple and effective production line, where large numbers of needle tubes may be processed in a relatively short period of time, as they are successively fed to the opposing shaping surfaces.

In particular embodiments of the invention the needle tube portion is an end portion of the needle tube, and the inventive method is thus a method of producing frustoconical needle ends. In other embodiments of the invention the needle tube portion is an intermediate portion between the two needle ends, whereby the method provides a flow constriction at a certain position along the length of the needle tube.

The second minimum distance may be predetermined. In particular, it may be predetermined to correspond to the formation of a needle end having a tip of a specific desired gauge. Thereby, the method enables a multi-step forming of injection needles, where each injection needle obtains a predetermined needle end configuration, which is designed to provide a limited exterior dimension for limited interaction with nerve ends as well as an optimised lumen for liquid flow.

Depending on the amount of deformation needed to provide the desired configuration of the individual needle tube portions further processing steps may be added to minimise the time spent in preparation of a specific number of needle tubes.

Thus, the method may further comprise:

(d) prior to (ii) transporting the needle tube portion of the first needle tube successively to one or more further locations, each of the one or more further locations being between a pair of opposing shaping surfaces which are inclined with respect to the first needle axis so as to provide a wedge configuration and which are arranged to operate at least intermittently in a relative position defining a minimum distance as a smallest distance between the pair of opposing shaping surfaces, the minimum distance being smaller than the minimum distance of the immediately preceding pair of opposing shaping surfaces and larger than the second minimum distance, and

(e) simultaneously with or subsequent to each transport of the needle tube portion of the first needle tube to a further location placing a needle tube portion of a further needle tube in a location immediately preceding the further location.

At least one pair of opposing shaping surfaces may comprise a first shaping surface and an opposing second shaping surface which form part of respective opposing cylindrical, frusto-conical, or conical bodies that rotate in opposite directions, and/or at least one pair of opposing shaping surfaces may comprise a first shaping surface and an opposing second shaping surface which alternately moves away from and towards the first shaping surface. This alternate diverging and converging relative motion between the first shaping surface and the opposing second shaping surface may e.g. be realised through an ultrasonic forging process.

The forming of needle tubes may be realised as an in-line production process where the pairs of opposing shaping surfaces are arranged in a row, each pair of opposing shaping surfaces between the first pair and the last pair operating at least intermittently at a smallest distance between the opposing shaping surfaces which is smaller than that of the immediately preceding pair of opposing shaping surfaces and greater than that of the immediately following pair of opposing shaping surfaces, and where the needle tubes are fed to the respective pairs of opposing shaping surfaces one at a time.

A plurality of needle tubes extending along and rotating about respective needle axes may then e.g. be arranged side-by-side on a conveyor belt which passes between the row of opposing shaping surfaces, and the needle tubes may be fed successively to each pair of opposing shaping surfaces in a feeding direction perpendicular to the respective needle axes.

Each needle tube may have a predetermined length, and each pair of opposing shaping surfaces may be arranged to receive an end portion of the respective needle tubes, which end portion is smaller than half of the predetermined length, for example smaller than one third of the predetermined length. Thereby, the method may be employed to form merely the tip portion of a needle tube or, alternatively, a significant portion of the length of the needle tube, such as approximately half of the needle tube to enable a production of e.g. a pen needle assembly in which the entire front needle is conical.

In one embodiment of the invention each pair of opposing shaping surfaces is adapted to simultaneously receive respective end portions of two needle tubes arranged co-axially in continuation of one another. This enables a simultaneous processing of two needle tubes in every step of the in-line process, and thereby a resulting doubling of the production capacity.

In one embodiment of the invention a method of forming injection needles is provided, the method comprising: i) placing a needle tube portion of a first needle tube extending along and rotating about a central axis in a first location between a first pair of rollers comprising a first shaping surface and an opposing second shaping surface, the first shaping surface and the second shaping surface being inclined with respect to the central axis so as to provide a wedge configuration and further alternately moved towards and away from one another, during which movement the first shaping surface and the second shaping surface reach a relative position defining a first minimum distance as a smallest distance between the first shaping surface and the second shaping surface, the first minimum distance being smaller than a diameter of the needle tube portion, ii) transporting the needle tube portion of the first needle tube to a second location between a second pair of rollers comprising a third shaping surface and an opposing fourth shaping surface, the third shaping surface and the fourth shaping surface being inclined with respect to the central axis so as to provide a wedge configuration and further alternately moved towards and away from one another, during which movement the third shaping surface and the fourth shaping surface reach a relative position defining a second minimum distance as a smallest distance between the third shaping surface and the fourth shaping surface, the second minimum distance being smaller than the first minimum distance, and iii) simultaneously with or subsequent to ii) placing a needle tube portion of a rotating second needle tube in the first location.

This exemplary deformation process thus comprises both a transversal sliding and a radial impact, and is thereby particularly suitable for forming hard surfaces.

The method may further comprise: iv) prior to ii) transporting the needle tube portion of the first needle tube successively to one or more further locations, each of the one or more further locations being between a pair of rollers having opposing shaping surfaces which are inclined with respect to the central axis so as to provide a wedge configuration and which are alternately moved towards and away from one another, during which movement the opposing shaping surfaces reach a relative position defining a smallest distance between the opposing shaping surfaces, which smallest distance is smaller than the smallest distance between opposing shaping surfaces of an immediately preceding pair of rollers and larger than the second minimum distance, and v) simultaneously with or subsequent to each transport of the needle tube portion of the first needle tube to a further location placing a needle tube portion of a further needle tube in a location immediately preceding the further location.

The individual rollers may comprise a shaping surface portion which is conical or frustoconical and which extends along and rotates about an axis that is parallel to the central axis of the respective needle tubes. Alternatively, the individual rollers may comprise a shaping surface portion which is cylindrical and which extends along and rotates about an axis that is inclined with respect to the central axis of the respective needle tubes. Any combination of the mentioned roller configurations may in principle be employed as long as the opposing shaping surfaces are arranged to provide a wedge shaped contact area.

Further, the individual rollers in each pair of rollers may extend along respective axes which together with the central axis of a needle tube positioned in a location between that pair of rollers span a single plane.

The pairs of rollers may be arranged in a row, and each pair of rollers between the first pair and the last pair may operate at a smallest distance between the opposing shaping surfaces which is smaller than that of the immediately preceding pair of rollers and greater than that of the immediately following pair of rollers, and the needle tubes may be fed to the respective pairs of rollers one or two at a time.

In another aspect of the invention a needle forming arrangement is provided comprising:

(A) a conveying surface adapted to carry needle tubes and to move in a transport direction, and

(B) a plurality of pairs of opposing shaping surfaces arranged in-line next to one another along the conveying surface, each pair of opposing shaping surfaces comprising a first shaping surface and an opposing second shaping surface arranged on either side of the conveying surface, each of the first shaping surface and the opposing second shaping surface being inclined with respect to the conveying surface to provide a wedge configuration, and being adapted to operate at least intermittently in a relative position defining a smallest distance between the first shaping surface and the opposing second shaping surface, wherein the smallest distance between the first shaping surface and the opposing second shaping surface of the respective pairs of opposing shaping surfaces decrease in the transport direction.

In the present specification, reference to a certain aspect or a certain embodiment (e.g. "an aspect", "a first aspect", "one embodiment", "an exemplary embodiment", or the like) signifies that a particular feature, structure, or characteristic described in connection with the respective aspect or embodiment is included in, or inherent of, at least that one aspect or embodiment of the invention, but not necessarily in/of all aspects or embodiments of the invention. It is emphasized, however, that any combination of the various features, structures and/or characteristics described in relation to the invention is encompassed by the invention unless expressly stated herein or clearly contradicted by context.

The use of any and all examples, or exemplary language (e.g., such as, etc.), in the text is intended to merely illuminate the invention and does not pose a limitation on the scope of the same, unless otherwise claimed. Further, no language or wording in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be further described with references to the drawings, wherein

Fig. 1 is a side view of an unprocessed needle tube,

Fig. 2 is a side view of the needle tube of Fig. 1 after processing according to an embodiment of the invention,

Fig. 3 is a side view showing the needle tube during processing according to an embodiment of the invention,

Fig. 4 is an end view of an in-line process setup according to an embodiment of the invention,

Fig. 5 is a cross-sectional perspective view of an in-line process setup according to another embodiment of the invention, and

Fig. 6 is a perspective view of an in-line process setup according to a further embodiment of the invention,

In the figures like structures are mainly identified by like reference numerals.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

When in the following relative expressions, such as "clockwise" and "counter-clockwise", are used, these refer to the appended figures and not necessarily to an actual situation of use. The shown figures are schematic representations for which reason the configuration of the different structures as well as their relative dimensions are intended to serve illustrative purposes only.

Fig. 1 is a side view of a needle tube 1 before processing according to the invention. The needle tube 1 has a circular-cylindrical wall 2 of outer tube diameter, D. The wall 2 extends along a longitudinal needle axis, L_n, and is processed in accordance with the invention to e.g. obtain a configuration as depicted in Fig. 2, i.e. to obtain a frustoconical end portion 3 and a tip 4 having an outer tip diameter, d, which is smaller than the outer tube diameter, D. The thickness of the wall 2 is uniform, or substantially uniform, over the entire length of the needle tube 1, even after the processing, and the inner wall of the end portion 3 is thus also frustoconical.

Fig. 3 is a side view of a portion of the needle tube 1 during a deformation process step according to an exemplary first embodiment of the invention in which the end portion 3 is subjected to forces from a pair of rollers 10. The end portion 3 is situated between a top roller 11 and a bottom roller 12. The top roller 11 extends along and rotates about a top roller axis, L_1, and the bottom roller 12 extends along and rotates about a bottom roller axis, L_2.

The top roller axis, L_1, and the bottom roller axis, L_2, are parallel to one another and to the needle axis, L_n. The top roller 11 has a frustoconical deformation surface 13 and the bottom roller 12 has a corresponding frustoconical deformation surface 14 which together with the deformation surface 13 provide a wedge shaped processing area for deformation of the end portion 3.

In addition to the respective rotational movements, each of the top roller 11 and the bottom roller 12 undergoes a reciprocating translational movement towards, respectively away from the other so as to provide a hammering effect. The end portion 3 is thus subjected to a combination of transversal sliding contact and radial impact from the pair of rollers 10.

Fig. 4 is an end view of an in-line process setup according to an embodiment of the invention comprising a first pair of rollers 20, a second pair of rollers 30, and a third pair of rollers 40 arranged next to one another in a line. Each of the first pair of rollers 20, the second pair of rollers 30, and the third pair of rollers 40 is similar in configuration to and has identical processing movements as the pair of rollers 10 of Fig. 3. They are, however, arranged pairwise such that they contact needle tubes at different distances from one another.

The needle tube 1, while rotating about the needle axis L_n, is fed sideways in a transport direction, T, to the first pair of rollers 20 which are arranged such that they deform the wall 2 to a first reduced tip diameter. The rotation of the needle tube 1 ensures an axisymmetrical (or at least substantially axisymmetrical depending on the speed of rotation of the needle tube 1 and the time spent between the first pair of rollers 20) deformation of the needle end 3. The needle tube 1 is subsequently moved to the second pair of rollers 30 which are arranged such that they deform the wall 2 further to a second reduced tip diameter, which is smaller than the first reduced tip diameter. Finally, the needle tube reaches the third pair of rollers which are arranged such that they deform the wall 2 even further to the final tip diameter, d. A step-wise reduction of the outer dimensions of the processed needle tube portion is thus obtained.

Various parameters can be tuned to optimise the process, such as e.g. speed of transport from one pair of rollers to the next, speed of rotation of the needle tubes, respectively of the individual rollers, and the stepwise reduction of the distance between the processing surfaces. The latter may e.g. include adding further pairs of rollers to the in-line setup.

In the setup shown in Fig. 4 the physical size of the respective rollers is identical as are their respective amplitudes of translation, and it is thus the minimum distance between the respective roller axes of each pair of rollers that decrease in the transport direction, T. To obtain the same gradually increasing deformation of the needle end 3, alternatively, the physical size of the respective rollers could increase in the transport direction, T, and/or the amplitudes of translation of the respective rollers could increase in the transport direction, T.

Fig. 5 is a cross-sectional perspective view of an in-line process setup according to another embodiment of the invention, showing a plurality of needle tubes arranged side by side on a conveyor belt 150 which moves in a transport direction, T. Each needle tube 101 rotates about its axis of extension due to a portion (not visible) of the conveyor belt 150 moving relative to the remaining portion of the conveyor belt 150, either in the transport direction, T, or opposite the transport direction, T.

The needle tubes are aligned along a side wall 155 of the conveyor belt 150, and as they are transported in the transport direction, T, they are successively fed to, respectively, a first pair of rollers 120, a second pair of rollers 130, and a third pair of rollers 140. The rollers rotate as indicated by the curved arrows, but do not undergo any translational motion. All rollers have the same frustoconical configuration, but whereas the respective rollers in the first pair of rollers 120 extend along roller axes which are separated by a first distance Z_1, the respective roller axes of the other pairs of rollers are separated by distances which decrease in the transport direction, T, to provide for a gradual deformation of the needle tube portions, corresponding to what is described with respect to Fig. 4.

Every time a needle tube 101 is being positioned between e.g. the second pair of rollers 130, another needle tube is being positioned between the first pair of rollers 120, and every time a needle tube 101 is being positioned between the third pair of rollers 40, another needle tube is being positioned between the second pair of rollers 130, and a further needle tube is being positioned between the first pair of rollers 120. The in-line process thus enables a fast high-volume processing of needle tubes as a preparation for subsequent processing steps, such as needle tip grinding and attachment of the needle tube to a needle hub.

Fig. 6 is a perspective view of an in-line setup according to a further embodiment of the invention where a plurality of opposing rolling needle tubes are arranged on a conveyor belt 250 and moved in a transport direction, T. Each pair of opposing needle tubes 201, 201' are successively processed by a first pair of rollers 220, a second pair of rollers 230, and a third pair of rollers 240 arranged next to one another. The respective contact surfaces 221, 231, 241 of the pairs of rollers 220, 230, 240 are shaped to provide a wedge configuration for frustoconical deformation of respective end portions 203, 203' of each pair of opposing needle tubes 201, 201'. A symmetrical setup as the one shown in Fig. 6 is a simple way of doubling the needle production capacity of the setup shown in Fig. 5.

CLAIMS

1. A method of forming injection needles, the method comprising:

(i) placing a needle tube portion of a first needle tube extending along and rotating about a first needle axis in a first location between a first pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a first minimum distance as a smallest distance between the first pair of opposing shaping surfaces, the first minimum distance being smaller than a diameter of the needle tube portion,

(ii) transporting the needle tube portion of the first needle tube to a second location between a second pair of opposing shaping surfaces being inclined with respect to the first needle axis so as to provide a wedge configuration and arranged to operate at least intermittently in a relative position defining a second minimum distance as a smallest distance between the second pair of opposing shaping surfaces, the second minimum distance being smaller than the first minimum distance, and

(iii) simultaneously with or subsequent to (ii) placing a needle tube portion of a second needle tube in the first location, the second needle tube extending along and rotating about a second needle axis.

2. A method according to claim 1, further comprising:

(iv) prior to (ii) transporting the needle tube portion of the first needle tube successively to one or more further locations, each of the one or more further locations being between a pair of opposing shaping surfaces which are inclined with respect to the first needle axis so as to provide a wedge configuration and which are arranged to operate at least intermittently in a relative position defining a minimum distance as a smallest distance between the pair of opposing shaping surfaces, the minimum distance being smaller than the minimum distance of the immediately preceding pair of opposing shaping surfaces and larger than the second minimum distance, and

(v) simultaneously with or subsequent to each transport of the needle tube portion of the first needle tube to a further location placing a needle tube portion of a further needle tube in a location immediately preceding the further location.

3. A method according to claim 1 or 2, wherein each pair of opposing shaping surfaces is arranged on either side of a conveyor belt and next to at least one other pair of opposing shaping surfaces, and wherein a plurality of needle tubes extending along and rotating about respective needle axes are arranged side by side on the conveyor belt and fed successively to each pair of opposing shaping surfaces in a feeding direction perpendicular to the respective needle axes.

4. A method according to any of claims 1 – 3, wherein each needle tube has a predetermined length, and wherein each pair of opposing shaping surfaces is arranged to receive an end portion of the respective needle tubes, which end portion is smaller than half of the predetermined length.

5. A method according to claim 4, wherein the end portion is smaller than one third of the predetermined length.

6. A method according to any of the preceding claims, wherein each pair of opposing shaping surfaces is adapted to simultaneously receive respective end portions of two needle tubes arranged co-axially in continuation of one another.

7. A method according to any of the preceding claims, wherein at least one pair of opposing shaping surfaces forms part of a pair of rollers comprising a first roller rotating clockwise and a second roller rotating counter-clockwise.

8. A method according to claim 3, wherein each pair of opposing shaping surfaces forms part of a pair of rollers comprising a first roller extending along and rotating clockwise about a first roller axis, the first roller axis being parallel to the respective needle axes, and a second roller extending along and rotating counter-clockwise about a second roller axis, the second roller axis being parallel to the first roller axis, and wherein the first roller and the second roller have respective conical or frustoconical configurations.

9. A method according to any of the preceding claims, wherein at least one pair of opposing shaping surfaces comprises a first shaping surface and an opposing second shaping surface which alternately moves away from and towards the first shaping surface.

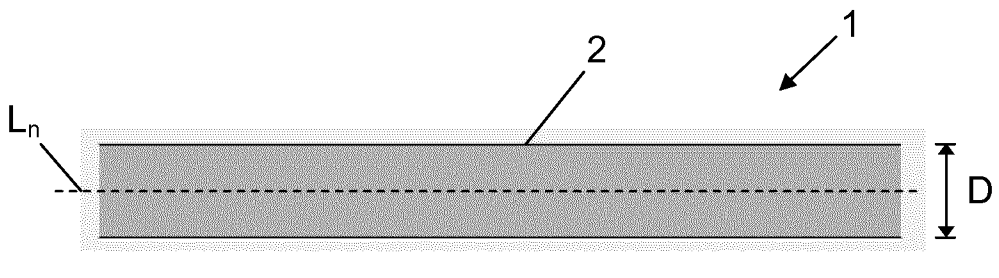

Fig. 1

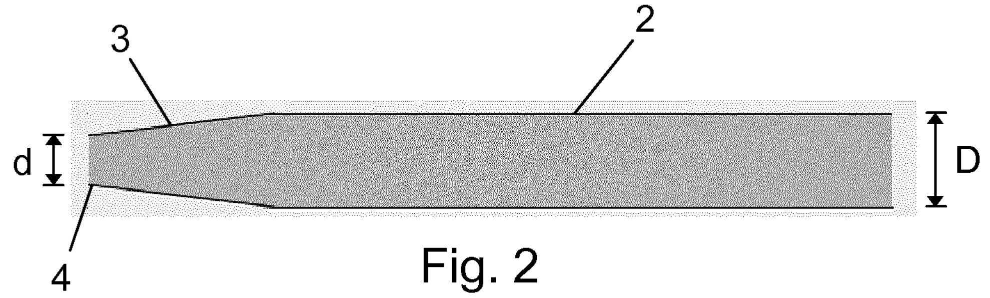

Fig. 2

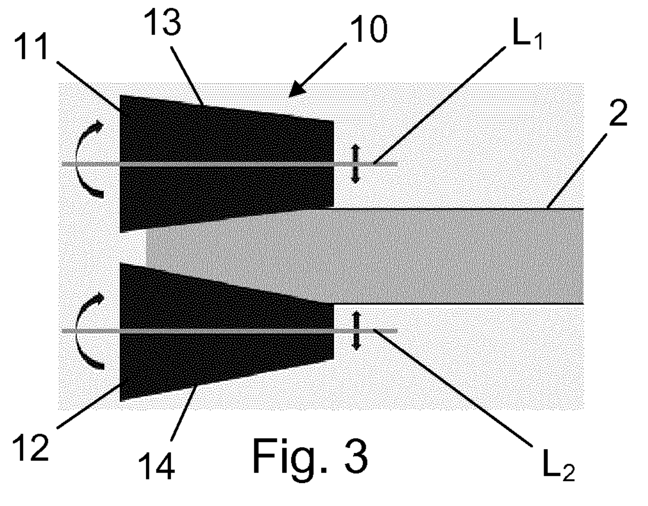

Fig. 3

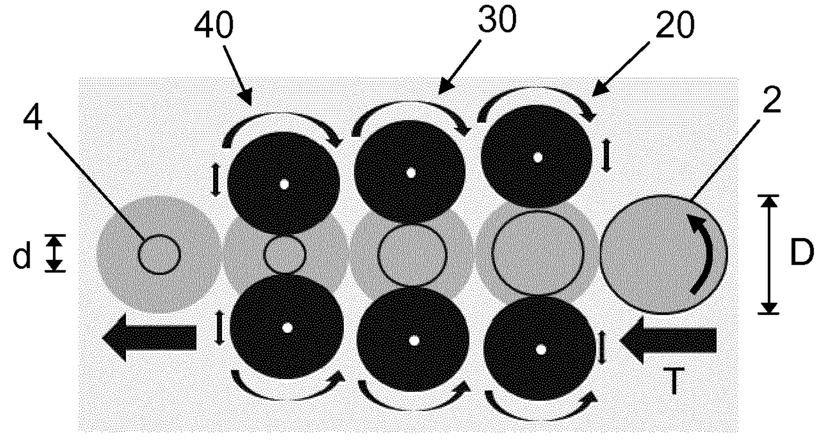

Fig. 4

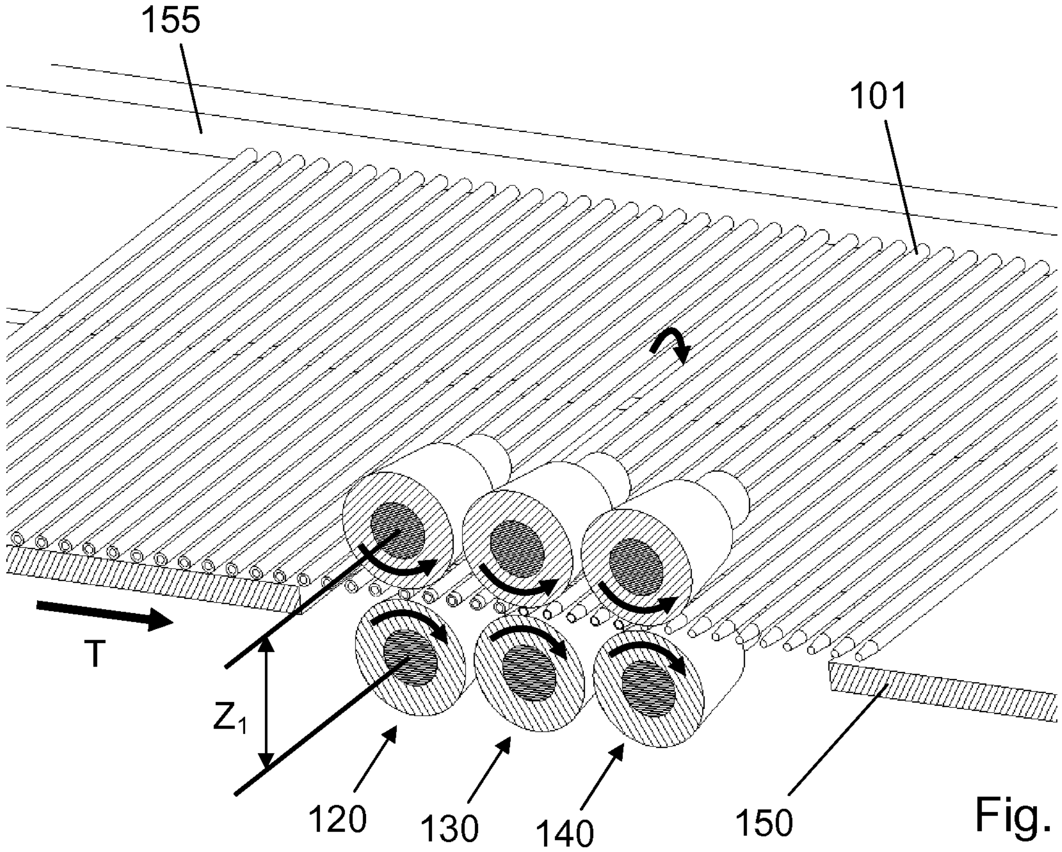
155
101
T
Z1
120
130
140
150

Fig. 5

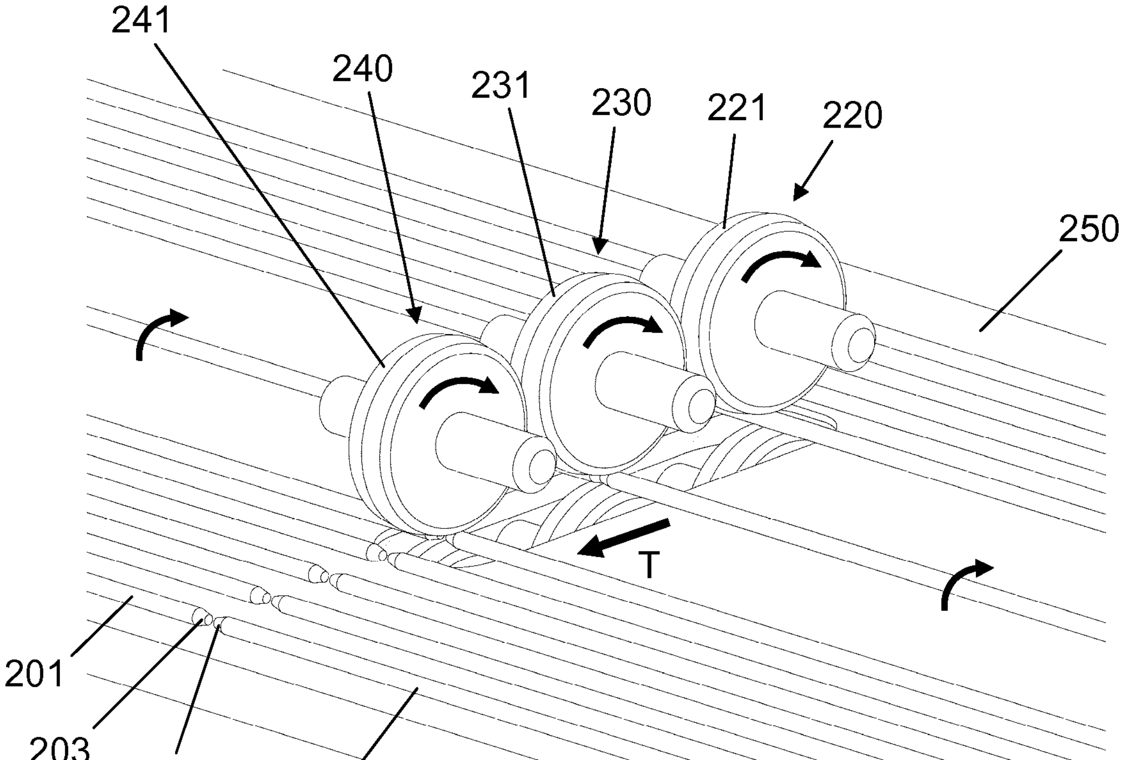
241
240
231
230
221
220
250
T
201
203
203'
201'

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2015/072716

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21G1/08 A61M5/32 B21D41/04
ADD.

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)
B21G A61M B21D

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002 307122 A (SANION KK; KATO SEIJI) 22 October 2002 (2002-10-22) abstract; figures 1-5	1-9
A	JP 2007 000934 A (TERUMO CORP; OKANO KOGYO KK) 11 January 2007 (2007-01-11) abstract; figures 3,4	1-9
A	WO 2007/114322 A1 (NF TECHNO SUMMIT CORP [JP]; TAMURA SATORU [JP]; KENJO AKIRA [JP]) 11 October 2007 (2007-10-11) abstract; figure 8	1-9
A	JP 2008 043583 A (UNIV TOYO) 28 February 2008 (2008-02-28) abstract; figures 4a-4d	1-9

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 December 2015	21/12/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Charvet, Pierre

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011/033102 A1 (NOVO NORDISK AS [DK]; LARSEN ANDRE [DK]; CHRISTOFFERSEN LASSE WENGEL [) 24 March 2011 (2011-03-24) cited in the application claim 1; figures 1, 2 -----	1-9
A	US 4 335 718 A (CALABRESE FRANK B) 22 June 1982 (1982-06-22) column 4, lines 28-60; figure 5 -----	1-9
A	JP 2009 142880 A (TAKASHIMA SANGYO CO LTD) 2 July 2009 (2009-07-02) abstract; figures 1-4 -----	1-9

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2015/072716

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2002307122 A	22-10-2002	NONE	
JP 2007000934 A	11-01-2007	JP 4473234 B2	02-06-2010
		JP 2007000934 A	11-01-2007
WO 2007114322 A1	11-10-2007	DE 112007000782 T5	29-01-2009
		JP 2007289664 A	08-11-2007
		US 2007256289 A1	08-11-2007
		WO 2007114322 A1	11-10-2007
JP 2008043583 A	28-02-2008	NONE	
WO 2011033102 A1	24-03-2011	CN 102548493 A	04-07-2012
		EP 2480146 A1	01-08-2012
		JP 2013505134 A	14-02-2013
		US 2012271249 A1	25-10-2012
		WO 2011033102 A1	24-03-2011
US 4335718 A	22-06-1982	NONE	
JP 2009142880 A	02-07-2009	JP 4755167 B2	24-08-2011
		JP 2009142880 A	02-07-2009