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(54) Title: A METHOD FOR MANUFACTURING A NEEDLE CANNULA HAVING IMPROVED FLOW PROPERTIES

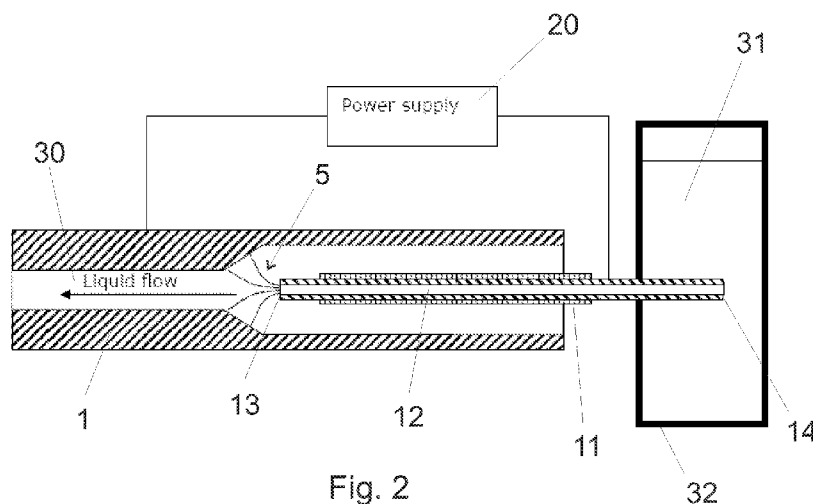


Fig. 2

(57) Abstract: A method of manufacturing a needle cannula (1) by applying electro polishing to the inside lumen (4) of the needle cannula (1). A cathode (10) is inserted into the lumen (4) of the needle cannula (1) and an electric current (21) is introduced between the cathode (10) and the needle cannula (1) which works as the anode. A liquid acid (31) is preferably flushed into the inside lumen (4) of the needle cannula (1) during the process.

A Method for Manufacturing a Needle Cannula Having Improved Flow Properties

THE TECHNICAL FIELD OF THE INVENTION:

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The invention relates to a method of manufacturing a needle cannula having improved flow properties and such needle cannula.

DESCRIPTION OF RELATED ART:

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Needle assemblies are commonly used to either inject substances into or extract substances out of human or animal bodies. Such needle assemblies are typically disposable and are discarded after only one use.

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When producing needle assemblies a needle cannula which is typically drawn from stainless steel is attached to a hub generally moulded from a suitable polymer. The hub usually carries means for attaching the needle assembly to an injection device. The needle cannula is typically mounted to the hub such that a liquid communication path can be established between the injection device, through the needle assembly and into the body of the user.

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The needle cannula is normally made from a stainless-steel tube drawn through progressively smaller dies to make the needle the wanted diameter. The ratio between the outside diameter and the inside diameter is a result of the wall thickness of the stainless tube drawn and the diameter to which it is drawn. The specific dimensions used for a cylindrical

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needle cannula are given in ISO 9626.

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Some drugs, such as insulin are self-administered, and the typical diabetes person will require subcutaneous injections of insulin several times during the course of the day. Recent studies have indicated that people who inject themselves experience less pain when using a thin needle i.e. a needle cannula having a little outside diameter. In order to reduce the discomfort of having to inject oneself several times a day, injection needles with a very thin needle cannula are very popular among people suffering from diabetes.

The outside diameter of a needle cannula is indicated by a "G" followed by a gauge number, which gauge number increases with thinner needles. At the present, the most commonly used injection needles among people suffering from diabetes are G30 or G31. Thus the outside diameter of a G 30 is according to ISO 9626 approximately 0,3 millimetres and of a G 31 approximately 0,26 millimetres.

WO 2002/076540 discloses a needle cannula which after it has been drawn is subjected to electro polishing at the tip such that the outside surface becomes conical. The tip inserted into the user during injection can therefore be made smaller than the ISO standard dictates.

A G31 needle could e.g. be electro polished at the tip such that the tip becomes that of a G32 needle having an outside diameter of 0,23 mm. Such needle cannula would then have the flow characteristic of a G31 needle, but the pain perception of a G32 needle cannula.

Electro polishing a needle cannula on the outside is also disclosed in JP 31-9364 and in US 4,335,718. The latter discloses that it is unwanted to have the liquid etching material flow inside the needle cannula which therefore can be sealed with a suitable mandrel.

US 2005/0015062 discloses an injection needle where the inside diameter of the needle cannula is expanded by cutting the narrow lumen with a drill.

A method of polishing a metallic tube on the inside is described in the article: "High Speed Slurry Flow Finishing of Inner Wall of Stainless Steel Capillary" by Toshiji Kurobe in International Journal of the Japan Society for Precision Engineering, Vol. 32, No. 1, in March 1998. By flushing a slurry containing grains through the lumen of a tube, the inside surface roughness can be lowered thereby enhancing the flow through the tube.

The flow through a needle cannula is determined by Pouseuilles formula. According to this formula, as explained in US 5,951,528, it is preferred to have as large an inside diameter as possible at as short a length as possible in order to maximise the flow through the needle cannula since the ratio of the radius is divided with the length in the formula.

However, a large inside diameter, in order to increase the flow properties, and a small outside, in order to minimize the pain perception, results in a needle cannula having a very thin wall thickness which makes the needle cannula easy breakable when bended.

DESCRIPTION OF THE INVENTION:

It is an object of the present invention to provide a simple, cheap and reliable method for manufacturing a needle cannula with improved flow characteristic combining a small outside diameter with a satisfactory resistance against breaking when bended.

Claim 1-2

According to the claimed invention a metallic needle cannula which has been drawn to the preferred diameter is subjected to inside electro polishing by inserting a cathode into the lumen of the needle cannula. By applying an electric current between the cathode and the needle cannula, the latter works as the anode of the cathodic reaction, material is removed from the inside of the needle cannula.

By moving the cathode axially inside the lumen, the area from which material is removed can be controlled. The cathode could e.g. be moved a certain distance into the lumen which would only remove material from within the area swept by the cathode.

Claim 3-5

The liquid acid used for the reaction can be any suitable acid and preferably a phosphoric acid. In order to remove bi-products from the area swept by the cathode, the liquid acid is flushed into the lumen at a controlled flow speed. The liquid acid can either be sprayed into the lumen from one end and leave the lumen at the same end, or it can flow through the lumen from one end to the other end, such that it enters at one end and leaves at the opposite end. The liquid can also be feed through the cathode which is then hollow.

Claim 6-7

The cathode can be made from a metallic material and is preferably partly electrical insulated from the anode such that the cathode reaction only takes place at a limited area of the cathode. This could e.g. be by placing the metallic cathode in a polymeric tube. The tube, however, does not necessarily have to cover the cathode through out the entire periphery, but could be made as bars only partly covering the periphery, in which case it would be preferred to rotate the cathode during the process such that the metallic material inside the lumen is evenly removed. What is important is that direct contact between the inside of the lumen of

the cannula and the cathode is avoided. Further, it is an advantage that the electro polishing only takes place in a limited area, such as at the vicinity of the insulating tube opening thereby increasing the controllability of the process. The polymeric tube or bars will typically be made from a polymer that is resistant to the acid used, for example PFA, FEP, PVDF, HDPE, PEEK, PES or PEI.

Claim 8

The cathode could alternatively be made from a non-metallic material such as a polymeric material, glass or a ceramic material with a hollow area containing a liquid fluid through which the electrical current is transported. The cathode could e.g. be formed as a tube and the liquid acid used could be flushed through the tube. The electric current is in such alternative applied to the liquid.

Claim 9-10

The needle cannula produced by the described process is usually anchored in a hub moulded from a suitable polymeric material. In order to provide the greatest resistance to breaking the needle cannula is anchored at a location where the needle cannula has the largest wall thickness.

DEFINITIONS:

As used herein, the term "drug" is meant to encompass any drug-containing flowable medicine capable of being passed through a delivery means such as a hollow needle in a controlled manner, such as a liquid, solution, gel or fine suspension. Representative drugs includes pharmaceuticals such as peptides, proteins (e.g. insulin, insulin analogues and C-peptide), and hormones, biologically derived or active agents, hormonal and gene based agents, nutritional formulas and other substances in both solid (dispensed) or liquid form.

Correspondingly, the term "subcutaneous" injection is meant to encompass any method of transcutaneous delivery to a subject.

Further the term "injection needle" defines a piercing member adapted to penetrate the skin of a subject for the purpose of delivering or removing a liquid. The term "Needle Cannula" is used to describe the actual conduit performing the penetration of the skin during injection. A

needle cannula is usually made from a metallic material such as stainless steel and connected to a hub to form an injection needle assembly. The "hub" being the part the needle cannula is mounted to and which carries the connecting means for connecting the needle cannula to an injection apparatus is usually moulded from a suitable thermoplastic material.

- 5 The "needle assembly" is to be understood as the needle unit itself i.e. comprising a needle cannula mounted in a hub as supplied to the user.

"Cartridge" is the term used to describe the container containing the insulin. Cartridges are usually made from glass but could also be made from any suitable polymer e.g. by moulding or extrusion. A cartridge or ampoule is preferably sealed at one end by a pierceable membrane which can be pierced e.g. by an injection needle. The opposite end is closed by a plunger or piston made from rubber or a suitable polymer. The plunger or piston can be slidable moved inside the cartridge. The space between the pierceable membrane and the movable plunger holds the insulin which is pressed out as the plunger decreased the volume of the space holding the insulin. As an alternative to a cartridge, a flexible reservoir could be used.

All references, including publications, patent applications, and patents, cited herein are incorporated by reference in their entirety and to the same extent as if each reference were individually and specifically indicated to be incorporated by reference and were set forth in its entirety herein.

All headings and sub-headings are used herein for convenience only and should not be construed as limiting the invention in any way.

The use of any and all examples, or exemplary language (e.g. such as) provided herein, is intended merely to better illuminate the invention and does not pose a limitation on the scope of the invention unless otherwise claimed. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention. The citation and incorporation of patent documents herein is done for convenience only and does not reflect any view of the validity, patentability, and/or enforceability of such patent documents.

This invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law.

BRIEF DESCRIPTION OF THE DRAWINGS:

The invention will be explained more fully below in connection with a preferred embodiment and with reference to the drawings in which:

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Figure 1 show the method according to the invention.

Figure 2 show another configuration of the method.

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Figure 3 show another configuration of the method.

Figure 4 show another configuration of the method.

Figure 5 show the finished needle assembly.

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The figures are schematic and simplified for clarity, and they just show details, which are essential to the understanding of the invention, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts.

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DETAILED DESCRIPTION OF EMBODIMENT:

When in the following terms as “upper” and “lower”, “right” and “left”, “horizontal” and “vertical”, “clockwise” and “counter clockwise” or similar relative expressions are used, these only refer to the appended figures and not to an actual situation of use. The shown figures are schematic representations for which reason the configuration of the different structures as well as there relative dimensions are intended to serve illustrative purposes only.

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In that context it may be convenient to define that the term “distal end” in the appended figures is meant to refer to the end of the needle cannula penetrating the patient whereas the term “proximal end” is meant to refer to the opposite end of the needle cannula.

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Figure 1 and 2 discloses the process of manufacturing the needle cannula 1 according to the invention. The needle cannula 1 which is typically drawn from a tube of stainless steel has a first end 2 and a second end 3. Connecting the two ends 2, 3 is the lumen 4 which is typical cylindrical. A cathode 10 made from a conducting material is inserted into the lumen 4 and

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an electric current 21 generated in a power supply 20 is applied between the cathode 10 and the needle cannula 1 which works as the anode. Metallic material is thereby removed from the anode (the needle cannula 1) and as the cathode 10 is moved further into the lumen 4 the inside diameter of lumen 4 is increased.

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In order to secure that no direct electric contact is created between the cathode 10 and the needle cannula 1, the cathode 10 could be electrical insulated by providing it with an insulating tube 11 as disclosed in figure 2. The tube 11 does not have to cover the entire periphery of the cathode 10 as long as it keeps the metallic component of the cathode 10 away from direct electrical contact with the inside surface of the lumen 4.

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In order to remove various bi-products from the area 5 of the needle cannula 1 where the cathodic reaction is taken place it is beneficial to provide a liquid flow 30 of a suitable liquid 31. Figure 2 discloses that the liquid flow 30 is supplied from a tank 32 containing the suitable liquid 31 which flows through an opening 12 in the cathode 10 and enters the needle cannula 1 at the first end 13 of the cathode 10. The second end 14 of the cathode 10 is connected to the tank 32.

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An alternative to this solution is disclosed in figure 3. Here the cathode 10 is formed as a solid rod which is insulated e.g. with an insulating tube 11. The liquid flow 30 is established by connecting the first end 2 of the needle cannula 1 to the tank 32 containing the suitable liquid 31. However, as an alternative the second end 3 of the needle cannula 1 could be connected to the tank 32. The cathode 10 could then be inserted into the correct position in the needle cannula 1 before the cathodic process is started and be moved from that position and towards the second end 3 of the needle cannula 1.

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In yet another alternative disclosed in figure 4, the entire cathode 10 is made from a non-metallic material having a through-going opening or lumen 12 through which the liquid 31 flows. The power supply 20 feeds power to an electrode 22 which is submerged in the tank 32 such that the electrical current is transported by the liquid 31 through the hollow cathode 10 and delivered to the anode (the needle cannula 1) at the end of the cathode 10.

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Figure 5 discloses the needle assembly comprising the needle cannula 1 and a hub 40. The needle cannula 1 is usually glued to the hub 40.

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Example

A 20 mm long needle cannula is drawn from AISI 304 with an outer diameter of 0,36 mm and an inner diameter of 0,15 mm. Following the ISO 9626 standard this is a G28 needle cannula.

- 5 The needle cannula is thereafter subjected to inside electro polishing by moving a non-metallic virtual cathode into the lumen thereby increasing the inside diameter to 0,26 mm. The virtual cathode is made from a PP tube having an outside diameter of 0,14 mm and an inside diameter of 0,08 mm. During the process concentrated phosphoric acid is pumped through the PP tube at a flow rate of 1 to 10 mm³/s and at a temperature of 50 °C.
- 10 The downstream opening of the PP tube forming the virtual cathode is moved from the proximal opening of the needle cannula to a position 12 mm from this opening at a speed of 12 mm/min.

The resulting needle cannula had an inside diameter of 0,15 mm on the distal 8 mm and a diameter of 0,26 mm on the remaining 12 mm.

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Some preferred embodiments have been shown in the foregoing, but it should be stressed that the invention is not limited to these, but may be embodied in other ways within the subject matter defined in the following claims.

Claims:

1. A method of manufacturing a needle cannula comprising the steps of:

- 5 (i) Providing a metallic needle cannula (1) having a first end (2) and a second end (3) and an inside approximately cylindrical lumen (4) there between,
 (ii) Inserting a cathode (10) into the lumen (4),
 (iii) Providing a liquid acid (31) inside the lumen (4),
 (iiii) Applying an electric current between the cathode (10) and the needle cannula
10 (1), thereby removing metallic material from the inside lumen (4).

2. A method of manufacturing a needle cannula according to claim 1, wherein the method further comprises the step of moving the cathode (10) in an axial direction.

- 15 3. A method of manufacturing a needle cannula according to claim 1 or 2, wherein the method further comprises the step of flushing liquid acid (31) into the inside of the lumen (4).

4. A method of manufacturing a needle cannula according to claim 3, wherein the method further comprises the step of flushing the liquid acid (31) axially through the inside of the lu-
20 men (4).

5. A method of manufacturing a needle cannula according to claim 3 or 4, wherein the liquid acid (31) is a phosphoric acid.

- 25 6. A method of manufacturing a needle cannula according to any of the preceding claims, wherein the cathode (10) is metallic and at least partly electrical insulated from the inside surface of the lumen (4).

7. A method of manufacturing a needle cannula according to claim 6, wherein the outside
30 surface of the cathode (10) is at least partly covered by a layer (11) of an electrical non-conducting material.

8. A method of manufacturing a needle cannula according to any of the claims 1 to 5,
 wherein the cathode (10) is made from a hollow non-metallic material holding a liquid in the
35 hollow area (12).

9. A needle cannula manufactured according to any of the claims 1 to 8.

10. A needle assembly comprising a hub attached to the needle cannula according to
5 claim 9.

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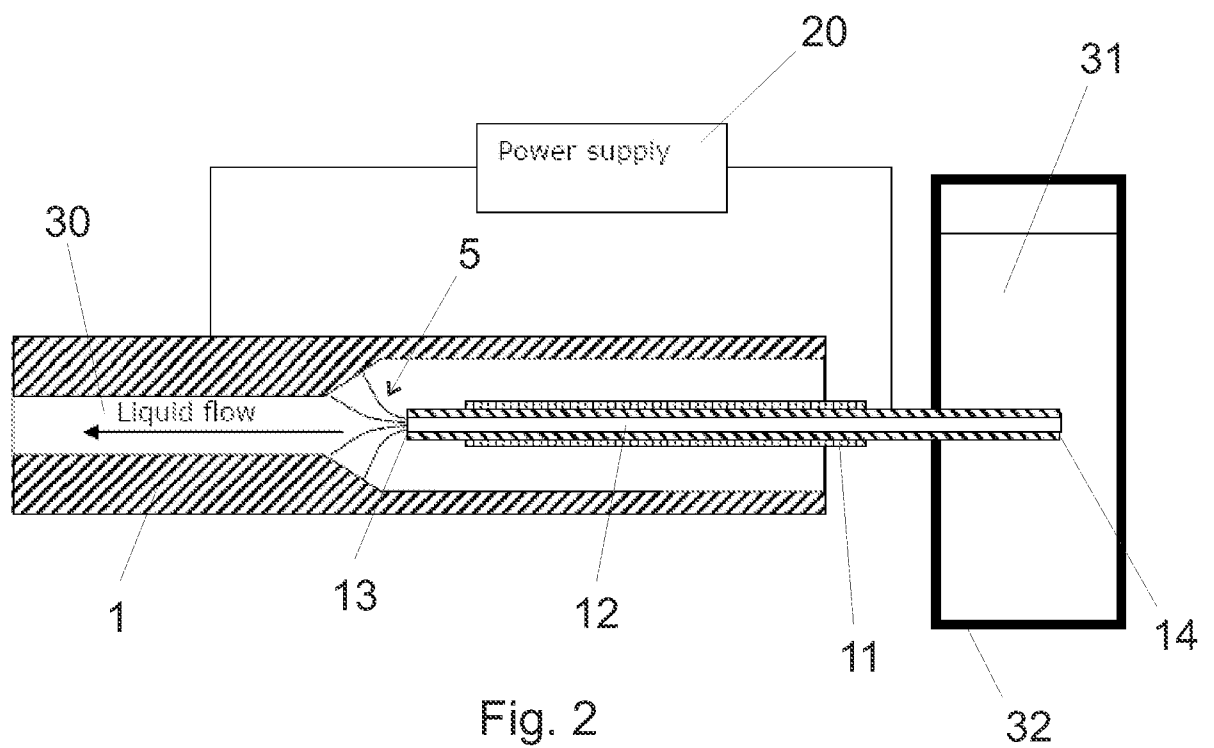
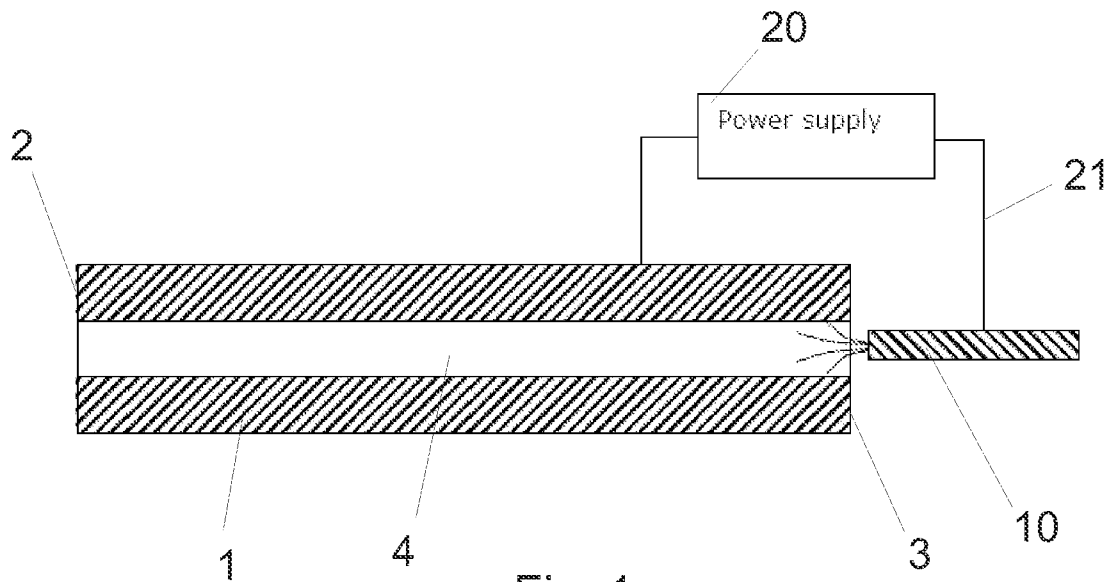
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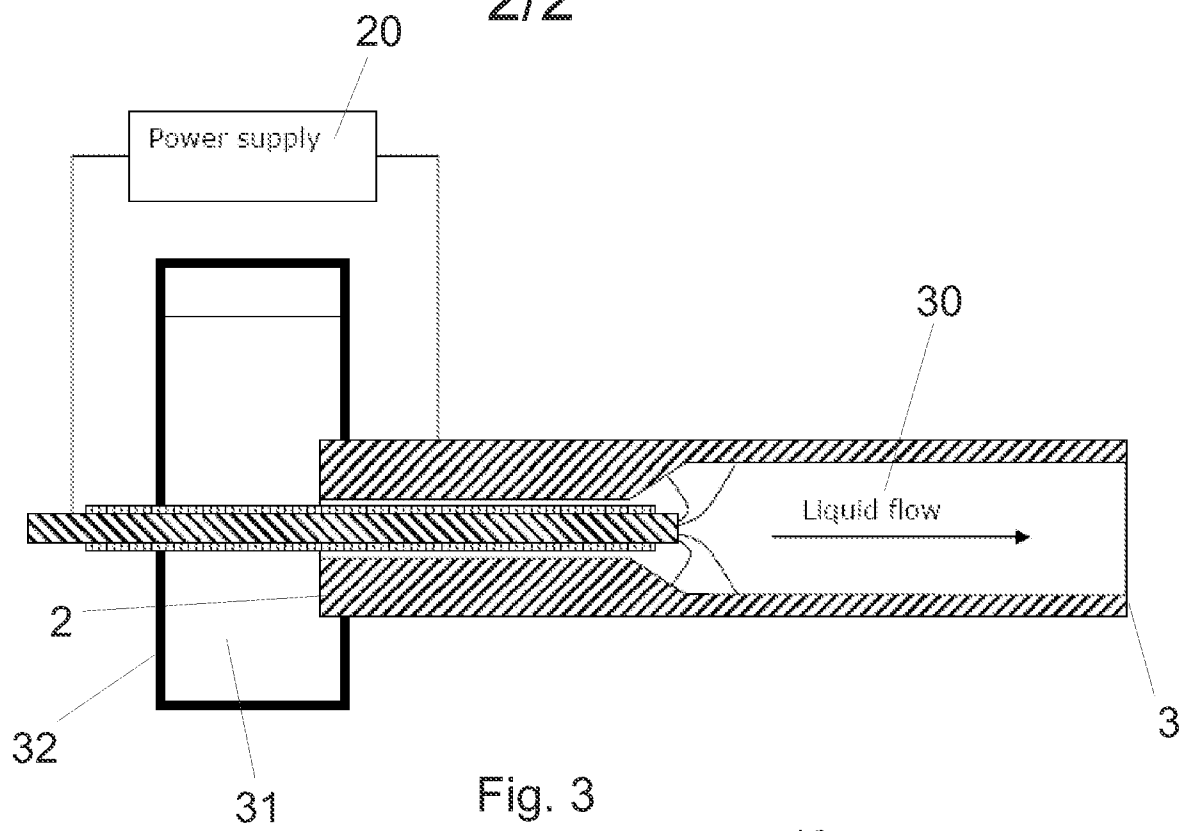


Fig. 3

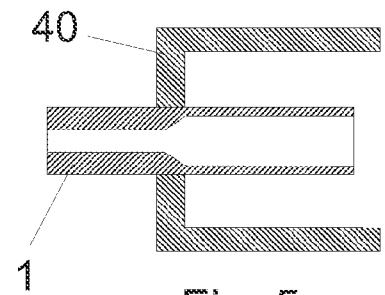


Fig. 5

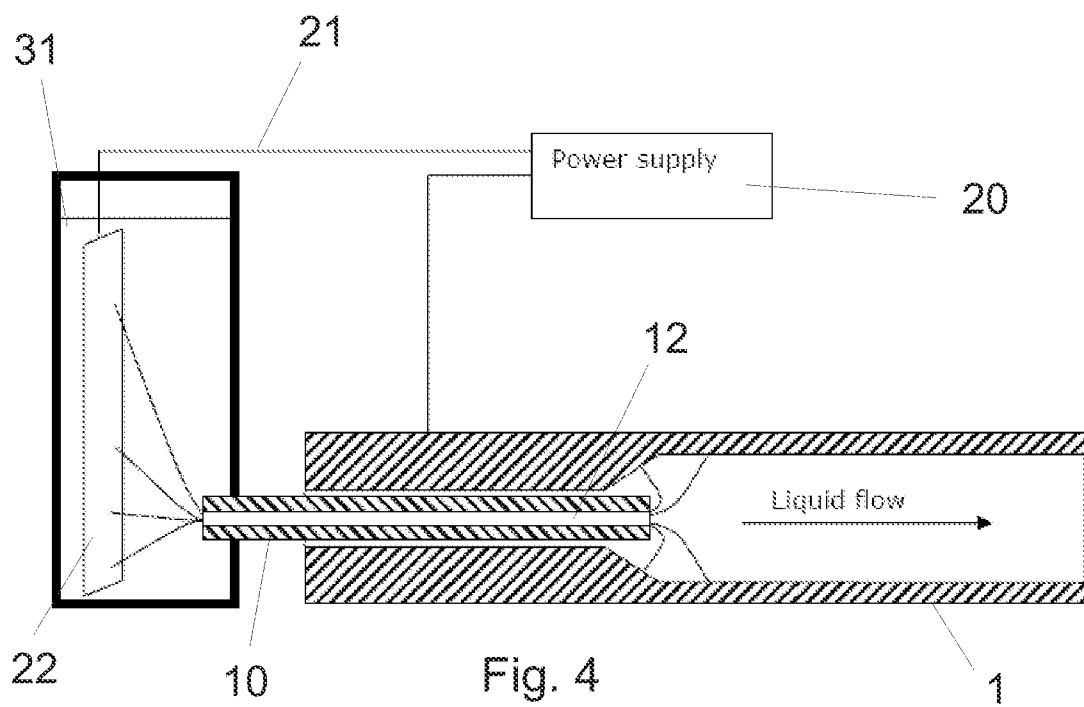


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/057531

A. CLASSIFICATION OF SUBJECT MATTER

INV. C25F3/24 A61D7/00 A61M5/32
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)

C25F A61D A61M

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 326 785 A (WILLIAMS LYNN A) 20 June 1967 (1967-06-20)	9,10
Y	column 2, line 30 - column 3, line 67; figure 2	1-8
X	US 2006/204535 A1 (JOHNSON JOHNNIE M [US]) 14 September 2006 (2006-09-14) paragraphs [0002], [0005], [0023]	9,10
Y	US 4 772 367 A (MENZEL JUERGEN [DE] ET AL) 20 September 1988 (1988-09-20) column 1, lines 6-12 column 2, lines 3-11 column 3, line 22 - column 4, line 15; figure 2	1-8
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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.

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Date of the actual completion of the international search

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13/08/2010

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/057531

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6 660 138 B2 (LIN CHUN-HUNG [TW] ET AL) 9 December 2003 (2003-12-09) * abstract; claim 1; figure 2 column 3, line 23 - column 4, line 6 -----	1-8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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