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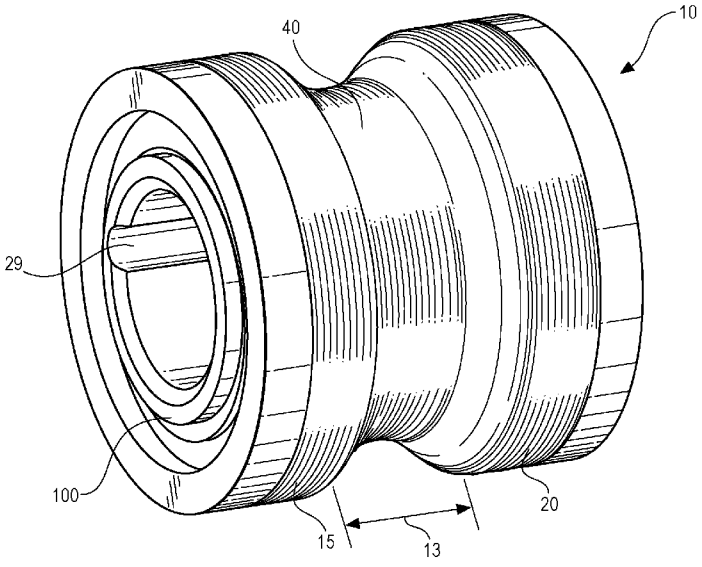
[Continued on next page]

(54) Title: MICA ROLLS FOR USE IN GLASS MANUFACTURING PROCESSES AND METHOD FOR MAKING THE SAME

Fig. 1



(57) Abstract: Push roll spools for engaging and driving softened glass tubes over a shaping mandrel. A push roll spool for use in processing a glass tube may comprise a base having first and second axially spaced ends, and multiple sheets of heat resistant material disposed on the base between the axially spaced ends, forming an axially extending stack. The stack may have a circumferential, generally U-section groove having a profile defined by the peripheral edges of multiple said sheets having different diameters. The U-section groove may be sized to engage and drive a glass tube. The U-section groove may have two contact areas at which to engage and drive a glass tube. The heat resistant material may comprise mica or a mica composition, for example mica paper or ceramic fiber millboard.

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MICA ROLLS FOR USE IN GLASS MANUFACTURING PROCESSES AND METHOD FOR MAKING THE SAME

[0001] This application claims the benefit of priority under 35 U.S.C. § 119 of U.S. Provisional Application Serial No. 62/112292 filed on February 5, 2015 the content of which is relied upon and incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates generally to various types of rolls, such as push rolls and pull rolls, for use in the manufacture of circular tubing and other shaped non-circular sleeves or tubes, used for example in a glass manufacturing process.

BACKGROUND

[0003] Rolls are used in glass manufacturing to apply a force, for example a vertical force, to convey a feed stock of glass from which an intermediate or final product is formed. For example, pull rolls are used in the manufacture of sheet glass to pull a ribbon or web of glass from which individual sheets are formed. The amount of frictional force applied by pull rolls to glass is utilized to control the nominal thickness of the glass as the glass is drawn from softened glass, such as in an overflow downdraw fusion process, as described in U.S. Pat. Nos. 3,338,696 and 3,682,609, or a similar process.

[0004] Pull rolls are typically designed to contact the glass web at its outer edges, usually in an area just inboard of the thickened beads that form at the very edges of the glass ribbon. An important aspect of pull roll function is to avoid cracking of the ribbon which can cause process outages and restarts. Because pull rolls are in direct contact with the surface of the glass ribbon, damage to the surface of the glass may occur from contact with the pull rolls. In addition, tramp glass

particles can become embedded in the surface of the pull roll resulting in additional damage to the glass as the pull rolls contact the glass.

[0005] In addition to a main pull roll, additional rolls are sometimes used in glass drawing processes to stabilize glass motion, or to create tension across the glass. When drawing a tube or rod, such as a hollow or solid cylinder, of softened glass over a shaping mandrel, it may be advantageous to have—in addition to, or in place of, pull rolls—one or more push rolls that are designed to push the tube of softened glass over the shaping mandrel. Accordingly, there is a need for new push roll designs.

SUMMARY

[0006] The present disclosure relates generally to push or pull roll spools for engaging and driving softened glass tubes over a shaping mandrel.

[0007] Optionally, a push roll spool for use in processing a glass tube may comprise a base having first and second axially spaced ends. The push roll spool may comprise multiple sheets of heat resistant material disposed on the base between the axially spaced ends, forming an axially extending stack. The stack may have a circumferential, generally U-section groove having a profile defined by the peripheral edges of multiple said sheets having different diameters. The U-section groove may be sized to engage and drive a glass tube. The U-section groove may have two contact areas at which to engage and drive a glass tube. The heat resistant material may comprise mica or a mica composition, for example mica paper or ceramic fiber millboard.

[0008] Optionally, a method for producing a push roll spool for use in glass manufacturing may comprise: providing a plurality of sheets of a heat resistant material; stacking the plurality of sheets; compressing the plurality of sheets axially; and optionally grinding the plurality of

sheets to form a concave groove around the spool. The heat resistant material may comprise mica or a mica composition, for example mica paper or ceramic fiber millboard.

[0009] Optionally, a method for producing a glass sleeve with a flattened portion may comprise the steps of: providing one or more rotatable push rolls, each rotatable push roll comprising a concave contact surface made of a first heat resistant material; providing a substantially cylindrical tube made of glass, the substantially cylindrical tube having a longitudinal axis, an outer curved surface, and an inner curved surface at least partially enclosing a space; introducing the concave contact surface into contact with the outer curved surface to push the substantially cylindrical tube; heating at least a portion of the substantially cylindrical tube to a temperature within the softening range of the glass; introducing one or more shaping mandrels into the partially-enclosed space; and moving the substantially cylindrical tube over the one or more shaping mandrels to deform the tube, forming the flattened portion. The concave contact surface may contact the substantially cylindrical tube at (for example) two contact areas. The substantially cylindrical tube may be moved over the one or more shaping mandrels to deform the tube, forming two opposing flattened portions, two opposing curved portions, or both. The two opposing curved portions may be substantially semi-circular. The first heat resistant material may comprise mica or a mica composition, for example mica paper or ceramic fiber millboard. One or more rotatable pull rolls having a flat contact surface made of a second heat resistant material may be introduced such that the flat contact surface contacts the outer surface to pull the substantially cylindrical tube over the one or more shaping mandrels. The second heat resistant material may comprise mica or a mica composition, for example mica paper or ceramic fiber millboard.

[0010] Additional features and advantages of the present disclosure will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the embodiments described herein, including the detailed description which follows, the claims, as well as the appended drawings.

[0011] It is to be understood that both the foregoing general description and the following detailed description describe various embodiments and are intended to provide an overview or framework for understanding the nature and character of the claimed subject matter. The accompanying drawings are included to provide a further understanding of the various embodiments, and are incorporated into and constitute a part of this specification. The drawings illustrate the various embodiments described herein, and together with the description serve to explain the principles and operations of the claimed subject matter.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0012] The following is a description of the figures in the accompanying drawings. The figures are not necessarily to scale, and certain features and certain views of the figures may be shown exaggerated in scale or in schematic in the interest of clarity or conciseness.

[0001] FIG. 1 is a perspective view of a push roll spool.

[0002] FIG. 2 shows a plan view of a sheet of heat resistant material.

[0003] FIG. 3 is a perspective view of a pull roll spool.

[0004] FIG. 4 is a perspective view of a push roll spool mounted on a roll shaft.

[0005] FIG. 5A shows a schematic of a non-complementary contact between a push roll spool and a glass tube.

[0006] FIG. 5B shows an enlargement of a portion of FIG. 5A.

[0007] FIG. 5C shows a close-up view of a contact area.

[0008] FIG. 5D shows a close-up view of a contact area.

[0009] FIG. 6 is a schematic illustration of the glass tube to glass sleeve manufacturing process.

[0010] FIG. 7 is a perspective view of a glass sleeve.

[0011] The following reference characters are used in this specification:

10 Push roll spool

11 Roll shaft

12 Glass tube

13 Midsection (of 10)

15 Surface (of 10)

20 Compacted stack

22 Glass sleeve

24 Sheet or disc

25 Hole

26 Sheet or disc

27 Keyway

28 Sheet or disc

29 Key

40 U-section groove (of 10)

42 Contact area

44 Contact area

50 Heating zone

52 Clamp

70 Shaping mandrel

90 Pull roll spool

95 Surface (of 90)

100 Hub shaft

110 Particle

[0012] The foregoing summary, as well as the following detailed description of certain inventive techniques, will be better understood when read in conjunction with the figures. It should be understood that the claims are not limited to the arrangements and instrumentality shown in the figures. Furthermore, the appearance shown in the figures is one of many ornamental appearances that can be employed to achieve the stated functions of the apparatus.

DETAILED DESCRIPTION

[0013] In the following detailed description, numerous specific details may be set forth in order to provide a thorough understanding of embodiments of the present invention. However, it will be clear to one skilled in the art when embodiments of the present invention may be practiced without some or all of these specific details. In other instances, well-known features or processes may not be described in detail so as not to unnecessarily obscure the invention. In addition, like or identical reference numerals may be used to identify common or similar elements.

[0014] FIGS. 1, 4, 5A, and 5B illustrate a push roll spool **10** of the present disclosure for contacting and driving a glass material over one or more shaping mandrels **70**. The push roll can also be used, for example, to push an end of one heated glass tube axially against the end of another heated glass tube to join them. This end-to-end joining can optionally be carried out repeatedly with a series of tubes to form a longer or even substantially continuous glass tube in a manufacturing operation. The glass material will typically be glass and in the form of a substantially cylindrical glass tube **12**. A push roll spool **10** comprises a compacted stack **20** of multiple sheets or discs such as **24, 26, 28** of a heat resistant material that are compressed together. The heat resistant material will typically be mica or a material containing mica, for example mica paper or a ceramic fiber millboard.

[0013] The compacted stack **20** may be manufactured from a roll of heat resistant material from which multiple sheets such as **24, 26, 28** are punched out or otherwise formed. Each of the multiple sheets such as **24, 26, 28** will typically have a hole in the center of the sheet **24, 26, 28**, to allow the sheets **24, 26, 28** to be stacked onto a hub shaft **100**. An example of a sheet is shown in FIG. 2. Once multiple sheets such as **24, 26, 28** are stacked on a hub shaft **100**, the sheets **24, 26, 28** may be clamped together to form the compacted stack **20** of

the push roll spool **10**. "Mushrooming" optionally can be managed by beginning and ending the stack with a silicone-impregnated mica paper board (in which the silicone has been oxidized to be a silica binder). Once the stack **20** is formed, the push roll spool surface **15** optionally may be ground to achieve a desired roll shape and surface finish. Optionally, carbide grinding can be used to grind the surface **15** of the push roll spool **10** to the desired roll shape and surface finish. For example, a push roll spool **10** may have a U-section groove **40** ground into its midsection **13**. The "midsection" **13** does not need to be in or near the middle of the stack **20**; it can be anywhere in the stack **20**. Grinding the push roll spool **10** into the desired shape after assembly may help to prevent "mushrooming" of the push roll spool **10** shape that can occur when attempting to form a compacted stack **20** by compressing multiple sheets such as **24, 26, 28** having different diameters. Optionally, a push roll spool **10** may be formed by cutting multiple sheets such as **24, 26, 28** to different diameters such that the push roll spool **10** has its desired final shape upon assembly of the compacted stack **20**.

[0014] Optionally, a pull roll spool **90** may be formed, as shown in FIG. 3. Examples of pull rolls are disclosed in U.S. Pat. No. 8,820,120 (issued September 2, 2014 to Cook et al.) and U.S. Ser. No. 14/454,278 (filed August 7, 2014), which are both incorporated by reference in their entirety. A pull roll spool **90** may have a flat surface finish. A pull roll spool may also be formed by stacking multiple sheets such as **24, 26, 28** on a hub shaft **100**. Once multiple sheets such as **24, 26, 28** are stacked on a hub shaft **100**, the sheets **24, 26, 28** may be clamped together to form the compacted stack **20** of the pull roll spool **90**. Optionally, carbide grinding can be used to grind the surface **95** of the pull roll spool **90** to the desired roll shape and surface finish. For example, a pull roll spool **90** may optionally be ground to ensure that the surface **95** is flat.

[0015] As illustrated in FIG. 4, a push roll spool **10** may be mounted on a roll shaft **11**. Similarly, a pull roll spool **90** may be mounted on a roll shaft **11**. Optionally, as illustrated in FIG. 4, a pair of push roll spools **10, 10** may be used to drive a glass tube **12.**

[0016] As illustrated in FIGS. 5A and 5B, the U-section groove **40** of a push roll spool **10** may optionally be designed to be non-complementary to the glass tube **12** that the push roll spool **10** is designed to engage and drive, where non-complementary means that the push roll spool **10** contacts the glass tube **12** at limited contact areas **42, 44** along the surface of the U-section groove **40**. Reducing the contact area to two contact areas **42, 44** rather than an extensive contact surface is designed to decrease the occurrence of defects in a glass tube **12** driven by a push roll spool **10**. FIGS. 5C and 5D each show a close-up view of a contact area **44** in which a particle **110** is penetrating into the surface **15** of a push roll **10** either between a pair of sheets **24, 26** (FIG. 5C) or within a single sheet **26** (FIG. 5D).

[0017] FIG. 6 schematically depicts an exemplary glass manufacturing apparatus for forming a glass sleeve **22** from a glass tube **12**. Optionally, the entering glass tube **12** is substantially cylindrical. One or more push roll spools **10**—typically, a pair of opposing push rolls **10, 10**—may drive the glass tube **12** through one or more heating zones **50** and over one or more shaping mandrels **70** to form a glass sleeve **22**. One or more clamps **52** may optionally be used to maintain alignment. Optionally, one or more pull roll spools **90** may be employed to pull the glass sleeve **22**. FIG. 7 illustrates a possible a glass sleeve **22** that may be formed pursuant to one of the presently disclosed manufacturing processes.

[0018] While the push roll spools **10** have been described in the present disclosure as being used in conjunction with an apparatus which utilizes a down-draw process, it should be understood that the push roll spools **10** may be used with similar processes in which glass

tubes **12** are shaped into different shapes, such as glass sleeves **22**. By way of example and not limitation, the push roll spools **10** of the present disclosure may also be used in conjunction with up-draw processes, slot-draw processes, float-draw processes, tube end-to-end joining processes and other, similar processes.

[0019] Optionally, the compacted stack **20** may be formed from multiple sheets such as **24, 26, 28** of mica paper. The multiple sheets such as **24, 26, 28** of mica paper generally comprise layers of overlapping mica platelets oriented substantially in parallel with one another and joined together by van der Waals forces, electrostatic forces, sintering, and/or the like. This configuration of the mica platelets provides for maximum stability of the resultant mica paper. Optionally, the mica paper is formed without the addition of a binder or any other matrix of material in which the mica platelets are embedded. The mica platelets in the mica paper generally have a high aspect-ratio (*i.e.*, the ratio of the average diameter to average thickness) and are highly delaminated. For example, the aspect-ratio of the mica platelets contained in the mica paper may optionally be in a range from about 50 to about 500. While not wishing to be bound by theory, it is generally believed that high aspect-ratio mica platelets oriented in parallel with one another improve the mechanical strength, geometrical stability, and wear resistance of the compacted stack. Specifically, it is believed that the interfacial friction between the mica platelets improves the resistance of the platelets to pull-out during use, thereby improving the wear resistance of the compacted stack and decreasing the occurrence of defects in glass tubes **12** driven by the push roll spools **10**.

[0020] Optionally, the mica paper may be formed from phlogopite mica platelets so as to increase the temperature range in which the mica paper is stable. For example, the mica paper may be phlogopite or muscovite mica-paper commercially available from Cogebi Group,

Belgium; Corona Films, USA; or Von Roll, USA. Optionally, this mica paper may not include a binder material. However, it should be understood that other types of mica paper may be used, including mica paper formed from other types of mica platelets and/or mica paper which includes a binder. For example, other suitable types of mica paper may include, without limitation, mica paper formed from fluorophlogopite mica (which is more thermally stable than phlogopite mica) or mica paper formed from muscovite mica.

[0021] Mica paper of various thicknesses can be used to form each of the multiple sheets such as **24, 26, 28** of heat resistant material, an example of which is depicted in FIG. 2. For example, each sheet **24, 26, 28** may optionally have an uncompressed thickness greater than about 100 μm. Following compression, each sheet **24, 26, 28** may have a compressed thickness of less than or equal to about 100 μm. However, it should be understood that mica paper with larger and smaller compressed thicknesses may also be used. The compacted stack **20** may be compressed to a target density or porosity that determines the Shore D hardness of the compacted stack **20**. Generally, the greater the compression, the harder the compacted stack **20**.

[0022] Sheets of heat resistant material **24, 26, 28** with compressed thicknesses as specified above facilitate forming a compacted stack **20** with the desired mechanical properties as well as the ability to withstand and/or mitigate damage to the contact surface caused by debris (*i.e.*, glass particulates or the like) encountered during the glass drawing process. In particular, forming the compacted stack **20** from relatively thin sheets **24, 26, 28** of heat resistant material (*i.e.*, sheets with a compressed thickness of less than or equal to about 200 μm) permits particles **110**, such as debris or other particulate matter positioned on the contact surface, to be enveloped between adjacent sheets (as illustrated in FIG. 5C) and/or between platelets within a

single sheet (as illustrated in FIG. 5D) such that it minimizes the flaws created on the surface of the glass tube **12** when the push roll spool surface **15** contacts the glass tube **12**.

[0023] Although the mica paper used for the multiple sheets such as **24, 26, 28** of heat resistant material has been described as being formed without a binder material, it should be understood that, optionally, the mica paper may contain a binder material to improve the mechanical stability of each sheet. For example, the mica paper may be impregnated with a filler material which may further bind the mica platelets together. The filler material may be organic, semi-organic, or inorganic. When the filler material is organic, the filler material may be removed from the mica paper by pyrolysis or a chemical process (*i.e.*, dissolved). The filler material may be, for example, silicone or another polymeric resin which improves the mechanical stability of the mica paper without significantly decreasing the flexibility of the mica paper. In general, the filler material increases both the density of the mica paper and the hardness of the mica paper.

[0024] Although the multiple sheets such as **24, 26, 28** of heat resistant material are described as being formed from mica paper, it should be understood that the sheets **24, 26, 28** may optionally be formed from other inorganic materials including, without limitation, ceramic fiber millboard, ceramic materials, elemental metals, metal alloys or the like. For example, the multiple sheets such as **24, 26, 28** may be formed from refractory paper (such as asbestos fiber paper, mica flake paper, ceramic fiber paper, or graphite paper), metal foils (such as aluminum foil or platinum foil), or a single crystal sheet (such as mica).

[0025] Optionally, each sheet of heat resistant material is formed with a central hole **25** to facilitate positioning each sheet on a hub shaft **100**. Although the hole **25** is depicted in FIG. 2 as generally circular, it should be understood that the hole **25** may have other

geometric shapes. For example, where each sheet is installed on a hub shaft **100** with a hexagonal cross section, the hole **25** may also be hexagonal so as to prevent the sheets from rotating on the hub shaft **100**. The hole **25** may also be optionally formed to include a keyway **27**, as depicted in FIG. 2. Where the hole **25** includes a keyway **27**, the keyway **27** may engage with a corresponding key **29** formed on the hub shaft **100** to prevent the sheets **24, 26, 28** from rotating on the hub shaft **100**. Optionally, the hole **25** and keyway **27** may be formed via a punching operation.

[0026] Prior to assembling each of the multiple sheets such as **24, 26, 28** on the hub shaft **100**, the sheets **24, 26, 28** may be pre-fired to calcine the sheets to preempt hardening of the sheets **24, 26, 28** during subsequent usage at elevated temperatures. Optionally, the sheets **24, 26, 28** are pre-fired by stacking the sheets **24, 26, 28** and heating them according to a heating schedule suitable for calcination. For example, the sheets **24, 26, 28** may be heated to a maximum temperature of about 700 °C at a ramp rate of 2 °C/min and held at this maximum temperature for about 6 hours. Optionally, the sheets **24, 26, 28** may be calcined following assembly and compression of the ring sheets.

[0027] Optionally, the multiple sheets such as **24, 26, 28** are stacked and axially compressed on the hub shaft **100** such that the push roll spool **10** permits particles **110**, such as tramp glass particles or other debris, to penetrate into the contact surface of the push rolls **10** such that the flaws caused by the particles **110** are minimized and/or the particles **110** do not contact as hard against the surface of the glass tube **12** driven by the push rolls **10**, thereby reducing the occurrence of repetitive defects and/or cracking. The resistance (or compliance) of the contact surface of the push roll spools can be qualitatively assessed using conventional hardness metrics, such as the Shore durometer metrics. The hardness of push roll spools is

typically measured with the Shore D scale and, in particular, according to ASTM D2240. The indenter used in the Shore D hardness measurement is conical, and, as such, the Shore D hardness measurement of the push roll surface **15** is generally indicative of the ability of the roll assembly to envelop particles **110** between multiple sheets such as **24, 26, 28** (as illustrated in FIG. 5C) or within a single sheet **26** (as illustrated in FIG. 5D). The smaller the Shore D number, the easier it is for particles **110** to penetrate into the contact surface of the push roll spool **10**. A smaller Shore D number also indicates that the push roll spool **10** is able to envelop larger particles **110**.

[0028] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

CLAIMS

1. A push roll spool for use in processing a glass tube, the spool comprising:

   a. a base having first and second axially spaced ends,

   b. multiple sheets of heat resistant material disposed on the base between the axially spaced ends, forming an axially extending stack,

   c. the stack having a circumferential, generally U-section groove having a profile defined by the peripheral edges of multiple said sheets having different diameters, the groove sized to engage and drive a glass tube.

2. The push roll spool of claim 1, wherein the groove has two contact areas at which to engage and drive a glass tube.

3. The push roll spool of claim 1, wherein the heat resistant material comprises mica.

4. The push roll spool of claim 1, wherein the heat resistant material comprises mica paper.

5. The push roll spool of claim 1, wherein the heat resistant material comprises ceramic fiber millboard.

6. A method for producing a push roll spool for use in glass manufacturing comprising:

   a. providing a plurality of sheets of a heat resistant material;

   b. stacking the plurality of sheets;

c. compressing the plurality of sheets axially;

d. grinding the plurality of sheets to form a concave groove around the spool.

7. The method for producing a push roll spool of claim 6, wherein the heat resistant material comprises mica.

8. The method for producing a push roll spool of claim 6, wherein the heat resistant material comprises mica paper.

9. The method for producing a push roll spool of claim 6, wherein the heat resistant material comprises ceramic fiber millboard.

10. A method for producing a glass sleeve with a flattened portion comprising the steps of:

a. providing one or more rotatable push roll spools, each rotatable push roll spool comprising a concave contact surface made of a first heat resistant material;

b. providing a substantially cylindrical tube made of glass, the substantially cylindrical tube having a longitudinal axis, an outer curved surface, and an inner curved surface at least partially enclosing a space;

c. introducing the concave contact surface into contact with the outer curved surface to push the substantially cylindrical tube;

d. heating at least a portion of the substantially cylindrical tube to a temperature within the softening range of the glass;

e. introducing one or more shaping mandrels into the partially-enclosed space;

f. moving the substantially cylindrical tube over the one or more shaping mandrels to deform the tube, forming the flattened portion.

11. The method of claim 10, wherein the concave contact surface contacts the substantially cylindrical tube at two contact areas.

12. The method of claim 10, further comprising moving the substantially cylindrical tube over the one or more shaping mandrels to deform the tube, forming two opposing flattened portions.

13. The method of claim 10, further comprising moving the substantially cylindrical tube over the one or more shaping mandrels to deform the tube, forming two opposing curved portions.

14. The method of claim 13, wherein the two opposing curved portions are substantially semi-circular.

15. The method of claim 10 wherein the first heat resistant material comprises mica.

16. The method of claim 10 wherein the first heat resistant material comprises mica paper.

17. The method of claim 10 wherein the first heat resistant material comprises ceramic fiber millboard.

18. The method of claim 10, comprising introducing one or more rotatable pull roll spools having a flat contact surface made of a second heat resistant material such that the flat

contact surface contacts the outer surface to pull the substantially cylindrical tube over the one or more shaping mandrels.

19. The method of claim 18 wherein the second heat resistant material comprises mica.

20. The method of claim 18 wherein the second heat resistant material comprises mica paper.

21. The method of claim 18 wherein the second heat resistant material comprises ceramic fiber millboard.

Fig. 1

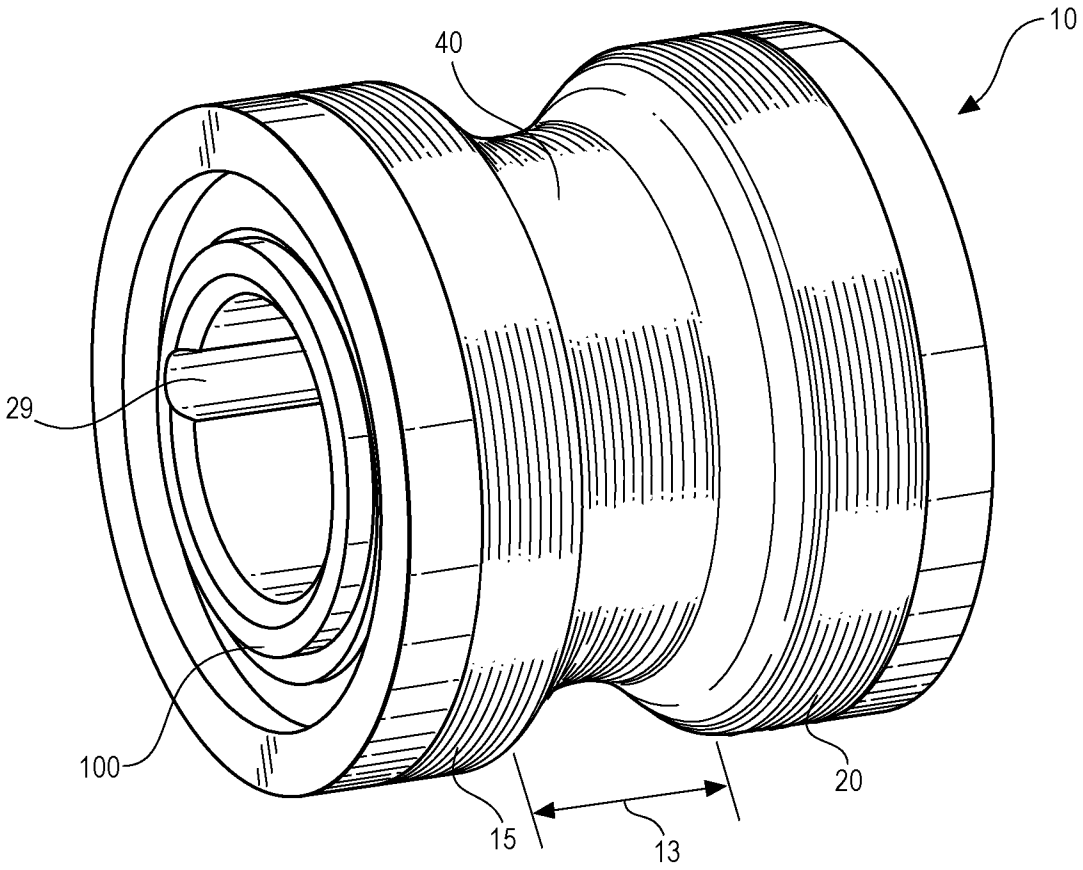


Fig. 2

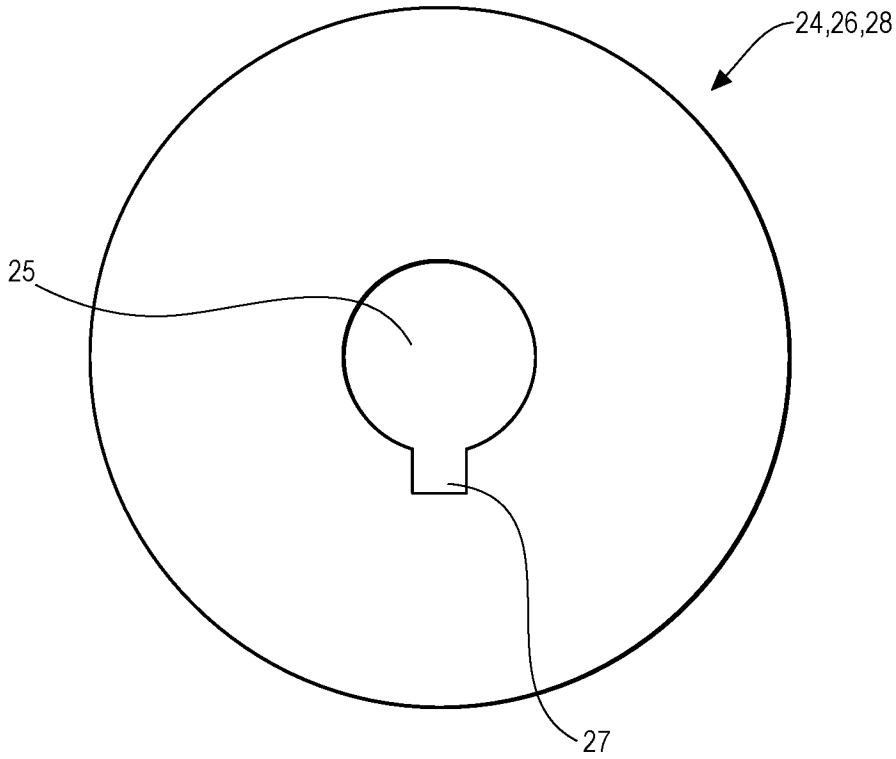


Fig. 3

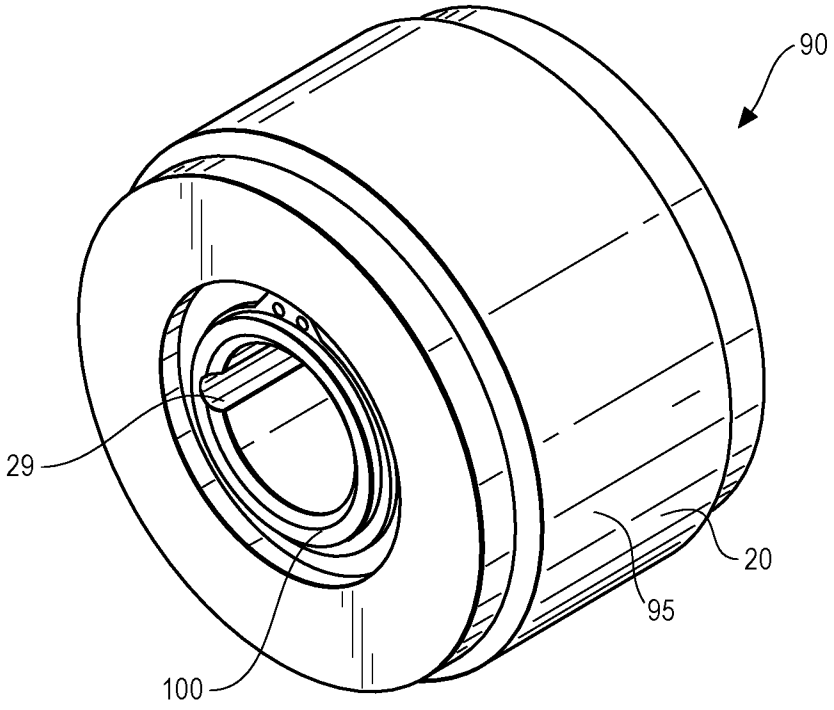


Fig. 4

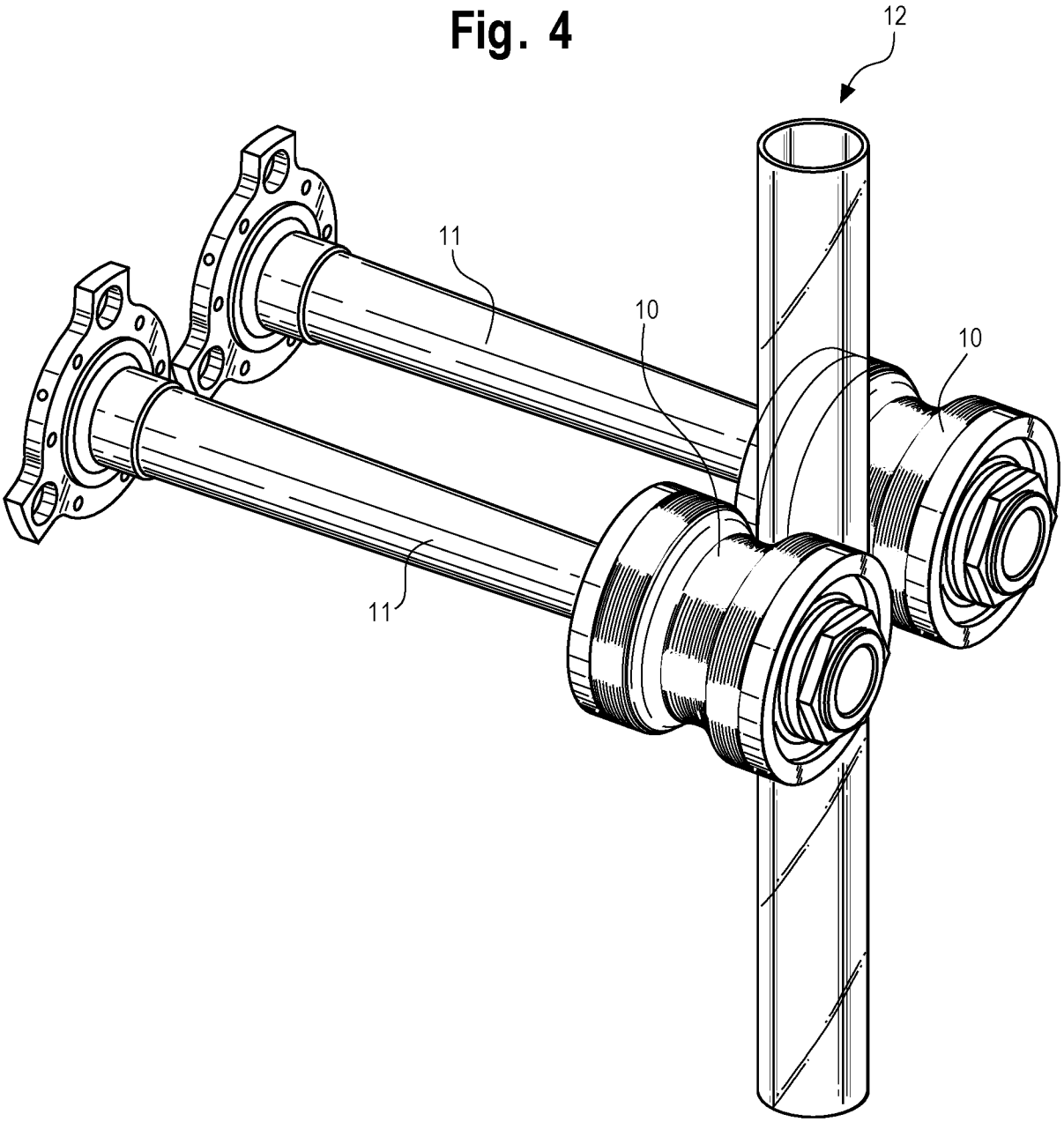


Fig. 5A

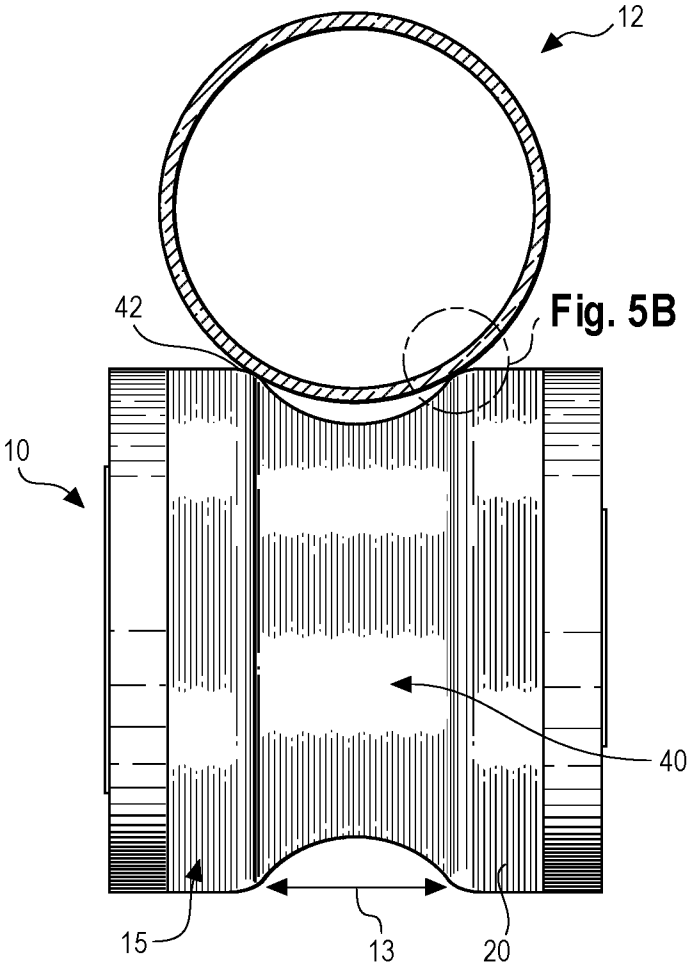


Fig. 5B

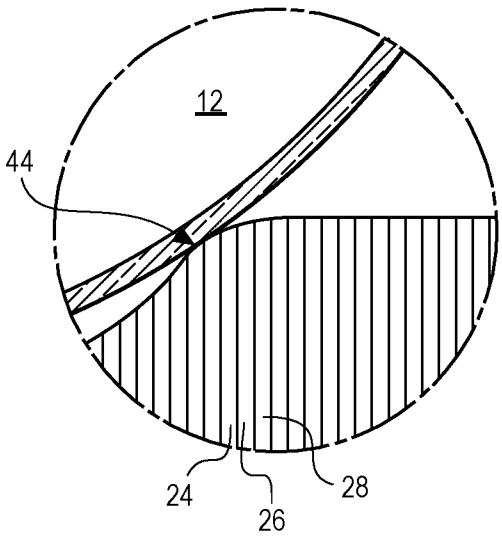


Fig. 5C

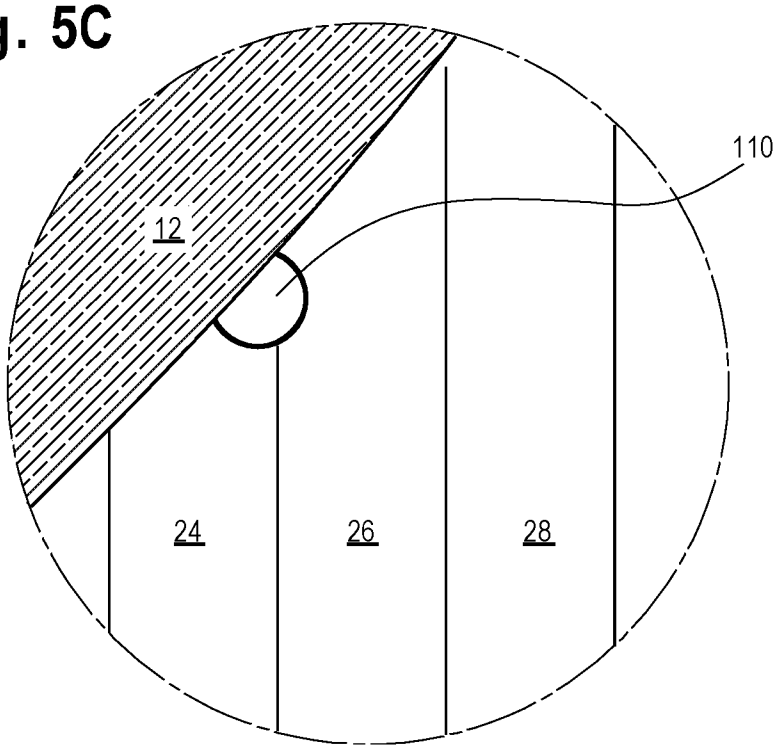


Fig. 5D

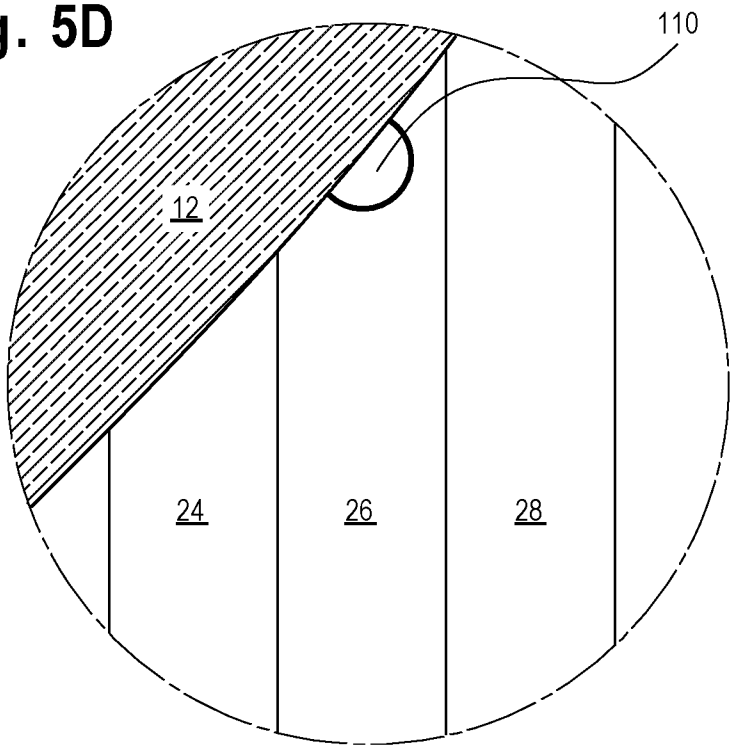


Fig. 6

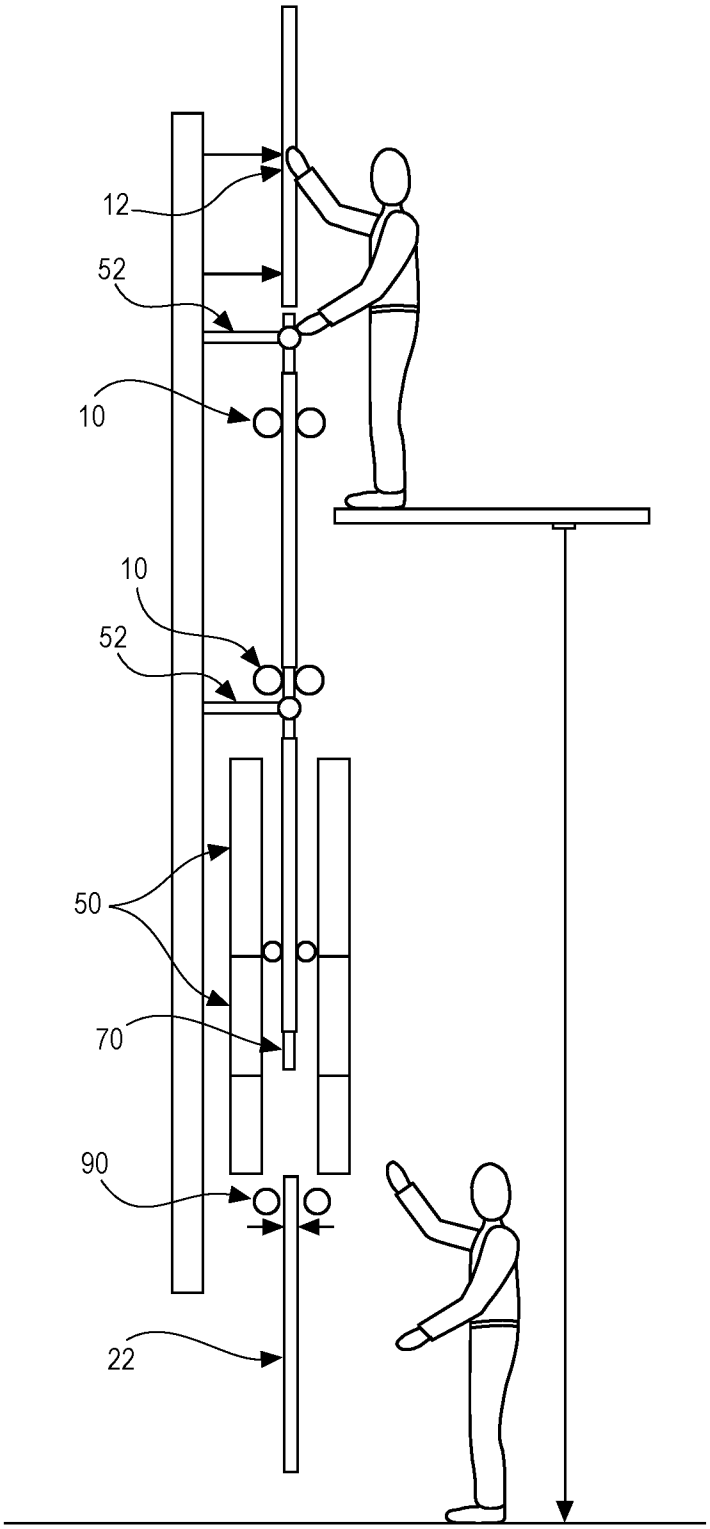
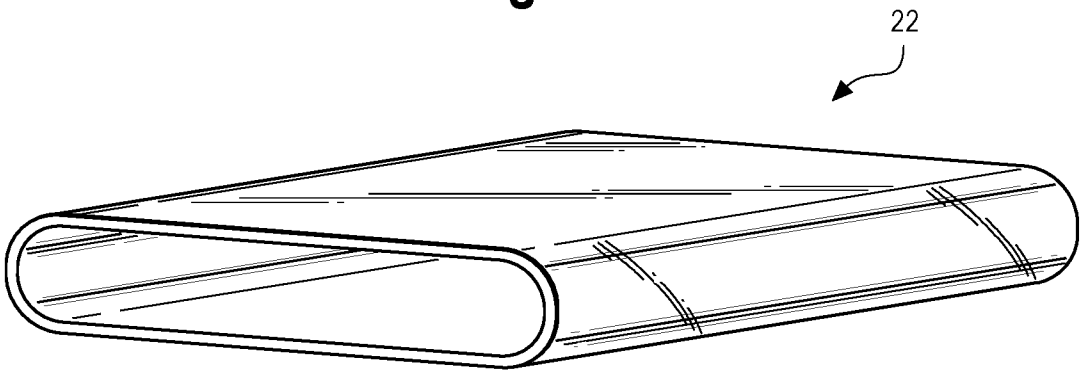


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/016262

A. CLASSIFICATION OF SUBJECT MATTER
INV. C03B23/045 C03B23/047
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)
C03B B32B

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.
X	JP 2003 238185 A (FUJIKURA LTD) 27 August 2003 (2003-08-27)	1,2
Y	items 4,12,12z,12x; paragraph [0019]; figure 3	6-21
Y	US 8 820 120 B2 (COOK GLEN BENNETT [US] ET AL) 2 September 2014 (2014-09-02)	1,3-5
A	items 202,; column 12, lines 23-28; claims 1,2; figures 1B,3,4 column 5, lines 23-32	15-17, 19-21
Y	US 3 652 248 A (LOXLEY TED A ET AL) 28 March 1972 (1972-03-28) items 22-23; figure 1	1,3-21

-/--

[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 May 2016	18/05/2016

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	Gkerou, Elisavet

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/016262

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2013/174609 A1 (WATANABE KAZUHISA [JP] ET AL) 11 July 2013 (2013-07-11) paragraphs [0001], [0020], [0026], [0040]; claims 1-8; figure 1	6,7,9 3-5, 18-21
Y	WO 2014/036236 A1 (CORNING INC [US]; BISSON ANTOINE GASTON DENIS [FR]; CIMO PATRICK JOSEP) 6 March 2014 (2014-03-06) items 200,100; paragraphs [0070] - [0072]; figures 3A-3G,4a-4b	10-21
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Y	FR 2 767 810 A1 (FRANCE TELECOM [FR]) 5 March 1999 (1999-03-05) figure 1	1
A	US 2004/007021 A1 (IGO MASAFUMI [JP] ET AL) 15 January 2004 (2004-01-15) figures 1-4	18
Y	JP H03 12332 A (FUYUUTEC FUAANESU KK) 21 January 1991 (1991-01-21) figure 2	1,6, 10-21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/016262

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-21

Apparatus for supporting a glass tube,method of producing said apparatus and method for producing a glass sleeve.

1.1. claims: 1-9

Apparatus for supporting a glass tube and method of producing said apparatus.

1.2. claims: 10-21

Method of producing a glass sleeve.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2016/016262

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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