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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 June 2017 (08.06.2017)

(10) International Publication Number
WO 2017/092721 A1

(51) International Patent Classification:
B21C 23/20 (2006.01) *B21C 23/32* (2006.01)

(21) International Application Number:
PCT/CZ2016/050001

(22) International Filing Date:
8 January 2016 (08.01.2016)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PV2015-855 3 December 2015 (03.12.2015) CZ

(71) Applicant: **VITKOVICE CYLINDERS A.S.** [CZ/CZ]; Ruska 24/83, 70600 Ostrava-Vitkovice (CZ).

(72) Inventors: **KUCERA, Pavel**; U Hraze 628, 73911 Frydlant nad Ostravici (CZ). **HOFRIK, Petr**; Generala Sochora 23, 70800 Ostrava-Poruba (CZ). **PIJANOWSKI, Tomas**; Plzenska 9, 70030 Ostrava-Hrabuvka (CZ).

(74) Agent: **RYLKOVA, Iva**; Polska 1525, 70800 Ostrava-Poruba (CZ).

(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).

Declarations under Rule 4.17:

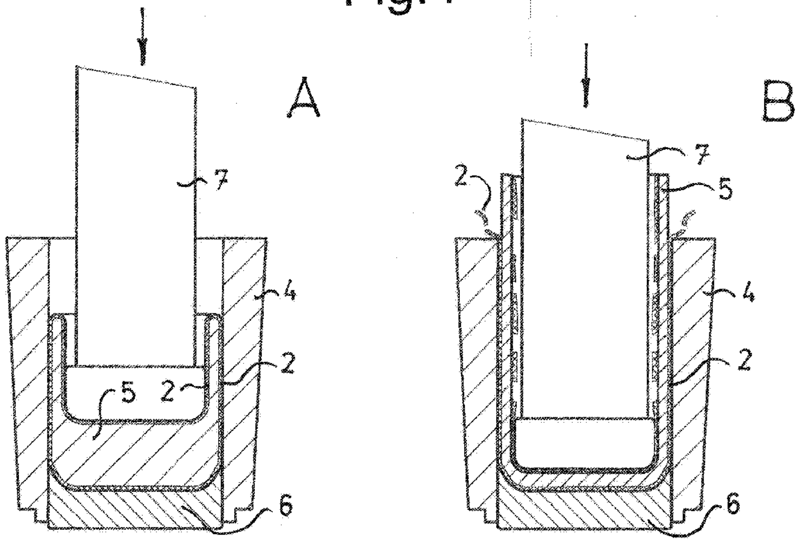
— *of inventorship (Rule 4.17(iv))*

Published:

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

(54) **Title**: METHOD OF PRODUCTION OF HIGH-PRESSURE SEAMLESS CYLINDER FROM CORROSION-RESISTANT STEEL

Fig.4



(57) **Abstract**: Blank (1) of corrosion-resistant steel is coated with coating (2) of water glass with thickness of 20 to 150 μm, cured at 15 to 60 °C, and heated in an induction furnace to the temperature of 1180°C to 1260°C. The heated up blank (1) is without cooling by water descaling transferred into an extrusion press and extruded here, while the coating (2) is broken to pieces and largely removed. Then drawing in a horizontal drawing press and necking are performed. After forming to the final shape of the cylinder, leftovers of coating (2) are removed by pressure blasting. A corrosion-resistant thin-walled seamless high-pressure cylinder with volume of 5 to 260 litres is manufactured.

WO 2017/092721 A1

METHOD OF PRODUCTION OF HIGH-PRESSURE SEAMLESS CYLINDER FROM CORROSION-RESISTANT STEEL

Technical Field

The invention relates to the field of material forming, namely the method of production of high-pressure cylinder from corrosion-resistant steel using the method of hot backward extrusion solved completely specifically for the possibility to obtain high-pressure seamless cylinder not showing hydrogen embrittlement and inner surface corrosion.

Background Art

High-pressure seamless steel cylinders are currently produced using the method of backward extrusion and drawing utilizing the process according to the CZ pat. 243247.

When using the procedure according to the CZ patent 243247, steel blanks are first cut from billets of square or circular section. The steel blanks are heated in an induction furnace to the output temperature of 1000 to 1250 ^{0}C, after which they are robotically transposed into a descaling device where a high-pressure water jetting is performed to remove the scales from the surface of blanks. Then each individual blank is inserted by stacker into an extrusion press, where it is upset and backward extruded. The backward extrusion process is realized in two steps. During the first step, the blank is inserted into a die with a vertically moving ram, cylindrical insert, and piercing mandrel fitted with a piercing head, where a thick-walled hollow semi-product, which is smooth inside without protrusions or bumps, is produced by means of extrusion from the blank. At the end of extrusion in the extrusion press, bottom is pressed in the semi-product basically to the final thickness, however the semi-product has larger diameter than the final product. After completion of the backward extrusion in the extrusion press, the semi-product is robotically removed from the extrusion press, turned by 90°, and seated in this position into the horizontal drawing press, where the second step of forming, which is backward drawing, will take place. During this second step, the semi-product is put on a drawing mandrel with the already final inner diameter of the cylinder, after which it is extruded through a stripper ring and roller cartridges fitted with reduction rollers. The semi-product on the mandrel is rolled, in which process reshaping of the semi-product wall thickness by approximately 25 % to 85 % will take place, and the semi-product will acquire the desired outer and inner diameter. In addition, the rest of scales will fall off. After the semi-product passing through the stripper ring and the roller cartridges, insertion of the semi-product bottom into a sizing die is performed, thus forming the final shape of the cylinder bottom. Then, in the course of backward movement of the drawing mandrel, the semi-product is pulled off from the drawing mandrel with the help of stripping jaws. The stage of the semi-product processing by rolling is mentioned in the Utility model CZ U 20492. After final forming by rolling, the hollow semi-products are aftercooled with air and subsequently necked, i.e. closed by means of rotary forming to create a steel cylinder of typical geometry.

Disadvantage of the existing procedures of production of high-pressure seamless cylinders is the fact that they do not allow production of cylinders from corrosion-resistant steels using the method of backward extrusion and drawing, because the corrosion-resistant material degrades when conventional method of backward extrusion and drawing is used and it is impossible to produce safe high-pressure seamless cylinder from it.

Currently there are also procedures that allow producing high-pressure cylinders from corrosion-resistant pipes. These are procedures in which necking of pipe segment is performed on both sides. In a seamless form, however, only double-necked cylinders of a simple shape can be manufactured with these procedures, because they do not allow seamless closure of the bottom. Cylinders of different types of alloys such as chrome-molybdenum can also be produced using these procedures. However, because it is not possible to produce sufficiently thin-walled tubes as the starting semi-product for these procedures, all such pressure bottles made using production methods based on pipes have thick-walled structure, and thus they have considerable disadvantage in a very big mass. Especially in the case of bigger and big volumes, such big weight of cylinders complicates handling, storage, and transportation. Existing thick-walled cylinders have another disadvantage in low strength.

In the steel industry, the use of water glass is known in the field of foundry practice for protection of casting moulds against damage. . In this field, the inner surface of the casting mould is sometimes provided with a coating of water glass so that this coating could prevent direct contact of molten metal with the mould surface and thereby increase the service life of the mould. This coating is resistant to high temperatures used in the foundry practice. Water glass is used in the foundry industry also as a cementing component for the production of foundry moulds of sand.

Disclosure of Invention

The above-mentioned disadvantages are eliminated by the invention. New method of manufacturing seamless high-pressure cylinder from corrosion-resistant steel is designed allowing the production of thin-walled seamless version of the cylinder from corrosion-resistant steel even for larger and high-volume high-pressure cylinders.

The invention starts from the existing method of manufacturing seamless high-pressure cylinders. The starting part in the form of a steel blank is heated in an induction furnace and then inserted into an extrusion press where it is upset and backward extruded in two steps. From this, during the first step, the blank is inserted into a die with a cylindrical insert and a vertically moving piercing tool, and here it is moulded by means of extrusion until a thick-walled hollow semi-product having an inner cavity, walls and bottom is moulded from it. After that, the semi-product is removed from the extrusion press, turned by 90°, and seated in this position into a horizontal drawing press, where the second step of forming, which is backward drawing, takes place. During this second step, the semi-product is put on a drawing mandrel with the diameter corresponding to the desired final inner diameter of the produced cylinder, while in this drawing press, the semi-product is extruded through a stripper ring and roller cartridges fitted with reduction rollers by means of which it is rolled on the mandrel. This rolling is performed so long until the semi-product acquires the desired outer and inner diameter corresponding to the required final dimensions of the produced cylinder. Then the final shape of the cylinder bottom is formed by insertion of the semi-product bottom into a sizing die and subsequently, in the course of the backward movement of the drawing mandrel, the semi-product is pulled off from the drawing mandrel with the help of stripping jaws and is aftercooled. Finally, the semi-product manufactured in this way is necked, by which the shape of the manufactured cylinder is finished. The essence of the new solution according to the invention is that even before heating in the induction furnace, at least 85 % of the blank surface is coated with coating from material based on water glass with thickness of 20 to 150 μm, this coating is cured by drying at the temperature of 15 to 60 °C and only after this curing, the blank is subjected to heating in the induction furnace.

The material based on water glass is applied to the blank for example by spraying with nozzles or brushing in the form of water glass suspension. The water glass suspension stands here for suspension containing 20 to 40 % w. w. of sodium silicate or potassium silicate or mixture of these silicates, and 80 to 40 % w. w. of water, while in the case of presence of admixtures such as borosilicates and/or corrosion inhibitors, these admixtures are contained in the amount of maximum 20 % w. w.

The blank with coating from material based on water glass is heated in the induction furnace to the temperature of 1180 °C to 1260 °C.

Then, when the blank with coating is heated up in the induction furnace, the blank with coating is taken out of here, and during persistence of its temperature of minimum 1110 °C, it is inserted into the extrusion press, preferably without performing water descaling between the removal from the induction furnace and insertion into the extrusion press.

During the first step of mechanical working, in the course of piercing, the coating of material based on water glass is broken to pieces by purposeful pushing of the piercing tool to the blank, while it is cracking off during extrusion in the extrusion press until at least its major part is removed, meant as thickness of layer.

Then, when the final shape of the cylinder is formed from the semi-product, the leftovers of coating based on water glass are preferably removed from the surface of the semi-product by pressure blasting of its outer as well as inner surface with abrasive.

The blank is made preferably from corrosion-resistant steel while the resulting cylinder is made as a seamless cylinder in the volume range from 5 litres up to

260 litres, as a single necked or double-necked cylinder for any volume within the said range.

Thin walled seamless high-pressure cylinders of the abovementioned volumes are preferably manufactured with the help of this invention. In the second step of forming, the semi-product wall is pressed to the thickness of 2 to 21.5 mm.

The invention is utilizable for manufacturing of seamless high-pressure cylinders. It makes possible to manufacture these cylinders from corrosion-resistant steel and that in the corrosion-resistant version, even for larger and high cylinder volumes from 5 to 260 litres. The invention makes possible to manufacture these cylinders in the thin-walled version from significantly wider range of high-strength corrosion-resistant steels than the existing methods. Using this invention, substantial reduction of the mass of high-pressure cylinders is achieved as compared to the present state of art, and savings of material for their production. The seamless thin-walled version with these volumes was not possible so far. The cylinders according to the invention exhibit high mechanical resistance as well as pressure resistance. They have relatively very low mass, which as compared to the present state of art facilitates manipulation, storage, as well as transport. As compared to cylinders currently manufactured for example for scuba diving, respirators, for calibration gases etc., the cylinders according to the invention are by as much as two thirds lighter. The option to use corrosion-resistant steel for the production makes possible to use these cylinders even for raw natural gas and for gases and mixtures that in the case of existing cylinders from common chrome-molybdenum steel are causing hydrogen embrittlement and accelerated corrosion when reacting with the gas under high pressure.

Brief Description of Drawings

The invention is illustrated using drawings, where Fig. 1 shows the blank with applied coating of water glass in cross-section, Fig. 2 shows the phase of curing of the coating on the blank, Fig. 3 shows the phase of relocation of the blank from the induction furnace directly into the extrusion press, and Fig. 4 A, B shows process of pressing of the blank in the extrusion press, from which A shows the phase of extrusion of the future cylinder cavity in the blank and B shows the subsequent phase of breaking and falling off of the coating from the semi-product during pressing.

Best Mode for Carrying Out the Invention

Example of embodiment of the invention is visually demonstrated with the help of Figs. 1 to 4 and the hereinafter-described method of production of corrosion-resistant high-pressure seamless cylinder for storage, transport, and use of natural gas.

Parts of the size needed for the manufacture of cylinders of the produced volume are first cut from billets of corrosion-resistant steel having square or circular section. Each individual part, i.e. the starting steel blank 1, is on at least 85 % of its surface coated with coating 2 from material based on water glass. The thickness of applied layer is 20 to 150 μm. Suspension usually called water glass is used as the material based on water glass. For the purposes of the invention, the suspension based on water glass stands for suspension containing 20 to 40 % w. w. of sodium silicate or potassium silicate or their mixture and 80 to 40 % w. w. of water. Admixtures of borosilicates and corrosion inhibitors such as hexamine, fenylethylamine, phosphates, etc. and/or possible other admixtures can be contained provided they do not exceed the amount of 20 % w. w. in the suspension.

Examples of material composition of the suspension are given below.

Suspension I

Material	weight % in the suspension
Silicates (sodium or potassium silicate or their mixture)	20
Water	80
Admixtures	0

Suspension II

Material	weight % in the suspension
Silicates (sodium or potassium silicate or their mixture)	40
Water	60

Admixtures.. 0

Suspension III

Material	weight % in the suspension
Silicates (sodium or potassium silicate or their mixture)....................	30
Water..	60
Admixtures (borosilicates and corrosion inhibitors in quantities 1:1)	10

Suspension IV

Material	weight % in the suspension
Silicates (sodium or potassium silicate or their mixture).................	40
Water..	40
Admixtures (borosilicates and unidentified admixtures)	20

This coating 2 can be applied by brushing or spraying. After the application, the coating is let to dry at the temperature of 15 to 60 °C until curing. Sufficient curing will not take place in the case of curing below the temperature of 15 °C, so that unwanted cracking and falling-off of the coating 2 layer would take place during subsequent heating in the induction furnace. In the case of curing above 60 °C, unwanted cracking of the coating 2 will take place as soon as during drying. During curing within the said range, creation of homogenous layer acting as a protective jacket on the surface of the blank 1 takes place. For the drying process or after it, the blank 1 is placed into the induction furnace, where it is heated up by gradual heating to the temperature of 1180 °C to 1260 °C. During heating, neither high-temperature oxidation of the surface of blanks 1 contained in the induction furnace nor forge welding of more pieces of blanks 1, imminent in the case of heating without the coating 2, takes place. The heated up blank 1 with the coating 2 is removed from the induction furnace by robotic feeder 3 and immediately after removal from the induction furnace it is inserted into a die 4 of extrusion press without significant cooling down, with continuation of its temperature of at least 1110 °C.

When compared with the process used until now, the step of descaling by water jetting of scale, which is always performed during the existing process between the removal from the induction furnace and insertion into the extrusion press, is skipped. Skipping of the up to now necessary step of water jetting of scale is very significant, because this is preventing cooling down by more than 80 °C, thus eliminating formation of temperature gradient and temperature fluctuations that are typical during the clearing of high-temperature-heating generated scale by means of high-pressure water jet descaling. In addition, the possibility of precise control of the blank 1 temperature is achieved by skipping the descaling.

In the extrusion press, the blank 1 and later the semi-product 5 created from it is upset and backward extruded in two steps. From this, during the first step, the blank 1 is placed at the bottom 6 of the extrusion press die 4 and here it is pressed by vertically moving ram ended with a piercing mandrel constituting the piercing tool 7. The blank 1 is moulded here by means of extrusion until a thick-walled hollow semi-product 5 having an inner cavity, walls, and bottom is moulded from it, as shown on Figs. 4 A, B. During this first step of mechanical working, in the course of piercing, the coating 2 of material based on water glass is broken to pieces by pushing of the piercing tool 7 to the blank 1 and the semi-product 5 made of it, the coating 2 cracks off, and approximately all this coating 2 is removed during extrusion in the extrusion press. During extrusion, the water glass admixtures will make their way from the coating 2 into the surface layer of the semi-product 5 to the depth of maximum 10 μm, these leftovers are removed later by blasting. The aforementioned extrusion takes place during continuation of the semi-product 5 temperature at 1100 to 1200 °C. Homogenous moulding of the first semi-product 5 does not take place and transversal cracks appear on the semi-product 5 body at a lower temperature. On the contrary, when exceeding the temperature above 1200 °C, oxidation of primary austenitic grains occurs and so called burning out of the material takes place and hence its irreversible degradation. Without using the coating 2, the semi-product 5 could not be extruded and drawn to the required shape, or the corrosion-resistant steel could not be used as the material and/or the result could not lead to the production of the thin-walled seamless high-pressure cylinder of required mechanical and pressure strength.

After completion of processing in the extrusion press, the semi-product 5 is removed from the extrusion press, turned by 90°, and seated in this position into a horizontal drawing press, where the second step of forming in terms of backward drawing takes place. During this second step, the semi-product 5 is put on a drawing mandrel having the diameter corresponding to the desired final inner diameter of the produced cylinder, and in this drawing press, the semi-product 5 is extruded through a stripper ring and roller cartridges fitted with reduction rollers by means of which it is rolled on the mandrel. Rolling is performed so long until the semi-product 5 acquires the required outer and inner diameter. Then the final shape of the cylinder bottom is formed by insertion of the semi-product 5 bottom into a sizing die and subsequently, in the course of the backward movement of the drawing mandrel, the semi-product 5 is pulled off from the drawing mandrel with the help of stripping jaws, aftercooled, and subsequently necked by already known method by means of rotary forming or die forging process. The shape of the manufactured cylinder is finished in this way.

Leftovers of the water glass based coating 2 are removed from the surface of the semi-product 5 by pressure blasting of its outer as well as inner surface with abrasive for example of steel-shot and cast-iron grit.

Corrosion-resistant seamless pressure cylinders in the volume range from 5 litres up to 260 litres can be manufactured using the method according to the invention for any volume within the said range as single necked or double-necked cylinders. In the second step of forming, the invention allows pressing the semi-product 5 wall even to the thickness of a thin-walled cylinder without loss of qualitative properties of the manufactured cylinder. The semi-product 5 wall is pressed even to the thickness of 2 to 21.5 mm. In so doing, the cylinder wall thickness is selected in concrete terms within the above said range depending on the required cylinder volume, pressure for which the cylinder is designated, and requirements for qualitative properties and mechanical strength of the cylinder.

Figures Fig. 1 to 4 illustrate only the steps related directly to the new steps of the process of production of the cylinder according to the invention. The other steps and processes that are already known in this field and are described in the Background Art paragraph do not need to be illuminated using figures.

CLAIMS

1. Method of production of high-pressure seamless cylinder from corrosion-resistant steel, in which the starting steel blank (1) is heated in an induction furnace and then inserted into an extrusion press where it is upset and backward extruded in two steps, from which during the first step, the blank (1) is inserted into a die (4) with a vertically moving piercing tool (7), and here it is moulded by means of extrusion until a thick-walled hollow semi-product (5) having an inner cavity, walls and bottom is moulded from it, after which this semi-product (5) is removed from the extrusion press, turned by 90°, and seated in this position into a horizontal drawing press, where the second step of forming in terms of backward drawing takes place, when during this second step, the semi-product (5) is put on a drawing mandrel having the diameter corresponding to the required final inner diameter of the produced cylinder, and in this drawing press, the semi-product (5) is extruded through a stripper ring and roller cartridges fitted with reduction rollers by means of which it is rolled on the mandrel, while this rolling is performed so long until the semi-product (5) acquires the required outer and inner diameter, after which the final shape of the cylinder bottom is formed by insertion of the semi-product (5) bottom into a sizing die and subsequently, in the course of the backward movement of the drawing mandrel, the semi-product (5) is pulled off from the drawing mandrel with the help of stripping jaws, aftercooled, and subsequently necked, by which the shape of the manufactured cylinder is finished, **characterized by that** even before heating in the induction furnace, the blank (1) is coated on at least 85 % of its surface with coating (2) from material based on water glass with thickness of 20 to 150 μm, this coating (2) is cured by drying at the temperature of 15 to 60 °C and only after this curing, the blank (1) is subjected to heating in the induction furnace.

2. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to claim 1, **characterized by that** the material applied to the blank (1) for example by spraying or by brush consists of suspension containing 20 to 40 % w. w. of sodium silicate or potassium silicate or mixture of these silicates, and 40 to 80 % w. w. of water, while in the case of presence of

admixtures such as borosilicates and/or corrosion inhibitors, the admixtures are contained in the amount of maximum 20 % w. w.

3. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to claims 1 and 2 **characterized by that** the blank (1) with the coating (2) from material based on water glass is heated in the induction furnace to the temperature of 1180 °C to 1260 °C.

4. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to any of claims 1 to 3, **characterized by that** after the blank (1) with coating (2) is heated up in the induction furnace, the blank (1) with coating (2) is taken out of here and during persistence of its temperature of minimum 1110 °C, it is inserted into the extrusion press without performing water jetting of scale between the removal from the induction furnace and insertion into the extrusion press.

5. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to any of claims 1 to 4, **characterized by that** during the first step of mechanical working, in the course of piercing, the coating (2) of material based on water glass is broken to pieces by pushing of the piercing tool (7) to the blank (1) and the coating (2) cracks off during extrusion in the extrusion press until at least its predominant part is removed.

6. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to claim 5, **characterized by that** after the final shape of the cylinder is formed from the semi-product (5), the leftovers of coating (2) based on water glass are removed from the surface of the semi-product (5) by pressure blasting of its outer as well as inner surface.

7. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to any of claims 1 to 6, **characterized by that** the blank (1) is made of corrosion-resistant steel while the resulting cylinder is made as a

seamless cylinder in the volume range from 5 litres up to 260 litres, as a single necked or double-necked cylinder for any volume within the said range.

8. Method of production of high-pressure seamless cylinder from corrosion-resistant steel according to claim 7, **characterized by that** in the second step of forming, the semi-product (5) wall is pressed to the thickness of 2 to 21.5 mm.

Fig.1

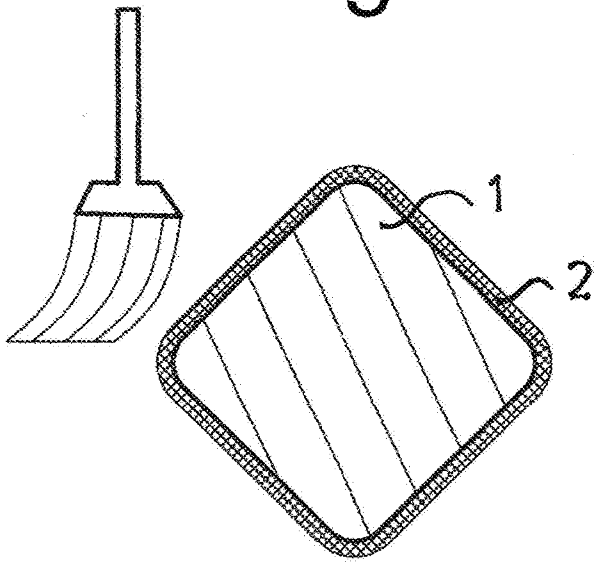


Fig.2

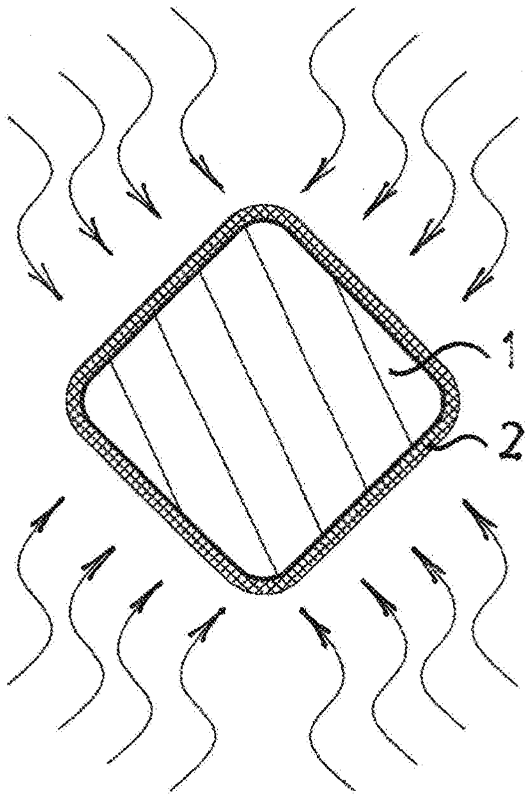


Fig.3

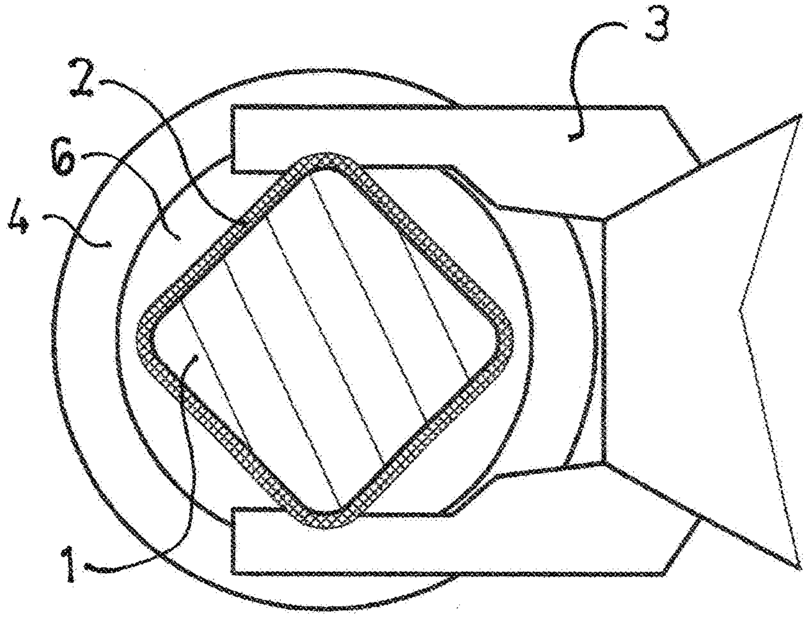
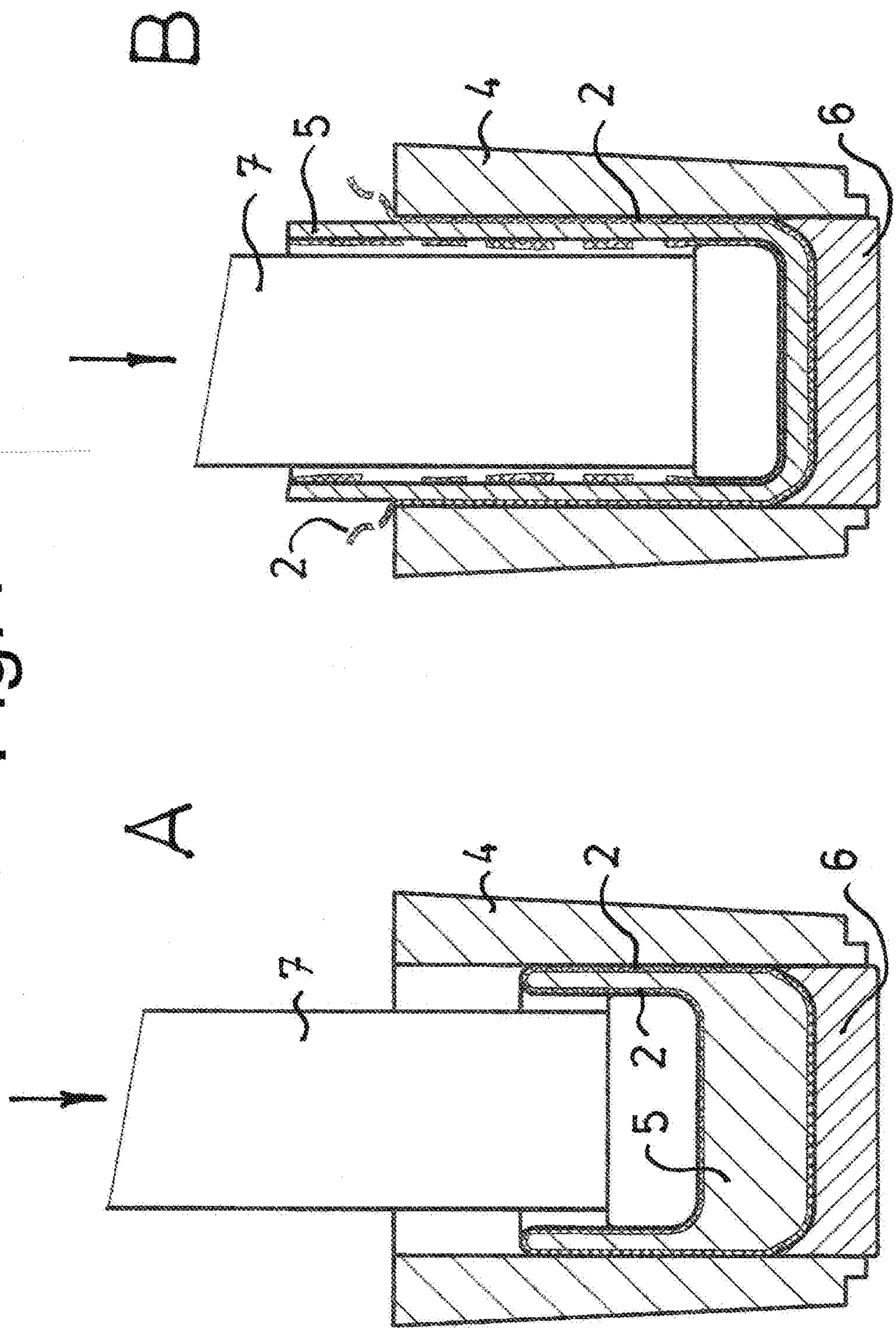


Fig.4



INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2016/050001

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21C23/20 B21C23/32
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)
B21C B05D C10M

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	CS 243 247 B1 (BARTECEK ROMAN INGI [CS]; MAMULA ZDENEK ING [CS]; SIMON LUBOS ING [CS]) 12 June 1986 (1986-06-12) cited in the application the whole document -----	1
A	US 4 147 639 A (LEE D WILLIAM ET AL) 3 April 1979 (1979-04-03) column 4, lines 13-41; figures 2-3 column 5, line 15 column 6, line 22 column 6, lines 32-45 -----	1
A	EP 2 703 454 A1 (PEMCO BRUGGE BVBA [BE]) 5 March 2014 (2014-03-05) paragraph [0003] -----	1

☐ Further documents are listed in the continuation of Box C.

☒ 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
22 August 2016	30/08/2016

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	Augé, Marc

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2016/050001

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
CS 243247	B1	12-06-1986	NONE		
US 4147639	A	03-04-1979	DE 2707787	A1	01-09-1977
			FR 2341384	A1	16-09-1977
			JP S52102862	A	29-08-1977
			US 4147639	A	03-04-1979
EP 2703454	A1	05-03-2014	EP 2703454	A1	05-03-2014
			EP 2900770	A1	05-08-2015
			WO 2014033098	A1	06-03-2014