(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 616 375 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
10.02.2016 Bulletin 2016/06

(21) Application number: **11728653.4**

(22) Date of filing: **10.06.2011**

(51) Int Cl.:
B65H 75/10 *(2006.01)* ***B65H 75/18*** *(2006.01)*
B65H 75/50 *(2006.01)*

(86) International application number:
PCT/GB2011/051084

(87) International publication number:
WO 2011/154745 (15.12.2011 Gazette 2011/50)

(54) **WEB-WINDING CORE**

WICKELHÜLSE FÜR BAHNMATERIAL

NOYAU D'ENROULEMENT DE TOILE

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

(30) Priority: **11.06.2010 GB 201009779**

(43) Date of publication of application:
24.07.2013 Bulletin 2013/30

(73) Proprietor: **F1 Core Solutions Limited**
Manchester
M1 4AD (GB)

(72) Inventor: **MORGAN, Steven John**
Chester, Cheshire CH4 7JJ (GB)

(74) Representative: **Hamilton, Alistair**
AHIP
Ty Eurgain
Cefn Eurgain Lane
Rhosesmor
Mold, Flintshire CH7 6PG (GB)

(56) References cited:
EP-A2- 0 729 911
DE-A1- 3 105 828
DE-A1-102008 025 580
DE-U1-202009 017 716
JP-A- 9 300 488
JP-A- 2004 083 391
US-A- 5 080 943
WO-A1-93/16947
DE-A1- 3 733 731
DE-U1- 29 612 786
JP-A- 5 053 249
JP-A- H06 239 533
US-A- 3 451 639

EP 2 616 375 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to a web-winding core. It has particular, but not exclusive, application to a web-winding core for use with a lightweight material, such as tissue paper.

[0002] Traditionally, webs such as paper have been wound on cores made of dense cardboard from which they are unwound, often at high speed, for subsequent processing. Since cardboard cores are essentially good for just a few uses, they are considered to be wasteful, and their disposal can be costly for their users. For that reason, alternative cores formed from metal or from composite materials have been developed that are capable of use multiple times. Metal and composite cores that have previously been proposed have been particularly intended for use with heavy webs such as newsprint. Such webs are wound with considerable tension and therefore exert substantial radial compressive forces upon the core. Therefore, the core must be made strong enough to resist crushing. They must also be made to have high beam stiffness to prevent them whirling excessively while rotating at high speed.

[0003] Much lighter webs, such as tissue paper, have also been traditionally carried on cardboard cores, and there has also been a demand to replace these with cores that can be used many times. However, those cores described above that are intended for use with newsprint have far greater strength, and are therefore heavier and more costly, than is necessary for use with a lightweight web. They are also not well-suited to production of cores with the larger diameters (150 mm or more) typically used for tissue. Excess weight of these cores mean that a core may weigh more than an equivalent cardboard core, which can cause manual handling issues.

[0004] DE 20 2009 017716 U1 discloses a winding core which has a composite body that has an inner and/or outer coating.

[0005] DE 296 12 786 U1 discloses a winding core that comprises a tube on which a compressible coating is formed, and a hard surround is formed on the compressible coating.

[0006] JPH09300488 discloses a large-diameter paper tube by filling a foamed cured resin layer in a gap between an outside paper tube and an inside paper tube whose end parts are fixed with a base.

[0007] DE-A-31 05 828 discloses a web-winding tube that comprises a paper tube coated with inner and outer layers of synthetic paper.

[0008] JP H06 239533 A discloses a web-winding core formed as a hollow cylindrical shell, the shell being a sandwich that includes three-layers, the layers including inner and outer skins (10, 40), between which is a filler (20) to which the inner and outer skins are bonded, the filler (20) being formed from a foam material, the inner skin (10) being formed from a reinforced composite material that comprises reinforcing fibres disposed within a polymer matrix.

[0009] An aim of this invention is to provide a web-winding core that is better optimised for use with a lightweight web material such as tissue paper, and which is no heavier than a cardboard core that it will replace.

[0010] To this end, from a first aspect, the invention provides a web-winding core as set forth in claim 1.

[0011] By careful selection of the materials from which the skins and the filler are made, the core can be sufficiently strong for use as a core for a lightweight web, and which is of a sufficiently low density that the core is not heavier than a conventional cardboard core. A cardboard core has a typical density of $0.75x10^3$ - $0.85x10^3$ kgm^{-3}. Embodiments of the present invention can typically save 10-15% of this. (A greater or lesser saving may be achieved while still gaining the advantage of the invention.) In addition, the cores have the advantage over cardboard that they are resistant to damage from water, and so can be stored outside.

[0012] The inner and outer layers may be of similar construction and composition. The reinforcing fibres comprise organic or inorganic materials and may be applied as preformed fabrics, short fibre fabrics or continuous orientated fibres. The fibres may be incorporated into a ballistic fabric. Fibres of aramid are particularly preferable for its resistance to cutting and abrasion. It is also highly desirable to make the core highly resistant to damage low-speed impacts. To this end, fibres of ultra-high molecular weight polyethylene are particularly suitable, because they have a high impact resistance, and resist adhesion from the matrix, which acts to disperse the energy of impact against the core. The fibres may be dry or may be pre-impregnated with an appropriate uncured polymer.

[0013] The matrix is typically a thermoset or thermoplastic polymer compound that is capable of a high degree of elongation. For example, it may be a modified polyester resin which has a urethane acrylate additive. Alternatively, the inner and/or outer layer may be formed from a hemp fibre.

[0014] A high proportion of the core will be void space formed either by the use of cellular materials with entrapped air, or low density 3D woven fabrics. This achieves low overall density of the tube wall construction. Alternatively, the filler may be formed from a low-density natural material, such as balsa or cork. A wide range of alternative filler materials can be used, with an aim of achieving a density within the core of $0.3\text{-}0.6x10^3$ kgm^{-3}. An example is foamed PET formed as a lightweight 3-dimensional core. In general, the filler is bonded to the inner and outer layers so that the filler transmits stresses between the inner and the outer layers. The filler is partially or wholly impregnated with the matrix of the inner and/or outer layers to form a strong bond between them, by effectively unifying the three layers of the wall.

[0015] The resin system proposed for the core tubes is a high grade modified polyester resin which has a urethane acrylate additive to impart very good impact resistant properties to the tube. This has already been exten-

sively trialled in the resin transfer moulding process and gives very good cycle times and product quality.

[0016] A ring of impact-resistant material, e.g., metal, such as steel, or a plastic material such as urethane polymer, may be provided at an end portion of the core to resist damage to the core, for example as might occur though impact. The ring will typically be bonded to one or both of the inner and the outer layers. Most preferably, the inner and outer diameters of the ring are substantially the same as the respective diameter of the core.

[0017] The core may include end portions in each of which there is a reinforcing structure that increases the hoop strength of the core. For example, the reinforcing structure may comprises a strengthening tape wound around the inner layer.

[0018] An embodiment of the invention will now be described in detail, by way of example, and with reference to the accompanying drawings, in which:

Figure 1 is a side view of an end portion of a web-winding core being an embodiment of the invention;

Figure 2 is a cross-section along A-A in Figure 1;

Figure 3 is an end view of a mould that can be used in production of the embodiment of Figure 1;

Figure 4 is a cross-section along B-B in Figure 3;

Figure 5 is a cross-section of a web-winding core being a modification of the embodiment of Figure 1;

Figure 6 is a cross-section of a web-winding core being a second modification of the embodiment of Figure 1; and

Figure 7 is an end view of the embodiment of Figure 6.

[0019] With reference to the drawings, a core for winding a lightweight web is formed as a generally cylindrical hollow cylindrical tube that is rotationally symmetrical about a longitudinal axis X-X. For the most common applications of embodiments of the invention, the outer diameter of the cylinder is typically in the range 150-510mm, and the wall thickness of the tube is typically in the range 12-20mm. The cylindrical tube is formed with three radially-spaced layers that are disposed coaxially around the axis X-X: an inner layer 12, an outer layer 14 and a low-density reinforcing filler 16 that fills the space between the inner layer 12 and the outer layer 14. The inner and outer layers 12, 14 are bonded to the filler 16 to form a composite sandwich structure. The thicknesses of the inner and outer layers of the wall are typically in the range 1.5-4 mm, and the thickness of the filler is typically in the range 8-16 mm.

[0020] The filler 16 serves to link the inner and outer layers 12, 14 and will transmit stresses between the layers 12, 14 to provide a stable structure.

[0021] The inner and outer layers 12, 14 are formed from reinforcing fibres which are impregnated with, and embedded in, a matrix of thermoset or thermoplastic polymer compound. In this embodiment, the fibres are ultra-high molecular weight polyethylene, the matrix is a polyester resin which has a urethane acrylate additive, and the filler is an expanded hexagonal segment PET foam core.

[0022] The sandwich core portion of the tube is formed from a cellular or foam material which is bonded between the inner and outer skins of the tube and is partially or wholly impregnated with the polymer matrix compound. A high proportion of the core will be void space formed either by the use of cellular materials with entrapped air, or low density 3D woven fabrics. This is key to achieving low overall density of the tube wall construction. In this example, the filler is polyethylene terephthalate (PET) foam formed as flexibly interconnected hexagonal units.

[0023] The tube wall is formed in layers with internal and external skins containing a reinforcing medium, and a bonded sandwich core portion which is of low density material. The sandwich core serves to link the two skins and will transmit stresses between the skins to provide a stable structure.

[0024] The skins are formed from reinforcing fibres which are impregnated with, and embedded in, a matrix of thermoset or thermoplastic polymer compound. The reinforcing fibres may be of organic or inorganic materials and may be applied as preformed fabrics, short fibre fabrics or continuous orientated fibres. The fibres may be dry or may be pre-impregnated with an appropriate uncured polymer as described.

[0025] One method and apparatus for manufacture of a core embodying the invention, and apparatus for implementing the method, will now be described.

[0026] A one-piece metal cylindrical member 20, of external diameter equal to the internal diameter of the finished core tube 10, forms a central part of a mould tool for forming a core embodying the invention. This central cylinder 20 is mounted concentrically with an outer metal mould shell 22, with an annular space 24 between the central cylinder 20 and the outer mould shell 22 equal to the design wall-thickness of the finished core tube 10. A highly polished finish is required on this central cylinder and it is treated with a release agent to ensure that the resin will not be able to adhere to the surface.

[0027] The external mould shell 22 is split along its longitudinal centreline at 30 into two identical half shells which are precisely located relative to each other to form an accurate hollow cylindrical mould shell equal in diameter to the outside diameter of the core tube 10 to be formed. This external mould shell 22 is provided with stiffeners (not shown) to ensure good dimensional stability of the structure, to provide the close dimensional tolerances required in the finished core tube 10.

[0028] Sealing rings 32 are fitted to the central cylinder at a distance apart which is equal to the required length

of the finished core tube 10. The longitudinal seams of the outer mould shell also incorporate airtight seals which are essential to the correct functioning of the mould.

[0029] A number of resin entry ports 34 and air venting points 36 are incorporated into the outer mould shell 22 to ensure that liquid resin can be introduced into the annular space 24 between the inner cylinder 20 and the outer split mould shell 22, and that air can be vented from the space 24 as the mould is filled. The air may be displaced naturally by the ingress of the resin or a small level of vacuum may be applied through the air vent ports 36 to improve the resin flow into the mould.

[0030] With the mould dismantled, the inner cylinder 20 is prepared by wrapping a layer of dry fibre fabric onto the surface between the two pre-located sealing rings 32 which determine the overall length of the core tube 10. A dry layer of the selected foam core medium is then applied to cover the inner glass fabric. This foam may be applied in sheets which are thermally preformed or may be applied as a spirally-wound or convolute-wound strip, depending upon the material selected. On top of the foam material, another layer of dry fibre fabric is applied over the entire surface.

[0031] The prepared inner cylinder 20 with the dry materials is then located within the lower half of the split external mould 22. The upper half of the external mould 22 is then accurately located onto the lower half mould trapping the internal cylinder 20 and the dry fabric and foam layers into the closed mould space.

[0032] A resin metering and pumping unit prepares a pre-determined quantity of liquid polyester resin with the appropriate curing agents added, and then pumps this mixed resin into the mould through one or more of the ingress ports 34 on the outer mould surface. Air venting or vacuum may be used to promote the resin flow through the mould and resin is pumped into the mould until all the air is displaced and resin flows from the air venting port 36.

[0033] The pumping process is stopped and the resin is allowed to cure, either at ambient temperature or at an elevated process temperature. Elevated temperature can be advantageous as it will speed up the curing reaction of the resin. Elevated temperature can readily be applied by pumping hot water or oil through the central cylindrical 20 member or by incorporating heating elements within the wall of the mould during construction.

[0034] Once the resin is cured the outer mould may be unsealed and split open and the cylindrical inner mould 20 with the laminated core tube may be removed from the assembly.

[0035] The moulded core tube 10 is then drawn off the internal cylinder with a mechanical or hydraulic pulling device. The finished tube should need minimal second operation works to make it ready for despatch. The possible removal of flash lines along the mould split lines may be necessary.

[0036] Similar production techniques can be used for the construction of cores using materials other than those described in the above example.

[0037] Some applications of cores embodying the invention may favour a textured external and/or internal surface on the core tube. This may be formed directly using the mould itself Alternatively the required internal and external surface textures may be applied by wrapping peel ply or similar textured fabric onto the central cylindrical mould member prior to applying the inner structural fabric layers, and/or onto the outer surface of the external layers of structural fabrics. The texture of the fabric is thereby transferred to the surface of the core. Use of such fabric has an additional advantage, in that it prevents the formation of mould flash, which obviates any need to remove such flash from the moulded core. There is some risk of the core tube edges spalling in the event of severe impact - typically if accidentally dropped during handling operations. A modification to the mould tooling has been incorporated within the initial design to permit a protective body 40 of tough material such as metal or urethane polymer to be bonded or moulded within to an end portion of the core tube 10 to enhance the impact resistance if required, as shown in Figure 5. This may be done by routing a cylindrical groove in an end face of the filler, and forming the protective body 40 by moulding it *in situ.* The material of the protective body flows into the groove to retain the protective body 40 in place. To enhance retention, the groove may be formed with a dovetail shape, as shown in the lower half of Figure 5.

[0038] The protective body 40 has a cylindrical locating portion 42 that is a close fit between the inner and the outer layers 12, 14. An end portion of each of the inner and outer layers 12, 14 projects beyond the end of the filler 16 to accommodate the locating portion 42, which is bonded to them. The protective body projects beyond the inner and outer layers 12, 14, and has an outer diameter that is substantially the same as that of the core tube 10. The protective body 40 has an axial through bore that has a diameter that is substantially the same as the inner diameter of the core tube 10. This arrangement ensures that the core as a whole has a substantially uniform inner and outer diameter along its length. An outer portion of the bore of the protective body, shown at 44, is chamfered to provide a lead-in to assist the insertion of handling apparatus into the bore of the core.

[0039] In the embodiment of Figure 6, additional strengthening can be applied to resist bursting of end portions of the core tube 10. The aim is to increase the hoop strength of the core tube 10 at a region close to each of its ends. This is achieved in the present embodiment by omitting the filler 16 from a region at the end of the core tube 10 approximately 50 mm in length. The inner layer 12 is encircled by a strengthening band 44 to the same depth as the filler 16. In this embodiment, the strengthening band 44 is formed from unidirectional glass tape, which has high tensile strength along its length.

[0040] In order to secure the protective body, several slots 50 are formed into the annular end surface of the

strengthening band 44 that is exposed at the end of the core tube 10. In order to form the slots, an entry hole is formed of 9mm diameter and 12 mm depth at a radius of approximately 212 mm from the centre of the core tube 10. The slot 50 is formed with a parallel cutter 6 or 7 mm in diameter, extending from the entry hole in an arc centred on the centre of the core tube 10. The slot 50 is then expanded with a dovetail cutter. The dovetail cutter enters the entry hole and moves along the previously formed slot. The dovetail cutter expands the slot such that it is approximately 7 mm in with at the surface and 9 mm in the base. The circumferential length of each slot is approximately 40 mm, and they are spaced apart by approximately 10 mm. In Figure 6, the lower part of the section is shown through the dovetailed part of the slot and the upper part of the section is shown through the space between the slots 50. This provides secure keying of the protective body 44 while maintaining the structural integrity of the core tube 10. The dimensions are specific to this embodiment and may be scaled as appropriate.

Claims

1. A web-winding core formed as a hollow cylindrical shell, the shell being a sandwich that includes three-layers, the layers including comprising inner and outer skins (12, 14), between which is a filler (16) to which the inner and outer skins are bonded, the filler (16) being formed from a synthetic polymer cellular or a foam material; **characterised in that** the inner and/or the outer skins (12, 14) are formed from a reinforced composite material that comprises reinforcing fibres disposed within a polymer matrix; and **in that** the filler (16) is partially or wholly impregnated with a matrix of the inner and outer layers and **in that** the fibres are one of aramid, ultra-high molecular weight polyethylene, or hemp.

2. A web-winding core according to claim 1 in which the reinforcing fibres are in the form of a preformed fabric, a short-fibre fabric or as continuous orientated fibres.

3. A web-winding core according to any preceding claim in which the fibres are pre-impregnated with an appropriate uncured polymer.

4. A web-winding core according to any preceding claim in which the matrix includes a modified polyester resin which has a urethane acrylate additive.

5. A web-winding core according to any preceding claim in which the filler (16) is a three-dimensional core of PET.

6. A web-winding core according to any preceding claim in which the filler (16) is cork or balsa.

7. A web-winding core according to any preceding claim in which the filler (16) has a density in the range 0.3 to 0.6 x $10^3 kgm^{-3}$.

8. A web-winding core according to any preceding claim further including a ring (40) of resilient material provided at an end portion of the core to resist damage to the core the ring (40) being bonded to one or both of the inner and outer layers (12, 14), the ring (40) having an inner and outer diameter substantially the same as the respective diameter of the core (10).

9. A web-winding core according to claim 8 in which the ring (40) is a resilient polymer that is moulded on the core (10).

10. A web-winding core according to claim 9 in which a slot (50) formed into an end surface of the core (10) to provide a key into which the ring (40) can be moulded.

11. A web-winding core according to any preceding claim in that includes end portions in each of which there is a reinforcing structure (44) wound around the inner layer (12) that increases the hoop strength of the core.

Patentansprüche

1. Wickelhülse für Bahnmaterial, die als ein hohler zylindrischer Mantel ausgebildet ist, wobei der Mantel eine Schichtanordnung ist, die drei Schichten umfasst, wobei die Schichten Innen- und Außenhäute (12, 14) umfassen, zwischen welchen ein Füllstoff (16) ist, an welchen die Innen- und Außenhäute gebunden sind, wobei der Füllstoff (16) aus einem synthetischen porösen Polymer oder einem Schaumstoffmaterial gebildet ist; **dadurch gekennzeichnet, dass** die Innen- und/oder die Außenhäute (12, 14) aus einem verstärkten Verbundmaterial gebildet sind, das Verstärkungsfasern umfasst, die innerhalb einer Polymermatrix angeordnet sind; und dadurch dass der Füllstoff (16) ganz oder teilweise mit einer Matrix der Innen- und Außenschichten imprägniert ist, und dadurch, dass die Fasern eines von Aramid, Polyethylen mit ultrahoher Molmasse oder Hanf sind.

2. Wickelhülse für Bahnmaterial nach Anspruch 1, wobei die Verstärkungsfasern in der Form eines vorgeformten Gewebes, eines Kurzfasergewebes oder als ausgerichtete Endlosfasern sind.

3. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, wobei die Fasern mit einem geeigneten unvernetzten Polymer vorimprägniert sind.

4. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, wobei die Matrix ein modifiziertes Polyesterharz umfasst, das ein Urethanacrylatadditiv aufweist.

5. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, wobei der Füllstoff (16) ein dreidimensionaler PET-Kern ist.

6. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, wobei der Füllstoff (16) Kork oder Balsa ist.

7. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, wobei der Füllstoff (16) eine Dichte im Bereich von 0,3 bis 0,6 x 10^3 kgm^{-3} aufweist.

8. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, ferner umfassend einen Ring (40) aus elastischem Material, der an einem Endabschnitt der Hülse vorgesehen ist, um Beschädigung der Hülse zu widerstehen, wobei der Ring (40) an eine oder beide der Innen- und Außenschichten (12, 14) gebunden ist, und der Ring (40) einen Innen- und Außendurchmesser aufweist, der im Wesentlichen gleich wie der jeweilige Durchmesser der Hülse (10) ist.

9. Wickelhülse für Bahnmaterial nach Anspruch 8, wobei der Ring (40) ein elastisches Polymer ist, das auf der Hülse (10) geformt ist.

10. Wickelhülse für Bahnmaterial nach Anspruch 9, wobei ein Schlitz (50), der in eine Endfläche der Hülse (10) gebildet ist, um einen Schlüssel bereitzustellen, in welchem der Ring (40) geformt werden kann.

11. Wickelhülse für Bahnmaterial nach einem der vorhergehenden Ansprüche, dadurch dass sie Endabschnitte umfasst, wobei in jeden von ihnen eine Verstärkungsstruktur (44) um die Innenschicht (12) gewickelt ist, welche die Ringsteifigkeit der Hülse erhöht.

Revendications

1. Mandrin d'enroulement de bande formé comme une coquille cylindrique creuse, la coquille constituant un sandwich incluant trois couches, les couches comprenant des peaux interne et externe (12, 14), entre lesquelles se trouve un élément intérieur (16) auquel les peaux interne et externe sont liées, l'élément intérieur (16) étant constitué d'un matériau polymère synthétique alvéolaire ou d'une mousse ; **caractérisé en ce que** les peaux interne et/ou externe (12, 14) sont constituées d'un matériau composite renforcé comprenant des fibres de renforcement disposées à l'intérieur d'une matrice polymère ; et **en ce que** l'élément intérieur (16) est en tout ou en partie imprégné d'une matrice des couches interne et externe ; et **en ce que** les fibres sont soit de l'aramide, soit du polyéthylène à poids moléculaire ultra-élevé, soit encore du chanvre.

2. Mandrin d'enroulement de bande selon la revendication 1, dans lequel les fibres de renforcement se présentent sous la forme d'un tissu préformé, d'un tissu à fibres courtes ou de fibres continues orientées.

3. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, dans lequel les fibres sont préimprégnées d'un polymère approprié non durci.

4. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, dans lequel la matrice comprend une résine de polyester modifié comportant un additif du type acrylate d'uréthane.

5. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, dans lequel l'élément intérieur (16) est un mandrin tridimensionnel en PET.

6. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, dans lequel l'élément intérieur (16) est du liège ou du balsa.

7. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, dans lequel l'élément intérieur (16) a une masse volumique située dans la plage de 0,3 à 0,6 x 10^3 $kg \cdot m^{-3}$.

8. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, comprenant en outre une bague (40) de matériau élastique, placée à une partie d'extrémité du mandrin pour résister à un endommagement du mandrin, la bague (40) étant liée à l'une des couches interne et externe (12, 14) ou aux deux, la bague (40) présentant un diamètre intérieur et extérieur sensiblement identique au diamètre respectif du mandrin (10).

9. Mandrin d'enroulement de bande selon la revendication 8, dans lequel la bague (40) est un polymère élastique qui est moulé sur le mandrin (10).

10. Mandrin d'enroulement de bande selon la revendication 9, dans lequel une encoche (50) est ménagée sur une surface d'extrémité du mandrin (10) pour procurer une clé dans laquelle la bague (40) peut être moulée.

11. Mandrin d'enroulement de bande selon l'une quelconque des revendications précédentes, comprenant des parties d'extrémité, dans chacune desquelles se trouve une structure de renforcement (44) enroulée autour de la couche interne (12), qui accroît la résistance circonférentielle du mandrin.

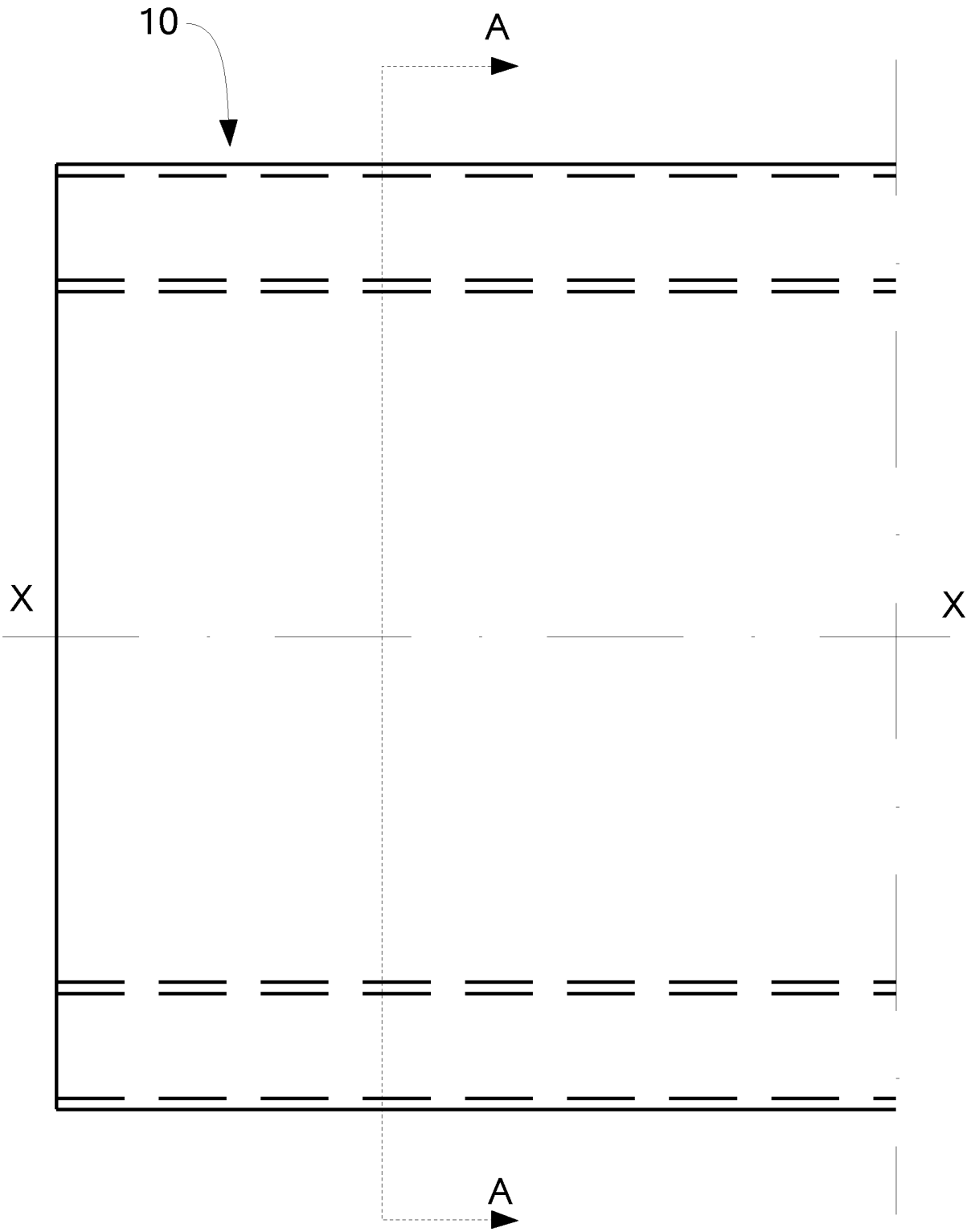

Fig 1

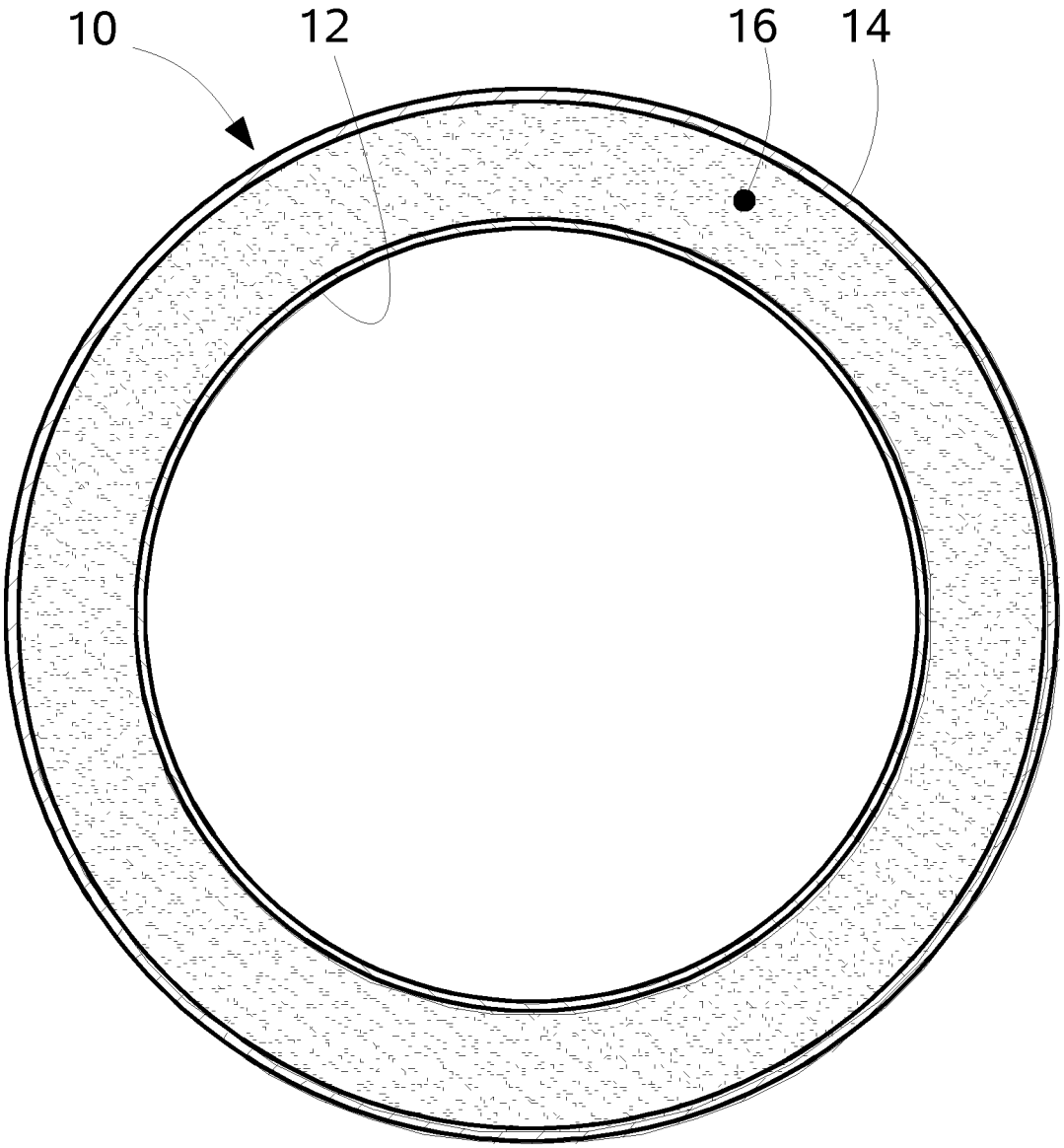

Fig 2

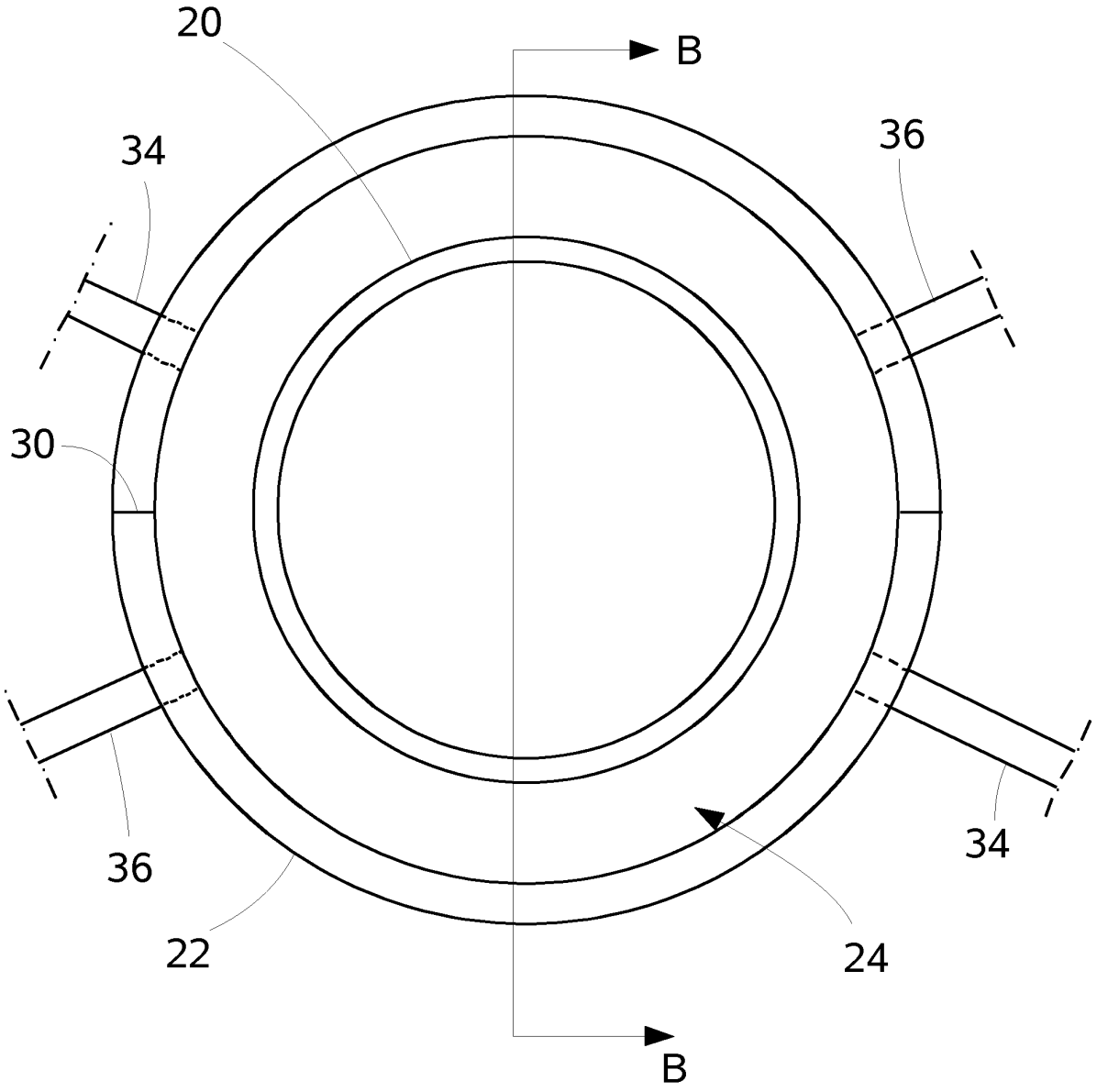

Fig 3

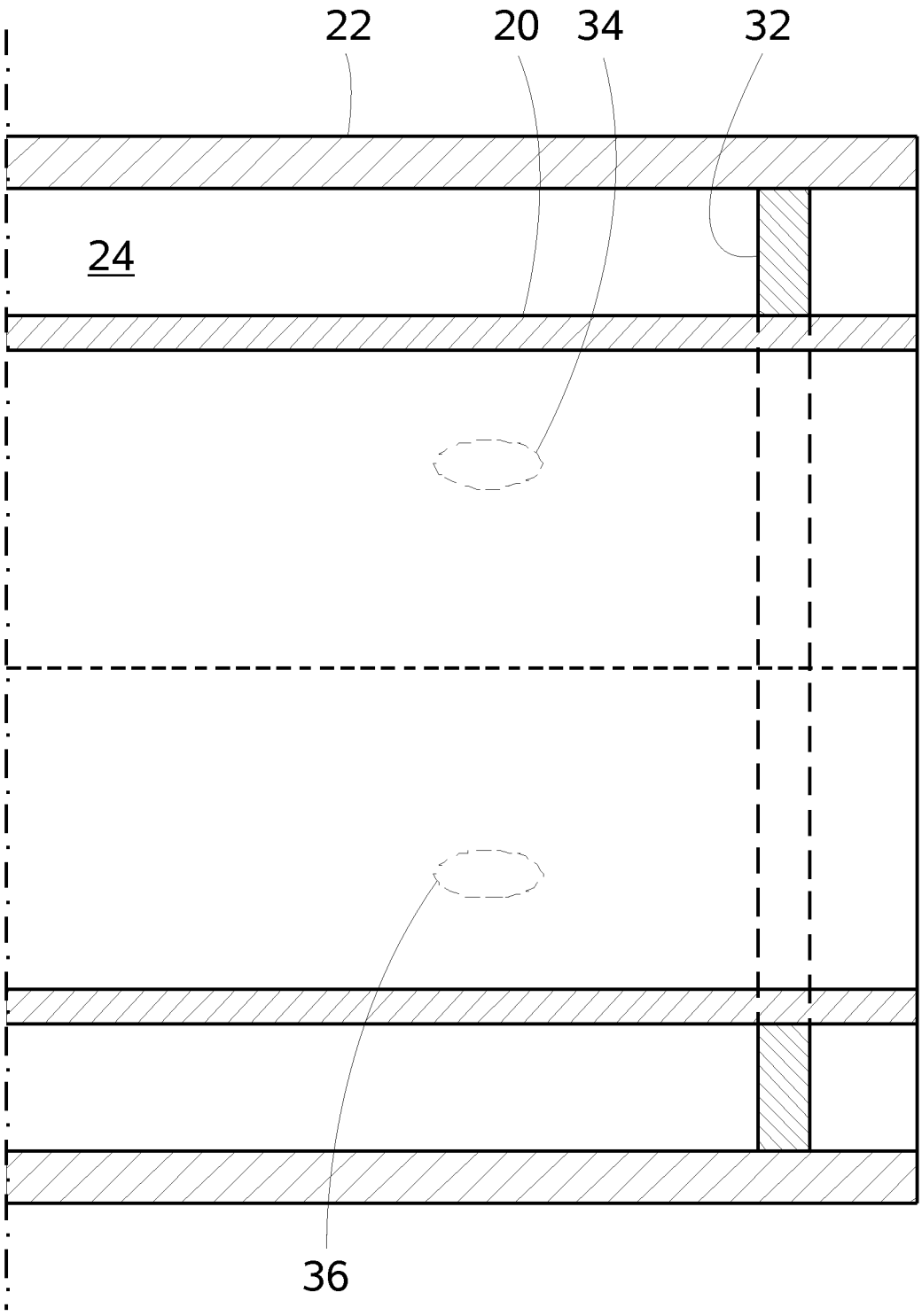

Fig 4

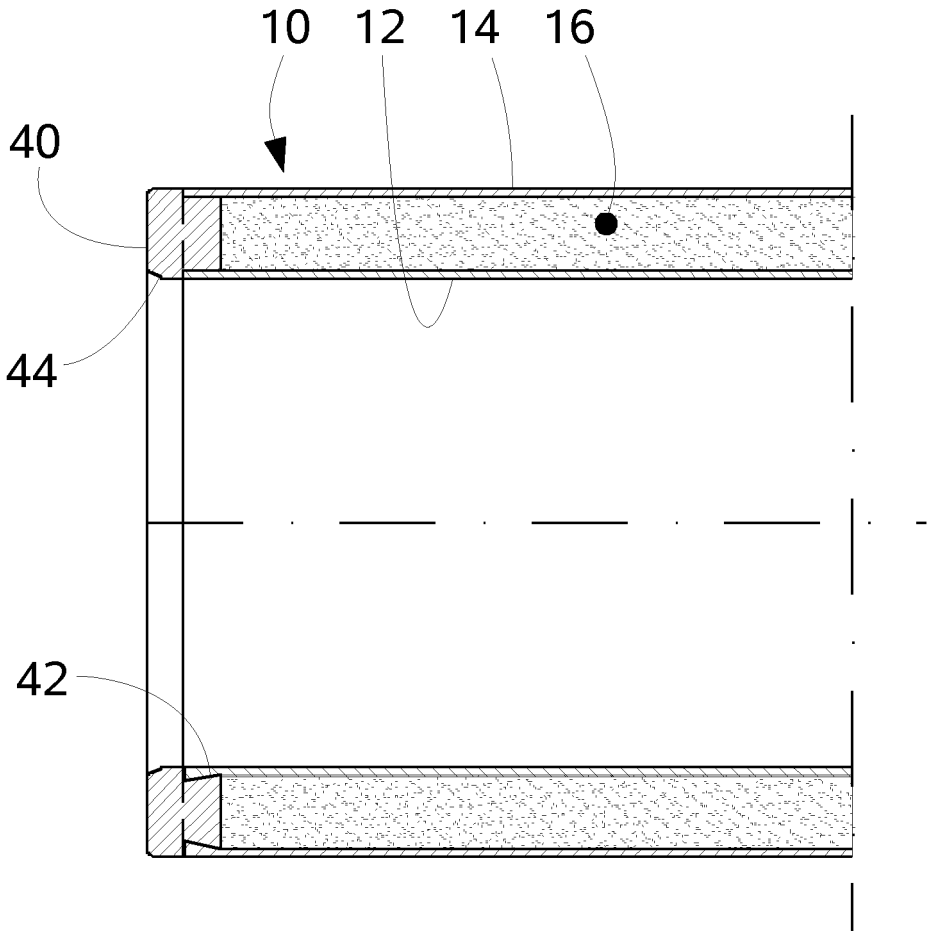

Fig 5

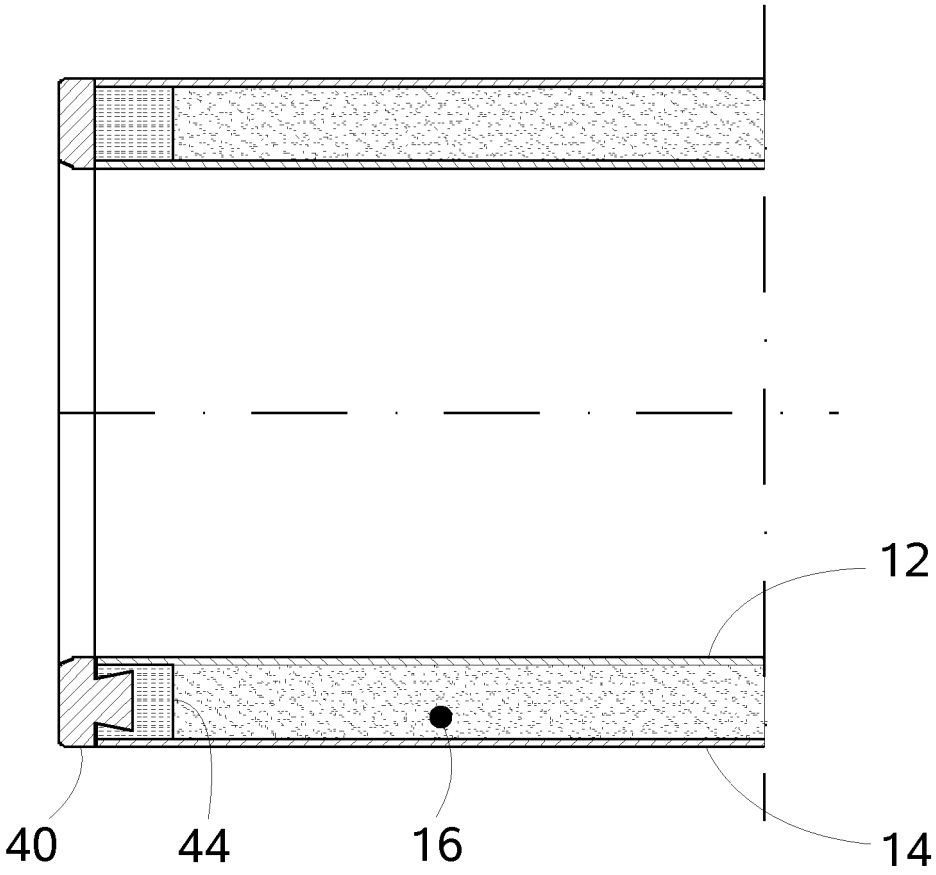

Fig 6

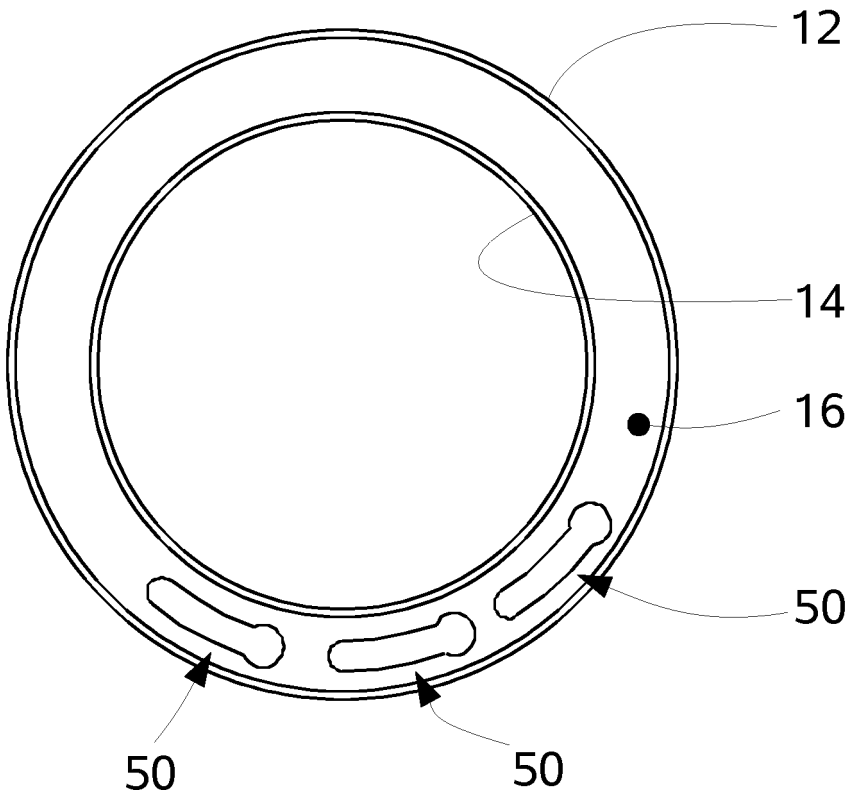

Fig 7

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- DE 202009017716 U1 **[0004]**
- DE 29612786 U1 **[0005]**
- DE 3105828 A **[0007]**
- JP H06239533 A **[0008]**