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

(11) **EP 2 602 802 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.03.2014 Bulletin 2014/13

(51) Int Cl.:
H01F 27/32 *(2006.01)*

(21) Application number: **12460073.5**

(22) Date of filing: **08.10.2012**

(54) **A method for making the insulation of a voltage coil of a HV instrument transformer and a device for making the insulation of a voltage coil**

Verfahren zur Herstellung einer Isolierung einer Spannungsspule eines Hochspannungsinstrumententransformators und Vorrichtung zur Herstellung der Isolierung einer Spannungsspule

Procédé de fabrication d'un isolant de bobine de tension d'un transformateur d'instrument HT et dispositif de fabrication d'un isolant de bobine de tension

(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: **05.12.2011 PL 39724111**

(43) Date of publication of application:
12.06.2013 Bulletin 2013/24

(73) Proprietor: **ABB Technology AG**
8050 Zürich (CH)

(72) Inventors:
- **Wesolowski, Zbigniew**
  01-641 Warszawa (PL)
- **Tarnowski, Marcin**
  06-300 Przasnysz (PL)
- **Debski, Pawel**
  06-300 Przasnysz (PL)
- **Grysztar, Pawel**
  06-300 Przasnysz (PL)
- **Duzdowski, Jaroslaw**
  06-413 Ciechanow (PL)

(74) Representative: **Chochorowska-Winiarska, Krystyna**
ABB Sp. z o. o.,
Ul. Zeganska 1
04-713 Warszawa (PL)

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Description

[0001] The invention deals with a method for making the insulation of a voltage coil of an HV instrument transformer and a device for making this insulation, applicable to isolating the voltage coil with insulating paper during the process of coil banding occurring during the production of a voltage transformer and during the production of a combined instrument transformer comprised of a current transformer and a voltage transformer.

[0002] In a known combined instrument transformer JUK-123a made by ABB Sp. z o.o, the main insulation and the interlayer insulation of a voltage coil and of a high voltage bushing is insulating paper. This insulation is made by winding in successive turns a layer of winding and applying a layer of insulating paper with paper edges cut longitudinally in relation to the tube axis, further on referred to as fringes, onto the insulating tube of the high voltage coil. In cross-section, the winding of the high voltage coil has the shape of a trapeze, whereas the paper insulation has the shape similar to a cylinder.

[0003] After winding, the coil is moved to the banding station. A top screen is applied onto the coil symmetrically in relation to the ends of the tube and the formation of the main insulation, further on referred to as banding, starts in horizontal position. Banding takes place as follows. Several paper layers with fringes on the right side of the winding are folded onto the top screen and fixed by gluing individual fringes from paper layers from the other side. Next, several paper layers with fringes on the left side of the winding are folded onto the top screen and fixed by gluing individual fringes from paper layers from the other side. The pasted layers are additionally fixed with crepe paper by enveloping the coil on its circumference with serpentine movements until the coil surface is completely covered with paper. These operations are repeated until the coil reaches a suitable diameter. Next, a conducting bar containing paper insulation with equipotential screens, further on referred to as high voltage bushing, is screwed into a sleeve located in the top screen. Further application of paper insulation and equipotential screens onto the conducting bar is done concurrently with banding the coil. The operations of banding the coil are repeated, only now, after each wrapping of the coil surface with crepe paper, further winding of the bushing follows. Banding of the coil and winding of the bushing take place by turns, so that the bushing insulation and the coil insulation overlap, which greatly affects the withstand voltage. Making of the external screen starts after the completion of banding. The external screen is made of thin aluminum foil and it is located on the upper part of the coil having a bell-like shape. The edge of the screen ends with a band of a conducting material, to eliminate sharp edges. The presented insulationmaking process is carried out manually, which is very laborious and requires considerable manual skills from the person performing these actions. The horizontal situation of the voltage coil during banding and breaking of the fixing paper band results in a free fall of the fringes due to gravitation. Each time, the fringes have to be picked up, straightened, and the paper fringes have to be manually stretched and glued alternately on the left and on the right. The falling of the fringes and their manual picking-up results in folding and uneven arrangement of the paper insulation, which affects the withstand voltage of the insulation. Moreover, fixing of the falling fringes requires a rather large amount of glue which has poorer insulating properties than paper-and-oil insulation, thus weakening the main insulation of the voltage coil. The presented process of making the insulation is complicated and requires considerable skill and precision. The appropriate parts of the voltage coil insulation, as well as its variable thickness, especially on the joint between the bushing and the coil, have to be made very precisely to prevent insulation breakdowns during the operation of the instrument transformer. For that reason, improvement in the method of making the insulation is important for the quality of the transformer.

[0004] The essence of the method of making the main insulation of the voltage coil of an HV instrument transformer according to the invention in which the insulating material are sheets of winding paper with longitudinally cut bands which are used to insulate first the individual layers of the voltage coil winding forming the interlayer insulation of the coil, and then to insulate the coil and the connection between the coil and the bushing of the HV instrument transformer, is that an upper screen is put on the insulated windings of the voltage coil, which screen is connected with a connecting bar of the bushing and then the coil and the place of connection of the voltage coil and the bushing is banded with bands of winding paper In vertical position of the coil, in turns from the upper and lower sides of the coil surface, as claimed in claim 1.

[0005] Preferably, the thickness of the layers of the voltage coil insulation decreases with the increase in the distance from the coil axis.

[0006] Preferably, after the completion of the process of banding of the voltage coil together with the top screen, a winding layer of semiconducting paper is applied on the external surface of the banded coil and the main insulation, forming an external screen of the instrument transformer.

[0007] Preferably, when the external screen has been applied on the banded coil and the main insulation, the external screen is wound with copper strap.

[0008] Preferably, during banding of the voltage coil, the conducting bar together with the insulation take horizontal position.

[0009] Preferably, the coil and the screen as well as the connection between the voltage coil and the conducting bar is banded using a gravitational banding device.

[0010] The essence of the device for making the main insulation of the voltage coil of a HV instrument transformer, comprising a crossbar and means for fixing the voltage coil with the main screen on the crossbar is that

the crossbar of the device is fixed on a revolving frame joined with a body and a base, as claimed in claim 7.

[0011] Preferably, the device for making the main insulation contains a block mechanism for blocking the crossbar together with the frame in a horizontal or vertical position, with the crossbar and the frame revolving by an angle of 90°.

[0012] Preferably, at the end of the crossbar of the device there are spacer disks and pressing sleeves.

[0013] Preferably, a holder with a clamping ring for keeping the transformer bushing in vertical position is fixed to the body of the device.

[0014] Preferably, the device according to the invention contains a nut for adjusting the height of the frame position.

[0015] The advantage of the method and device according to the invention is a significant facilitation in the process of making the insulation achieved by using the gravitational force for arranging the fringes while banding the coil in vertical position in the device, which also prevents crumpling and wrinkling of the fringes and facilitates their fixing to the surface of the coil. During the application of the interlayer insulation consisting of a few or more than a dozen sheets of paper with cut fringes, the fringes of the winding paper are not shifted in relation to one another and they form packets which can be easily arranged on the circumference of the coil during vertical banding of the coil. Different thicknesses of the interlayer insulation of the coil, so that the insulation tension between layers is the same throughout the coil, ensure small partial discharges and a proper withstand voltage of the coil. Improvement in the quality of the insulation is achieved by increasing the insulation homogeneity, which is achieved by minimizing the gluing process. Leading the end of the winding out through a port in the carcass on which the coil is wound ensures a proper withstand voltage between the output lead and the external screen of the coil. The alternate application of the bushing insulation and the coil insulation at the place where the voltage coil joins the bushing causes that the insulation in this place is homogenous and forms a monolith without any spaces or gaps. The use of a full external screen made of semi-conducting paper ensures equal spacing between high-potential coil elements and ground and it ensures a repeatable electric field distribution, and it also protects the coil against possible edges in the housing and other ground-potential elements. The advantage of the device for making insulation is a significant facilitation of the process of coil banding by keeping the coil in vertical position and by easy rotation of the coil by 180°. Also the installation of the external screen in the device in vertical position is easier and permits quick and uniform spreading of conducting tape on the external screen of the coil using two insulation discs fastened to the sides of the coil and thereby it ensures a uniform potential distribution on the voltage coil.

[0016] The method according to the invention is illustrated by an embodiment in the drawing, where fig. 1 shows the device for making insulation, in side view, fig. 2 shows the voltage coil together with insulating winding material after the completion of the coil winding process, in cross-section, fig. 3 - detail "A" from fig. 2, fig. 4 - the voltage coil after connection with a HV bushing before starting the banding process, in cross-section, fig. 5 - the voltage coil partly banded together with the bushing, in cross-section, and fig. 6 - the voltage coil together with the bushing after the completion of the winding process, in cross-section.

The method of making the insulation of a voltage coil of a HV instrument transformer is first carried out on a traditional winding machine for voltage coil winding, and then by means of the device for making insulation according to the invention. The device for making insulation, so called gravitationally insulating device, comprises a frame 1 of an arched shape, rigidly fixed to a revolving body 2 which is joined movably in vertical direction with a base 3 by a nut 4 which controls the regulation of the height of the position of the body 2. The revolving body 2 is provided with a blocking mechanism 5 used to block the position of the body together with the frame 1 with a revolution of 90°. The frame 1 comprises a crossbar 6 furnished with pressing sleeves 7 at its ends, and spacer disks 8. To the body 2 there is fixed a holder 9 ending with a clamp for keeping the high voltage bushing in vertical position at the moment when the voltage coil is in horizontal position, useful during the further execution of the insulating process, e.g. during the application of the external screen.

The process of insulating a voltage coil 10 takes place as follows.

First, using a traditional winding machine, the first winding layer 12 is wound onto an insulating tube 11 constituting the coil carcass, and then insulation layers 13 and winding layers 12 are wound in turns, which is shown in fig. 3, and the winding terminal 14 is lead out through a suitable port in the carcass and left outside the insulating tube 11. The direction of each next layer of winding is opposite to the previous direction. The insulation layer is formed of multiple sheets of paper wound on the insulating tube 11 and technological tubes 15. The sheets of paper are cut longitudinally and they form winding bands 16, also called fringes. Insulation packets differ in thickness, that is, in the number of sheets of insulating paper. The thickness of subsequent layers of insulation paper depends on the tension between subsequent layers, which in turn depends on the number of turns in the layer. The number of sheets in a layer is selected to keep the tension falling on one sheet of paper constant in all layers of paper. Preferably, the thickness of the insulation layers 13 of the voltage coil 10 decreases with increase in their distance to the coil axis.

Preferably, insulation packets also differ in width, giving a gradated shape to a spool formed by the wound coil 10 and the insulation packets.

When the process of winding on the winding machine is completed, a top screen 17 comprising a metal protective

guard (a cone) being an element of the screen is put onto the coil 10. Next, the coil 10 with paper insulation and with the screen 10 is mounted upon the crossbar 6 of the gravitationally insulating device whose frame 1 is placed in horizontal position, and the position of the coil 10 is immobilized on the crossbar 6 by means of clamping sleeves 7. Next, the end of a conducting bar 18 which, with the exception of the ends, is enveloped in a paper insulation 19 containing equipotential screens 20 is fixed to the top screen 17 of the coil 10. The conducting bar 18 together with the insulation 19 forms a bushing of the high voltage instrument transformer. When the coil 10 with the top screen 17 have been mounted on the crossbar 6 of the device, the frame 1 of the device is turned to vertical position, and after breaking the first tape that fixes the winding paper bands which are situated vertically above the coil, paper bands 16 of the first insulation packet are released, which bands fall gravitationally onto the upper surface of the coil 10. The bands 16, after being squared, are attached to the surface by means of crepe paper, not shown in the drawing, the first insulation layer being attached to the surface of the top screen 17 with minute amounts of glue. After attaching all bands of the given packet, after clipping and wrapping them in crepe paper, the revolving frame 1 of the device is turned by 180°, and after breaking another fixing tape, the paper bands 16 of the second insulation packet are released, achieving a free, gravitational fall of the bands 16 onto the bottom surface of the coil 10, which is now situated in the top position. The bands of the second packet are glued to the insulation layer obtained from the first packet of bands and made on the surface of the coil now situated in the bottom position. Next, after gluing all the band layers of the second packet and after their clipping, the revolving frame 1 of the device is turned again and another layer of insulation is fixed in the same way as before. The banding process includes application of paper insulation first on the coil 10, and then on the top screen 17 and on the uninsulated end of the conducting bar 18, at the place where it joins the coil 10. Insulation is applied in turns, so that insulation in the place where the HV bushing joins the voltage coil 10 interlaces with the insulation of the voltage coil 10, forming a main insulation 21 as a monolith without any gaps.

When the main insulation 21 has been formed on the coil 10 and on the joint between the bar 18 of the HV bushing and the coil 10, the revolving frame 1 of the device is turned by an angle of 90° and the coil bushing is set in vertical position. Then another insulating stage starts, which is not shown in the drawing, in which an external screen of the coil is made in the form of a layer of semiconducting paper placed on the outer surface of the insulation of the coil 10 and its joint with the bushing. Next, copper strap is coiled around the external screen using two insulating discs attached on the sides of the coil forming a zigzag braid on the outer surface of the coil, which is not shown in the drawing. More copper straps are coiled around the main insulation 21 screened with black semiconducting paper, on the joint between the HV bushing and the voltage coil 10, which is not shown in the drawing either. Cuts in all copper straps are soldered with filler metal. The application of copper strap permits an even potential distribution on the voltage coil.

[0017] The method for banding a voltage coil according to the invention is carried out in vertical position of the coil, which reduces the labor consumption for making the coil and at the same time it improves banding quality. The vertical situation of the coil during banding causes that when the bands 16 of the first insulation packet, previously protected with girding bands, are released, the bands fall naturally, by gravitation, onto the top surface of the coil, without causing folds and they spread evenly on the coil circumference. Fastening the bands 16 to the surface of the coil is then much simpler and does not require so much strength and skill as in the case of banding in horizontal position. In addition, this method does not produce creases in the insulation and greatly reduces the need to use glue, since the bands take the right position by themselves, under its own weight. Owing to these advantages, after the impregnation process, we obtain a uniform paper-and-oil insulation, that is, without inclusions of glue, and sufficiently hard due to the lack of creases. The insulation according to the invention has great electric break-down strength and small partial discharges, which is very important for the quality of a voltage transformer.

Key to the drawing

[0018]

1. the frame
2. the body
3. the base
4. the nut
5. the block mechanism
6. the frame crossbar
7. the pressure sleeve
8. the spacer disk
9. the holder ending with a clamp
10. the voltage coil
11. the insulating tube of the voltage coil
12. the winding layer
13. the insulation layer
14. the winding terminal
15. technological tube
16. the band of winding paper
17. the top screen
18. the conducting bar of the HV instrument transformer
19. the insulation of the conducting bar
20. the equipotential screens
21. the main insulation of the instrument transformer

Claims

1. A method for making the main insulation of a voltage coil of an HV instrument transformer, wherein the insulation material are sheets of winding paper with longitudinally cut bands which are used first to insulate the individual layers of the winding of the voltage coil forming an interlayer insulation of the coil, and then to insulate the coil as well as the joint between the coil and the bushing of the HV instrument transformer, **characterized in that** a top screen (17) which is joined with a conducting bar (18) of the bushing is placed on the insulated windings of the voltage coil (10) and next the coil and the place of the joint between the voltage coil (10) and the bushing is banded with bands of winding paper (16) in vertical position of the coil (10), by turns from the top and bottom surfaces of the coil.

2. A method according to claim 1, **characterized in that** the thickness of the layers of the insulation (13) of the voltage coil (10) decreases with the increase in their distance to the coil axis.

3. A method according to claim 1 or 2, **characterized in that** after the completion of the process of banding the voltage coil (10) together with the top screen (17), a winding layer of semiconducting paper forming an external screen of the voltage coil is applied on the external surface of the main insulation of the instrument transformer (21) of the banded coil (10).

4. A method according to claim 3, **characterized in that**, following the application of the external screen on the main insulation of the instrument transformer (21) of the banded coil (10), the external screen is enveloped in copper strap.

5. A method according to claim 1, **characterized in that** the conducting bar (18) with the insulation (19) takes vertical position during banding of the voltage coil (10).

6. A method according to claim 1, **characterized in that** banding of the coil (10) and the screen (17) and the joint between the voltage coil (10) and the insulated conducting bar (18) is done by means of a gravitational banding device.

7. Device for making the main insulation of a voltage coil of a HV instrument transformer according to the method of claim 1 wherein the insulation material are sheets of winding paper with longitudinally cut bands which are used first to insulate the individual layers of the winding of the voltage coil forming an interlayer insulation of the coil, and then to insulate the coil as well as the joint between the coil and the bushing of the HV instrument transformer, comprising a crossbar and means for fixing the position on the crossbar of the voltage coil together with a top screen (17) wherein the crossbar (6) is fastened to a frame (1) connected with a revolving body (2) joined movably in vertical direction with a base (3).

8. A device according to claim 7, **characterized in that** it comprises a block mechanism (5) for blocking the crossbar (6) with the frame (1) in horizontal or vertical position with a revolution of the crossbar (6) and the frame (1) by an angle of 90°.

9. A device according to claim 7 **characterized in that** there are distance disks (8) and pressing sleeves (7) situated at the end of the crossbar (6).

10. A device according to claims 7 - 9, **characterized in that** there is a holder (9) with a clamping ring fastened to the body (2), for keeping the transformer bushing in vertical position.

11. A device according to claims 7 - 10, **characterized in that** it comprises a nut (4) for regulating the height of the frame (1) position.

Patentansprüche

1. Verfahren zur Herstellung einer Spannungsspule eines Hochspannungsinstrumententransformators und Vorrichtung zur Herstellung der Isolierung einer Spannungsspule, wobei das Isolationsmaterial aus Blättern von Wicklungspapier mit längs geschnittenen Bändern besteht, die als erstes zur Isolation der einzelnen Lagen der Wicklung der Spannungsspule dienen und so eine Zwischenisolierung der Spule bilden, und dann dazu dienen, die Spule sowie die Verbindungsstelle zwischen Spule und Durchführung des Hochspannungsinstrumententransformators zu isolieren, **dadurch gekennzeichnet, dass** eine obere Abschirmung (17), die mit einem leitenden Stab (18) der Durchführung verbunden ist, auf den isolierten Wicklungen der Spannungsspule (10) angeordnet ist und anschließend die Spule und die Stelle der Verbindung der Spannungsspule (10) und der Durchführung mit Bändern von Wicklungspapier (16) in senkrechter Position der Spule (10) durch Wicklungen abwechselnd von der Ober- und Unterseite der Spulenfläche festgebunden ist.

2. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Dicke der Schichten der Isolation (13) der Spannungsspule (10) mit zunehmendem Abstand von der Achse der Spule abnimmt.

3. Ein Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** nach der Fertigstellung des Prozesses, die Spannungsspule (10) mit der oberen

Abschirmung (17) zusammenzubinden, auf die Außenfläche der Hauptisolierung des Instrumententransformators (21) der zusammengebundenen Spannungsspule (10) eine Wicklungsschicht aus halbleitendem Papier, die eine äußere Abschirmung der Spannungsspule bildet, angebracht wird.

4. Ein Verfahren gemäß Anspruch 3, **dadurch gekennzeichnet, dass**, nach der Anbringung der äußeren Abschirmung auf der Hauptisolation des Instrumententransformators (21) der zusammengebundenen Spule (10), die äußere Abschirmung mit Kupferband umwickelt wird.

5. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der leitende Stab (18) mit der Isolierung (19) eine vertikale Position während der Zusammenbindung der Umwicklung der Spannungsspule (10) einnimmt.

6. Ein Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** das Zusammenbinden der Spule (10) und der Abschirmung (17) und die Verbindung der Spannungsspule (10) mit dem isolierten leitenden Stab (18) mit Hilfe einer Schwerkraft-Wickeleinrichtung erfolgt.

7. Vorrichtung zur Herstellung der Hauptisolierung der Spannungsspule eines Hochspannungsinstrumententransformators gemäß Verfahren nach Anspruch 1, wobei das Isolationsmaterial aus Blättern von Wicklungspapier mit längs geschnittenen Bändern besteht, die als erstes zur Isolation der einzelnen Lagen der Wicklung der Spannungsspule dienen und so eine Zwischenisolierung der Spule bilden, und dann dazu dienen, die Spule sowie die Verbindungsstelle zwischen Spule und Durchführung des Hochspannungsinstrumententransformators zu isolieren, die eine Traverse sowie Mittel zur Fixierung der Position auf der Traverse der Spannungsspule zusammen mit einer oberen Abschirmung (17) enthält, wobei die Traverse (6) an einem Rahmen (1) befestigt ist, der mit einem drehbaren Körper (2) verbunden ist, der in vertikaler Richtung beweglich auf einem Sockel angeschlossen ist.

8. Eine Vorrichtung gemäß Anspruch 7, **dadurch gekennzeichnet, dass** sie einen Blockierungsmechanismus (5) enthält, um die Traverse (6) mit dem Rahmen (1) in horizontaler oder vertikaler Position zu blockieren, indem die Traverse (6) und der Rahmen (1) um einen Winkel von 90° gedreht werden.

9. Eine Vorrichtung gemäß Anspruch 7, **dadurch gekennzeichnet, dass** Distanzscheiben (8) und Presshülsen (7) an den Enden der Traverse (6) angeordnet sind.

10. Eine Vorrichtung gemäß Anspruch 7 - 9, **dadurch gekennzeichnet, dass** eine Halterung (9) mit einem Klemmring, an dem Körper (2) befestigt ist, um die Durchführung des Transformators in vertikaler Position zu halten.

11. Eine Vorrichtung gemäß Anspruch 7 - 10, **dadurch gekennzeichnet, dass** sie eine Schraubenmutter (4) enthält, um die Höhe der Position des Rahmens (1) zu regulieren.

Revendications

1. Procédé de fabrication d'un isolant de bobine de tension d'un transformateur d'instrument HT et dispositif de fabrication d'un isolant de bobine de tension, où comme le matériau isolant sont utilisées des feuilles de papier isolant pré-coupées longitudinalement en des bandes servant à isoler, en premier lieu, les enroulements individuels du bobinage de la bobine de tension de façon à former l'isolation entre les couches de la bobine et, en deuxième lieu, sont isolées la bobine et la connexion de la bobine avec la traversée du transformateur d'instrument HT, **caractérisé en ce qu'**un écran (17) relié à une tige conductrice (18) de la traversée est placé sur le bobinage de la bobine de tension d'en haut, et par la suite, la bobine ainsi que l'endroit de connexion de la bobine de tension (10) et de la traversée sont bandés avec les bandes du papier isolant (16) en position verticale de la bobine (10), en alternant par la haute et la basse surface de la bobine.

2. Procédé selon la revendication 1, **caractérisé en ce que** l'épaisseur des couches d'isolation (13) de la bobine de tension (10) diminue au fur et à mesure de l'augmentation de leur éloignement de l'axe de la bobine.

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que**, lorsque la procédure de bandage de la bobine de tension (10) avec l'écran d'en haut (17) est terminée, une couche d'enroulement en papier semi-conducteur formant un écran extérieur de la bobine de tension est mise sur la surface extérieure d'isolation principale du transformateur d'instrument (21) de la bobine bandée (10).

4. Procédé selon la revendication 3, **caractérisé en ce que**, lorsque l'écran extérieur est mis sur l'isolation principale du transformateur d'instrument (21) de la bobine bandée (10), une bande en cuivre est enroulée autour de cet écran extérieur.

5. Procédé selon la revendication 1, **caractérisé en ce que** la barre conductrice (18) avec l'isolation (19) est en position horizontale pendant la procédure de ban-

dage de la bobine de tension (10).

6. Procédé selon la revendication 1, **caractérisé en ce que** le bandage de la bobine (10) et de l'écran (17) ainsi que de la connexion de la bobine de tension (10) à la barre conductrice munie d'isolant (18) est exécuté à l'aide d'un dispositif pour bandage gravitationnel.

7. Dispositif de fabrication d'un isolant de bobine de tension du transformateur d'instrument HT selon la revendication 1, où comme le matériau isolant sont utilisées des feuilles de papier isolant pré-coupées longitudinalement en des bandes servant à isoler en premier lieu les enroulements individuels du bobinage de la bobine de tension de façon à former l'isolation entre les couches de la bobine et, en deuxième lieu, sont isolées la bobine et la connexion de la bobine avec la traversée du transformateur d'instrument HT, ledit dispositif comprenant une traverse et des moyens à déterminer la position de la bobine de tension avec l'écran d'en haut (17) sur la traverse, où la traverse (6) est fixée à un cadre (1) relié à un corps pivotant (2) qui est relié de façon mobile à la base (3) dans le sens vertical.

8. Dispositif selon la revendication 7, **caractérisé en ce qu'**il comprend un mécanisme de blocage (5) pour immobiliser la traverse (6) avec le cadre (1) en position horizontale ou verticale au moment de la rotation de la traverse (6) et du cadre (1) de 90°.

9. Dispositif selon la revendication 7, **caractérisé en ce que** des galets d'écartement (8) et des douilles de pression (7) sont situés aux extrémités de la traverse (6).

10. Dispositif selon la revendication 7 à 9, **caractérisé en ce qu'**un manchon (9) avec un collier sont installés sur le corps (2) afin de maintenir la traversée du transformateur en position verticale.

11. Dispositif selon la revendication 7 à 10, **caractérisé en ce qu'**il est muni d'un écrou (4) pour le réglage de la hauteur de position du cadre (1).

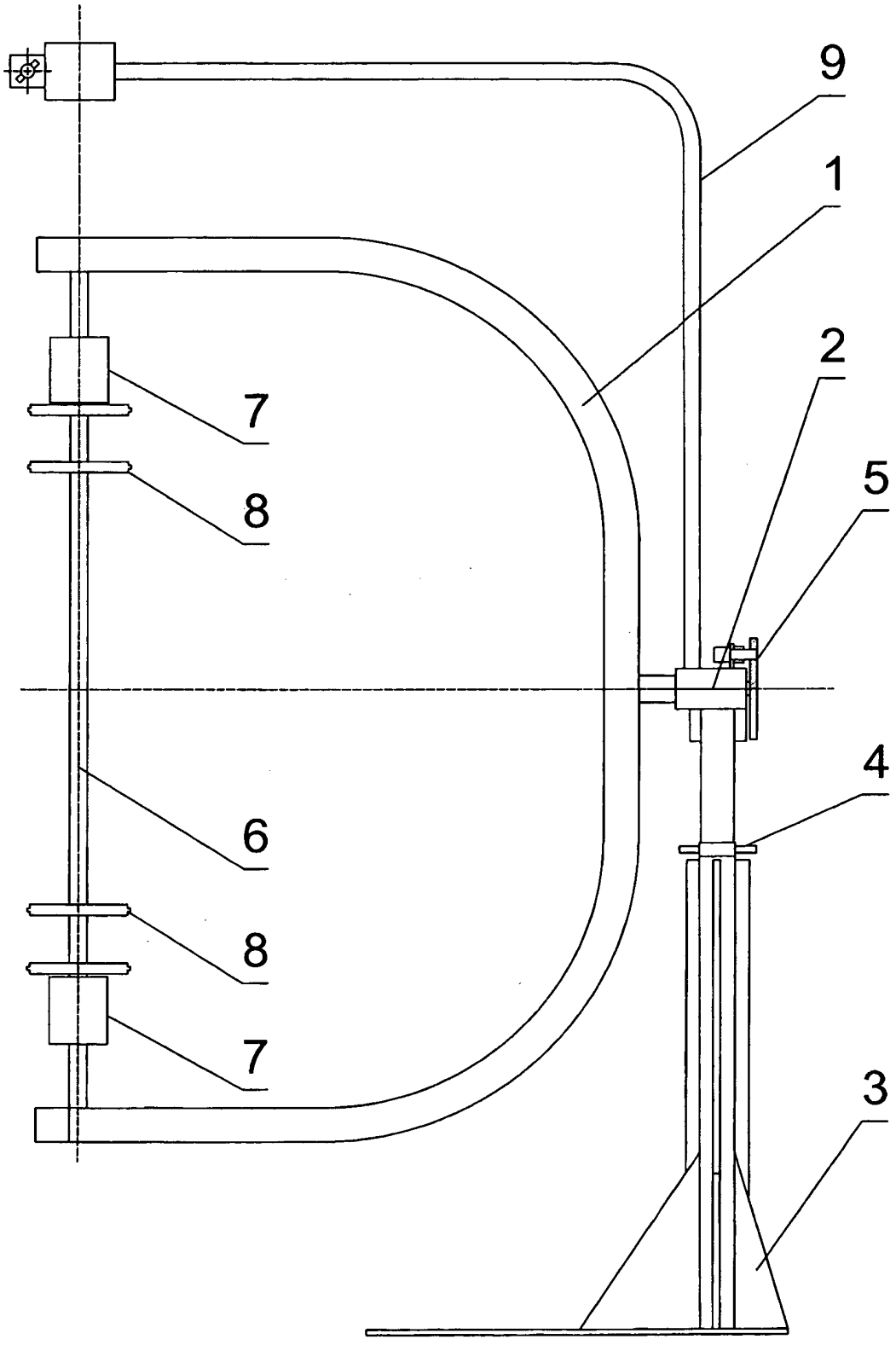

Fig. 1

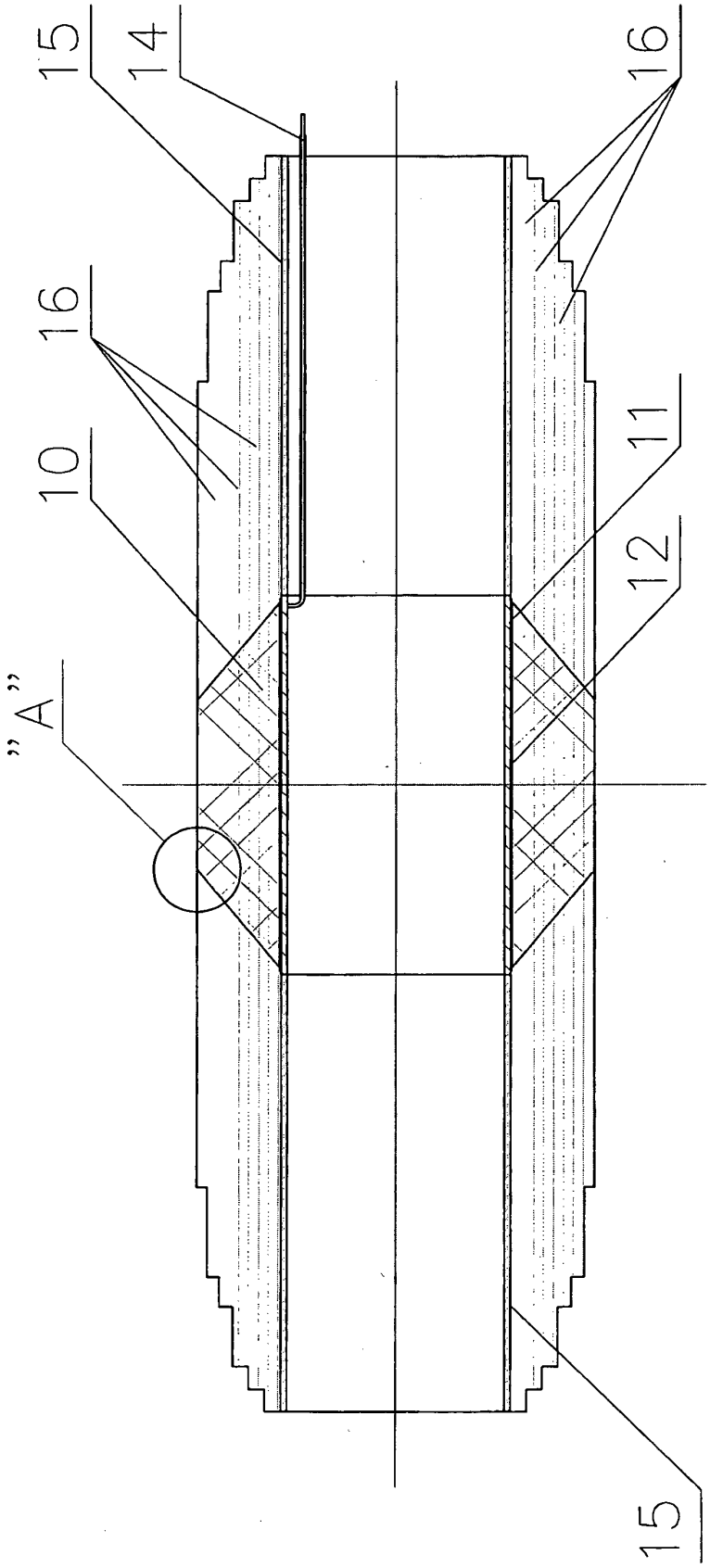

Fig. 2

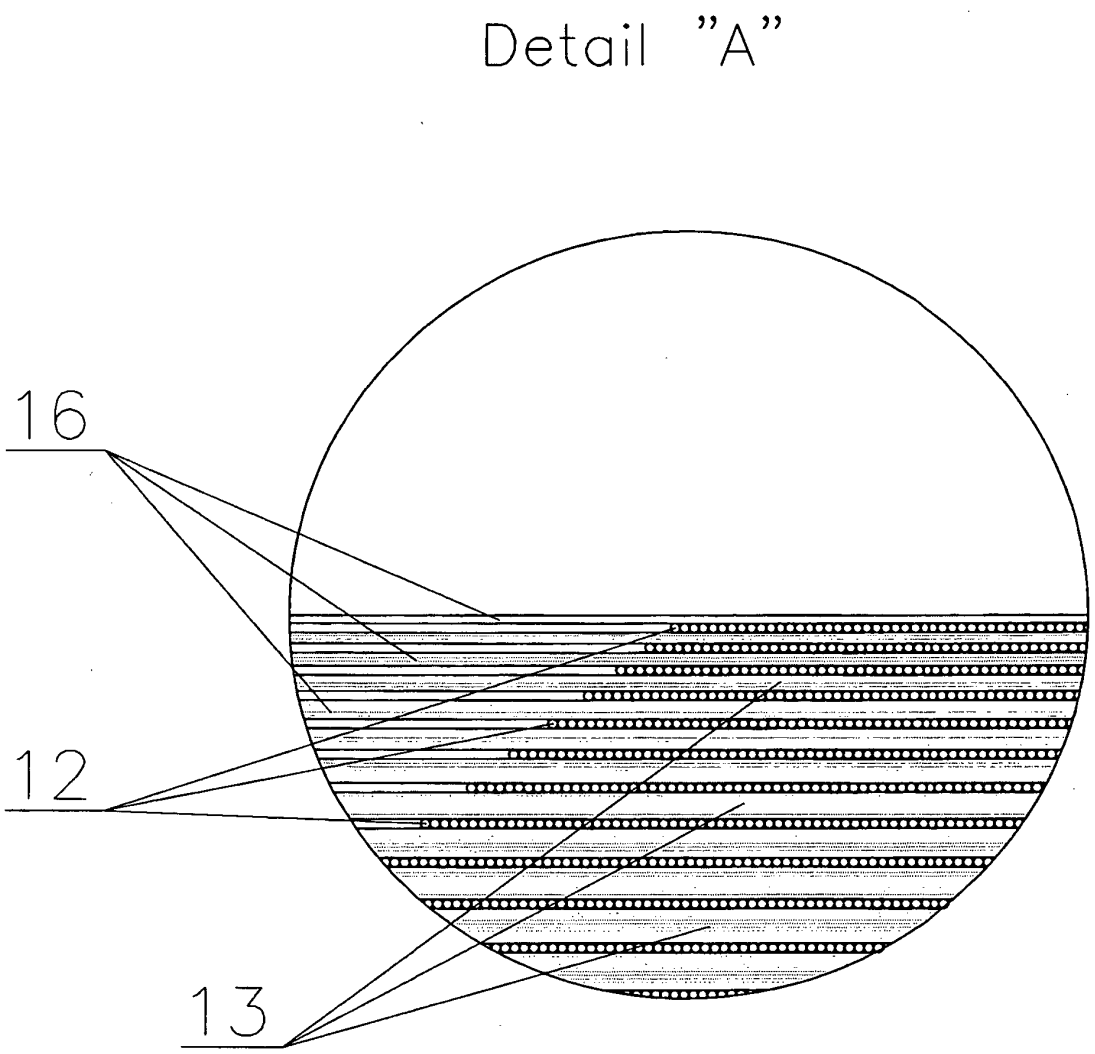

Fig. 3

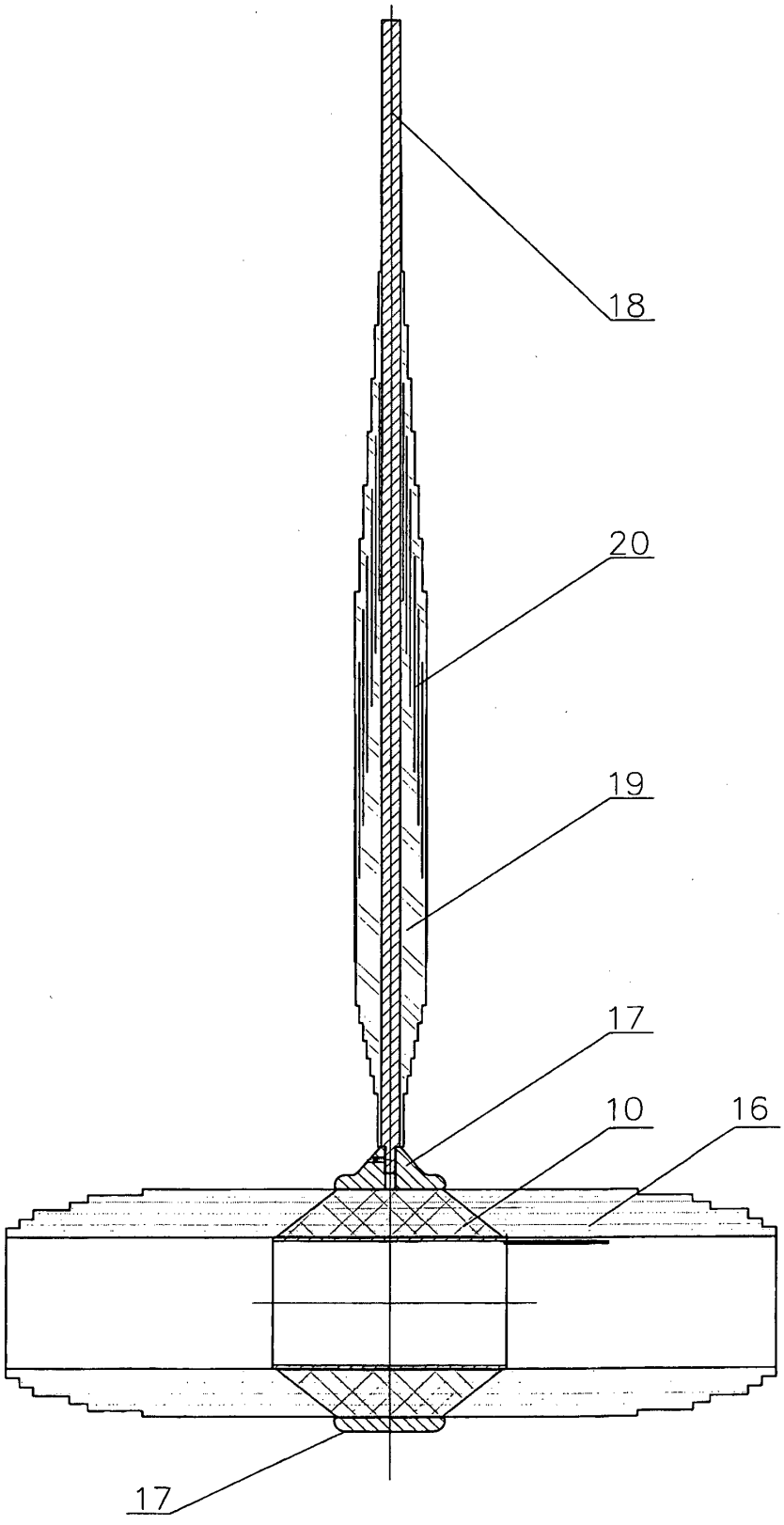

Fig. 4

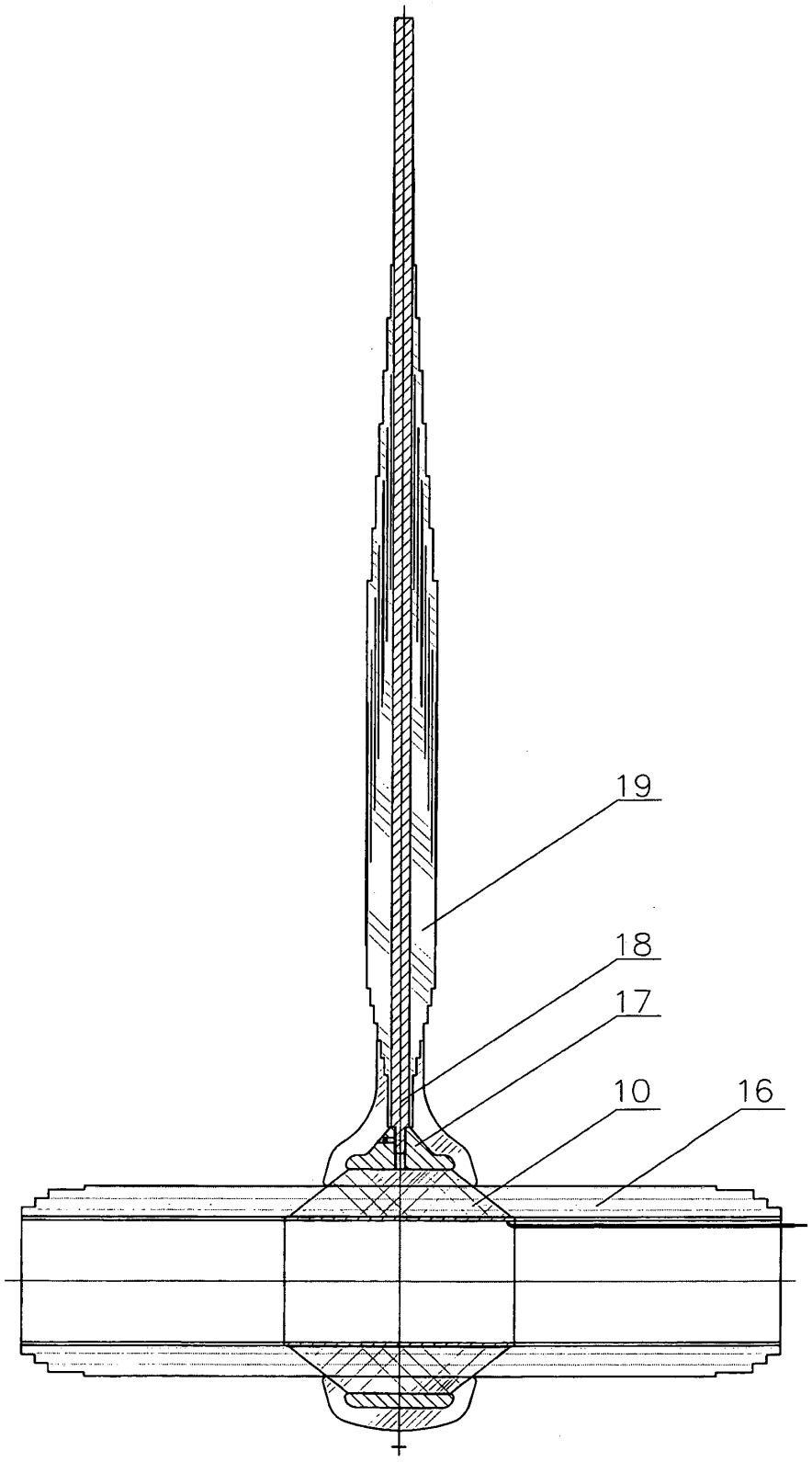

Fig. 5

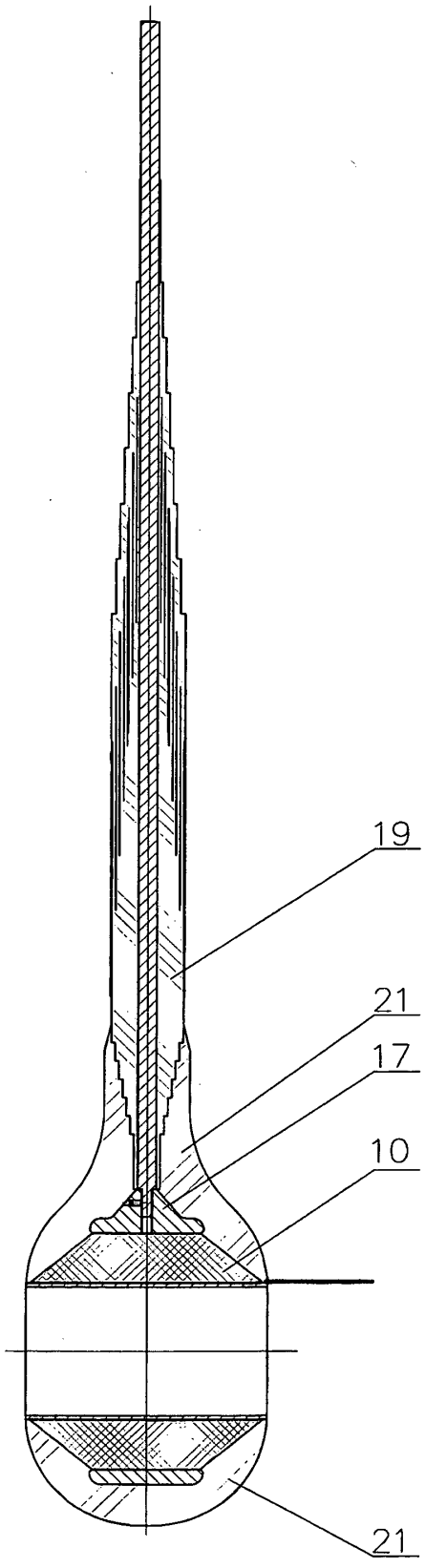

Fig. 6