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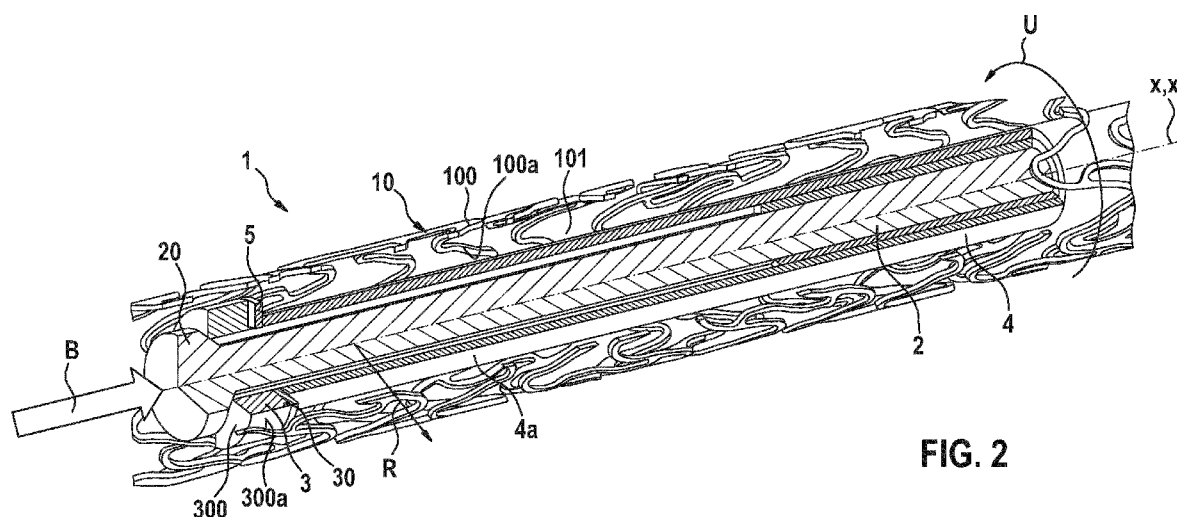


FIG. 2

(57) Abstract: The invention relates to an electrode pin (1) for making anodic contact with a component (10) during electropolishing of the component (10), the component (10) having a supporting structure (100) that extends along a longitudinal axis (x) and encircles the component (10) in a peripheral direction (U), so that the supporting structure (100) surrounds an interior (101) of the component (10), the supporting structure (100) having an inner surface (100a) facing the interior (101), and the electrode pin (1) further having: an anode (3) and a cathode (4). The invention provides that the electrode pin (1) be designed to be inserted into the interior (101) of the component (10), so that the anode (3) and the cathode (4) are arranged in the interior (101) of the component (10), the anode (3) being configured to make contact with the inner surface (100a) of the component (10).



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ELECTRODE PIN

The invention relates to an electrode pin for electropolishing a tubular component, in particular in the form a supporting structure, e.g., in the form of a stent.

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Electropolishing tubular components, especially tubular grid structures, presents the challenge, especially in the case of small component diameters, of the component used for carrying out the electropolishing making contact.

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For tubular components in the form of balloon-expandable stents, the polishing stands used today consist of a fixed counter bearing and one or two prestressed nitinol wires. While the stent is being polished, it is located between these two elements and is contacted from outside. During the polishing process, contact is made with the stent several times. The cathode plate is located horizontally beneath the stent.

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With regard to the previously mentioned methodology, which is used in the case of balloon-expandable stents, it can turn out to be disadvantageous that the maximum number of contact points to the stent is two, and that movement of the contact points is possible in only one direction and is limited in number. In addition, surface defects can occur due to contact points on the outer surface of the stent. Furthermore, contact does not occur over the entire periphery of the stent, so that under some circumstances the contact is insufficient, due to the grid structure of the stent. Furthermore, a large surface of the abutment of the outside contact can make it more difficult to supply the electrolytes in this area.

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The above-described electropolishing of self-expandable stents turns out to be problematic, since here in the case of manual movement an internal anode increases the risk of

scratching the inner surface of the stent, and furthermore the anode and cathode are spatially separated.

US 20147/0360887 describes an anode that is used as a mandrel to hold the stent in the electrolyte bath.

US 7,776,189 further discloses a stent electropolishing system that involves rotating the stents in the electrolyte by means of a drive.

Starting from this, this invention has the goal of providing an electrode pin that allows good contact of the tubular component for electropolishing and simultaneously reduces the risk of scratching the inner surface of the component and allows, in particular, a uniform electrolyte flow to all areas of the component.

This is accomplished by an electrode pin having the features of claim 1. Advantageous embodiments of the electrode pin are indicated in the corresponding subordinate claims and are described below. Further aspects of the invention relate to an arrangement and a process for electropolishing using the electrode pin.

Claim 1 discloses an electrode pin for making anodic contact with a component during electropolishing of the component, the component having a supporting structure that extends along a longitudinal axis and encircles the component in a peripheral direction, so that the supporting structure surrounds an interior of the component, the supporting structure having an inner surface facing the interior, and the electrode pin having at least one anode and one cathode.

The invention now provides that the electrode pin be designed or be configured to be inserted into the interior of the component in the direction of the longitudinal axis, so that the anode and the cathode are arranged in the interior of the component, the anode being configured to make contact with the inner surface of the component. The interior is, in particular, a longitudinally extending cylindrical interior or a cylindrical volume.

This invention allows anodic and cathodic contact inside the component. This is especially advantageous if the component is an intraluminal endoprosthesis or/and a stent-based heart valve prosthesis. It has been found that arranging the anode and cathode so that they are inside the component simultaneously achieves clearly improved roundness of the struts of the supporting structure of the prosthesis.

It is preferably provided that the cathode lie opposite the inner surface and that it be separated from it when the electrode pin is arranged in the way it is supposed to be in the interior of the component, the electrode preferably extending along the longitudinal axis over at least 50%, especially over at least 70%, especially over at least 80%, especially over at least 90%, of the length of the component.

The supporting structure of the component to be worked can have multiple openings through it, and accordingly need not form a continuously closed outside or outer surface of the component in the form of a jacket. Therefore, the supporting structure can be formed, in particular, by a grid structure that has, e.g., multiple struts that are connected with one another and that can form cells of the supporting structure or grid structure.

In particular, the component can be a stent that is intended especially for implantation in the body of a patient. The stent can be a vessel support (e.g., for use in angioplasty) or a support of a heart valve of an implantable heart valve prosthesis. The stent can also be self-expandable. Alternatively, the stent can be designed to be expanded by means of a balloon.

This invention advantageously allows all stents to anodically contacted from inside. It is also possible to integrate the necessary counter electrode (cathode) into the same component. This can ensure clean and uniform polishing of the outside surface without defects at the contact points. Above all, for longer stents or components, an internal cathode along the entire length of the stent or component is advantageous.

The inventive internal contact additionally makes it possible to move the stent or the component in both directions along the longitudinal axis of the component as often as desired, and to vary the contact point.

5 The integrated internal cathode ensures a uniform separation between the stent and the cathode along the longitudinal axis of the component. This makes it possible, for example, to increase the edge roundness on the balloon-facing inner surface of the stent. Balloon damage due to sharp edges can be avoided.

10 Furthermore, any number of internal contacts can be distributed over the entire length of the stent or component. This makes it possible to use the invention for various sizes (lengths, diameters) of stents or components.

One embodiment of the electrode pin provides that the anode have at least one first contact
15 surface to make contact with the inner surface of the component, the at least one first contact surface for making contact with the inner surface of the component being movable out of a first position into an extended second position when the electrode pin is arranged in the interior of the component, so that the at least one first contact surface of the anode makes contact with the inner surface of the component in the second position. It is
20 preferably provided that in the second position the at least one first contact surface projects further, in a radial direction of the electrode pin, beyond an outer surface of the cathode than it does in the first position. When a first contact surface is arranged in the first position, the outside diameter of the electrode pin is correspondingly smaller than when a first contact surface is arranged in the second position, so that the electrode pin can be
25 positioned in the interior of the component without making contact with the component when the at least one first contact surface is arranged in the first position (this also applies in the case of multiple first and/or second contact surfaces, see below).

The electrode pin preferably has a longitudinally extending shape and extends in an axial
30 direction, that is, along a first longitudinal axis, the radial direction always being perpendicular to the axial direction or to the longitudinal axis of the electrode pin and pointing outward, that is away from the longitudinal axis.

One embodiment of the electrode pin further provides that the electrode pin has a longitudinally extending support that extends along the longitudinal axis of the electrode pin, the anode and the cathode being arranged on the support so that the support is movable
5 with respect to the anode and the cathode along the longitudinal axis.

One embodiment of the electrode pin further provides that the support have at least one expansion element that is configured so that as the support moves with respect to the anode along the longitudinal axis of the support / electrode pin this expansion element presses
10 against the anode in such a way that the at least one first contact surface of the anode is moved out of the first position into the second position, that is, it is pushed radially outward.

One embodiment of the electrode pin further provides that the at least one expansion
15 element be in the form of an expansion cone or have a cone-shaped section that when pressed against the anode pushes the at least one first contact surface (or the multiple first contact surfaces, see below) outward (in the direction toward the inner surface of the component), so that the at least one first contact surface makes contact with the inner surface of the component when the electrode pin is arranged in the interior of the
20 component.

One embodiment of the electrode pin further provides that the cathode surround at least sections of the support and the anode.

25 One embodiment of the electrode pin further provides that an electrical insulation be arranged between the cathode and the anode. This insulation is preferably tubular and can, in particular, be in the form of a heat-shrink tubing.

One embodiment of the electrode pin further provides that the at least one expansion
30 element be formed at a first end of the support. The at least one expansion element can be formed, e.g., by a projection encircling the end of the support.

One embodiment of the electrode pin further provides that the at least one expansion element be configured so that as the support moves with respect to the anode along the longitudinal axis of the support, this expansion element presses against multiple first sections (in particular end sections) of the anode which, in particular, protrude out of the cathode in the direction of the longitudinal axis of the support, the at least one first contact surface being formed by one of the first sections, and the other first sections of the anode forming other first contact surfaces of the anode, each of which is movable out of a first position into a second position, the respective first contact surface being moved out of its first position into its second position when the at least one expansion element of the support presses against the respective first section as the support moves. Preferably, in the second position the first contact surfaces project in the radial direction of the electrode pin beyond the outer cathode to make contact with the inner surface of the component when the electrode pin is arranged in the interior of the component.

Due to the multiple first contact surfaces, the inner surface of the component can make contact by means of the first contact surfaces of the anode along the entire periphery of the component, when these first contact surfaces are arranged in the second position.

One embodiment of the electrode pin further provides that the first sections of the anode be formed by a tubular end section of the anode, this tubular end section extending along the longitudinal axis of the electrode pin and, in particular, projecting out of the cathode in the direction of the longitudinal axis, the first sections being separated from one another or formed by slots of the tubular end section, the respective slot extending along the longitudinal axis of the tubular end section of the anode or of the electrode pin. The slots make it easy for the expansion element to press the said first sections apart in the radial direction, the first contact surfaces provided on the outside of these first sections being moved into their respective second position and making contact with the inner surface of the component (e.g., stent).

One embodiment of the electrode pin further provides that the support have another expansion element that is designed to be separated from the other expansion element on the support, the other expansion element being designed / configured to press against multiple

second sections of the anode as the support moves with respect to the anode along the longitudinal axis of the support, every second section forming a second contact surface of the anode to make contact with the inner surface of the component, so that the respective second contact surface is moved out of a first position into a second position when the
5 other expansion element of the support presses against the respective second section of the anode as the support moves. The other expansion element can be in the form, e.g., of a projection on the support encircling the support.

Here again, due to the multiple second contact surfaces, the inner surface of the component
10 can make contact by means of the second contact surfaces of the anode along the entire periphery of the component when these second contact surfaces are arranged in the second position. The other expansion element can once again be in the form of an expansion cone or can have a cone-shaped section that when pressed against the second sections of the anode pushes the second contact surfaces outward (in the direction toward the inner
15 surface of the component), so that the second contact surfaces make contact with the inner surface of the component when the electrode pin is arranged in the interior of the component.

One embodiment of the electrode pin further provides that the cathode have a first section
20 and an adjacent second section, which are separated from one another by a gap encircling an outer surface of the electrode pin in the peripheral direction of the electrode pin, the second contact surfaces of the anode being configured so that in the respective second position they project beyond the two sections of the cathode out of the gap in a radial direction of the electrode pin, to make contact with the inner surface of the component
25 when the electrode pin is arranged in the interior of the component.

One embodiment of the electrode pin further provides that the first section of the cathode have an electrically conductive connection with a core of the cathode, this core running within the support along the longitudinal axis of the electrode pin or the support, and, in
30 particular, the second section of the electrode being connected with the core through a conductor that runs, in particular, outside of the support. In the context of this application,

the core of the cathode or anode is understood to be the innermost electrically conductive structure.

One embodiment of the electrode pin further provides that the electrode pin have a spring element that is configured to apply a force to the support in such a way that the respective contact surface (i.e., the at least one first contact surface or the first contact surfaces and/or the second contact surfaces) is prestressed in the direction toward the respective second position.

That is, the support can, e.g., by advancing against the spring force, be disengaged from the first and/or second sections of the anode. This reduces the outside diameter of the electrode pin (the contact surfaces are in the first position) and the electrode pin can be inserted into the interior of the component. The support can then be moved with respect to the anode along the longitudinal axis in the direction in which the spring force is acting, causing the contact surfaces to be moved into their respective second position and make contact with the inner surface of the component.

Another aspect of this invention relates to an arrangement with an inventive electrode pin and a component (especially a stent, see above), the component having a supporting structure that extends along a longitudinal axis and encircles the component in a peripheral direction, so that the supporting structure surrounds an interior of the component, the supporting structure having an inner surface facing the interior, and the electrode pin being inserted into the interior of the component, so that the anode and the cathode are arranged in the interior of the component, in particular the anode making contact with the inner surface of the component, e.g., in the way described here.

Another aspect of this invention relates to a process for electropolishing a component using an inventive electrode pin, the component having a supporting structure that extends along a longitudinal axis and encircles the component in a peripheral direction, so that the supporting structure surrounds an interior of the component, the supporting structure having an inner surface facing the interior, this process comprising the following steps:

- Inserting the electrode pin into the interior of the component so that the anode and the cathode are arranged in the interior of the component;
- Producing a contact between the inner surface of the component and the anode (in particular by moving the support with respect to the anode); and
- 5 - Arranging the electrode pin and the component in a bath that contains an electrolyte, and applying a voltage between the anode and the cathode to electropolish the component.

The invention advantageously allows uniform removal on the outer surface of the component and on the inner surface of the component, and makes it possible to avoid
10 defects. The invention also ensures a uniform electrolyte flow along the entire component. Furthermore, the invention achieves improved edge roundness on the inner surface of the component. The arbitrarily large number of contact points produces a better current distribution. Furthermore, the internal cathode forms a better field, which favors uniform
15 removal. Lower contact resistance values allow better process control. The fact that the electrode pin is easily movable in both directions also makes it possible to achieve a uniform removal. Finally, the design of the inventive electrode pin has substantial potential for automation, so that manual manipulation has a smaller influence on the working of the component.

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Embodiments of the invention and features and advantages of the invention are described below using the figures. The figures are as follows:

Fig. 1 a perspective view of a first sample embodiment of an inventive electrode
25 pin;

Fig. 2 a partially cutaway view of a detail of the electrode pin shown in Figure 1;

Fig. 3 a cutout exploded view of the electrode pin shown in Figures 1 and 2;

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Fig. 4 a perspective view of another sample embodiment of an inventive electrode
pin;

Fig. 5 a sectional view of the electrode pin shown in Figure 4; and

Fig. 6 different design possibilities for an electrode of an inventive electrode pin.

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This invention relates to an electrode pin 1 for making anodic contact with a component 10 during electropolishing of the component 10, the component 10 having, as can be seen in Figures 1 and 2, a supporting structure 100 that extends along a longitudinal axis x and encircles the component 10 in a peripheral direction U, so that the supporting structure 100 defines an interior 101 of the component 10, the supporting structure 100 having an inner surface 100a facing the interior 101.

According to the embodiment shown in Figures 1 through 3, the electrode pin has an anode 3 and a cathode 4, which are arranged in the interior of the component 10 when the electrode pin is, as is shown in Figure 2, inserted as intended into the interior 101 of the component 10, an example of which is provided here by a stent. To make contact with the inner surface 100a of the component 10, the anode 3 has at least one first contact surface 300a, there being, e.g., four such first contact surfaces 300a here. These first contact surfaces 300a are formed on four first sections 300 of a tubular end section 30 of the anode 3, the first sections 300 being separated from one another by a total of four slots 31, which extend along the longitudinal axis x' of the electrode pin 1.

The first contact surfaces 300a can now be moved out of a withdrawn first position into an extended second position, to make contact with the inner surface 100a, by a preferably cone-shaped expansion element 20 pushing the sections 300 apart in the radial direction R of the electrode pin 1. This expansion element 20 is formed at one end of a support 2 of the electrode pin 1, this support extending along the longitudinal axis x', the anode 3 and the cathode 4 being arranged on the support 2 so that the support 2 is movable with respect to the anode 3 and the cathode 4 along the longitudinal axis x'. The cathode 4 surrounds at least sections of the anode 3 and the support 2 (see Figures 1 and 2), the said first sections 300 protruding out of the cathode 4 in the direction of the longitudinal axis x'. Preferably, the anode 3 and the cathode 4 have an electrical insulation 5, e.g., in the form of a heat-

shrink tubing, arranged between them. At least sections of the cathode 4 can have a hollow cylindrical shape, and the cathode 4 preferably extends along the longitudinal axis of the component essentially over the entire length of the component 10 (with exception of the section that is occupied by the first the first contact surfaces 300a of the anode 3).

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The support 2 can now be moved along the longitudinal axis x' against the anode 3 in such a way that the expansion element 20 runs into the first sections 300 in the direction of motion B shown in Figures 1 and 2, and pushes them apart in the radial direction R. When this happens, the first contact surfaces 300a are displaced outward into the second positions, where each of them make contact with the inner surface 100a of the component 10.

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Figures 4 and 5 show another embodiment of an inventive electrode pin, each respective first section 300 of the anode 3 being formed by one end section of a first electrical conductor 33, each first conductor 33 forming a part of the anode 3 and extending along the support 2. These first conductors 33 extend to an electrical contact 32 of the anode 3, this contact 32 being opposite the expansion element 20 in the direction of the longitudinal axis x' .

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The said first sections 300 of the anode 3 in turn form first contact surfaces 300a, which can be pressed apart by the expansion element 20 at the end of the support 2 in the above-described way, so that these first contact surfaces 300a are moved into the respective second position, in which they make contact with the inner surface 100a of the component 10.

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An embodiment of the electrode pin 1 according to Figures 4 and 5 differs from that shown in Figures 1 through 3 in that it now further provides that the electrode pin 1 have another expansion element 21 formed on the support 2, this other expansion element 21 being designed to press against multiple second sections 301 of the anode 3 as the support 2 is moved with respect to the anode 3 along the longitudinal axis x' of the electrode pin 1, every second section 301 forming a second contact surface 301a of the anode 3 to make contact with the inner surface 100a of the component 10, the respective second contact

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surface 301a being moved out of a first position into a second position when the support 2 with the other expansion element 21 presses against the respective second section 301 of the anode 3. Each of the second sections 301 of the anode 3 is preferably formed by an end section of a second conductor 34, the second conductor 34 being routed along the first conductor 33 or along the support 2 to the contact 32, through which all conductors 33, 34 or contact surfaces 300a, 301a of the anode 3 can make electrical contact.

As can further be seen in Figure 4, it is preferably provided that the cathode 4 have a first (e.g., helical) section 40 and an adjacent second (e.g., helical) section 41, which are separated from one another by a gap 8 in the direction of the longitudinal axis x' , the second contact surfaces 301a of the anode 3 being configured so that in the respective second position they protrude out of the gap 8 in a radial direction R of the electrode pin 1, projecting beyond the two sections 40, 41 of the cathode 4 in the radial direction R, to make contact with the inner surface 100a of the component 10, when the electrode pin 1 is arranged in the interior 101 of the component 10.

To form the said gap 8, it is provided that the first section 40 of the cathode 4 have an electrically conductive connection with a core 42 of the cathode 4, this core running within the support 2 along the longitudinal axis x' of the electrode pin 1, and past the gap 8. In particular, the second section 41 of the electrode 4 is connected, through an electrical conductor 43, with an end section of the core 42, so that a contact 44 for the cathode 4 is formed, in particular the conductor 43 running outside the support 2.

Furthermore, it can be provided, according to Figure 4, that the electrode pin 1 have a spring element 6 that is configured to apply a force to the support 2 in such a way that the respective contact surface 300a, 301a is prestressed in the direction toward the respective second position. The spring element 6 can be supported against a counter bearing 7 of the support 2, and this abutment 7 can also be used as a handle to move the support 2 with respect to the anode 3.

The first and/or second contact surfaces 300a, 301a of the anode 3 of the above-described sample embodiments of the electrode pin 1 can be gold-plated or can be formed by a noble

metal or have such a noble metal. This allows the contact resistance to be as low as possible.

Furthermore, the cathode 4 of the above-described electrode pins 1 or their sections 40 and
5 41 can be designed, e.g., as shown in Figure 6. This allows, e.g., the cathode 4 (also see
Fig. 4) to have an electrical conductor, at least sections of which are helically arranged, it
being possible for this electrical conductor to be in the form, e.g., of a round wire (see Fig.
6 (A)) or in the form of a flat wire (see Fig. 6(C)). For instance, it is provided, e.g.,
according to Figure 4 that at least sections of the two sections 40 and 41 of the cathode 4
10 are helically shaped.

Furthermore, the cathode 4 can also have an electrical conductor at least sections of which
are in the form of a hollow cylinder (see Figures 1 through 3), as is shown in Fig. 6 (B). It
is conceivable for each of the two helical cathode sections 40, 41 of Figure 4 to be replaced
15 by a hollow cylindrical section.

Claims

1. An electrode pin (1) for electropolishing a component (10), the component (10) having a supporting structure (100) that extends along a longitudinal axis (x) and encircles the component (10) in a peripheral direction (U), so that the supporting structure (100) surrounds an interior (101) of the component (10), the supporting structure (100) having an inner surface (100a) facing the interior (101), and the electrode pin (1) further having:

- an anode (3); and
- a cathode (4),

characterized in that

the electrode pin (1) is configured to be inserted into the interior (101) of the component (10), so that the anode (3) and the cathode (4) are arranged in the interior (101) of the component (10), the anode (3) being configured to make contact with the inner surface (100a) of the component (10).

2. An electrode pin according to claim 1, **characterized in that** to make contact with the inner surface (100a) of the component (10), the anode (3) has at least one first contact surface (300a), the at least one first contact surface (300a) for making contact with the inner surface (100a) of the component (10) being movable out of a first position into a second position with respect to the cathode (4).

3. An electrode pin according to claim 2, **characterized in that** in the second position the at least one contact surface (300a) projects further, in a radial direction (R) of the electrode pin (1), beyond an outer surface (4a) of the cathode (4) than it does in the first position.

4. An electrode pin according to any one of claims 1 through 3, **characterized in that** the electrode pin (1) has a longitudinally extending support (2) that extends along the longitudinal axis (x') of the electrode pin, the anode (3) and the cathode (4) being arranged on the support (2) so that the support (2) is movable with respect to the anode (3) and the cathode (4) along the longitudinal axis (x').

5. An electrode pin according to claim 4, **characterized in that** the support (2) has at least one expansion element (20) that is configured so that as the support (2) moves with respect to the anode (3) along the longitudinal axis (x') of the electrode pin (1) this expansion element presses against the anode (3) in such a way that the at least one first contact surface (300a) of the anode (3) is moved out of the first position into the second position.
6. An electrode pin according to any one of claims 4 through 5, **characterized in that** the cathode (4) surrounds at least sections of the support (2) and the anode (3).
7. An electrode pin according to any one of the preceding claims, **characterized in that** the cathode (4) and the anode (3) have an electrical insulation (5) arranged between them.
8. An electrode pin according to any one of claims 5 through 7, **characterized in that** the at least one expansion element (20) is formed at a first end of the support (2).
9. An electrode pin according to claim 2 and according to any one of claims 5 through 8, **characterized in that** the at least one expansion element (20) is configured so that as the support (2) moves with respect to the anode (3) along the longitudinal axis (x') of the electrode pin (1), this expansion element presses against multiple first sections (300) of the anode (3), the at least one first contact surface (300a) being formed by one of the first sections (300), and the other first sections (300) forming other first contact surfaces (300a) of the anode (3), each of which is movable out of a first position into a second position, the respective first contact surface (300a) being moved out of its first position into its second position when the at least one expansion element (20) of the support (2) presses against the respective first section (300).
10. An electrode pin according to claim 9, **characterized in that** the first sections (300) of the anode (3) are formed by a tubular end section (30) of the anode (3), this

tubular end section (30) extending along the longitudinal axis (x') of the electrode pin (1), the first sections (300) being separated from one another by slots (31) of the end section (30), and the respective slot (31) extending along the longitudinal axis (x') of the tubular end section (30) of the anode (3).

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11. An electrode pin according to any one of claims 5 through 10, **characterized in that** the support (2) has another expansion element (21) that is configured to press against multiple second sections (301) of the anode (3) as the support (2) moves with respect to the anode (3) along the longitudinal axis (x') of the electrode pin (1), every second section (301) forming a second contact surface (301a) of the anode (3) to make contact with the inner surface (100a) of the component (10), the respective second contact surface (301a) being moved out of a first position into a second position when the other expansion element (21) of the support (2) presses against the respective second section (301) of the anode (3).

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12. An electrode pin according to claim 11, **characterized in that** the cathode (4) has a first section (40) and an adjacent second section (41), which are separated from one another by a gap (8), the second contact surfaces (301a) of the anode (3) being configured so that in the respective second position they protrude out of the gap (8) in a radial direction (R) of the electrode pin (1), beyond the two sections (40, 41) of the cathode (4), to make contact with the inner surface (100a) of the component (10), when the electrode pin (1) is arranged in the interior (101) of the component (10).

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13. An electrode pin according to claim 12, **characterized in that** the first section (40) of the cathode (4) has an electrically conductive connection with a core (42) of the cathode (4), this core running within the support (2) along the longitudinal axis (x') of the electrode pin (1), and, in particular, the second section (41) of the electrode (4) being connected with the core (42) through a conductor (43) that runs, in particular, outside of the support (2).

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14. An electrode pin according to any one of claims 4 through 13, **characterized in that** the electrode pin has a spring element (6) that is configured to apply a force to the

support (2) in such a way that the respective contact surface (300a, 301a) is prestressed in the direction toward the respective second position.

15. A process for electropolishing a component (10) using an electrode pin (1) according to any one of the preceding claims, the component (10) having a supporting structure (100) that extends along a longitudinal axis (x) and encircles the component (10) in a peripheral direction (U), so that the supporting structure (100) surrounds an interior (101) of the component (10), the supporting structure (100) having an inner surface (100a) facing the interior (101), this process comprising the following steps:
- 10 - Inserting the electrode pin (1) into the interior (101) of the component (10) so that the anode (3) and the cathode (4) are arranged in the interior (101) of the component (10);
 - Producing a contact between the inner surface (100a) of the component (10) and the anode (3);
 - 15 - Arranging the component (10) in an electrolyte and applying an electric voltage between the anode (3) and the cathode (4) to electropolish the component (10).

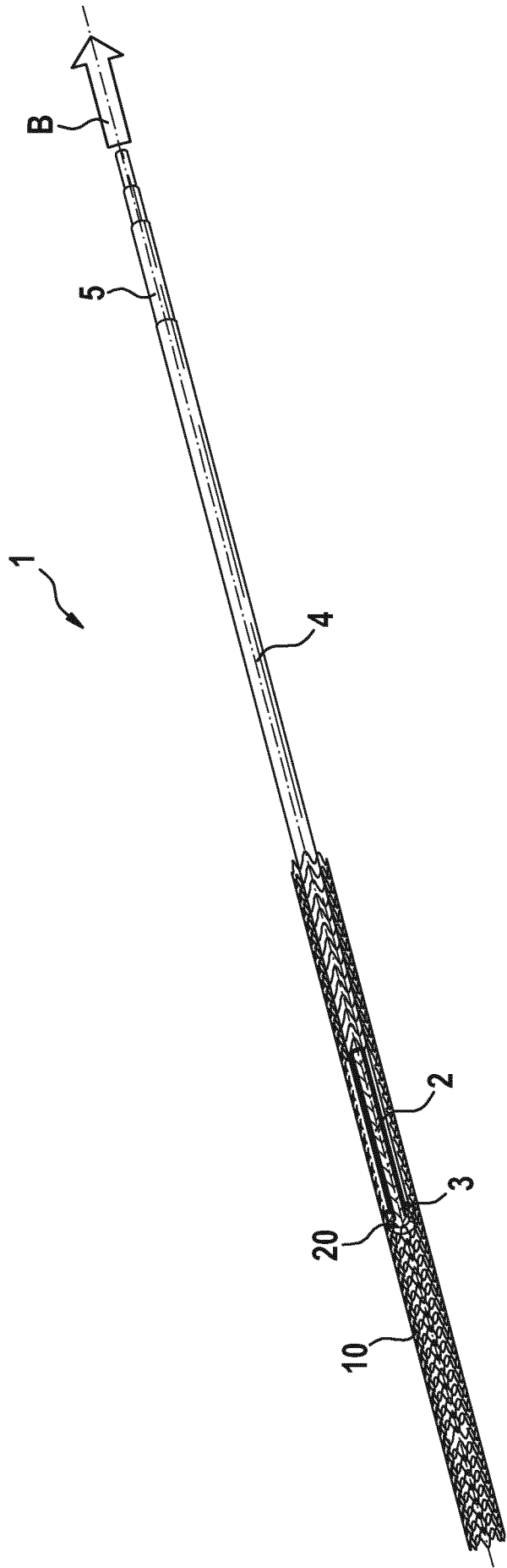


FIG. 1

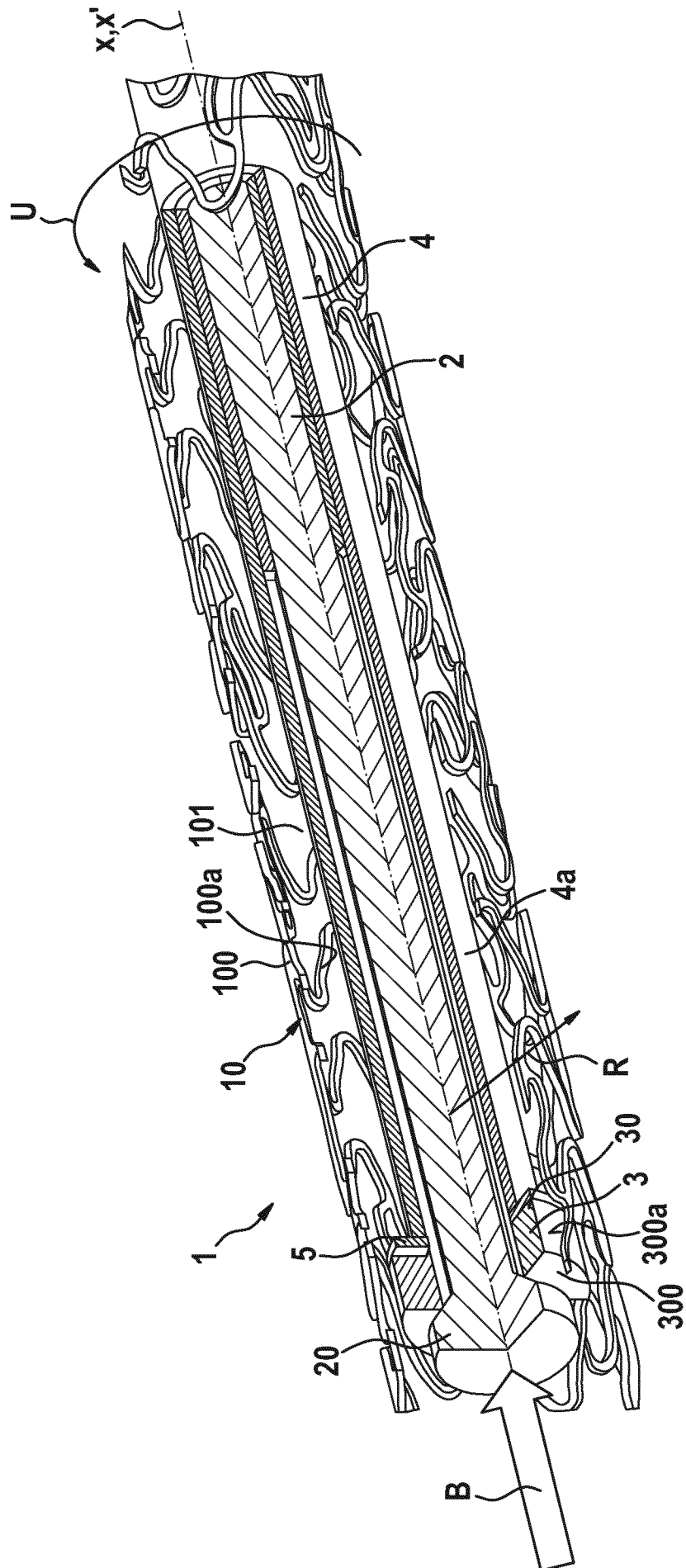


FIG. 2

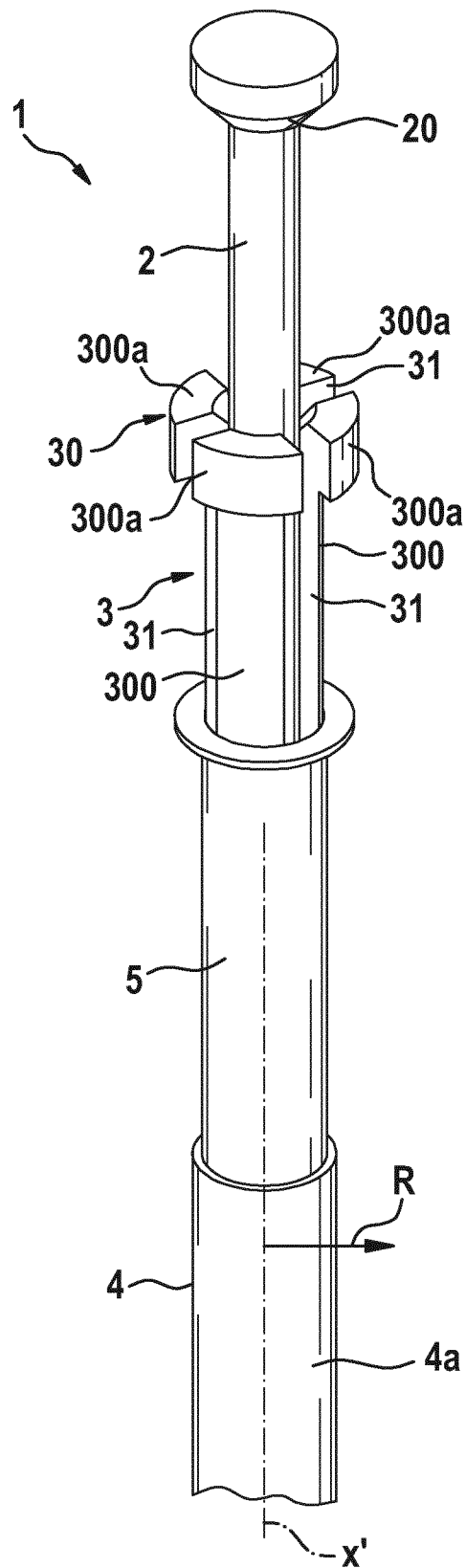


FIG. 3

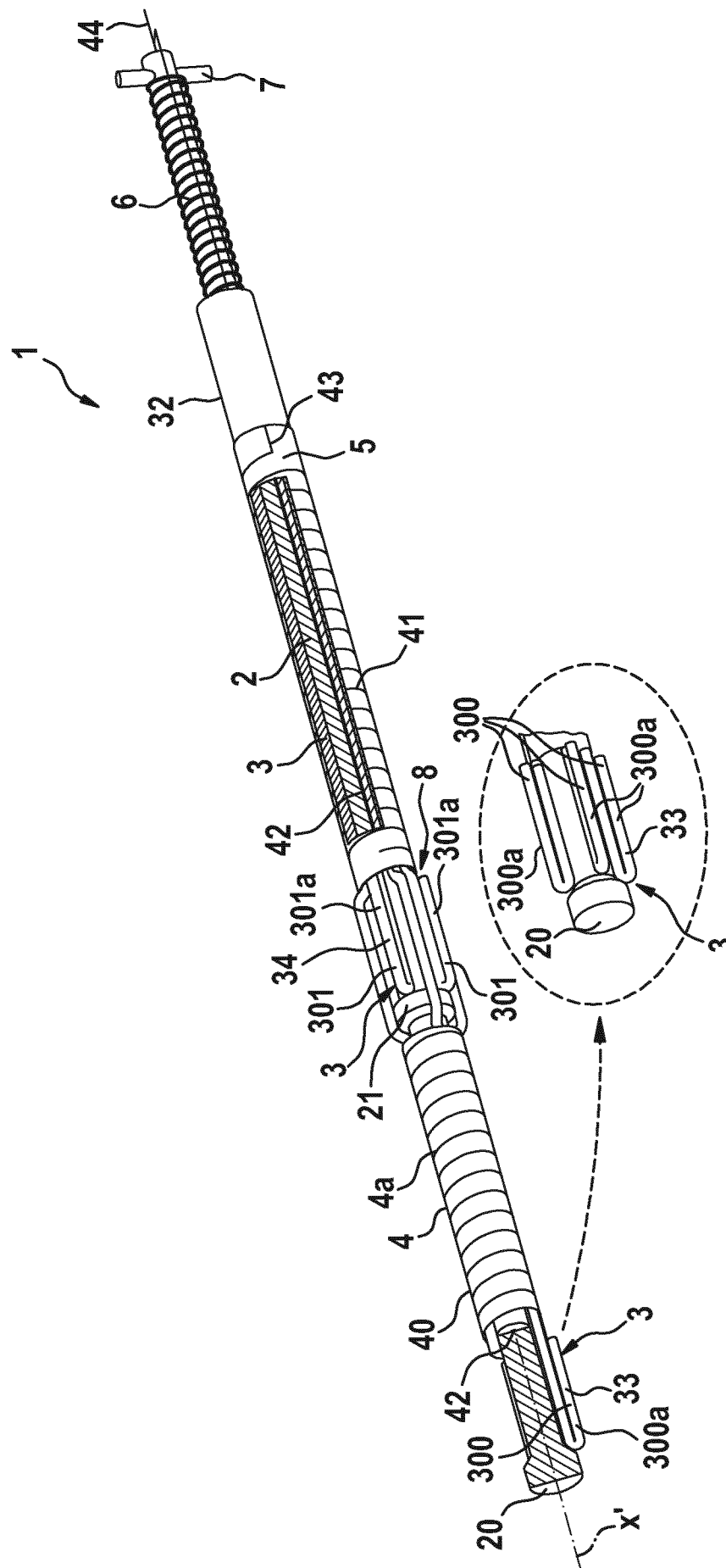


FIG. 4

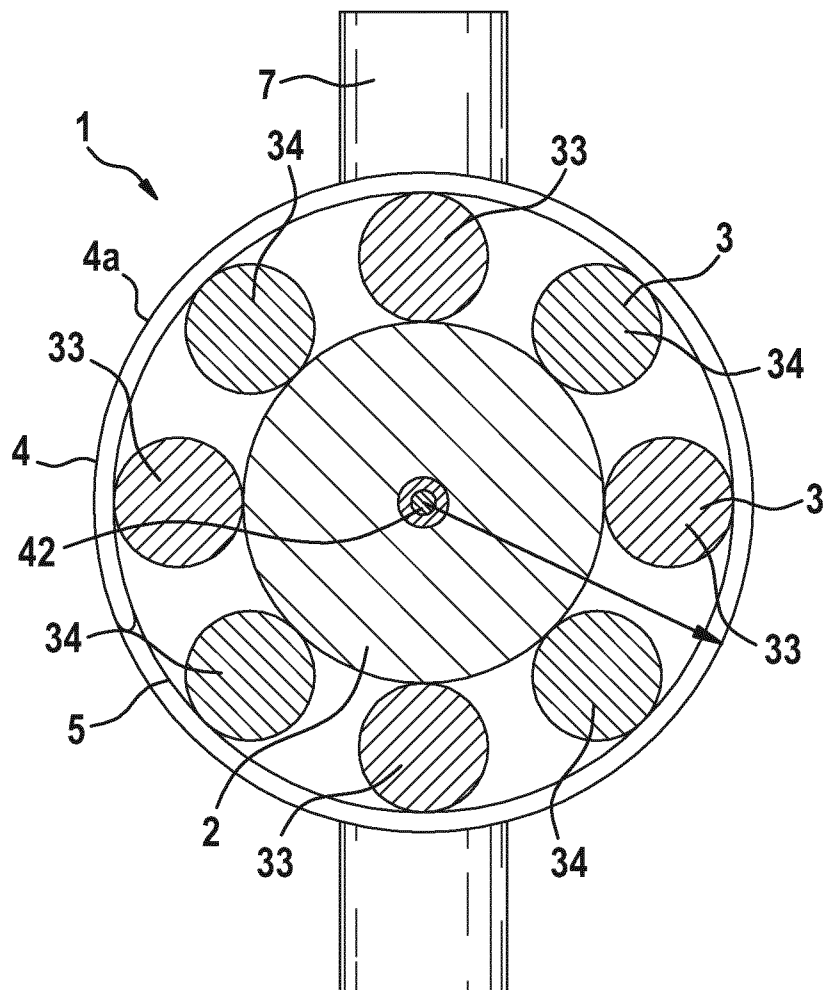


FIG. 5

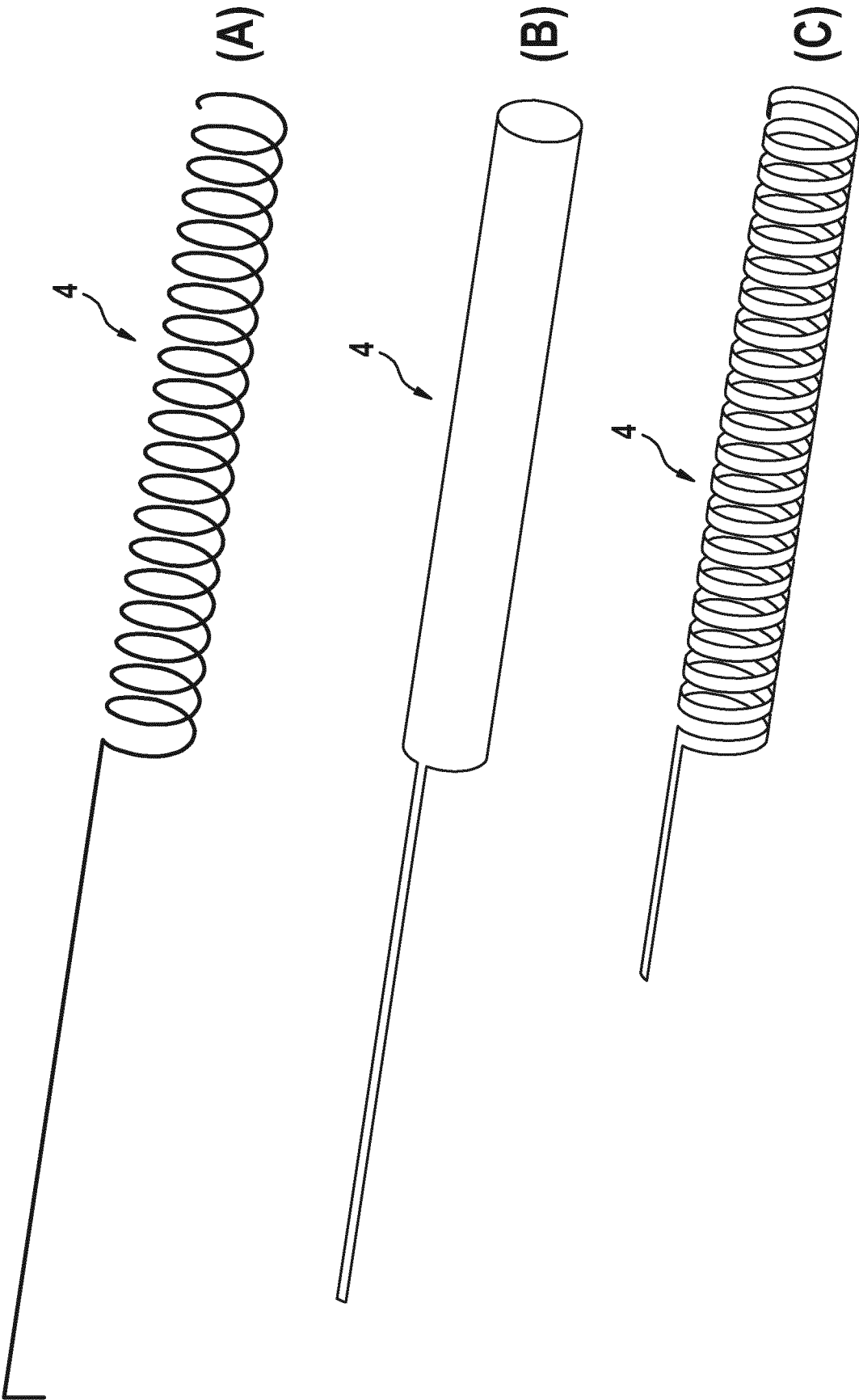


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/080676

A. CLASSIFICATION OF SUBJECT MATTER
INV. C25F7/00 C25F3/18
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C25F

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	EP 2 873 754 A1 (MARUI GALVANIZING CO LTD [JP]) 20 May 2015 (2015-05-20) the whole document -----	1-15
A	US 6 217 726 B1 (LORINCZ THOMAS A [US] ET AL) 17 April 2001 (2001-04-17) the whole document -----	1-15
A	WO 2016/171116 A1 (KANEKA CORP [JP]) 27 October 2016 (2016-10-27) the whole document -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 February 2020

Date of mailing of the international search report

09/03/2020

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/080676

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 2873754	A1	20-05-2015	EP 2873754 A1	20-05-2015
			JP 5807938 B2	10-11-2015
			JP W02014010540 A1	23-06-2016
			US 2015159294 A1	11-06-2015
			WO 2014010540 A1	16-01-2014

US 6217726	B1	17-04-2001	US 6217726 B1	17-04-2001
			US 2001020584 A1	13-09-2001

WO 2016171116	A1	27-10-2016	JP W02016171116 A1	15-02-2018
			WO 2016171116 A1	27-10-2016
