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(54) Title: MEDICAL INSTRUMENT, IN PARTICULAR FOR PERCUTANEOUS SURGICAL/MEDICAL PROCEDURES

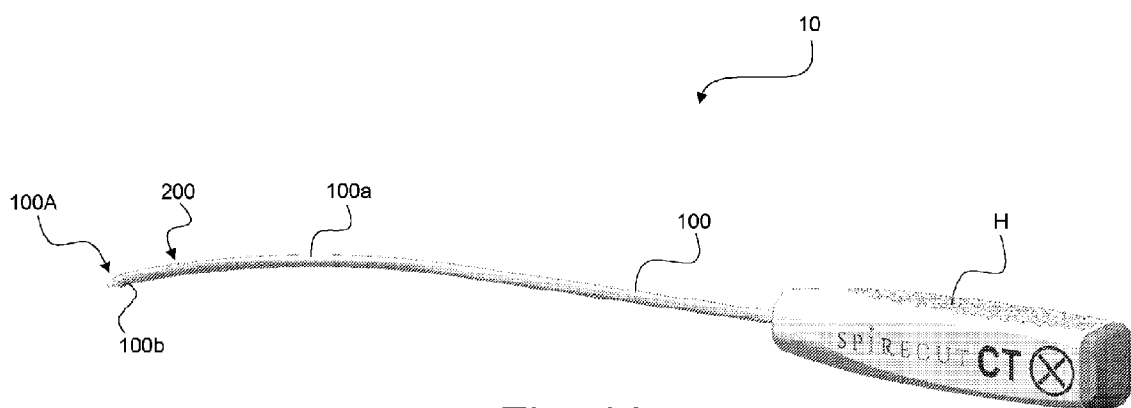


Fig. 1A

(57) Abstract: There is especially described a medical instrument (10), in particular for percutaneous surgical/medical procedures, comprising a handle portion (H) designed to allow handling, orientation and manipulation of the medical instrument (10) by an operator and an elongated rod member (100) secured to the handle portion (H). The elongated rod member (100) extends from the handle portion (H) up to a distal end. At least one portion of the elongated rod member (100), proximate to the distal end, is provided with a marking (200) distinguishable under sonography. The marking (200) is designed as a rotationally asymmetric marking (200A, 200B) configured to allow a location and a rotational orientation of the elongated rod member (100) to be uniquely detectable in sonographic imagery. The marking (200) includes first and second rotationally asymmetric markings (200A, 200B) extending in opposite directions along the elongated rod member (100).



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MEDICAL INSTRUMENT, IN PARTICULAR FOR PERCUTANEOUS SURGICAL/MEDICAL PROCEDURES

TECHNICAL FIELD

The present invention generally relates to a medical instrument as used, in particular, for carrying out percutaneous surgical/medical procedures, especially percutaneous release procedures on upper or lower limbs, such as but not limited to percutaneous carpal tunnel release and percutaneous A1 pulley release. The invention is also applicable to other surgical or medical procedures that are performed under sonography, such as but not limited to biopsies, infiltrations, injections, needling, removal of foreign bodies, tenolysis, tenotomy, tenotomy-lengthening, aponeurotomy, neurolysis, neurotomy and any other surgical release procedure beyond carpal tunnel release and digital/thumb pulley release, such as for the treatment of Dupuytren disease, de Quervain syndrome, tennis elbow, Morton neuroma, and in general in any percutaneous procedure at any anatomical location.

BACKGROUND OF THE INVENTION

Carpal tunnel syndrome (CTS) and trigger finger syndrome (TFS) can conveniently be treated by percutaneous surgical release procedures. These procedures are typically carried out using simple puncture needles or more complex hook knives or push knives. Such medical instruments may also be used for other surgical release procedures on upper or lower limbs, such as for the treatment of Morton's neuroma, tarsal tunnel release, de Quervain syndrome, epicondylalgia, shoulder surgery, and similar release procedures, which list is not meant to be exhaustive.

Various solutions are known in the art, for instance from U.S. Patents Nos. US 5,507,800 A, US 5,029,573 A, and US 8,603,124 B1, but these solutions are not suitable for carrying out percutaneous release procedures.

U.S. Patent Publication No. US 2014/0296974 A1 discloses a system and method of assisting the positioning of medical instruments. More specifically, the system comprises a hollow tubular member, such as a sheath or sleeve,

comprising a rotational indicator element. The system further comprises an elongated rod having a blade (also referred to as PMP blade) on its distal end and comprising a rotational indicator element, which is aligned with the blade orientation, and a stopper close to its proximal end. The blade per se is neither
5 designed nor configured to act as a cutting device to sever tissue. Rather, the blade is used to act as a Papillary Muscle Pointer (PMP) for pointing to, i.e. indicating the location of the space between papillary muscles of a heart ventricle. In that regard, the PMP blade specifically exhibits two opposite, substantially flat surfaces that are parallel to one another so as to allow the PMP blade to be
10 inserted in the space between the papillary muscles. There is no indication or suggestion that the aforementioned elongated rod and blade may be used to carry out percutaneous release procedures.

Percutaneous release procedures can be carried out using simple puncture needles. This solution is not satisfying however since the release
15 procedure is not easy to carry out and potentially dangerous for adjacent structures. A more elaborated solution is disclosed in U.S. Patent No. US 5,782,850 A but the configuration of the relevant medical instrument disclosed therein is still relatively complex and may cause unwanted damage to surrounding tissues and structures, especially during withdrawal of the medical
20 instrument.

International (PCT) Publication No. WO 2020/003263 A1 in the name of the present Applicant, the content of which is incorporated herein by reference in its entirety, discloses various medical instruments for truly percutaneous release procedures, especially such medical instruments that are designed to be used
25 under sonography, i.e. in combination with a sonography probe. According to WO 2020/003263 A1, it is especially contemplated to provide a plurality of markings in the form of embossings along different portions of the elongated rod member of the medical instrument, which markings are designed to be distinguishable under sonography. While the provision of embossings may help
30 identifying the elongated rod member in sonographic imagery and detect a position of the distal end of the elongated rod member, such markings as specifically contemplated in WO 2020/003263 A1 may not necessarily be

sufficient to properly determine the orientation of the elongated rod member and of its tip.

French Patent Publication No. FR 2 272 633 A1 discloses a puncture needle of the type comprising peripheral annular grooves that are distributed
5 along a length of the puncture needle, which puncture needle is in essence rectilinear. These peripheral annular grooves have the effect of dispersing ultrasonic waves and therefore facilitate location of the puncture needle in sonographic imagery. Further solutions aimed at enhancing echogenicity of medical instruments are disclosed in U.S. Patents Nos. US 4,582,061 A,
10 US 4,977, 897 A, US 5,490,521 A, U.S. Patent Publications Nos. US 2012/0150208 A1, US 2014/0265024 A1, US 2016/0074130 A1, US 2020/0069330 A1 and European Patents Nos. EP 1 132 049 B1, EP 2 384 146 B1.

While these solutions provide some ability to enhance echogenicity, they
15 are not entirely satisfactory in that they do not allow to detect the actual rotational orientation of the medical instrument about its axis. There therefore remains a need for an improved solution that enables not only the location but also the rotational orientation of the relevant elongated rod member of the medical instrument to be detected and identified.

20 Referring to the medical instruments disclosed in WO 2020/003263 A1, there also remains a need to provide such a medical instrument which has a better ability to cut through tissue, especially ligaments which are reasonably hard tissues to cut through, while also improving echogenicity of the cutting end of the medical instrument.

SUMMARY OF THE INVENTION

25 A general aim of the invention is to provide an improved medical instrument, in particular for (but not limited to) percutaneous release procedures, especially percutaneous release procedures on upper or lower limbs, such as percutaneous carpal tunnel release or percutaneous digital/thumb pulley release, as well as other percutaneous release procedures used in the treatment of the
30 conditions or syndromes as for instance listed in the introductory part of this description.

More specifically, an aim of the present invention is to improve echogenicity of such medical instruments that especially comprise an elongated rod member extending from a handle portion up to a distal end and being preferably curved and/or bent substantially within a defined plane with a view to
5 facilitate identification and detection of a location as well as of a rotational orientation of the elongated rod member and of its distal end especially.

These aims, and others, are achieved, in accordance with a first aspect of the invention, thanks to the solution defined in claim 1, namely a medical instrument, in particular for percutaneous surgical/medical procedures,
10 comprising a handle portion designed to allow handling, orientation and manipulation of the medical instrument by an operator and an elongated rod member secured to the handle portion, which elongated rod member extends from the handle portion up to a distal end. At least one portion of the elongated rod member, proximate to the distal end, is provided with a marking
15 distinguishable under sonography. According to this first aspect of the invention, the marking is designed as a rotationally asymmetric marking configured to allow a location and a rotational orientation of the elongated rod member to be uniquely detectable in sonographic imagery. Furthermore, the marking includes first and second rotationally asymmetric markings extending in opposite directions along
20 the elongated rod member.

In accordance with a particularly preferred embodiment, the first and second rotationally asymmetric markings are first and second rotationally asymmetric grooves formed along a periphery of the elongated rod member.

Advantageously, each rotationally asymmetric groove may consist of one
25 or more helical turns. Preferably, the first and second rotationally asymmetric grooves have opposite helix orientations, which particularly facilitates detectability in sonographic imagery and therefore determination of the actual rotational orientation of the medical instrument. Even more specifically, a distance separating a proximal end of the first rotationally asymmetric groove and
30 a proximal end of the second rotationally asymmetric groove may be substantially equal to a pitch of each rotationally asymmetric groove. Said distance and said pitch are preferably of approximately 2 mm.

In accordance with a further advantageous embodiment, each rotationally asymmetric groove may exhibit a width comprised between 0.5 mm and 1 mm and/or a depth comprised between 0.1 mm and 0.2 mm.

Furthermore, in one embodiment variant, a depth of each rotationally asymmetric groove may be constant. In another embodiment variant, a depth of each rotationally asymmetric groove may vary along a length of the rotationally asymmetric groove, which other embodiment variant is particularly advantageous in that a further variable enhancing and modulating echogenicity is introduced.

As a further refinement, one may additionally contemplate that an inner surface of each rotationally asymmetric groove be structured to further enhance echogenicity.

In accordance with another embodiment of the invention, the elongated rod member is curved and/or bent substantially within a defined plane and the first and second rotationally asymmetric markings are positioned along a curved section or along an angled section of the elongated rod member proximate to the distal end of the elongated rod member. In this latter context, the distal end of the elongated rod member preferably comprises a tapered end configured to act as a cutting device to sever tissue, the tapered end being at least partly delineated by first and second opposite surfaces, namely a first, bevelled surface that is inclined with respect to the defined plane and a second, recessed surface that is substantially parallel to the defined plane. In effect, this latter aspect forms another aspect of the invention that is potentially applicable independently of the aforementioned first aspect of the invention.

In other words, in accordance with a second aspect of the invention, as defined in independent claim 14, there is further provided a medical instrument for percutaneous release procedures, comprising a handle portion designed to allow handling, orientation and manipulation of the medical instrument by an operator and an elongated rod member secured to the handle portion, which elongated rod member extends from the handle portion up to a distal end and is curved and/or bent substantially within a defined plane. The distal end of the elongated rod member comprises a tapered end configured to act as a cutting device to sever tissue. According to this second aspect of the invention, the

tapered end of the elongated rod member is at least partly delineated by first and second opposite surfaces, namely a first, bevelled surface that is inclined with respect to the defined plane and a second, recessed surface that is substantially parallel to the defined plane.

5 This particular configuration of the tapered end of the elongated rod member is especially aimed at enhancing echogenicity of the distal end of the medical instrument, and additional measures are contemplated hereafter with a view to further enhance echogenicity of the distal end of the medical instrument.

10 By way of preference, the tapered end of the elongated rod member may be further delineated by a pair of side surfaces forming side bevels alongside at least a portion of the bevelled surface and of the recessed surface. In this context, an angle of inclination of each side surface with respect to the recessed surface is preferably comprised between 25° and 35°.

15 Furthermore, an angle of inclination of a plane comprising the bevelled surface with respect to the defined plane (and thus with respect to the recessed surface) is comprised between 10° and 15°.

20 In accordance with an advantageous embodiment, a thickness of the tapered end, as measured perpendicularly to the defined plane, does not exceed 1 mm, and/or a width of the tapered end, as measured within the defined plane, does not exceed 2 mm.

25 In accordance with an advantageous variant of the invention, the tapered end includes a longitudinal ridge that projects away from the recessed surface. The presence of this longitudinal ridge is helpful in that echogenicity of the tapered end is improved as a result. By way of preference, a height of the longitudinal ridge, as measured perpendicularly to the defined plane, does not exceed 0.5 mm. Furthermore, a leading edge of the longitudinal ridge may be tapered and may be stopping short of a leading edge of the tapered end with a view to further minimize interference during insertion of the medical instrument in the area to be treated and prevent any impact on the cutting properties and sharpness of the leading edge of the tapered end.

30 Preferably, the elongated rod member extends along a generatrix and a lateral breadth of the elongated rod member as measured at any point along the

generatrix, up to and including the distal end of the elongated rod member, does not exceed 2 mm.

Furthermore, a cross-sectional area of the elongated rod member preferably does not exceed 2.5 mm².

- 5 In addition, the elongated rod member may especially have a substantially circular or polygonal cross-section, upstream of the distal end of the elongated rod member, whose lateral breadth does not exceed 1.5 mm.

Further advantageous embodiments of the invention are discussed below.

BRIEF DESCRIPTION OF THE DRAWINGS

- Other features and advantages of the present invention will appear more clearly from reading the following detailed description of embodiments of the invention which are presented solely by way of non-restrictive examples and illustrated by the attached drawings in which:

- Figure 1A is a perspective view of a medical instrument in accordance with a first embodiment of the invention, which medical instrument is particularly suited for percutaneous carpal tunnel release in the treatment of the carpal tunnel syndrome;

Figure 1B is a perspective view of the medical instrument of Figure 1A shown from a different viewing angle;

- Figures 1C and 1D are enlarged views of the distal end (or tip) of the elongated rod member of the medical instrument shown in Figures 1A and 1B, respectively;

- Figure 2A is a side view of an elongated rod member of a medical instrument in accordance with a variant of the first embodiment shown in Figures 1A-D, as shown perpendicularly to the defined plane in which the elongated rod member extends;

Figure 2B is an enlarged view of the distal end of the elongated rod member of Figure 2A showing a tapered end thereof in greater detail;

Figure 2C is an enlarged side view of the tapered end of the elongated rod member of Figures 2A-B;

- 30 Figure 2D is a cross-sectional view of the tapered end shown in Figures 2B-C as taken along sectional plane A-A identified in Figure 2B;

Figure 2E is an enlarged, partially cut-out view of part of the marking provided along a portion of the elongated rod member of Figure 2A, proximate to the distal end thereof

Figure 3A is an enlarged side view of the tapered end of the elongated rod member of a medical instrument in accordance with a further variant of the embodiments shown in Figures 1A-D and 2A-E;

Figure 3B is a cross-sectional view of the tapered end shown in Figures 3A as taken along a same sectional plane as in Figure 2D;

Figure 4 is an enlarged side view of the tapered end of the elongated rod member of a medical instrument in accordance with a variant of the embodiment shown in Figures 3A-B;

Figure 5A is a perspective view of a medical instrument in accordance with a second embodiment of the invention, which medical instrument is particularly suited for percutaneous A1 pulley release in the treatment of the trigger finger syndrome;

Figure 5B is a perspective view of the medical instrument of Figure 5A shown from a different viewing angle;

Figures 5C and 5D are enlarged views of the distal end (or tip) of the elongated rod member of the medical instrument shown in Figures 5A and 5B, respectively;

Figure 6A is a side view of an elongated rod member of a medical instrument in accordance with a variant of the second embodiment shown in Figures 5A-D, as shown perpendicularly to the defined plane in which the elongated rod member extends;

Figure 6B is an enlarged view of the distal end of the elongated rod member of Figure 6A showing a tapered end thereof in greater detail;

Figure 6C is an enlarged side view of the tapered end of the elongated rod member of Figures 6A-B;

Figure 6D is a cross-sectional view of the tapered end shown in Figures 6B-C as taken along sectional plane B-B identified in Figure 6B;

Figure 6E is an enlarged view of part of the marking provided along a portion of the elongated rod member of Figure 6A, proximate to the distal end thereof;

Figure 7A is an enlarged side view of the tapered end of the elongated rod member of a medical instrument in accordance with a further variant of the
5 embodiments shown in Figures 5A-D and 6A-E;

Figure 7B is a cross-sectional view of the tapered end shown in Figures 7A as taken along a same sectional plane as in Figure 6D;

Figure 8 is an enlarged side view of the tapered end of the elongated rod member of a medical instrument in accordance with a variant of the embodiment
10 shown in Figures 7A-B;

Figure 9A is a photographic illustration of sonographic imagery showing the terminal portion of the elongated member of a medical instrument that is provided with a marking in accordance with the invention, as shown e.g. in
15 Figures 5A-D and 6A-E, which medical instrument is positioned in a first rotational orientation; and

Figures 9B and 9C are photographic illustrations of sonographic imagery showing the terminal portion of the elongated member of the medical instrument of Figure 9A positioned in two further rotational orientations.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

20 The present invention will be described in relation to various illustrative embodiments. It shall be understood that the scope of the invention encompasses all combinations and sub-combinations of the features of the medical instruments disclosed herein as defined in the appended claims.

As described herein, when two or more parts or components are described
25 as being connected, attached, secured or coupled to one another, they can be so connected, attached, secured or coupled directly to each other or through one or more intermediary parts.

Referring to Figures 1A-D, there is shown a first embodiment of a medical instrument, designated by reference numeral 10, in accordance with the present
30 invention, which first embodiment is particularly suited for percutaneous carpal

tunnel release in the treatment of the carpal tunnel syndrome (CTS). Variants of this first embodiment are further shown in Figures 2A-E, 3A-B and 4.

Referring to Figures 5A-D, there is shown another embodiment of a medical instrument, designated by reference numeral 10*, in accordance with the present invention, which other embodiment is particularly suited for percutaneous A1 pulley release in the treatment of the trigger finger syndrome (TFS). Variants of this second embodiment are further shown in Figures 6A-E, 7A-B and 8.

The medical instruments 10, 10* shown in the Figures are specifically designed to be used under sonography, i.e. in a combination with a sonography probe.

All embodiments share a number of common features, including a handle portion H, resp. H*, (not shown in Figures 2A-E to 4 and 6A-E to 8) designed to allow handling, orientation and manipulation of the medical instrument by an operator, such as a surgeon or physician (including e.g. a radiologist or rheumatologist), and an elongated rod member 100, resp. 100*, secured to the handle portion H, resp. H*, and extending therefrom up to a distal end. The elongated rod member 100, resp. 100* is curved and/or bent substantially within a defined plane, designated by reference P0.

As shown in the illustrations, a first, rectilinear section of the elongated rod member 100, resp. 100*, extends substantially along a first direction within the defined plane P0 away from the handle portion H, resp. H*, namely parallel to the longitudinal axis of the handle portion H, resp. H*. The remainder of the elongated rod member 100, resp. 100*, downstream of the first rectilinear section, is curved and/or bent within the defined plane P0. Reference sign GX in Figures 2A, 2B, 6A and 6B designates a generatrix along which the elongated rod member 100, resp. 100*, extends. The free end of the first, rectilinear section of the elongated rod member 100, resp. 100* (see Figures 2A and 6A) is here bent at 90° to provide better retention within the handle portion H, resp. H*.

Furthermore, as this will be described in greater detail hereafter, the distal end of the elongated rod member 100, resp. 100*, comprises a tapered end 100A, 100A', 100A'', 100A*, 100A** resp. 100A***, configured to act as a cutting device

to sever tissue. The particular configuration of this tapered end 100A, 100A', 100A'', 100A*, 100A** resp. 100A***, forms one aspect of the present invention.

Referring more specifically to the embodiments of Figures 1A-D and 2A-E (which considerations apply to the variants shown in Figures 3A-B and 4), the
5 elongated rod member 100 includes a curved section 100a extending over an angle α_1 (see Figure 2A which applies by analogy to the embodiments of Figures 1A-D, 3A-B and 4) that exceeds 60° . A radius of curvature R1 of the curved section 100a is of approximately 30 to 45 mm. By way of illustration, angle α_1 and radius of curvature R1 can be selected to equal approximately 68° and
10 37 mm, respectively, which values are not to be considered as limiting the scope of the invention. In this instance, it may be appreciated that the terminal section 100b of the elongated rod member 100 (including the aforementioned tapered end 100A, 100A', resp. 100A'') is bent with respect to the end of the curved section 100a by an angle α_2 of approximately 20° (here 22°), so that the terminal
15 section 100b extends substantially perpendicularly to the direction in which the first rectilinear section of the elongated rod member 100 extends (i.e. substantially perpendicularly to the longitudinal axis of the handle portion H).

By way of further illustration, an overall length L1 of the elongated rod member 100, as measured in the longitudinal direction (see Figure 2A) can be of
20 approximately 125 mm. A length L2 of the first rectilinear section of the elongated rod member 100 can be of approximately 90 mm and a length L3 of the terminal section 100b of the elongated rod member 100 (including the tapered end 100A, 100A', resp. 100A'') can be of approximately 4 mm. In the illustrated example, a length L0 of the bent portion at the free end of the first, rectilinear section of the
25 elongated rod member 100 is of approximately 4 mm.

By way of preference, a lateral breadth of the elongated rod member 100 as measured at any point along the generatrix GX, up to and including the distal end of the elongated rod member 100, does not exceed 2 mm. More specifically, in the illustrated examples, the elongated rod member 100 preferably has a
30 substantially circular cross-section, upstream of the distal end of the elongated rod member 100, whose diameter D does not exceed 1.5 mm. Other cross-sectional shapes could however be contemplated, including triangular, square,

rectangular, trapezoidal, hexagonal, and other polygonal cross-sections whose lateral breadth likewise preferably does not exceed 1.5 mm. A polygonal cross-section may be of advantage over a circular cross-section in that echogenicity is further improved.

5 More generally, a cross-sectional area of the elongated rod member 100 (including the tapered end 100A, 100A', resp. 100A'') preferably does not exceed 2.5 mm². In other words, the elongated rod member 100 is of a particularly thin configuration, alike that of a puncture needle, which favours insertion and withdrawal of the medical instrument 10 without causing damage to surrounding
10 tissues or structures.

 The illustrated arc shape allows the medical instrument 10 to be introduced under or against the structure to be released into the sonography field without any interference between the handle portion of the instrument and the sonography probe all over the procedure. This shape also allows withdrawal of
15 the medical instrument without risk of causing involuntary lesion to surrounding soft tissue.

 Referring to the embodiments of Figures 5A-D and 6A-E (which considerations apply to the variants shown in Figures 7A-B and 8), the elongated rod member 100* exhibits an angled configuration including three curved sections
20 and three substantially rectilinear sections 100a*, 100b*, 100c* that are angled with respect to the first, rectilinear section of the elongated rod member 100*. In the illustrated example, each curved section has an angle α_1^* , α_2^* , α_3^* , of approximately 35°, meaning that angled sections 100a*, 100b*, 100c* are angled at approximately 35°, 70° and 105°, respectively, with respect to the first,
25 rectilinear section of the elongated rod member 100*. In other words, the terminal, angled section 100c* extends approximately perpendicularly, albeit a slightly rearward direction, with respect to the direction in which the first rectilinear section of the elongated rod member 100* extends (i.e. substantially perpendicularly to the longitudinal axis of the handle portion H*).

30 By way of further illustration, an overall length L1* of the elongated rod member 100*, as measured in the longitudinal direction (see Figure 6A) can be of approximately 90 mm. A length L2* of the first rectilinear section of the

elongated rod member 100* can be of approximately 60 mm, while a length L3*, resp. L4* of angled sections 100a*, resp. 100b*, can be of approximately 20 mm. A length L5* of the terminal section 100c* of the elongated rod member 100* (including the tapered end 100A*, 100A**, resp. 100A***) can be of approximately 4 mm. In the illustrated example, a length L0* of the bent portion at the free end of the first, rectilinear section of the elongated rod member 100* is of approximately 4 mm.

By way of preference, a lateral breadth of the elongated rod member 100* as measured at any point along the generatrix GX, up to and including the distal end of the elongated rod member 100*, likewise does not exceed 2 mm. More specifically, in the illustrated examples, the elongated rod member 100* similarly has a substantially circular cross-section, upstream of the distal end of the elongated rod member 100*, whose diameter D* does not exceed 1.5 mm. Other cross-sectional shapes could likewise be contemplated, including polygonal cross-sections.

More generally, a cross-sectional area of the elongated rod member 100* (including the tapered end 100A*, 100A**, resp. 100A***) does not exceed 2.5 mm². In other words, the elongated rod member 100* is again of a particularly thin configuration, alike that of a puncture needle, which favours insertion and withdrawal of the medical instrument 10* without causing damage to surrounding tissues or structures.

The illustrated angled shape similarly allows the medical instrument 10* to be introduced under or against the structure to be released into the sonography field without any interference between the handle portion of the instrument and the sonography probe all over the procedure. This shape likewise also allows withdrawal of the medical instrument without risk of causing involuntary lesion to surrounding soft tissue.

One will therefore appreciate that parts of the curved or bent portions of the elongated rod member 100, resp. 100*, can especially be exploited during surgery as a fulcrum to facilitate severance of the desired tissue. In effect, parts of the curved or bent portions can suitably be used to bear on underlying tissues or onto an additional instrument inserted for that very purpose, thereby providing

support for manipulation of the medical instrument during the severance operation.

It will also be appreciated that the medical instrument of the invention advantageously exhibits a minimal cross-section that in essence corresponds to the cross-section of the elongated rod member 100, resp. 100*, which greatly facilitates penetration through the tissues, with minimal interference both during insertion of the medical instrument in the area to be treated and during withdrawal thereof. Furthermore, the limited cross-sectional area of the elongated member (which by way of preference does not exceed 2.5 mm² as mentioned above) is such that surgery can be carried out in a truly percutaneous manner without necessitating any incision at the point of entry of the medical instrument, but merely a puncture, which therefore heals without any noticeable scar for the patient, much like after an intravenous infusion.

In accordance with an important aspect of the invention, as shown in Figures 1A-D, 2A, 2E, 5A-D, 6A and 6E, at least one portion of the elongated rod member 100, resp. 100*, proximate to the distal end, is provided with a marking 200, resp. 200*, that is distinguishable under sonography. More specifically, this marking 200, resp. 200*, is designed as a rotationally asymmetric marking configured to allow a location and a rotational orientation of the elongated rod member to be uniquely detectable in sonographic imagery. In effect, the marking 200, resp. 200*, is such that it produces a specific and particular echo in sonography imagery depending on the actual rotational orientation of the medical instrument in the sonographic field.

Referring to the embodiments of Figures 1A-D to 2A-E (which considerations likewise apply to the variants shown in Figures 3A-B and 4), the marking 200 is preferably positioned on the curved section 100a such that a central portion of the marking 200 is located at an angle β of approximately 45° with respect to the terminal section 100b of the elongated rod member 100, as shown in Figure 2A. Referring to the embodiments of Figures 5A-D to 6A-E (which considerations likewise apply to the variants shown in Figures 7A-B and 8), the marking 200* is preferably positioned on the second angled section 100b* so that a distance d* between the distal end of the second angled section 100b*

and the marking 200* is of approximately 4 mm, as shown in Figure 6A. In this way, the marking 200, resp. 200*, will be visible in the sonographic imagery, along with the distal end of the elongated rod member 100, resp. 100*, thus allowing a location as well as a rotational orientation of the tip of the elongated rod member, and thus of the tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A***, to be identifiable and detectable.

Such detection can be performed visually by a trained operator, or even automatically or semi-automatically, using dedicated image processing software to properly identify relevant echoes/markers in the sonographic imagery. In that context, it could in particular be contemplated to use the relevant marking 200, resp. 200*, to automatically locate and detect the orientation of the medical instrument in the sonographic imagery, and provide visual assistance to the operator. This visual assistance could in particular include the superimposition in real time of a virtual representation of the medical instrument on the sonographic imagery, if need be.

As shown in greater detail in Figures 1C-D and 5C-D, the marking 200, resp. 200*, includes two rotationally asymmetric markings that are preferably configured as grooves formed along a periphery of the elongated rod member 100, resp. 100*. As shown, the two rotationally asymmetric grooves 200A, 200B, resp. 200A*, 200B*, extend in opposite directions along the elongated rod member 100, resp. 100*. In the illustrated example, these grooves 200A, 200B, resp. 200A*, 200B*, are here in effect the mirrored image of one another.

More specifically, each asymmetric groove 200A, 200B, resp. 200A*, 200B*, consists of one helical turn, namely a single spire with an angle of development of approximately 360°. More than one helical turn could however be contemplated. Furthermore, in the illustrated example, the first and second rotationally asymmetric grooves 200A, 200B, resp. 200A*, 200B*, advantageously have opposite helix orientations, with the first groove 200A, resp. 200A*, extending away from the tapered end 100A, resp. 100A*, in the form of a left-handed (i.e. counter-clockwise) helix, while the second groove 200B, resp. 200B*, extends toward to the tapered end 100A, resp. 100A*, in the form of a right-handed (i.e. clockwise) helix. By way of preference, a distance D_s

separating a proximal end of the first groove 200A, resp. 200A*, and a proximal end of the second groove 200B, resp. 200B*, is substantially equal to a pitch P_s of each groove. In the illustrated examples, the distance D_s and pitch P_s are of approximately 2 mm.

5 Looking at the illustrated embodiments, especially Figures 1C-D and 5C-D, one will appreciate and understand that, depending on the actual rotational orientation of the tip of the elongated rod member 100, resp. 100*, with respect to the sonography probe, the grooves 200A, 200B, resp. 200A*, 200B*, will present two to four indentations to incoming ultrasonic waves produced by the
10 sonography probe, thus producing different echoes, moreover with a unique and therefore clearly distinguishable spacing and/or distribution.

Figure 9A is a photographic illustration of sonographic imagery showing the terminal portion of the elongated member of a medical instrument that is provided with a marking in accordance with the invention, as shown e.g. in
15 Figures 5A-D and 6A-E. Visible on the surface of the elongated rod member depicted in Figure 9A are four indentations (designated by continuous arrows) where the relevant grooves 200A*, 200B* are provided, as well as related “shadows” (designated by dashed arrows) in the sonographic imagery that betray the presence of the relevant grooves. These echoes and markers can be
20 exploited to determine the actual rotational orientation of the medical instrument about its axis. Also visible in Figure 9A is the echo generated by the tapered end of the medical instrument (designated by a dotted arrow), which echo is further enhanced by the presence of a longitudinal ridge as discussed in greater detail hereafter.

25 Figure 9B is a photographic illustration showing the terminal portion of the elongated member of the medical instrument of Figure 9A positioned in a different rotational orientation such that only two indentations (designated by continuous arrows) remain visible on the surface of the elongated rod member. Due to the opposite helix orientations of the relevant grooves 200A*, 200B*, the spacing
30 between these indentations varies as a function of the rotational orientation of the medical instrument, as highlighted by Figure 9C which shows the medical instrument positioned in a further different rotational orientation.

Each rotationally asymmetric groove 200A, 200B, resp. 200A*, 200B*, exhibits a width w_0 (see Figures 2A and 2E), resp. w_0^* (see Figure 6E) that is preferably comprised between 0.5 mm and 1 mm. In the illustrated example, such width w_0 , w_0^* is of approximately 0.6 mm to 0.7 mm. A depth of each groove is
5 comparatively smaller and is advantageously comprised between 0.1 mm and 0.2 mm (see Figures 2E and 6E where such depth is designated by reference sign d_0 , resp. d_0^*).

In one embodiment, the depth of each rotationally asymmetric groove 200A, 200B, resp. 200A*, 200B*, may be constant. In another embodiment, the
10 depth of each rotationally asymmetric groove 200A, 200B, resp. 200A*, 200B*, may advantageously vary along a length of the groove, which adds a further variable enhancing differentiated echogenicity depending on the actual rotational orientation of the marking in the sonographic field.

A further measure to enhance echogenicity may consist in structuring an
15 inner surface of each rotationally asymmetric groove 200A, 200B, resp. 200A*, 200B*, as this favours dispersion of the ultrasonic waves hitting the inner surface of the grooves. Interestingly, structuring of the inner surface of each rotationally asymmetric groove 200A, 200B, resp. 200A*, 200B* may also favourably impact haptic feedback as the grooves 200A, 200B, resp. 200A*, 200B* may have a
20 tendency to slightly cling on surrounding soft tissue, which also helps the operator to “feel” where the distal end of the medical instrument is located.

One may further play with the particular profile of each groove 200A, 200B, resp. 200A*, 200B* to cause distinctive dispersion of the ultrasonic waves hitting the inner surface of the grooves. Specifically, the groove profile could be
25 essentially cylindrical or exhibit some asymmetry.

One will appreciate and understand that other marking configurations could be contemplated as long as the marking as a whole retains a rotationally asymmetric configuration. For instance, in the illustrated example, one of the two grooves 200A, 200B, resp. 200A*, 200B*, could perfectly be replaced by a simple
30 annular groove, as the marking 200, resp. 200*, as a whole would still retain its rotational asymmetry. This being said, the solution illustrated in the Figures is favoured in that it is more easily identifiable in sonographic imagery.

A further aspect of the invention, applicable independently of the use of the aforementioned marking, will now be described with particular reference to Figures 1C-D, 2B-D, 3A-B, 4, 5C-D, 6B-D, 7A-B and 8, namely in relation to the particular shape of the tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A***, of the elongated rod member 100, resp. 100*. As illustrated, such tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A*** is at least partly delineated by first and second opposite surfaces SA, SB, resp. SA*, SB*, namely a first, bevelled surface SA, resp. SA*, that is inclined with respect to the defined plane P0 and a second, recessed surface SB, resp. SB*, that is substantially parallel to the defined plane P0. By way of preference, as shown, the tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A***, is further delineated by a pair of side surfaces SC, resp. SC*, forming side bevels (see especially Figures 1C, 2B-D, 3A-B, 4, 5C, 6B-D, 7A-B and 8) alongside at least a portion of the bevelled surface SA, resp. SA*, and of the recessed surface SB, resp. SB*. In this way, particularly sharp cutting edges can be achieved at the leading and side edges of the resulting tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A***.

Referring more specifically to Figures 2B-D (which considerations apply by analogy to the variants shown in Figures 3A-B and 4), a length LA of the bevelled surface SA and a length LB of the tapered tip of the elongated rod member 100, as measured within defined plane P0 (see Figure 2B) are of approximately 1.5 mm and 2.6 mm, respectively, in the illustrated example. A width w of the tapered end 100A, 100A', resp. 100A'', as likewise measured within the defined plane P0, is here, by way of illustration, of approximately 1.8 mm, i.e. slightly larger than the relevant diameter D of the elongated rod member 100. Ideally, such width w should not exceed 2 mm. A length LC of the recessed surface SB (and of the tapered end 100A, 100A', resp. 100A'' as such) is of approximately 1.8 mm in the illustrated example, while a thickness t of the tapered end 100A, 100A', resp. 100A'', as measured perpendicularly to the defined plane P0, is of approximately 0.3 mm (see Figure 2C, 3A and 4).

Figures 3A-B and 4 show variants of the tapered end, designated by reference signs 100A' and 100A'' respectively, of the elongated rod member 100 that are aimed at further improving echogenicity of the tapered end 100A', resp.

100A". The main difference compared to the embodiments shown in Figures 1A-D and 2A-E resides in the fact that the tapered end 100A', resp. 100A" further includes a longitudinal ridge 150', resp. 150" projecting away from the recessed surface SB. A height h of this longitudinal ridge 150', resp. 150" as measured perpendicularly to defined plane P0 preferably does not exceed 0.5 mm. In the illustrated example, the height h is of approximately 0.3 mm. The width of the longitudinal ridge 150', resp. 150" as measured within defined plane P0 is only a fraction (e.g. 10% to 20%) of the width w of the tapered end 100A', resp. 100A".

Tests carried by the Applicant have demonstrated that the provision of the longitudinal ridge 150', resp. 150" further improves echogenicity of the tapered end 100A', resp. 100A" under sonography.

One will appreciate that the presence of the longitudinal ridge 150', resp. 150" on the recessed surface SC causes a local increase of the thickness of the tapered end 100A', resp. 100A" compared to that of the tapered end 100A shown in Figures 1A-D and 2A-E. This being said, the dimensions of the longitudinal ridge 150', resp. 150" are selected such as to minimize any interference during insertion of the medical instrument in the area to be treated. Furthermore, the leading edge of the longitudinal ridge 150', resp. 150" is preferably tapered to further minimize any interference during insertion of the medical instrument. One may also further note that the leading edge of the longitudinal ridge 150', resp. 150" stops short of the leading edge of the tapered end 100A', resp. 100A" in order not to impact the cutting properties and sharpness thereof. Figures 3A and 4 for instance show the provision of a suitable curved section (Figure 3A) or chamfered section (Figure 4) at the leading edge of the longitudinal ridge 150', resp. 150".

Referring more specifically to Figures 6B-D (which considerations apply to the variants shown in Figures 7A-B and 8), a length LA* of the bevelled surface SA* and a length LB* of the tapered tip of the elongated rod member 100*, as measured within defined plane P0 (see Figure 6B) are of approximately 1.5 mm and 2 mm, respectively, in the illustrated example. A width w* of the tapered end 100A*, 100A**, resp. 100A***, as likewise measured within the defined plane P0,

is here, by way of illustration, of approximately 1.25 mm, i.e. slightly smaller than the relevant diameter D^* of the elongated rod member 100*. Ideally, such width w^* should likewise not exceed 2 mm. A length LC^* of the recessed surface SB^* (and of the tapered end 100A*, 100A**, resp. 100A*** as such) is of approximately
5 2 mm in the illustrated example, while a thickness t^* of the tapered end 100A*, 100A**, 100A***, as measured perpendicularly to the defined plane P_0 , is of approximately 0.35 mm (see Figure 6C, 7A and 8).

Figures 7A-B and 8 show variants of the tapered end, designated by reference signs 100A** and 100A*** respectively, of the elongated rod member
10 100* that are aimed at further improving echogenicity of the tapered end 100A**, resp. 100A***. The main difference compared to the embodiments shown in Figures 5A-D and 6A-E resides in the fact that the tapered end 100A**, resp. 100A*** further includes a longitudinal ridge 150**, resp. 150*** projecting away from the recessed surface SB^* . A height h^* of this longitudinal ridge 150**, resp.
15 150*** as measured perpendicularly to defined plane P_0 preferably does not exceed 0.5 mm. In the illustrated example, the height h^* is of approximately 0.3 mm. The width of the longitudinal ridge 150**, resp. 150*** as measured within defined plane P_0 is only a fraction (e.g. 10% to 20%) of the width w^* of the tapered end 100A**, resp. 100A***.

20 Tests carried by the Applicant have again demonstrated that the provision of the longitudinal ridge 150**, resp. 150*** likewise further improves echogenicity of the tapered end 100A**, resp. 100A*** under sonography.

One will again appreciate that the presence of the longitudinal ridge 150**, resp. 150*** on the recessed surface SC^* causes a local increase of the thickness
25 of the tapered end 100A**, resp. 100A*** compared to that of the tapered end 100A* shown in Figures 5A-D and 6A-E. This being said, the dimensions of the longitudinal ridge 150**, resp. 150*** are likewise selected such as to minimize any interference during insertion of the medical instrument in the area to be treated. Furthermore, the leading edge of the longitudinal ridge 150**, resp.
30 150*** is preferably tapered to further minimize any interference during insertion of the medical instrument. One may likewise further note that the leading edge of the longitudinal ridge 150**, resp. 150*** stops short of the leading edge of the

tapered end 100A**, resp. 100A*** in order not to impact the cutting properties and sharpness thereof. Figures 7A and 8 for instance show the provision of a suitable curved section (Figure 7A) or chamfered section (Figure 8) at the leading edge of the longitudinal ridge 150**, resp. 150***.

- 5 An angle of inclination γ , resp. γ^* , of a plane comprising the bevelled surface SA, resp. SA*, with respect to the defined plane P0 (see Figures 2C, 3A, 4, 6C, 7A and 8) is preferably comprised between 10° and 15°, while an angle of inclination δ , resp. δ^* , of side surfaces SC, resp. SC*, with respect to the defined plane P0 (i.e. with respect to the recessed surface SB, resp. SB* – see
10 Figures 2D, 3B, 4D and 7B) is preferably comprised between 25° and 35°.

As this will be appreciated from reading the foregoing description, the medical instrument of the invention is of simple construction and is therefore reasonably economical to produce.

- Advantageously, as illustrated in Figures 1A-B and 5A-B, a visible marking
15 (such as a laser marking) may be provided on the handle portion H, resp. H*, to identify an orientation of the medical instrument when performing surgery, i.e. when the distal end of the medical instrument has been inserted into the area to be treated. This visible marking may in particular be provided on an inner face of the handle portion H, resp. H*, which is oriented in a same direction as the
20 tapered end 100A, 100A', 100A'', 100A*, 100A**, resp. 100A***.

- In the illustrations of Figures 1A-D to 8, one may appreciate that the elongated rod member 100, resp. 100*, is shown as being solid and non-hollow. One may however possibly contemplate to use a hollow rod member instead, which would provide for the ability to detect a possible bleeding through the
25 relevant rod cavity, in case of damage to a blood vessel, and/or to inject a local anaesthetic (or any other drug like steroids or corticosteroids) using a dedicated syringe inserted in the relevant rod cavity. In this case, it is advantageous to further adapt the handle portion H, resp. H*, of the medical instrument to likewise exhibit a corresponding cavity communicating with the rod cavity to e.g. allow
30 injection of the local anaesthetic or even a window allowing observation of a potential reflux of blood.

As already mentioned, the medical instrument of the invention can in particular be used for the purpose of performing percutaneous release procedures on upper or lower limbs, especially under the assistance of a sonography. Other uses could however be contemplated. Furthermore, the provision of the relevant marking discussed above could be contemplated on medical instruments that are not necessarily designed for the purpose of performing percutaneous release procedures, and could be applied to any medical instrument designed for the purpose of carrying out any other surgical or medical procedure, such as e.g. biopsy probes or devices designed to remove foreign bodies.

As regards the relevant surgical procedures for release of the transverse carpal ligament (TCL) using e.g. the medical instrument 10 discussed above or for release of the A1 pulley using e.g. the medical instrument 10* discussed above, such surgical procedures can be carried out in essentially the same manner as already disclosed in International (PCT) Publication No. WO 2020/003263 A1 in the name of the present Applicant.

Various modifications and/or improvements may be made to the above-described embodiments without departing from the scope of the invention as defined by the appended claims. In particular, while embodiments of the invention have been described for the purpose of carrying out percutaneous carpal tunnel release and percutaneous A1 pulley release, the invention is generally applicable to any percutaneous release procedure, be it on upper or lower limbs, or other parts of the body, such as the neck or spine.

With regard to the configuration of the relevant marking that is distinguishable under sonography, one will appreciate that such marking may take any other suitable shape or structure and does not necessarily need to be comprised of two separate grooves formed in the periphery of the elongated rod member as illustrated in the drawings. In effect, the two grooves could be merged into a common groove structure by connecting the proximal ends of the grooves one with the other. The marking may moreover comprise a series of indentations distributed non-uniformly about a portion of the circumference of the elongated rod member or any other suitable structuration or pattern providing rotational

asymmetry to the marking. The machining of grooves however remains a cost-efficient solution to create the desired marking.

Furthermore, while the embodiments of Figures 1A-D to 8 show medical instruments where the tapered end exhibits strictly planar surfaces, the claims shall be construed as encompassing all variants where each surface is substantially planar or exhibits a slight curvature, be it slightly concave or convex. By way of convention, the plane of the relevant surfaces can generally be defined as a plane that best approximates each surface being considered.

In addition, while the cross-section of the longitudinal ridge 150', 150'', 150**, resp. 150*** is shown as being substantially rectangular (which gives very good results), such cross-section could alternatively be V-shaped, trapezoidal, rounded, or exhibit any other suitable shape to enhance echogenicity of the tapered end of the medical instrument.

LIST OF REFERENCE NUMERALS AND SIGNS USED THEREIN

10	medical instrument according to the invention (first embodiment)
15 H	handle portion of medical instrument 10
100	elongated rod member of medical instrument 10 extending within defined plane P0
100a	(single) curved section of elongated rod member 100
100b	terminal section of elongated rod member 100 including tapered end
20 100A, 100A', resp. 100A''	
100A	tapered end of elongated rod member 100 designed to act as a cutting device to severe tissue (Figures 1A-D to 2A-E)
100A'	tapered end of elongated rod member 100 designed to act as a cutting device to severe tissue (variant of Figures 3A-B)
25 100A''	tapered end of elongated rod member 100 designed to act as a cutting device to severe tissue (variant of Figure 4)
150'	longitudinal ridge projecting away from recessed surface SB (variant of Figures 3A-B)
150''	longitudinal ridge projecting away from recessed surface SB (variant of Figure 4)
30 200	rotationally asymmetric marking distinguishable under sonography

	200A	(first) rotationally asymmetric groove formed along a periphery of the elongated rod member 100, proximate to the distal end thereof (e.g. left-handed helix)
5	200B	(second) rotationally asymmetric groove formed along a periphery of the elongated rod member 100, proximate to the distal end thereof (e.g. right-handed helix)
	SA	bevelled surface (first surface) delineating a first side of tapered end 100A, 100A', resp. 100A'' / surface inclined with respect to defined plane P0
10	SB	recessed surface (second surface) delineating a second side of tapered end 100A, 100A', resp. 100A'', opposite the first side / surface substantially parallel to defined plane P0
	SC	pair of side surfaces forming side bevels alongside at least a portion of the bevelled surface SA and of the recessed surface SB
15	D	diameter (or lateral breadth) of elongated rod member 100
	L0	length of bent portion at proximal end of elongated rod member 100
	L1	overall length of elongated rod member 100
	L2	length of (first) rectilinear section of elongated rod member 100
	L3	length of terminal section 100b (including tapered end 100A, 100A', resp. 100A'')
20	LA	approximate length, as measured within defined plane P0, of bevelled surface SA
	LB	approximate length, as measured within defined plane P0, of tapered tip of elongated rod member 100
25	LC	approximate length, as measured within defined plane P0, of recessed surface SB / tapered end 100A, 100A', resp. 100A''
	h	approximate height, as measured perpendicularly to defined plane P0, of longitudinal ridge 150', resp. 150''
	R1	radius of curvature of curved section 100a
30	α_1	angle of curved section 100a
	α_2	angle of bent portion at the junction between curved section 100a and terminal section 100b

	β	angle between terminal section 100b and central portion of marking 200
	γ	angle of inclination of bevelled surface SA with respect to defined plane P0
5	δ	angle of inclination of side surfaces SC with respect to defined plane P0 / recessed surface SB
	w	width of tapered end 100A, 100A', resp. 100A'', as measured within defined plane P0
10	t	thickness of tapered end 100A, as measured perpendicularly to defined plane P0 / thickness of tapered end 100A', resp. 100A'', as measured perpendicularly to defined plane P0 (excluding longitudinal ridge 150', resp. 150'')
	w ₀	width of rotationally asymmetric groove 200A, resp. 200B
	10*	medical instrument according to the invention (second embodiment)
15	H*	handle portion of medical instrument 10*
	100*	elongated rod member of medical instrument 10* extending within defined plane P0
	100a*	(first) angled section of elongated rod member 100*
	100b*	(second) angled section of elongated rod member 100*
20	100c*	(third) angled section of elongated rod member 100* (terminal section of elongated rod member 100* including tapered end 100A*, 100A**, resp. 100A***)
	100A*	tapered end of elongated rod member 100* designed to act as a cutting device to severe tissue
25	100A**	tapered end of elongated rod member 100 designed to act as a cutting device to severe tissue (variant of Figures 7A-B)
	100A***	tapered end of elongated rod member 100 designed to act as a cutting device to severe tissue (variant of Figure 8)
	150**	longitudinal ridge projecting away from recessed surface SB* (variant of Figures 7A-B)
30	150***	longitudinal ridge projecting away from recessed surface SB* (variant of Figure 8)

	200*	rotationally asymmetric marking distinguishable under sonography
	200A*	(first) rotationally asymmetric groove formed along a periphery of the elongated rod member 100*, proximate to the distal end thereof (e.g. left-handed helix)
5	200B*	(second) rotationally asymmetric groove formed along a periphery of the elongated rod member 100*, proximate to the distal end thereof (e.g. right-handed helix)
	SA*	bevelled surface (first surface) delineating a first side of tapered end 100A*, 100A**, resp. 100A*** / surface inclined with respect to defined plane P0
10	SB*	recessed surface (second surface) delineating a second side of tapered end 100A*, 100A**, resp. 100A***, opposite the first side / surface substantially parallel to defined plane P0
	SC*	pair of side surfaces forming side bevels alongside at least a portion of the bevelled surface SA* and of the recessed surface SB*
15	D*	diameter (or lateral breadth) of elongated rod member 100*
	L0*	length of bent portion at proximal end of elongated rod member 100*
	L1*	overall length of elongated rod member 100*
	L2*	length of (first) rectilinear section of elongated rod member 100*
20	L3*	length of (first) angled section 100a*
	L4*	length of (second) angled section 100b*
	L5*	length of (third) angled section 100c*
	LA*	approximate length, as measured within defined plane P0, of bevelled surface SA*
25	LB*	approximate length, as measured within defined plane P0, of tapered tip of elongated rod member 100*
	LC*	approximate length, as measured within defined plane P0, of recessed surface SB*/ tapered end 100A*, 100A**, resp. 100A***
	h*	approximate height, as measured perpendicularly to defined plane P0, of longitudinal ridge 150**, resp. 150***
30	d*	distance between distal end of (second) angled section 100b* and marking 200*

	α_1^*	angle of curved section between (first) rectilinear section of elongated rod member 100* and (first) angled section 100a*
	α_2^*	angle of curved section between (first) angled section 100a* and (second) angled section 100b*
5	α_3^*	angle of curved section between (second) angled section 100b* and (third) angled section 100c*
	γ^*	angle of inclination of bevelled surface SA* with respect to defined plane P0
10	δ^*	angle of inclination of side surfaces SC* with respect to defined plane P0 / recessed surface SB*
	w*	width of tapered end 100A*, 100A**, resp. 100A***, as measured within defined plane P0
	t*	thickness of tapered end 100A*, as measured perpendicularly to defined plane P0 / thickness of tapered end 100A**, resp. 100A***, as measured perpendicularly to defined plane P0 (excluding longitudinal ridge 150**, resp. 150***)
15	w_0^*	width of rotationally asymmetric groove 200A*, resp. 200B*
	d_0^*	depth of rotationally asymmetric groove 200A*, resp. 200B*
20	D_s	distance separating a proximal end of the first rotationally asymmetric groove 200A, resp. 200A*, and a proximal end of the second rotationally asymmetric groove 200B, resp. 200B*
	P_s	pitch of helical turn forming rotationally asymmetric groove 200A, 200B, 200A*, resp. 200B*
25	GX	generatrix along which the elongated rod member 100, resp. 100*, extends
	P0	defined plane in which the elongated rod member 100, resp. 100*, extends

CLAIMS

1. A medical instrument (10; 10*), in particular for percutaneous surgical/medical procedures, comprising a handle portion (H; H*) designed to allow handling, orientation and manipulation of the medical instrument (10; 10*) by an operator and an elongated rod member (100; 100*) secured to the handle
5 portion (H; H*),

wherein the elongated rod member (100; 100*) extends from the handle portion (H; H*) up to a distal end,

wherein at least one portion of the elongated rod member (100; 100*), proximate to the distal end, is provided with a marking (200; 200*) distinguishable
10 under sonography,

wherein the marking (200; 200*) is designed as a rotationally asymmetric marking configured to allow a location and a rotational orientation of the elongated rod member (100; 100*) to be uniquely detectable in sonographic imagery,

15 and wherein the marking (200; 200*) includes first and second rotationally asymmetric markings (200A, 200B; 200A*, 200B*) extending in opposite directions along the elongated rod member (100; 100*).

2. The medical instrument (10; 10*) according to claim 1, wherein the
20 first and second rotationally asymmetric markings are first and second rotationally asymmetric grooves (200A, 200B; 200A*, 200B*) formed along a periphery of the elongated rod member (100; 100*).

3. The medical instrument (10; 10*) according to claim 2, wherein
25 each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) consists of one or more helical turns.

4. The medical instrument (10; 10*) according to claim 3, wherein the
30 first and second rotationally asymmetric grooves (200A, 200B; 200A*, 200B*) have opposite helix orientations.

5 5. The medical instrument (10; 10*) according to claim 3 or 4, wherein a distance (D_s) separating a proximal end of the first rotationally asymmetric groove (200A; 200A*) and a proximal end of the second rotationally asymmetric groove (200B; 200B*) is substantially equal to a pitch (P_s) of each rotationally asymmetric groove (200A, 200B; 200A*, 200B*).

6. The medical instrument (10; 10*) according to claim 5, wherein said distance (D_s) and said pitch (P_s) are of approximately 2 mm.

10 7. The medical instrument (10; 10*) according to any one of claims 2 to 6, wherein each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) exhibits a width (w_0 ; w_0^*) comprised between 0.5 mm and 1 mm.

15 8. The medical instrument (10; 10*) according to any one of claims 2 to 7, wherein each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) exhibits a depth (d_0^*) comprised between 0.1 mm and 0.2 mm.

20 9. The medical instrument (10; 10*) according to any one of claims 2 to 8, wherein a depth of each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) is constant.

25 10. The medical instrument (10; 10*) according to any one of claims 2 to 8, wherein a depth of each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) varies along a length of the rotationally asymmetric groove (200A, 200B; 200A*, 200B*)

11. The medical instrument (10; 10*) according to any one of claims 2 to 10, wherein an inner surface of each rotationally asymmetric groove (200A, 200B; 200A*, 200B*) is structured.

12. The medical instrument (10; 10*) according to any one of the preceding claims, wherein the elongated rod member (100; 100*) is curved and/or bent substantially within a defined plane (P0),

and wherein the first and second rotationally asymmetric markings (200A, 200B; 200A*, 200B*) are positioned along a curved section (100a) or along an angled section (100b*) of the elongated rod member (100; 100*) proximate to the distal end of the elongated rod member (100; 100*).

13. The medical instrument (10; 10*) according to claim 12, wherein the distal end of the elongated rod member (100; 100*) comprises a tapered end (100A; 100A'; 100A''; 100A*; 100A**; 100A***) configured to act as a cutting device to sever tissue,

and wherein the tapered end (100A; 100A'; 100A''; 100A*; 100A**; 100A***) is at least partly delineated by first and second opposite surfaces (SA, SB; SA*, SB*), namely a first, bevelled surface (SA; SA*) that is inclined with respect to the defined plane (P0) and a second, recessed surface (SB; SB*) that is substantially parallel to the defined plane (P0).

14. A medical instrument (10; 10*) for percutaneous release procedures, comprising a handle portion (H; H*) designed to allow handling, orientation and manipulation of the medical instrument (10; 10*) by an operator and an elongated rod member (100; 100*) secured to the handle portion (H; H*),

wherein the elongated rod member (100; 100*) extends from the handle portion (H; H*) up to a distal end and is curved and/or bent substantially within a defined plane (P0),

wherein the distal end of the elongated rod member (100; 100*) comprises a tapered end (100A; 100A'; 100A''; 100A*; 100A**; 100A***) configured to act as a cutting device to sever tissue,

and wherein the tapered end (100A; 100A'; 100A''; 100A*; 100A**; 100A***) of the elongated rod member (100; 100*) is at least partly delineated by first and second opposite surfaces (SA, SB; SA*, SB*), namely a first, bevelled surface (SA; SA*) that is inclined with respect to the defined plane (P0) and a

second, recessed surface (SB; SB*) that is substantially parallel to the defined plane (P0).

15 15. The medical instrument (10; 10*) according to claim 13 or 14,
5 wherein the tapered end (100A; 100A'; 100A''; 100A*; 100A**; 100A***) of the
elongated rod member (100; 100*) is further delineated by a pair of side surfaces
(SC; SC*) forming side bevels alongside at least a portion of the bevelled surface
(SA; SA*) and of the recessed surface (SB; SB*).

10 16. The medical instrument (10; 10*) according to claim 15, wherein an
angle of inclination (δ ; δ^*) of each side surface (SC; SC*) with respect to the
recessed surface (SB; SB*) is comprised between 25° and 35°.

15 17. The medical instrument (10; 10*) according to any one of claims 13
to 16, wherein an angle of inclination (γ ; γ^*) of a plane comprising the bevelled
surface (SA; SA*) with respect to the defined plane (P0) is comprised between
10° and 15°.

20 18. The medical instrument (100; 110) according to any one of
claims 13 to 17, wherein a thickness (t ; $t+h$; t^* ; t^*+h^*) of the tapered end (100A;
100A'; 100A''; 100A*; 100A**; 100A***), as measured perpendicularly to the
defined plane (P0), does not exceed 1 mm.

25 19. The medical instrument (100; 110) according to any one of
claims 13 to 18, wherein a width (w ; w^*) of the tapered end (100A; 100A'; 100A'';
100A*; 100A**; 100A***), as measured within the defined plane (P0), does not
exceed 2 mm.

30 20. The medical instrument (100; 110) according to any one of
claims 13 to 19, wherein the tapered end (100A'; 100A''; 100A*; 100A***)
includes a longitudinal ridge (150'; 150''; 150*; 150***) that projects away from
the recessed surface (SB; SB*).

21. The medical instrument (100; 110) according to claim 20, wherein a height (h; h*) of the longitudinal ridge (150'; 150''; 150**; 150***), as measured perpendicularly to the defined plane (P0), does not exceed 0.5 mm.

5

22. The medical instrument (100; 110) according to claim 20 or 21, wherein a leading edge of the longitudinal ridge (150'; 150''; 150**; 150***) is tapered and stops short of a leading edge of the tapered end (100A'; 100A''; 100A**; 100A***).

10

23. The medical instrument (10; 10*) according to any one of the preceding claims, wherein the elongated rod member (100; 100*) extends along a generatrix (GX) and wherein a lateral breadth of the elongated rod member (100; 100*) as measured at any point along the generatrix (GX), up to an including
15 the distal end of the elongated rod member (100; 100*), does not exceed 2 mm.

24. The medical instrument (10; 10*) according to any one of the preceding claims, wherein a cross-sectional area of the elongated rod member (100; 100*) does not exceed 2.5 mm².

20

25. The medical instrument (10; 10*) according to any one of the preceding claims, wherein the elongated rod member (100; 100*) has a substantially circular or polygonal cross-section, upstream of the distal end of the elongated rod member (100; 100*), whose lateral breadth does not exceed
25 1.5 mm.

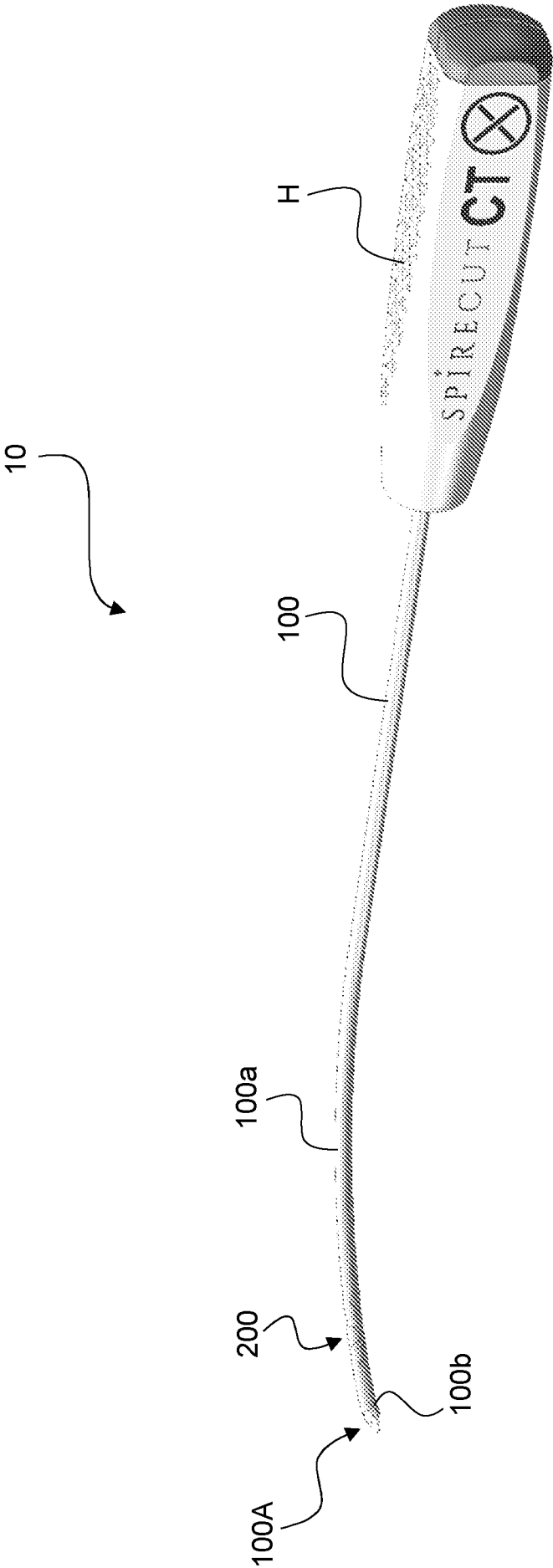


Fig. 1A

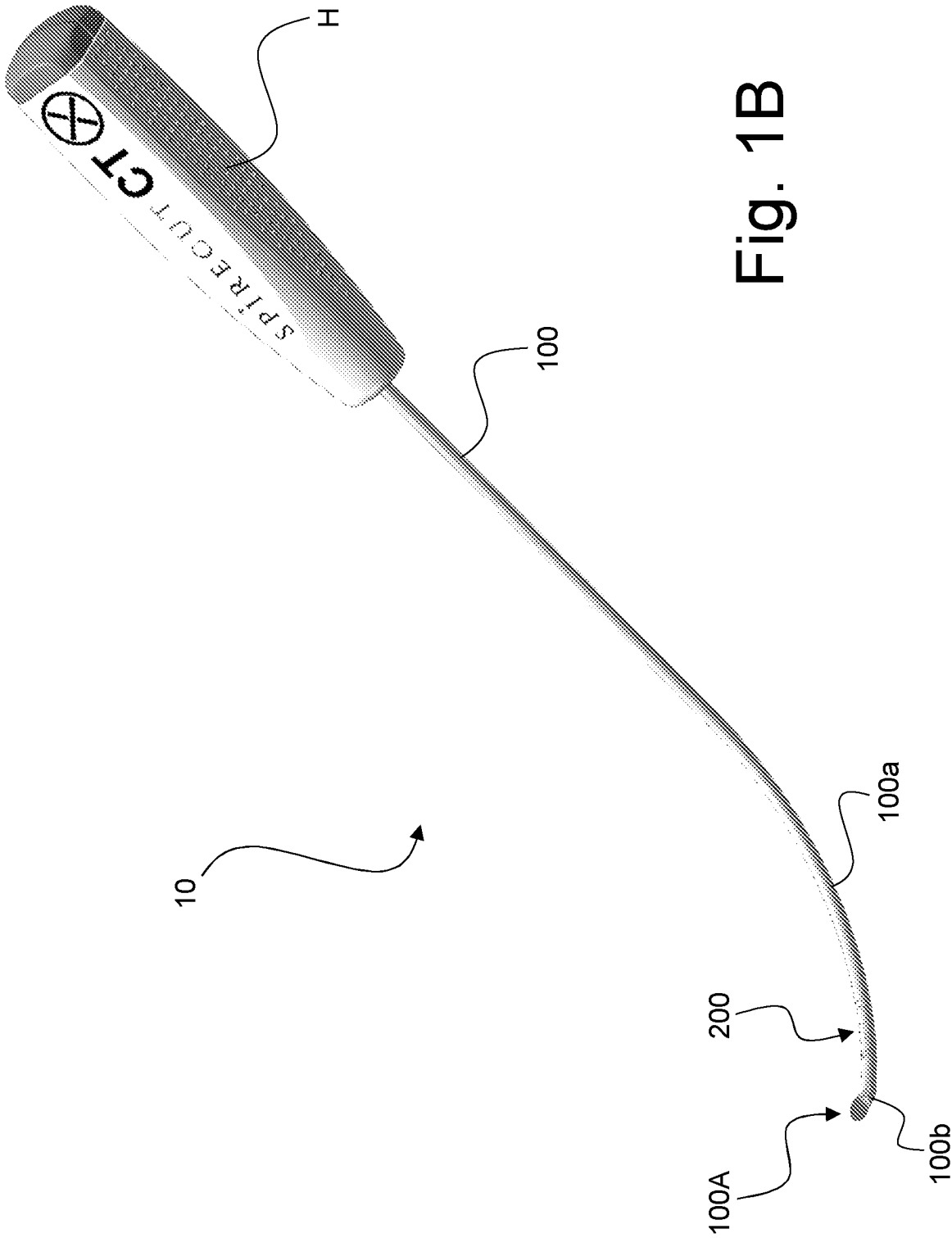


Fig. 1B

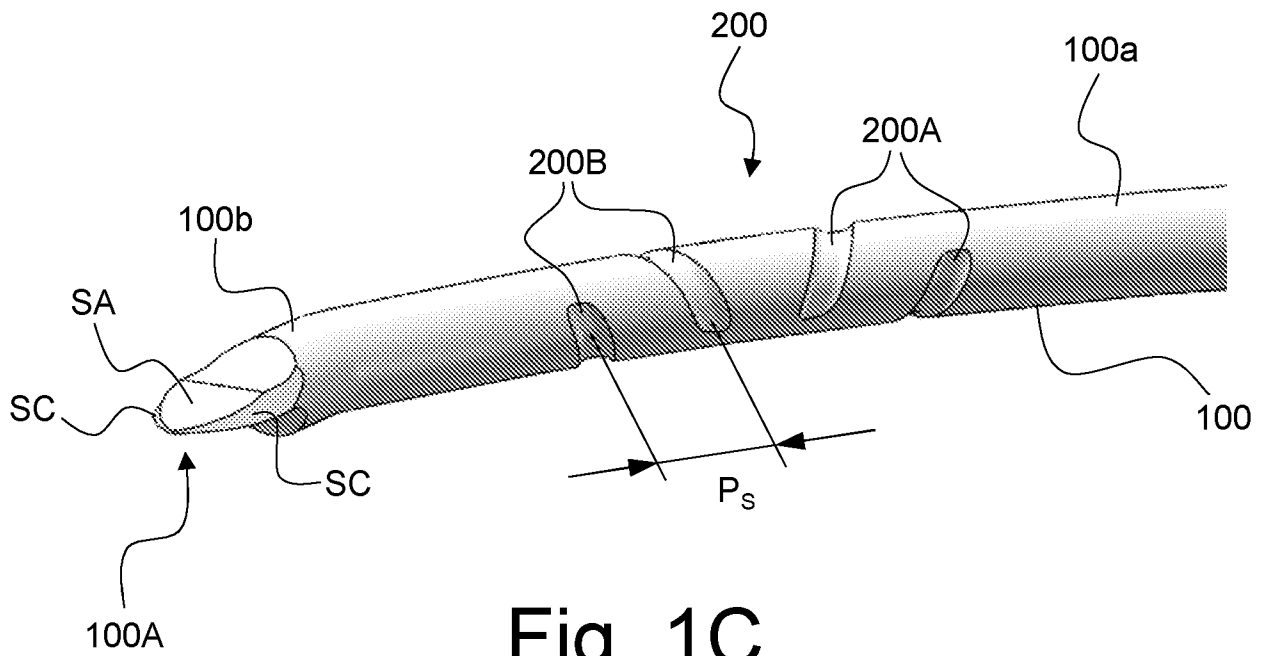


Fig. 1C

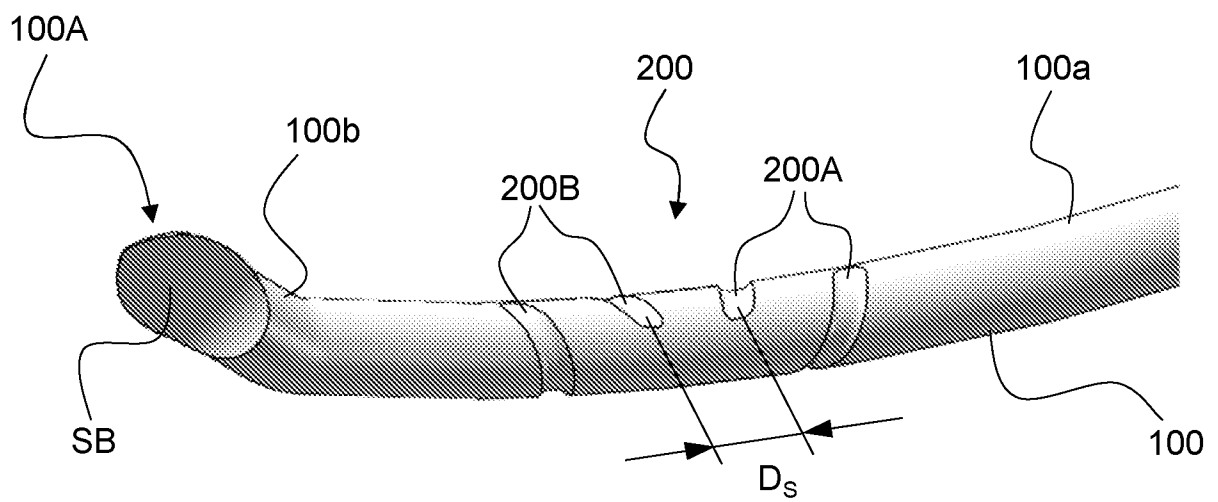


Fig. 1D

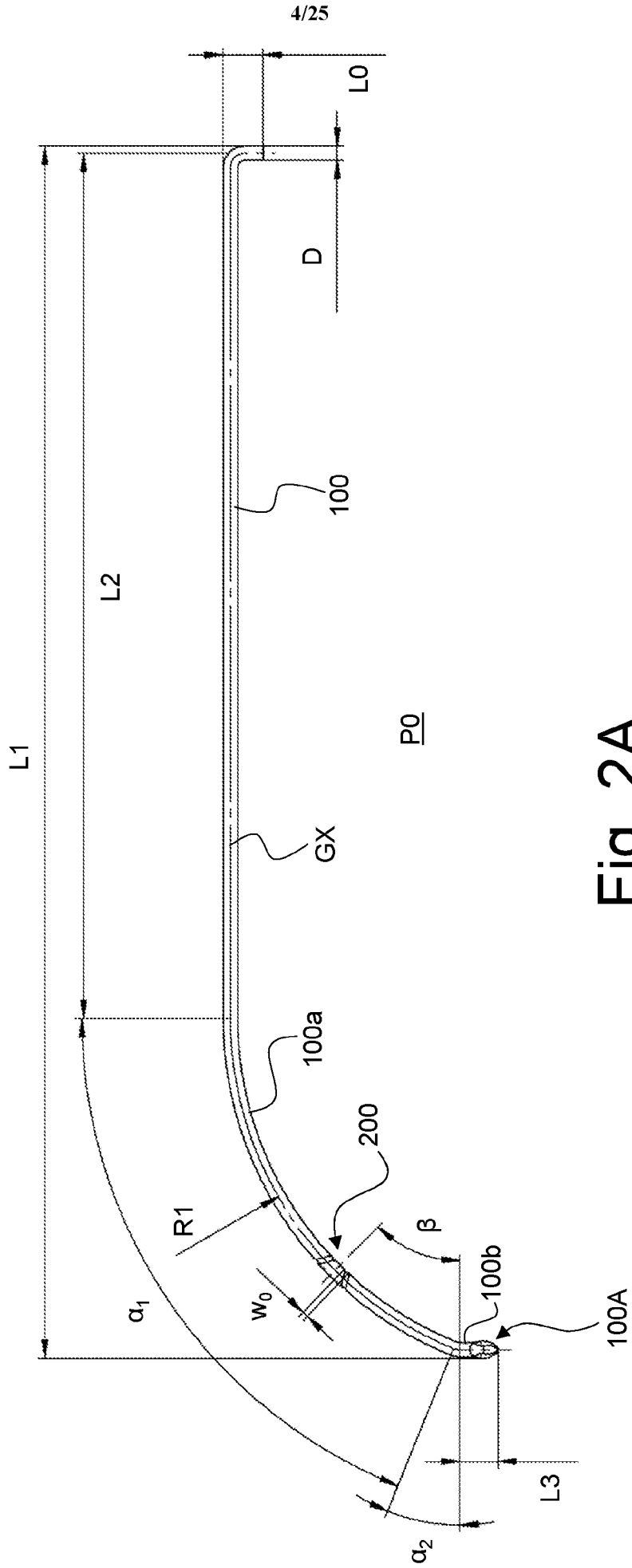


Fig. 2A

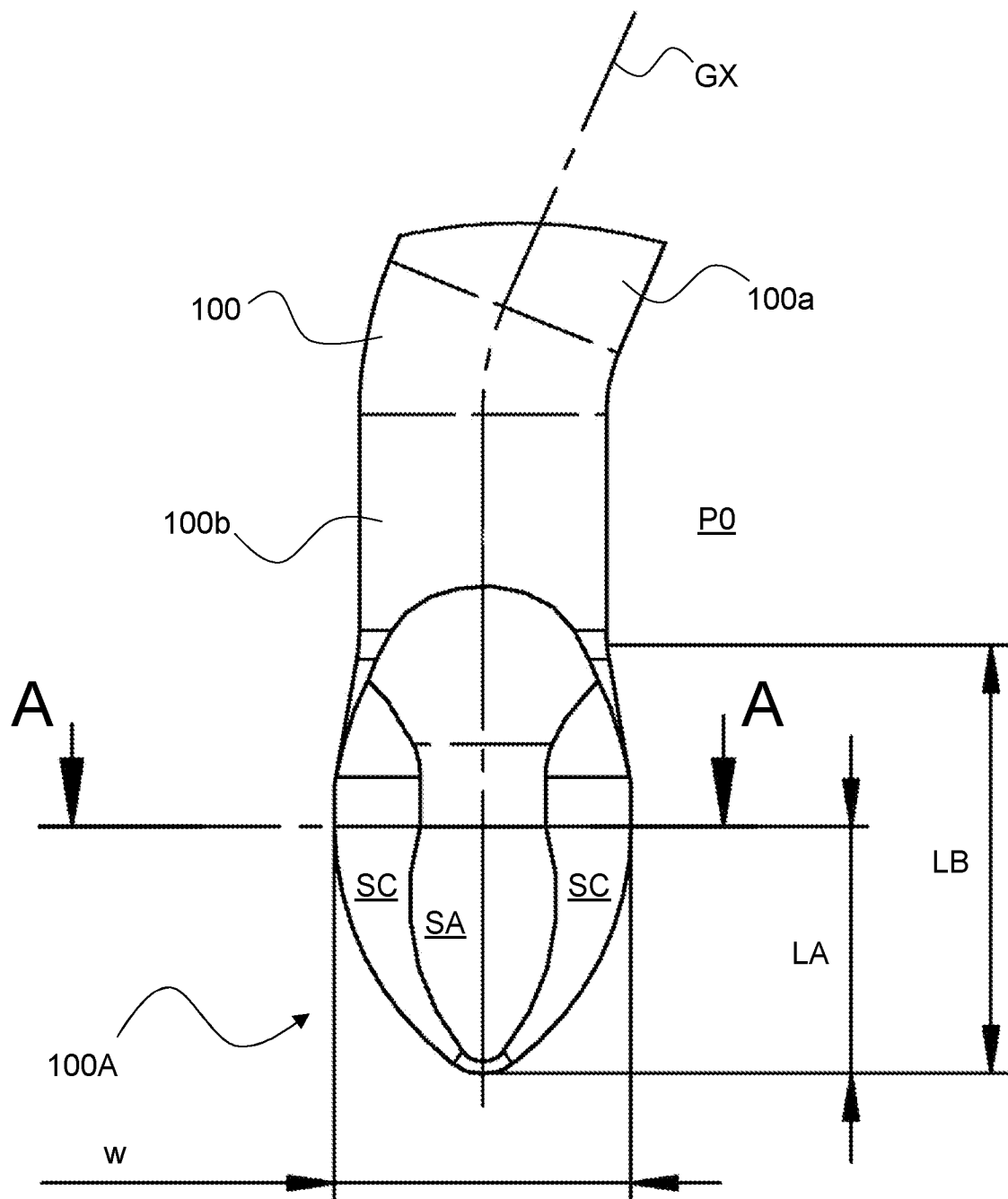


Fig. 2B

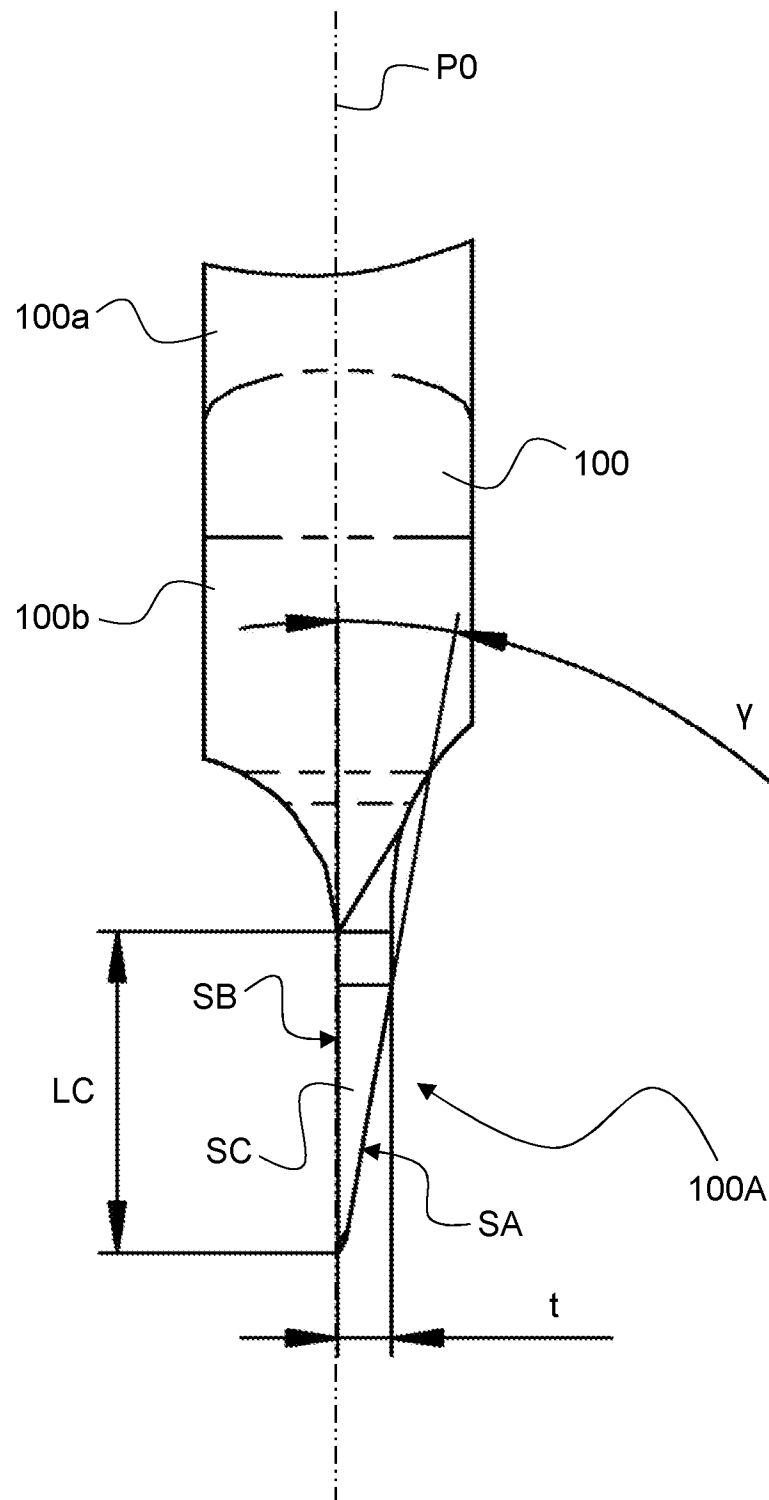


Fig. 2C

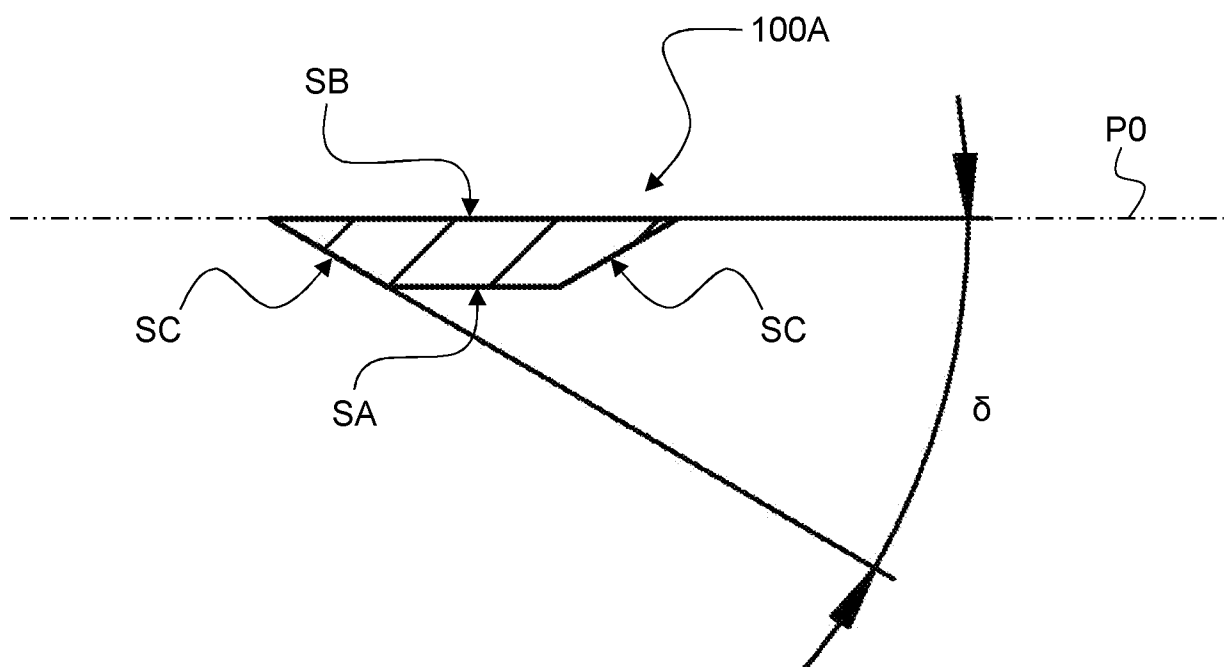


Fig. 2D
(A-A)

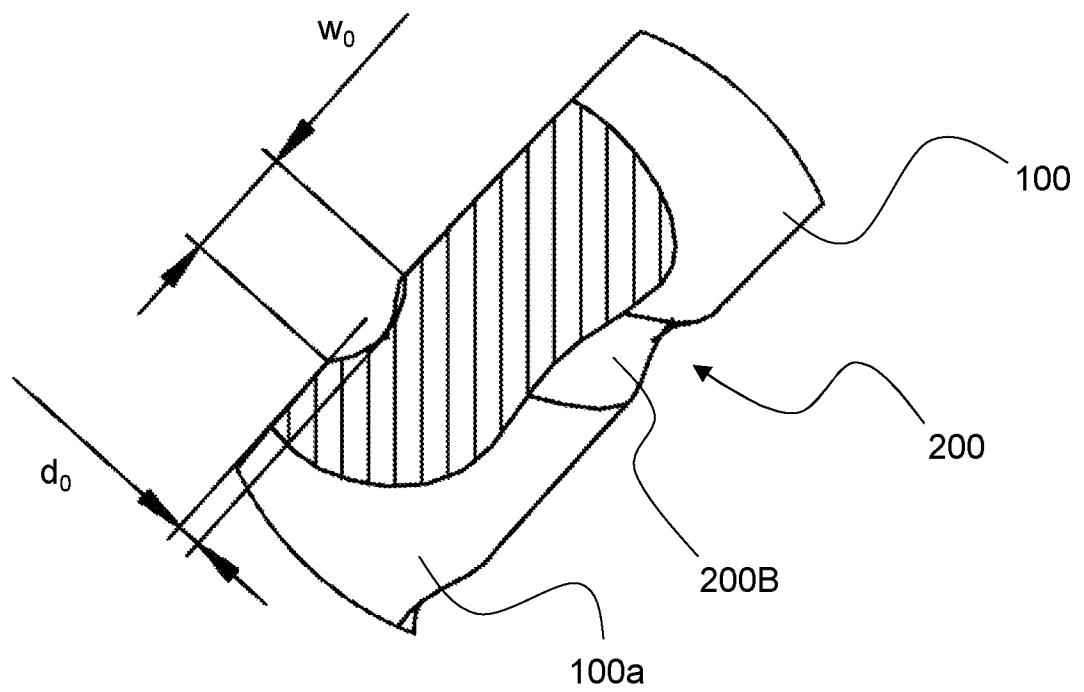


Fig. 2E

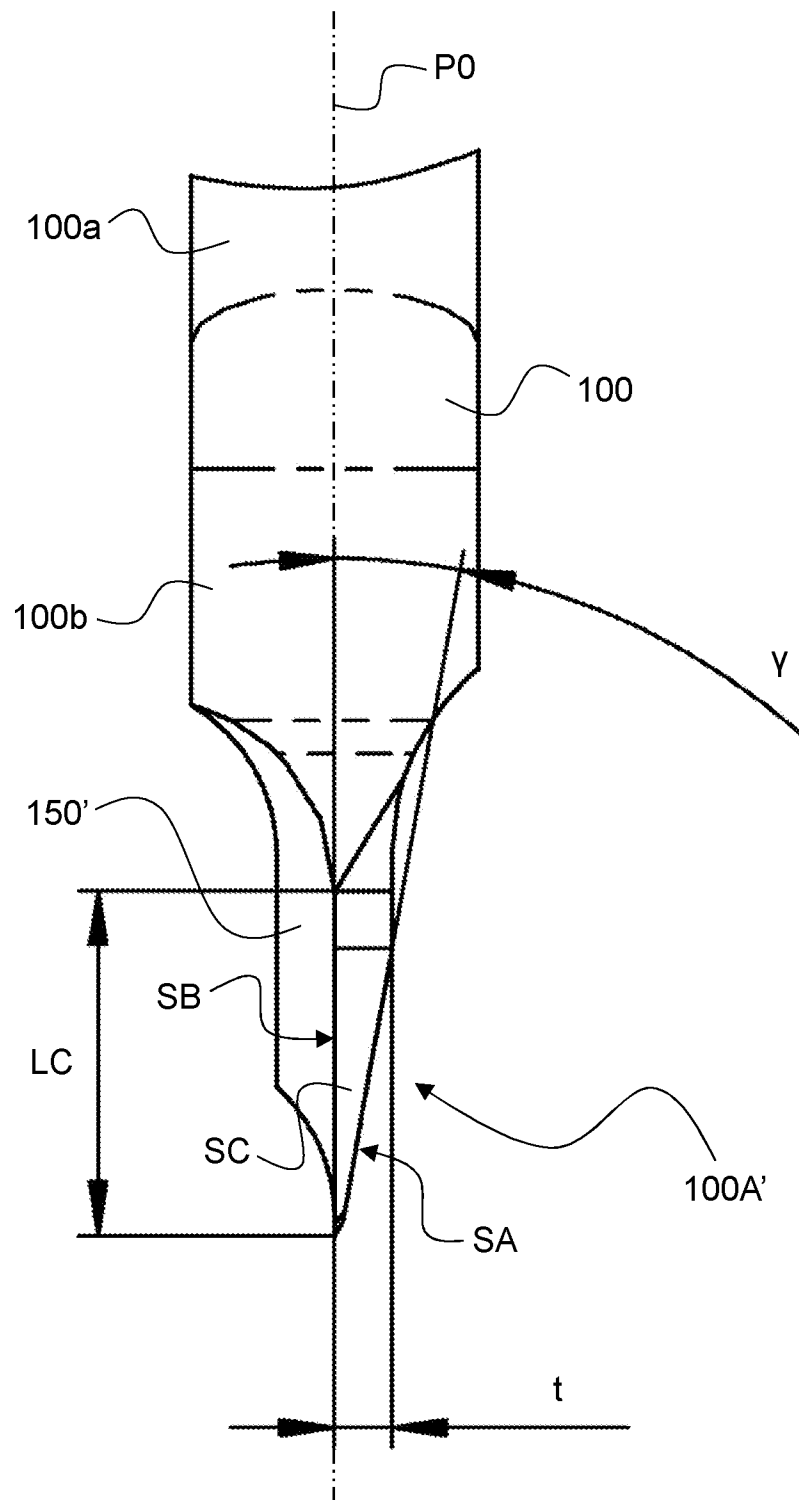


Fig. 3A

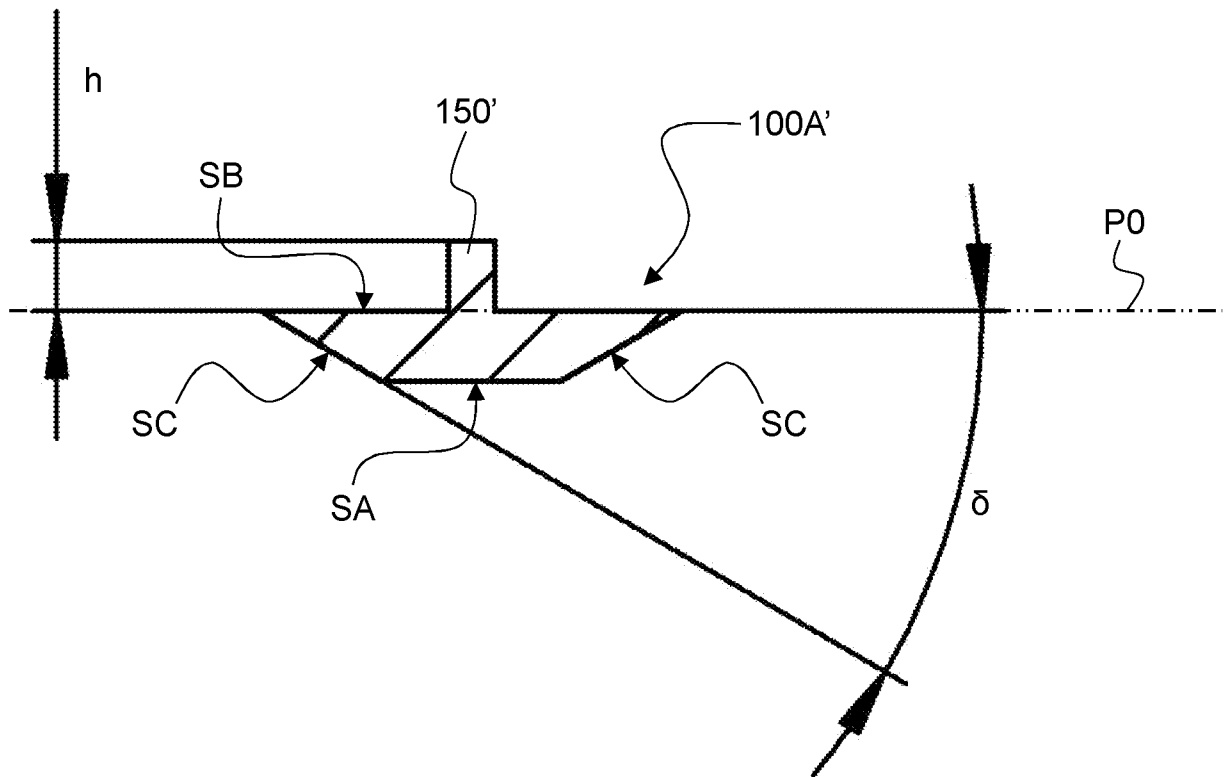


Fig. 3B

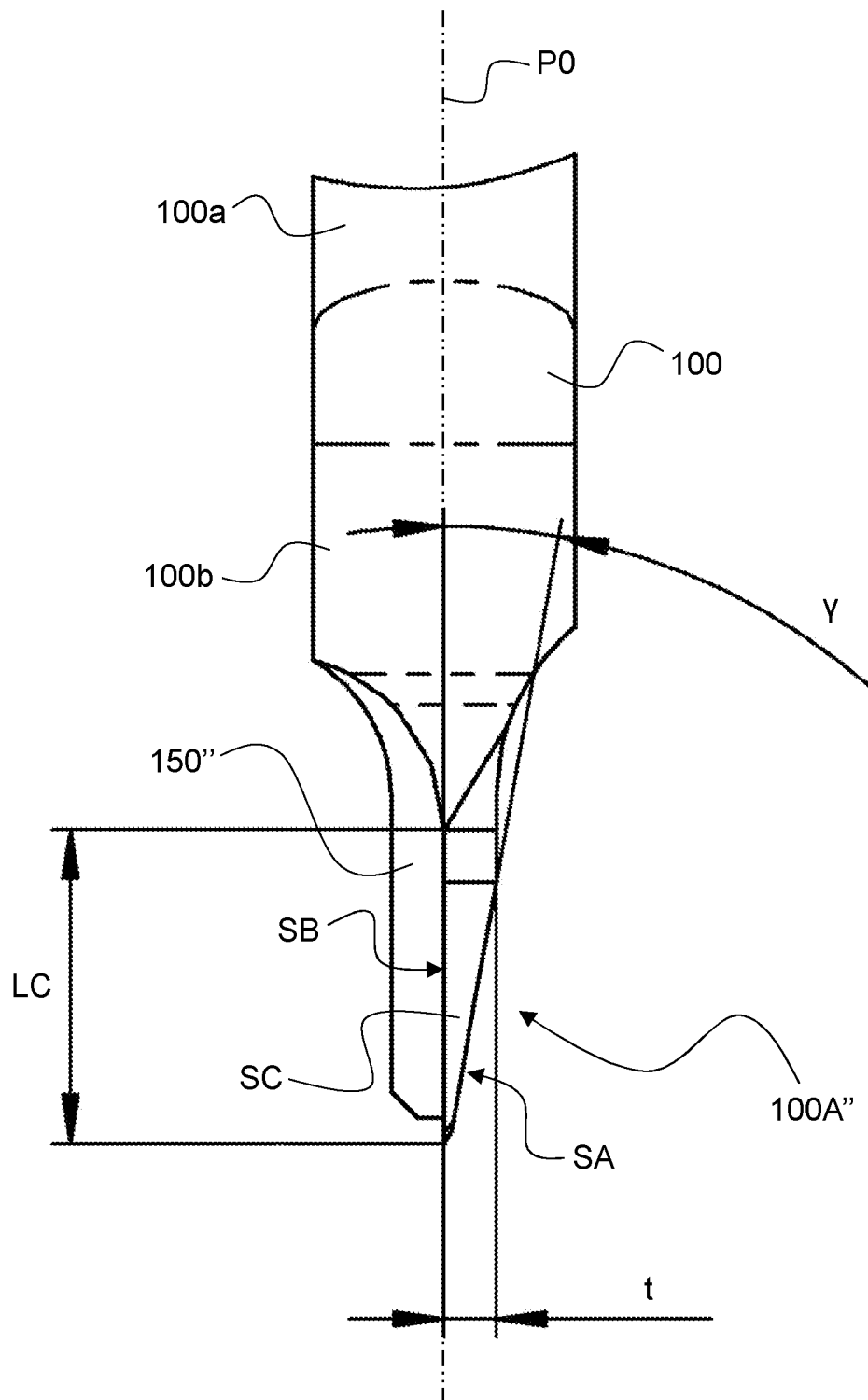


Fig. 4

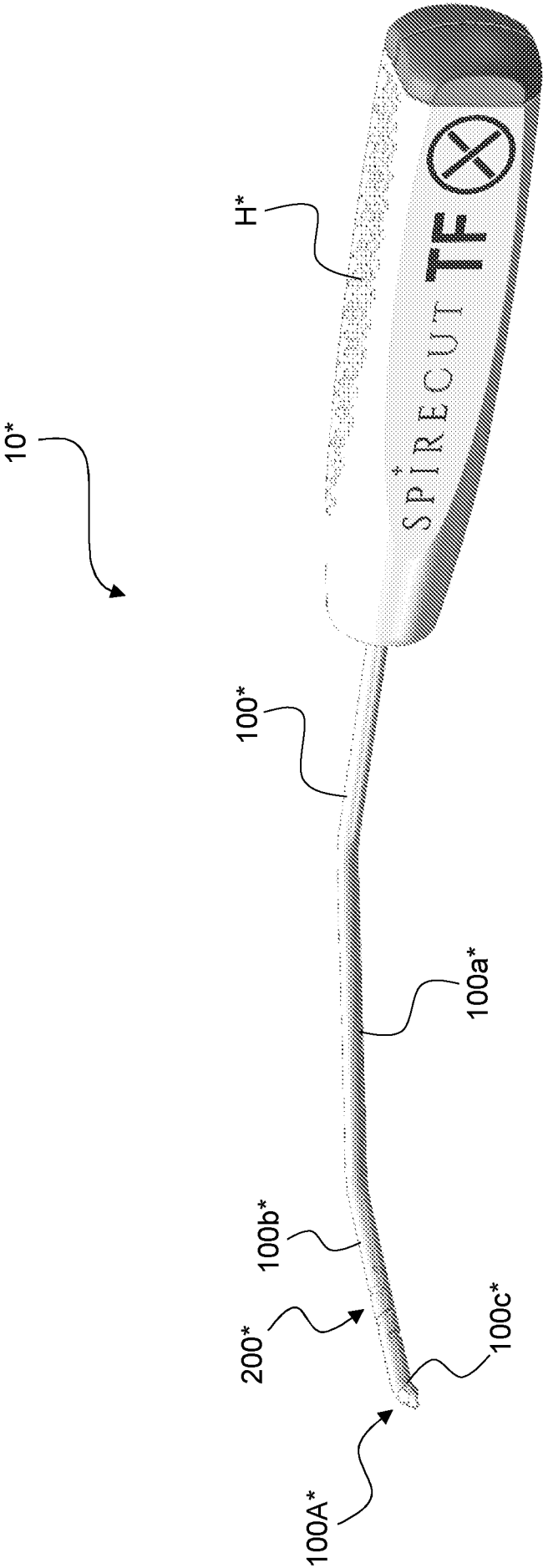


Fig. 5A

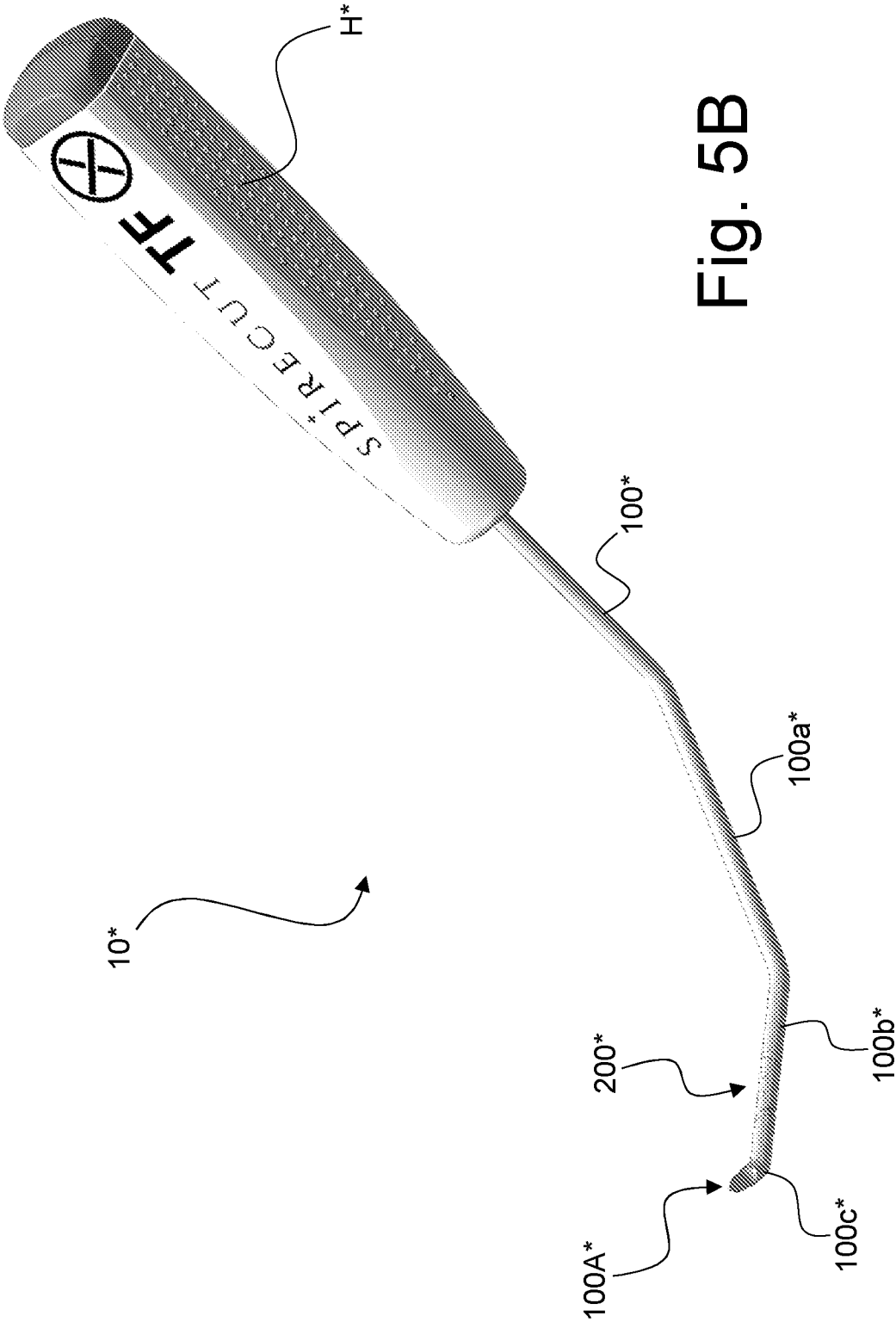


Fig. 5B

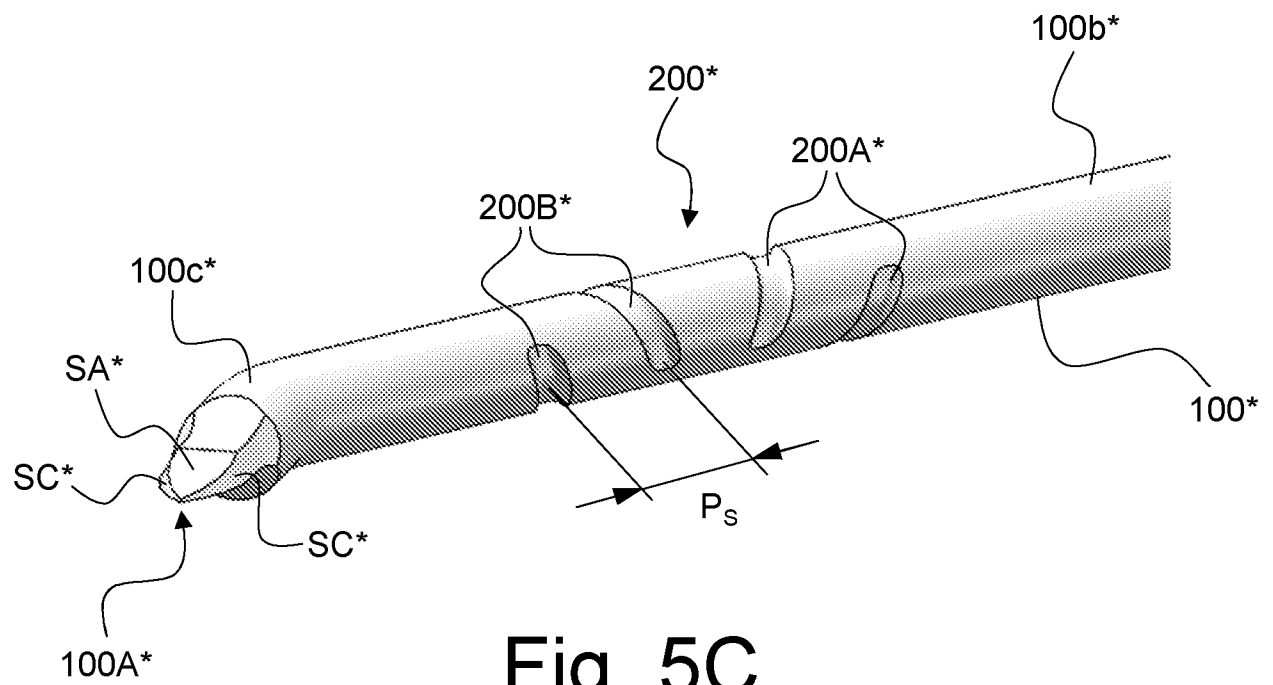


Fig. 5C

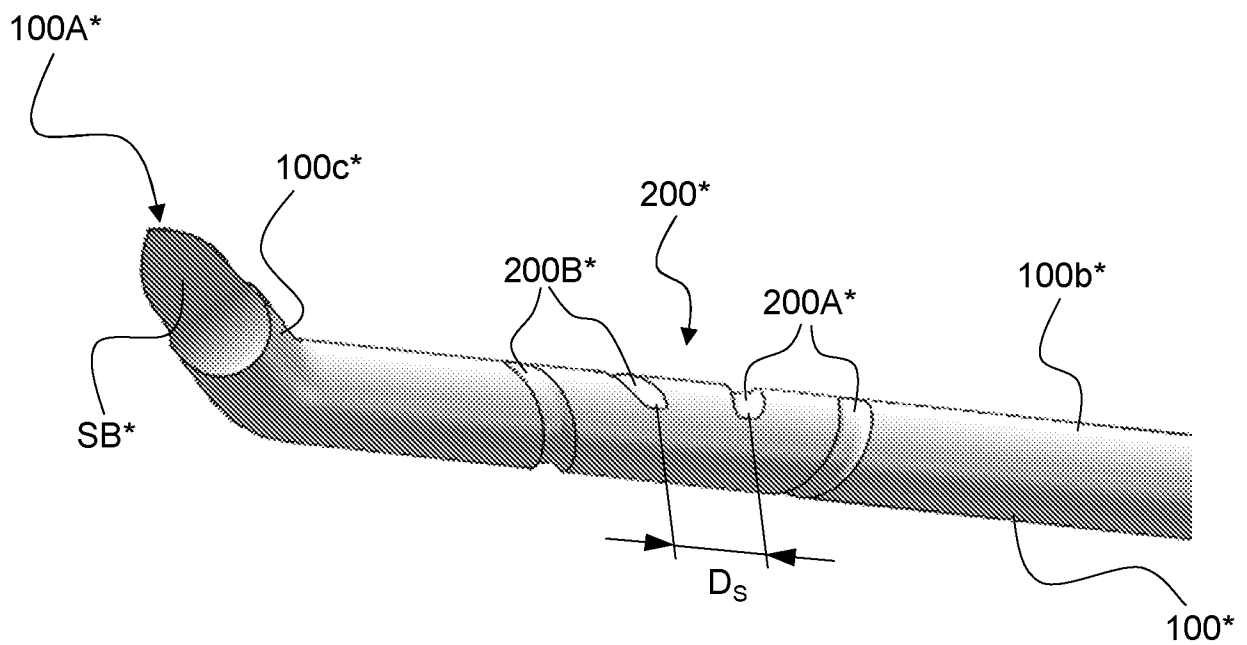


Fig. 5D

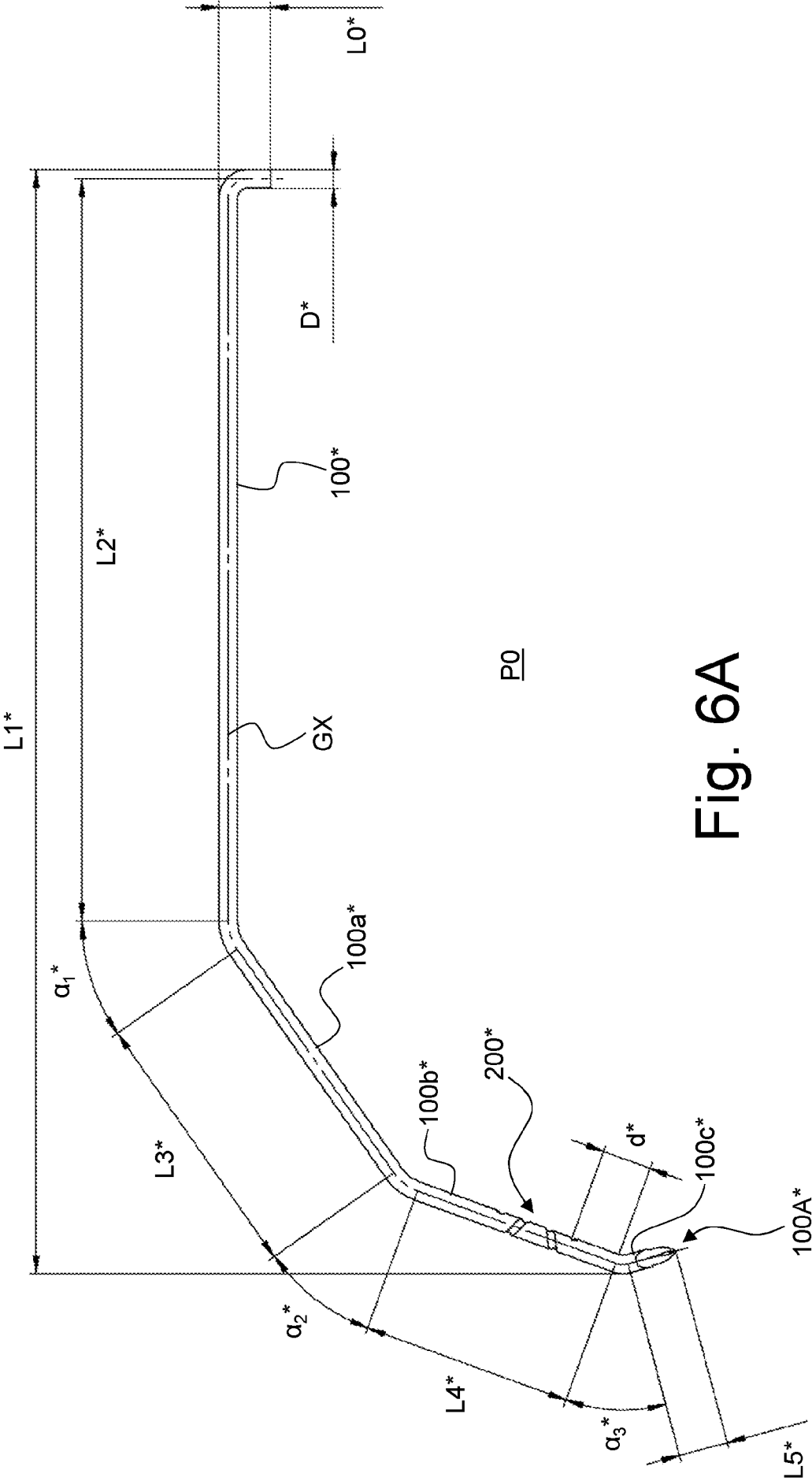


Fig. 6A

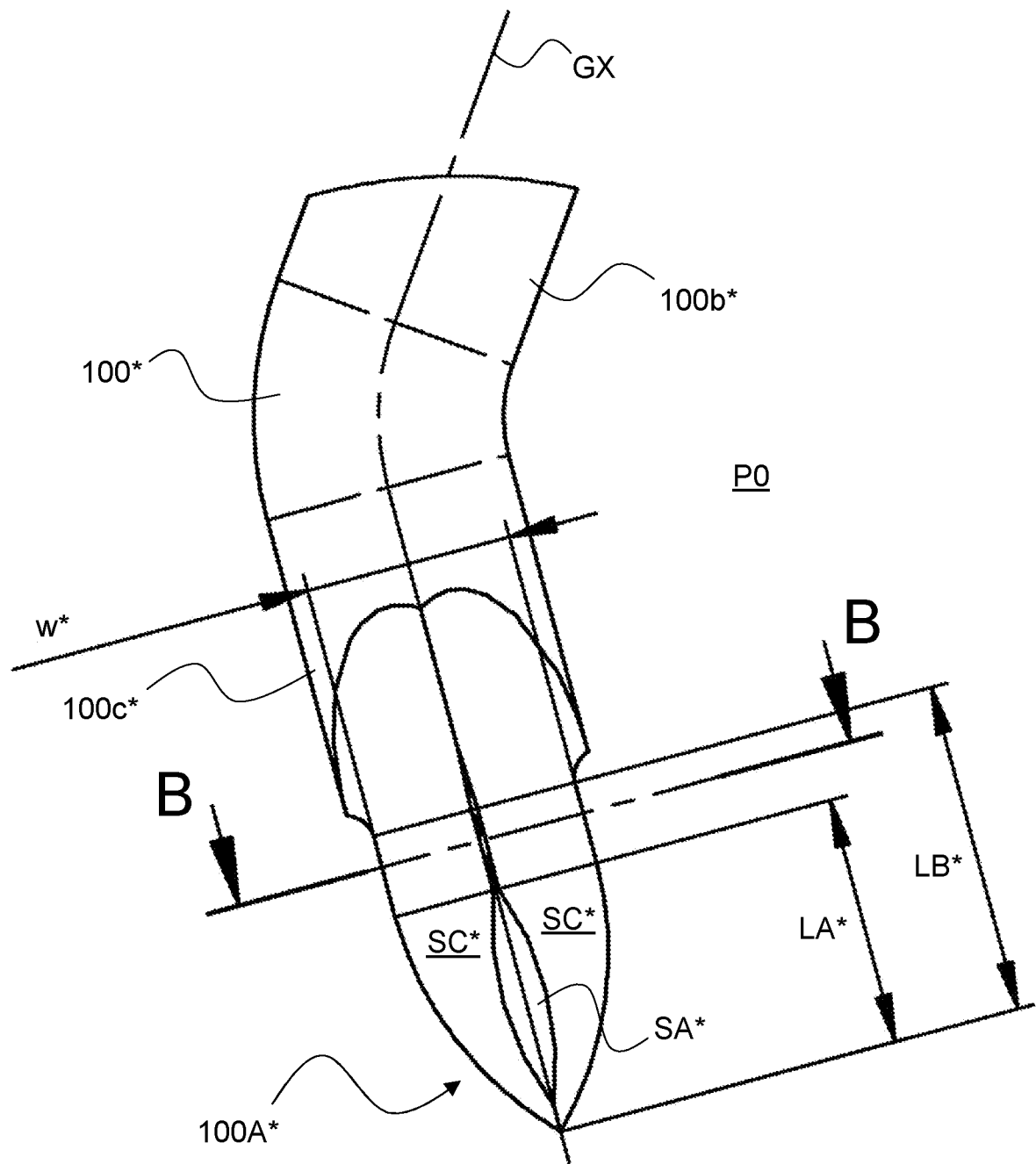


Fig. 6B

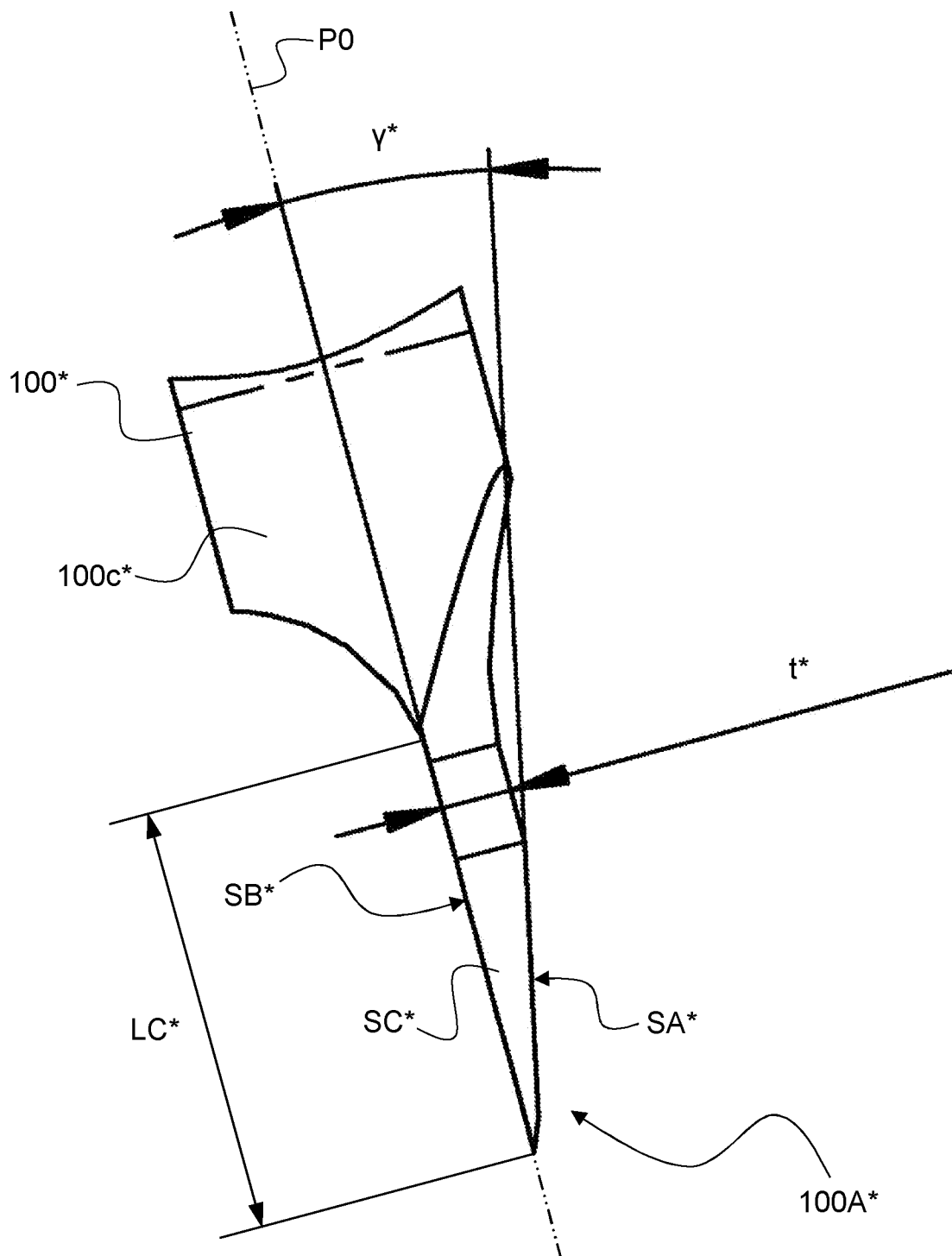


Fig. 6C

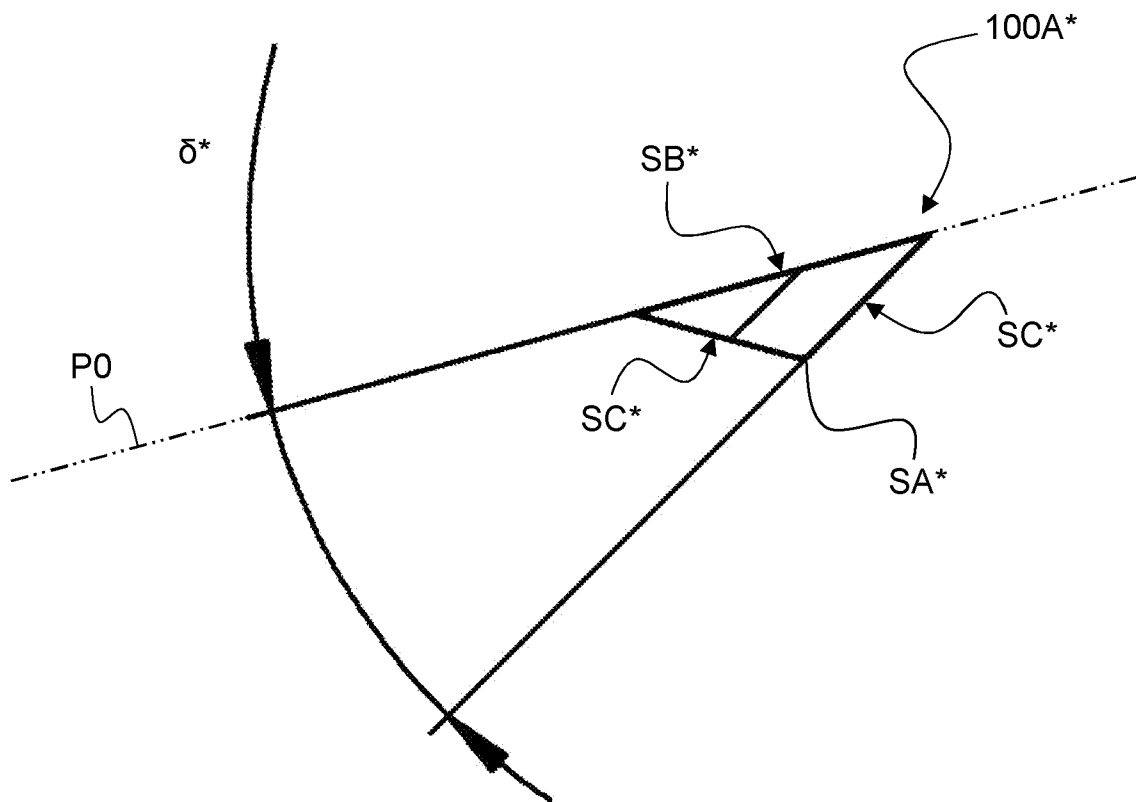


Fig. 6D
(B-B)

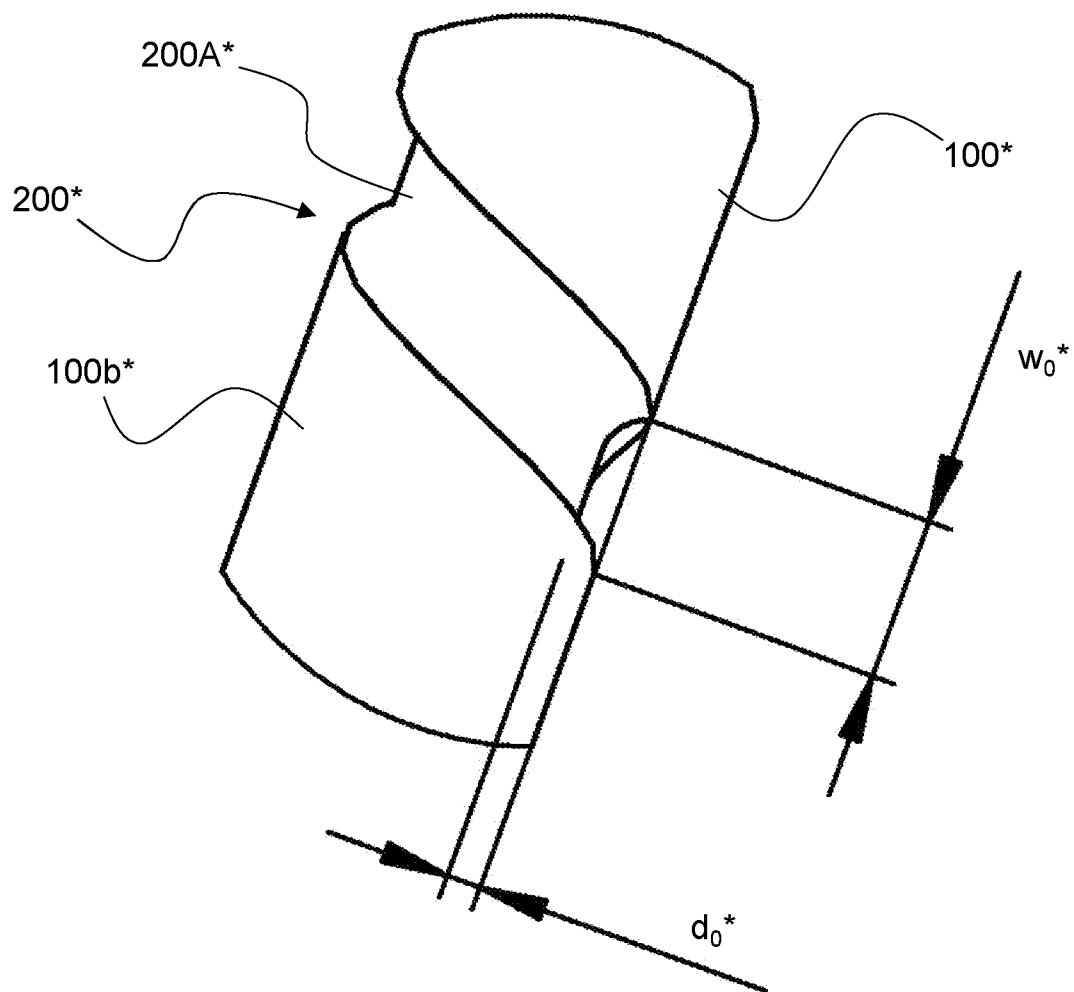


Fig. 6E

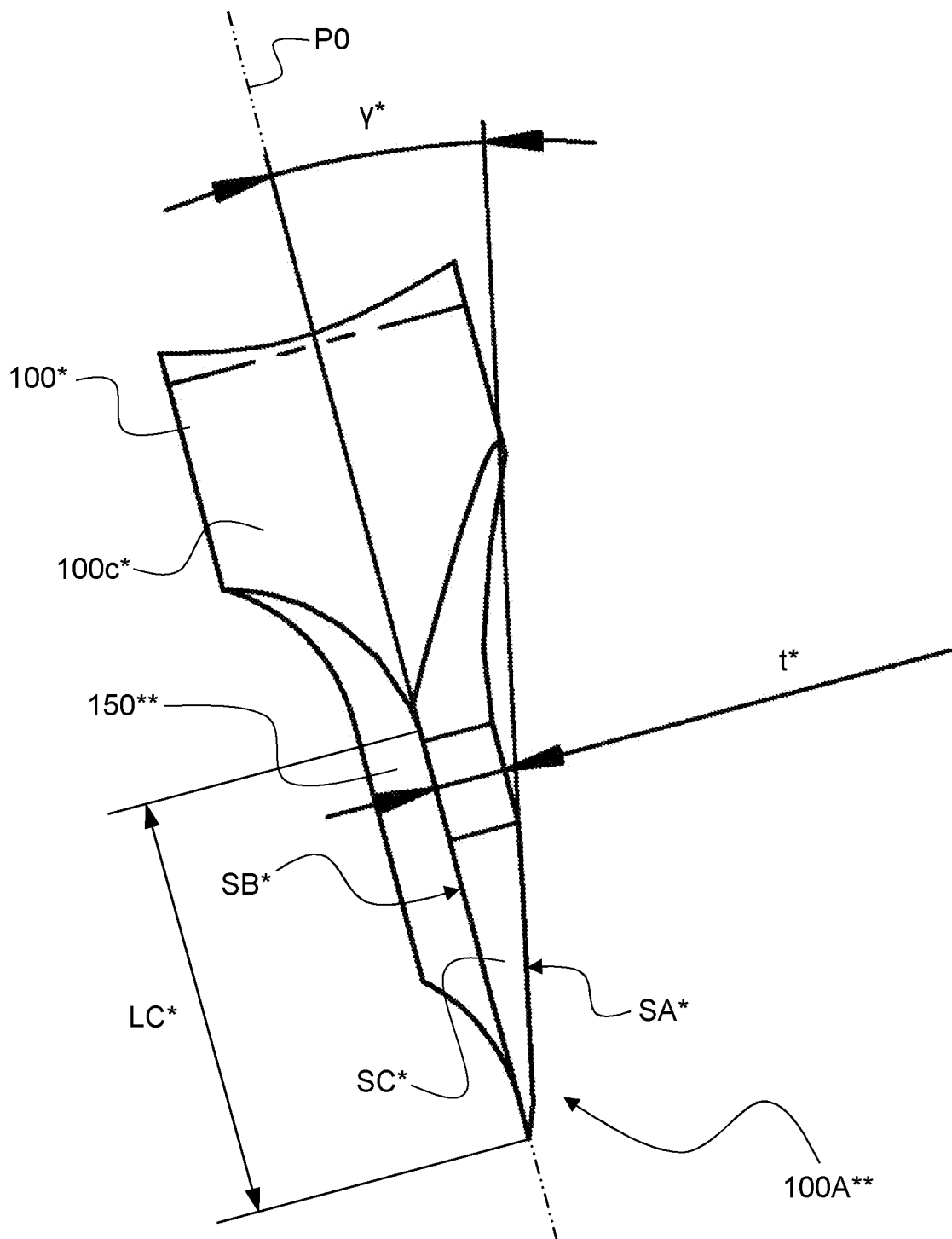


Fig. 7A

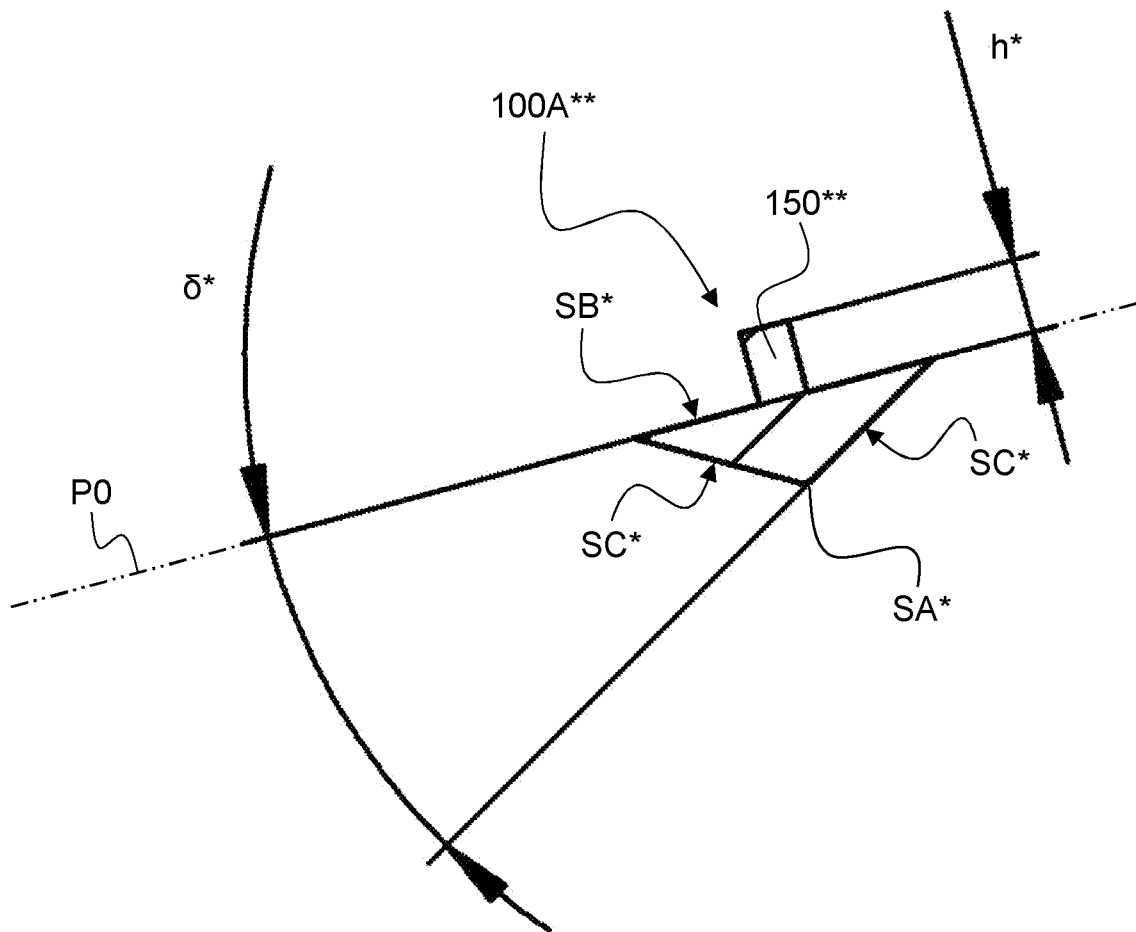


Fig. 7B

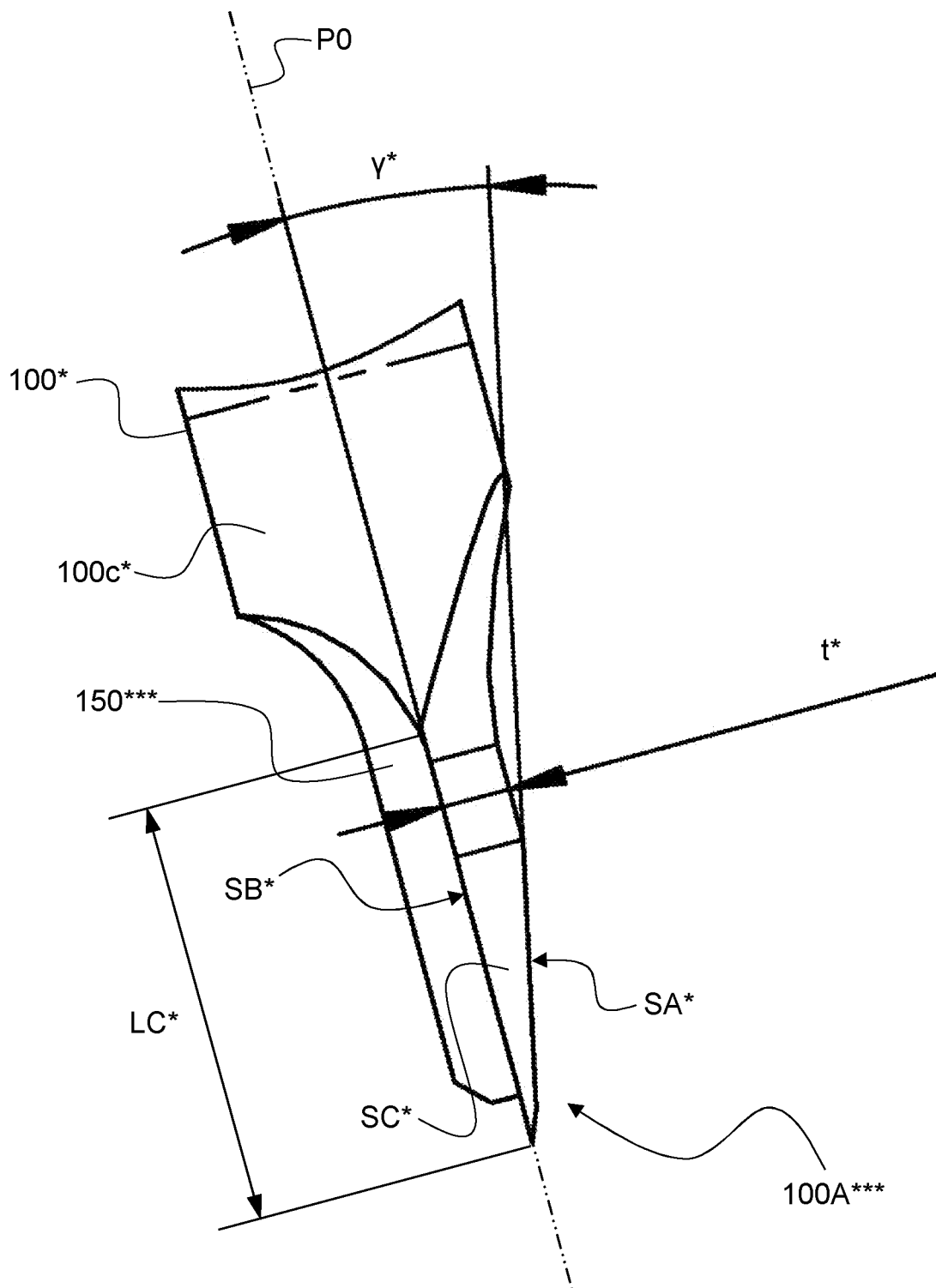


Fig. 8

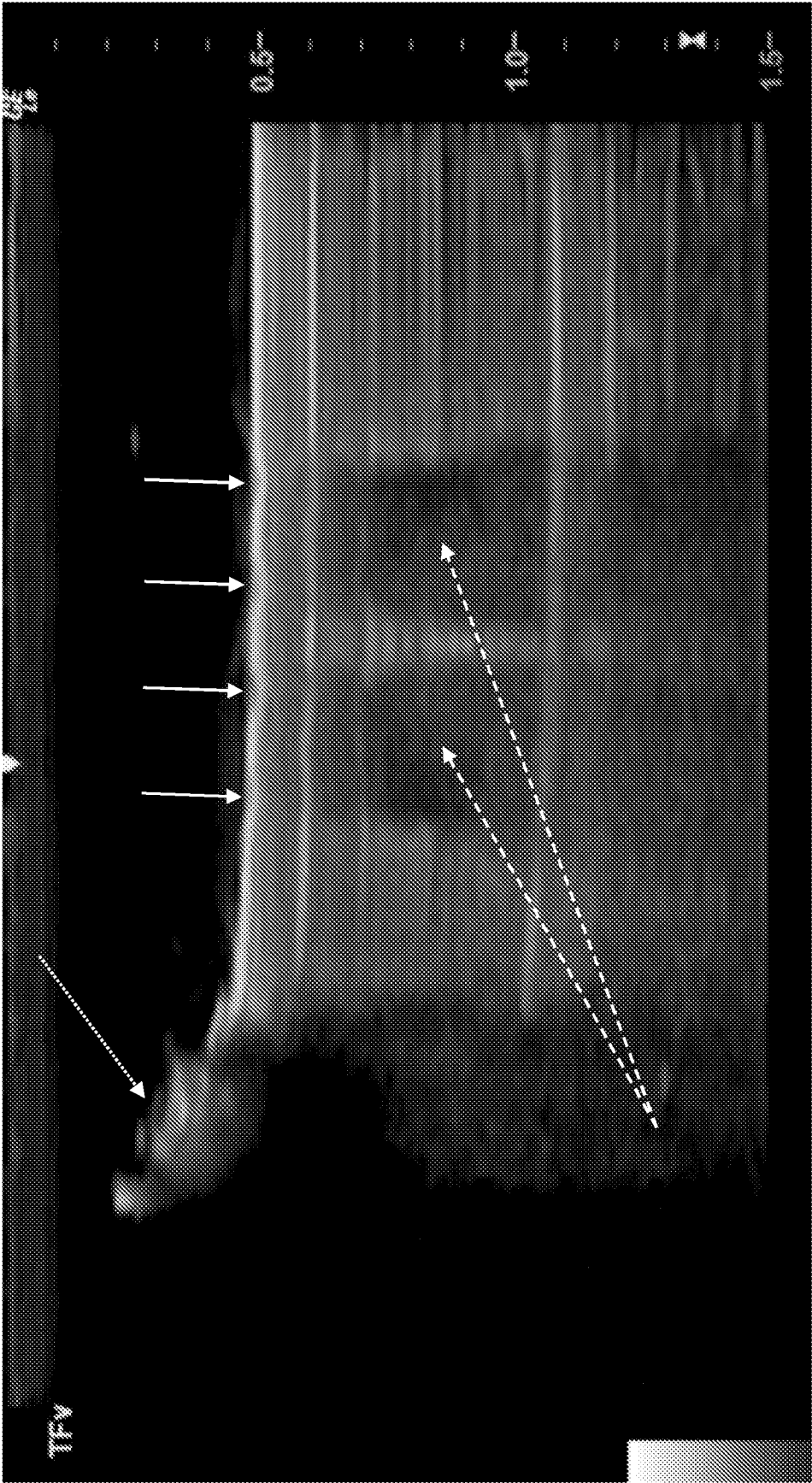


Fig. 9A

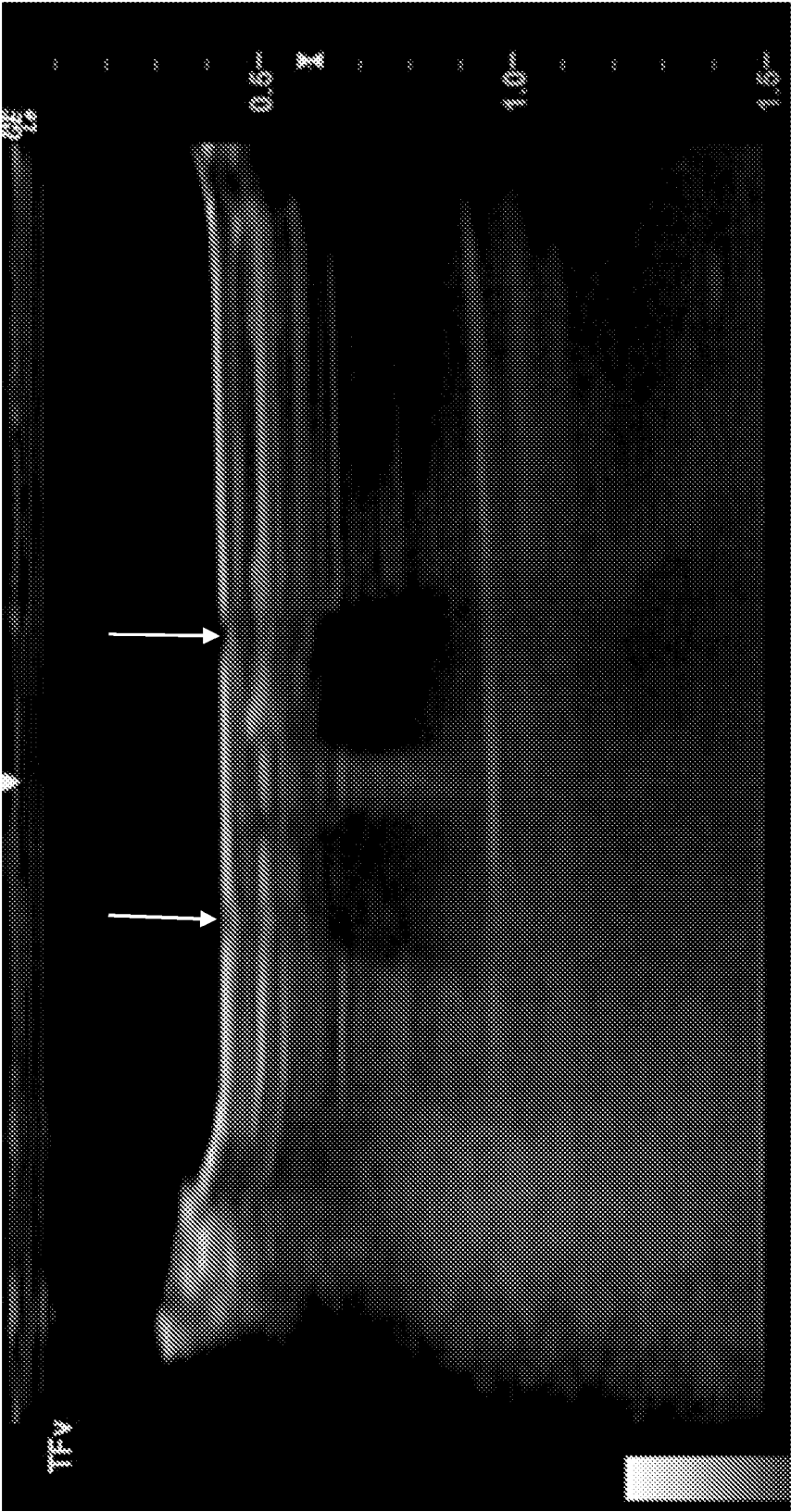


Fig. 9B

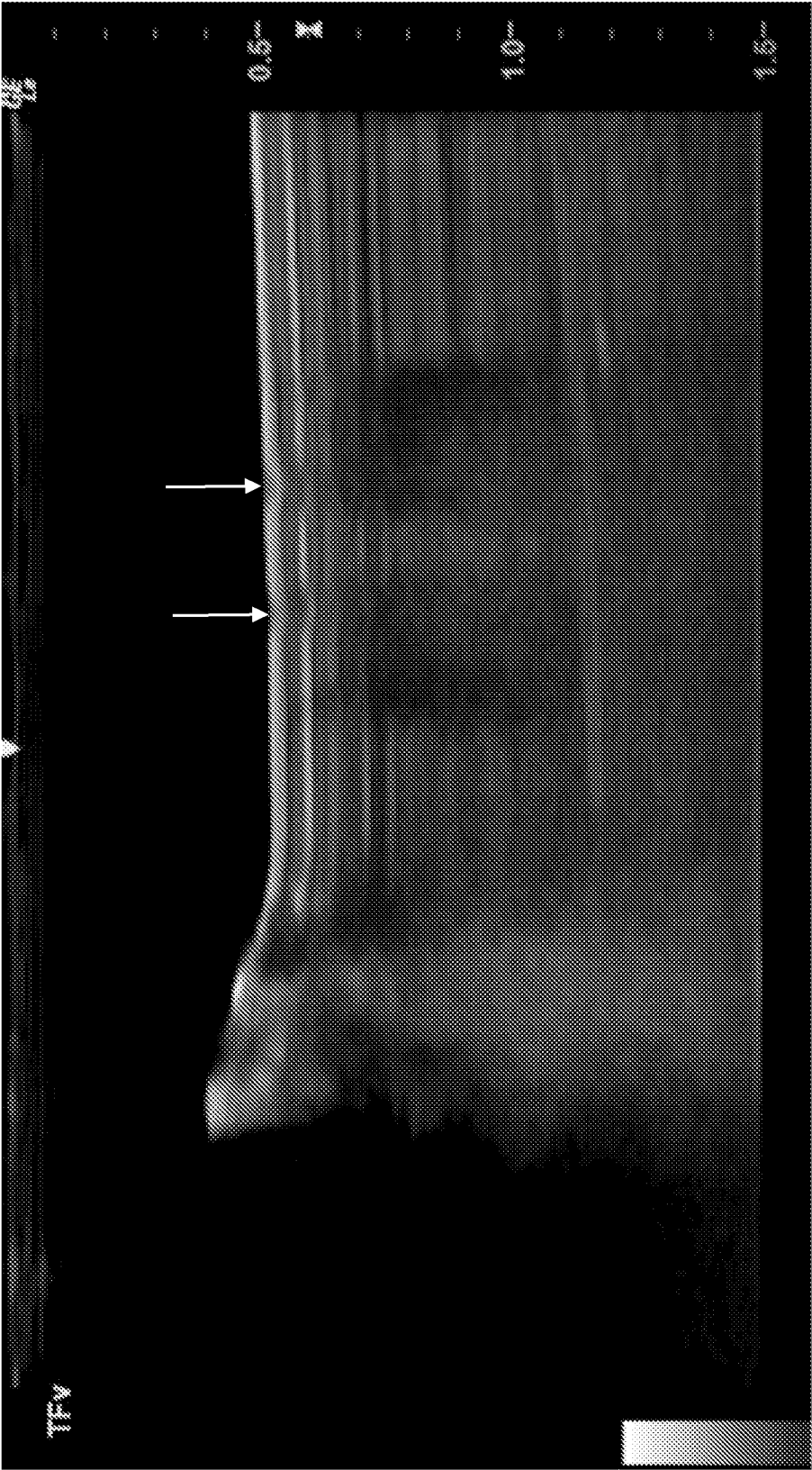


Fig. 9C

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2022/060518

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B17/32

ADD. A61B17/00 A61B90/00

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)

A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 3 586 776 A1 (SWIBRACE SA [CH]) 1 January 2020 (2020-01-01) cited in the application	1, 12, 15-25
Y	figures 3, 13, 23-25, 28, 29 paragraph [0045] - paragraph [0046] -----	2-11, 13-25
X	US 2016/074130 A1 (QUEARRY BENJAMAN B [US] ET AL) 17 March 2016 (2016-03-17)	1
Y	figures 1, 2 paragraph [0026] paragraph [0035] -----	2-11
X	US 2014/265024 A1 (QUEARRY BENJAMAN B [US]) 18 September 2014 (2014-09-18) figure 1 paragraph [0025] paragraph [0028] - paragraph [0032] paragraph [0037] -----	1
-/--		

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

22 February 2023

Date of mailing of the international search report

02/03/2023

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Biegler, Marcel

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2022/060518

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2020/069330 A1 (BUTKI ANDREW J [US]) 5 March 2020 (2020-03-05) figures 16, 20 paragraph [0054] paragraph [0058] -----	1
A	US 2012/150208 A1 (MESSMER SARAH [US]) 14 June 2012 (2012-06-14) figures 5, 6A/B paragraph [0024] -----	1-13
X	WO 2016/148882 A1 (SPIRATION INC D/B/A OLYMPUS RESPIRATORY AMERICA [US]) 22 September 2016 (2016-09-22) figures 2A-D paragraph [0040] - paragraph [0041] -----	1
A	US 2008/109021 A1 (MEDOFF ROBERT J [US]) 8 May 2008 (2008-05-08) figures 3A-D paragraph [0068] - paragraph [0072] -----	14-25
A	WO 2020/247476 A1 (GREAT PLAINS IMAGING LLC [US]) 10 December 2020 (2020-12-10) figure 10 paragraph [0033] -----	14-25
Y	US 2014/296974 A1 (MEYER-BRODNITZ GIDEON [IL] ET AL) 2 October 2014 (2014-10-02) figures 1A, 3 paragraph [0014] paragraph [0109] -----	13-25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2022/060518

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

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

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

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

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

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

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

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-25

sonographically distinguishable markings / tapered, bevelled cutting ends

1.1. claims: 1-13 (completely); 15-25 (partially)

sonographically distinguishable markings

1.2. claims: 14 (completely); 15-25 (partially)

tapered, bevelled cutting ends

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2022/060518

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