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

(11) EP 1 455 880 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
17.02.2010 Bulletin 2010/07

(21) Application number: **02761822.2**

(22) Date of filing: **25.09.2002**

(51) Int Cl.:
A61M 25/01 *(2006.01)*

(86) International application number:
PCT/US2002/030402

(87) International publication number:
WO 2003/051444 (26.06.2003 Gazette 2003/26)

(54) SUPER ELASTIC GUIDEWIRE WITH SHAPE RETENTION TIP

SUPER-ELASTISCHER FÜHRUNGSDRAHT MIT FORMBESTÄNDIGER SPITZE

FIL GUIDE SUPERELASTIQUE AVEC POINTE A MEMOIRE DE FORME

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

(30) Priority: **18.12.2001 US 25668**

(43) Date of publication of application:
15.09.2004 Bulletin 2004/38

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WO-A-99/46109
US-A- 5 814 705
US-A1- 2001 009 980

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention generally relates to intravascular guidewires. More specifically, the present invention relates to intravascular guidewires utilizing super elastic materials.

[0002] Intravascular guidewires are commonly used to navigate through a patient's vascular system for the diagnosis and treatment of a wide variety of vascular disorders. Guidewires conventionally utilize a stainless steel or nitinol (super elastic) core wire. Stainless steel core wires are advantageous because they are shapeable, but are disadvantageous because they may become deformed in tortuous vascular anatomy. Nitinol core wires are advantageous because they do not become deformed in tortuous vasculature, but are disadvantageous because they are not shapeable.

[0003] US 2001/0009980 A1 discloses a guidewire having at least two different polymeric jackets that impart different handling characteristics to the portions of the guidewire they surround. The guidewire may have jackets of different grades of polymer or different types of polymers, or may have a single polymeric jacket with continuously varying properties along its length.

[0004] US 5 814 705 discloses a composition that softens at a predetermined temperature and comprises at least one block copolymer having at least two thermal transition temperatures. The composition is characterized by at least two thermal transition temperatures, one of which is a predetermined lower transition temperature, and one of which is an upper transition temperature.

[0005] WO 01/07499 A1 discloses a shape memory polyurethane or polyurethane-urea polymer.

[0006] Thus, there is a need for a guidewire that offers both advantages, namely a guidewire that is shapeable and that is not readily deformed in tortuous vasculature.

[0007] To address this need, the present invention provides several design alternatives as recited in the claims. For example, in one embodiment, the present invention provides a guidewire having a super elastic core wire surrounded by a shape memory polymer jacket. The super elastic core wire permits the guidewire to be navigated through tortuous vasculature without undergoing plastic deformation, and the shape memory polymer jacket permits the guidewire to be shapeable.

[0008] Preferred embodiments of the invention will be described in the following with reference to the drawings, in which :

Figure 1 is a plan view of a guidewire according to the present invention, in combination with a balloon catheter;

Figure 2 is a foreshortened longitudinal cross-sectional view of a distal portion of a guidewire of the present invention, showing a polymer jacket surrounding a distal tip of a core wire;

Figure 3 is a foreshortened longitudinal cross-sectional view of a portion of a guidewire of the present invention, showing a polymer jacket surrounding a mid portion of a core wire; and

Figures 4 and 5 are side views of a distal tip portion of a guide wire showing a polymer jacket surrounding a distal portion of a spring tip and core wire, wherein the distal tip is deformed about a cylinder-shaped object.

[0009] The following detailed description should be read with reference to the drawings in which similar elements in different drawings are numbered the same. The detailed description and the drawings, which are not necessarily to scale, depict illustrative embodiments and are not intended to limit the scope of the invention:

[0010] Refer now to Figure 1 which illustrates a plan view of a guidewire 10 in combination with an intravascular device 100. In this particular example, the intravascular device 100 comprises a balloon catheter, but those skilled in the art will recognize that guidewires may be used alone or in combination with a wide variety of intravascular devices for coronary, peripheral and cerebral use, including balloon catheters, guide catheters, diagnostic catheters, micro-catheters, etc. For purposes of illustration only, intravascular device 100 is shown to be a balloon catheter 100 having an elongate shaft 100, a proximally disposed manifold 104, and a distally disposed inflatable balloon 106, all of which are conventional in the art. Guidewire 10 may extend through the entire length of the balloon catheter 100, and includes a proximal end 12 and a distal tip portion 14. The guidewire 10 may have a size (length and diameter) to navigate coronary, peripheral and/or cerebral vasculature, depending on the particular clinical application, and the distal tip portion 14 may be shaped to facilitate steering in such vascular anatomy.

[0011] As seen in Figure 2, the guidewire 10 may include a core wire 20 with a polymer jacket 50 surrounding a distal tip portion 14 thereof. Alternatively, the polymer jacket 50 may surround a mid portion of the guidewire 10 as shown in Figure 3. As shown in Figures 4 and 5, a radiopaque coil 40 may surround a distal portion 14 of the core wire 20, with a distal weld 42 connecting the distal end of the coil 40 to the distal end of the core wire 20 (not visible in Figures 4 and 5). In this latter instance, the polymer jacket 50 may surround the core wire 20 and the radiopaque coil 40. As a further alternative, the polymer jacket 50 may surround an inner polymer jacket (not shown) disposed on the core wire 20, resulting in a multi-layered polymer jacket arrangement, with layer thicknesses that may vary, but preferably do not exceed the proximal profile of the guidewire. In all embodiments, the polymer jacket 50 may incorporate radiopaque filler.

[0012] In all embodiments illustrated, the polymer jacket 50 may surround the core wire 20 and/or radiopaque coil 40 to establish contact therebetween or to establish an annular space therebetween. In addition, the polymer jacket 50 may surround and encase the core wire 20 and/or radiopaque coil 40 to encase the distal tip 14 as shown in Figures 2, 4 and 5, or merely surround a portion thereof without encasing as shown in Figure 3.

[0013] Core wire 20 may comprise a stainless steel metal or a super elastic metal such as nitinol (nickel titanium alloy) for purposes of navigating tortuous vasculature without causing plastic deformation thereof. Polymer jacket 50 may comprise a polymer and may have suitable dimensions and material characteristics that render the polymer jacket 50 more stiff than the distal tip portion 14 of the super elastic core wire 20 which it surrounds. As used herein, stiff or stiffness refers to the collective property defined by material characteristics and shape, as conventionally used in mechanical engineering design. In particular, the cross-sectional bending moment and the flexural modulus of the polymer jacket 50 may be selected such that when the tip 14 is deformed into a shape within the elastic limit of the super elastic core wire 20, and beyond the elastic limit of the polymer, the tip 14 substantially retains the shape, although some recoil may occur.

[0014] The polymer jacket 50 may comprise a shape memory polymer such as shape memory polyurethane available from Mitsubishi, polynorbomene polymers and copolymers (including blends with polyethylene and Kraton), polycaprolactone or (oligo)caprolactone copolymer, polymethylmethacylate, PLLA or PL/D LA copolymer, PLLA PGA copolymer, PMMA, cross-linked polyethylene, cross-linked polyisoprene, polycyclooctene, styrene-butadiene copolymer, or photocrosslinkable polymer including azo-dye, zwitterionic and other photoschromic materials (as referenced in Shape memory Materials, Otsuka and Wayman, Cambridge University press, © 1998).

[0015] With a shape memory polymer, the distal tip 14, including polymer jacket 50, core wire 20, and/or radiopaque coil 40, may be deformed into the desired shape. By way of example, not limitation, the distal tip portion 14 may be deformed about a cylindrical object 90 to impart a J-tip shape as shown in Figure 4, or a bent-L shape as shown in Figure 5. Although only basic shapes are shown, it is contemplated that a wide variety of simple and complex shapes may be achieved with the present invention. While the desired shape is maintained, the polymer jacket 50 may be subjected to heat at a temperature at or above the glass transition temperature (or near the melt temperature) of the shape memory polymer, and subsequently cooled to a temperature below the glass transition temperature. Once cooled, the distal tip 14 may be released from the constrained shape.

[0016] After releasing the distal tip 14 from the constrained shape, the elastic forces of the super elastic core wire 20 work against the polymer jacket 50, biasing the shape of the distal tip back to the original (e.g., straight) configuration. However, the polymer jacket 50 has sufficient stiffness, by virtue of its size and its material properties, to substantially oppose, if not completely offset, the biasing force of the super elastic core wire 20. The biasing force of the core wire 20 may be reduced by reducing the size (e.g., diameter) thereof, and the opposing force of the polymer jacket 50 may be increased by increasing the size (cross-sectional area moment) and/or the flexural modulus thereof. Thus, by substantially opposing, if not completely offsetting, the biasing force of the super elastic core wire 20, the polymer jacket 50 substantially maintains the deformed shape, although some recoil may occur. To compensate for such recoil, the deformed shape may be exaggerated relative to the desired final shape.

[0017] The distal tip 14 may be re-shaped by re-deforming the distal tip 14 and exposing the polymer jacket 50 to heat at a temperature at or above the glass transition temperature (or near the melt temperature) of the shape memory polymer, and subsequently cooled to a temperature below the glass transition temperature. The original (e.g., straight) configuration of the distal tip 14 may be recaptured by exposing the polymer jacket 50 to heat at a temperature at or above the transformation temperature of the shape memory polymer, followed by cooling. The distal tip 14 may be repeatedly shaped without compromising shapeability or guidewire performance.

[0018] The polymer jacket 50 may surround the distal tip portion 14 as shown in Figure 2 or a mid portion of the core wire 20 as shown in Figure 3. To accommodate the polymer jacket 50 and to provide a uniform outer profile, the core wire 20 may be ground to have a single taper or a series of tapers as shown in Figure 2 or ground to define a recess as shown in Figure 3.

[0019] In Figure 2, the distal portion 14 of the core wire 20 includes a series of tapers to accommodate the polymer jacket 50 and to provide a gradual reduction in stiffness toward the distal end thereof. For example, the core wire 20 may have a proximal uniform diameter portion 22 having a diameter of about 0.178 to 0.965 mm (0.007 to 0.038 inches) and a length "A" of about 100 to 260 cm, a mid uniform diameter portion 26 having a diameter of about 0.076 to 0.254 mm (0.003 to 0.010 inches) and a length "C" of about 5 to 30 cm, and a distal uniform diameter portion 30 having a diameter of about 0.038 to 0.127 mm (0.0015 to 0.005 inches) and a length "E" of about 5 to 30 cm. Alternatively, distal portion 30 may comprise a flat ribbon having a thickness of 0.038 to 0.127 mm (0.0015 to 0.005 inches). The core wire 20 may also include tapered portions 24/28 between the uniform diameter portions 22/26/30, having tapering diameters and lengths "B" and "D" of about 0.1 to 10 cm to provide a smooth transition between the uniform diameter portions 22/26/30. As an alternative, the core wire 20 may have a continuous taper terminating in a radiopaque tip, and covered by the polymer jacket 50.

[0020] In Figure 3, a mid portion (i.e., a portion that is proximal of the distal end and distal of the proximal end) of the core wire 20 is provided with an optional recess having a uniform diameter portion 34 and two tapered portions 32/36. The position of the recess 34 and thus the position of the polymer jacket 50 in this embodiment is dictated by the length "F" of the proximal uniform diameter portion 22 and the length "J" of the distal uniform diameter portion 38. The length "H" of the recess portion 34 may be selected depending on the desired shapeable length of the core wire 20. The lengths "G" and "I" of the tapered portion 32/36 may be the same or similar to that of tapered portions 24/28 described previously.

[0021] Those skilled in the art will recognize that the present invention may be manifested in a variety of forms other than the specific embodiments described and contemplated herein. Accordingly, departures in form and detail may be made without departing from the scope of the present invention as described in the appended claim.

Claims

1. A method of shaping a guidewire (10), comprising the steps of:

    providing a guidewire (10) comprising an elongate core wire (20) formed of a super elastic metal with a shape memory polymer jacket (50) surrounding a portion of the core wire (20), the super elastic metal having an elastic limit and the shape memory polymer having an elastic limit less than the elastic limit of the super elastic metal;
    deforming the polymer jacket (50) and the portion of the core wire (20) which it surrounds into a shape;
    heating the deformed polymer jacket (50) to a temperature at or above a glass transition temperature of the shape memory polymer; and
    cooling the deformed polymer jacket (50) to a temperature below the glass transition temperature of the shape memory polymer to maintain the shape;
    wherein when the polymer jacket (50) and the portion of the core wire (20) which it surrounds are deformed into a shape, the portion of the core wire (20) is within the elastic limit of the super elastic metal and the polymer jacket (50) is beyond the elastic limit of the shape memory polymer, thereby the polymer jacket retains the shape.

2. A method of shaping a guidewire as in claim 1, further comprising the steps of:

    deforming the polymer jacket (50) and the portion of the core wire (20) which it surrounds into a different shape;
    reheating the deformed polymer jacket (50) to a temperature at or above a glass transition temperature of the shape memory polymer; and
    cooling the deformed polymer jacket (50) to a temperature below the glass transition temperature of the shape memory polymer to maintain the different shape.

3. A method of shaping a guidewire as in claim 2, further comprising the steps of:

    reheating the deformed polymer jacket (50) to a temperature at or above a glass transition temperature of the shape memory polymer such that the guidewire (10) returns to its original shape; and
    cooling the deformed polymer jacket (50) to a temperature below the glass transition temperature of the shape memory polymer.

4. An intravascular guidewire (10) including an elongate core wire (20) formed of a super elastic metal having an elastic limit and a polymer jacket (50) surrounding a distal tip portion (14) of the core wire (20), the intravascular guidewire (10) further **characterized in that**:

    the polymer jacket (50) comprises a shape memory polymer having an elastic limit less than the elastic limit of the super elastic metal, the polymer jacket (50) being more stiff than the distal tip portion (14) of the core wire (20) which it surrounds such that when the distal tip portion (14) is deformed into a shape within the elastic limit of the super elastic metal and beyond the elastic limit of the shape memory polymer, the polymer jacket (50) substantially retains the shape of the distal tip portion (14).

5. An intravascular guidewire as in claim 4 wherein the super elastic metal comprises a nickel titanium alloy.

6. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory polyurethane.

7. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory polynorbomene or copolymers or blends thereof.

8. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory polycaprolactone or (oligo)caprolactone copolymer.

9. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory polymethylmethacylate.

10. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory PLLA copolymer.

11. An intravascular guidewire as in claim 4, wherein the

shape memory polymer comprises shape memory PLLA PGA copolymer.

12. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory PL/D LA copolymer.

13. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory PMMA copolymer.

14. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory cross-linked polyethylene.

15. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises shape memory cross-linked polyisoprene.

16. An intravascular guidewire as in *claim* 4, wherein the shape memory polymer comprises shape memory styrene-butadiene copolymer.

17. An intravascular guidewire as in claim 4, wherein the shape memory polymer comprises a photocrosslinkable polymer.

Patentansprüche

1. Verfahren zum Formen eines Führungsdrahts (10) mit den Schritten:

Versehen eines Führungsdrahts (10), der einen länglichen Kerndraht (20) aufweist, der aus einem superelastischen Metall gebildet ist, mit einem Formgedächtnis-Polymermantel (50), der einen Abschnitt des Kerndrahts (20) umgibt, wobei das superelastische Metall eine Elastizitätsgrenze hat und das Formgedächtnis-Polymer eine Elastizitätsgrenze hat, die kleiner als die Elastizitätsgrenze des superelastischen Metalls ist;
Verformen des Polymermantels (50) und des Abschnitts des Kerndrahts (20), den er umgibt, in eine Form;
Erwärmen des verformten Polymermantels (50) auf eine Temperatur auf oder über einer Glasübergangstemperatur des Formgedächtnis-Polymers; und
Abkühlen des verformten Polymermantels (50) auf eine Temperatur unter der Glasübergangstemperatur des Formgedächtnis-Polymers, um die Form beizubehalten;
wobei bei Verformen des Polymermantels (50) und des Abschnitts des Kerndrahts (20), den er umgibt, in eine Form der Abschnitt des Kerndrahts (20) innerhalb der Elastizitätsgrenze des superelastischen Metalls liegt und der Polymermantel (50) jenseits der Elastizitätsgrenze des Formgedächtnis-Polymers liegt, wodurch der Polymermantel die Form beibehält.

2. Verfahren zum Formen eines Führungsdrahts nach Anspruch 1, ferner mit den Schritten:

Verformen des Polymermantels (50) und des Abschnitts des Kerndrahts (20), den er umgibt, in eine unterschiedliche Form;
Wiedererwärmen des verformten Polymermantels (50) auf eine Temperatur auf oder über einer Glasübergangstemperatur des Formgedächtnis-Polymers; und
Abkühlen des verformten Polymermantels (50) auf eine Temperatur unter der Glasübergangstemperatur des Formgedächtnis-Polymers, um die unterschiedliche Form beizubehalten.

3. Verfahren zum Formen eines Führungsdrahts nach Anspruch 2, ferner mit den Schritten:

Wiedererwärmen des verformten Polymermantels (50) auf eine Temperatur auf oder über einer Glasübergangstemperatur des Formgedächtnis-Polymers, so daß der Führungsdraht (10) in seine ursprüngliche Form zurückkehrt; und Abkühlen des verformten Polymermantels (50) auf eine Temperatur unter der Glasübergangstemperatur des Formgedächtnis-Polymers.

4. Intravaskulärer Führungsdraht (10) mit einem länglichen Kerndraht (20), der aus einem superelastischen Metall mit einer Elastizitätsgrenze gebildet ist, und einem Polymermantel (50), der einen distalen Spitzenabschnitt (14) des Kerndrahts (20) umgibt, wobei der intravaskuläre Führungsdraht (10) ferner **dadurch gekennzeichnet ist, daß**:

der Polymermantel (50) ein Formgedächtnis-Polymer mit einer Elastizitätsgrenze aufweist, die kleiner als die Elastizitätsgrenze des superelastischen Metalls ist, wobei der Polymermantel (50) steifer als der distale Spitzenabschnitt (14) des Kerndrahts (20) ist, den er umgibt, so daß bei Verformen des distalen Spitzenabschnitts (14) in eine Form innerhalb der Elastizitätsgrenze des superelastischen Metalls und jenseits der Elastizitätsgrenze des Formgedächtnis-Polymers der Polymermantel (50) im wesentlichen die Form des distalen Spitzenabschnitts (14) beibehält.

5. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das superelastische Metall eine Nickel-Titan-Legierung aufweist.

6. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-Polyurethan aufweist.

7. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-Polynorbomen oder Copolymere oder Mischungen davon aufweist.

8. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-Polycaprolacton oder (Oligo)caprolacton-Copolymer aufweist.

9. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-Polymethylmethacrylat aufweist.

10. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-PLLA-Copolymer aufweist.

11. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-PLLA-PGA-Copolymer aufweist.

12. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-PL/D-LA-Copolymer aufweist.

13. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-PMNIA-Copolymer aufweist.

14. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer vernetztes Formgedächtnis-Polyethylen aufweist.

15. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer vernetztes Formgedächtnis-Polyisopren aufweist.

16. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer Formgedächtnis-Styrol-Butadien-Copolymer aufweist.

17. Intravaskulärer Führungsdraht nach Anspruch 4, wobei das Formgedächtnis-Polymer ein photovernetzbares Polymer aufweist.

Revendications

1. Procédé de configuration d'un fil guide (10), comprenant les étapes consistant à :

   procurer un fil guide (10) comprenant un fil central allongé (20) constitué d'un métal superélastique, une enveloppe polymère (50) à mémoire de forme entourant une portion du fil central (20), le métal superélastique possédant une limite élastique et le polymère à mémoire de forme possédant une limite élastique inférieure à la limite élastique du métal superélastique ;
   soumettre à une déformation l'enveloppe polymère (50) et la portion du fil central (20) qu'elle entoure, pour leur conférer une configuration ;
   chauffer l'enveloppe polymère (50) qui a été soumise à une déformation, à une température égale ou supérieure à la température de transition vitreuse du polymère à mémoire de forme ; et
   refroidir l'enveloppe polymère (50) qui a été soumise à une déformation, à une température inférieure à la température de transition vitreuse du polymère à mémoire de forme, afin de maintenir la configuration ;
   dans lequel, lorsque l'enveloppe polymère (50) et la portion du fil central (20) qu'elle entoure sont soumis à une déformation pour leur conférer une configuration, la portion du fil central (20) se trouve en deçà de la limite élastique du métal superélastique et l'enveloppe polymère (50) se trouve au-delà de la limite élastique du polymère à mémoire de forme, si bien que l'enveloppe polymère conserve sa configuration.

2. Procédé de configuration d'un fil guide selon la revendication 1, comprenant en outre les étapes consistant à :

   soumettre à une déformation l'enveloppe polymère (50) et la portion du fil central (20) qu'elle entoure pour leur conférer une configuration différente ;
   chauffer à nouveau l'enveloppe polymère (50) qui a été soumise à une déformation à une température égale ou supérieure à la température de transition vitreuse du polymère à mémoire de forme ; et
   refroidir l'enveloppe polymère (50) qui a été soumise à une déformation, à une température inférieure à la température de transition vitreuse du polymère à mémoire de forme, afin de maintenir la configuration différente.

3. Procédé de configuration d'un fil guide selon la revendication 2, comprenant en outre les étapes consistant à :

   chauffer à nouveau l'enveloppe polymère (50) qui a été soumise à une déformation à une température égale ou supérieure à la température de transition vitreuse du polymère à mémoire de forme, de telle sorte que le fil guide (10) reprenne sa configuration initiale ; et refroidir l'enveloppe polymère (50) qui a été soumise à une déformation, à une température inférieure à la température de transition vitreuse du polymère à mémoire de forme.

4. Fil guide intravasculaire (10) comprenant un fil central allongé (20) constitué d'un métal superélastique possédant une limite élastique et une enveloppe polymère (50) entourant une portion terminale (14) en position distale du fil central (20), le fil guide intravasculaire (10) étant en outre **caractérisé en ce que** :

l'enveloppe polymère (50) comprend un polymère à mémoire de forme possédant une limite élastique inférieure à la limite élastique du métal superélastique, l'enveloppe polymère (50) étant plus rigide que la portion terminale (14) en position distale du fil central (20) qu'elle entoure, de telle sorte que, lorsque la portion terminale (14) en position distale subit une déformation pour prendre une configuration en deçà de la limite élastique du métal superélastique et audelà de la limite élastique du polymère à mémoire de forme, l'enveloppe polymère (50) conserve essentiellement la configuration de la portion terminale (14) en position distale.

5. Fil guide intravasculaire selon la revendication 4, dans lequel le métal superélastique comprend un alliage à base de nickel titane.

6. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend du polyuréthane à mémoire de forme.

7. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend du polynorbornène à mémoire de forme ou ses copolymères ou ses mélanges.

8. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend de la polycaprolactone ou un copolymère d'(oligo)caprolactone à mémoire de forme.

9. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend du polyméthacrylate de méthyle à mémoire de forme.

10. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un copolymère PLLA à mémoire de forme.

11. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un copolymère PLLA PGA à mémoire de forme.

12. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un copolymère PL/D LA à mémoire de forme.

13. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un copolymère PMMA à mémoire de forme.

14. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend du polyéthylène réticulé à mémoire de forme.

15. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend du polyisoprène réticulé à mémoire de forme.

16. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un copolymère de styrène-butadiène à mémoire de forme.

17. Fil guide intravasculaire selon la revendication 4, dans lequel le polymère à mémoire de forme comprend un polymère photoréticulable.

Fig. 1

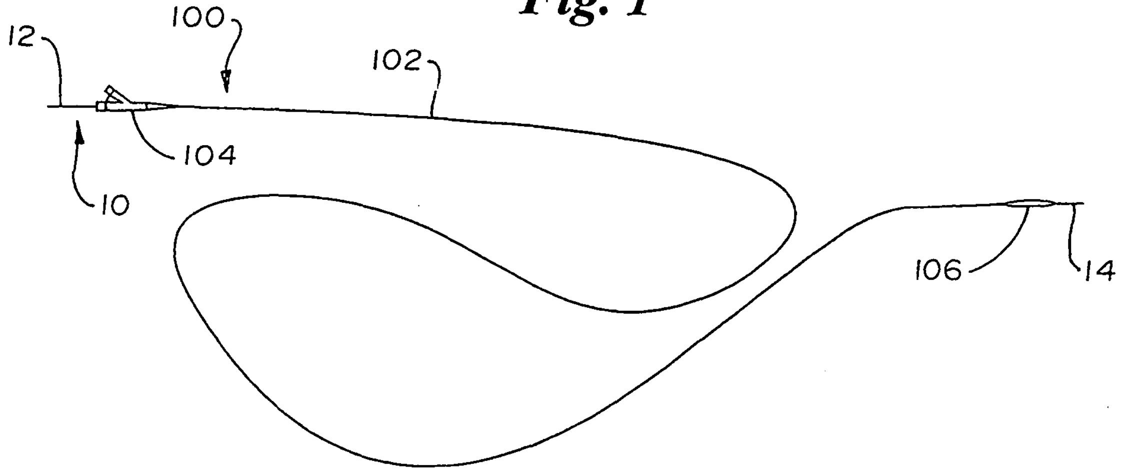


Fig. 2

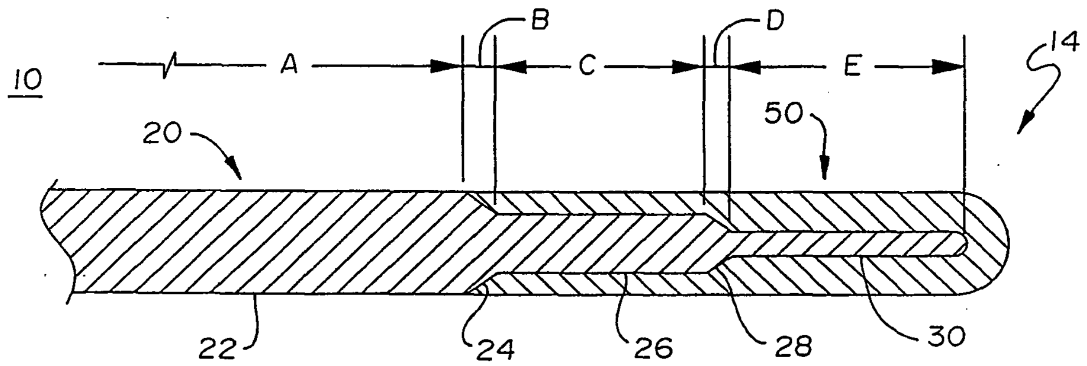
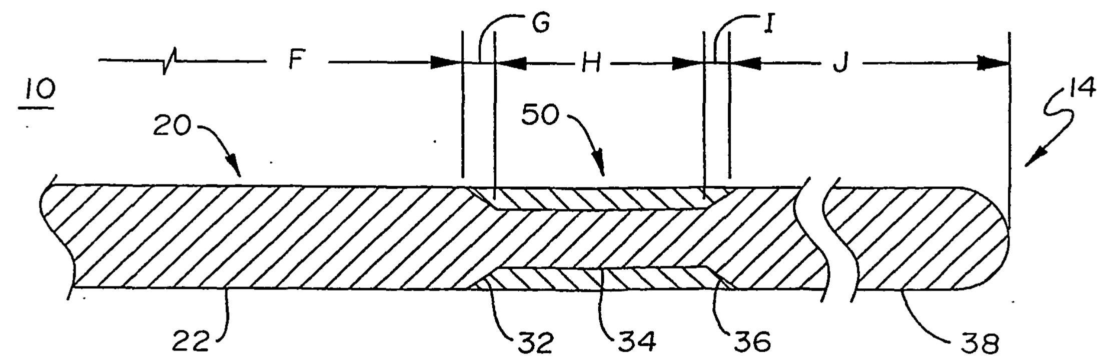


Fig. 3



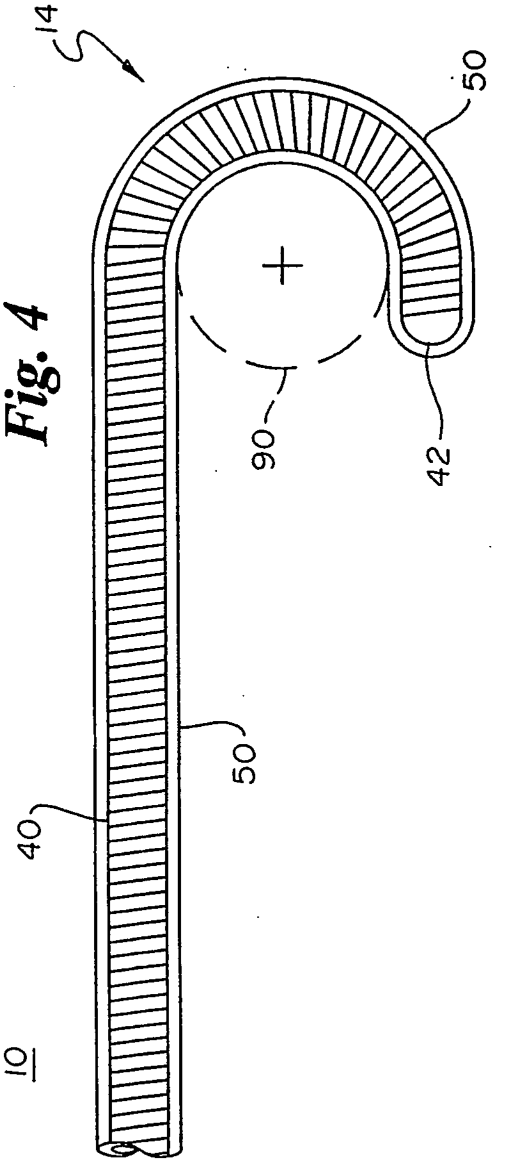


Fig. 4

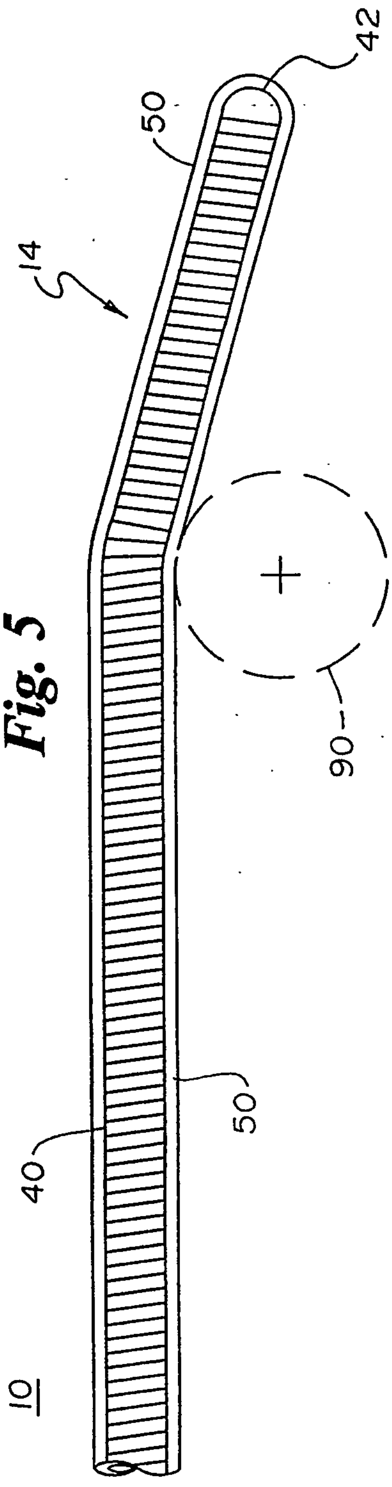


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- WO 0107499 A1 **[0005]**

Non-patent literature cited in the description

- **Otsuka ; Wayman.** Shape memory Materials. Cambridge University press, 1998 **[0014]**

patsnap

专利名称(译)	超弹性导丝，具有形状保持尖端		
公开(公告)号	EP1455880B1	公开(公告)日	2010-02-17
申请号	EP2002761822	申请日	2002-09-25
[标]申请(专利权)人(译)	波士顿科学有限公司		
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IPC分类号	A61M25/01 A61L27/00 A61B5/00 A61M25/09		
CPC分类号	A61L31/022 A61L31/10 A61L2400/16 A61M25/09 A61M2025/09141		
代理机构(译)	法思博事务所		
优先权	10/025668 2001-12-18 US		
其他公开文献	EP1455880A1		
外部链接	Espacenet		

摘要(译)

一种具有由形状记忆聚合物护套（50）包围的超弹性芯（20）的导丝（10）。超弹性芯线允许导丝通过迂回脉管系统导航而不经历塑性变形，并且形状记忆聚合物护套允许医生将导丝成形。