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# (54) FLEXIBLE ENDOLUMINAL STENT AND PROCESS OF MANUFACTURE

FLEXIBLER ENDOLUMINARER STENT UND VERFAHREN ZUR HERSTELLUNG

STENT ENDOLUMINAL FLEXIBLE ET SON PROCEDE DE FABRICATION

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## Description

### TECHNICAL FIELD

**[0001]** The present invention relates generally to endoluminal grafts or "stents" and, more specifically, to a flexible stent advantageous for use in a curved or tortuous lumen.

### BACKGROUND OF THE INVENTION

**[0002]** A stent is an elongated device used to support an intraluminal wall. In the case of a stenosis, a stent provides an unobstructed conduit for blood in the area of the stenosis. An intraluminal prosthesis may comprise a stent that carries a prosthetic graft layer of fabric. Such a prosthesis may be used, for example, to treat a vascular aneurysm by removing the pressure on a weakened part of an artery so as to reduce the risk of rupture. Typically, an intraluminal stent or prosthesis is implanted in a blood vessel at the site of a stenosis or aneurysm endoluminally, i.e. by so-called "minimally invasive techniques" in which the stent, restrained in a radially compressed configuration by a sheath or catheter, is delivered by a stent deployment system or "introducer" to the site where it is required. The introducer may enter the body through the patient's skin, or by a "cut down" technique in which the entry blood vessel is exposed by minor surgical means. When the introducer has been threaded into the body lumen to the stent deployment location, the introducer is manipulated to cause the stent to be ejected from the surrounding sheath or catheter in which it is restrained (or alternatively the surrounding sheath or catheter is retracted from the stent), whereupon the stent expands to a predetermined diameter at the deployment location, and the introducer is withdrawn. Stent expansion may be effected by spring elasticity, balloon expansion, or by the self-expansion of a thermally or stress-induced return of a memory material to a preconditioned expanded configuration.

**[0003]** WO-A-99 44535 describes a stent having a plurality of individual hoops connected by a connecting spine.

**[0004]** Some locations in which stents may be implanted are tortuous in nature, such as the aortic arch for thoracic aneurysm treatment. Additionally, the aneurysm may gradually change in volume after implantation of the stent (known in the art as D3 and H3 shrinkage). Known stents may not be flexible enough to adjust to the tortuosity of the lumen along its length or to changes in the aneurysm after implantation. Thus, it would be useful to have a more flexible stent to accommodate such situations.

### SUMMARY OF THE INVENTION

**[0005]** The present invention comprises a generally tubular intraluminal compound stent comprising a plurality of component stents, each component stent having a length and a plurality of individual hoops axially disposed along the length and connected by a connecting spine. The component stents are meshed with one another such that at least one hoop of one component stent is positioned between axially adjacent hoops of another component stent. Each component stent may comprise a single wire, each hoop comprising a circumferential winding of the wire, and the connecting spine comprising at least one connecting spine member comprising an extension of the wire between adjacent hoops. Each connecting spine may traverse each component stent circumferentially in a helical pattern, wherein the spine of at least one component stent is oriented in a different helical direction than the helical direction of the spine of another component stent in the compound stent. The compound stent may consist essentially of a first component stent having a first connecting spine and a second component stent having a second connecting spine. The hoops of the first component stent may be axially interspersed with the hoops of the second component stent in an alternating pattern, such as a single hoop alternating pattern. The first connecting spine may be helically oriented in a clockwise direction and the second connecting spine oriented in a counter-clockwise direction.

**[0006]** Each hoop may further have a periphery comprising a pattern of zig-zags having apices, wherein adjacent hoops of the meshed stents are aligned such that the apices of adjoining hoops abut or are interdigitated with one another. The compound stent may further comprise connectors, such as sutures, connecting at least some of the abutting or interdigitated apices.

**[0007]** The invention also comprises a process for manufacture of a compound stent having a length, the method comprising creating a plurality of component stents, each component stent having a length and a plurality of hoops axially disposed along the length and connected by a connecting spine. The process comprises meshing the plurality of component stents together such that at least one hoop of one component stent is positioned between axially adjacent hoops of another component stent. Each hoop of each stent may further comprise a pattern of zig-zags having apices in which case the method further comprises meshing the component stents so that the apices of adjacent hoops of the meshed component stents abut or are interdigitated with one another. The process may further comprise connecting at least some of the abutting or interdigitated apices with one another. Creating each component stent may comprise creating each component stent by winding a single wire circumferentially to form each hoop and extending connecting spine members between adjacent hoops, aligning the connecting spine members such that the connecting spine members collectively form a connecting spine oriented in a helical pattern. In such case, the process further comprises cre-

ating at least one of the component stents with a connecting spine that traverses the component stent in a helical orientation opposite the helical orientation of the connecting spines of the other component stents, so that meshing the component stents together comprises crossing the oppositely-oriented helical spines in at least one location along the compound stent.

**[0008]** It is to be understood that both the foregoing general description and the following detailed description are exemplary, but are not restrictive, of the invention.

## BRIEF DESCRIPTION OF DRAWING

**[0009]** The invention is best understood from the following detailed description when read in connection with the accompanying drawing. It is emphasized that, according to common practice, the various features of the drawing are not to scale. On the contrary, the dimensions of the various features are arbitrarily expanded or reduced for clarity. Included in the drawing are the following figures:

Figs. 1A and 1B are end and side views, respectively, of an exemplary first component stent of the present invention in isolation.

Figs. 2A - 2B are end and side views, respectively, of an exemplary second component stent of the present invention in isolation.

Fig. 3 is a side view illustration of an exemplary compound stent of the present invention comprising the component stents of Fig. 1B and Fig. 2B meshed together.

Figs. 4A - 4C are schematic side view illustrations of the exemplary compound stent of Fig. 3 in a flexed configuration viewed along an inner radius of curvature, showing differing amounts of overlap between successive hoops at varying radii of curvature.

Fig. 5 is a flowchart depicting an exemplary process for manufacture of a stent of the present invention.

## DETAILED DESCRIPTION OF INVENTION

**[0010]** Referring now to the drawing, Figs. 1A - 4 illustrate various aspects of an intraluminal compound stent according to the present invention. Generally, compound stent 10 is a tubular stent comprising a plurality of hoops 12i-iii and 12'i-iii disposed axially along the length of the stent. Compound stent 10 comprises two component stents 20 and 20' joined together: a first component stent 20 having a plurality of axially-disposed individual hoops 12i-iii and a connecting spine 22, and a second component stent 20' having a plurality of axially-disposed individual hoops 12'i-iii and a connecting spine 22'. The hoops of the first and second component stents are meshed together so that at least one hoop of one component stent is positioned between axially adjacent hoops of the other component stent, as shown in Fig. 3. For example, hoop $12'_i$ is positioned between hoops $12_i$ and 12ii, hoop 12ii is positioned between hoops 12'i and 12'ii, and so on.

**[0011]** As shown in Fig. 3, hoops 12i-iii and 12'i-iii of stents 20 and 20', respectively, are meshed with one another in a single hoop alternating pattern. "Single hoop alternating pattern" as used herein means that the hoops alternate one hoop from stent 20, one hoop from stent 20', and so on, traversing compound stent 10 in an axial direction. The alternating pattern of stent 10 may be represented by a shorthand such as 1:1:1:1:1:1, indicating that there are 6 hoops overall, alternating one at a time. Other stents may be constructed in a two or other multiple-hoop alternating pattern (2:2:2:2) or in a non-homogeneous alternating pattern (3:2:2:3, 1:2:1, etc.). Compound stents comprising more than two component stents may also be constructed.

**[0012]** Each hoop 12 and 12' of stents 20 and 20' comprises a pattern of zig-zags between apices 13, as shown in Figs. 1A-3. As shown in Fig. 3, abutting apices 13 of hoops 20 and 20' may be connected together by sutures 14, as is well known in the art. As shown in Figs. 1A and 1B, hoops 12 of stent 20 may be formed of a continuous wire 18 that winds circumferentially in a zig-zag pattern to make a first hoop 12i, then forms a spine member 21i, then hoop 12ii, and so on. The combination of spine members 21n between hoops 12n and 12n + 1 collectively form spine 22, which wraps around the circumference of the stent in a helical pattern. As shown in Figs. 1A and 1B, spine 22 wraps about stent 20 in a helical counter-clockwise fashion, as viewed from hoop 12iii looking in the direction of hoop 12i.

**[0013]** Similarly, stent 20', as shown in Figs. 2A and 2B, comprises wire 18' wound into corresponding hoops 12'i-iii and connecting segments 21'i-ii of spine 22' in what is essentially a mirror image of stent 20. As shown in Figs. 2A and 2B, spine 22' wraps about stent 20' in a helical clockwise fashion, as viewed from hoop 12'iii looking in the direction of hoop 12'i. As shown in Fig. 3, the two stents 20 (dark wires 18) and 20' (light wires 18') come together to form compound stent 10. Although only three hoops 12 or 12' are shown on each stent 20 and 20' to conserve space in Figs. 1A-3, compound stent 10 may comprise as many hoops as necessary to reach the desired length.

**[0014]** Wires 18 and 18' may comprise a shape-memory material, such as nitinol. Although shown as single-wire, helical-spine stents in Figs. 1A-3, component stents may be formed of compound stents having multiple wires, having non-helical spines or spines where the helical or other pattern is broken into discrete sections between adjacent hoops rather than aligned in a continuous spine, or having a spine that comprises a

separate wire from the wire comprising the hoops.

**[0015]** Figs. 4A-4C are side views of a curved portion of compound stent 10 at the inner radius of that curvature, showing how the apices 13 of adjacent pairs of hoops 12 and 12' may slip relative to one another and become interdigitated when compound stent 10 is flexed. As used herein, the term "interdigited" means that a portion of one hoop extends axially into the axial length defined by an adjacent hoop. Thus, Fig. 4A shows a curved portion having a radius of curvature "R" that is greater than the radius of curvature for Figs. 4B and 4C, with Fig. 4C illustrating the smallest radius of curvature, or the most flexed state, of the three related figures.

**[0016]** The slippage direction of apices 13 of adjacent hoops 12 and 12' relative to one another may prevent torsional forces from developing in compound stent 10. The helical orientation of spines 22 and 22' in opposite directions from one another may facilitate and direct such slippage. The apices of hoops 12 tend to slip in the direction of arrow "B" and the apices of hoops 12' tend to slip in the direction of arrow "C", producing substantially a net zero torsional resultant force on compound stent 10. Even if one or more hoops slip in the opposite direction than expected, other hoops may compensate for such misdirection, making the overall resultant still substantially zero. Providing a substantially zero resultant force is desirable so that stent 10 may be flexed either at or after deployment to meet the tortuous curvature of the lumen in which it is implanted without torsional resistance forces potentially affecting the integrity of any seal between the stent and the lumen. To achieve such a substantially zero resultant, each component stent having opposite helical spines preferably has the same number of hoops.

**[0017]** Because spines 22 and 22' circumscribe component stents 20 and 20' , respectively, in opposite rotational directions, the spines have overlapping sections 40 at regular intervals, as shown in Fig. 3. Overlapping section 40 may be a less flexible section than the remainder of the compound stent 10, and such overlaps may be integrated into the overall stent design to provide flexibility and rigidity where desired. Where more than two component stents are meshed together to form a compound stent, overlapping sections may be distributed in a particular pattern to provide stiffness where desired. In particular, it may be desirable to distribute overlapping sections so that each is spaced circumferentially 180° from another. The more component stents meshed together, the more such overlapping sections created and the stiffer the resulting compound stent.

**[0018]** Abutting apices 13 of adjacent hoops 12 and 12' are connected to one another with connectors 14, which may be sutures as shown in detail oval 16 of Fig. 4B. During flexion of compound stent 10, sutures or other connectors 14 connecting interdigitated apices 13 may tend to develop an angular orientation with respect to longitudinal axis A of the compound stent as shown in Figs. 4A-4C. As shown, the angular orientation of successive connectors 14L and 14R along the length of compound stent 10 may even alternate in opposing directions with respect to longitudinal axis A. Thus, connectors 14L may become oriented from axis A pointing to the left in the distal direction, whereas connectors 14R may become oriented from axis A pointing to the right in the distal direction. Slippage may still occur, however, without the sutures developing the particular angular orientation as illustrated by sutures 14L and 14R in Figs. 4A-4C.

**[0019]** Although illustrated herein with respect to compound stents comprising only two stents having hoops meshed in an alternating fashion with one another, the invention may also comprise a stent having more than two such stents with hoops so meshed. Where more than two such stents are involved, at least one of the stents may have a helical spine that is oriented oppositely from the others. For example, a three-stent compound stent may comprise two clockwise spines and one counter-clockwise spine, or vice versa, whereas a four-stent compound stent may comprise two clockwise and two counter-clockwise or three in one direction and one in the opposite direction. The compound stent as disclosed herein may also comprise a liner of biocompatible graft material covering either the outside of the stent, the inside of the stent, or both.

**[0020]** The present invention also comprises a process for manufacture of a compound stent as described and illustrated herein. Referring now to Fig. 5, there is shown a flowchart depicting an exemplary such process. The process comprises in step 100, creating a plurality of component stents such as stents 20 and 20' of Figs. 1A-2B, each having a length and a plurality of individual hoops 12i-iii and 12'i-iii respectively, axially disposed along their length and each having a connecting spine 22 and 22', respectively. Forming each component stent in step 100 may further comprise step 100a of winding a single wire, such as wires 18 and 18', on for example a mandrel, to form each hoop 12i-iii and 12'i-iii respective connecting spine members 21i-ii and 21'i-ii between adjacent hoops, each set of collective connecting spine members forming helically-oriented connecting spines 22 and 22'. Step 100a may comprise creating at least one component stent having a connecting spine with a helical orientation opposite the helical orientation of a connecting spine in the another component stent, such as spine 22 that is helical counter-clockwise as compared to spine 22' that is helical clockwise. Forming each hoop in step 100a may further comprise in step 100b, winding each hoop in a zig-zag pattern having apices 13.

**[0021]** Next, the process comprises in step 110, meshing the plurality of component stems together such that at least one hoop of one component stent is positioned between axially adjacent hoops of another component stent, such as hoop 12'i of stent 20' meshed between hoops 12i and 12ii of stent 20 in compound stent

10 of Fig. 3. The meshing step 110 may further comprise step 110a of distributing the hoops so that the apices of adjacent hoops of the meshed component stents abut or are interdigitated with one another, as is illustrated by abutting apices 13 in Fig. 3. Furthermore, the meshing step 110 may comprise in step 110b meshing the plurality of component stents together such that the oppositely-orientated helical spines cross one another in at least one location along the compound stent, such as overlapping section 40 as shown in Fig. 3. Finally, in step 120, the process may further comprise connecting at least some of the abutting or interdigitated apices, such as sutures 14 shown connecting apices 13 in Fig. 3.

**[0022]** Although illustrated and described herein with reference to certain specific embodiments, the present invention is nevertheless not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope of the invention as defined by the appended set of claims.

## Claims

1. A generally tubular intraluminal compound stent comprising a plurality of component stents, each component stent having a length and a plurality of individual hoops axially disposed along said length and connected by a connecting spine, said component stents meshed with one another such that at least one hoop of one component stent is positioned between axially adjacent hoops of another component stent.

2. The compound stent of claim 1 wherein each connecting spine of each component stent is oriented in a helical pattern.

3. The compound stent of claim 2 wherein the connecting spine of a first component stent is oriented in a first helical direction and the connecting spine of a second component stent is oriented in a second helical direction opposite said first helical direction.

4. The compound stent of claim 2 wherein each component stent comprises a single wire, each hoop comprising a circumferential winding of said wire, said connecting spine comprising at least one connecting spine member comprising an extension of said wire between adjacent hoops.

5. The compound stent of claim 1 wherein each said hoop comprises a pattern of zig-zags having apices.

6. The compound stent of claim 5 wherein axially adjacent hoops of the meshed component stents are aligned such that the apices of axially adjacent hoops abut or are interdigitated with one another.

7. The compound stent of claim 6 further comprising connectors connecting at least some of said abutting or interdigitated apices.

8. The compound stent of claim 7 wherein said connectors are sutures.

9. The compound stent of claim 1 wherein each component stent comprises a shape-memory material.

10. The compound stent of claim 1 further comprising a biocompatible graft liner that covers said compound stent inside of the compound stent, outside of the compound stent, or some combination thereof.

11. The compound stent of claim 1 consisting essentially of a first component stent having a first connecting spine and a second component stent having a second connecting spine.

12. The compound stent of claim 11 wherein the hoops of said first component stent are axially interspersed with the hoops of said second component stent in an alternating pattern.

13. The compound stent of claim 12 wherein said alternating pattern of hoops comprises a single hoop alternating pattern.

14. The compound stent of claim 13 wherein the first component stent further comprises a first wire, each hoop of said first component stent comprising a circumferential winding of said first wire, said first connecting spine comprising at least one connecting spine member comprising an extension of said first wire between adjacent hoops of said first component stent, and wherein the second component stent further comprises a second wire, each hoop of said second component stent comprising a circumferential winding of said second wire, said second connecting spine comprising at least one connecting spine member comprising an extension of said second wire between adjacent hoops of said second component stent.

15. The compound stent of claim 14 wherein the first connecting spine is helically oriented in a clockwise direction and the second connecting spine is helically oriented in a counter-clockwise direction.

16. The compound stent of claim 15 wherein each said hoop of said first and second component stents further comprises a pattern of zig-zags having apices, the compound stent further comprising axially adjacent hoops of the meshed component stents aligned such that the apices of axially adjacent hoops abut or are interdigitated with one another

and have connectors connecting at least some of said abutting or interdigitated apices.

**17.** The compound stent of claim 16 wherein the connectors are sutures.

**18.** A process for manufacture of a compound stent, the method comprising:

a) creating a plurality of component stents, each component stent having a length and a plurality of hoops axially disposed along said length and connected by a connecting spine;

b) meshing said plurality of component stents together such that at least one hoop of one component stent is positioned between axially adjacent hoops of another component stent.

**19.** The process of claim 18 wherein each said hoop of said component stents further has a periphery comprising a pattern of zig-zags having apices, the method further comprising meshing said component stents so that the apices of adjacent hoops of the meshed component stents abut or are interdigitated with one another.

**20.** The process of claim 19 further comprising connecting at least some of the abutting or interdigitated apices with one another.

**21.** The process of claim 18 further comprising in step (a) creating each said component stent by winding a single wire circumferentially to form each hoop and extending connecting spine members between adjacent hoops, aligning said connecting spine members such that said connecting spine members collectively form a connecting spine oriented in a helical pattern.

**22.** The process of claim 21 further comprising in step (a) creating at least one of said plurality of component stents having a connecting spine that traverses the component stent in a helical orientation opposite a helical orientation of a connecting spine of another of said plurality of component stents, wherein in step (b) meshing said plurality of component stents together further comprises crossing said spines having opposite helical orientations in at least one location along said compound stent.

**Patentansprüche**

**1.** Ein im wesentlichen tubularer endoluminaler Verbund-Stent, aufweisend eine Vielzahl von Stentkomponenten, wobei jede Stentkomponente eine Länge und eine Vielzahl von Einzelringen, die entlang dieser Länge verteilt angeordnet sind und mittels eines Verbindungsrückgrats verbunden sind, aufweist, wobei die Stentkomponenten miteinander derart vermascht sind, dass wenigstens ein Ring einer Stentkomponente zwischen axial benachbarten Ringen einer anderen Stentkomponente angeordnet ist.

**2.** Verbund-Stent nach Anspruch 1, wobei jedes Verbindungsrückgrat einer jeden Stentkomponente in einem spiralförmigen Muster ausgerichtet ist.

**3.** Verbund-Stent nach Anspruch 2, wobei das Verbindungsrückgrat einer ersten Stentkomponente in einer ersten spiralförmigen Richtung ausgerichtet ist und das Verbindungsrückgrat einer zweiten Stentkomponente in einer zweiten spiralförmigen Richtung entgegengesetzt zur ersten spiralförmigen Richtung ausgerichtet ist.

**4.** Verbund-Stent nach Anspruch 2, wobei jede Stentkomponente einen einzelnen Draht aufweist, jeder Ring eine Umfangs-Windung dieses Drahtes aufweist, wobei das Verbindungsrückgrat wenigstens ein Verbindungsrückgrat-Teil aufweist, welches einen Ausleger des Drahtes zwischen benachbarten Ringen aufweist.

**5.** Verbund-Stent nach Anspruch 1, wobei jeder Ring ein Zickzack-Muster mit Spitzen aufweist.

**6.** Verbund-Stent nach Anspruch 5, wobei axial benachbarte Ringe des vermaschten Verbund-Stents derart aneinander gereiht sind, dass die Spitzen von axial benachbarten Ringen aneinander angrenzen oder untereinander ineinander verflochten sind.

**7.** Verbund-Stent nach Anspruch 6 weiterhin aufweisend Verbinder, welche wenigstens einige der angrenzenden oder ineinander verflochtenen Spitzen miteinander verbinden.

**8.** Verbund-Stent nach Anspruch 7, wobei die Verbinder chirurgische Nähte sind.

**9.** Verbund-Stent nach Anspruch 1, wobei jede Stentkomponente ein Formgedächnis-Material aufweist.

**10.** Verbund-Stent nach Anspruch 1, weiterhin aufweisend ein bioverträgliches Transplantatrohr, welches den Verbund-Stent im Inneren des Verbund-Stents, außerhalb des Verbund-Stents oder in einer Kombination hieraus bedeckt.

**11.** Verbund-Stent nach Anspruch 1, im wesentlichen bestehend aus einer ersten Stentkomponente mit einem ersten Verbindungsrückgrat und einer zwei-

ten Stentkomponente mit einem zweiten Verbindungsrückgrat.

**12.** Verbund-Stent nach Anspruch 11, wobei die Ringe der ersten Stentkomponente axial mit den Ringen der zweiten Stentkomponente in einem alternierenden Muster durchsetzt sind.

**13.** Verbund-Stent nach Anspruch 12, wobei das alternierende Muster der Ringe ein alternierendes Muster aus Einzelringen aufweist.

**14.** Verbund-Stent nach Anspruch 13, wobei die erste Stentkomponente weiterhin einen ersten Draht aufweist, jeder Ring der ersten Stentkomponente eine umfängliche Windung des ersten Drahtes aufweist, das erste Verbindungsrückgrat wenigstens ein Verbindungsrückgrat-Teil aufweist, welches einen Ausleger des ersten Drahtes zwischen benachbarten Ringen der ersten Stentkomponente aufweist, und wobei die zweite Stentkomponente weiterhin einen zweiten Draht aufweist, jeder Ring der zweiten Stentkomponente eine umfängliche Windung dieses zweiten Drahtes aufweist, das zweite Verbindungsrückgrat wenigstens ein Verbindungsrückgrat-Teil aufweist, welches einen Ausleger des zweiten Drahtes zwischen benachbarten Ringen der zweiten Stentkomponente aufweist.

**15.** Verbund-Stent nach Anspruch 14, wobei das erste Verbindungsrückgrat spiralförmig in einer Richtung im Uhrzeigersinn ausgerichtet und das zweite Verbindungsrückgrat spiralförmig in einer Gegen-Uhrzeigerrichtung ausgerichtet ist.

**16.** Verbund-Stent nach Anspruch 15, wobei jeder Ring der ersten und zweiten Stentkomponente weiterhin ein ZickzackMuster mit Spitzen aufweist, der Verbund-Stent weiterhin axial benachbarte Ringe der vermaschten Stentkomponente aufweist, welche derart aufeinanderfolgend angeordnet sind, dass die Spitzen von axial benachbarten Ringen aneinander grenzen oder untereinander ineinander verflochten sind und Verbinder haben, die wenigstens einige der benachbarten oder ineinander verflochtenen Spitzen verbinden.

**17.** Verbund-Stent nach Anspruch 16, wobei die Verbinder chirurgische Nähte sind.

**18.** Prozess zur Herstellung eines Verbund-Stents, wobei das Verfahren aufweist:

a) Erzeugen einer Vielzahl von Stentkomponenten, wobei jede Stentkomponente eine Länge und eine Vielzahl von Ringen hat, die axial entlang der Länge verteilt angeordnet sind und durch ein Verbindungsrückgrat miteinander verbunden sind;

b) Zusammenvermaschen dieser Vielzahl von Stentkomponenten derart, dass wenigstens ein Ring einer Stentkomponente zwischen axial benachbarten Ringen einer anderen Stentkomponente angeordnet ist.

**19.** Prozess nach Anspruch 18, wobei jeder Ring der Stentkomponenten weiterhin eine Peripherie aufweist, welche ein Zickzack-Muster mit Spitzen aufweist, wobei das Verfahren weiterhin das Vermaschen der Stentkomponenten aufweist derart, dass die Spitzen von benachbarten Ringen der vermaschten Stentkomponenten aneinander angrenzen oder untereinander ineinander verflochten sind.

**20.** Prozess nach Anspruch 19, weiterhin aufweisend das Verbinden wenigstens einiger der angrenzenden oder ineinander verflochtenen Spitzen untereinander.

**21.** Prozess nach Anspruch 18, weiterhin aufweisend im Schritt das Erzeugen einer jeden Stentkomponente durch umfängliches Winden eines einzelnen Drahtes zur Formung eines jeden Ringes und das Erstrecken von Verbindungsrückgrat-Teilen zwischen benachbarten Ringen, das Aneinaderreihen der Verbindungsrückgrat-Teile derart, dass diese Verbindungsrückgrat-Teile zusammen ein Verbindungsrückgrat bilden, welches in einem spiralförmigen Muster ausgerichtet ist.

**22.** Prozess nach Anspruch 21, weiterhin umfassend im Schritt das Erzeugen wenigstens einer aus der Vielzahl der Stentkomponenten mit einem Verbindungsrückgrat, welches die Stentkomponente in einer spiralförmigen Orientierung entgegengesetzt zu einer spiralförmigen Orientierung eines Verbindungsrückgrats eines anderen aus der Vielzahl der Stentkomponenten quert, wobei in Schritt das Zusammenvermaschen dieser Vielzahl von Stentkomponenten weiterhin das Überkreuzen der Rückgrate mit entgegengesetzter spiralförmiger Richtung an wenigstens einer Stelle entlang der Stentkomponent umfasst.

**Revendications**

**1.** Stent endoluminal composé globalement tubulaire constitué d'une pluralité de stents élémentaires, chaque stent élémentaire ayant une longueur et une pluralité d'arceaux individuels disposés axialement sur ladite longueur et reliés par un brin de liaison, lesdits stents élémentaires s'accrochant les uns aux autres de telle sorte qu'au moins un arceau d'un stent élémentaire est placé entre des arceaux

axialement adjacents d'un autre stent élémentaire.

**2.** Stent composé selon la revendication 1, dans lequel chaque brin de liaison de chaque stent élémentaire est orienté suivant une configuration hélicoïdale.

**3.** Stent composé selon la revendication 2, dans lequel le brin de liaison d'un premier stent élémentaire est orienté dans une première direction hélicoïdale et le brin de liaison d'un deuxième stent élémentaire est orienté dans une deuxième direction hélicoïdale opposée à ladite première direction hélicoïdale.

**4.** Stent composé selon la revendication 2, dans lequel chaque stent élémentaire est constitué d'un seul fil, chaque arceau comportant un enroulement circonférentiel dudit fil, ledit brin de liaison comportant au moins un élément de brin de liaison constituant un prolongement dudit fil entre des arceaux adjacents.

**5.** Stent composé selon la revendication 1, dans lequel chaque dit arceau constitue un motif de zigzags ayant des sommets.

**6.** Stent composé selon la revendication 5, dans lequel des arceaux axialement adjacents des stents élémentaires accrochés les uns aux autres sont alignés de telle sorte que les sommets d'arceaux axialement adjacents butent les uns contre les autres ou sont imbriqués les uns dans les autres.

**7.** Stent composé selon la revendication 6, comprenant en outre des éléments de liaison reliant au moins certains desdits sommets en butée ou imbriqués.

**8.** Stent composé selon la revendication 7, dans lequel lesdits éléments de liaison sont des sutures.

**9.** Stent composé selon la revendication 1, dans lequel chaque stent élémentaire est en matière à mémoire de forme.

**10.** Stent composé selon la revendication 1, comprenant en outre une gaine de greffe biocompatible qui couvre ledit stent composé à l'intérieur du stent composé, à l'extérieur du stent composé, ou une certaine combinaison de ceux-ci.

**11.** Stent composé selon la revendication 1, essentiellement constitué d'un premier stent élémentaire ayant un premier brin de liaison et d'un deuxième stent élémentaire ayant un deuxième brin de liaison.

**12.** Stent composé selon la revendication 11, dans lequel les arceaux dudit premier stent élémentaire sont mêlés axialement aux arceaux dudit deuxième stent élémentaire suivant un motif alterné.

**13.** Stent composé selon la revendication 12, dans lequel ledit motif alterné d'arceaux comporte un seul motif alterné d'arceaux.

**14.** Stent composé selon la revendication 13, dans lequel le premier stent élémentaire comprend en outre un premier fil, chaque arceau dudit premier stent élémentaire comportant un enroulement circonférentiel dudit premier fil, ledit premier brin de liaison étant constitué d'au moins un élément formant brin de liaison constituant un prolongement dudit premier fil entre des arceaux adjacents dudit premier stent élémentaire, et dans lequel le deuxième stent élémentaire comporte en outre un deuxième fil, chaque arceau dudit deuxième stent élémentaire comportant un enroulement circonférentiel dudit deuxième fil, ledit deuxième brin de liaison étant constitué d'au moins un élément formant brin de liaison constituant un prolongement dudit deuxième fil entre des arceaux adjacents dudit deuxième stent élémentaire.

**15.** Stem composé selon la revendication 14, dans lequel le premier brin de liaison est orienté de manière hélicoïdale dans un sens horaire et le deuxième brin de liaison est orienté de manière hélicoïdale dans un sens anti-horaire.

**16.** Stent composé selon la revendication 15, dans lequel chaque dit arceau desdits premier et deuxième stents élémentaires comporte en outre un motif de zig-zags ayant des sommets, le stent composé comprenant en outre des arceaux axialement adjacents des stents élémentaires accrochés les uns aux autres alignés de telle sorte que les sommets d'arceaux axialement adjacents butent les uns contre les autres ou sont imbriqués les uns dans les autres et ont des éléments de liaison reliant au moins certains desdits sommets en butée ou imbriqués.

**17.** Stent composé selon la revendication 16, dans lequel les éléments de liaison sont des sutures.

**18.** Procédé de fabrication d'un stent composé, le procédé comprenant les étapes consistant à:

a) créer une pluralité de stents composés, chaque stent composé ayant une longueur et une pluralité d'arceaux disposés axialement sur ladite longueur et reliés par un brin de liaison;
b) accrocher ladite pluralité de stents élémentaires les uns aux autres de telle sorte qu'au moins un arceau d'un stent élémentaire est pla-

cé entre des arceaux axialement adjacents d'un autre stent élémentaire.

**19.** Procédé selon la revendication 18, dans lequel chaque dit arceau desdits stents élémentaires a un pourtour constituant un motif de zig-zags ayant des sommets, le procédé comprenant en outre l'étape consistant à accrocher lesdits stents élémentaires les uns aux autres de façon que les sommets d'arceaux adjacents des stents élémentaires accrochés les uns aux autres butent les uns contre les autres ou soient imbriqués les uns dans les autres.

**20.** Procédé selon la revendication 19, comprenant en outre l'étape consistant à relier les uns aux autres au moins certains des sommets en butée ou imbriqués.

**21.** Procédé selon la revendication 18, comprenant en outre, lors de l'étape (a) les étapes consistant à créer chaque dit stent élémentaire en enroulant un seul fil dans la direction circonférentielle pour former chaque arceau et prolonger des éléments formant brins de liaison entre des arceaux adjacents, aligner lesdits éléments formant brins de liaison de telle sorte que lesdits éléments formant brins de liaison forment collectivement un brin de liaison orienté suivant une configuration hélicoïdale.

**22.** Procédé selon la revendication 21, comprenant en outre, lors de l'étape (a), les étapes consistant à créer au moins un de ladite pluralité de stents élémentaires ayant un brin de liaison qui passe dans le stent élémentaire suivant une orientation hélicoïdale opposée à une orientation hélicoïdale d'un brin de liaison d'un autre de ladite pluralité de stents élémentaires et, lors de l'étape (b) consistant à accrocher les uns aux autres ladite pluralité de stents élémentaires compte en outre l'étape consistant à croiser lesdits stents à orientations hélicoïdales opposées en au moins un endroit le long dudit stent élémentaire.

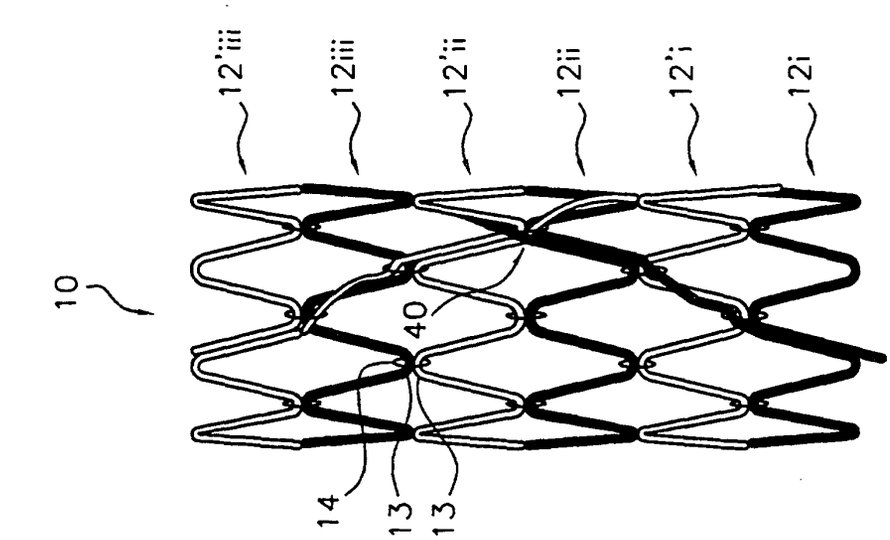


FIG. 3

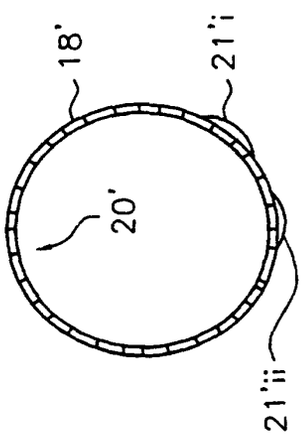


FIG. 2A

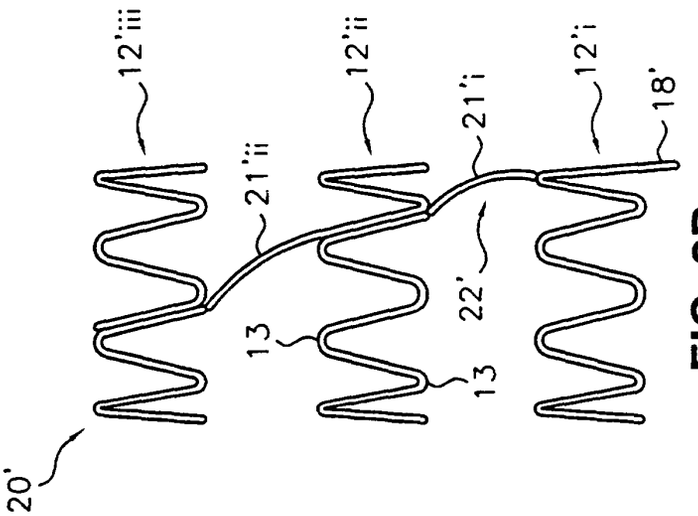


FIG. 2B

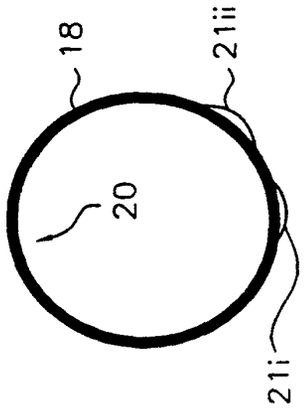


FIG. 1A

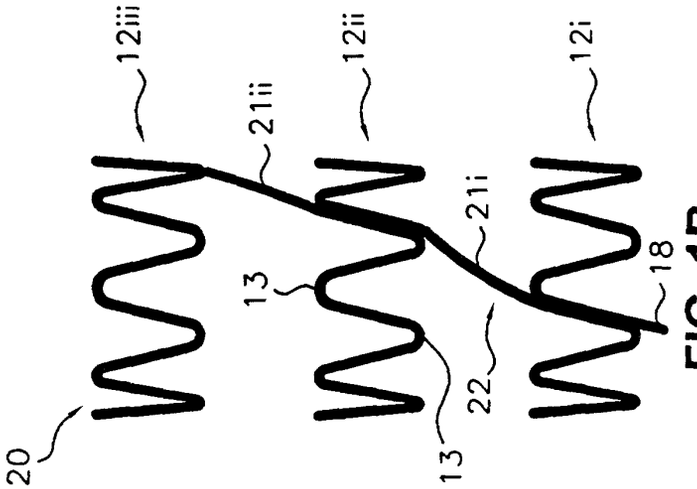


FIG. 1B

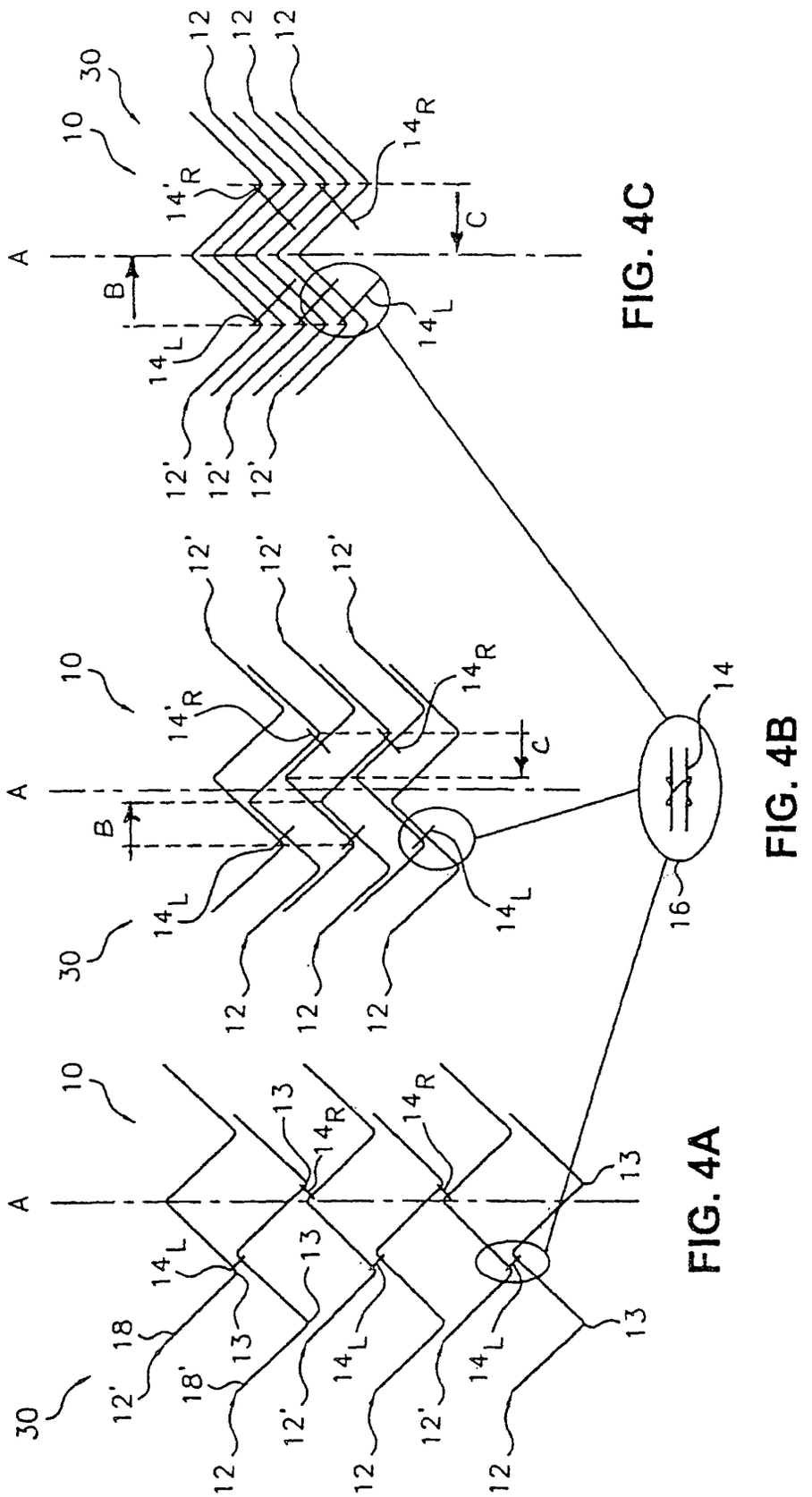


FIG. 4C




FIG. 4B




FIG. 4A

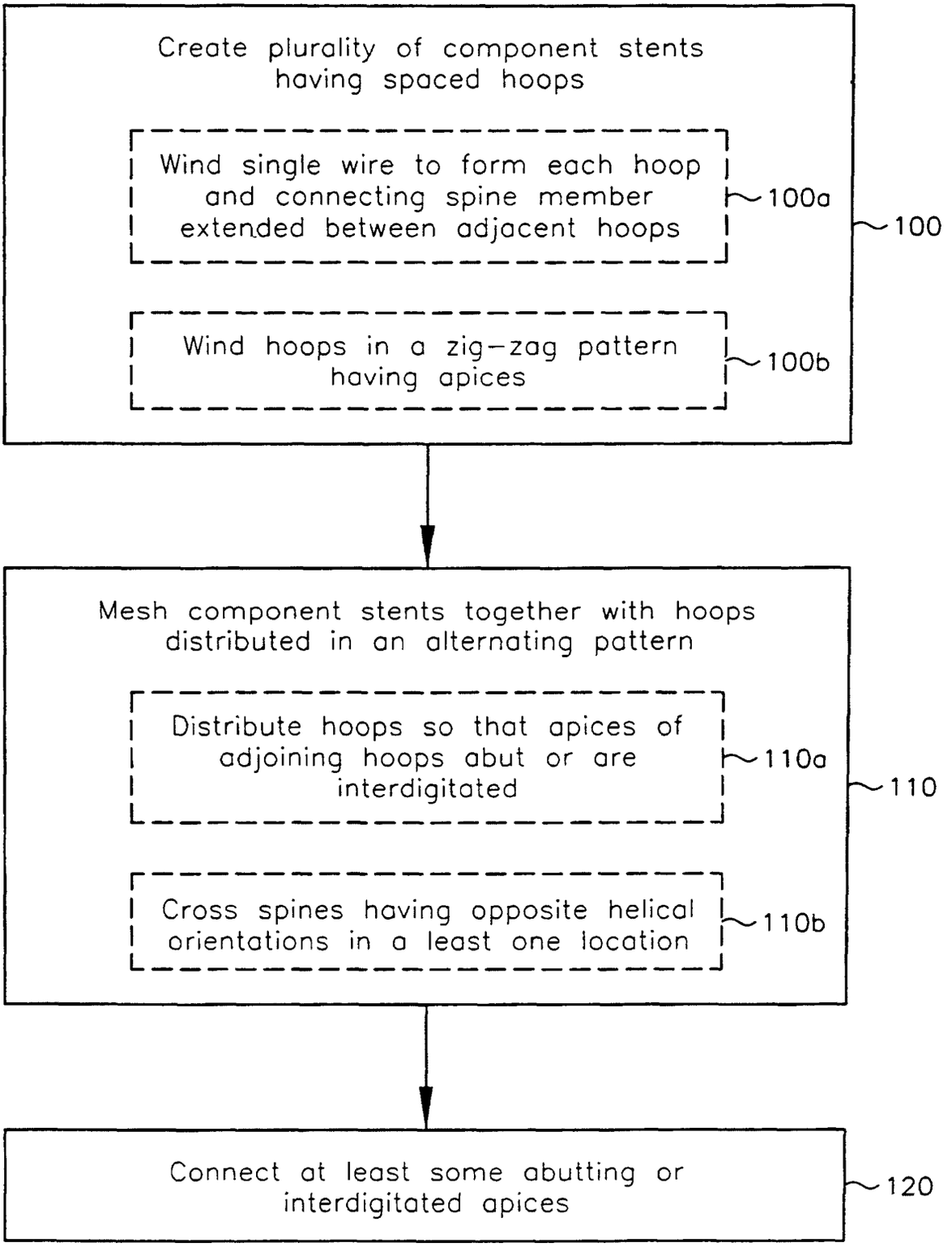
Create plurality of component stents having spaced hoops
Wind single wire to form each hoop and connecting spine member extended between adjacent hoops
100a
Wind hoops in a zig-zag pattern having apices
100b
100
Mesh component stents together with hoops distributed in an alternating pattern
Distribute hoops so that apices of adjoining hoops abut or are interdigitated
110a
Cross spines having opposite helical orientations in a least one location
110b
110
Connect at least some abutting or interdigitated apices
120

FIG. 5