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(54) Title: STENT WITH DEFLECTING CONNECTOR

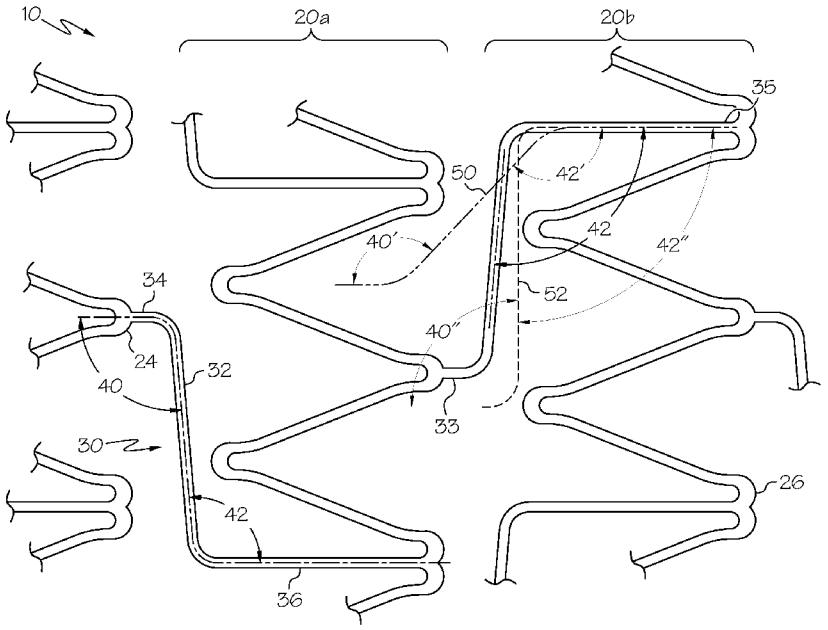

FIG. 3

(57) Abstract: This disclosure is directed primarily to a stent for use in the trachea. The stent has a nominally deployed state, an axially extended state and an axially compressed state. The stent has a length. In the axially extended state, the length is at least 20% greater than in the nominally deployed state.

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Stent with Deflecting Connector

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application claims the benefit of and priority to U.S. Provisional Application No. 61/837,770, filed June 21, 2013, which is herein incorporated by reference.

BACKGROUND

A stent is a medical device introduced into a body lumen. A stent is typically delivered in an unexpanded state to a desired location in a bodily lumen and then expanded by an internal radial force. Stents, grafts, stent-grafts, vena cava filters, expandable frameworks, and similar implantable medical devices, collectively referred to hereinafter as stents, are radially expandable endoprostheses, which are typically intravascular implants capable of being implanted transluminally.

Stents have previously been introduced into the trachea in order to address a variety of medical issues: to provide additional support to the trachea itself and/or the surrounding tissue following surgery, to prevent the airway from being constricted from tumor in growth, to alleviate stenosis, etc.

Tracheal stents face a unique environment of use, one in which the deployed stent must expand and contract during respiration and also be capable of providing support to the trachea.

When referring to tracheal stents, removability and flexibility are often the two things physicians speak about when referring to a great stent. Removability allows the physician the option to place a stent with confidence in treatable malignant conditions, as well as benign conditions, without the dangers of leaving an implant behind. Flexibility of a stent translates to comfort for a patient, e.g., a stent that does not force the lumen in to a straightened path offers reduced irritation. This disclosure will describe stents having geometries which exhibit both of these properties.

SUMMARY

As mentioned above, embodiments of the present disclosure are directed to stents and stent geometries which provide improved flexibility and removability

characteristics. Some embodiments are directed to stents for use in a mammalian trachea.

As mentioned above, embodiments of the stent disclosed herein are provided with geometries that provide the stent with desired tracheal flexiblility as well as allow the stent to be readily removed from the trachea following either short-term or long term deployment.

Removability: The stent geometry is designed in such a way that it allows axial extension and compression to mimic the anatomical environment's extreme conditions. The connectors of the embodiments disclosed herein are configured to be in tension with one another and provide minimal diameter shift, direct pull force translation, and increased durability. These features are improvements over known stents in that prior stents are known to fracture and pull apart if there is significant tissue in-growth anchoring the stent to the anatomy; this is due to the stent cells distorting beyond the designed intent and inducing high stress regions. In the arrangements of the stent connectors shown and described herein, the stress concentration is in straightening the offset connector allowing for greater force to be displaced without creating fracture.

Flexibility: Often times in existing stents the tradeoff between flexibility and removability leaves one of these attributes with diminished performance. To achieve the requisite level of flexibility, the stent should have stent geometry that allows for inside and outside chord length changes. In order for this to happen, the cell design is usually weakened allowing the distortion or deflection to come from a shift in the cell geometry. In embodiments disclosed herein, the stent connectors are provided with an offset design, which lends itself to allowing these distortions to be displaced directly without significantly affecting the cell geometry. This provides a multitude of advantages: it allows the radial and indenter force to maintain consistency throughout a deflection, keeps indenter force high while allowing for a great deal of flexibility, prevents kinking/ovaling during deflection, and it also maintains the ability of the stent to be removed.

Embodiments of the stent described herein have the ability to axially extend or compress at least 20% or more of the stent's nominal deployed length without significantly altering the deployed diameter of the stent or suffering permanent deformation. In some embodiments, the stents described herein have the ability to axially extend or compress up to 40% or more of the nominal deployed length without

significantly altering the deployed diameter of the stent or suffering permanent deformation.

In some embodiments, a tracheal stent comprises an expandable tubular member having a proximal end, a distal end, a longitudinal axis extending through the proximal and distal ends, an inner surface, and an outer surface. The stent comprises a plurality of strut columns and at least one connector extending between each strut column. The ends of the at least one connector are longitudinally and circumferentially offset from one another. In some embodiments the at least one connector extends from a peak of a strut pair of one strut column to a trough of a strut pair in a circumferentially adjacent strut column.

In some embodiments, the at least one connector comprises a first axial segment extending from a first end of a circumferential segment and second axial segment extending from a second end of the circumferential segment. In some embodiments the tracheal stent has a nominal state and an axially extended state. In at least one embodiment the tracheal stent has an axially shortened or compressed state.

In the nominal state the first axial segment and the circumferential segment define a nominal angle of about 90 degrees to about 115 degrees. In the axially extended state the first axial segment and the circumferential segment define an angle greater than that of the nominal angle. In the axially shortened state the first axial segment and the circumferential segment define an angle less than that of the nominal angle.

In at least one embodiment, in the axially extended state the first axial segment and the circumferential segment define an angle about 125 degrees to about 180 degrees.

In the nominal state the second axial segment and the circumferential segment define a nominal angle of about 90 degrees to about 115 degrees. In the axially extended state the second axial segment and the circumferential segment define an angle greater than that of the nominal angle. In the axially shortened state the second axial segment and the circumferential segment define an angle less than that of the nominal angle.

In at least one embodiment, in the axially extended state the second axial segment and the circumferential segment define an angle about 125 degrees to about 180 degrees.

In the various embodiments described herein a tracheal stent has a length. In the axially extended state the length is at least 20% greater than the length of the stent in the nominal state. In some embodiments when the stent is in the axially extended state the length is up to 40% greater than the length of the stent in the nominal state.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flat view of a portion of a stent in a nominal state, according to one embodiment;

FIG. 2 is a flat view of the stent portion shown in FIG. 1 in an axially extended state, according to one embodiment;

FIG. 3 is an annotated close-up view of a connector and adjacent strut columns of the stent shown in FIG. 1, wherein the annotations depict examples of configurations of the connector in an axially compressed state and an axially extended state, according to one embodiment;

FIG. 4 illustrates the entire stent depicted in FIG. 1 in a laboratory setting with the stent in an axially extended state, according to one embodiment; and

FIG. 5 is a flat view of a portion of another embodiment of the stent.

DETAILED DESCRIPTION

For the purposes of this disclosure, like reference numerals in the figures shall refer to like features unless otherwise indicated.

A partial view of a stent 10 is depicted in FIG. 1. In the embodiment shown, the stent 10 is depicted in a nominal deployed state. In an environment of use the nominal deployed or extended state of the stent 10 is a state wherein the outer surface of the stent is in contact with the trachea (not shown) of a patient, and the trachea is at rest (between inspiration and expiration events). Alternatively, the nominal deployed state can be defined as a state wherein the stent 10 is expanded to its programmed shape-memory deployed diameter.

As is shown in the various figures 1-5, the stent 10 is comprised of a plurality of strut columns 20. Each strut column 20 is comprised of a series of interconnected struts 22 which form alternating peaks 24 and troughs 26. Adjacent strut columns 20 are connected by one or more connectors 30.

Each connector 30 is comprised of a circumferential segment 32 and first and second axial segments 34 and 36, which extend in substantially opposite directions from the opposing ends of the circumferential segment 32.

In the embodiments shown in FIG. 1-4, a first (or proximal) end 33 of each connector 30 extends from a peak 24 of a first (or proximal) strut column 20a. A second (or distal) end 35 of each connector 30 extends from a trough 26 of a second (or distal) strut column 20b. In some embodiments the connectors 30 can extend from a trough 26 of the first strut column 20a and engage a peak 24 of the second strut column 20b such as in the manner depicted in FIG. 5.

In the various embodiments described herein, the length of the circumferential segment 32 results in the first and second axial segments 34 and 36 being circumferentially offset from one another in the nominal state. The length of the circumferential segment 32 is such that it extends in a circumferential direction across at least one trough 26 of the first strut column 20a and at least one peak 24 of the second strut column 20b. The length of the circumferential segment 32 can vary a great deal. For example, in the alternative embodiment shown in FIG. 5, the length of the circumferential segment 32 is sufficient to cross over six peaks 24 of the first strut column 20a and five troughs 26 of the second strut column 20b. Various other lengths and configurations of peak and trough crossings can be provided to the connectors 30.

In the nominally extended state shown the first axial segment 34 and the circumferential segment 32 define a nominal angle 40 of about 90 degrees to about 115 degrees, as shown in FIG. 3. Similarly, the second axial segment 36 and the circumferential segment 32 define a nominal angle 42 of about 90 degrees to about 115 degrees. In some embodiments angles 40 and 42 define alternate interior angles.

When deployed within the trachea, stent 10 is configured to be capable of extending from the nominally deployed state shown in FIG. 1 to an axially extended state, such as is shown in FIGs. 2 and 4. In the axially extended state the stent may have an axial length 20 percent greater (or more) than the length of the stent 10 in the nominally deployed state. As illustrated via FIG. 2, when the stent 10 is expanded to the axially extended state, deflection of the connectors 30 permits the stent 10 to axially elongate such that a majority of the axial elongation results from deflection of the connectors 30 rather than from distortions of the strut columns 20.

In the axially extended state the first axial segment 34 and the circumferential segment 32 define an angle 40' greater than that of the nominal angle 40. In at least one embodiment, in the axially extended state the first axial segment 34 and the circumferential segment 32 define an angle 40' of about 125 degrees to about 180 degrees. Likewise, in the axially extended state the second axial segment 36 and the circumferential segment 32 define an angle 42' greater than that of the nominal angle 42. In at least one embodiment, in the axially extended state the second axial segment 36 and the circumferential segment 32 define an angle 42' of about 125 degrees to about 180 degrees. In some embodiments angles 40' and 42' define alternate interior angles.

In addition to being capable of extending axially during an inspiration event, embodiments of the stent 10 are also configured to adapt to expiration events wherein the trachea may compress in the axial direction. An example of the extent to which a connector 30 can "extend" from the nominally deployed state to an axially extended state is illustrated by annotation line 50 and an example of the extent to which the connector 30 can compress from the nominally deployed state to an axially compressed state is shown by annotation line 52.

When the stent 10 is extended from the nominally deployed state (trachea at rest) to the axially extended state (inspiration), the connectors 30 (as represented by annotation line 50 in FIG. 3) will deflect such that the adjacent strut columns can move axially apart from one another (e.g. axially extend) without significantly affecting the deployed diameter of the stent 10. When the stent 10 is axially compressed (expiration) from the nominally deployed diameter (trachea at rest) in the axially compressed state, the connectors 30 (as represented by annotation line 52 in FIG. 3) will deflect such that the adjacent strut columns can move axially toward one another (e.g. axially compress) without significantly affecting the deployed diameter of the stent 10.

In the various embodiments shown and described herein, when the stent 10 is in the axially compressed or shortened state (as represented by annotation line 52 in FIG. 3), the first axial segment 34 and the circumferential segment 32 define an angle 40" that is less than that of the nominal angle 40. Similarly, in the axially compressed state the second axial segment 36 and the circumferential segment 32 define an angle 42" that is less than that of the nominal angle 42. In some embodiments angles 40" and 42" define alternate interior angles.

The unique geometry of the stent 10 provides the stent 10 with the capability to axially extend or compress by at least 20% or more of its nominal deployed length without significantly altering the deployed diameter of the stent or causing the stent to suffer permanent deformation. In some embodiments, the stent 10 is capable of axially extending or compressing by up to 40% of the nominal deployed length without significantly altering the deployed diameter of the stent or causing the stent to suffer permanent deformation.

In some embodiments a force necessary to change the length of the stent from a nominal length to an axially extended length is less than about 0.5 lbs. In at least one embodiment the force necessary to change the length of the stent from a nominal length to an axially extended length is about 0.472 lbs. In some embodiments a force necessary to change the length of the stent from a nominal length to an axially extended length is about 0.2 lbs to about 0.25 lbs.

In addition to the above it is recognized that any embodiments of the present stent 10 may be provided with a uniform diameter, may taper in portions or along the entire length of the stent, may have struts 20 and/or connectors 30 with uniform or different widths and/or thicknesses.

Embodiments of stent 10 may be manufactured using any appropriate stent manufacturing techniques. Appropriate methods for manufacturing the stents may include laser cutting, chemical etching or stamping of a tube. The stents may also be manufactured by laser cutting, chemically etching, stamping a flat sheet, rolling the sheet and welding the sheet, by electrode discharge machining, or by molding the stent with the desired design.

Any appropriate stent material may be used in the manufacture of the inventive stent 10. Examples of such materials may include polymeric materials, metals, ceramics and composites. Appropriate polymeric materials include thermotropic liquid crystal polymers (LCP's). Where the stent 10 is made of metal, the metal may be stainless steel, cobalt chrome alloys such as elgiloy, tantalum or other plastically deformable metals. Other suitable metals include shape-memory metals such as nickel-titanium alloys generically known as "nitinol", platinum/tungsten alloys and titanium alloys, stainless steel, tantalum and elgiloy. This disclosure also contemplates the use of more than one material in the manufacture of the stent 10. For example, first strut columns 20a and second strut columns 20b may be made of different materials.

Optionally, the connectors 30 may be made of a different material than the strut columns 20.

Embodiments of the stent 10 are self-expanding. However in some embodiments the stent 10 may be provided in mechanically expandable form, in self- or as a hybrid of self-expanding and mechanically expandable. Mechanically expandable stents, in accordance with the disclosure, may be expanded using any suitable mechanical device.

Embodiments of the stent 10 may include suitable radiopaque coatings. For example, the stents may be coated with gold or other noble metals or sputtered with tantalum or other metals. The stents may also be made directly from a radiopaque material to obviate the need for a radiopaque coating or may be made of a material having a radiopaque inner core. Other radiopaque metals which may be used include platinum, platinum-tungsten, palladium, platinum-iridium, rhodium, tantalum, or alloys or composites of these metals.

Embodiments of the stent 10 may be provided with various bio-compatible coatings to enhance various properties of the stent. For example, the stents may be provided with lubricious coatings. The stents may also be provided with drug-containing coatings which release drugs over time.

Embodiments of the stent 10 may also be used as the framework for a graft, sleeve, covering or coating (partially or over the entire surface of the stent). Suitable coverings include but are not limited to, nylon, collagen, PTFE and expanded PTFE, polyethylene terephthalate and KEVLAR. More generally, any known graft material may be used including natural or synthetic polymers such as silicone, polyethylene, polypropylene, polyurethane (or urethane), polyglycolic acid, polyesters, polyamides, their mixtures, blends, copolymers, mixtures, blends and copolymers.

A description of some embodiments of the stents and the delivery catheter are contained in one or more of the following numbered statements:

Statement 1. A stent having a nominally deployed state, an axially extended state, and an axially compressed state, the stent having a length, in the axially extended state the length being at least 20% greater than in the nominally deployed state.

Statement 2. The stent of statement 1, wherein the stent is a tracheal stent.

Statement 3. The stent of any one of the preceding statements, wherein the stent is formed from a shape-memory metal.

Statement 4. The stent of any one of the preceding statements, wherein the stent is self-expanding.

Statement 5. The stent of any one of the preceding statements, wherein the stent is balloon-expandable.

Statement 6. The stent of any one of the preceding statements further comprising a radiopaque coating.

Statement 7. The stent of any one of the preceding statements further comprising a plurality of strut columns.

Statement 8. The stent of statement 7, wherein strut columns comprise columnar struts interconnected by alternating peaks and troughs.

Statement 9. The stent of statement 8 further comprising connector columns, the connector columns comprising connector struts extending between adjacent strut columns in a peak-to-trough configuration.

Statement 10. The stent of statement 9, wherein:

the connector struts comprise a first axial segment, a second axial segment, and a circumferential segment, the first axial segment and the second axial segment extending from the circumferential segment, the circumferential segment disposed between the first and second axial segments;

the first axial segment and the circumferential segment defining a first angle therebetween and the second axial segment and the circumferential segment defining a second angle therebetween, wherein:

when the stent is in the nominally deployed state the first angle is between 90 and 115 degrees and the second angle is between 90 degrees and 115 degrees;

when the stent is in the axially extended state the first angle is between 125 and 180 degrees and the second angle is between 125 and 180 degrees; and

when the stent is in the axially compressed state, the first angle and second angle are less than when the stent is in the nominally deployed state.

Statement 11. The stent of any one of claims 7-10, wherein at least one of the strut columns is formed from a material different than at least one of the other strut columns.

Statement 12. The stent of statement 10, wherein the strut columns comprise first strut columns and second strut columns, the first and second strut columns comprising alternating peaks and troughs;

the circumferential segments extend in a circumferential direction across at least one trough of the first strut column and at least one peak of the second strut column.

Statement 13. The stent of statement 12, wherein the circumferential segments extend in a circumferential direction across at least one trough of the first strut column and at least two peaks of the second strut column.

Statement 14. The stent of any one of the preceding statements, wherein , in the axially extended state the length is up to 40% greater than in the nominally deployed state.

Statement 15. The stent of any one of the preceding statements, wherein at least a portion of the stent is formed from a nickel-titanium alloy.

Statement 16. The stent of any one of the preceding statements, wherein the stent is laser cut.

Statement 17. The stent of any one of statements 9, 10, 12, and 13, wherein the connector struts deflect when the stent is in the axially extended state and an axially compressed state.

The above disclosure describes using the stent 10 in the trachea. However, the disclosure may be used in any application involving expansion of a vessel (or support of a vessel wall) where a flow path on an outer surface of the stent is required, such as in the biliary duct and the duodenum.

The above disclosure is intended to be illustrative and not exhaustive. This description will suggest many variations and alternatives to one of ordinary skill in this art. All these alternatives and variations are intended to be included within the scope of the claims where the term “comprising” means “including, but not limited to.” Those familiar with the art may recognize other equivalents to the specific embodiments described herein which equivalents are also intended to be encompassed by the claims.

CLAIMS:

What is claimed is:

1. A stent having a nominally deployed state, an axially extended state, and an axially compressed state, the stent having a length, in the axially extended state the length being at least 20% greater than in the nominally deployed state.

2. The stent of claim 1, wherein the stent is a tracheal stent.

3. The stent of any one of the preceding claims, wherein the stent is formed from a shape-memory metal.

4. The stent of any one of the preceding claims, wherein the stent is self-expanding.

5. The stent of any one of the preceding claims, wherein the stent is balloon-expandable.

6. The stent of any one of the preceding claims further comprising a radiopaque coating.

7. The stent of any one of the preceding claims further comprising a plurality of strut columns.

8. The stent of claim 7, wherein the plurality of strut columns comprise columnar struts interconnected by alternating peaks and troughs.

9. The stent of claim 8 further comprising connector columns, the connector columns comprising connector struts extending between adjacent strut columns in a peak-to-trough configuration.

10. The stent of claim 9, wherein:

the connector struts comprise a first axial segment, a second axial segment, and a circumferential segment, the first axial segment and the second axial

segment extending from the circumferential segment, the circumferential segment disposed between the first and second axial segments;

the first axial segment and the circumferential segment defining a first angle therebetween and the second axial segment and the circumferential segment defining a second angle therebetween, wherein:

when the stent is in the nominally deployed state the first angle is between 90 and 115 degrees and the second angle is between 90 degrees and 115 degrees;

when the stent is in the axially extended state the first angle is between 125 and 180 degrees and the second angle is between 125 and 180 degrees; and

when the stent is in the axially compressed state, the first angle and second angle are less than when the stent is in the nominally deployed state.

11. The stent of any one of claims 7-10, wherein at least one of the plurality of strut columns is formed from a material different than at least one of the other strut columns.

12. The stent of claim 10, wherein the plurality of strut columns includes a first strut column and a second strut column, the first and second strut column comprising alternating peaks and troughs;

the circumferential segment extending in a circumferential direction across at least one trough of the first strut column and at least one peak of the second strut column.

13. The stent of claim 12, wherein the circumferential segment extends in a circumferential direction across at least one trough of the first strut column and at least two peaks of the second strut column.

14. The stent of any one of the preceding claims, wherein, in the axially extended state the length is up to 40% greater than in the nominally deployed state.

15. The stent of any one of the preceding claims, wherein the stent is laser cut.

16. A stent having a nominally deployed state, an axially extended state, and an axially compressed state, the stent having a length, in the axially extended state the length being at least 20% greater than in the nominally deployed state.

17. The stent of claim 16, wherein the stent comprises strut columns and connector columns, the strut columns alternating with the strut columns along the length of the stent, wherein the strut columns comprising columnar struts interconnected by alternating peaks and troughs.

18. A stent having a nominally deployed state, an axially extended state, and an axially compressed state, the stent having a length, in the axially extended state the length being up to 40% greater than in the nominally deployed state.

19. The stent of claim 18, wherein the stent is laser cut.

20. The stent of claim 18, wherein the stent comprises strut columns and connector columns, the connector columns alternating with the strut columns.

21. A stent having a nominally deployed state, an axially extended state, and an axially compressed state, the stent comprising:

a plurality of strut columns and a plurality of connector columns connecting adjacent strut columns, the connector columns comprising connector struts, the connector struts comprising a first axial segment, a second axial segment, and a circumferential segment, the first axial segment and the second axial segment extending from the circumferential segment, the circumferential segment disposed between the first and second axial segments;

the first axial segment and the circumferential segment defining a first angle therebetween and the second axial segment and the circumferential segment defining a second angle therebetween, wherein:

when the stent is in the nominally deployed state the first angle is between 90 and 115 degrees and the second angle is between 90 degrees and 115 degrees;

when the stent is in the axially extended state the first angle is between 125 and 180 degrees and the second angle is between 125 and 180 degrees; and

when the stent is in the axially compressed state, the first angle and second angle are less than when the stent is in the nominally deployed state.

22. The stent of claim 21, wherein the plurality of strut columns comprise columnar struts interconnected by alternating peaks and troughs.

23. The stent of claim 22, wherein the connector struts extend between adjacent strut columns in a peak-to-trough configuration.

24. The stent of claim 21, wherein the stent is a tracheal stent.

25. The stent of claim 21 having a length, wherein the length is at least 20% greater in the axially extended state than in the nominally deployed state.

26. The stent of claim 21, wherein the length is at least 40% greater in the axially extended state than in the nominally deployed state.

27. The stent of claim 21, wherein the stent is formed from a shape-memory metal.

28. The stent of claim 21, wherein at least one of the plurality of strut columns is formed from a material different than at least one of the other strut columns.

29. The stent of claim 21, wherein the stent is self-expanding.

30. The stent of claim 21, wherein the stent is balloon-expandable.

31. The stent of claim 21, further comprising a radiopaque coating.

32. The stent of claim 21, wherein the stent is laser cut.

33. The stent of claim 21, wherein the connector struts deflect when the stent is in the axially extended state and an axially compressed state.

34. The stent of claim 21, wherein the strut columns include a first strut column and a second strut column, the first and second strut column comprising alternating peaks and troughs;

the circumferential segment extending in a circumferential direction across at least one trough of the first strut column and at least one peak of the second strut column.

35. The stent of claim 34, wherein the circumferential segment extends in a circumferential direction across at least one trough of the first strut column and at least two peaks of the second strut column.

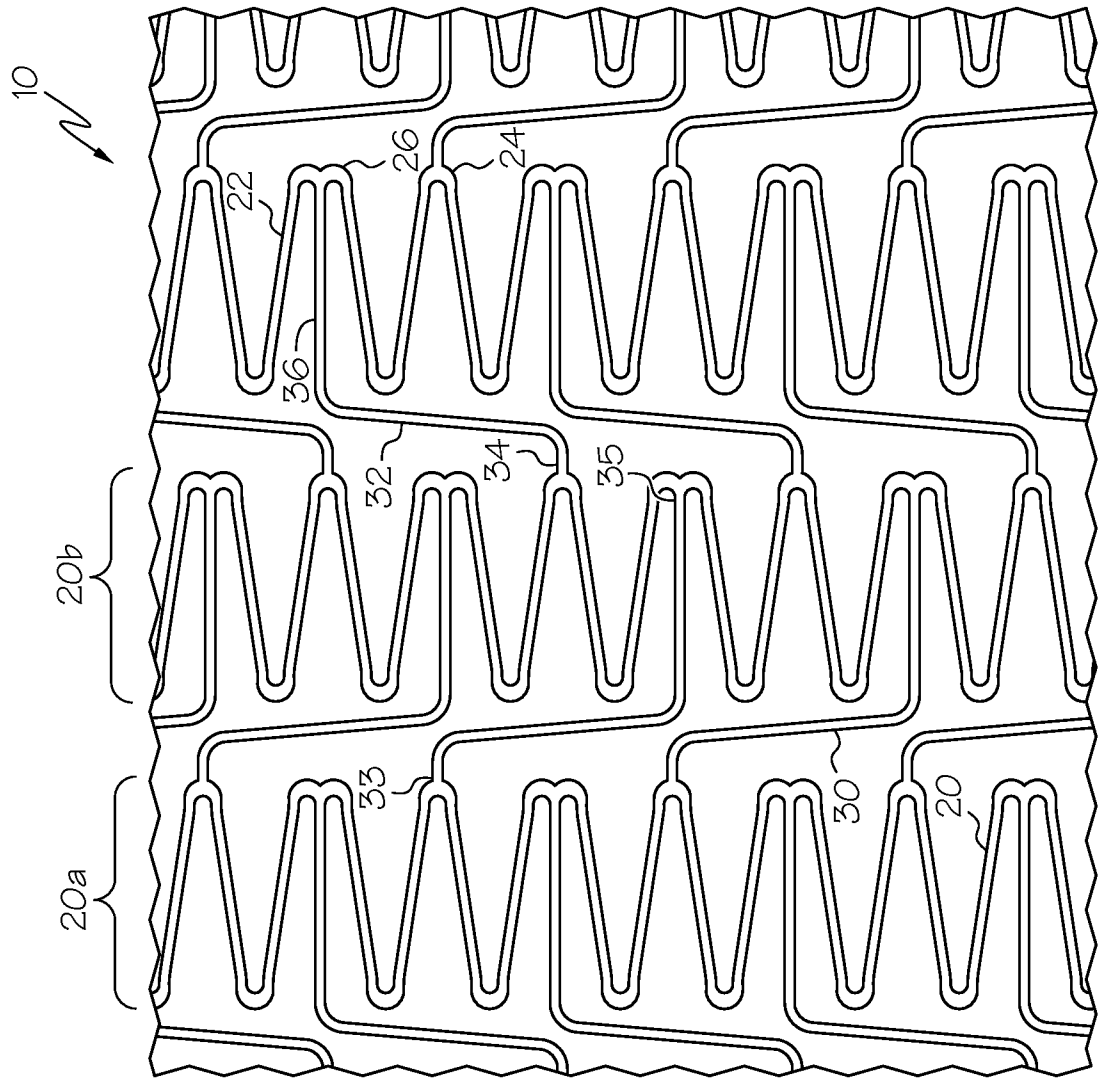

FIG. 1

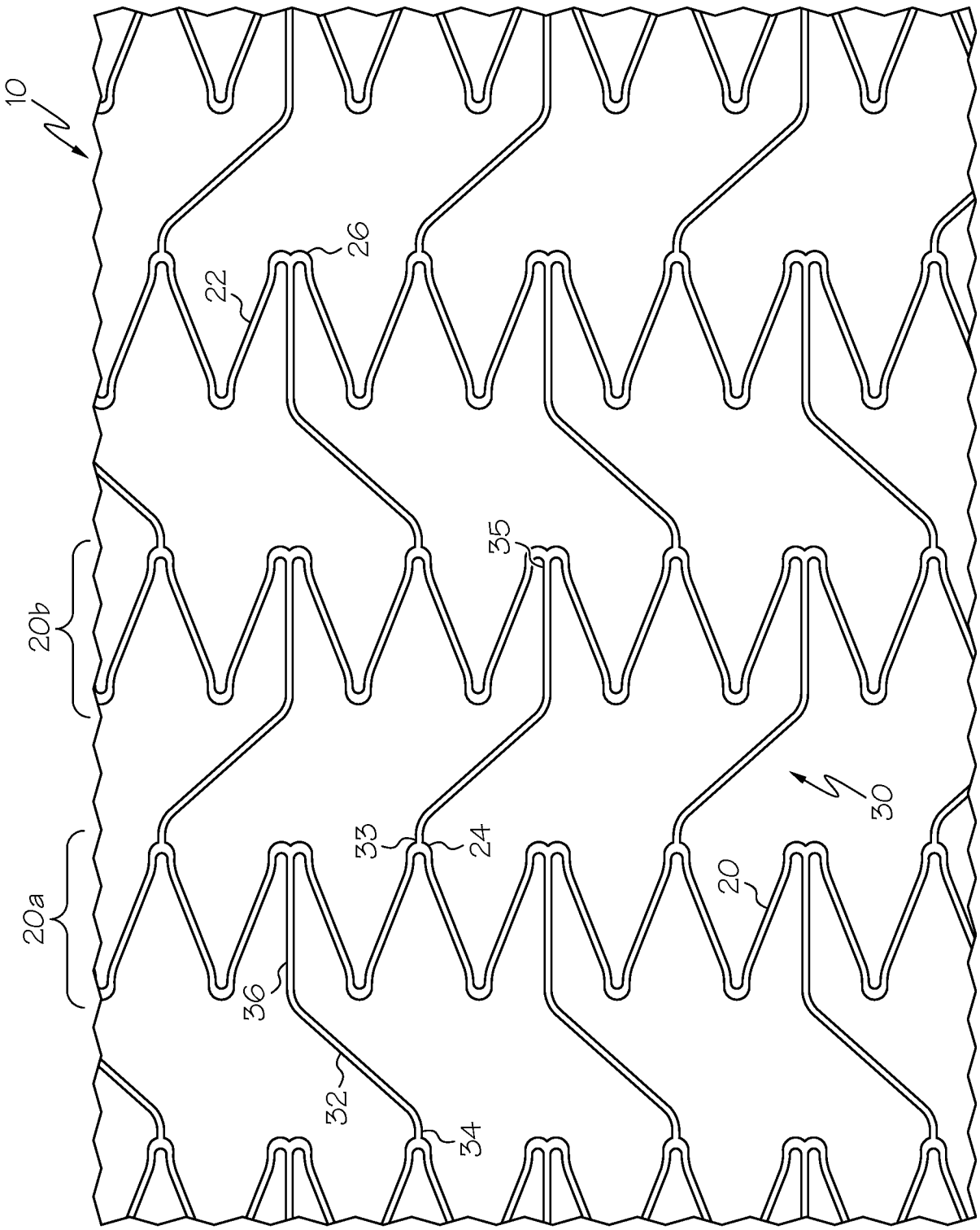

FIG. 2

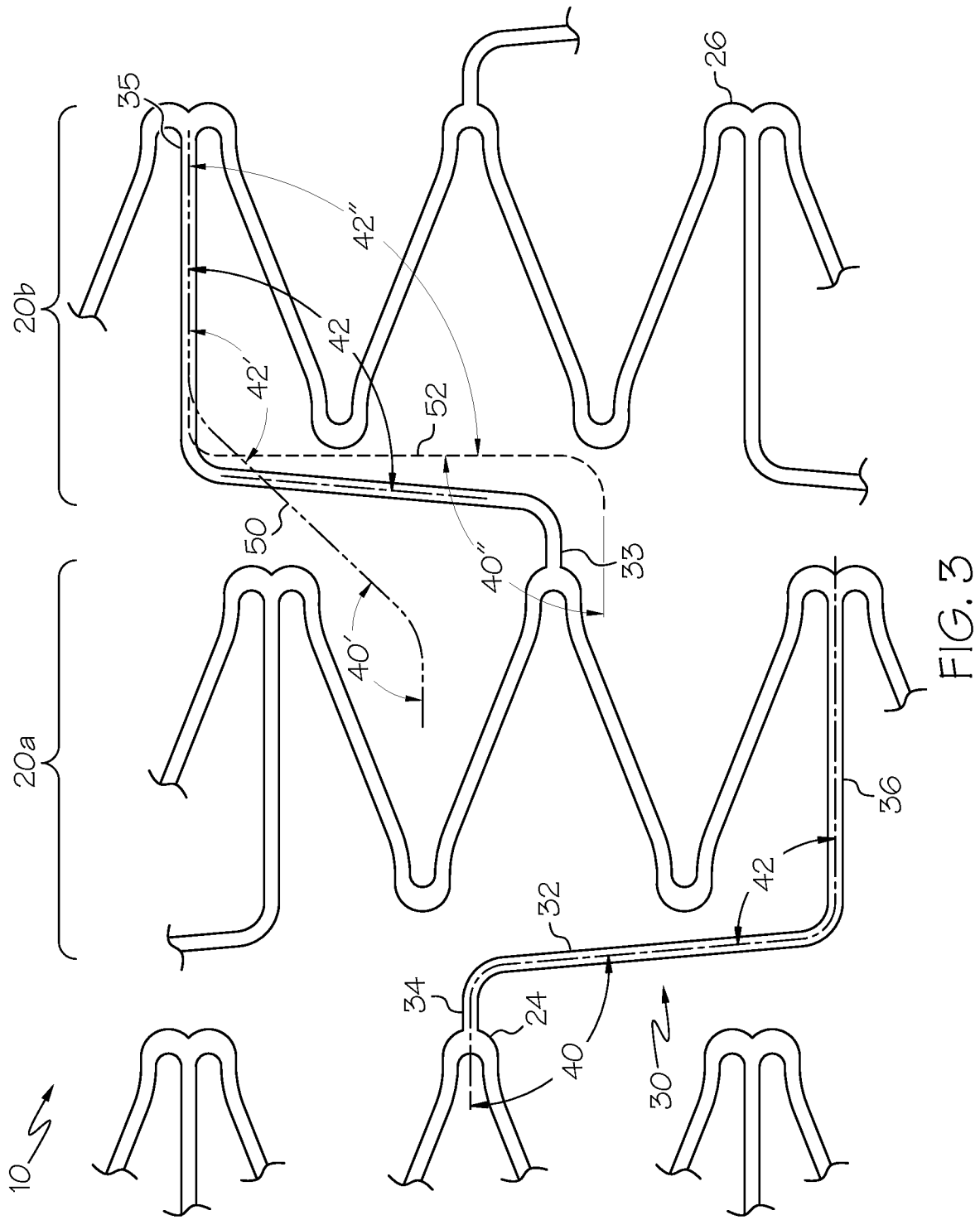

FIG. 3

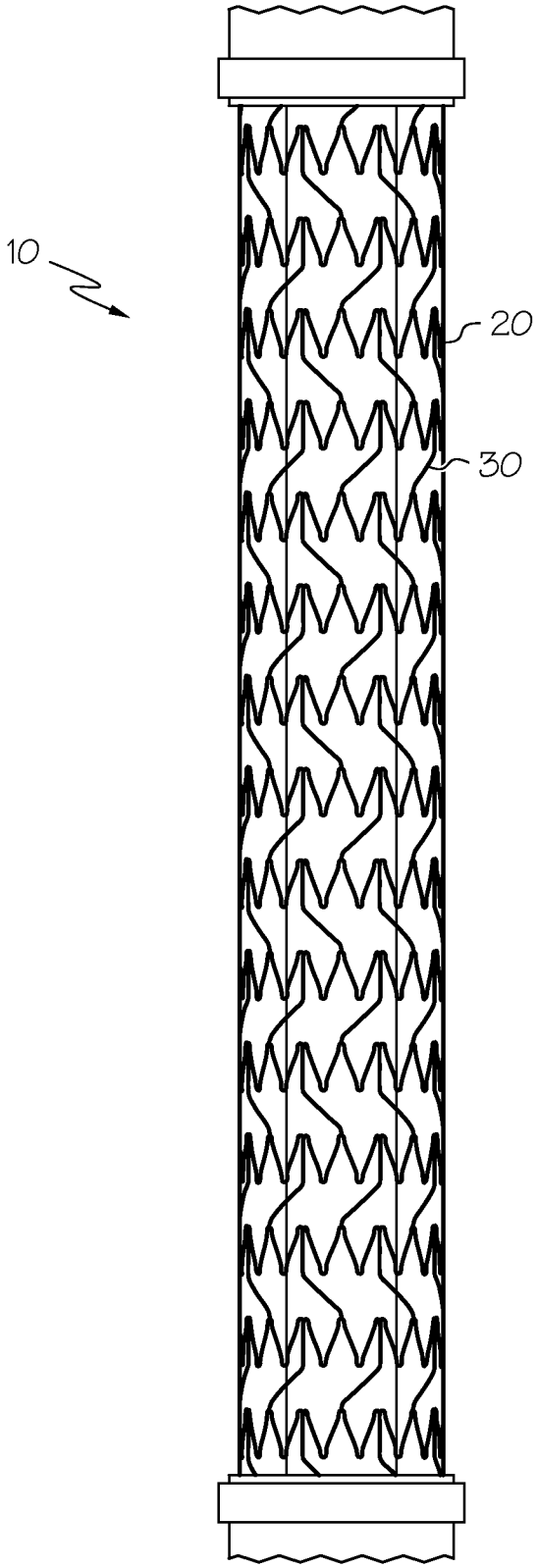

FIG. 4

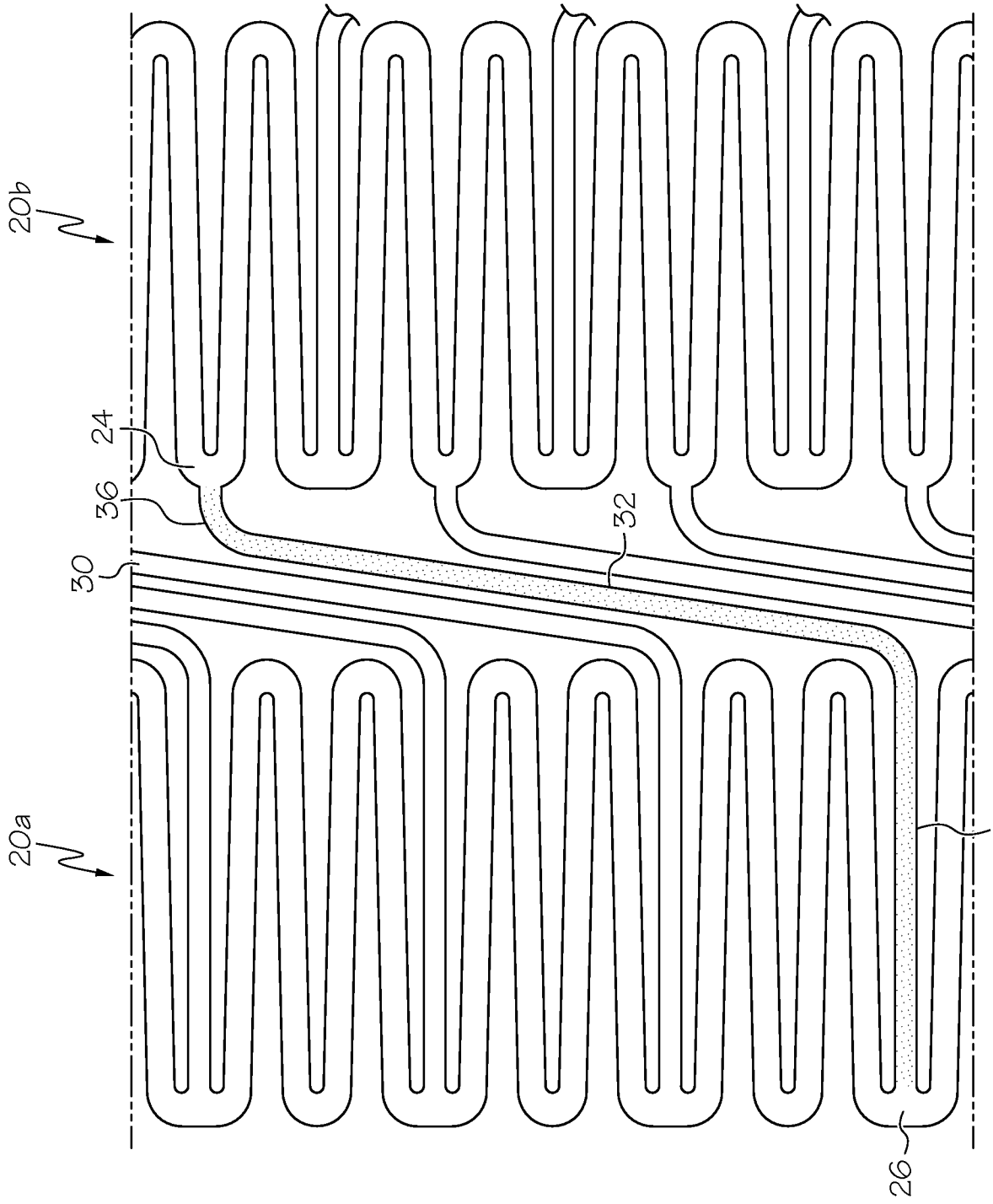

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/043406

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61F2/89 A61F2/915 A61F2/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61F

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	US 2006/036312 A1 (TOMONTO CHARLES V [US]) 16 February 2006 (2006-02-16) claims; figure 1a	1-35
X	US 2005/222671 A1 (SCHAEFFER DARIN G [US] ET AL) 6 October 2005 (2005-10-06) figure 3	1-35
X	US 2010/137973 A1 (SUTERMEISTER DEREK [US] ET AL) 3 June 2010 (2010-06-03) claims; figures 2,3	1-35
Y	WO 2007/079363 A2 (BARD INC C R [US]; MCDERMOTT JOHN D [US]; TA KHOI Q [US]) 12 July 2007 (2007-07-12) figure 3b	1-35

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 September 2014	01/10/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Serra i Verdaguer, J

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/043406

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2006/015173 A1 (CLIFFORD ANTON [US] ET AL) 19 January 2006 (2006-01-19) figure 14b	1-35
Y	WO 2009/103011 A1 (NELLIX INC [US]; RAO K T VENKATESWARA [US]; KUMAR ANANT [US]; TZVETANO) 20 August 2009 (2009-08-20) the whole document	1-35
Y	DE 101 50 547 A1 (QUALIMED INNOVATIVE MED PROD [DE]) 30 April 2003 (2003-04-30) the whole document	1-35

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/043406

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