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CA 2271698 C 2005/05/10

(11)(21) 2 271 698

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 1999/05/14

(41) Mise à la disp. pub./Open to Public Insp.: 1999/11/16

(45) Date de délivrance/Issue Date: 2005/05/10

(30) Priorité/Priority: 1998/05/16 (198 22 157.6) DE

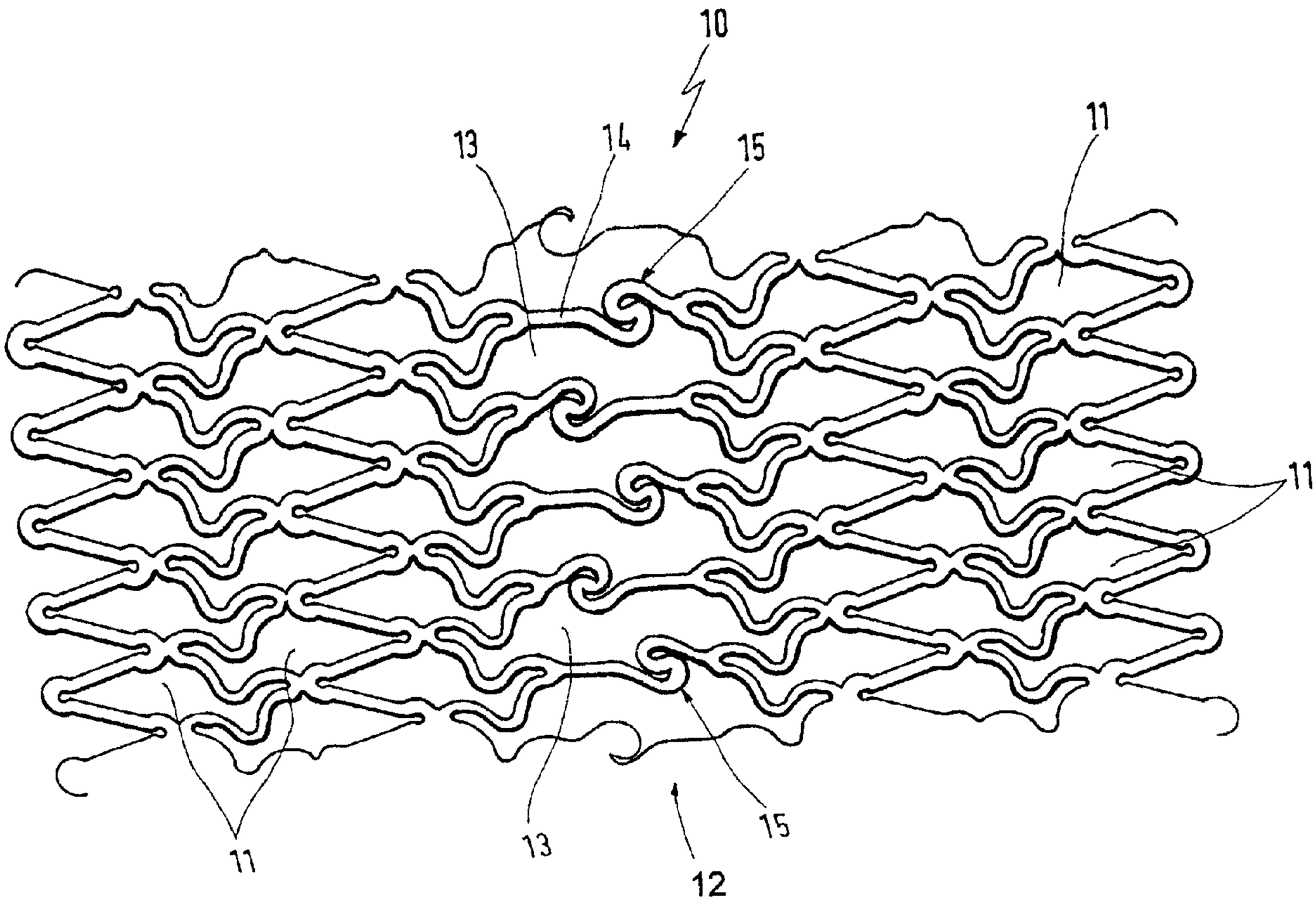
(51) Cl.Int.^{6}/Int.Cl.^{6} A61F 2/06

(72) Inventeur/Inventor:
VON OEPEN, RANDOLF, DE

(73) Propriétaire/Owner:
JOMED IMPLANTATE GMBH, DE

(74) Agent: MARKS & CLERK

(54) Titre : TUTEUR A EXPANSION RADIALE POUR IMPLANTATION DANS UN VAISSEAU CORPOREL
(54) Title: RADIALLY EXPANDABLE STENT FOR IMPLANTING IN A BODY VESSEL



(57) Abrégé/Abstract:
A radially expandable stent for implanting in a body vessel, in particular in the area of a vascular branching, which has at least one section (12) with radial openings (13), the border of (14) of which is striated, at least by area, and forms one or more loops (15) and/or recesses.

Abstract:

A radially expandable stent for implanting in a body vessel, in particular in the area of a vascular branching, which has at least one section (12) with radial openings (13), the border of (14) of which is striated, at least by area, and forms one or more loops (15) and/or recesses.
(Fig. 1)

Radially Expandable Stent For Implanting In A Body Vessel

D e s c r i p t i o n :

Stents are generally inserted into the vessels after a vasodilatation and expanded there so that a renewed occlusion of the vessel can be prevented. Vessel occlusions of this type can also occur in the area of vascular branching, whereby, if necessary, the entire branch area must be secured with stents after expansion of the vessels. In this connection, it has already been proposed that a first stent be inserted into the main vessel and then, via a radial opening of this first stent, to insert a second stent into the branching vessel and then also expand it. To enable the second stent to be led through a radial opening of the first stent and to prevent too great a flow resistance in the branch area of the vessel for the blood, DE 297 01 758 has already proposed a stent that has radial openings that are enlarged by sections. However, in practice, it has been shown that these stents cannot be used everywhere. In the area of the enlarged radial openings, the radial rigidity of the stent is often not sufficient. Moreover, the degree of coverage of the vascular wall in the area of the enlarged openings is too slight to safely prevent deposits separating from the vascular wall from entering into the blood stream. Depending on the location of the vessels, these separated deposits can result in embolisms, strokes or the like.

To remedy this problem, the present invention proposes a radially expandable stent for implanting in a body vessel, in particular in the area of a vascular branching, in the form of

a hollow cylindrical part, which is characterized therein that it has at least one section with radial openings, the borer of which is striated, at least by area, and forms one or more loops or recesses. The loops and/or recesses can thereby be dimensioned and arranged in such a way that the diameter of the radial openings may be enlarged such that a second stent, which is not expanded, can be easily led through the radial openings or even be radially expandable in the area of the openings. This is possible due to the fact that the loops or recesses are pulled apart when the second stent is led through and/or expanded, as a result of which the cross sectional area of the opening may be greatly enlarged. Those radial openings through which no second stent is led have, however, either the same cross sectional size as the radial openings in other sections of the stent or only a slightly enlarged diameter vis-à-vis these. This ensures both a sufficient radial stability and a sufficient degree of coverage of the vascular wall in order to safely prevent deposits separating from the vascular wall from entering into the blood stream. The radial rigidity of the stent in at least the one section may be set in such a way that it corresponds at least approximately to the radial rigidity in the remaining sections.

According to one aspect of the present invention, there is provided a radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising a first plurality of cells forming a first plurality of radial openings, and a second plurality of cells forming a second plurality of radial openings, wherein each of the first plurality of radial openings is larger than each of the second plurality of radial openings, and wherein the first plurality of cells

comprises a radial strength that is at least approximately equal to a radial strength of the second plurality of cells.

According to a further aspect of the present invention, there is provided a radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising a first plurality of radial openings having edges with shaped formations, and a second plurality of radial openings, wherein the first plurality of radial openings is formed by a first plurality of cells and the second plurality of radial openings is formed by a second plurality of cells, each of the first plurality of radial openings being larger than each of the second plurality of radial openings and the radial strength of the first plurality of cells being at least approximately equal to the radial strength of the second plurality of cells, wherein the first plurality of radial openings are disposed over at least an end of the stent, and wherein the shaped formations of the edges comprise a loop shape that is doubled over and forms an opening.

According to another aspect of the present invention, there is provided a radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising a first plurality of radial openings comprising edges having shaped formations that double over and form an opening, and a second plurality of radial openings, wherein the first plurality of radial openings is formed by a first plurality of cells and the second plurality of radial openings is formed by a second plurality of cells, each of the first plurality of radial openings being larger than each of the second plurality of radial openings and the radial strength of the first plurality of cells being at least approximately equal to

the radial strength of the second plurality of cells, wherein each of the first plurality of radial openings is configured for expansion to a first expanded width that is greater than a second expanded width to which each of the second plurality of radial openings is configured for expansion, wherein each of the first plurality of radial openings is configured to expand in isolation to the first expanded width upon expansion of a second stent therein, and wherein the first plurality of radial openings are disposed over at least an end of the stent.

In a preferred embodiment, the stent is provided with radial openings over half of its length, the border of which is striated, at least by area, and forms one or more loops and/or recesses. The placement of the first stents having a design of this type is then relatively simple, since it is provided with the specially designed radial openings over a relatively great length. The stent according to the invention can, advantageously, be made from a solid tubule by laser-cutting or the like. Other advantages result if it is made of a material which is easily visible during X-ray examinations or provided with a coating consisting of such a material. For

example, gold or platinum are suitable as possible materials.

Preferred embodiments of a stent according to the invention are described in greater detail in the following with reference to the drawings, showing:

Fig. 1 a representation of the surface structure of a stent according to the invention;

Fig. 2 a representation of the surface structure of a second stent according to the invention.

Fig. 1 shows a section from the surface of a stent 10 which has essentially rhombic openings 11 distributed uniformly over its surface. In a middle area 12, radial openings 13 are provided whose cross sectional area is only slightly enlarged vis-à-vis the cross sectional area of the other radial openings 11. The radial openings 13 are also surrounded by striated borders 14, just like the radial openings 11. In this case, the borders 14 of the radial openings 13 have S-shaped loops 15. As a result, it is possible to greatly enlarge the openings 13 in their cross sectional area. The stent 10 is thus excellent for placing in the area of vascular branchings. A second stent can be easily led through one of the openings 13 and radially expanded by unfolding the S-shaped loops 15, so that the blood stream through the vessel is not affected by the stents. Even if the branching vessel does not have to be provided with a stent, one of the radial openings 13 can be expanded in diameter, so that an unhindered blood stream is possible in the side vessel. Placing the stent 10 in the vessel is relatively simple since the openings 13 extend over the entire stent periphery in the area 12.

Unlike stent 10, the stent 10′ of Fig. 2 has radial openings 13′ distributed over half of it, not only in a middle area, with borders 14′ into which S-shaped loops 15′ are formed. As a result of this design of the stent 10′, placing it inside the vessel in a branching area is even simpler.

Both stents 10 and 10′ have the advantage that they provide a very good degree of coverage of the vascular wall and nevertheless still allow a very large expansion of individual radial openings for leading a second stent through. The high degree of coverage of the vascular wall ensures that no deposits separate from the vascular wall and reach the blood stream. Moreover, the radial rigidity of the stents 10 and 10′ is just as high in the area of the radial openings 13′ as in the area of the radial openings 11, 11′. Of course, meander-shaped loops, recesses or the like can also be provided in the borders 14, 14′ instead of the S-shaped loops 15, 15′.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising:

a first plurality of cells forming a first plurality of radial openings; and

a second plurality of cells forming a second plurality of radial openings,

wherein each of said first plurality of radial openings is larger than each of said second plurality of radial openings, and

wherein said first plurality of cells comprises a radial strength that is at least approximately equal to a radial strength of said second plurality of cells.

2. A radially expandable stent as defined in claim 1, wherein each of said first plurality of radial openings is configured for expansion to a first expanded width that is greater than a second expanded width to which each of said second plurality of radial openings is configured for expansion.

3. A radially expandable stent as defined in claim 2, wherein each of said first plurality of radial openings is configured to expand in isolation to the first expanded width upon expansion of a second stent therein.

4. A radially expandable stent as defined in claim 2 or 3, wherein said first expanded width is configured for passage of a second stent therethrough.

5. A radially expandable stent as defined in claim 2 or 3, wherein said first expanded width is configured for expansion of a second stent therein.

6. A radially expandable stent as defined in any one of claims 1 to 5, wherein said first plurality of radial openings comprises edges having shaped formations.

7. A radially expandable stent as defined in claim 6, wherein said edges are strip-shaped.

8. A radially expandable stent as defined in claim 6, wherein said shaped formations of said edges comprise a shape chosen from the group consisting of bulges, meandering loops, S-shaped loops, and loops.

9. A radially expandable stent as defined in any one of claims 1 to 8, wherein the stent is formed by laser cutting.

10. A radially expandable stent as defined in any one of claims 1 to 9, wherein the stent comprises a material visible during X-Ray radiation.

11. A radially expandable stent as defined in claim 10, wherein the material is chosen from the group consisting of gold and platinum.

12. A radially expandable stent as defined in any one of claims 1 to 11, wherein the second plurality of radial openings are substantially rhombus-shaped.

13. A radially expandable stent as defined in any one of claims 1 to 12, wherein the first plurality of radial openings are disposed over at least a half of length of the stent.

14. A radially expandable stent as defined in any one of claims 1 to 12, wherein the first plurality of radial openings are disposed over at least a central region of the stent.

15. A radially expandable stent as defined in any one of claims 1 to 12, wherein said first plurality of radial openings are disposed over at least an end of the stent.

16. The radially expandable stent as defined in any one of claims 1 to 15, wherein said radial strength of said first plurality of cells is equal to said radial strength of said second plurality of cells.

17. A radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising:

a first plurality of radial openings having edges with shaped formations; and

a second plurality of radial openings,

wherein said first plurality of radial openings is formed by a first plurality of cells and said second plurality of radial openings is formed by a second plurality of cells, each of said first plurality of radial openings being larger than each of said second plurality of radial openings and the radial strength of said first plurality of cells being at least approximately equal to the radial strength of said second plurality of cells,

wherein said first plurality of radial openings are disposed over at least an end of the stent, and

wherein said shaped formations of said edges comprise a loop shape that is doubled over and forms an opening.

18. A radially expandable stent as defined in claim 17, wherein said loop shape of said shaped formations further comprises a shape chosen from the group consisting of bulges, meandering loops, and S-shaped loops.

19. The radially expandable stent as defined in claim 17 or 18, wherein said radial strength of said first plurality of cells is equal to said radial strength of said second plurality of cells.

20. A radially expandable stent for implanting in a blood vessel in the region of a vessel branch, the stent comprising:

a first plurality of radial openings comprising edges having shaped formations that double over and form an opening; and

a second plurality of radial openings,

wherein said first plurality of radial openings is formed by a first plurality of cells and said second plurality of radial openings is formed by a second plurality of cells, each of said first plurality of radial openings being larger than each of said second plurality of radial openings and the radial strength of said first plurality of cells being at least approximately equal to the radial strength of said second plurality of cells,

wherein each of said first plurality of radial openings is configured for expansion to a first expanded width that is greater than a second expanded width to which each of

said second plurality of radial openings is configured for expansion,

wherein each of said first plurality of radial openings is configured to expand in isolation to the first expanded width upon expansion of a second stent therein, and

wherein said first plurality of radial openings are disposed over at least an end of the stent.

21. A radially expandable stent as defined in claim 20, wherein said shaped formations of said edges comprise a shape chosen from the group consisting of bulges, meandering loops, S-shaped loops, and loops.

22. The radially expandable stent as defined in claim 20 or 21, wherein said radial strength of said first plurality of cells is equal to said radial strength of said second plurality of cells.

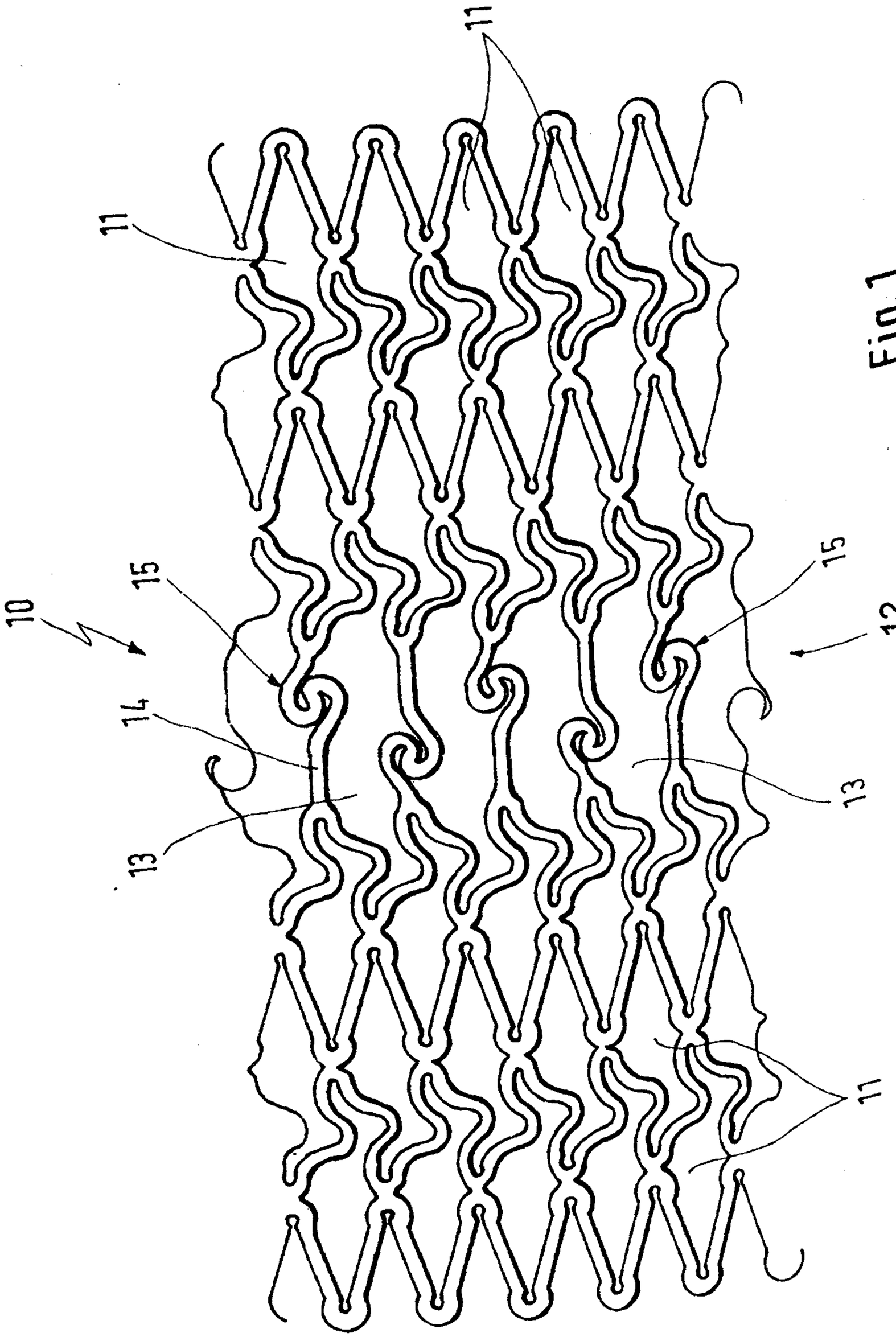


Fig.1

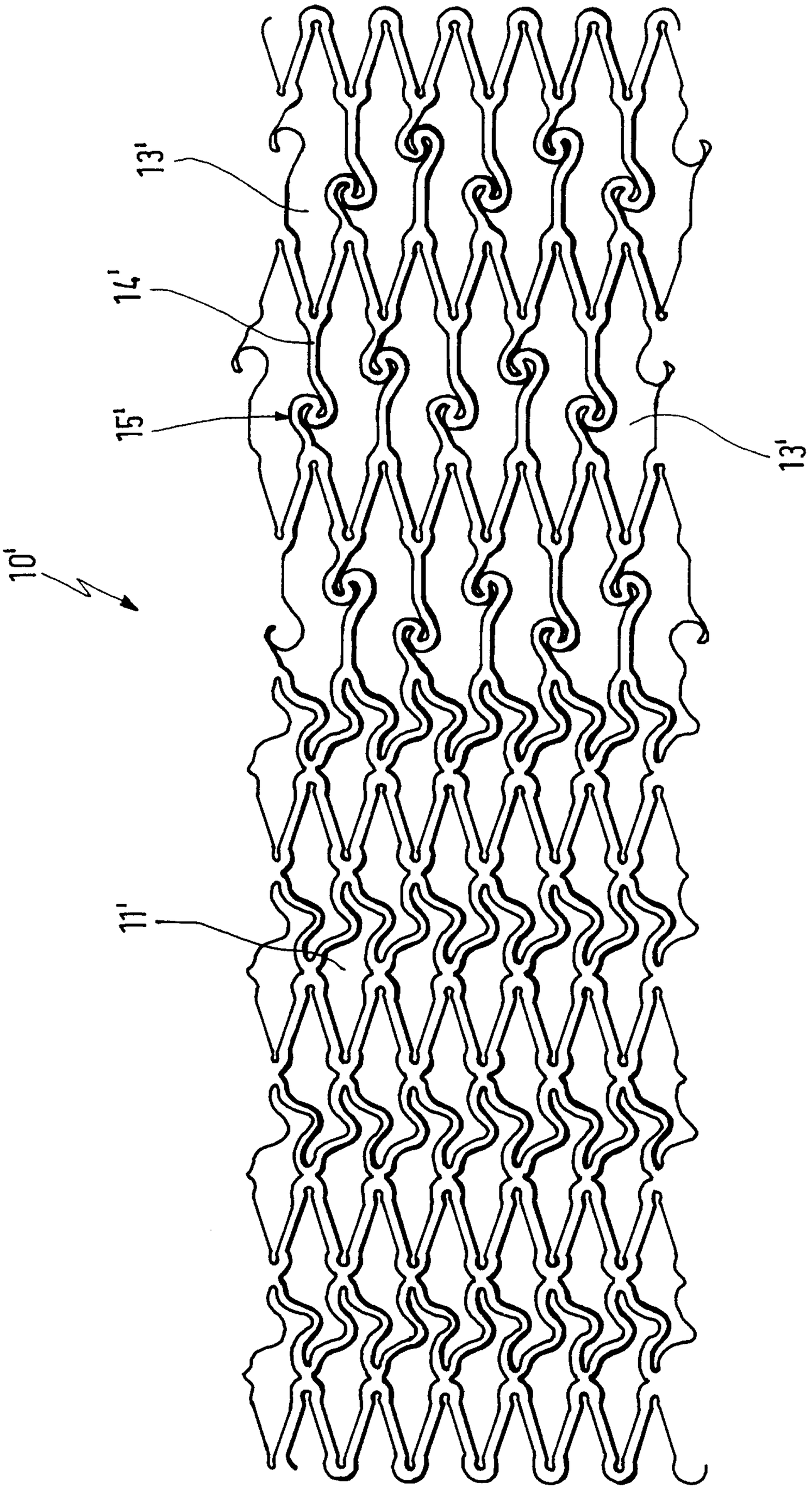
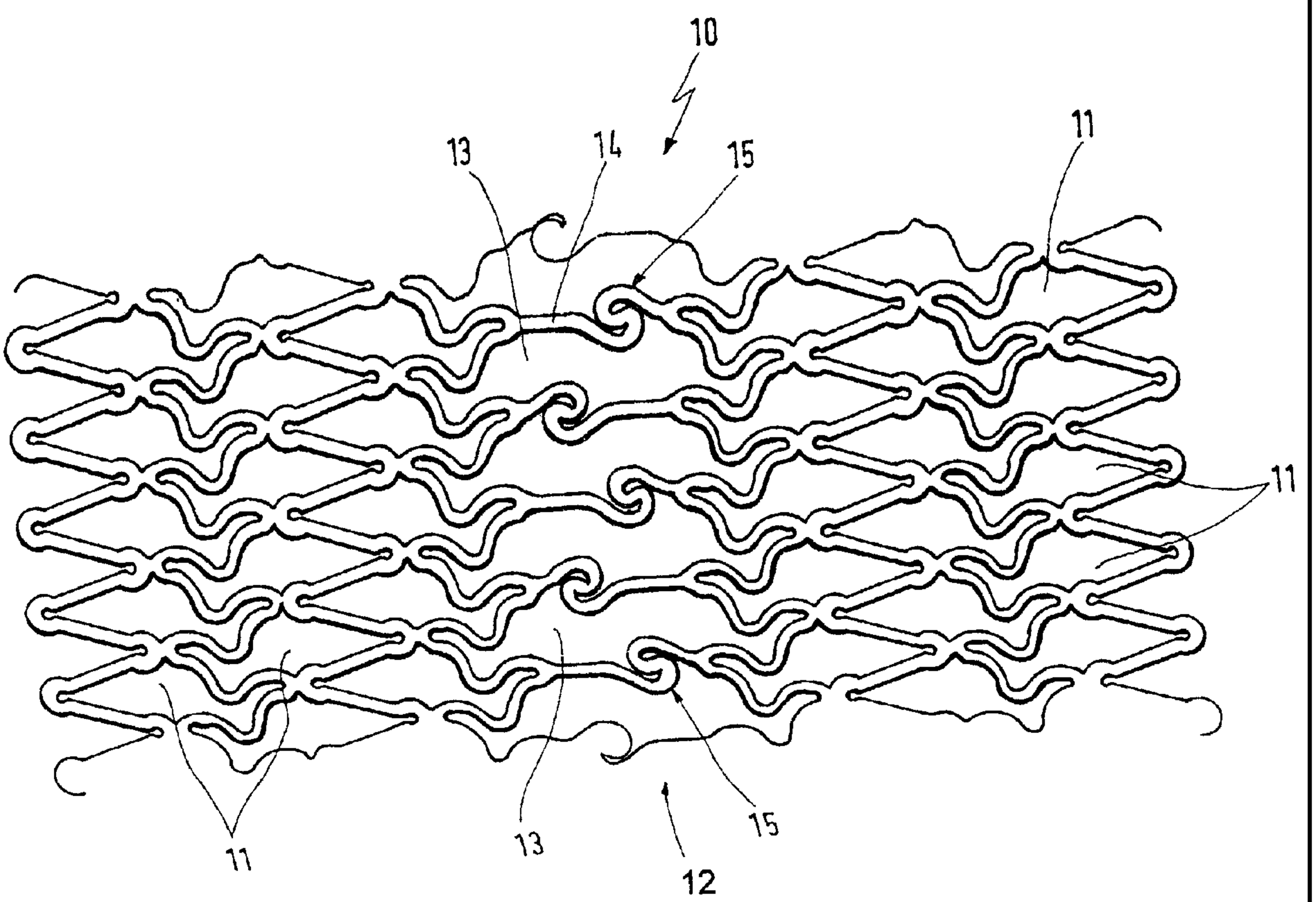


Fig.2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