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We, the above named applicant, state the following:

1. The person nominated for the grant of the patent:

   (b) has entitlement from the actual inventors by assignment from the inventors to the nominated person and Heidi M. Brun and by assignment from Heidi M. Brun to the nominated person.

FOR PCT APPLICATIONS (delete 2 and 3 if inapplicable)

2. The person nominated for the grant of the patent:

   (b) has entitlement to claim priority from the applicants of the application listed in the declaration under Article 8 of the PCT by assignment from the applicants of the application listed in the said declaration and by assignment from Heidi M. Brun to the nominated person.

DATED this 16th day of December, 1998

(a member of the firm of DAVIES COLLISON CAVE for and on behalf of the Applicant)

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2. Special forms required for Divisionals, Patents of Addition, Provisionals, Applications requiring microorganism deposits and cases where earlier filed applications to be disregarded for Convention purposes.

DAVIES COLLISON CAVE
A stent formed of a tube having a patterned shape, the patterned shape including:

a. even first meander patterns having axes extending in a first direction;

b. odd first meander patterns, also having axes extending in said first direction, wherein said odd first meander patterns are 180° out of phase with said even first meander patterns and occur between every two even first meander patterns;

c. second meander patterns having axes extending in a second direction different than said first direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a generally uniform distributed structure.

A stent including a mesh of adjacent, connected cells, each cell including:

an even number of fixed length, alternating first and second loops, connected together in a closed cell, each loop having at least two portions with an area of inflection therebetween, said first and second loops defining first and second angles whose bisecting lines are at angles one to another.
38. A flexible connector for connecting the apices of cells included in a stent, including:

a flexible member having a first end and a second end with an area of inflection
disposed between said first end and said second end, a portion of said flexible member having
a width smaller than the width of said apices to which said first end and said second end are
connected.
(54) Title: A FLEXIBLE EXPANDABLE STENT

There is disclosed a stent (30) for implanting in the body. The stent (30) is formed of a tube having a patterned shape which has first and second meander patterns (11, 12) having axes extending in first and second directions. The first meander patterns can be formed into even and odd first meander patterns. The even and odd first meander patterns are 180 degrees out of phase with each other, and the odd patterns occur between every two even patterns. The second meander patterns are intertwined with the first meander patterns. The first and second directions can be orthogonal to each other. The second meander patterns can also be formed of even and odd patterns.
A FLEXIBLE EXPANDABLE STENT

FIELD OF THE INVENTION

The present invention relates generally to stents for implanting into a living body.

BACKGROUND OF THE INVENTION

Various stents are known in the art wherein, for the present application, the term "stent" indicates a device, made of body-compatible material, which is utilized to widen a blood vessel, or other orifice in the body, and to maintain the resultant size of the lumen. Typically, the stent is delivered to the desired location in the body with an inflatable balloon and, when the balloon is inflated, the stent expands, thereby widening the orifice. Other mechanical devices which cause expansion of the stent are also utilized.


The stents described in U.S. 5,102,417 to Palmaz and Schatz have expandable tubular grafts connected together with a flexible connector. The grafts are formed of a plurality of slots disposed parallel to the longitudinal axis of the tube. The flexible connectors are helical connectors. Since the tubular grafts are relatively rigid, the flexible connectors are needed so that the stents can bend when being fed through a curved blood vessel. When the stents of U.S. 5,102,417
expand, the grafts expand radially and, consequently, shrink longitudinally. However, at the same time, the helical connectors twist. The twisting motion is most probably harmful to the blood vessel.

U.S. 5,195,984 to Schatz describes a similar stent but with one straight connector, parallel to the longitudinal axis of the tubular grafts, between tubular grafts. The straight member removes the twisting motion; however, it is not a very strong connector.

SUMMARY OF THE PRESENT INVENTION

It is therefore an object of the present invention to provide a flexible stent which minimally shrinks, in the longitudinal direction, during expansion.

According to the present invention there is provided a stent formed of a tube having a patterned shape, the patterned shape including:

a. even first meander patterns having axes extending in a first direction;

b. odd first meander patterns, also having axes extending in said first direction, wherein said odd first meander patterns are 180° out of phase with said even first meander patterns and occur between every two even first meander patterns;

c. second meander patterns having axes extending in a second direction different than said first direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a generally uniform distributed structure.

The invention also provides a stent formed of a tube having a patterned shape, the patterned shape including:

a. even and odd first meander patterns having axes extending in a first direction;

b. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a generally uniform distributed structure.

The invention also provides a stent, including:

a. at least odd and even alternating serpentine sections, each having first areas of inflection, wherein said odd serpentine section is out of phase from said even
serpentine section such that first areas of inflection on said odd serpentine section are adjacent first areas of inflection on said even serpentine section; and

b. at least one flexible connector, comprising a plurality of flexible links connecting adjacent first areas of inflection of adjacent even and odd serpentine sections, wherein each flexible link has at least two portions connected by at least one second area of inflection, and wherein said first and second areas of inflection define first and second angles whose bisecting lines are at angles one to another.

The invention also provides a stent including a mesh of adjacent, connected cells, each cell including:

10 an even number of fixed length, alternating first and second loops, connected together in a closed cell, each loop having at least two portions with an area of inflection therebetween, said first and second loops defining first and second angles whose bisecting lines are at angles one to another.

The invention also provides a stent formed of a tube having a patterned shape, the patterned shape including:

15 even first meander patterns having axes extending in a first direction;
odd first meander patterns, also having axes extending in said first direction, wherein said odd first meander patterns are 180° out of phase with said even first meander patterns and occur between every two even first meander patterns;

20 second meander patterns having axes extending in a second direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a distributed structure,
wherein said second meander patterns have two loops per period, and
wherein said even and odd first meander patterns are connected on first and second sides, respectively, of each loop.

The invention also provides a stent formed of a tube having a patterned shape, the patterned shape including:

25 even first meander patterns having axes extending in a first direction;
odd first meander patterns, also having axes extending in said first direction, wherein said odd first meander patterns are 180° out of phase with said even first meander patterns
and occur between every two even first meander patterns;
second meander patterns having axes extending in a second direction, wherein said
second meander patterns are intertwined with said even and odd first meander patterns to form
a distributed structure, and

wherein said second meander patterns are formed of even and odd second meander
patterns.

The invention also provides an expandable stent defining a longitudinal aperture,
including:

a plurality of flexible connected cells, each of said flexible cells including:

a. a first member having a longitudinal component having a first end and a second
   end;

b. a second member having a longitudinal component having a first end and a second
   end;

c. a third member having a longitudinal component having a first end and a second
   end;

d. a fourth member having a longitudinal component having a first end and a second
   end;

e. a first loop defining a first angle disposed between said first end of said first
   member and said first end of said second member;

f. a second loop defining a second angle disposed between said second end of said third
   member and said second end of said fourth member, and disposed generally
   opposite to said first loop;

g. a first flexible compensating member or flexible link having a first end and a
   second end disposed between said first member and said third member, said first end
   of said first flexible compensating member or flexible link communicating with said
   second end of said first member and said second end of said first flexible
   compensating member or flexible link communicating with said first end of said third
   member, said first and said second ends disposed a variable longitudinal distance from
   each other;

h. a second flexible compensating member or flexible link having a first end and
a second end disposed between said second member and said fourth member, said first end of said second flexible compensating member or flexible link communicating with said second end of said second member and said second end of said second flexible compensating member or flexible link communicating with said first end of said fourth member, said first and said second ends disposed a variable longitudinal distance from each other, said first and said second flexible compensating member or flexible links differentially extendable or compressible when said stent is bent in a curved direction away from the longitudinal axis of said aperture; and

i. said first, said second, said third, and said fourth members and said first and said second loops, and said first and said second flexible compensating member or flexible links disposed so that as said stent is expanded the distance between said first and said second flexible compensating member or flexible links increases and the longitudinal component of said first, second, third and fourth members decreases while said first and said second loops remain generally opposite to one another, the ends of said first and said second flexible compensating member or flexible links open so as to increase said variable longitudinal distance between said first and said second ends of said first flexible compensating member or flexible link and so as to increase said variable longitudinal distance between said first and said second ends of said second flexible compensating member or flexible link so as to compensate for the decreasing of the longitudinal component of said first, second, third, and fourth members and substantially lessen the foreshortening of said stent upon its expansion.

The invention also provides an expandable stent having a longitudinal axis, which consists essentially of:

a plurality of flexible cells having a longitudinal axis and a first longitudinal and a second longitudinal end, said cells disposed about the circumference of the stent, each of said cells including:

a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of said cell;

a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of said cell; and
a plurality of flexible links connecting said first and second pair of members and
generally disposed between each neighboring cell about the circumference of said stent,
wherein said flexible links have some area with a width smaller than the width of said areas
of inflection.

The invention also provides an expandable stent, including:

a plurality of connected cells defining a substantially uniform structure defining a
longitudinal aperture having a longitudinal axis, said cells arranged in a plurality of bands,
each of said bands lying in a plane substantially perpendicular to said longitudinal axis, each
of said plurality of cells in each of said bands comprising:

10  a. a first member having a first end and a second end;
b. a second member having a first end and a second end;
c. a third member having a first end and a second end;
d. a fourth member having a first end and a second end;
e. a first loop defining a first angle disposed between said first end of said first
member and said first end of said second member;
f. a second loop defining a second angle disposed between said second end of said
third member and said second end of said fourth member;
g. a first flexible arcuate compensating member disposed between said second end
of said first member and said first end of said third member;
h. a second flexible arcuate compensating member disposed between said second
end of said second member and said first end of said fourth member, said first flexible
arcuate compensating member and said second flexible arcuate compensating member
of each of said plurality of cells in each of said plurality of bands flexibly connecting
adjacent bands.

The invention also provides a stent formed of a tube having a patterned shape, the
patterned shape including:

first meander patterns which are periodic about axes extending in a first direction;
second meander patterns which are periodic about axes extending in a second direction
different than said first direction, wherein said second meander patterns are intertwined with
said first meander patterns to form a generally uniform distributed structure, wherein said
second meander patterns define a plurality of flexible arcuate compensating members adapted
to elongate in said second direction to compensate for the tendency of said first meander
patterns to foreshorten when said stent is expanded.

The invention also provides a generally longitudinally extending tubular stent which
is substantially uniformly flexible with respect to its longitudinal axis by the flexibility of its
cells with respect to said axis including:

a. a plurality of cells flexible around said longitudinal axis connected to one
   another about the circumference of said stent to form a band of flexible cells, each of
   said flexible cells having apices disposed apart and generally opposite to one another
   along said longitudinal extension of the cell;

b. each of said flexible cells having a plurality of flexible links disposed apart and
genearly opposite to one another along the circumferential extension of said cells;

c. each of said flexible links including a plurality of portions with neighboring
   portions having an area of inflection therebetween; and

d. said flexible cells in said adjacent bands of flexible cells connected to one
   another.

The invention also provides a flexible connector for connecting the apices of cells
included in a stent, including:

a flexible member having a first end and a second end with an area of inflection
disposed between said first end and said second end, a portion of said flexible member having
a width smaller than the width of said apices to which said first end and said second end are
connected.

The invention also provides an expandable stent, including:

a plurality of connected cells having a longitudinal axis defining a substantially
uniform structure of flexible cells having a longitudinal axis and a circumferential axis
substantially perpendicular to said longitudinal axis;

each of said flexible cells having apices disposed apart and generally opposite to one
   another along said longitudinal axis of each of said cells;

each of said flexible cells having at least two flexible links disposed apart and
   generally opposite to one another about the circumferential extension of the cell, each of said
flexible links including at least two portions with an area of inflection therebetween.

The invention also provides an expandable stent, consisting essentially of:

a plurality of flexible cells disposed about the circumference of the stent, each of said cells having a first longitudinal end and a second longitudinal end, each of said cells including:

1. a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of each of said cells;
2. a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of each of said plurality of cells; and
3. a flexible link connecting said first and second pair of members and generally disposed about the circumference of the stent between each neighboring cell.

The invention also provides an expandable stent having a longitudinal axis, including:

a plurality of flexible cells having a longitudinal axis and a first longitudinal and a second longitudinal end, said cells disposed about the circumference of the stent, each of said cells including:

1. a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of said cell;
2. a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of said cell; and
3. a plurality of flexible links connecting said first and second pair of members and generally disposed between each neighboring cell about the circumference of said stent.

The invention also provides a stent formed of a tube having a patterned shape, the patterned shape including:

1. even first meander patterns having areas extending in a first direction;
2. odd first meander patterns also having axes extending in said first direction, wherein after expansion of said stent, said odd first meander patterns are out of phase with said even first meander patterns, and wherein said odd first meander patterns occur between every two even first meander patterns;
3. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns intersect with said even
and odd first meander patterns to form a distributed structure;

d. wherein said first meander patterns have loops;

e. wherein said first meander patterns are spaced apart to leave a portion of said second meander patterns between each pair of adjacent first meander patterns; and

f. wherein each of said second meander patterns has at least one loop between at least one pair of adjacent first meander patterns.

The invention also provides an expandable stent formed of an elongated cylindrical unitary tube suitable for insertion into a lumen or blood vessel in which it may be expanded, including:

10 a plurality of first meanders extending in a first direction on the cylinder of the tube and a plurality of second meanders extending in a second direction, on the cylinder of the tube, wherein the first and second meanders are formed with loops and are interconnected such that at least one of the loops of each of the first meanders is disposed between each consecutive second meander to which the first meander is connected, and at least one of the loops of each of the second meanders is disposed between each consecutive first meander to which it is connected;

the first and second meanders defining a plurality of enclosed spaces.

The invention also provides a stent formed of a tube having a patterned shape, the patterned shape including:

20 a. first meander patterns having axes extending in a first direction;

b. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns intersect with said first meander patterns;

c. wherein said first meander patterns have loops;

d. wherein said first meander patterns are spaced apart to leave a portion of said second meander patterns between each pair of adjacent first meander patterns;

e. wherein each of said second meander patterns has at least one loop between at least one pair of adjacent first meander patterns.
BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is an illustration of a patterned stent, constructed and operative in accordance with a first preferred embodiment of the present invention;

Fig. 2 is an illustration of the pattern of the stent of Fig. 1;

Fig. 3 is an illustration of the stent of Fig. 1 in a bent position;

Fig. 4 is an illustration of the stent of Fig. 1 in an expanded format;

Figs. 5A and 5B are illustrations of the changes in the patterns of the stent of Fig. 1 due to expansion;

Fig. 6 is a schematic illustration of a second embodiment of the pattern for a stent;

Fig. 7 is an illustration of a third embodiment of the pattern for the stent; and
Fig. 8 is an illustration of the pattern of Fig. 7 in an expanded format.

**DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

Reference is now made to Figs. 1 - 4 which illustrate a first embodiment of a stent, constructed and operative in accordance with the principles of the present invention. Fig. 1 illustrates the stent in its non-expanded form, Fig. 2 illustrates the pattern of the stent, Fig. 3 illustrates it in a partially bent position and Fig. 4 illustrates it in an expanded form.

The stent of the present invention is a tube whose sides are formed into a plurality of each of two orthogonal meander patterns which patterns are intertwined with each other. The term "meander pattern" is taken herein to describe a periodic pattern about a center line and "orthogonal meander patterns" are patterns whose center lines are orthogonal to each other.

In the stent of Figs. 1 - 4, the two meander patterns are labeled 11 and 12 and they are most easily seen in Fig. 2. Meander pattern 11 is a vertical sinusoid having a vertical center line 9. Meander pattern 11 has two loops 14 and 16 per period wherein loops 14 open to the right while loops 16 open to the left. Loops 14 and 16 share common members 15 and 17, where member 15 connects from one loop 14 to its following loop 16 and member 15 connects from one loop 16 to its following loop 14.

Meander pattern 12 is an horizontal pattern having an horizontal center line 13. Meander pattern 12 also has loops, labeled 18 and 20, but between loops of a period is an extended straight section labeled 22. Loops 18 open downwards and loops 20 open upwards.

Vertical meander pattern 11 is provided in odd and even (o and e) versions which are 180° out of phase with
each other. Thus, each left opening loop 16 of meander pattern 110 faces a right opening loop of meander pattern 11e and a right opening loop 14 of meander pattern 110 faces a left opening loop 16 of meander pattern 11e.

Horizontal meander pattern 12 is also provided in odd and even forms. The straight sections 22 of horizontal meander pattern 12e intersect with every third common member 17 of vertical meander pattern 11e. The straight sections 22 of horizontal meander pattern 120 intersect with every third common member 15 of vertical meander pattern 11e. beginning with the common member 15 two after an intersected common member 17. The result is a full loop 14 between meander patterns 12e and 120 and a full loop 16 between meander patterns 120 and 12e.

Returning to Fig. 1, the pattern of Fig. 2 is formed into a tube 30 of an easily deformable material, such as a metal. Due to the two meander patterns, the stent of Fig. 1, when attached over a catheter balloon, is flexible and can therefore be easily dragged through curved blood vessels. An example of the way in which the stent of Fig. 1 bends is illustrated in Fig. 3.

In Fig. 3, the stent begins to bend at the point marked A in the direction marked by arrow 40. As the stent begins to curve, the section marked I becomes the inside of the curve while the section marked O becomes the outside of the curve. The inside of the curve I is shortened vis-a-vis the outside of the curve O.

During bending, the loops 14 - 20 to the right of the point A change shape in order to compensate for the differences in length between the inside and outside curves. For example, loops 181 and 201 near the inside of the curve are closer together than loops 180 and 200 on the outside of the curve, which expand. Loops 14i and 16i near the inside I are compressed while the
loops 140 and 160 closer to the outside O of the curve are expanded.

As can be seen, both meander patterns 11 and 12 are involved in the bending. Although not shown, it will be appreciated that the stent of Figs. 1 - 4 can bend in any direction and in more than one direction at any time.

Fig. 4 illustrates the stent of Fig. 1 in its expanded form. When the stent expands, both meander patterns 11 and 12 expand (i.e. all loops 14 - 20 open up). As can be seen, the expanded stent has two types of enclosed spaces, a large space 42 between meander patterns 120 and 12e and a small space 44 between meander patterns 12e and 12o. As can also be seen, each large space 42 has two loops 14 on its left side and two loops 16 on its right side. The large spaces between vertical meander patterns 11e and 11o, which are labeled 42a, have loops 18 at their tops and bottoms while the large spaces between vertical meander patterns 11o and 11e, which are labeled 42b, have loops 20 at their tops and bottoms. Similarly for small spaces 44a and 44b.

It is noted that, due to the orthogonal meander patterns 11 and 12, the stent of Fig. 1 does not significantly shrink during expansion. This is illustrated in detail in Figs. 5A and 5B to which reference is now made. Fig. 5A illustrates the movement, during expansion, of one vertical meander pattern 11 and Fig. 5B illustrates the movement, during expansion, of one horizontal meander pattern 12. The original patterns are shown with solid lines and the expanded patterns are shown with dashed lines.

The vertical meander pattern 11 of Fig. 5A expands by widening its loops 14 and 16. As a result, the vertical meander pattern 11 grows vertically by an amount $2h_1$, per loop. However, it also shrinks
horizontally, by an amount $2\times d_1$. Similarly, the horizontal meander pattern 12 of Fig. 5B expands by widening its loops 18 and 20. As a result, the horizontal meander pattern 12 grows horizontally by an amount $2\times d_2$ per loop. However, it also shrinks vertically, by an amount $h_2$. Thus, the vertical growth of the vertical meander pattern 11 compensates, at least partially, for the vertical shrinkage of the horizontal meander pattern 12, and vice versa. It is noted that the end portions of any stent are only partially compensated and therefore, may shrink somewhat.

It will be appreciated that the two orthogonal meander patterns 11 and 12 and the compensation they provide to each other provides flexibility to the unexpanded stent of Fig. 1. However, when the stent is expanded, the changes in each of loops 14 and 16 provide rigidity to the resultant stent and thus, enable the stent to maintain a blood vessel at a desired inner diameter.

The stent of the present invention can be manufactured from flat metal which is etched into the pattern of Fig. 2. The etched metal is then bent to form the tube 30. Alternatively, the pattern of Fig. 2 can be manufactured from welded or twisted wire.

It will be appreciated that the stent of the present invention can be made from metal and/or wire. Additionally, it can be plated with a protective material, embedded with a medicine, and/or covered with a material which can fill in the spaces 42 and 44.

It will be appreciated that the present invention encompasses all stents manufactured with a pattern formed of two meander patterns, orthogonal or otherwise. Another exemplary pattern, also with orthogonal meander patterns, is provided herein wherein Fig. 6 is a schematic version and Fig. 7 is a more
rounded version. Fig. 8 shows the pattern of Fig. 7 in an expanded format. The pattern of Figs. 6 and 7 is similar to that shown in Fig. 2 except that it has more horizontal meander patterns 12 and they are of one kind, rather than being even and odd as in Fig. 2.

As can be seen in both Figs. 6 and 7, there are two types of vertical meander patterns \(11e\) and \(11o\) which are \(180^\circ\) out of phase with each other. The horizontal meander patterns 12 connect with every line 15 of vertical meander pattern \(11e\).

Fig. 8 illustrates the pattern of Fig. 7 in an expanded format. Since there are no even and odd horizontal meander patterns, in the expanded format of Fig. 8, there are no large and small spaces. Instead, all spaces are of the same size.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined by the claims which follow:
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A stent formed of a tube having a patterned shape, the patterned shape including:
   a. even first meander patterns having axes extending in a first direction;
   b. odd first meander patterns, also having axes extending in said first direction,
      wherein said odd first meander patterns are 180° out of phase with said even first
      meander patterns and occur between every two even first meander patterns;
   c. second meander patterns having axes extending in a second direction different
      than said first direction, wherein said second meander patterns are intertwined with
      said even and odd first meander patterns to form a generally uniform distributed
      structure.

2. A stent according to claim 1 and wherein said even first meander patterns and said odd
   first meander patterns are periodic about axes extending in said first direction and wherein
   said second meander patterns are periodic about axes extending in said second direction.

3. A stent according to either of claims 1 or 2 and wherein said second meander patterns
   have two loops per period and wherein said even and odd first meander patterns are connected
   on first and second sides, respectively, of each loop.

4. A stent according to any one of the previous claims and wherein said second meander
   patterns are formed of even and odd second meander patterns.

5. A stent according to claim 4 and wherein said even and odd first meander patterns
   have loops and wherein said even and odd second meander patterns are connected to said even
   and odd first meander patterns so as to leave one full loop between each pair of even and odd
   second meander patterns.

6. A stent formed of a tube having a patterned shape, the patterned shape including:
   a. even and odd first meander patterns having axes extending in a first direction;
b. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a generally uniform distributed structure.

7. A stent according to claim 6 and wherein said first meander patterns are periodic about axes extending in said first direction and wherein said second meander patterns are periodic about axes extending in said second direction.

8. A stent according to any one of claims 1 to 7 and wherein said first and second directions are orthogonal.

9. A stent according to any one of claims 1 to 7 and wherein said first and second directions are not orthogonal.

10. A stent according to any one of claims 1 to 9 and wherein said first and second meander patterns are formed from wire.

11. A stent according to any one of claims 1 to 9 and wherein said first and second meander patterns are cut from flat metal.

12. A stent according to any one of the previous claims and wherein said stent is finished in one of the following ways: plating with a protective material, embedding with medicine, and covered with a material.

13. A stent, including:
   a. at least odd and even alternating serpentine sections, each having first areas of inflection, wherein said odd serpentine section is out of phase from said even serpentine section such that first areas of inflection on said odd serpentine section are adjacent first areas of inflection on said even serpentine section; and
b. at least one flexible connector, comprising a plurality of flexible links connecting adjacent first areas of inflection of adjacent even and odd serpentine sections, wherein each flexible link has at least two portions connected by at least one second area of inflection, and wherein said first and second areas of inflection define first and second angles whose bisecting lines are at angles one to another.

14. A stent including a mesh of adjacent, connected cells, each cell including:
   an even number of fixed length, alternating first and second loops, connected together in a closed cell, each loop having at least two portions with an area of inflection therebetween, said first and second loops defining first and second angles whose bisecting lines are at angles one to another.

15. A stent formed of a tube having a patterned shape, the patterned shape including:
   even first meander patterns having axes extending in a first direction;
   odd first meander patterns, also having axes extending in said first direction, wherein said odd first meander patterns are 180° out of phase with said even first meander patterns and occur between every two even first meander patterns;
   second meander patterns having axes extending in a second direction, wherein said second meander patterns are intertwined with said even and odd first meander patterns to form a distributed structure,
   wherein said second meander patterns have two loops per period, and
   wherein said even and odd first meander patterns are connected on first and second sides, respectively, of each loop.

25. The stent of claim 15, wherein said second meander patterns define a plurality of flexible arcuate compensating members adapted to elongate in said second direction to compensate for the tendency of said first meander patterns to foreshorten when said stent is expanded.
17. A stent formed of a tube having a patterned shape, the patterned shape including:
even first meander patterns having axes extending in a first direction;
odd first meander patterns, also having axes extending in said first direction, wherein
said odd first meander patterns are 180° out of phase with said even first meander patterns
and occur between every two even first meander patterns;
second meander patterns having axes extending in a second direction, wherein said
second meander patterns are intertwined with said even and odd first meander patterns to form
a distributed structure, and
wherein said second meander patterns are formed of even and odd second meander
patterns.

18. A stent according to claim 17 and wherein said even and odd first meander patterns
have loops and wherein said even and odd second meander patterns are connected to said even
and odd first meander patterns so as to leave one full loop between each pair of even and odd
second meander patterns.

19. The stent of claim 17, wherein said second meander patterns define a plurality of
flexible arcuate compensating members adapted to elongate in said second direction to
compensate for the tendency of said first meander patterns to foreshorten when said stent is
expanded.

20. An expandable stent defining a longitudinal aperture, including:
a plurality of flexible connected cells, each of said flexible cells including:
a. a first member having a longitudinal component having a first end and a second
   end;
b. a second member having a longitudinal component having a first end and a second
   end;
c. a third member having a longitudinal component having a first end and a second
   end;
d. a fourth member having a longitudinal component having a first end and a
second end;

e. a first loop defining a first angle disposed between said first end of said first member and said first end of said second member;

f. a second loop defining a second angle disposed between said second end of said third member and said second end of said fourth member, and disposed generally opposite to said first loop;

g. a first flexible compensating member or flexible link having a first end and a second end disposed between said first member and said third member, said first end of said first flexible compensating member or flexible link communicating with said second end of said first member and said second end of said first flexible compensating member or flexible link communicating with said first end of said third member, said first and said second ends disposed a variable longitudinal distance from each other;

h. a second flexible compensating member or flexible link having a first end and a second end disposed between said second member and said fourth member, said first end of said second flexible compensating member or flexible link communicating with said second end of said second member and said second end of said second flexible compensating member or flexible link communicating with said first end of said fourth member, said first and said second ends disposed a variable longitudinal distance from each other, said first and said second flexible compensating member or flexible links differentially extendable or compressible when said stent is bent in a curved direction away from the longitudinal axis of said aperture; and

i. said first, said second, said third, and said fourth members and said first and second loops, and said first and said second flexible compensating member or flexible links disposed so that as said stent is expanded the distance between said first and said second flexible compensating member or flexible links increases and the longitudinal component of said first, second, third and fourth members decreases while said first and said second loops remain generally opposite to one another, the ends of said first and said second flexible compensating member or flexible links open so as to increase said variable longitudinal distance between said first and said second
ends of said first flexible compensating member or flexible link and so as to increase said variable longitudinal distance between said first and said second ends of said second flexible compensating member or flexible link so as to compensate for the decreasing of the longitudinal component of said first, second, third, and fourth members and substantially lessen the foreshortening of said stent upon its expansion.

21. The stent of claim 20, wherein the material of said first and said second compensating members is provided with a width that is smaller than the width of the material of said first and said second loops.

22. The stent according to claim 21 wherein said compensating members define an area of inflection between said first end and said second end and said area of inflection remains inflected after the expansion of said stent.

23. The stent of claim 22 in which the area of inflection enlarges during the expansion of the stent.

24. The stent of claim 20, in which said members are generally straight.

25. The stent of claim 20, wherein said first flexible compensating member or flexible link is arcuate and said second flexible compensating member or flexible link is arcuate and said compensating members elongate in an amount substantially equal to the amount that the distance between the ends of said first and second members and said third and fourth members increases when said stent is expanded.

26. The stent of claim 20, wherein said cells define a uniform cellular structure.

27. The stent of claim 20, wherein said first flexible compensating member or flexible link and said second flexible compensating member or flexible link also serve to connect other cells which themselves have first and second compensating members.
28. The stent of claim 20, wherein said first and said second flexible compensating member or flexible links do not tend to project into or outside of said longitudinal aperture when said stent is expanded.

29. The stent of claim 20, wherein said first and said second flexible compensating member or flexible links do not tend to project into or outside of said longitudinal aperture when said stent is flexed.

30. An expandable stent having a longitudinal axis, which consists essentially of:

a plurality of flexible cells having a longitudinal axis and a first longitudinal and a second longitudinal end, said cells disposed about the circumference of the stent, each of said cells including:

a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of said cell;

a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of said cell; and

a plurality of flexible links connecting said first and second pair of members and generally disposed between each neighboring cell about the circumference of said stent, wherein said flexible links have some area with a width smaller than the width of said areas of inflection.

31. An expandable stent, including:

a plurality of connected cells defining a substantially uniform structure defining a longitudinal aperture having a longitudinal axis, said cells arranged in a plurality of bands, each of said bands lying in a plane substantially perpendicular to said longitudinal axis, each of said plurality of cells in each of said bands comprising:

a. a first member having a first end and a second end;

b. a second member having a first end and a second end;

c. a third member having a first end and a second end;

d. a fourth member having a first end and a second end;
e. a first loop defining a first angle disposed between said first end of said first member and said first end of said second member;

f. a second loop defining a second angle disposed between said second end of said third member and said second end of said fourth member;

g. a first flexible arcuate compensating member disposed between said second end of said first member and said first end of said third member;

h. a second flexible arcuate compensating member disposed between said second end of said second member and said first end of said fourth member, said first flexible arcuate compensating member and said second flexible arcuate compensating member of each of said plurality of cells in each of said plurality of bands flexibly connecting adjacent bands.

32. The stent of claim 31 wherein said first and said second flexible arcuate compensating members are adapted to lengthen upon the expansion of said stent to compensate for the tendency of said stent to foreshorten when said stent is expanded.

33. The stent of claim 32 wherein said first and said second flexible arcuate compensating members elongate in an amount substantially equal to the amount that the distance between the ends of said first and second members and said third and fourth members increases when said stent is expanded by a catheter balloon.

34. The stent of claim 31, wherein said first and said second flexible arcuate compensating members are readily differentially compressible or expandable when said stent is unexpanded and are less differentially compressible or expandable after said stent is expanded.

35. The stent of claim 31, wherein said first and said second flexible arcuate compensating members are provided with a width that is smaller than the width of said first, said second, said third, and said fourth members and said first loop and said second loop.
36. A stent formed of a tube having a patterned shape, the patterned shape including:
first meander patterns which are periodic about axes extending in a first direction;
second meander patterns which are periodic about axes extending in a second direction
different than said first direction, wherein said second meander patterns are intertwined with
said first meander patterns to form a generally uniform distributed structure, wherein said
second meander patterns define a plurality of flexible arcuate compensating members adapted
to elongate in said second direction to compensate for the tendency of said first meander
patterns to foreshorten when said stent is expanded.

37. A generally longitudinally extending tubular stent which is substantially uniformly
flexible with respect to its longitudinal axis by the flexibility of its cells with respect to said
axis including:
   a. a plurality of cells flexible around said longitudinal axis connected to one
      another about the circumference of said stent to form a band of flexible cells, each of
      said flexible cells having apices disposed apart and generally opposite to one another
      along said longitudinal extension of the cell;
   b. each of said flexible cells having a plurality of flexible links disposed apart and
      generally opposite to one another along the circumferential extension of said cells;
   c. each of said flexible links including a plurality of portions with neighboring
      portions having an area of inflection therebetween; and
   d. said flexible cells in said adjacent bands of flexible cells connected to one
      another.

38. A flexible connector for connecting the apices of cells included in a stent, including:
a flexible member having a first end and a second end with an area of inflection
disposed between said first end and said second end, a portion of said flexible member having
a width smaller than the width of said apices to which said first end and said second end are
connected.

39. The connector of claim 38, wherein said portion is in said area of inflection.
40. The connector of claim 38, wherein said portion is adjacent to each side of the centre of the area of inflection.

41. The connector of claim 38, wherein said portion is disposed between said first end and said second end.

42. An expandable stent, including:
   a plurality of connected cells having a longitudinal axis defining a substantially uniform structure of flexible cells having a longitudinal axis and a circumferential axis substantially perpendicular to said longitudinal axis;
   each of said flexible cells having apices disposed apart and generally opposite to one another along said longitudinal axis of each of said cells;
   each of said flexible cells having at least two flexible links disposed apart and generally opposite to one another about the circumferential extension of the cell, each of said flexible links including at least two portions with an area of inflection therebetween.

43. An expandable stent, consisting essentially of:
   a plurality of flexible cells disposed about the circumference of the stent, each of said cells having a first longitudinal end and a second longitudinal end, each of said cells including:
   a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of each of said cells;
   a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of each of said plurality of cells; and
   a flexible link connecting said first and second pair of members and generally disposed about the circumference of the stent between each neighboring cell.

44. An expandable stent having a longitudinal axis, including:
   a plurality of flexible cells having a longitudinal axis and a first longitudinal and a second longitudinal end, said cells disposed about the circumference of the stent, each of said
cells including:

a first pair of members connected by an area of inflection generally disposed at said first longitudinal end of said cell;

a second pair of members connected by an area of inflection generally disposed at said second longitudinal end of said cell; and

a plurality of flexible links connecting said first and second pair of members and generally disposed between each neighboring cell about the circumference of said stent.

45. The stent of claim 43 or 44, wherein said flexible links have some area with a width smaller than the width of said areas of inflection.

46. A stent formed of a tube having a patterned shape, the patterned shape including:

a. even first meander patterns having areas extending in a first direction;

b. odd first meander patterns also having axes extending in said first direction, wherein after expansion of said stent, said odd first meander patterns are out of phase with said even first meander patterns, and wherein said odd first meander patterns occur between every two even first meander patterns;

c. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns intersect with said even and odd first meander patterns to form a distributed structure;

d. wherein said first meander patterns have loops;

e. wherein said first meander patterns are spaced apart to leave a portion of said second meander patterns between each pair of adjacent first meander patterns; and

f. wherein each of said second meander patterns has at least one loop between at least one pair of adjacent first meander patterns.

47. An expandable stent formed of an elongated cylindrical unitary tube suitable for insertion into a lumen or blood vessel in which it may be expanded, including:

a plurality of first meanders extending in a first direction on the cylinder of the tube and a plurality of second meanders extending in a second direction, on the cylinder of the
tube, wherein the first and second meanders are formed with loops and are interconnected such that at least one of the loops of each of the first meanders is disposed between each consecutive second meander to which the first meander is connected, and at least one of the loops of each of the second meanders is disposed between each consecutive first meander to which it is connected;

the first and second meanders defining a plurality of enclosed spaces.

48. A stent according to claim 47, wherein the first and second meanders are connected together such that the loops thereof cooperate so that upon the expansion of the stent, the growth of some loops in the longitudinal direction of the tube compensates for the shrinkage of other loops in the longitudinal direction of the tube to substantially eliminate any significant shrinkage of the stent in length during expansion.

49. A stent according to claim 47, wherein the enclosed spaces of said stent are formed from interconnected circumferential and longitudinal meanders, and wherein upon expansion the circumferential growth of the circumferential meanders compensates, at least partially, for the circumferential shrinkage of the longitudinal meanders and vice versa.

50. A stent according to claim 47, wherein the first and second meanders are connected together such that the loops thereof cooperate so that upon bending of the stents the loops change shape to compensate for the difference in length between the inside and outside curves.

51. A stent according to claim 47, wherein upon expansion changes in the shape of the loops provides rigidity of the stent to enable the stent to maintain a blood vessel or lumen at a desired inner diameter.

52. A stent according to claim 47, wherein the stent can bend in any direction and in more than one direction at any time.
53. A stent according to claim 47, wherein the first meanders pattern comprise even first meanders pattern and odd first meanders and wherein the odd first meanders are 180° out of phase with the even first meanders and occur between every two even first meanders.

54. A stent according to claim 53, wherein the even and odd first meanders are connected to the second meanders on first and second sides of each loop of the second meanders.

55. A stent formed of a tube having a patterned shape, the patterned shape including:
   a. first meander patterns having axes extending in a first direction;
   b. second meander patterns having axes extending in a second direction, different than said first direction, wherein said second meander patterns intersect with said first meander patterns;
   c. wherein said first meander patterns have loops;
   d. wherein said first meander patterns are spaced apart to leave a portion of said second meander patterns between each pair of adjacent first meander patterns;
   e. wherein each of said second meander patterns has at least one loop between at least one pair of adjacent first meander patterns.

56. A stent according to claim 55 wherein said first meander patterns include even and odd first meander patterns, said odd first meander patterns occur between every two even first meander patterns, and prior to expansion of said stent, said odd first meander patterns are out of phase with said even first meander patterns.

57. A stent according to claim 55 wherein said first meander patterns include even and odd first meander patterns, said odd first meander patterns occur between every two even first meander patterns, and after expansion of said stent, said odd first meander patterns are out of phase with said even first meander patterns.

58. A stent according to claim 55 wherein each loop of said second meander patterns includes at least two portions with an area of inflection therebetween.
59. A stent according to claim 55 wherein each loop of said second meander patterns is rounded.

60. A stent according to claim 55 wherein said first meander patterns intersect with said second meander patterns so as to leave at least one loop of said second meander patterns between each pair of adjacent first meander patterns.

61. A stent according to claim 55 wherein said second meander patterns intersect with said first meander patterns so as to leave at least one loop of said first meander patterns between each pair of adjacent second meander patterns.

62. A stent according to claim 55 wherein said second meander patterns intersect with said first meander patterns at common members which are shared by said first and said second meander patterns.

63. A stent according to claim 55 wherein said first and second meander patterns are cut from flat metal.

64. A stent substantially as hereinbefore described with reference to the accompanying drawings.

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By its Patent Attorneys

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FIG. 5A

FIG. 6