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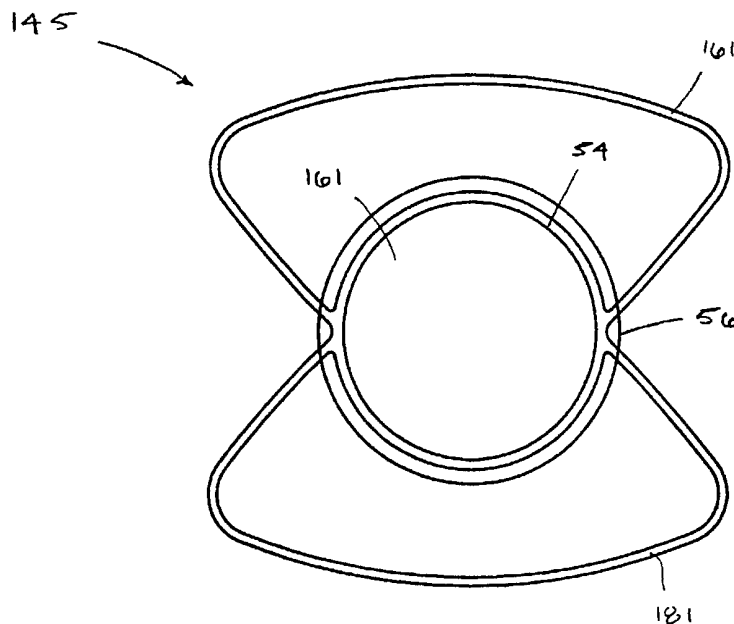
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- (71) Applicant (for all designated States except US): **STAAR SURGICAL COMPANY, INC.** [US/US]; 1911 Walker Avenue, Monrovia, CA 91016 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **FRIEDMAN, Robert, S.** [US/US]; 1503 S. Durango Avenue, Los Angeles, CA 90035 (US). **CHAMBERS, Thomas, J.** [US/US]; 442 Deborah Court, Upland, CA 91784 (US).
- (74) Agent: **KLIMA, William, L.**; Klima & Pezzlo, P.C., P.O. Box 2855, Stafford, VA 22555-2855 (US).
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(54) Title: INTRAOCULAR LENS



(57) Abstract: An intraocular lens (14) is provided having an optic body (16), a first haptic portion (18) connected to the optic body and at least a second haptic portion (22) connected to the optic body, the first and the at least second haptic portions configured to engage the bounds of an implant site within an eye and to prevent rotation of the optic body relative to the cornea of the eye. Preferably, the first and at least the second haptic portions each include a main portion (28) with a first end (32) and a second end (34), a first leg portion, connecting the first end of the main portion to the optic body and a second leg portion connecting the second end of the main portion to the optic body. Preferably, the intraocular lens includes a deformation control device.

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Title of the Invention

INTRAOCULAR LENS*Field of the Invention*

The present invention is directed to intraocular lenses, particularly, to deformable
5 intraocular lenses.

Background of the Invention

Intraocular lenses are implanted into the eye of a patient either as a supplement to
or a replacement for the natural lens of the eye. Most intraocular lenses implanted today
are of the deformable variety, and are compressed into a relatively small mass for delivery
10 through a small ocular incision into an implant site within the eye of a patient.

A deformable intraocular lens typically includes an optic body and a pair of haptics
extending therefrom. Typically, this lens is implanted into the capsular bag of a patient
after the natural lens has been removed by phacoemulsification. The haptics of the lens
engage the equator or periphery of the capsular bag and support the lens in position
15 behind the cornea and in front of the retina of the eye. As the capsular bag of the eye
tends to undergo shrinkage and other alterations over time, the deformable intraocular lens
is subjected to forces which tend to cause the lens to shift within the capsular bag.
Consequently, the optic body, while remaining within the light path to the retina, may for
example rotate out of original implanted position. There are certain types of optic bodies,

for example, optic bodies including a toric shaped portion, which must remain in proper rotational orientation relative to the astigmatic characteristics of the cornea in order to function properly. Thus, there is a need for a deformable intraocular lens which will not shift out of position after implanted.

5 ***Summary of the Invention***

Accordingly, it is a first object of the present invention to provide an intraocular lens.

It is a second object of the present invention to provide an improved intraocular lens.

10 It is a third object of the present invention to provide an intraocular lens which will engage the bounds of an implant site within an eye without causing undue trauma to the implant site or surrounding ocular tissue.

15 It is a fourth object of the present invention to provide a deformable intraocular lens which, once implanted into an implant site within the eye, will maintain the optic body thereof in proper position relative to the astigmatic characteristics of the cornea of the eye.

It is a fifth object of the present invention to provide a lens which will self-center within the implant site.

It is a sixth object of the present invention to provide a lens which, under the compressive forces of the implant site, translates the optic body thereof.

5 It is a seventh object of the present invention to provide a lens having an optic body, a first haptic portion and at least a second haptic portion each including a main portion with a first end and a second end, a first leg portion connecting the first end of the main portion to the optic body and a second leg portion connecting the second end of the main portion to the optic body.

10 It is an eighth object of the present invention to provide an intraocular lens having at least a first haptic portion and at least a second haptic portion constructed from a single continuous strand of material.

It is a ninth object of the present invention to provide a lens having an optic body reinforced with a strand of material continuous with a haptic portion of the lens.

It is a tenth object of the present invention to provide a lens incorporating at least one deformation control device.

15 The present invention provides an intraocular lens having an optic body, a first haptic portion and at least a second haptic portion. The haptic portions of a lens according to the present invention are configured to engage the bounds of an implant site

within an eye and to prevent rotation of the optic body relative to the astigmatic characteristics of the cornea of the eye.

In a preferred embodiment of a lens according to the present invention, a pair of diametrically opposed haptic portions each include a main portion with a first end and a second end, a first leg portion connecting the first end of the main portion to the optic body and a second leg portion connecting the second end of the main portion to the optic body.

In a further preferred embodiment of a lens according to the present invention, a deformation control device is incorporated to the lens in the form of a ring within the optic body and near the edge thereof.

A lens according to the present invention is typically implanted into an implant site within the eye of a patient. Most often, the implant site is the capsular bag from which the natural lens of the eye has been removed. When implanted, the haptic portions of the lens engage the generally circular shaped equator, which is located along the line of intersection between the anterior and posterior walls of the capsular bag. The haptic portions of a lens are preferably capable of substantial deformation according to the present invention. Thus, a surgeon using a lens according to the present invention is not required to precisely assess the geometry and dimensional characteristics of the implant site prior to implanting the lens i.e. ("one-size-fits-all").

Importantly, the haptic portions of a lens according to the present invention are configured to prevent rotation of the optic body relative to the astigmatic characteristics of the cornea of the eye in which the lens is implanted, particularly, without causing excessive trauma to the tissues of the eye proximal to or part of the implant site. In other words, regardless of any net resultant moment upon the lens created at any time during the life of the implant, the rotational orientation of optic body relative to the cornea is preserved. Thus, the present invention is particularly suitable in applications wherein it is desirable to preserve the implanted orientation of the optic body relative to the astigmatic characteristics of the cornea, such as in the use of a lens according to the present invention including a toric shaped optic body.

Another important aspect of an intraocular lens according to the present invention is the incorporation of at least one deformation control device to the lens. A deformation control device according to the present invention allows the lens to deform in a controlled manner prior to implantation, for example, a deformation control device according to the present invention may be configured to allow, or even be biased to promote, certain types of lens deformation. For example, a deformation control device according to the present invention may be configured to allow a lens to deform into a "roll" type of configuration prior to implantation, or as another example, a deformation control device according to the present invention may be configured to allow a lens to deform into a "fan" type of configuration prior to implantation through an ocular incision.

5 A deformation control device according to the present invention may also be configured to assist in the prevention of lens damage which may occur during delivery of the lens to the implant site. For example, a deformation control device may resist “extreme” types of lens deformation such as excessive lens stretching or folding which may result in tears or creases in the optic body of the lens. As another example, a deformation control device according to the present invention may assist in preventing a haptic of the lens from being stretched, broken, misshapen, or otherwise damaged during the lens delivery process.

10 A deformation control device according to the present invention may also provide an intraocular lens according to present invention with an increased likelihood of returning properly to a non-deformed configuration within the implant site. For example, a deformation control device according to the present invention may be configured such that the lens is provided with a bias to a non-deformed condition. As another example, a deformation control device may be configured to resist returning to a non-deformed condition, thus, when a lens including such a deformation control device is implanted, rather than “springing back” to a non-deformed configuration due, for example, to the elastic forces of the optic body of the lens, the lens instead slowly returns to a non-deformed configuration due to the resistance provided by the deformation control device according to the present invention.

20 A deformation control device according to the present invention may also be configured to maintain the structural integrity of the lens when implanted into the eye. For

example, a deformation control device may be configured such that when incorporated into the lens, the lens, and particularly, the optic body thereof, is maintained in a substantially planar configuration within the implant site.

Brief Description of the Drawings

5 Fig. 1 shows a planar view of a lens according to the present invention.

 Fig. 2 shows a side view of the lens shown in Fig. 1.

 Fig. 3 shows the lens shown in Fig. 1 implanted in an implant site within the eye of a patient.

 Fig. 4 shows a planar view of the haptic portions of the lens shown in Fig. 1.

10 Fig. 5 shows a transverse cross-sectional view of a haptic portion according to the present invention.

 Fig. 6. shows a transverse cross-sectional view of an alternative embodiment of a haptic portion according to the present invention.

15 Fig. 7 shows a transverse cross-sectional view of an alternative embodiment of a haptic portion according to the present invention.

Fig. 8 shows an alternative embodiment of a lens according to the present invention.

Fig. 9 shows an alternative embodiment of a lens according to the present invention.

5 Fig. 10 shows a portion of an alternative embodiment of a haptic portion according to the present invention.

Fig. 11 shows a portion of an alternative embodiment of a haptic portion according to the present invention.

10 Fig. 12 shows an alternative embodiment of a lens according to the present invention implanted within the capsular bag of an eye of a patient.

Fig. 13 shows an alternative embodiment of a lens according to the present invention.

Fig. 14 shows a preferred embodiment of a lens incorporating a deformation control device in the form of a continuous ring according to the present invention.

15 Fig. 15 shows a transverse cross-section of the deformation control device shown in Fig. 14.

Fig. 16 shows an alternative embodiment of a transverse cross-section of a deformation control device according to the present invention.

Fig. 17 shows a partial planar side view of an alternative embodiment of a deformation control device according to the present invention.

5 Fig. 18 shows the deformation control device shown in Fig. 17 in a "roll" type deformation.

Fig. 19 shows a partial planar side view of an alternative embodiment of a deformation control device according to the present invention.

10 Fig. 20 shows the deformation control device shown in Fig. 19 in a "fan" type deformation.

Figs. 21-26 show alternative embodiments of lenses according to the present invention.

Detailed Description of Preferred Embodiments

15 Fig. 1 shows a preferred embodiment of an intraocular lens 14 according to the present invention. Preferably, lens 14 is deformable and configured for introduction to an implant site within the eye of a patient.

Lens 14 includes generally, an optic body 16, a first haptic portion 18 and at least a second haptic portion 22. As shown in Fig. 1, haptic portions 18 and 22 are preferably identical and provided in a diametrically opposed configuration about optic body 16. Optic body 16 is preferably a thin substantially disc shaped member made of a deformable material (e.g., silicone) as shown in Figs. 1 and 2, however, an optic body 16 according to the present invention may be provided in any number of shapes, for example, polygonal shaped. Further, optic body 16 may be made of other materials according to the present invention, for example, acrylic.

Haptic portions 18 and 22 of lens 14 are configured to engage the bounds of an implant site within a patient's eye and further to prevent rotation of the optic body relative to the astigmatic characteristics of the cornea of the eye in which the lens is implanted. For example, Fig. 3 shows lens 14 implanted at a preferred implant site 24 within the eye according to the present invention, specifically, a capsular bag from which the natural lens of the eye has been removed. In the implant site shown in Fig. 3, haptic portion 18 and haptic portion 22 engage the bounds of the implant site by contacting and deforming against the capsular bag equator 25. Note that haptic portions 18 and 22 slightly deform equator 25 from a generally circular shape thereby fixating the lens rotationally with respect to the capsular bag.

The haptics of lens 14 are preferably capable of extensive deformation in order to conform to the bounds of the implant site. Thus, the burden on the surgeon to size a lens

according to the geometry and dimensions of the implant site is greatly diminished, if not fully alleviated (i.e. one-size-fits-all).

5 It is also important to note from Figure 3 that haptic portion 18 and haptic portion 22 are further configured to prevent rotation of optic body 16 relative to the astigmatic characteristics of the cornea of the eye in which the lens is implanted without causing excessive trauma to the tissues of the eye proximal to or part of the implant site 24. In other words, regardless of any net resultant moment upon lens 14 created at any time during the life of the implant, the rotational orientation of optic body 16 relative to the cornea is preserved by haptic portions 18 and 22 configured according to the present invention. Thus, the present invention is particularly suitable in applications wherein it is 10 desirable to preserve the implanted orientation of optic body 16 relative to the cornea, such as in the use of a lens according to the present invention including a toric shaped optic body.

15 In the preferred embodiment of a lens 14 shown in Figures 1-3, haptic portion 18 and haptic portion 24 are identical. Preferably, and as shown in Figs. 1-3, identical haptic portions 18 and 22 cause lens 14 to self-center within any given implant site 24.

20 Fig. 4 shows a detailed view of the preferred embodiment of haptic portion 18 and haptic portion 22 shown in Figs. 1-3. Each haptic portion 18 and 22 preferably includes a main portion 28, a first leg portion 32 and a second leg portion 34. Preferably, and as shown in Figs. 1-3, main portion 28 is preferably longer than the diameter of circular optic

body 16. As shown in Figure 3, first leg portion 32 connects a first end of main portion 28 of haptic portions 18 and 22 to optic body 16 and second leg portion 34 preferably connects a second end of each main portion 28 to optic body 16.

Each haptic portion 18 and 22 shown in Figs. 1-4 further includes anchor portions 36. Specifically, each leg portion 32 and 34 includes an anchor portion 36 connected to the end thereof. Anchor portions 36 on first and second leg portions 32 are preferably continuous with haptic portions 18 and 22 as shown in Fig. 4. In other words, a single length of material preferably forms haptic portions 18 and 22. In the construction of lens 14 according to the present invention, optic body 16 is preferably molded onto haptic portions 18 and 22 such that anchor portions 36 and a portion of first and second leg portions 32 are within optic body 16, as shown in Figs. 1-3.

Haptic portion 18 and haptic portion 22 shown in Figs. 1-4 are preferably formed from a strand of material, preferably, polyimide having a circular transverse cross-sectional profile 26, as shown in Fig. 5. Fig. 6 shows an alternative embodiment of a transverse cross-sectional profile of haptic 18 and/or haptic portion 22, specifically, transverse cross-sectional profile 261 defines a polygonal shape. Fig. 7 shows a transverse cross-sectional profile 262 of a haptic portion defining a segment of an arc.

The preferred embodiment of a lens 14 shown in Figs. 1-3 shows haptic portions 18 and 22 made of a polyimide strand of material which as noted above may have a variety of transverse cross-sectional profiles along the length thereof. Alternatively or in addition

thereto, haptic portion 18 and/or haptic portion 22 may be constructed of a material which is formed from a material included in the construction of optic body 16, for example, haptic portions 181 and 221 may be formed from silicone and may be continuous with optic body 16 as shown in Fig. 8. Alternatively, a lens according to the present invention may include a haptic portion defined by a strand portion 182 connected to optic body 16 and a plate type haptic portion 222 integral with optic body 16, as shown in Fig. 9.

Haptic portions according to the present invention may be provided with other configurations. For example as shown in Fig. 10, a haptic portion according to the present invention may include helical coiled portions 38. Helical coiled portions 38 allow a haptic portion of a lens according to the present invention to be used in a wide range of implant site sizes since the material within coiled portions 38 may uncoil or recoil according to the dimensions of an implant site. Further, the increased surface area associated with a coiled portion 38 provides greater contact area to the implant site thus further ensuring that the lens will exhibit a decreased tendency to rotate relative to astigmatic characteristics of the cornea of the eye in which the lens is implanted. Moreover, coiled portions 38 may be configured to longitudinally compress, like a spring, thereby providing a lens which is more easily passed through an ocular incision.

Haptic portions according to the present invention may also be provided with surface features which further decrease the likelihood of lens rotation within the implant site. For example, a section of a haptic portion shown in Fig. 11 includes nibs 42 which engage the bounds of an implant site to prevent rotation. Potential surface features of a

haptic portion according to the present invention also include modifying the coefficient of friction of the surface, for example, by chemical etching.

In the preferred embodiment of a lens 143 according to the present invention shown in Fig. 12, haptic portions 183 and 223 are connected to optic body 16 in such a manner that a midplane of optic body 16 and a midplane defined by leg portions 343 of haptic portions 18 and 22 are coincident. Haptic portions according to the present invention may also be configured such that leg portions 343 lie in planes which are not coincident with a midplane of optic body 16. In the preferred embodiment of a lens 143 according to the present invention shown in Fig. 12, leg portions 343 define planes at an angle, A, with the midplane of optic body 16. Thus, the compressive forces of the implant site, indicated as vectors C in Fig. 12, of the capsular bag against haptic portions 183 and 223 causes the leg portions 343 of lens 143 to produce moment forces against optic body 16. These forces cause the optic body to translate or vault against the posterior wall 44 of the capsular bag in which the lens is shown implanted. The contact created by the vaulting of lens 143 against the posterior wall of the capsular bag may further fixate lens 143 relative to the cornea of the eye in which the lens is implanted.

Further embodiments of a lens configured according to the present invention are shown in Figs. 13 - 26.

Fig. 13 shows a lens 144 according to the present invention having an array of three (3) haptic portions 184 provided along the periphery of optic body 164. Each haptic

portion 184 includes main portions 284 connected by leg portions 324 to optic body 164. Each haptic portions 184 is further provided with an anchor portion 364 for further securing each haptic portion 184 to optic body 164.

5 Haptic portions 184 are specifically configured to conform according to the bounds of an implant site while simultaneously maintaining sufficient force against the bounds of the implant site to prevent movement of the lens relative to the cornea. Each haptic portion 184 is provided with a first compression zone 46, specifically, main portion 284 is configured to deform from the arcuate configuration shown in Fig. 13. Further, the transition between main portion 284 and leg portions 324 form a second compression zone 48 as shown in Fig. 13. Specifically, the angle, x , between main portion 284 and leg portion 324 may be configured to decrease once a predetermined moment force is attained at compression zone 48. A third compression zone 52 is included in each haptic portion 184, specifically, at the junction between leg portions 324 and anchor portion 364. Angle, y , between leg portions 324 is preferably configured to increase once a predetermined moment force is attained between each leg portion 324 and anchor portion 364. Compression zones 46, 48, and 52 may be configured to deform simultaneously in the presence of a compressive force. Alternatively, compression zones 46, 48, and 52 may be configured to deform in a stepwise manner, such that, for example, compression zone 46 may be configured to deform under a first force threshold, compression zone 48 may be configured to deform under a second greater force threshold, and compression zone 52 may be configured to deform under a third even greater force threshold.

Fig. 14 shows an alternative embodiment of a lens 145 according to the present invention. Specifically, lens 145 is identical to lens 144 shown in Fig. 13 however lens 145 further includes a deformation control device in the form of a ring 54 which is continuous with haptic portions 161 and 181. Further note that ring 54 is continuous and located within optic 161 proximally to the edge 56 thereof.

5

Ring 54 is preferably provided with a transverse cross-sectional profile which defines a circle as shown in Fig. 15. However, ring 54 may have other transverse cross-sectional profiles according to the present invention. For example, a ring 541 according to the present invention may have a main axis, x, and a minor axis, y, which are equal in length, as shown in Fig. 15, or different in length, as shown in Fig. 16. Note that ring 541 has a greater tendency to deform about main axis, x, than about minor axis, y. Thus, ring 541 is particularly suitable in applications where it is desirable to provide an intraocular lens with, for example, greater resistance to deformation about a first axis and less resistance to deformation about a second axis.

10

A deformation control device, such as ring 54, may be configured to promote a “roll” type of deformation to an intraocular lens according to the present invention. For example, as shown in Fig. 17, a ring 542 may be provided with reliefs 56 which allow ring 542 to more easily deform into a “roll” type of deformation as shown in Fig. 18. As another example, a deformation control device according to the present invention may be configured to allow a “fan” type of deformation to an intraocular lens according to the present invention. For example, as shown in Fig. 19, a ring 543 may be provided with

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reliefs 56 on opposing surfaces of ring 542. Thus, as shown in Fig. 20, ring 543 may more easily deform into a “fan” type of deformation.

5 It is important to note that ring 54 also provides additional structural integrity to lens 145 thereby maintaining optic body 164 in a substantially planar configuration within the implant site.

Other lenses according to the present invention including a three (3) haptic portion array provided along the periphery of the optic body are shown in Figs. 21-24. Lenses according to the present invention including a four (4) haptic portion array provided along the periphery of the optic body are shown in Figs. 25-32.

10 Whereas the present invention has been described with respect to specific embodiments thereof, it will be understood that various changes and modifications will be suggested to one skilled in the art and it is intended to encompass such changes and modifications as fall within the scope of the appended claims.

What is Claimed is:

1. An intraocular lens, comprising:

an optic body; and,

5 a first haptic portion connected to said optic body, and at least a second haptic portion connected to said optic body, said first and said at least said second haptic portions configured to conform according to the bounds of an implant site within an eye and to prevent rotation of said optic body relative to a cornea of said eye.

2. An intraocular lens according to claim 1, wherein

10 said first and said at least said second haptic portions are configured to center said optic body within said implant site.

3. An intraocular lens according to claim 1, wherein

said first and said at least said second haptic portions are configured to translate said optic body relative to said haptic portions.

4. An intraocular lens according to claim 1, wherein

at least said first haptic portion is defined by a strand of material.

5. An intraocular lens according to claim 1, wherein

5 said first and said at least said second haptic portions are defined by a single continuous strand of material.

6. An intraocular lens according to claim 1, wherein

at least said first haptic portion is defined by a material of said optic body and contiguous therewith.

7. An intraocular lens according to claim 1, wherein

10 said first and said at least said second haptic portions are identical.

8. An intraocular lens according to claim 1, wherein

said first and said at least said second haptic portions each include a main portion with a first end and a second end, a first leg portion, said first leg portion connecting said first end of said main portion to said optic body, and a second leg portion.

9. An intraocular lens according to claim 8, wherein

said second leg portion of a least said first haptic portion connects said second end of said main portion to said optic body.

10. An intraocular lens according to claim 9, wherein

5 said first and said at least said second haptic portions define diametrically opposed closed loops.

11. An intraocular lens according to claim 10, wherein

at least said first leg portion of said haptic portion includes an anchor portion.

12. An intraocular lens according to claim 11, wherein

10 at least said first leg portion of said first haptic portion includes an optic body reinforcing portion.

13. An intraocular lens according to claim 10, wherein

said optic body is circular and at least said main portion of said first haptic portion is longer than a diameter of said optic body.

14. An intraocular lens according to claim 10, wherein

at least said first haptic portion includes a transverse cross-sectional portion defining a circle.

15. An intraocular lens according to claim 10, wherein

5 at least said first haptic portion includes a transverse cross-sectional portion defining an arc length.

16. An intraocular lens according to claim 10, wherein

at least said first haptic portion includes at least one hole.

17. An intraocular lens according to claim 10, wherein

10 at least said first haptic portion includes surface projections for engaging the bounds of said implant site.

18. An intraocular lens according to claim 10, wherein

at least said first haptic portion includes a helical coiled portion.

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19. An intraocular lens according to claim 10, wherein

said haptic portions define an array along a periphery of said optic body.

20. An intraocular implant, comprising:

5 a deformable intraocular lens defined by at least one optic body and at least one haptic attached to said optic body, said lens incorporating at least one deformation control device.

21. An intraocular lens according to claim 20, wherein:

said deformation control device is provided within said optic body.

22. An intraocular lens according to claim 21, wherein:

10 said deformation control device is provided proximally to an edge of said optic body.

23. An intraocular lens according to claim 22, wherein:

said deformation control device is a ring.

24. An intraocular lens according to claim 23, wherein:

said deformation control device is a continuous ring.

25. An intraocular lens according to claim 24, wherein:

said ring is continuous with said at least one haptic of said lens.

5 26. An intraocular lens according to claim 24, wherein:

at least a portion of said ring has a transverse cross-sectional profile which defines a shape having a main axis and a minor axis.

27. An intraocular lens according to claim 26, wherein:

said main axis and said minor axis are equal in length.

10 28. An intraocular lens according to claim 26, wherein:

at least a portion of said ring has a transverse cross-sectional profile which defines a circle.

29. An intraocular lens according to claim 24, wherein:

said main axis and said minor axis are different in length.

30. An intraocular lens according to claim 24, wherein:

said ring is configured to promote a "roll" type of deformation of said lens.

5

31. An intraocular lens according to claim 24, wherein:

said ring is configured to promote an "accordion" type of deformation of said lens.

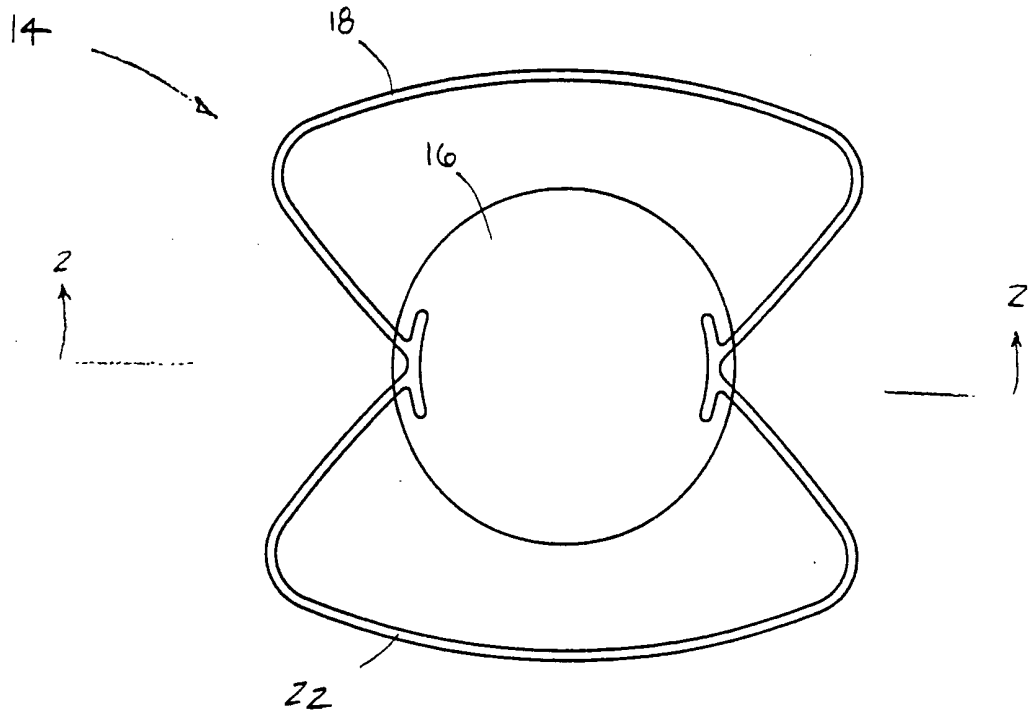


Fig. 1

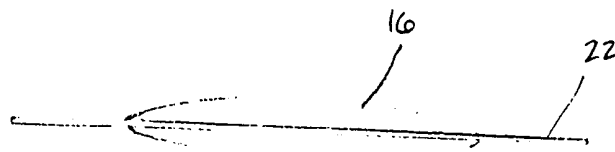


Fig. 2

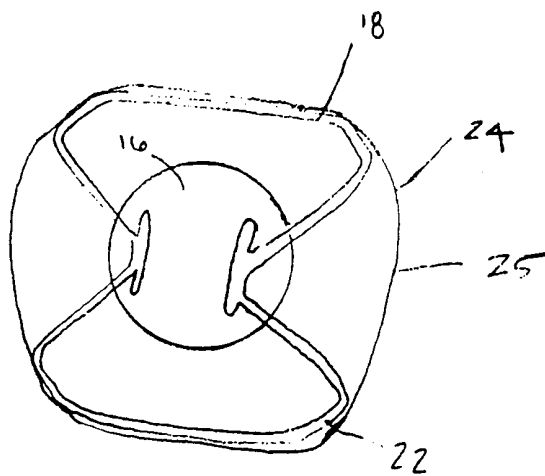


Fig. 3

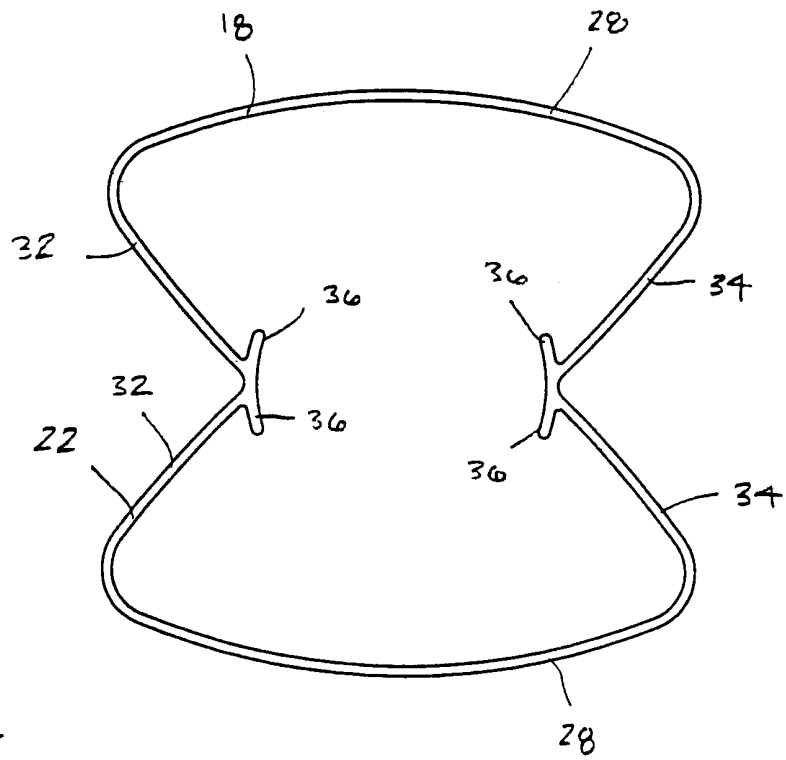


Fig. 4



Fig. 5

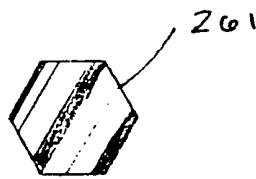


Fig. 6

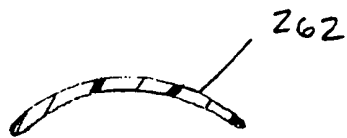


Fig. 7

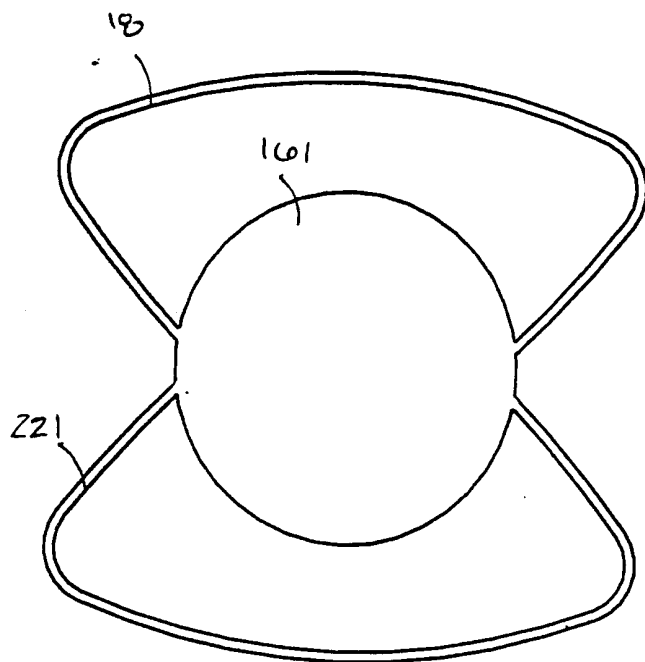


Fig. 8

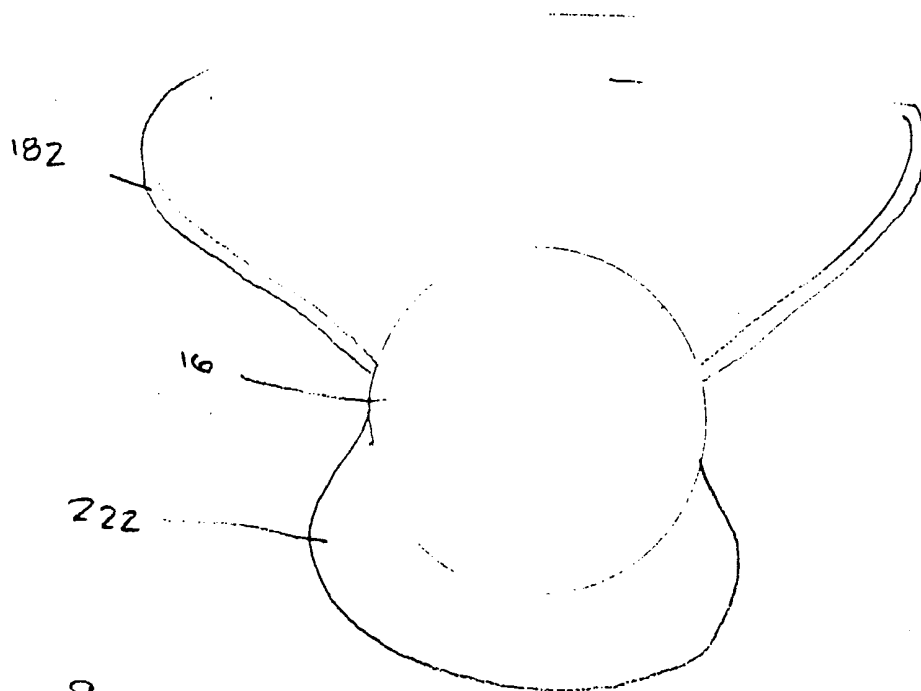


Fig. 9

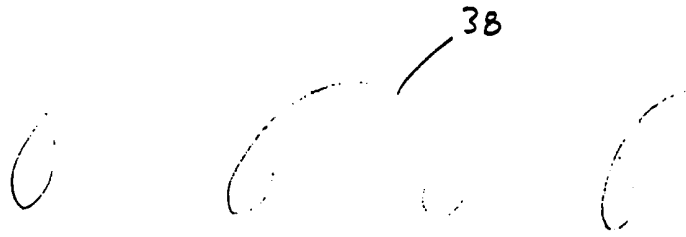


Fig. 10

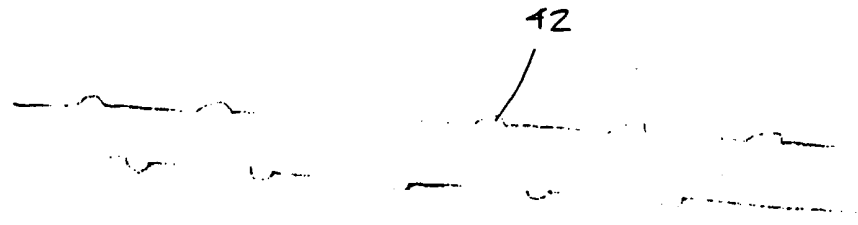


Fig. 11

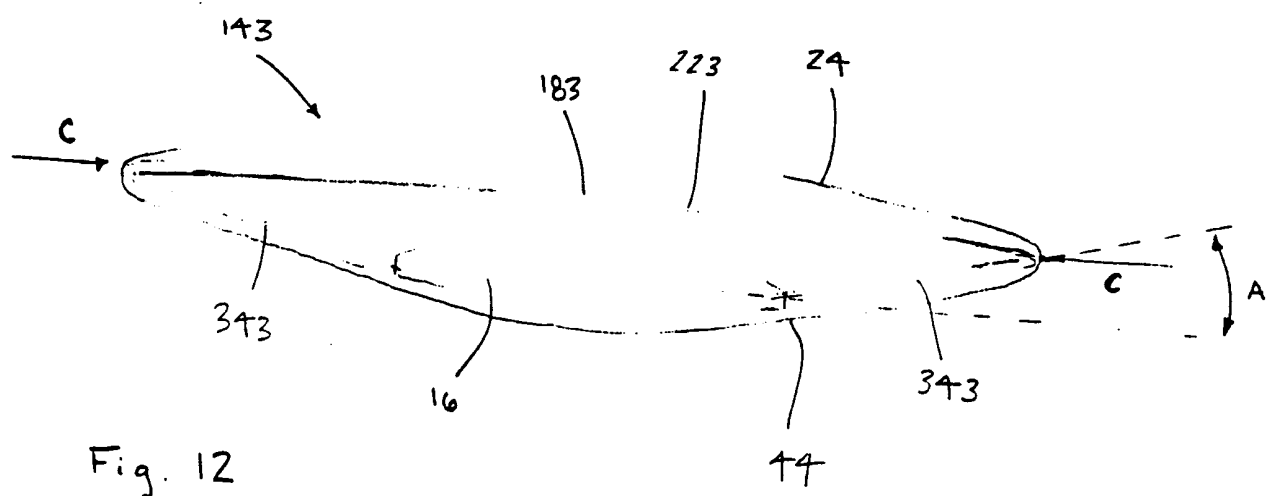


Fig. 12

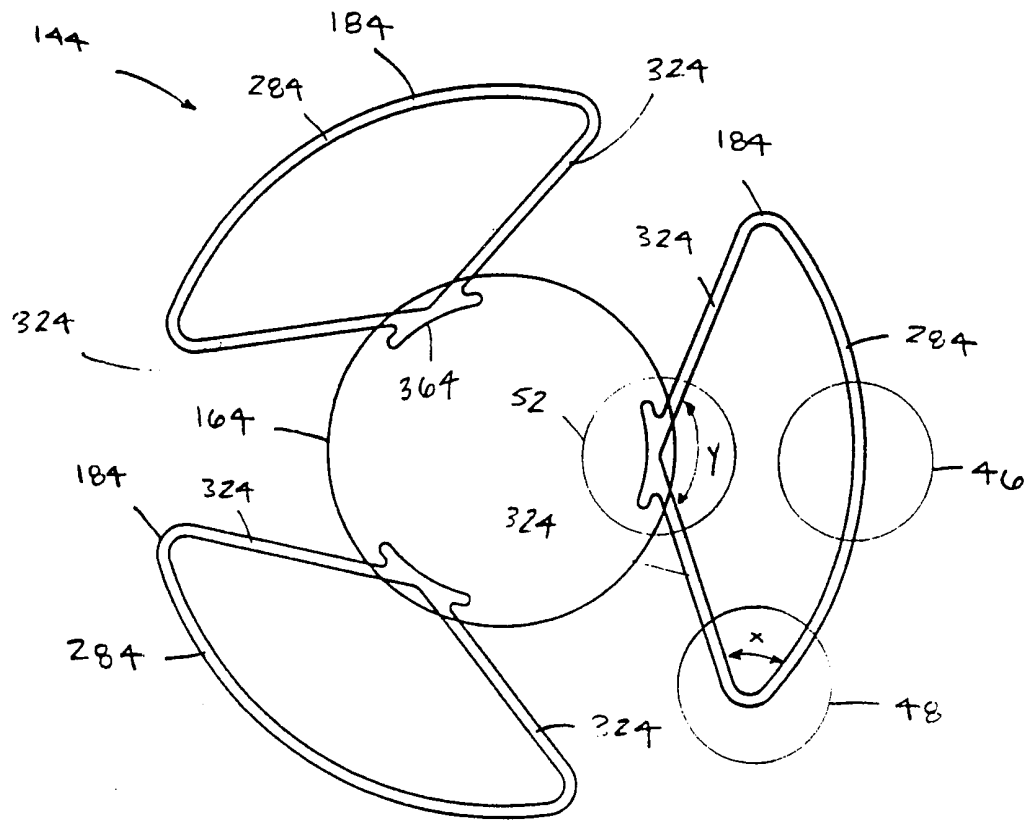


Fig. 13

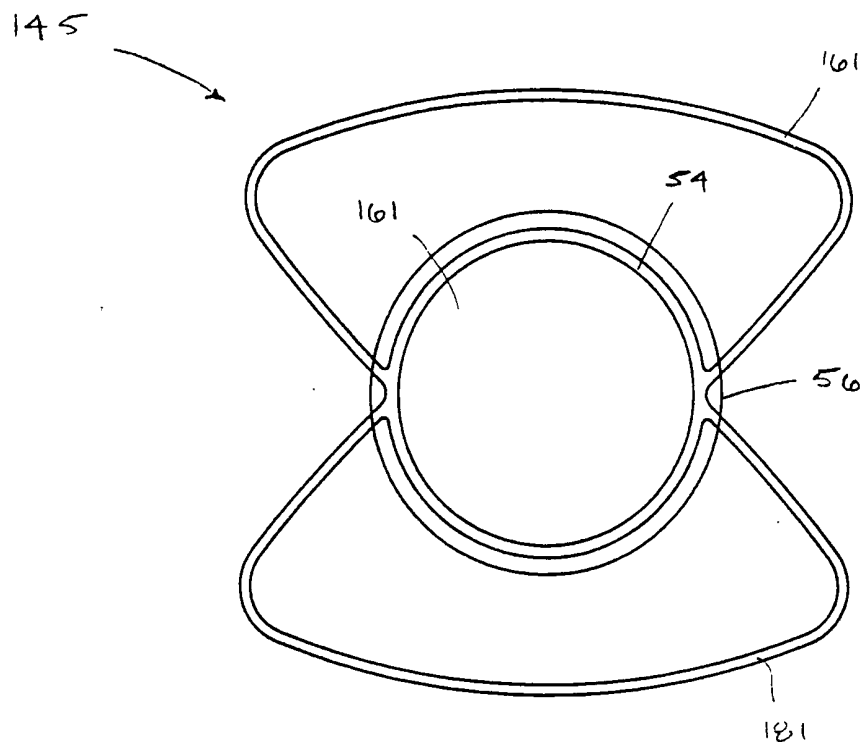


Fig. 14

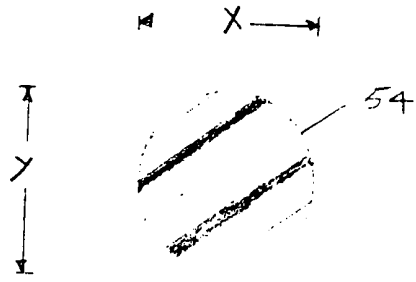


Fig. 15

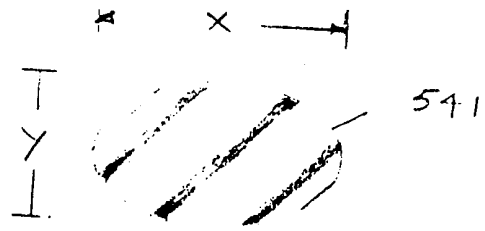


Fig. 16

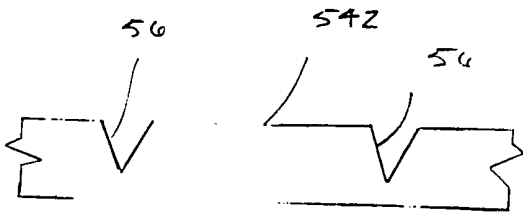


Fig. 17

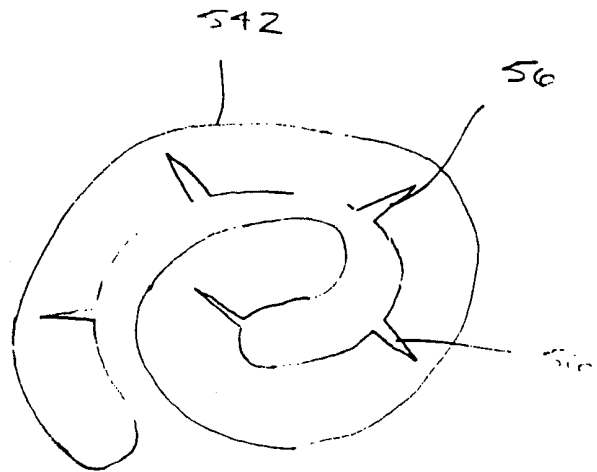


Fig. 18

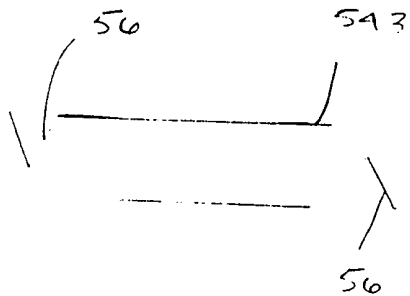


Fig. 19.

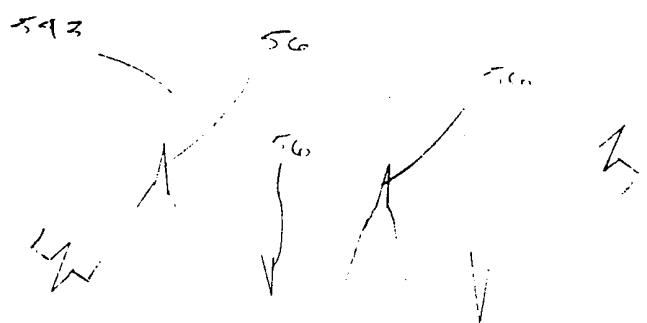


Fig. 20

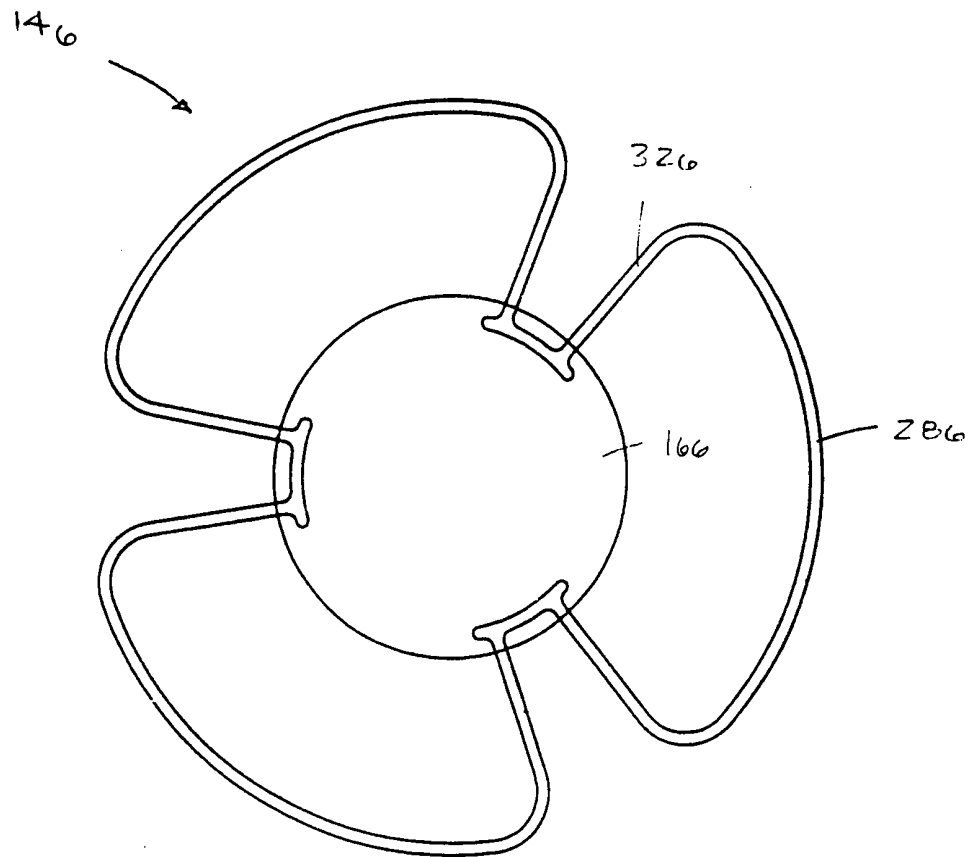


Fig. 21

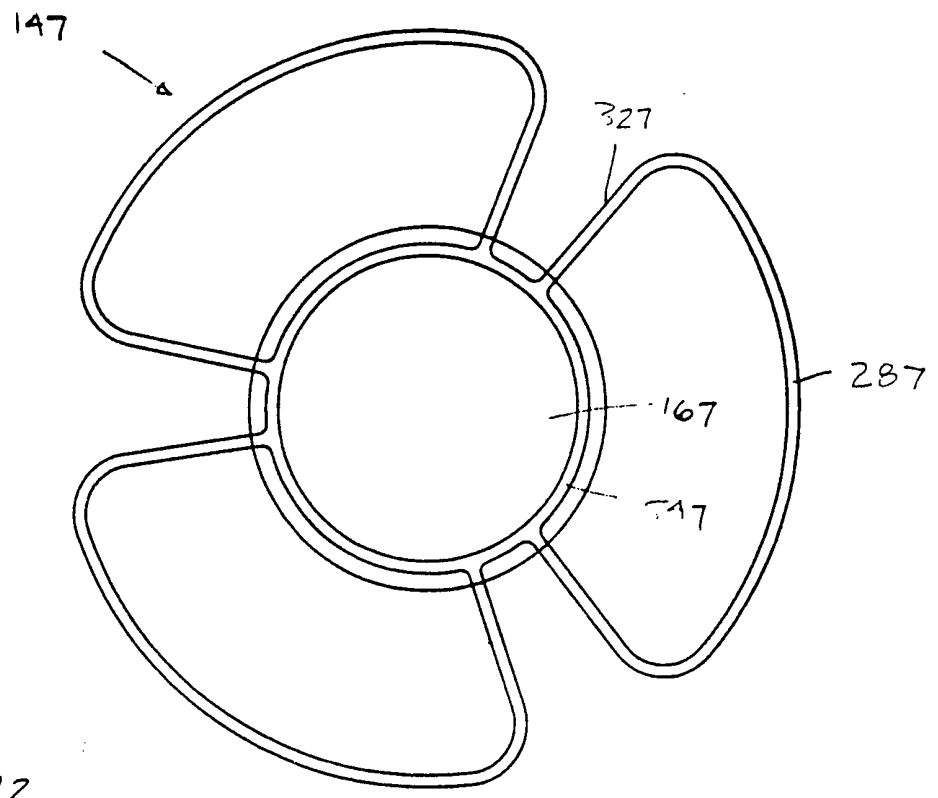


Fig. 22

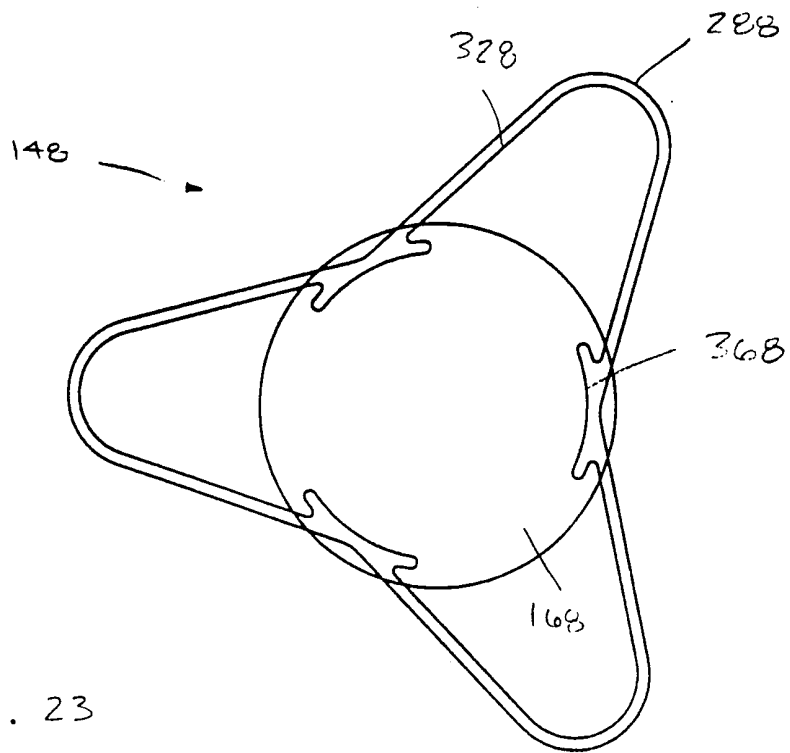


Fig. 23

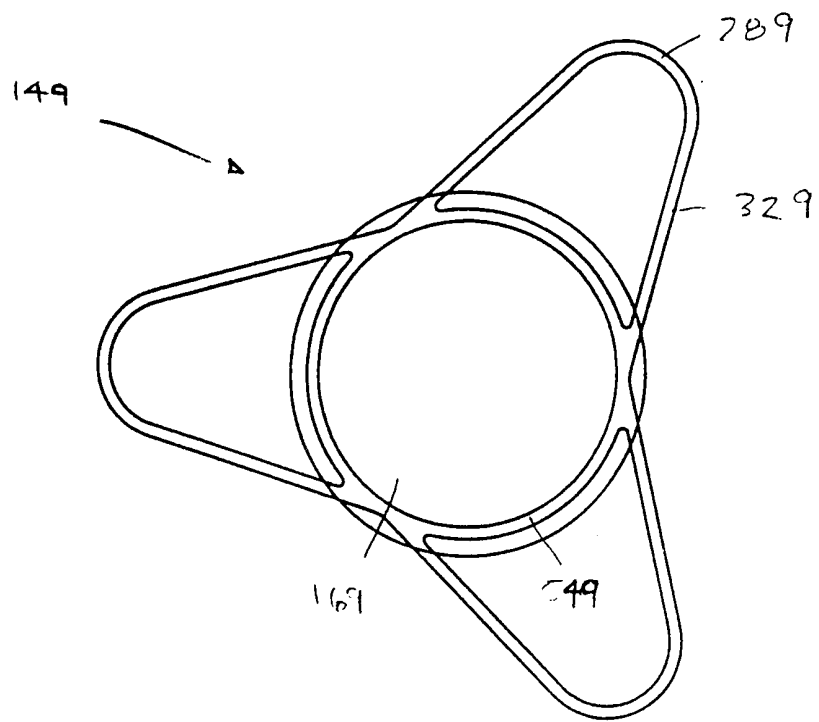


Fig. 24

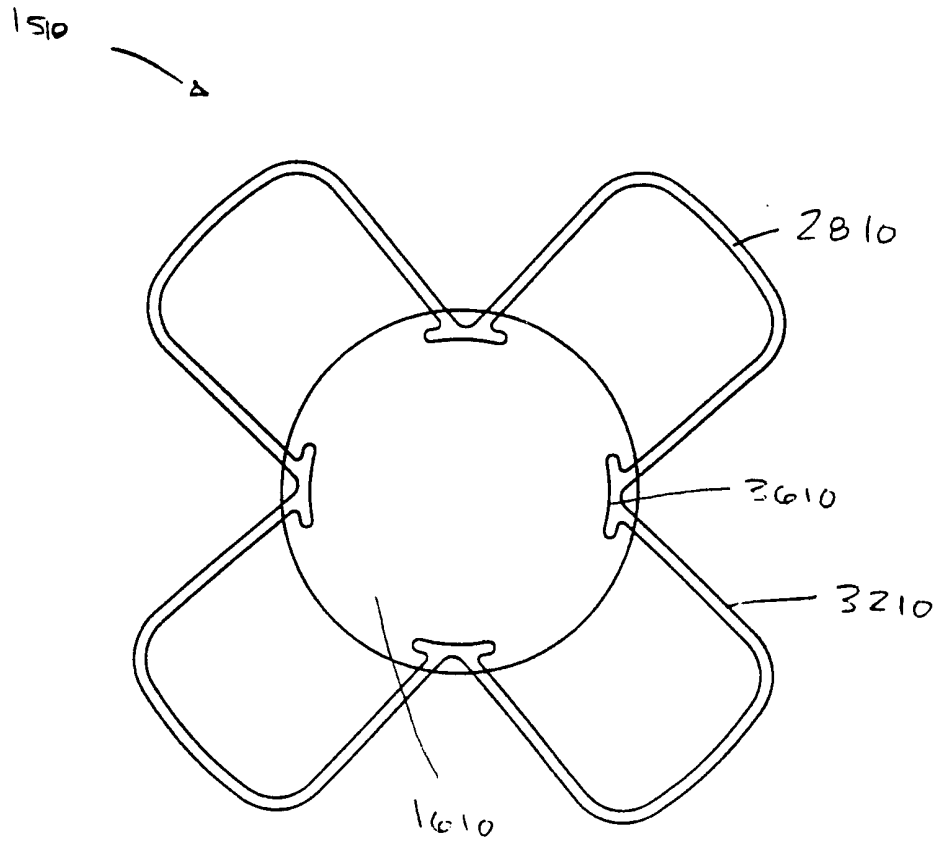


Fig. 25

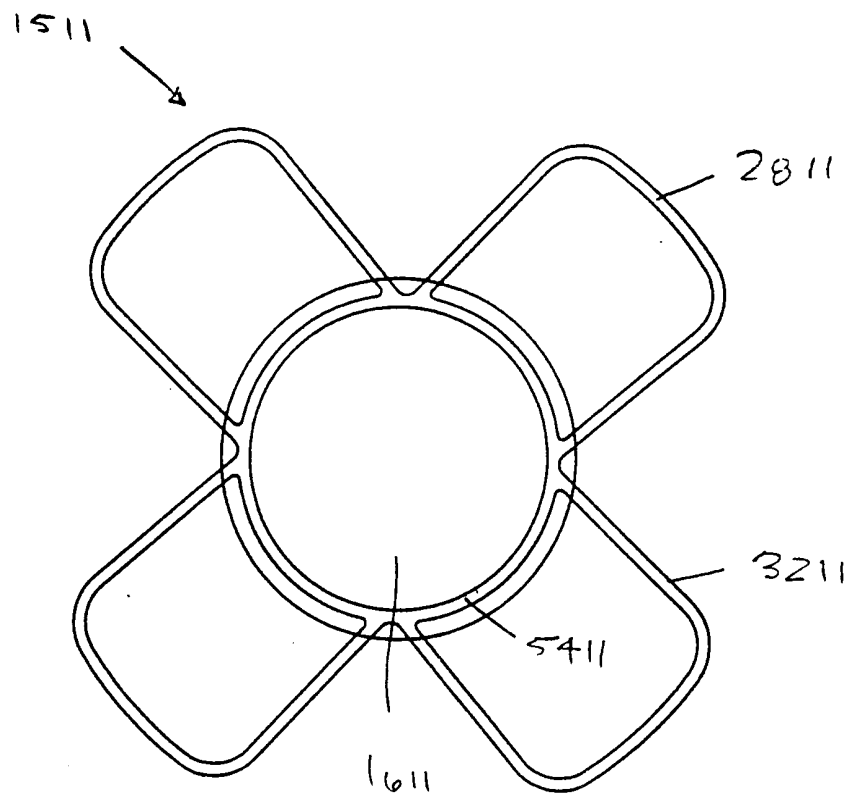


Fig. 26

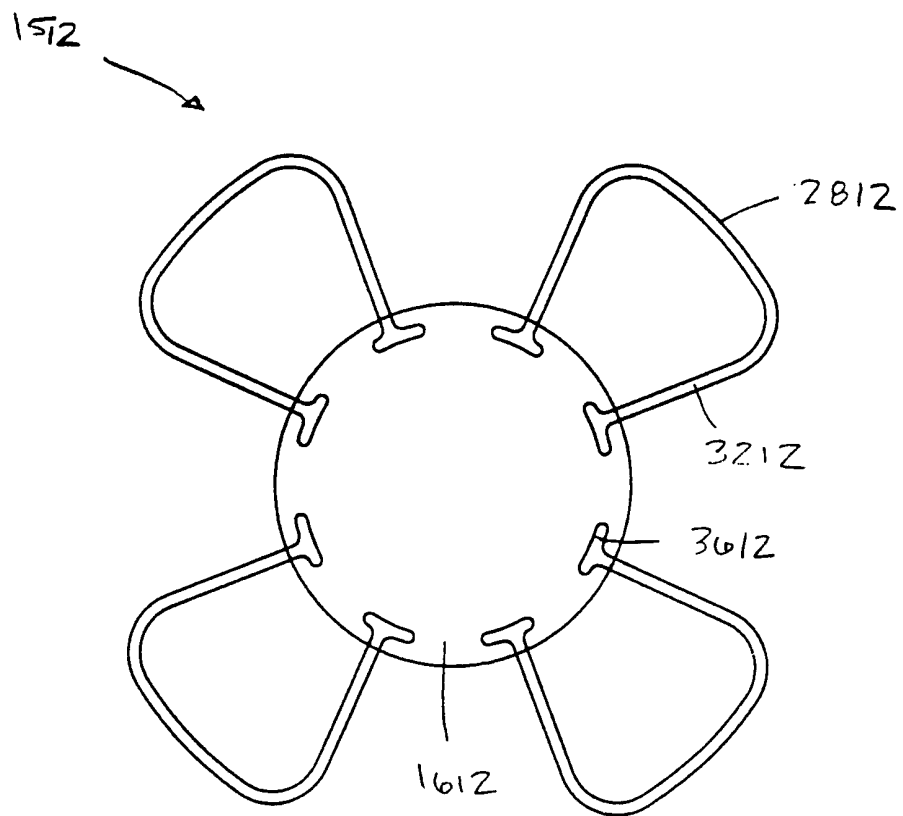


Fig. 27

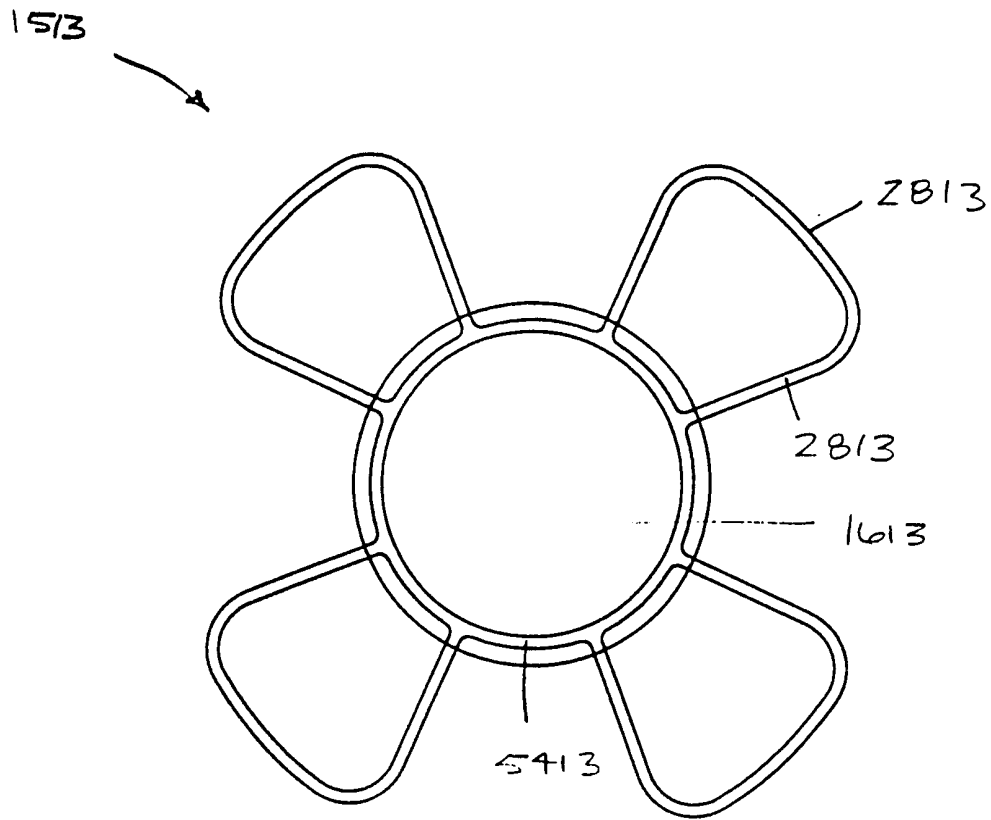


Fig. 28

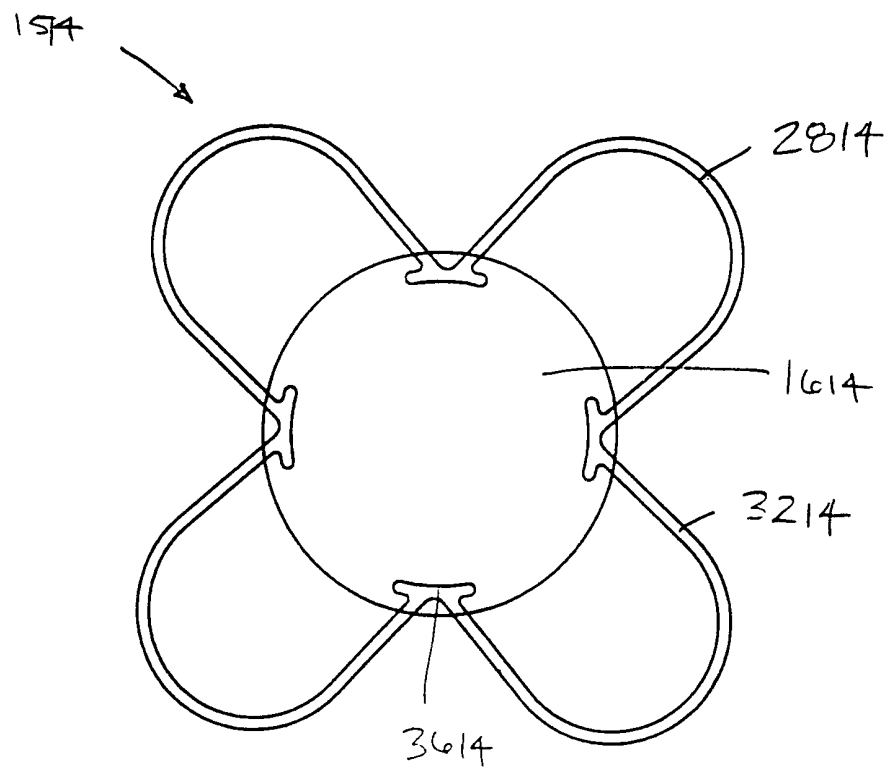


Fig. 29

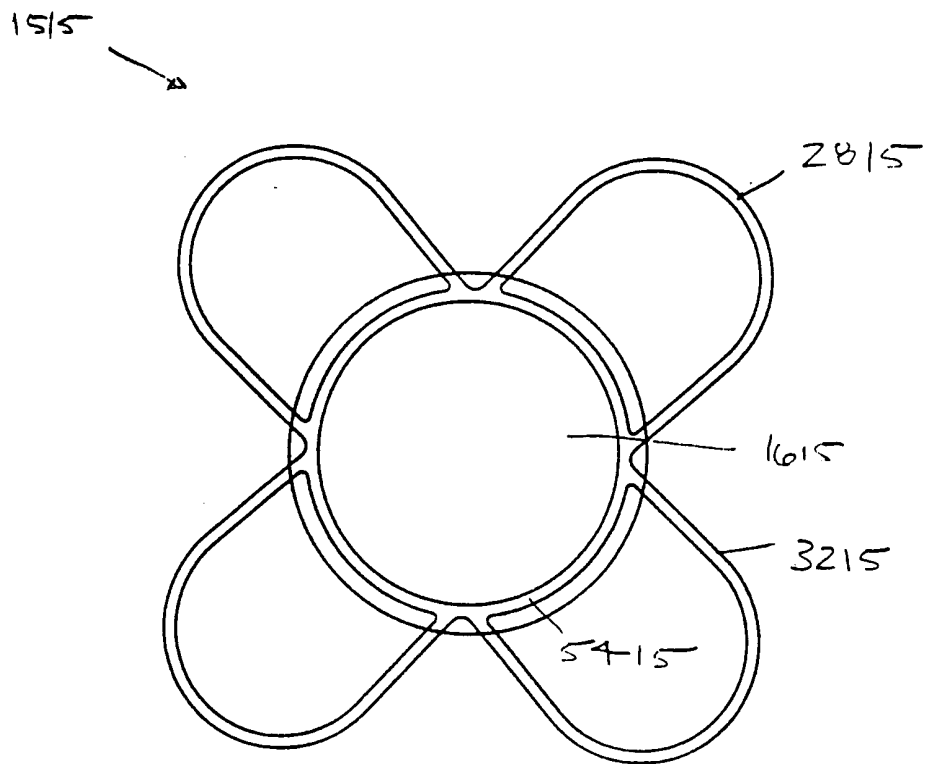


Fig. 30

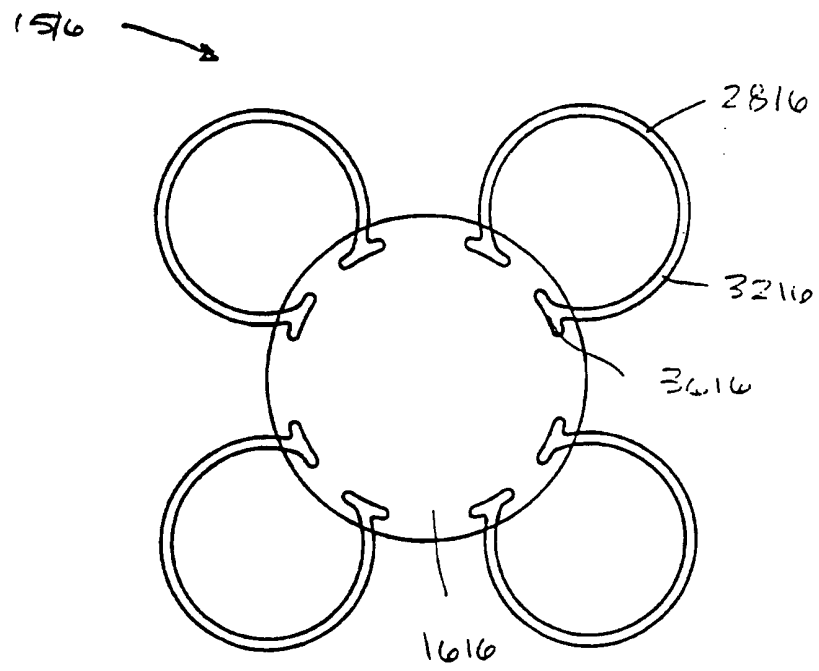


Fig. 31

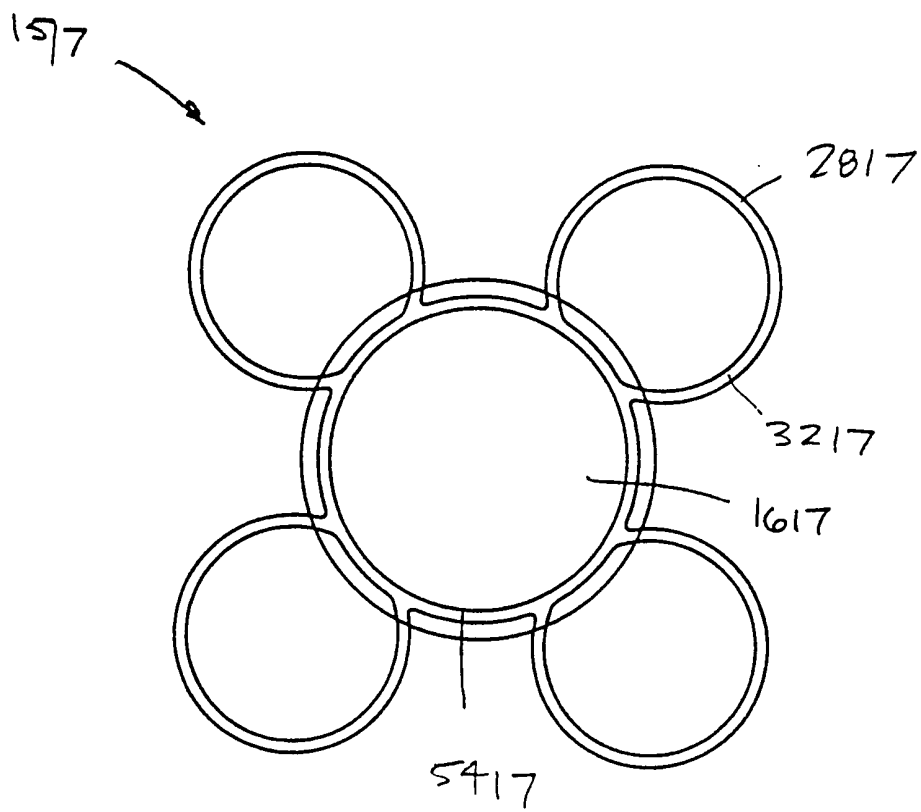
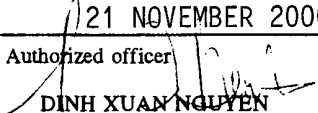


Fig. 32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/24611

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(7) : A61F 2/16 US CL : 623/6.11 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) U.S. : 623/6.11, 6.38, 6.39, 6.40, 6.42, 6.43, 6.45, 6.46, 6.47, 6.49, 6.51		
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)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,439,873 A (POLER) 03 April 1984, see entire document.	1-10, 13-15
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Y		12, 17, 18, 24-30
X, P	US 6,007,579 A (LIPSHITZ et al.) 28 December 1999, see entire disclosure.	20-23
-----		-----
Y		12, 24-30
Y	US 5,300,117 A (BAIKOFF et al.) 05 April 1994, see entire disclosure.	17
Y	US 4,816,030 A (ROBINSON) 28 March 1989, see entire disclosure.	18
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	*T*	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X*	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
E earlier document published on or after the international filing date	*Y*	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*&*	document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means		
P document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
23 OCTOBER 2000	21 NOVEMBER 2000	
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer  DINH XUAN NGUYEN Telephone No. (703) 308-0858	