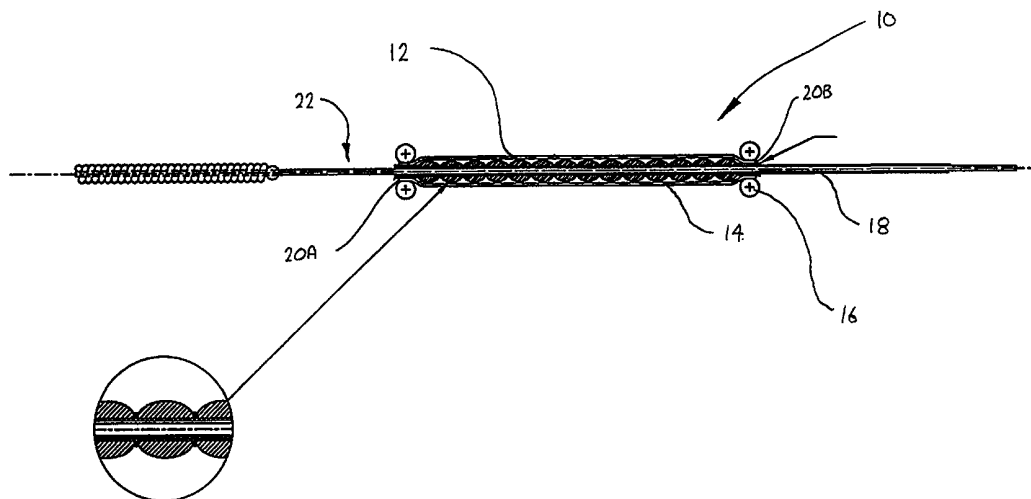




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: A RADIOISOTOPE DELIVERY DEVICE



## (57) Abstract

The present invention relates generally to a radioisotope delivery device (10) comprising a radioisotope housing (12) containing a series of radioisotope sources (14), and inflatable balloons (16) being located at opposing ends of the housing (12). The delivery device (10) is slidably received over a conventional guidewire (22). The inflatable balloons (16) are in this example located at opposing ends of the radioisotope housing (12) and consist of four generally elliptical-shaped balloons (16A to 16D). The balloons (16) are provided so as to radially space the radioisotope sources (14) a predetermined and fixed distance from a wall of an artery or blood vessel. The balloons (16) both in an inflated and deflated configuration provide a passage designated generally as (24) between the radioisotope housing (12) and the arterial or blood vessel wall for the flow of blood through the artery or blood vessel.

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## A RADIOISOTOPE DELIVERY DEVICE

### FIELD OF THE INVENTION

The present invention relates generally to a radioisotope  
5 delivery device and relates particularly, though not  
exclusively, to a delivery device for use in intracoronary  
irradiation before, during or subsequent to balloon  
angioplasty.

### 10 BACKGROUND TO THE INVENTION

Balloon angioplasty is a widely applied therapy for  
obstructive coronary artery disease. In balloon  
angioplasty, a balloon is inflated in a heavily diseased  
segment of an artery with thick eccentric or concentric  
15 plaque. Although the arterial lumen is narrowed the  
external dimensions of the artery may be wider than normal  
due to radial growth of the space occupying plaque. When  
the balloon is inflated, the lumen together with the  
external dimensions of the artery are expanded forming  
20 cracks and splits in the plaque and arterial wall.  
Following deflation of the balloon the artery undergoes  
restenosis involving:

- i. elastic recoil of the overstretched artery;
- ii. intimal proliferation resulting in new tissue  
25 growth occupying cracks and tears in the  
arterial wall; and
- iii. contraction of the artery so that the external  
elastic lamina occupies a smaller circumference  
than it did following balloon angioplasty.

30

Intracoronary irradiation is a known technique that permits  
the delivery of narrowly targeted high-dose gamma  
irradiation to adjacent coronary segments. The benefits of  
intracoronary irradiation for the impairment of restenosis  
35 have been researched and reported by Wiedermann *et al* in  
their paper entitled "Intracoronary Irradiation Markedly

Reduces Neointimal Proliferation After Balloon Angioplasty in Swine: Persistent Benefit at 6-Month Follow-Up", JACC Vol. 25, No. 6 May 1995: 1451-6.

5     **SUMMARY OF THE INVENTION**

An intention of the present invention is to provide a radioisotope delivery device and method of intracoronary irradiation which are relatively effective in at least reducing restenosis.

10

According to one aspect of the present invention there is provided a radioisotope deliver device comprising:

one or more radioisotope sources located over a guidewire; and

15

at least one inflatable balloon being disposed about the radioisotope sources so as to radially space said sources a predetermined distance from a wall of an artery or blood vessel within which the delivery device is inserted, said at least one inflatable

20

balloon whilst inflated providing a passage in an annular space between the radioisotope sources and the arterial or blood vessel wall which permits the flow of blood through the artery or blood vessel.

25     According to another aspect of the present invention there is provided a method of intracoronary irradiation involving the steps of:

providing a radioisotope delivery device including a one or more radioisotope sources, and at least one

30

inflatable balloon disposed about said sources;

locating the radioisotope delivery device over a guidewire within an artery or blood vessel;

inflating said at least one inflatable balloon thereby radially spacing the radioisotope sources a

35

predetermined distance from a wall of the artery or blood vessel, said at least one inflatable balloon

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whilst inflated providing a passage in an annular space between the radioisotope sources and the arterial or blood vessel wall which permits the flow of blood through the artery or blood vessel.

5

Preferably, said at least one inflatable balloon is one of a plurality of longitudinally extending balloons each extending substantially the length of the radioisotope sources. More preferably the plurality of longitudinal  
10 inflatable balloons are angularly equi-spaced about the radioisotope sources.

Generally, the radioisotope sources are contained within a radioisotope housing configured to be slidably received  
15 over the guidewire.

Alternatively, said at least one inflatable balloon includes a plurality of segmented balloons located circumferentially about the radioisotope housing at  
20 predetermined axial positions along said housing. More typically, the delivery device includes a pair of the plurality of segmented balloons being located at opposing ends of the radioisotope housing.

25 In one embodiment, there are four (4) generally elliptical-shaped balloons, provided at opposing ends of the housing. The circumferential space between the plurality of segmented balloons defines the passage in the annular space for the flow of blood through the artery or  
30 blood vessel.

Alternatively, the radioisotope housing includes a sheath which envelopes said one or more radioisotope sources, the sheath being movable relative to the sources from a  
35 shielded into an exposed configuration whereby the artery or blood vessel is directly exposed to radiation from the

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sources.

Generally, said one or more radioisotope sources are both Beta and Gamma emitters such as Palladium 103 ( $^{103}\text{Pd}$ ) or  
5 Iodine 125 ( $^{125}\text{I}$ ). Preferably the radioisotope sources are of a solid form. Typically, the sources deliver from between 10 to 40 Grays (Gy).

10 Preferably, the radioisotope housing is tubular and the radioisotope generally bead-shaped in form, the radioisotope beads being slidably received over the guidewire and axially located adjacent one another within the housing.

15 Typically, the delivery device further comprises a tubular substrate located axially through the radioisotope housing, the radioisotope beads being mounted to the tubular substrate. Preferably, the tubular substrate and radioisotope housing are constructed of a flexibly  
20 resilient material.

Preferably, the radioisotope deliver device also comprises one or more radioisotope markers mounted to the radioisotope housing and/or the tubular substrate, said  
25 markers being constructed of a radiopaque substance such as gold. The radioisotope markers permit accurate positioning of the delivery device within the artery or blood vessel.

Generally, the radioisotope delivery device is used in  
30 conjunction with a conventional catheter of either a standard "over the wire" configuration or a rapid exchange device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

35 In order to achieve a better understanding of the nature of the present invention several preferred embodiments of a

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radioisotope delivery device will now be described in some detail, by way of example only, with reference to the accompanying drawings in which:

- 5        Figure 1 is a sectional view taken axially through a radioisotope delivery device;
- Figure 2 are enlarged sectional views taken radially through the delivery device of Figure 1 with inflatable balloons shown in an inflated and deflated configuration;
- 10       Figure 3 is an axial sectional view of another radioisotope delivery device; and
- Figure 4 is an axial sectional view of a further radioisotope delivery device.

15       **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

As shown in Figure 1 there is a radioisotope delivery device shown generally as 10 comprising a radioisotope housing 12 containing a series of radioisotope sources 14, and inflatable balloons 16 being located at opposing ends of the housing 12. In this example, the radioisotope sources 14 are bead-shaped and mounted to a tubular substrate 18 located co-axially in the housing 12. The radioisotope beads are both beta and gamma emitters of an Iodine 125 ( $^{125}\text{I}$ ) source.

25       The housing 12 is generally tubular in form having opposing ends tapered inwardly toward the tubular substrate 18. The internal diameter of the housing 12 is substantially equal to an outer diameter of the radioisotope beads 14. The housing 12 and tubular substrate 18 are formed of a flexibly resilient material so as to allow manipulation of the delivery device 10 through a blood vessel.

35       The delivery device 10 is also provided with a pair of radioisotope markers 20A and 20B mounted internally within the radioisotope housing 12 at opposing ends thereof. The

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radioisotope markers 20 are constructed of gold being a radiopaque substance. Thus, the delivery device 10 can be accurately tracked and located through the vessel.

5 The delivery device 10 is designed to be slidably received over a conventional guide wire 22. The guide wire 22 is fourteen (14) thousandth of an inch in diameter and includes a toroidal coil at a distal end thereof. The radioisotope delivery device 10 is used in conjunction with  
10 a conventional catheter of either a standard "over the wire" configuration or a rapid exchange device.

As best illustrated in Figure 2, the inflatable balloons located at opposing ends of the radioisotope housing 12  
15 consist of four (4) generally elliptical-shaped balloons 16A to 16D. Whilst deflated the elliptical balloons 16A to 16D "wrap around" the housing 12 with a major axis extending generally tangential to an outer surface of the housing 12. When inflated the balloons 16 are expanded  
20 with a major axis extending radially from the housing 12. The balloons 16 are provided so as to radially space the radioisotope sources 14 a predetermined and fixed distance from a wall of an artery or blood vessel. Significantly, the balloons 16 both in an inflated and deflated  
25 configuration provide a passage designated generally as 24 between the radioisotope housing 12 and the arterial or blood vessel wall for the flow of blood through the artery or blood vessel. In this embodiment, the passage 24 is defined by the second circumferential space between  
30 adjacent balloons 16A to 16D located within an annular space between the radioisotope housing 12 and the vessel wall. Thus, the delivery device 10 does not obstruct the flow of blood whilst the balloons 16 are inflated.

35 Intra-coronary irradiation using the radioisotope delivery device 10 may be performed before, during or subsequent to



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a conventional percutaneous transluminal angioplasty (PTA) procedure. The delivery device 10 is configured to locate over the guide wire 22 within a standard balloon catheter. Inflation/deflation of the balloons 16 is effected via a  
5 50/50 saline to contrast fluid being injected therein.

Figure 3 illustrates another radioisotope delivery device 100 of similar construction to the preceding device 10 with like components designated with an additional "0". In this  
10 example, the housing 12 of the preceding delivery device 10 is replaced with a delivery catheter 260. The inflatable balloons 160 are located at opposing ends of the series of isotope beads 140. Radio opaque markers 200 together with the radioisotope beads 140 are mounted to the tubular  
15 substrate 180 as described in the context of the preceding delivery device 10.

Figure 4 depicts a further radioisotope delivery device 1000 of similar construction to the preceding examples with  
20 like components designated with an additional "00". In this embodiment there are three (3) longitudinally extending balloons 1600 angularly disposed at 120 degrees relative to one another. It will be appreciated that the longitudinal balloons 1600 radially space the radioisotope  
25 sources 1400 from a wall of an artery or blood vessel for substantially the full length of the delivery device 1000. It is essentially damage of this wall, known as the intima, and the muscular layer that produces excessive neointimal proliferation leading to reocclusion of the artery.

30

Now that several preferred embodiments of the present invention have been described in some detail it will be apparent to those skilled in the relevant arts that the radioisotope delivery device has at least the following  
35 advantages:

1. the radioisotope delivery device whilst in operation with the balloons inflated permits the flow of blood through the artery or blood vessel;
2. the radioisotope delivery device is suitable for use with conventional guide wires and balloon catheters; and
3. the radioisotope delivery device can be used with relative ease in intracoronary irradiation before, during or subsequent to balloon angioplasty.

Those skilled in the art will appreciate that the invention described herein is suitable to variations and modifications other than those specifically described. For example, the segmented balloons of the delivery device described may be substituted with a single annular balloon having one or more through going holes or ports to permit blood flow through the artery or blood vessel. The radioisotope source is not restricted to Iodine 125 but rather extends to other Beta and Gamma emitters such as Palladium 103. Typically, these radioisotope sources deliver from between 10 to 40 Grays although the invention is not restricted to radioisotope sources of this strength range. In an alternative embodiment of the invention, the radioisotope housing is replaced with a sheath which is designed to envelope the radioisotope sources, the sheath being movable relative to the sources from a shielded into an exposed configuration whereby the artery or blood vessel is directly exposed to radiation from the sources. The radioisotope delivery device is equally applicable and has benefits in irradiation of peripheral arteries.

All such variations and modifications are to be considered within the scope of the present invention the nature of which is to be determined from the foregoing description.

**THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:**

1. A radioisotope deliver device comprising:  
one or more radioisotope sources located over a  
5 guidewire; and  
at least one inflatable balloon being disposed about  
the radioisotope sources so as to radially space said  
sources a predetermined distance from a wall of an artery  
or blood vessel within which the delivery device is  
10 inserted, said at least one inflatable balloon whilst  
inflated providing a passage in an annular space between  
the radioisotope sources and the arterial or blood vessel  
wall which permits the flow of blood through the artery or  
blood vessel.  
15
2. A radioisotope delivery device as defined in claim 1  
wherein said at least one inflatable balloon is one of a  
plurality of longitudinally extending balloons each  
extending substantially the length of the radioisotope  
20 sources.
3. A radioisotope delivery device as defined in claim 1  
wherein the radioisotope sources are contained within a  
radioisotope housing configured to be slidably received  
25 over the guidewire.
4. A radioisotope delivery device as defined in claim 3  
wherein said at least one inflatable balloon includes a  
plurality of segmented balloons located circumferentially  
30 about the radioisotope housing, the circumferential space  
between the plurality of segmented balloons defining the  
passage in the annular space for the flow of blood through  
the artery or blood vessel.
- 35 5. A radioisotope delivery device as defined in claim 3  
wherein the radioisotope housing includes a sheath which

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envelopes said one or more radioisotope sources, the sheath being movable relative to the sources from a shielded into an exposed configuration whereby the artery or blood vessel is directly exposed to radiation from the sources.

5

6. A radioisotope delivery device as defined in claim 3 wherein the radioisotope housing is tubular and the radioisotope generally bead-shaped in form, the radioisotope beads being slidably received over the guidewire and axially located adjacent one another within the housing.

7. A radioisotope delivery device as defined in claim 6 further comprising a tubular substrate located axially through the radioisotope housing, the radioisotope beads being mounted to the tubular substrate.

8. A radioisotope delivery device as defined in any one of the preceding claims also comprising one or more radioisotope markers mounted to the radioisotope housing and/or the tubular substrate, said markers being constructed of a radiopaque substance such as gold.

9. A radioisotope delivery device as defined in any one of the preceding claims wherein said one or more radioisotope sources are both Beta and Gamma emitters such as Palladium 103 ( $^{103}\text{Pd}$ ) or Iodine 125 ( $^{125}\text{I}$ ).

10. A radioisotope delivery device as defined in any one of the preceding claims wherein the radioisotope sources are of a solid form and deliver from between 10 to 40 Grays (Gy).

11. A method of intracoronary irradiation involving the steps of:

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providing a radioisotope delivery device including a one or more radioisotope sources, and at least one inflatable balloon disposed about said sources;

5 locating the radioisotope delivery device over a guidewire within an artery or blood vessel;

10 inflating said at least one inflatable balloon thereby radially spacing the radioisotope sources a predetermined distance from a wall of the artery or blood vessel, said at least one inflatable balloon whilst inflated providing a passage in an annular space between the radioisotope sources and the arterial or blood vessel wall which permits the flow of blood through the artery or blood vessel.

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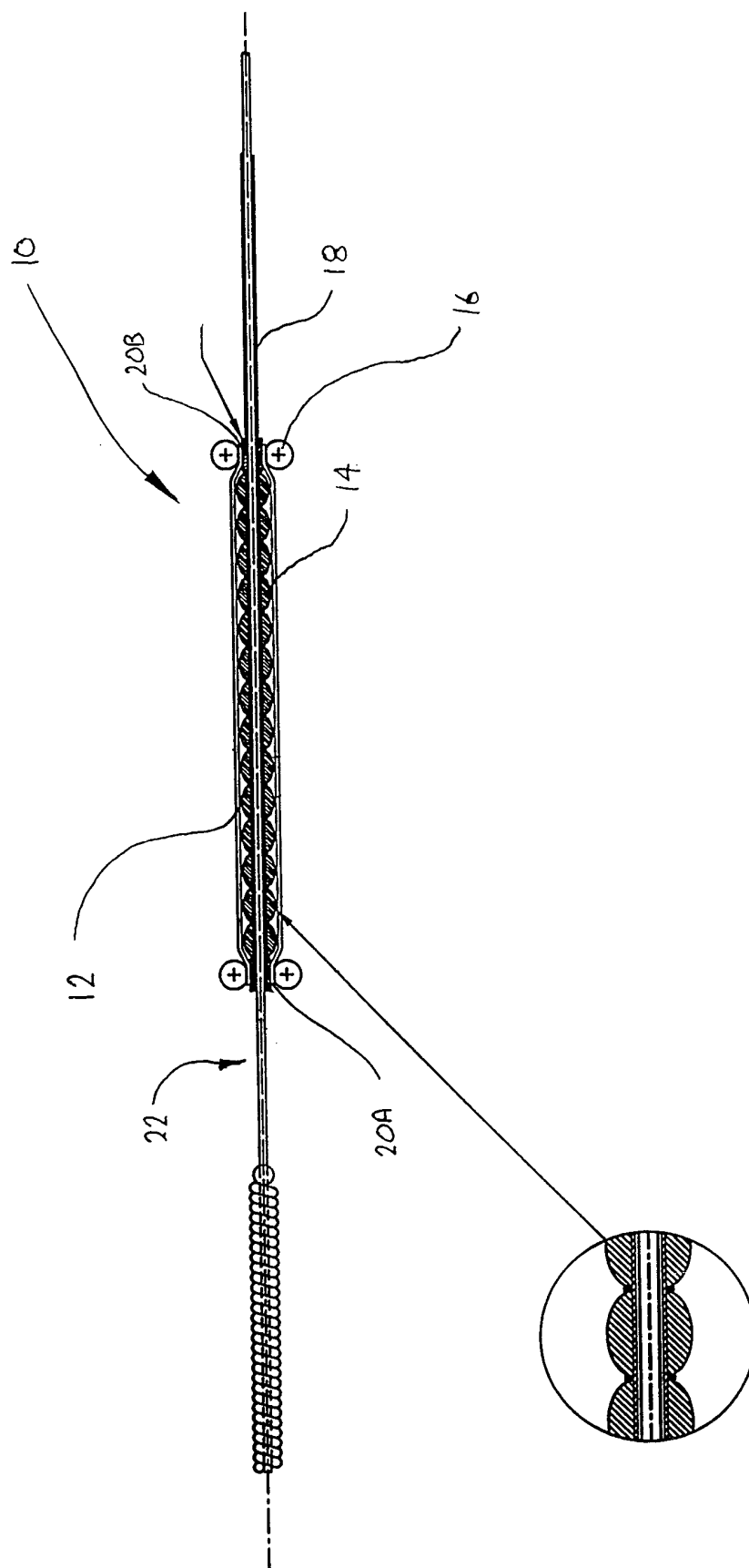
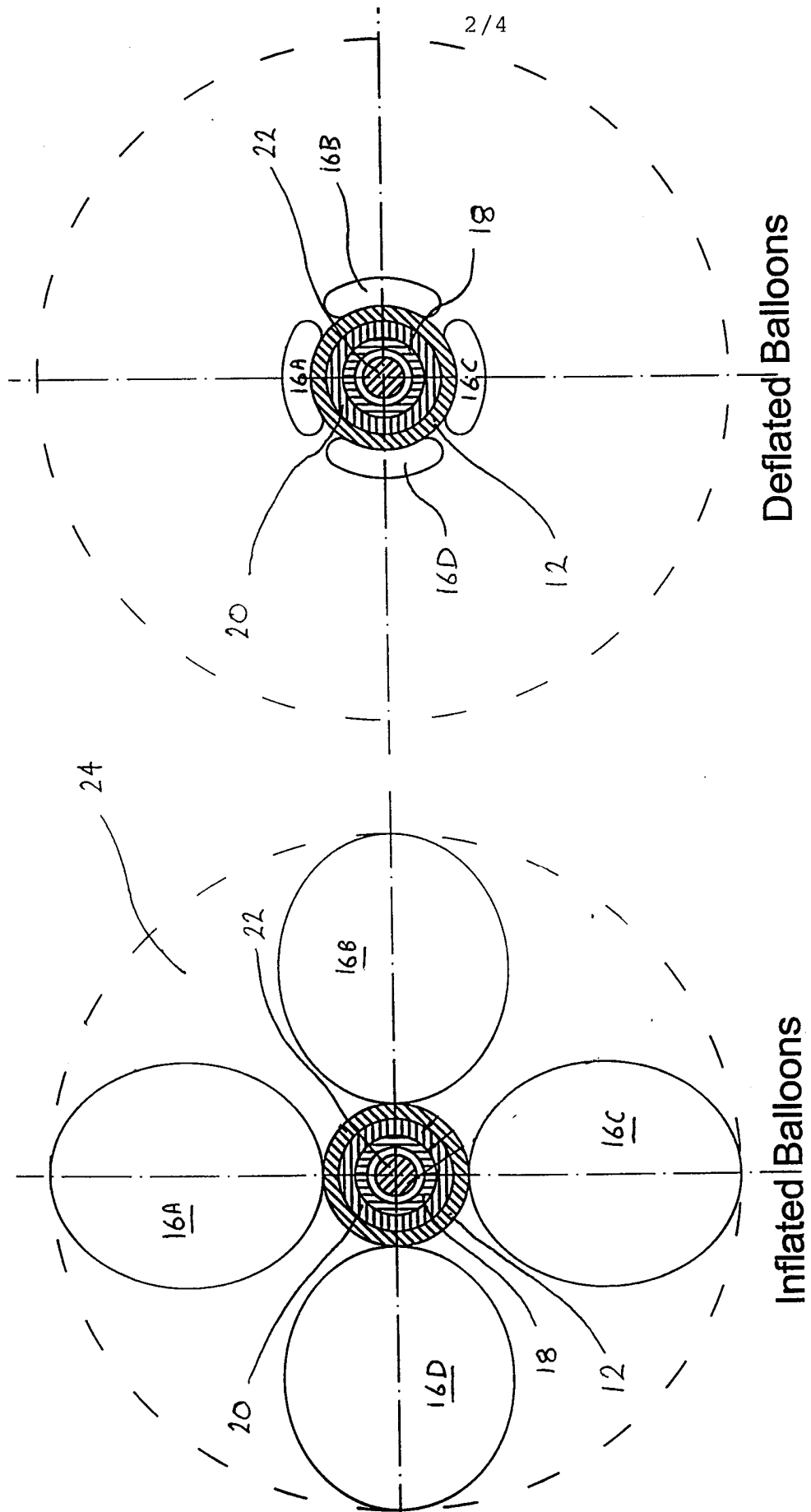


FIG. 1



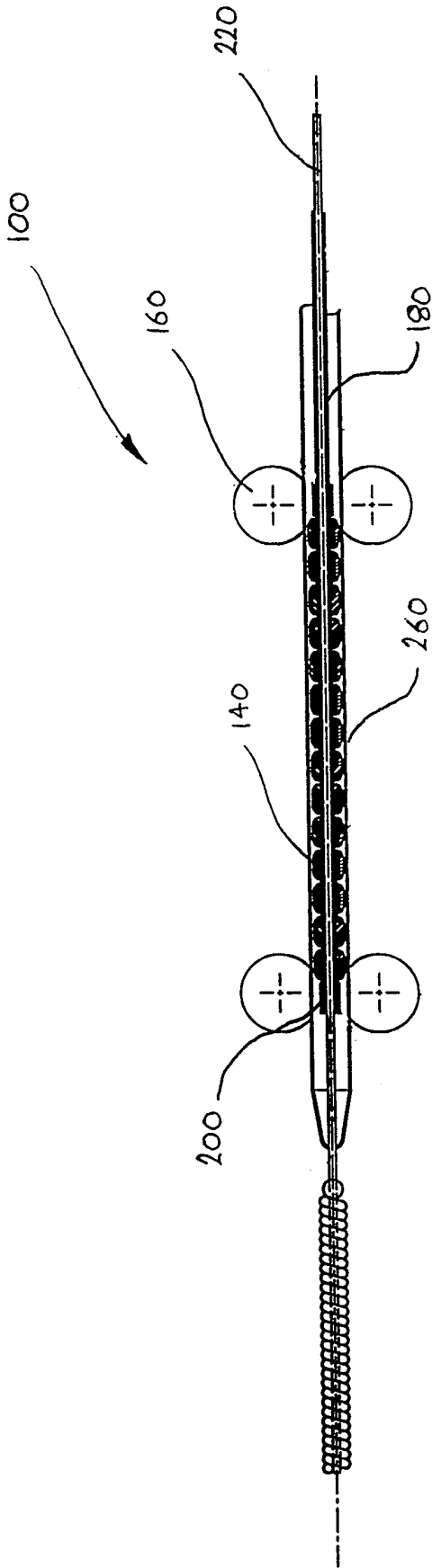


FIG. 3



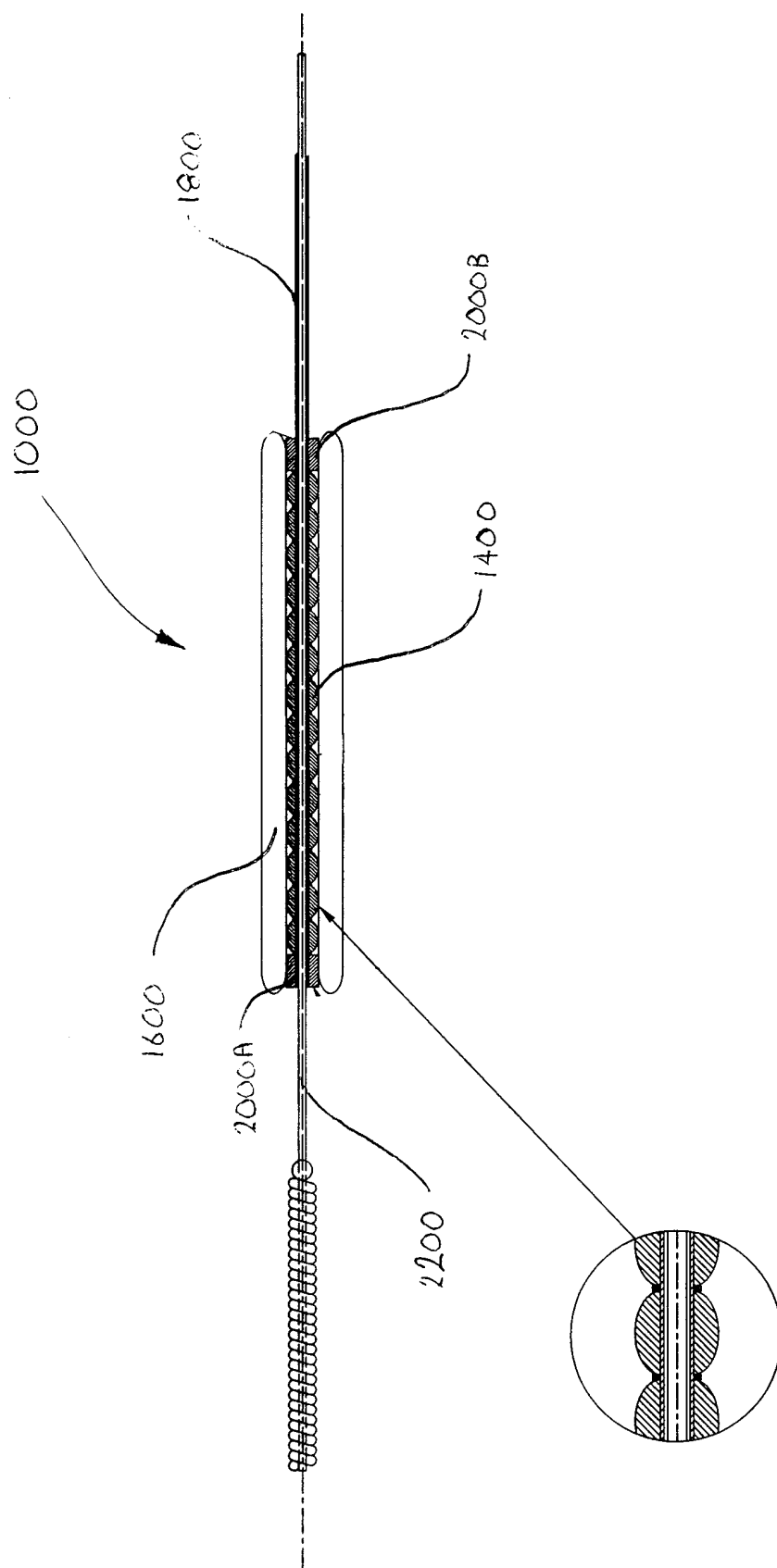


FIG. 4

# INTERNATIONAL SEARCH REPORT

international application No.

PCT/AU 99/00122

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>																						
Int Cl <sup>6</sup> : A61M 36/04																						
According to International Patent Classification (IPC) or to both national classification and IPC																						
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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) WPAT and JAPIO																						
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>																						
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																				
Y	US 5213561 A (Weinstein et al) 25 May 1993 see abstract, figure 2, column 3 line 57 - column 4 line 5	1-11																				
Y	US 5618266 A (Liprie) 8 April 1997 see figures 3, 23, 26, column 5 lines 16-24	1-11																				
Y	EP 829271 A (Angiorad L.L.C.) 18 March 1998 see figures 5, 6, column 3 lines 22-27	1-11																				
P,X	FR 2759913 (Osterreichisches Forschungszentrum Seibersdorf GMBH) 28 August 1998 See abstract, figures 3 and 4, page 13 lines 4 to 16	1-4, 6-11																				
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Date of the actual completion of the international search 20 May 1999		Date of mailing of the international search report - 1 JUN 1999																				
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer  <b>A.R. HENDRICKSON</b> Telephone No.: (02) 6283 2415																				

## INTERNATIONAL SEARCH REPORT

international application No.  
**PCT/AU 99/00122**

### Information on patent family members

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Patent Document Cited in Search Report				Patent Family Member			
US	5618266	AU	21925/95	AU	97047/98	CA	2186889
		EP	754010	US	5556389	WO	9526681
		US	5840064	AU	36408/95	CA	2199967
		EP	783340	WO	9610436	AU	17787/97
		CA	2201463	EP	801961	JP	10028740
EP	829271	AU	37534/97	CA	2213384	JP	10179751
FR	2759913	AT	333/97	DE	19808170		
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