PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 :
A61M 25/10, 25/00, 29/02, 25/01

A1

(11) International Publication Number: **WO 00/33910**

(43) International Publication Date: 15 June 2000 (15.06.00)

(21) International Application Number: PCT/US99/29344

(22) International Filing Date: 9 December 1999 (09.12.99)

(30) Priority Data:
09/208,335 9 December 1998 (09.12.98) US

(71) Applicant: SCIMED LIFE SYSTEMS, INC. [US/US]; One SciMed Place, Maple Grove, MN 55311-1566 (US).

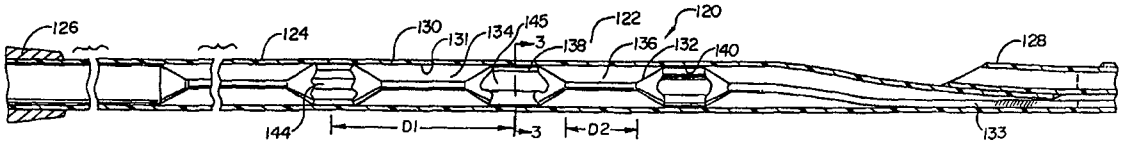
(72) Inventors: STIVLAND, Timothy, M.; 2725 Weston Lane, Plymouth, MN 55447 (US). KHOURY, Elias, A.; 8206 109th Place North, Champlin, MN 55316 (US).

(74) Agents: SEAGER, Glenn, M. et al.; Crompton, Seager & Tufte, LLC, Suite 895, 331 Second Avenue South, Minneapolis, MN 55401 (US).

(81) Designated States: CA, JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: CATHETER HAVING IMPROVED FLEXIBILITY CONTROL



(57) Abstract

Catheters having improved flexibility control, which can be provided by a slidable core wire disposed within the catheter and by shafts formed from segmented spine wires (132) disposed within polymeric tubes. One catheter is an angioplasty catheter including an axially slidable core wire disposed within an inflation lumen, and having a pressure seal disposed about the core wire extending proximally from the catheter proximal end. The slidable core wire can provide a varying degree of stiffness to the catheter. The catheter can have greater stiffnes when the core wire is axially distally extended and less stiffness when core wire is retracted. One catheter has a shaft including a spine wire or stiffening element within an outer polymeric tube (130). The spine wire can include multiple segments having alternating wide and narrow segments, with the wide segments contacting the outer tube and contributing stiffness to the shaft and with the narrow segments contributing flexibility to the shaft. In one catheter, the wide segments have apertures (156, 166) therethrough allowing fluid flow through the polymeric tube. In one catheter, the wide segments have distally increasing inter-segment distance, providing distally increasing flexibility.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

CATHETER HAVING IMPROVED FLEXIBILITY CONTROL

Field of the Invention

The present invention relates generally to medical devices. More specifically, the present invention relates to catheters having improved flexibility control. In particular, the present invention includes angioplasty catheters having a slidable core wire disposed within and catheter shafts including a spine wire disposed within a polymeric tube.

Background of the Invention

Angioplasty procedures have gained wide acceptance in recent years as efficient and effective methods for treating types of vascular disease. In particular, angioplasty is widely used for opening stenoses in the coronary arteries and is used for treating stenoses in other vascular regions.

One widely used form of angioplasty makes use of a dilatation catheter which has an inflatable balloon at the distal end and a guide wire lumen within at least a portion of the catheter shaft. Typically, a guide wire is inserted through the vascular system to a position near the stenoses, leaving a proximal portion of the guide wire extending from the patient. The proximal guide wire portion is threaded through the dilatation catheter guide wire lumen and the dilatation catheter advanced through the vascular system over the guide wire to the position near the stenoses. The treating physician manipulates the dilatation catheter until the balloon is positioned across the stenoses. The balloon is then inflated by supplying fluid under pressure through an inflation lumen in the catheter to the

balloon. The inflation of the balloon widens the lumen through the stenosed area by pressing the inflating balloon wall against the lesion inside wall.

Flexibility, torqueability, and pushability are important properties in catheter design. Flexibility relates to the ability of the catheter to track through tortuous vessels, particularly through smaller secondary and tertiary coronary vessels. Torqueability refers to the ability to transmit torque from the proximal end to the distal end of the catheter. Treating physicians often require the ability to rotate a curved distal catheter end by rotating the proximal catheter end extending from the patient's body. Rotating the catheter distal end allows the distal tip to be pointed toward a vessel opening, such as a coronary artery ostium. Pushability relates to the ability to transmit lateral force along the catheter without buckling. Flexibility, torqueability, and pushability sometimes conflict as design goals, with one or more being of predominant importance for a given region of a catheter. For example, pushability may be of more importance in the proximal region of a catheter, which may be required to push the distal remainder of the catheter. For example, flexibility may be of more importance in the distal region, which may be required to track tortuous vessel paths having small inside diameters. It may be desirable for catheter flexibility, and other properties, to be varied along the catheter length. What would be desirable is a catheter having varied flexibility along its length. A catheter having flexibility varied with time would also be desirable.

Summary of the Invention

The present invention includes catheters having improved flexibility control. Some embodiments of the invention have movable core wires slidably disposed within lumen within the catheter shaft. One group of catheters is angioplasty catheters having a core wire slidably disposed within an inflation lumen. One angioplasty catheter includes a pressure seal disposed about the portion of core wire extending proximally from the catheter. In use, one angioplasty catheter having the movable core wire and seal can have the core wire alternately advanced and retracted during different stages of catheter insertion and angioplasty. The core wire can be advanced to enhance stiffness when pushability in a given catheter region is desired, and retracted when flexibility in a given region is desired.

One group of catheters includes a shaft portion having a spine wire or stiffening element disposed within the lumen of a polymeric tube. The spine wire can be formed of metal and have alternating wide and narrow portions formed of wide and narrow segments. The wide segments can approach or preferably touch the inside wall of the outer polymeric tube. The wide segments can contribute to shaft stiffness by their length and by the inter-segment distance between segments. One shaft includes a spine wire having substantially constant inter-segment distance. Another shaft includes a spine wire having distally increasing inter-segment distances, contributing to distally increasing flexibility.

One group of catheters incorporating the present invention has a fluid pathway formed within the outer polymeric tube. Catheters in this group can have

alternating narrow and wide segments, with apertures or openings formed around or through the wide segments. One group of wide segments have openings or apertures formed between portions of the segments and the outer tube wall. One group of segments has apertures formed through the segments. Openings through or around the wide segments allow fluid flow through or past the wide segments, which could otherwise block or greatly inhibit fluid flow.

Catheter shafts having openings through the wide segments can be used to deliver fluid. One such fluid delivery catheter is a dye delivery catheter used to deliver radiopaque contour media for angiography. Other catheters incorporating the present invention are angioplasty catheters, which can use the tubular shaft containing the spine wire as an inflation tube for delivery of balloon inflation fluid.

Brief Description of the Drawings

Figure 1 is a longitudinal, cross-sectional view of an angioplasty balloon catheter having a distal guide wire lumen and a movable stiffening element disposed within an inflation lumen;

Figure 2 is a longitudinal, cross-sectional view of a proximal catheter shaft region including a stiffening element or spine wire having alternating wide and narrow regions disposed within an outer tube;

Figure 3 is a transverse, cross-sectional view of one embodiment of a proximal catheter shaft taken through 3-3 in Figure 2, having a tri-lobed profile;

Figure 4 is a transverse, cross-sectional view of another embodiment of a

proximal catheter shaft having a bi-lobed or hour-glass profile;

Figure 5 is a transverse, cross-sectional view of another embodiment of a proximal catheter; and

Figure 6 is a transverse, cross-sectional view of another embodiment of a proximal catheter having a triangular profile.

Detailed Description of the Preferred Embodiments

Figure 1 illustrates a single operator exchange balloon angioplasty catheter 20 incorporating one aspect of the present invention. Catheter 20 includes generally a proximal region 22, a distal region 24, a manifold 26, a proximal outer tube 28 coupled to manifold 26, a distal outer tube 30 coupled to proximal outer tube 28, and an inflatable balloon 34 disposed on distal outer tube 30. Catheter 20 also includes a distal inner tube 32, which is inserted into and disposed within distal outer tube 30. Distal inner tube 32 has a lumen 38 within and can serve as a guide wire lumen. Proximal outer tube 28 and distal outer tube 30 have an inflation lumen 36 within, with inflation lumen 36 being in fluid communication with the interior of balloon 34. In one embodiment, proximal outer tube 28 is formed of a relatively stiff polymeric material such as polyimide, while distal outer and inner tubes 30 and 32 are formed of polyethylene.

Disposed within inflation lumen 36 is a movable core wire 40. Movable core wire 40 is slidably disposed within the inflation lumen in the example illustrated, allowing the core wire to extend distally to a location near balloon 34. In a preferred embodiment, a proximal pressure seal 42 is disposed about core

wire 40 and secured to a proximal portion of manifold 26, forming a tight seal about core wire 40. Pressure seal 42 can serve to maintain inflation fluid pressure within inflation lumen 36 while core wire 40 remains disposed within the inflation lumen.

Core wire 40 is preferably tapered distally, having a smaller profile in the distal region than in the proximal region. Distally tapering the core wire can contribute to having a more flexible and smaller profile catheter in the catheter distal region. Continuously tapering the core wire over much of its length can provide increasing flexibility over much of its length. Core wire 40 preferably has a rounded distal tip 44 or other safety tip configuration. Core wire 40 is formed of Nitinol in one embodiment, and stainless steel in another embodiment. While a metallic core wire is preferred, other embodiments have elongate stiffening elements formed of polymeric materials, which can also provide stiffness.

In use, core wire 40 can be distally inserted within catheter 20 and catheter 20 inserted within the vasculature of a patient. In a preferred method, core wire 40 is inserted to the maximum desired distal extend prior to inserting catheter 20 within a patient. This can provide a maximum stiffness prior to inserting the catheter into the patient. The catheter can then be advanced within the patient's blood vessels. The core wire may lie within a distal portion of the catheter, initially in part to support the catheter distal region against buckling. In one method, core wire 40 is retracted relative to catheter 20 when the distal portion of the catheter is advanced into regions where greater flexibility is desired. In one

method, core wire 40 is held in position while catheter 20 is advanced distally past the core wire. Even when partially proximally retracted, core wire 40 can provide pushability to the catheter, leaving only a catheter distal region without the added support of the core wire. In one method, the catheter distal portion having the core wire retracted is insinuated into vessels requiring the added flexibility of the catheter distal portion given by the core wire retraction. After the catheter distal portion is in position, the core wire can be advanced distally, providing support for further catheter advancement. This process can be repeated multiple times to properly position the catheter distal portion.

Once in position, the core wire is left in place in one embodiment, and inflation fluid injected into the inflation lumen around the core wire. In this method, the core wire can remain in place during the entire angioplasty procedure. In another method, the core wire can be removed substantially or entirely from the catheter prior to inflation of the balloon. In this method, the core wire can be advanced again after inflation, if desired. This method takes advantage of the fact that the added stiffening properties of the core wire may not be needed once the catheter is in position and no longer being advanced. Catheters taking advantage of this fact may be constructed having thinner walls and smaller profiles. In particular, catheters may be constructed incorporating the present invention which are not expected to be advanceable within the vasculature without the aid of an inserted core wire.

Referring now to Figure 2, another catheter 120 is illustrated, including a proximal region 122 having a proximal shaft region 124. Catheter 120 includes a

proximal manifold 126 and a distal guide wire tube 128. Proximal shaft 124 includes an outer tube 130 having an inner wall 131 containing an inner stiffening element or spine wire 132. In one embodiment, spine wire 132 includes an elongate distal portion 133, which can extend into a distal portion of the catheter. In the embodiment illustrated, spine wire distal portion 133 is distally tapered and extends near guide wire tube 128. Spine wire 132 can include a plurality of narrow regions, such as 134 and 136, and a plurality of wide regions or segments 138 and 140. In an alternate embodiment, the Spine wire has essentially a single wide segment such as wide segment 138, with no interspersed narrow segments. The terms "narrow" and "wide" refer generally to the maximum spine wire extent when viewed in transverse cross section. The spine wire narrow regions typically have a smaller cross-sectional profile or cross-sectional area relative to the wide regions. The wide regions can approach and typically are in contact with outer tube inside wall 131. The wide regions provide stiffness and support to the catheter shaft while the narrow regions provide flexibility.

Wide regions are separated by an inter-segment distance as indicated at "D1". D1 is a measure of the inter-segment distance measured from segment center-to-center. The inter-segment distance can also be measured by the length of the narrow region separating the wide regions, as indicated at "D2". The degree of stiffness of the shaft can be increased both by increasing the length of the wide regions and by decreasing the inter-segment distance between wide regions. In one embodiment, both the wide region length and the inter-segment distance are substantially constant over the shaft length. In another embodiment,

the wide region length remains substantially constant while the inter-segment distance increases distally over a substantial portion of the shaft length. Increasing the inter-segment distance distally can provide increasing flexibility distally over the shaft length. In yet another embodiment, the wide region length is decreased distally. In still another embodiment, inter-segment distance is increased distally and wide region length is decreased distally, providing distally increasing flexibility. In some embodiments, proximal shaft 124 includes open or un-occluded regions 144 and 145, allowing fluid flow therethrough. Open regions 144 and 145 can be formed from fluted regions disposed on the periphery of the wide spine wire regions. In embodiments allowing such fluid flow, wide regions 140 are configured to allow fluid flow through the wide regions as well. In such embodiments, open regions can effectively function as inflation or dye delivery lumens.

Referring now to Figure 3, one wide region 150 is illustrated in transverse cross section. Wide region 150 has three lobes 152 creating a tri-lobed profile contacting outer tube 130 in three locations. An open area through wide region 150 is formed by three openings or apertures 146 through the body of the spine wire. As used herein, apertures refer to openings either around or through the wide regions of the spine wire relative to what could otherwise be a solid, circular central member occluding the lumen of the outer tube. The outer extent of lobes 152 can provide stiffness or rigidity where contacting outer tube 130.

Referring now to Figures 4-6, other shaped wide regions are illustrated. Figure 4 illustrates a wide region having a bi-lobed or hour-glass profile 154 and

two apertures 156 through the wide region. Figure 5 illustrates another profile 162 including a central member 164 and peripheral members 166 attached thereto. Peripheral members 166 form a series of apertures 168 between the members. Figure 6 illustrates a triangular profile 158 having three apertures 160 allowing fluid flow past the spine wire wide regions.

The spine wire or stiffening member, such as member 132 in Figure 2, can be manufactured using various techniques. In one method, a metallic wire is drawn through a releasable die for a length corresponding to the length of the narrow segment. The die is released or opened, a wide segment allowed to pass, the die closed again, and the next narrow segment formed by drawing through the die. To provide for fluid flow through the final shaft product, the wide segments can be formed in non-circular shapes or in less than perfect circular shapes. To form these non-circular shapes, the wire stock used initially can have a non-circular shape such as a triangle, a bi-lobed hourglass shape, tri-lobed shape, or a generally fluted outer surface. The wire stock can be drawn through a circular die to form the narrow sections, and the die released, allowing the non-circular shapes to retain shapes related to the original shapes.

In another method, the stiffening element can be manufactured by centerless grinding. Portions of the wire corresponding to the narrow segments can be ground down to the desired width or diameter. In this method, the beginning stock can have a non-circular shape, for example, the triangular, bi-lobed, or tri-lobed shapes previously mentioned. In yet another method, a central core element can be used to form the narrow regions and separate elements

affixed to the central member to form the wide regions. For example, elements having central apertures can have non-circular shapes slip fit over the central member and further secured. For example, individual pieces or members can be affixed to the central element, thereby creating a wide element, leaving apertures or passages through the wide element. Figure 5 illustrates one embodiment including a central element having peripheral members disposed about the central element which applicants believe suitable for manufacture by affixing members about a central core wire.

Numerous characteristics and advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size and ordering of steps without exceeding the scope of the invention. The invention's scope is, of course, defined in the language in which the appended claims are expressed.

What is claimed is:

1. A catheter comprising:

a proximal end, a proximal region, a distal region, and an intermediate region disposed between said proximal and distal regions;

a tubular shaft having a lumen extending distally from said proximal end through at least said intermediate region; and

a stiffening member slidably disposed within said lumen from said proximal end to at least said intermediate region, such that said stiffening member can be slid longitudinally through said lumen.

2. A catheter as recited in claim 1, wherein said tubular shaft includes a proximal pressure seal disposed near said shaft proximate end and disposed about said stiffening member.

3. A balloon angioplasty catheter comprising:

a proximal end, a proximal region, a distal region, and an intermediate region disposed between said proximal and distal regions;

a tubular shaft having an inflation lumen extending distally from said proximal end through at least said intermediate region;

a balloon disposed proximate said tubular shaft distal region, said balloon having an envelope and an interior in fluid communication with said tubular shaft lumen;

a stiffening member slidably disposed within said inflation lumen from

said proximal end to at least said intermediate region, such that said stiffening member can be slid longitudinally through said lumen; and

a proximal pressure seal disposed proximate said shaft proximal end and disposed about said stiffening member.

4. A catheter as recited in claim 3, wherein said tubular shaft is formed of polymeric material.

5. A catheter as recited in claim 3, further comprising a distal guide wire lumen having a proximal port proximal of said balloon and a distal port distal of said balloon.

6. A catheter as recited in claim 3, wherein said balloon has a proximal region and a distal region, further comprising a guide wire tube extending through said balloon, said guide wire tube having a proximal port proximal of said balloon proximal region and a distal port distal of said balloon distal region.

7. A catheter as recited in claim 6, wherein said stiffening member is a core wire.

8. A catheter as recited in claim 7, wherein said core wire has a distally decreasing taper.

9. A method for advancing a catheter having a lumen comprising:

providing said catheter having a first lumen and a second lumen;

providing an elongate stiffening member;

providing a guide wire;

advancing said guide wire through a vessel to a target vessel region;

advancing said stiffening member distally through said second catheter lumen;

threading said guide wire through said first lumen;

advancing said catheter distally into said vessel over said guide wire; and

movement of said stiffening member proximally.

10. A method as recited in claim 9, wherein said first lumen is a distal guide wire lumen, said catheter is an angioplasty catheter, said second lumen is an inflation lumen, said retracting step includes withdrawing said stiffening member from substantially all of said inflation lumen.

11. A tubular catheter shaft comprising:

an outer tube having a lumen therethrough;

an elongate stiffening member disposed within said lumen, said stiffening member including a plurality of alternating wide and narrow segments, said segments having a cross-sectional area, wherein said wide segments having a

larger cross-sectional area than said narrow segments.

12. A tubular catheter shaft as recited in claim 11, wherein said elongate stiffening member has a proximal end, a distal end, and said wide segments have an inter-segment distance therebetween and said inter-segment distance is generally distally increasing, such that said shaft flexibility is generally distally increasing.

13. A tubular catheter shaft comprising:

an outer tube having a lumen therethrough; and

an elongate stiffening member disposed within said lumen, said stiffening member including a plurality of alternating wide and narrow segments, said segments having a cross-sectional area, wherein said wide segments have a larger cross-sectional area than said narrow segments.

14. A tubular catheter shaft as recited in claim 13, wherein said wide segments have a cross-sectional profile not completely occluding said outer tube lumen, such that fluid flow through said plurality of wide segments within said outer tube is possible.

15. A tubular catheter shaft as recited in claim 14, wherein said wide segment cross-sectional profiles have at least one aperture therethrough, such that fluid flow is possible through said segment within said outer tube.

16. A tubular catheter shaft as recited in claim 15, wherein said wide segment cross-sectional profiles have at least two apertures therethrough.

17. A tubular catheter shaft comprising:

an outer tube having a lumen therethrough; and

an elongate stiffening member disposed within said lumen, said stiffening member including at least one wide segment having a cross-sectional profile, wherein said cross-sectional profile has a maximum extent in close proximity to said outer tube, wherein said cross-sectional profile does not completely occlude said outer tube lumen, such that fluid flow through said wide segment within said outer tube is possible.

18. A tubular catheter shaft as recited in claim 17, wherein said cross-sectional profile has at least one aperture therethrough, such that fluid flow is possible through said segment within said outer tube.

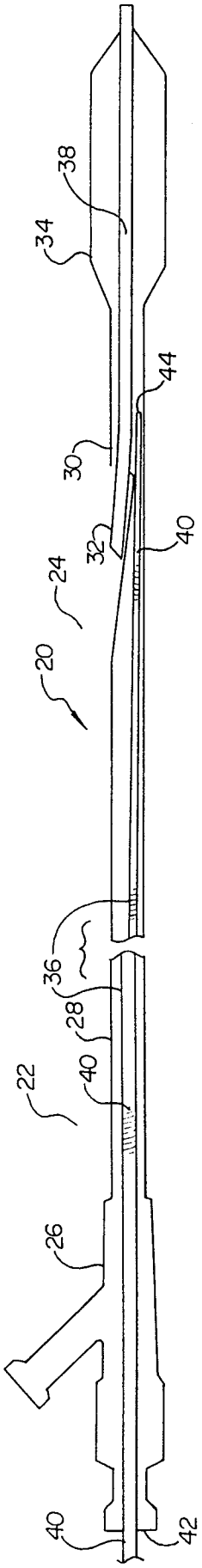


Fig. 1

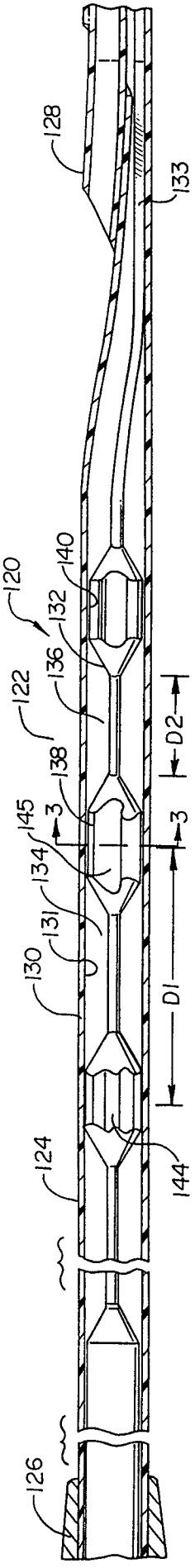


Fig. 2

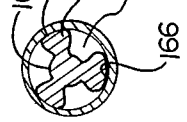


Fig. 5

Fig. 6

Fig. 4

Fig. 3

INTERNATIONAL SEARCH REPORT

Inter. nal Application No
PCT/US 99/29344

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M25/10 A61M25/00 A61M29/02 A61M25/01

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)
IPC 7 A61M

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 practical, 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 5 545 138 A (FUGOSO MAURICIO L ET AL) 13 August 1996 (1996-08-13)	1-4,7,8
A	column 2, line 32-54	11
Y	column 3, line 37,38 column 4, line 19-34 column 4, line 62-65 column 5, line 45-54 figure 6	6

X	US 5 807 328 A (BRISCOE RODERICK E) 15 September 1998 (1998-09-15) column 4, line 53-59 figure 2	1

A	WO 89 04686 A (SCIMED LIFE SYSTEMS INC) 1 June 1989 (1989-06-01) page 25, line 16 -page 26, line 12 figure 14	11

	-/--	

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

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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)

"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

"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

"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

"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.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 April 2000	25/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Bichlmayer, K-P

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Inte. ional Application No
PCT/US 99/29344

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 830 870 A (CORDIS EUROP) 25 March 1998 (1998-03-25) column 2, line 34 -column 3, line 31 figure 2	11,13-18
X	US 4 601 713 A (FUQUA CLARK R) 22 July 1986 (1986-07-22)	11, 13-15, 17,18
Y	figures 4,5 column 6, line 64 -column 7, line 17 claims 1,9-12	12
Y	WO 95 24236 A (SCHNEIDER USA INC) 14 September 1995 (1995-09-14) page 2, line 26 -page 3, line 7 page 5, line 28 -page 6, line 17 page 8, line 23 -page 9, line 12 page 11, line 19-25 figures 2,6	12
X	US 5 382 238 A (ABRAHAMSON TIMOTHY A ET AL) 17 January 1995 (1995-01-17) figure 9 column 10, line 16-26	11,13
Y	US 5 468 225 A (TEIRSTEIN PAUL S) 21 November 1995 (1995-11-21) figure 3 column 5, line 62 -column 6, line 1	6

1

INTERNATIONAL SEARCH REPORT

...information on patent family members

Inter ...nal Application No
PCT/US 99/29344

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5545138 A	13-08-1996	NONE	
US 5807328 A	15-09-1998	NONE	
WO 8904686 A	01-06-1989	US 4846174 A	11-07-1989
		CA 1305386 A	21-07-1992
		EP 0387298 A	19-09-1990
		US 4930341 A	05-06-1990
EP 0830870 A	25-03-1998	NL 1004102 C	26-03-1998
		US 5897536 A	27-04-1999
US 4601713 A	22-07-1986	AU 5994986 A	07-01-1987
		EP 0225921 A	24-06-1987
		US 4738666 A	19-04-1988
		WO 8607267 A	18-12-1986
		US 4710181 A	01-12-1987
WO 9524236 A	14-09-1995	AU 685575 B	22-01-1998
		AU 1464695 A	25-09-1995
		BR 9507017 A	09-09-1997
		CA 2185146 A	14-09-1995
		EP 0749333 A	27-12-1996
		FI 963537 A	09-09-1996
		JP 9504980 T	20-05-1997
		KR 186950 B	01-04-1999
		NO 963777 A	04-11-1996
		US 5605543 A	25-02-1997
		US 5743876 A	28-04-1998
US 5382238 A	17-01-1995	NONE	
US 5468225 A	21-11-1995	US 5336184 A	09-08-1994
		AU 7335894 A	13-02-1995
		WO 9502429 A	26-01-1995
		US 5472425 A	05-12-1995
		US 5540659 A	30-07-1996
		US 5891091 A	06-04-1999