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United States Patent [19]

Ravenscroft

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[54] **STENT DELIVERY SYSTEM**

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[21] Appl. No.: **526,968**

[22] Filed: **Sep. 12, 1995**

[51] **Int. Cl.**[6] **A61B 17/00**

[52] **U.S. Cl.** **606/198**; 623/1; 623/12; 606/108

[58] **Field of Search** 606/1, 108, 191, 606/192, 194, 195, 158, 200; 623/1, 12; 128/4, 6, 898, 899; 604/164

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,553,545	11/1985	Maass et al. .	
4,580,568	4/1986	Gianturco .	
4,655,771	4/1987	Wallsten .	
4,681,110	7/1987	Wiktor .	
4,732,152	3/1988	Wallsten et al. .	
4,733,665	3/1988	Palmaz .	
4,875,480	10/1989	Imbert .	
4,907,336	3/1990	Gianturco .	
4,950,227	8/1990	Savin et al. .	
4,990,151	2/1991	Wallsten	606/108
5,026,377	6/1991	Burton et al. .	
5,159,920	11/1992	Condon et al.	606/108
5,411,507	5/1995	Heckele	606/108
5,480,423	1/1996	Ravenscroft et al.	623/1
5,484,444	1/1996	Braunschweiler et al.	606/191

FOREIGN PATENT DOCUMENTS

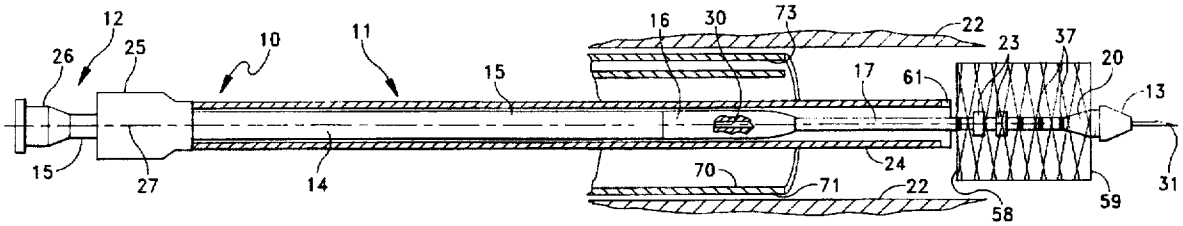
8704935	8/1987	WIPO	606/198

Primary Examiner—Michael Buiz
Assistant Examiner—William Lewis
Attorney, Agent, or Firm—Pearson & Pearson

[57] **ABSTRACT**

A stent delivery system includes a catheter with an axially extending inner core and outer sheath. Axially spaced rings extending from a relatively narrow diameter portion of the inner core proximate the distal end thereof. The rings engage proximal portions of a compacted stent disposed within the sheath and over the core and rings. A proximal handle of the system has a first portion that supports the sheath and a second portion that supports the core for relative displacement of the core and the sheath. Retraction of the sheath relative to the core uncovers the stent engaged by the rings which tends to remain stationary relative to the core so that upon partial retraction of the sheath a distal end of the stent expands to its expanded form. Further retraction of the sheath deploys the stent, retracting the core returns the distal portion of the stent into the sheath.

23 Claims, 3 Drawing Sheets



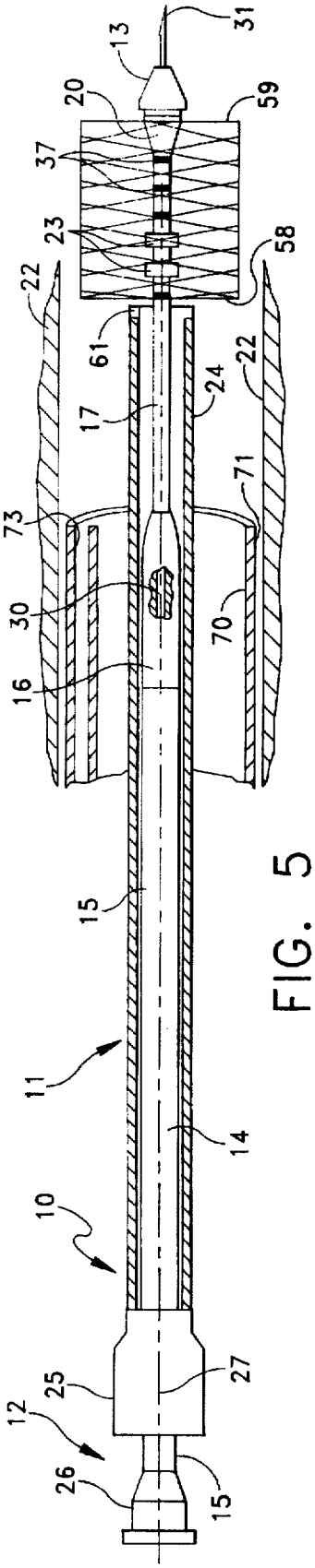


FIG. 5

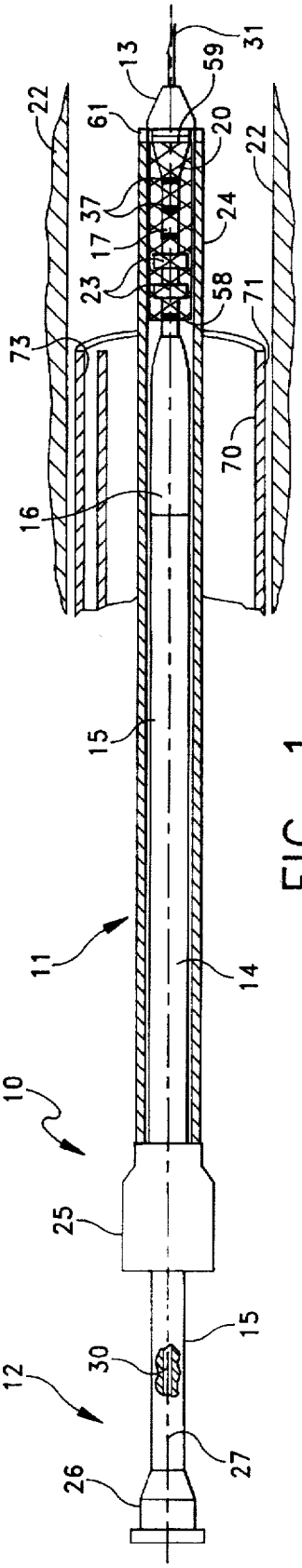


FIG. 1

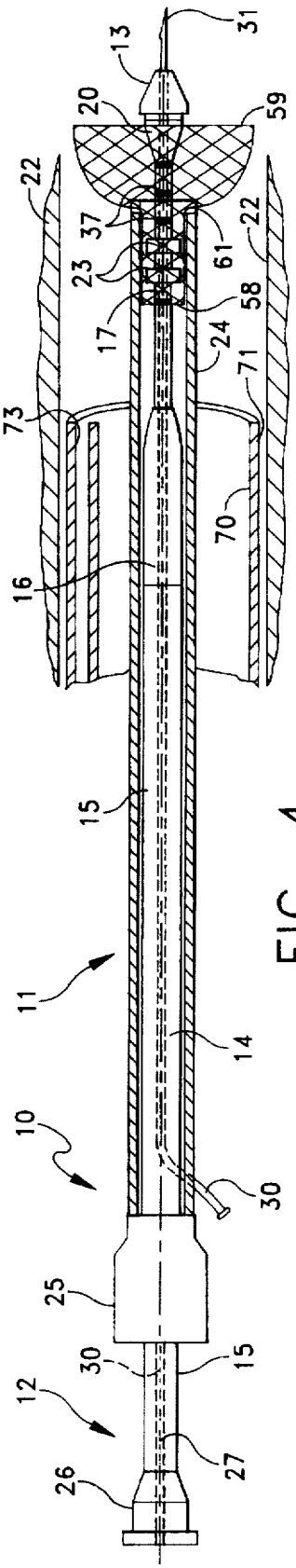


FIG. 4

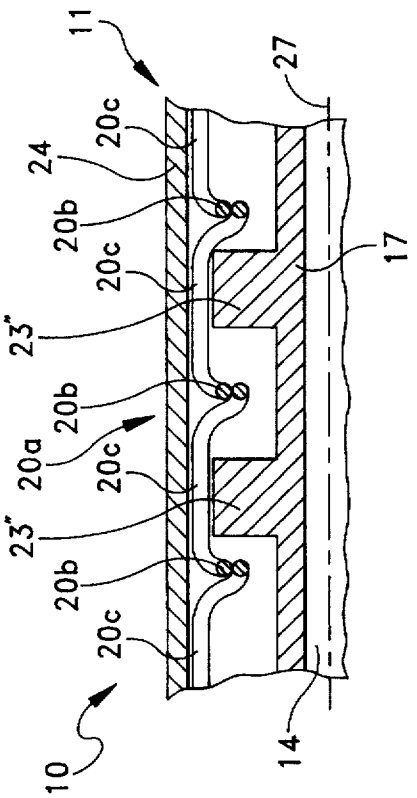


FIG. 3

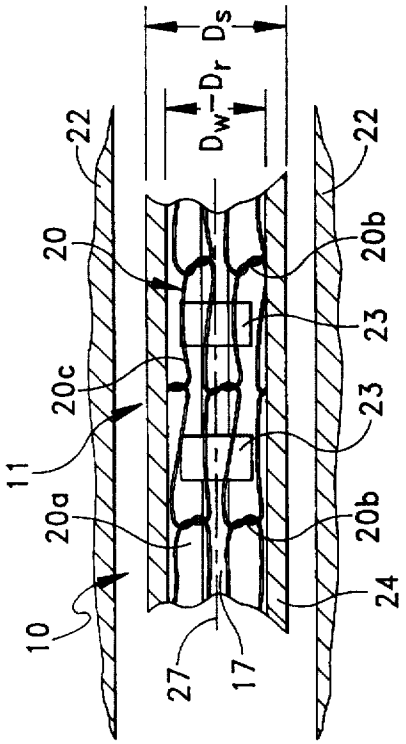


FIG. 2

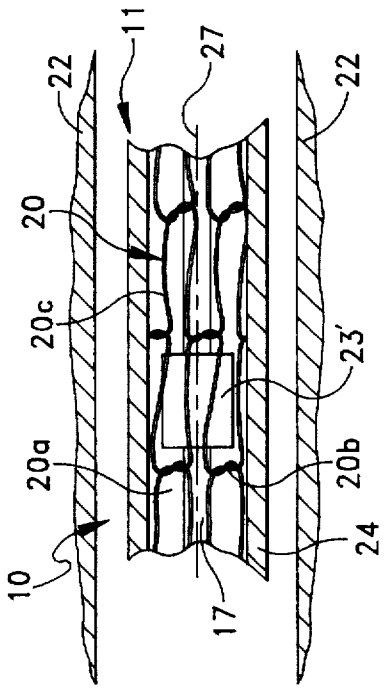


FIG. 6

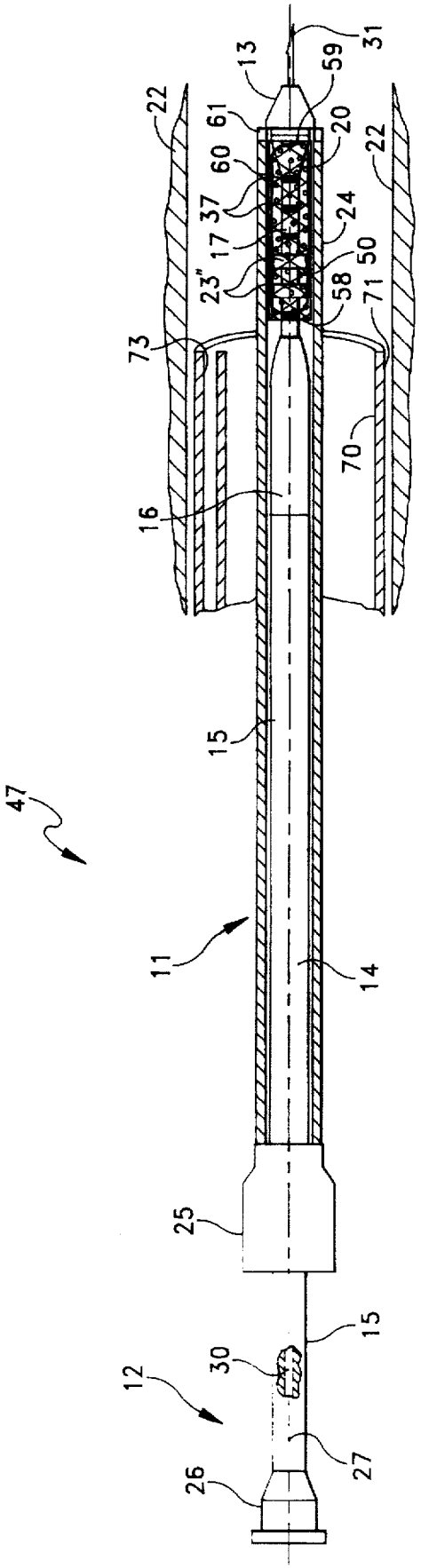


FIG. 7

STENT DELIVERY SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a percantaneous and endoscopic delivery of a stent in a patient's body and more particularly to a stent delivery system including a catheter for the selective deployment of an expandable stent.

2. Description of Related Art

Stents are well known endoprostheses. A typical endoprosthetic stent comprises a tubular structure that expands radially from a compact form for transit to an expanded form for implantation. Radial expansion causes the stent to implant into the tissues of a wall of a "vessel" being repaired or bridged to maintain its patency. Such stents may be utilized in body canals, blood vessels, ducts and other body passages, and the term "vessel" is meant to include all such passages.

Stents can be characterized as self-expansive and mechanically expansive. This invention relates to both self-expansive and mechanically expansive stents further characterized by being formed of a single wire or plurality of wires woven together to form a mesh structure which can be located on or in a distal end of a tubular body, such as a medical catheter, in such compact form. A delivery system for such stent comprises a catheter with various associated control apparatus extending from a distal end to a proximal end. Such a delivery system enables a surgeon to guide the distal end with the compact stent to a selected location in a patient's vessel. The surgeon then operates the control apparatus to release and expand the stent so as to deploy and fix the stent in the selected location. The control apparatus may be integral with the catheter for a mechanically expandable stent or ancillary to the catheter for a self-expansive stent. In either version, the control apparatus releases the stent from the catheter and, in the case of a mechanically expansive stent, expands the stent radially. After the stent has expanded, the surgeon returns the catheter typically to its pre-deployment form, free from the stent, and then removes the catheter from the patient. The expanded stent remains in the vessel in its expanded shape to maintain vessel patency.

Stent delivery systems must generally conform to several important criteria. First, it is critical in most applications to keep the transverse dimension of the delivery system to a minimum, as the distal end of the delivery system typically must be navigated through and along a patient's lumens either in a percantaneous insertion procedure or through the working channel of an endoscope. Second, the delivery system must facilitate the deployment of the stent into contact with the patient's vessel walls once it is located at a selected site. Third, the stent delivery system must easily disengage from the stent after deployment to enable separation of the delivery system from the deployed stent. Fourth, the procedure for removing the delivery system from the body must be straightforward and relatively simple to speed and ease the work of a physician employing the stent delivery system. Fifth, the stent delivery system must be reliable and efficient to reduce trauma and patient risk. Sixth, preferably the delivery system should also enable partial deployment and retraction of the stent to enable the surgeon to recover a stent not properly positioned during deployment thereof.

The prior art stent delivery systems for self-expansive endoprosthetic stents are illustrated by the following United States Letters Patent:

4,580,568	(1986)	Gianturco
4,655,771	(1987)	Wallsten
4,681,110	(1987)	Wiktor
4,732,152	(1988)	Wallsten et al.
5,026,377	(1991)	Burton et al.

U.S. Pat. No. 4,580,568 to Gianturco discloses a system for delivering a self-expanding stent. The system comprises a tubular sheath positioned with a distal end proximate a selected delivery site. The stent is then compressed and inserted into a proximal end of the sheath. A user inserts a pusher rod into the tubular sheath and urges the stent through the sheath to a position proximate the distal end of the tubular member. The user then retracts the sheath relative to the push rod to release the stent.

U.S. Pat. No. 4,655,771 to Wallsten discloses a delivery system for a stent that includes a catheter that supports a tubular stent in a compact form on its exterior distal end surface. Gripper members proximate the proximal and distal ends of the tubular stent secure to the catheter. A handle at the proximal end of the tubular part of the apparatus enables a user to control the axial movement of the gripper members. That is, axial displacement of the gripper members by the control mechanisms frees the stent from the outer surface of the catheter and enables expansion of the stent.

U.S. Pat. No. 4,681,110 to Wiktor discloses a catheter arrangement in which a tubular member contains a radially expandable liner and a deployment mechanism for deploying the liner. The deployment mechanism includes an internal tube that extends through the outer portion of the tube and engages a proximal end of the liner. Distal displacement of the inner tube relative to the outer tube urges the liner distally of the distal end of the outer tube enables the liner to deploy in its radially expanded form.

U.S. Pat. No. 4,732,152 to Wallsten et al. discloses a device and method for implantation of a prosthetic stent. The stent is maintained in a compact state within the device during transport to a selected location within a patient's vessels and then is released to expand and fix in a patient's vessel.

The following United States Letters Patent illustrate prior art stent delivery systems for mechanically expansive stents:

4,553,545	(1985)	Maass et al.
4,733,665	(1988)	Palmaz
4,907,336	(1990)	Gianturco
4,950,227	(1990)	Savin et al.
5,026,377	(1991)	Burton et al.

U.S. Pat. No. 4,553,545 to Maass et al. discloses a coil spring stent and an instrument for transporting the stent in a compact form and then deploying the stent in an expanded form within a patient's body. A tubular body carried on the distal end of a catheter underlies and supports the stent. Proximal and distal ends of the stent are clamped between the ends of the tubular body and enlarged first and second end sections of the catheter. The end sections connect by first and second portions of a coaxial cable to a knob member at a proximal end of the instrument. A second knob member at the proximal end connects with the tubular body so that relative rotation of the knobs in a first sense urges rotation of the tubular body relative to the end section to urge radial expansion of the stent thereby. Opposite rotation of the knobs tend to contract the stent. Successive opposed relative axial displacement of the knobs successively widens the

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