An Apparatus and Method for Delivering at least One Physical Object to a Desired Site and Method for Manufacture of Apparatus

Technical Field

This invention relates to an apparatus and method of delivering a physical object to a desired site, and refers particularly, but not exclusively, to such an apparatus and method for delivering a physical object to a part of an organic body, such as, for example, intra-cranial regions. The apparatus and method may be employed in a field of medicine such as, for example, neurology, when used to treat victims of stroke. This invention also relates to a method for manufacturing an apparatus for use in the method of delivering a physical object to a desired site.

Background of the Invention

Stroke is one of the major causes of disability and death in the developed world today. Stroke is a type of cardiovascular disease. It affects the arteries leading to and within the brain. A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked by a clot or when the blood vessel bursts. When either instance happens, part of the brain cannot get the blood (and oxygen) it needs, so it starts to die.

CT scans and MRIs are able to provide accurate views of intra-cranial regions. While the prohibitive cost of such scans prevents people from undergoing the scans before an episode of stroke actually occurs, the affluence of society has made pre-emptive scanning a regular practice as a stroke prevention measure. Currently, stroke survivors and people who wish to minimize their risk of getting a stroke/relapse usually consume antiplatelets such as for example, aspirin, and/or anticoagulants such as, for example, warfarin on a regular basis as the agents lowers the viscosity of blood, and its ability to clot.

Minimally invasive procedures are good alternatives to open scull operations. Such procedures are sometimes performed using balloon angioplasty with implantable metallic scaffolds (stents) to treat blood vessels that have a build-up of fatty deposits lining the vessel. While such procedures actually rectify the situation, they also are causing the potential problem, the more invasive the procedure, the greater the risk of complications occurring during the procedure. Hence, alternative means which minimize the risk of performing such invasive procedures are constantly sought.

Thus, there exists a need to deliver implantable medical devices for placement within intracranial blood vessels to treat occlusions of those vessels before they are completely sealed without substantial risk to the patient. The smaller the incision required to perform the procedure, the lower the risk to the patient.

Summary of the Invention

There is provided an apparatus for delivering at least one physical object to a desired site including: a proximal port for manipulating the apparatus, and a shaft for maintaining rigidity of the apparatus. The shaft and the proximal port are co-axially positioned and secured to one another, and the at least one physical object is delivered through a guide channel that the apparatus is passed into.

There may be a heat shrinkable sheath adjacent to the proximal port that contracts when the ambient temperature increases.

It is preferable that the shaft comprises a plurality of sections with different mechanical properties and geometrical features to enhance track-ability to a desired site. The number of sections in the shaft may be at least three. The three sections may preferably consist of: a proximal section, a mid-shaft section, and a distal balloon section.

It is most preferable that the various sections are made from biocompatible materials. The various sections may be made from materials selected from the group consisting of: stainless steel, cobalt and chromium alloy, an alloy made from nickel and titanium, and braided composite polymer.

The distal end of the proximal section may be tapered to facilitate adjoinment with the mid-shaft section. Alternatively, the distal end of the proximal section may be profiled to facilitate laser welding with a mandrel of the mid-shaft section.

It is advantageous that a tapered core wire encapsulated by a polymeric outer tubing liner is attached to the proximal section at its distal end further, and that the core wire passes into the mid-shaft section. It is also preferred that the mid-shaft section includes a support structure encapsulated by a polymeric outer tubing liner. The support structure may be selected from the group comprising: tapered core wire, braiding and a combination of tapered core wire and braiding. The polymeric outer lining may also be selected from the group comprising: nylon, pebax, and polyimide.

It is preferable that the mid-shaft section includes a pre-balloon section. The distal balloon section at a distal end of the shaft may include: a flexible tip structure to enhance track-ability to the target area; a coiled up polymeric micro-tube; and an object deployment mechanism including a nylon balloon positioned along a substantial portion of the distal balloon section.

It is advantageous that the supporting structure comprises core wire made from a material selected from the group comprising: an alloy based on cobalt chromium and stainless steel. The supporting structure may be covered with pebax.

The apparatus may preferably include a protection device to trap embolic particles. The protection device may be actuated by means selected from

the group comprising: mechanical, hydromechanical, and electromechanical.

The guide channel used with the apparatus may be a catheter or a micro-catheter. The desired site of deploying the physical object may be in an organic body that has imperfections such as: a lesion, an aneurysm, or an occlusion. The physical object to be deployed may preferably be selected from the group comprising: stents, glue, pharmaceutical agents, radioactive tracers, and microbiosensors. The deployable stent may be selected from the types comprising: balloon expandable, self-expandable, stainless steel, nickel-titanium alloyed, cobalt-chromium alloyed, platinum-iridium alloyed, platinum-tungsten alloyed, and polymeric.

There is also provided a method for delivering a physical object to a desired site, including: introducing a guide catheter into an opening to reach the desired site; inserting a guide wire into the guide catheter; inserting a micro-catheter into the guide catheter by sheathing the guide wire; and removing the guide wire when a distal end of the micro-catheter is at a desired site, characterized in that the physical object is positioned on an apparatus and delivered through the micro-catheter for introduction to the desired site.

It is advantageous that the physical object positioned on an apparatus is introduced through the micro-catheter to the desired site. Depending on the object to the deployed, the inflation of a balloon on the apparatus may be required.

A method for manufacturing an apparatus for delivering at least one physical object to a desired site is also provided. The method includes: forming a plurality of different shafts; and co-axially joining the different shafts together. The plurality of shafts are joined securely together and further yet remain flexible to optimize track-ability. The different shafts are preferably selected from the group comprising: a proximal section, a mid-shaft section, and a distal balloon section.

It is preferable that the proximal and mid-shaft sections are fabricated by: forming the section on a mandrel using an inner lining of Pebax; inserting braiding along the inner lining; and shrinking the outer layer over the braid. A degree of flexure in the shaft may preferably be maintained.

It is preferable that the proximal section is tapered at a first end and joined to the mid-shaft section at the tapered end. Alternatively, the proximal section is profiled at a first end and laser welded to the mandrel of the mid-shaft section at the profiled end.

It is advantageous that a pre-balloon section on the mid-shaft section is post-heat treated to provide desirable profile and greater flexibility of the pre-balloon section. This section can also be braided if required.

Brief Description of the Drawings

In order that the invention may be better understood and readily put into practical effect, there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being in reference to the accompanying drawings in which:

Figure 1 shows the outline of the apparatus according to a preferred embodiment of the present invention;

Figure 2 shows the section joining a proximal section and a mid-shaft section of the apparatus according to an embodiment of the present invention;

Figure 3 shows the section joining a proximal section and a mid-shaft section of the apparatus according to an alternative embodiment of the present invention;

Figure 4 shows a distal balloon section according to a preferred embodiment of the present invention;

Figure 5 shows a sequence of steps of the apparatus in use according to a preferred embodiment of the present invention;

Figure 6 shows a flow chart showing a sequence of steps of the apparatus in use according to a preferred embodiment of the present invention;

Figure 7 shows a flow chart showing a sequence of steps of fabrication of the apparatus according to a preferred embodiment of the present invention; and

Figure 8 shows outline of a single lumen catheter with perforated distal lumen, fixed tip wire and braided composite proximal/middle shaft.

Detailed Description of the Preferred Embodiments

Referring to Figure 1, there is illustrated an apparatus 20 for delivering a physical object to a desired site according to a preferred embodiment of the present invention. The apparatus 20 may be used together with a guide for delivering at least one physical object to a desired site. The desired site may be a position in an organic body. The position may have physical imperfections, such as, for example, lesions, aneurysms, and occlusions. The apparatus 20 may be used as an introducer of physical objects, such as, for example, stents, glue, pharmaceutical agents, radioactive tracers, and microbiosensors. The stents used may be such as, for example, balloon expandable, self-expandable, stainless steel, nickel-titanium alloyed, cobalt-chromium alloyed, platinum-iridium alloyed, platinum-tungsten alloyed, or polymeric.

The apparatus 20 may be able to fit into a guide of a minute diameter. In a preferred embodiment of the present invention, a microcatheter may be used as a guide for the apparatus 20. A catheter may also be used as a guide for the apparatus 20. The inner diameter of the microcatheter may vary within the range of 0.014" to 0.032". The apparatus 20 together with at least one deployable physical object, may be sized to fit into the microcatheter which may be used to guide the apparatus 20 to the desired site. The use of a microcatheter minimizes the size of the incision required to be made on the organic body and consequently, also the risk of an adverse reaction by the body towards the procedure. The guide may be sufficiently small to reach the most distal region in an intracranial region,

the circle of Willis. The circle of Willis is the location where the system of arteries in the brain cluster together at the base of the cranial cavity. The guide provides a channel for the passage of the apparatus 20 to the desired site.

The apparatus 20 may include a proximal port 22 for use as a handle to guide the apparatus 20 to a desired site. The proximal port 22 enables manipulation of the apparatus 20 by gripping and handling. The proximal port 22 may also be used as a cap at a proximal end 24 of a shaft 26. The shaft may be a structure to maintain a level of stiffness with some flexure for the apparatus 20. The shaft 26 and the proximal port 22 may be co-axially positioned and secured to one another in the apparatus 20. There may be a heat shrinkable sheath 28 placed over the proximal end 24 of the shaft 26. The sheath 28 may shrink and encapsulate the shaft 24 when the ambient temperature surrounding it increases. This may happen when a user of the apparatus 20 grasps the proximal end 24 of the apparatus 20 when maneuvering the apparatus 20.

The shaft 26 may comprise a plurality of separable sections made with different mechanical properties and geometrical features. Having the shaft 26 being made up of separable sections enhances the tracking ability of the apparatus 20 to a target site in an organic body. There are three sections in the shaft 26. The shaft 26 comprises a proximal section 30, a mid-shaft section 32, and a distal balloon section 34. An enlarged view of the distal balloon section 34 is depicted in Figure 4.

The various sections of the shaft 26 are made from biocompatible materials such as, for example, stainless steel, alloys made from cobalt and chromium, alloys made from nickel and titanium, and braided composite polymers. The materials are bio-compatible since the apparatus 20 comes into direct contact with organic tissue when the guide catheter is removed. Using bio-compatible materials minimizes adverse reactions from the tissue during the invasive procedure.

The proximal section 30 may be fabricated from 304 stainless steel as the material provides sufficient stiffness to push through an inner lumen of the guide catheter. Referring to Figures 1 and 2, a distal end 36 of the proximal section 30 may be tapered to facilitate adjoinment with the mid-shaft section 32. The region adjoining the proximal section 30 and the mid-shaft section 32 should not be rigid. Flexibility at the joint between the proximal section 30 and the mid-shaft section 32 may be required in order for the apparatus 20 to be able to track the guide catheter to the desired site. The proximal section 30 may also be fabricated from an alloy of cobalt and chromium as the greater strength of the material allows for thinner walls that consequently allow for an inner lumen of greater diameter. The mid-shaft section 32 may be a braided composite polymer tube with wire/ribbon braid 38. Due to the difference in stiffness between the proximal section 30 and the mid-shaft section 32, additional support on the inner lumen of the mid-shaft section 32 may be required to allow for both strength and slight flexure at the joint. Push wire may be employed at the joint to minimize deformation at the joint. A proximal end 42 of the mid-shaft section 32 may have a mandrel 40 for additional support at the joint.

Referring to Figure 3, in an alternative embodiment of the present invention, the distal end 36 of the proximal section is profiled to facilitate laser welding with the mandrel 40 the mid-shaft section 32. The resulting joint may also have sufficient strength and flexure required by apparatus 20.

The proximal section 30 may also include a tapered core wire (not shown) encapsulated by a polymeric outer tubing liner (not shown), such as, for example, nylon, pebax, or polyimide. The core wire may pass into the mid-shaft section 32.

The mid-shaft section 32 may also include a support structure comprising tapered core wire, braiding and/or a combination of tapered core wire and braiding encapsulated by a polymeric outer tubing liner. The polymeric

outer lining employed in the mid-shaft section 32 may comprise materials such as, for example, nylon, pebax, or polyimide.

Referring back to Figure 1, the mid-shaft section 32 includes a pre-balloon section 44. The pre-balloon section 32 may include either wire made from an alloy of nickel titanium or ribbon coil. In order to use the wire/coil in the pre-balloon section 32, the wire/coil may require post heat treatment.

Referring to Figures 1 and 4, the distal balloon section 34 may be located at a distal end 46 of the shaft 20. The distal balloon section 34 may include a flexible structure 48 at the distal end 46 to enhance track-ability of the apparatus 20 to the target area. The flexible structure 48 may consist of a core wire/ribbon 50 with an atraumatic wire made of either a platinum tungsten alloy or stainless steel. The flexible structure 48 may reside in a coiled up polymeric micro-tube up to the proximal balloon sleeve. The flexible structure 48 may be covered with pebax. The distal balloon section 34 may be employed as an object deployment mechanism including a nylon balloon 52 positioned along a substantial portion of the distal balloon section 34. Stents may be placed on the balloon 52 prior to insertion into the desired site in the organic body for deployment.

The apparatus 20 may also include a protection device (not shown) placed sequentially on the distal end 46 of the shaft 26 to trap embolic particles. This device is especially crucial when apparatus 20 is used in intracranial vessels where the diameters of the vessels are small and a single stray embolic particle may cause blockage in the vessel resulting in adverse consequences. The protection device may be actuated by various means, such as, for example, mechanical, hydromechanical, and electromechanical. Micro machines may be used for the protection device when apparatus 20 is used for the placement of physical objects in the intracranial area.

Figure 5 shows a sequence of steps from (a) – (e) of the apparatus 20 in use according to a preferred embodiment of the present invention. Figure

5(a) shows a sterile guide catheter 80 being into a vessel 82 of an organic body. When the guide catheter 80 is placed in position with a first end of the guide catheter 80 being positioned adjacent to the desired site of an occlusion 84, a guide wire 86 is inserted into the catheter 80 to enhance the stiffness of the catheter 80. Subsequently, a micro-catheter 88 is inserted into the guide catheter 80 by sheathing the guide wire 86. A first end of the micro-catheter 88 is positioned as close to the occlusion 84 as possible.

Referring to Figure 5(b), the guide wire 86 is removed. The apparatus 20 loaded with a stent 90 is deployed to the occlusion 84, with the distal balloon section 34 exactly at the site of the occlusion 84. The balloon 52 of apparatus 20 is inflated to deploy the stent 90 at the site of occlusion 84. With the deployment of stent 90 compressing the deposits causing the occlusion, the vessel 82 may enhance the flow of fluid in the vessel 82.

Referring to Figure 5(c), another stent 92 is loaded onto apparatus 20 to be deployed at an aneurysm 94. Figure 5(d) shows the inflation of the balloon 52 to deploy the stent 92 such that fluid is prevented from accumulating in the aneurysm 94 and also consequently prevents the build-up of pressure in the aneurysm 94, which is the main cause of rupture.

Figure 5(e) shows the stent 92 in position and the withdrawal of the apparatus 20 with a deflated balloon 52 from the vessel 82.

Referring to Figure 6, there is also illustrated a preferred embodiment of a method for delivering a physical object to a desired site. Firstly, a sterile guide catheter 80 is introduced at an opening on the surface of an organic body (100). When the guide catheter 80 is placed in position with a first end of the guide catheter 80 being positioned adjacent to the desired site, a guide wire 86 is inserted into the catheter (102) to enhance the stiffness of the catheter 80. Subsequently, a micro-catheter 88 is inserted into the guide catheter 80 by sheathing the guide wire 86 (104). A first end of the micro-catheter 88 is positioned as close to the desired site as possible. The guide wire 86 is then removed when a first end of the micro-catheter 88 is

in a desired position (106). The apparatus 20 loaded with the physical object to be deployed is introduced through the micro-catheter 88 to the desired site (108). In the case when the physical object is a stent, the balloon 52 of apparatus 20 is inflated to deploy the stent at the desired site (110). In the case when self-expandable stents, radioactive tracers/microbiosensors/pharmaceutical agents are to be deployed, the balloon 52 may not be required to be inflated. However, the balloon 52 may still be inflated to activate a dispenser of radioactive tracers/microbiosensors/pharmaceutical agents.

The guide catheters 80 and micro-catheters 88 used in the procedure may be single or multi lumen, depending on the actual procedure being performed. Besides stents, other objects such as, for example, glue, pharmaceutical agents, radioactive tracers, or microbiosensors may also be deployed in an organic body using the method as described. The use of the method as described may be used for imperfections/conditions in an organic body, such as, for example, a lesion, an aneurysm, and an occlusion in an intracranial vessel.

Referring to Figure 7, a preferred embodiment of a method for manufacturing an apparatus 20 for delivering at least one physical object is illustrated. Firstly, a plurality of different shafts are formed (120). Then, the different shafts are joined together coaxially (122), with the plurality of shafts are securely joined together but with the apparatus 20 still remaining flexible to optimize track-ability. The different shafts mentioned earlier in this paragraph may be either one of: a proximal section, a mid-shaft section, and a distal balloon section. However, it is not desirable to have more than one section of each type in the apparatus 20 as the sections are be able to fit with one another.

The proximal 30 and mid-shaft 32 sections may be fabricated by first forming the section on a mandrel using an inner lining of Pebax, followed by inserting braiding along the inner lining. The outer layer is then shrunk over the braid such that the sections maintain a degree of flexure. The pre-

balloon section 44 on the mid-shaft section 32 may also be post-heat treated for greater flexibility of the pre-balloon section 44.

Single lumen catheter with perforated distal lumen, fixed tip wire and braided composite proximal/middle shaft

Referring to Figure 8, in another embodiment, a single lumen catheter with perforated distal lumen, fixed tip wire and braided composite proximal/middle shaft 810 is provided.

Firstly, a single braided polymeric lumen with different types of braiding from proximal to distal, preballoon section, which changes braiding wires stiffness and pitch depending on functional necessity, providing either pushability, torqueability or just structural support. The lumen continues from the proximal port to the distal end of balloon 811 as one body. This provides different mechanical properties along its length.

Secondly, perforated inner lumen of balloon section 812. This inner lumen is a continuation of the same tubing, but is heat shrunk on the tapered mandrel to the desirable diameter. This part is extruded with the braided pebax shaft from one tubing. Heat shrinking over a tapered mandrel or bump extrusion can be used. This perforated lumen section provides a balloon support and channel/exiting section for inflation deflation activity.

Thirdly, the distal tip is specially shaped, tapered core wire. Its proximal end is attached (glued or welded if braiding is continued to this point) to the distal end of lumen, under the distal joint of the balloon or even further towards distal end.

Fourthly, a balloon as a deployment apparatus.

This type of inflation enables:

1. Improved delivery characteristics allowing the device to access tighter and more distal lesions.

2. Reduces shaft and balloon profile by eliminating the need for a guide wire lumen through the catheter shaft.

3. Reduces shaft and balloon profile by eliminating the need for a core wire inside the midshaft.

4. Eliminates the possibility of kinking of the proximal shaft by eliminating the proximal element, metal hypotube, from the design.

5. Reduces the number of joints and structural elements by using a single lumen.

6. Improves deflation time by having a larger lumen cross section.

Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications may be made to details of design or construction without departing from the present invention.

The present invention extends to all features disclosed either individually, or in all possible permutations and combinations.

THE CLAIMS

1. An apparatus (20) for delivering at least one physical object to a desired site including:

a proximal port (22) for manipulating the apparatus (20), and

a shaft (26) for maintaining rigidity of the apparatus (20),

characterized in that the shaft (26) and the proximal port (22) are co-axially positioned and secured to one another, and further characterized in that the at least one physical object is delivered through a guide channel that the apparatus (20) is passed into.

2. An apparatus (20) as claimed in claim 1, further including a heat shrinkable sheath (28) adjacent to the proximal port (22), characterized in that the sheath (28) contracts when the ambient temperature increases.

3. An apparatus (20) as claimed in either claim 1 or 2, characterized in that the shaft (26) comprises a plurality of sections with different mechanical properties and geometrical features to enhance track-ability to a desired site.

4. An apparatus (20) as claimed in claim 3, characterized in that the number of sections in the shaft (26) is at least three.

5. An apparatus (20) as claimed in any one of claims 1 to 4, characterized in that the shaft (26) comprises sections selected from the group consisting of: a proximal section (30), a mid-shaft section (32), and a distal balloon section (34).

6. An apparatus (20) as claimed in claim 5, characterized in that the various sections are made from bio-compatible materials.

7. An apparatus (20) as claimed in claim 6, characterized in that the various sections are made from materials selected from the group

consisting of: stainless steel, cobalt and chromium alloy, an alloy made from nickel and titanium, and braided composite polymer.

8. An apparatus (20) as claimed in claim 5, characterized in that a distal end (36) of the proximal section (30) is tapered to facilitate adjoinment with the mid-shaft section (32).

9. An apparatus (20) as claimed in claim 5, characterized in that a distal end (36) of the proximal section (30) is profiled to facilitate laser welding with a mandrel (40) of the mid-shaft section (32).

10. An apparatus (20) as claimed in any one of claims 5 to 9, characterized in that the proximal section (30) further includes a tapered core wire encapsulated by a polymeric outer tubing liner, and characterized in that the core wire passes into the mid-shaft section (32).

11. An apparatus (20) as claimed in claim 5, characterized in that the mid-shaft section (32) includes a support structure encapsulated by a polymeric outer tubing liner.

12. An apparatus (20) as claimed in claim 11, characterized in that the support structure is selected from the group comprising: tapered core wire, braiding and a combination of tapered core wire and braiding.

13. An apparatus (20) as claimed in any one of claims 10 to 12, characterized in that the polymeric outer lining is selected from the group comprising: nylon, pebax, and polyimide.

14. An apparatus (20) as claimed in any one of claims 11 to 13, characterized in that the mid-shaft section (32) includes a pre-balloon section (44).

15. An apparatus (20) as claimed in claim 5, characterized in that the distal balloon section (34) at a distal end (46) of the shaft (26) includes:

a flexible structure (48) to enhance track-ability to the target area;

a coiled up polymeric micro-tube; and

an object deployment mechanism including a nylon balloon (52) positioned along a substantial portion of the distal balloon section (34).

16. An apparatus (20) as claimed in claim 15, characterized in that the supporting structure comprises core wire made from a material selected from the group comprising: an alloy based on cobalt chromium, and stainless steel.

17. An apparatus (20) as claimed in either claim 15 or 16, characterized in that the supporting structure is covered with pebax.

18. An apparatus (20) as claimed in any one of claims 1 to 17, further including a protection device to trap embolic particles.

19. An apparatus (20) as claimed in claim 18, characterized in that the protection device is actuated by means selected from the group comprising: mechanical, hydromechanical, and electromechanical.

20. An apparatus (20) as claimed in any one of claims 1 to 19, characterized in that the guide is a catheter (80).

21. An apparatus (20) as claimed in any one of claims 1 to 19, characterized in that the guide is a micro-catheter (88).

22. An apparatus (20) as claimed in any one of claims 1 to 21, characterized in that the desired site is in an organic body.

23. An apparatus (20) as claimed claim 22, characterized in that the desired site in the organic body has imperfections chosen from the group comprising: a lesion, an aneurysm, and an occlusion.

24. An apparatus (20) as claimed in any one of the preceding claims, characterized in that the physical object to be deployed is selected from the group comprising: stents, glue, pharmaceutical agents, radioactive tracers, and microbiosensors.

25. An apparatus (20) as claimed in claim 24, characterized in that the stents are selected from the types comprising: balloon expandable, self-expandable, stainless steel, nickel-titanium alloyed, cobalt-chromium alloyed, platinum-iridium alloyed, platinum-tungsten alloyed, and polymeric.

26. A method for delivering a physical object to a desired site, including:

introducing a guide catheter (80) into an opening to reach the desired site;

inserting a guide wire (86) into the guide catheter (80);

inserting a micro-catheter (88) into the guide catheter (80) by sheathing the guide wire (86); and

removing the guide wire (86) when a distal end of the micro-catheter (88) is at a desired site;

characterized in that the physical object is positioned on an apparatus (20) and delivered through the micro-catheter (88) for introduction to the desired site.

27. A method as claimed in claim 26, further including deploying the physical object by inflating a balloon (52) on the apparatus (20).

28. A method as claimed in either claim 26 or 27, characterized in that the apparatus (20) is the apparatus as claimed in any one of claims 1 to 25.

29. A method as claimed in any one of claims 26 to 28, characterized in that the guide catheter (80) is single lumen.

30. A method as claimed in any one of claims 26 to 28, characterized in that the guide catheter (80) is multi lumen.

31. A method as claimed in any one of claims 26 to 30, characterized in that the micro-catheter (88) is single lumen.

32. A method as claimed in any one of claims 26 to 30, characterized in that the micro-catheter (88) is multi-lumen.

33. A method as claimed in any one of claims 26 to 32, characterized in that the physical object is selected from the group comprising: stents, glue, pharmaceutical agents, radioactive tracers, and microbiosensors.

34. A method as claimed in claim 33, characterized in that the stents are selected from the types comprising: balloon expandable, self-expandable, stainless steel, nickel-titanium alloyed, cobalt-chromium alloyed, platinum-iridium alloyed, platinum-tungsten alloyed, and polymeric.

35. A method as claimed in any one of claims 26 to 34, characterized in that the desired site is in an organic body.

36. A method as claimed in claim 35, characterized in that the desired site has imperfections chosen from the group comprising: a lesion, an aneurysm, and an occlusion.

37. A method for manufacturing an apparatus (20) for delivering at least one physical object to a desired site including:

forming a plurality of different shafts; and

coaxially joining the different shafts together,

characterized in that the plurality of shafts are joined securely together and further characterized in that the apparatus remains flexible to optimize track-ability.

38. A method as claimed in claim 37, characterized in that the different shafts are selected from the group comprising: a proximal section (30), a mid-shaft section (32), and a distal balloon section (34).

39. A method as claimed in claim 38, characterized in that the proximal (30) and mid-shaft sections (32) are fabricated by:

forming the sections (30, 32) on a mandrel (40) using an inner lining of Pebax;

inserting braiding (38) along the inner lining; and

shrinking an outer layer over the braiding (38),

characterized in that the sections (30, 32) maintain a degree of flexure.

40. A method as claimed in any one of claims 36 to 39, characterized in that the proximal section (30) is tapered at a first end (36) and joined to the mid-shaft section (32) at the tapered end.

41. A method as claimed in any one of claims 36 to 39, characterized in that the proximal section (30) is profiled at a first end (36) and laser welded to the mandrel (40) of the mid-shaft section (32) at the profiled first end.

42. A method as claimed in claim 38, characterized in that a pre-balloon section (44) on the mid-shaft section (32) is post-heat treated to provide greater flexibility of the pre-balloon section (44).

43. A single lumen catheter including:

a perforated distal lumen,

a fixed tip wire at the distal end of the catheter; and

a braided composite shaft (810) at the proximal end of the catheter;

characterized in that the fixed tip wire is a specially shaped, tapered core wire.

44. A single lumen catheter as claimed in claim 43, further including a balloon (811).