CLAIMS

1. A catheter apparatus comprising:

an elongated shaft having a proximal portion and a distal portion;

a carrier that is preferably in a meshed tubular stent structure and carries at least one therapeutic assembly, wherein the carrier is located at, or proximate to, the distal portion of the elongated shaft, and wherein the therapeutic assembly comprises at least one therapeutic member for intravascular treatment;

wherein the carrier is configured to vary between a delivery configuration and a deployed configuration;

wherein the distal portion of the shaft is configured for intravascular delivery of the carrier;

wherein the carrier comprises m right-handed helical wires and n left-handed helical wires which are simply intersected or bi-axially woven into each other, $m \geq 2$, and $n \geq 2$;

wherein the carrier comprises at least one interstice that is defined by four helical wire segments from two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other; and

wherein the at least one therapeutic assembly wraps around at least one of the four helical wire segments to stabilize the at least one interstice, to maintain structural integrity of the carrier, and to prevent tangling of the helical wires, when the carrier is being distorted intravascularly.

2. The catheter apparatus according to claim 1, wherein the at least one therapeutic member is an electrode or a heating element configured to deliver energy such as electrical energy, radiofrequency (RF) electrical energy, pulsed electrical energy, and thermal energy to a target blood vessel.

3. The catheter apparatus according to claim 1, wherein the carrier comprises m right-handed helical wires and n left-handed helical wires which are simply intersected or bi-axially woven into a tubular structure, $2 \leq m \leq 30$, $2 \leq n \leq 30$, and $m = n$.

4. The catheter apparatus according to claim 3, wherein the carrier carries six therapeutic assemblies, each of which comprises an electrode as the therapeutic member, providing six

~~electrodes in total.~~

~~5. The catheter apparatus according to claim 4, wherein the six electrodes are configured to create interrupted spiral-shaped but fully circumferential lesions on an internal wall of a target blood vessel.~~

~~6. The catheter apparatus according to claim 1, wherein at least one of the m right-handed helical wires and at least one of the n left-handed helical wires are made from one single wire having a first portion of right-handed helical wire and a second portion of left-handed helical wire by folding or bending the single wire at a point between the first portion and the second portion by an angle from about 160° to 180°.~~

~~7. The catheter apparatus according to claim 1, wherein the therapeutic assembly wraps around only one of the four helical wire segments to stabilize the interstice.~~

~~8. The catheter apparatus according to claim 7, wherein the therapeutic assembly comprises two terminal bodies and a main body positioned between the two terminal bodies; and~~

~~wherein a cross-sectional area of the main body along a plane perpendicular to an elongation direction of the helical wire segment being wrapped around is larger than cross-sectional areas of the terminal bodies along the plane perpendicular to the elongation direction of the helical wire segment being wrapped around, and the cross-sectional areas of the terminal bodies along the plane perpendicular to the elongation direction of the helical wire segment being wrapped around are larger than a cross-sectional area of the helical wire segment being wrapped around along the plane perpendicular to the elongation direction of the helical wire segment.~~

~~9. The catheter apparatus according to claim 8, wherein a length of the helical wire segment being wrapped around is maintained to be equal to, or longer than, the main body's length along the elongation direction of the helical wire segment being wrapped around.~~

~~10. The catheter apparatus according to claim 8, wherein a length of the helical wire segment being wrapped around is maintained to be equal to, or longer than, the main body's length plus a length of one of the two terminal bodies along the elongation direction of the helical wire segment being wrapped around, or the length of the helical wire segment being wrapped around is maintained to be equal to, or longer than, the main body's length plus a total length of the two terminal bodies along the elongation direction of the helical wire segment~~

being wrapped around.

11. The catheter apparatus according to claim 6, further comprising a multi-lumen bundler for converging the folded or bent helical wires at the folded or bent portion, and the helical wires are permanently glued and fixed to the multi-lumen bundler with a liquid adhesive material.

12. The catheter apparatus according to claim 8, wherein at least one of the two terminal bodies and the main body includes at least one of:

(1) one or more grooves for accommodating or guiding one or more helical wires to slide over the helical wire segment around which the therapeutic assembly wraps; and

(2) one, two or more protrusions, wherein a gap between the protrusion and the helical wire segment around which the therapeutic assembly wraps, and a gap between protrusions themselves, are configured for accommodating or guiding one or more helical wires that slide(s) over the helical wire segment around which the therapeutic assembly wraps.

13. A method of stabilizing structural integrity of a carrier of a catheter apparatus comprising an elongated shaft having a proximal portion and a distal portion, and preventing tangling of helical wires of the carrier, wherein the carrier is located at, or proximate to, the distal portion of the elongated shaft, and wherein the therapeutic assembly comprises at least one therapeutic member for intravascular treatment; wherein the carrier is configured to vary between a delivery configuration and a deployed configuration; wherein the distal portion of the shaft is configured for intravascular delivery of the carrier; the method comprises:

simply intersecting or bi-axially weaving $m \geq 2$ right-handed helical wires and $n \geq 2$ left-handed helical wires into each other to prepare a carrier comprising at least one interstice that is defined by four helical wire segments from two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other; and

wrapping at least one therapeutic assembly around at least one of the four helical wire segments to stabilize the at least one interstice, to maintain structural integrity of the carrier, and to prevent tangling of the helical wires, when the carrier is being distorted intravascularly.

14. A method of manufacturing the catheter apparatus according to claim 1, comprising:

(i) providing m right-handed helical wires and n left-handed helical wires, $m \geq 2$, and $n \geq 2$;

(ii) simply intersecting or bi-axially weaving the helical wires into a tubular structure as

the carrier;

(iii) forming at least one interstice that is defined by four helical wire segments of two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other; and

(iv) wrapping at least one therapeutic assembly around at least one of the four helical wire segments to stabilize the interstice.

15. The method according to Claim 14, wherein step (i) comprises:

(ia) providing one single wire having a first portion of right-handed helical wire and a second portion of left-handed helical wire; and

(ib) folding or bending the single wire at a point between the first portion and the second portion to provide a right-handed helical wire and a left-handed helical wire.

16. The method according to Claim 15, further comprising cutting the bent single wire near the bending point to make a separate right-handed helical wire and a separate left-handed helical wire.

17. The method according to Claim 14, wherein step (i) comprises:

(iA) providing a number of wires, each of the wires having a first portion of right-handed helical wire and a second portion of left-handed helical wire;

(iB) folding or bending each of the wires at a point between the first portion and the second portion to provide a right-handed helical wire and a left-handed helical wire; and

(iC) bundling the wires together at ends of the bending points of the wires with a multi-lumen bundler, wherein the multi-lumen bundler has a cylinder body, and a number of lumens pass axially through the cylinder body along a longitudinal axis of the cylinder body; and wherein the first portion of right-handed helical wire and the second portion of left-handed helical wire from a same wire are inserted into and pass through two different lumens.

18. The method according to Claim 17, wherein the number of lumens is no less than the number of wires.

19. The method according to Claim 14, wherein step (ii) comprises: simply intersecting or bi-axially weaving the helical wires, around a bobbin having an array of holes, into a tubular structure as the carrier, wherein pins are inserted into at least some of the holes during weaving, and the pins are removed from the holes after the weaving is completed.

20. The method according to Claim 19, further comprising placing a multi-lumen

~~bundler with wires bundled at one end and loose at the other end on a top tip of the bobbin, before the weaving of the wires starts.~~

1. A catheter apparatus comprising:

an elongated shaft having a proximal portion and a distal portion;

a carrier that is preferably in a meshed tubular stent structure and carries at least one therapeutic assembly, wherein the carrier is located at, or proximate to, the distal portion of the elongated shaft, and wherein the therapeutic assembly comprises at least one therapeutic member for intravascular treatment;

wherein the carrier is configured to vary between a delivery configuration and a deployed configuration;

wherein the distal portion of the shaft is configured for intravascular delivery of the carrier;

wherein the carrier comprises m right-handed helical wires and n left-handed helical wires which are simply intersected or bi-axially woven into each other, $m \geq 2$, and $n \geq 2$;

wherein the carrier comprises at least one interstice that is defined by four helical wire segments from two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other;

wherein the at least one therapeutic assembly wraps around at least one of the four helical wire segments to stabilize the at least one interstice, to maintain structural integrity of the carrier, and to prevent tangling of the helical wires, when the carrier is being distorted intravascularly;

wherein at least one of the m right-handed helical wires and at least one of the n left-handed helical wires are made from one single wire having a first portion of right-handed helical wire and a second portion of left-handed helical wire by folding or bending the single wire at a point between the first portion and the second portion by an angle from about 160°to 180°; and

wherein the catheter apparatus further comprises a multi-lumen bundler for converging the folded or bent helical wires at the folded or bent portion.

2. The catheter apparatus according to claim 1, wherein the at least one therapeutic member is an electrode or a heating element configured to deliver energy such as electrical

energy, radiofrequency (RF) electrical energy, pulsed electrical energy, and thermal energy to a target blood vessel.

3. The catheter apparatus according to claim 1, wherein the carrier comprises m right-handed helical wires and n left-handed helical wires which are simply intersected or bi-axially woven into a tubular structure, $2 \leq m \leq 30$, $2 \leq n \leq 30$, and $m=n$.

4. The catheter apparatus according to claim 3, wherein the carrier carries six therapeutic assemblies, each of which comprises an electrode as the therapeutic member, providing six electrodes in total.

5. The catheter apparatus according to claim 4, wherein the six electrodes are configured to create interrupted spiral-shaped but fully circumferential lesions on an internal wall of a target blood vessel.

6. The catheter apparatus according to claim 1, wherein the therapeutic assembly wraps around only one of the four helical wire segments to stabilize the interstice.

7. The catheter apparatus according to claim 6, wherein the therapeutic assembly comprises a main body, and preferably the therapeutic assembly further comprises two terminal bodies and the main body is positioned between the two terminal bodies; and

wherein a cross-sectional area of the main body along a plane perpendicular to an elongation direction of the helical wire segment being wrapped around is larger than cross-sectional areas of the terminal bodies along the plane perpendicular to the elongation direction of the helical wire segment being wrapped around, and the cross-sectional areas of the terminal bodies along the plane perpendicular to the elongation direction of the helical wire segment being wrapped around are larger than a cross-sectional area of the helical wire segment being wrapped around along the plane perpendicular to the elongation direction of the helical wire segment.

8. The catheter apparatus according to claim 7, wherein a length of the helical wire segment being wrapped around is maintained to be equal to, or longer than, the main body's length along the elongation direction of the helical wire segment being wrapped around.

9. The catheter apparatus according to claim 7, wherein a length of the helical wire segment being wrapped around is maintained to be equal to, or longer than, the main body's length plus a length of one of the two terminal bodies along the elongation direction of the helical wire segment being wrapped around, or the length of the helical wire segment being

wrapped around is maintained to be equal to, or longer than, the main body's length plus a total length of the two terminal bodies along the elongation direction of the helical wire segment being wrapped around.

10. The catheter apparatus according to claim 1, wherein the helical wires are permanently glued and fixed to the multi-lumen bundler with a liquid adhesive material.

11. The catheter apparatus according to claim 7, wherein at least one of the two terminal bodies and the main body includes at least one of:

(1) one or more grooves for accommodating or guiding one or more helical wires to slide over the helical wire segment around which the therapeutic assembly wraps; and

(2) one, two or more protrusions, wherein a gap between the protrusion and the helical wire segment around which the therapeutic assembly wraps if the protrusion is one, and a gap between one of the protrusions and the helical wire segment and /or a gap between protrusions themselves if the protrusions are two or more, are configured for accommodating or guiding one or more helical wires that slide(s) over the helical wire segment around which the therapeutic assembly wraps.

12. The catheter apparatus according to claim 11, wherein

the one or more grooves is/are arranged as follows: (1) if the therapeutic assembly does not comprise the two terminal bodies, the one or more grooves is/are arranged at a corner between the main body and the helical wire segment around which the therapeutic assembly wraps; and (2) if the therapeutic assembly comprises the two terminal bodies, the one or more grooves is/are arranged at a corner between one of the terminal bodies and the helical wire segment around which the therapeutic assembly wraps, and/or at a corner between the main body and one of the terminal bodies;

the one, two or more protrusions is/are arranged as follows: (1) if the therapeutic assembly does not comprise the two terminal bodies, the one, two or more protrusions is/are arranged on an outer surface, intersecting with the helical wire segment around which the therapeutic assembly wraps, of the main body; and (2) if the therapeutic assembly comprises the two terminal bodies, the one, two or more protrusions is/are arranged on an outer surface, intersecting with the helical wire segment around which the therapeutic assembly wraps, of at least one of the terminal bodies.

13. The catheter apparatus according to claim 1, wherein

the delivery configuration is a compressed configuration, and the carrier is configured to be delivered to a blood vessel in the compressed configuration; and

upon delivery to a target site within the blood vessel, the carrier is configured to be deployed into the deployed configuration.

14. The catheter apparatus according to claim 1, wherein

a distal end of the carrier is coupled to an end piece, and a proximal end of the carrier is coupled to the elongated shaft by using a multi-lumen coupling part;

the elongated shaft, the multi-lumen coupling part, the carrier, and the end piece include passages sized and shaped to accommodate a control wire or pull/push wire, and the control wire or pull/push wire is fixed to the distal end of the carrier or the end piece and passes through the elongated shaft to the proximal portion of the elongated shaft; and

the control wire or pull/push wire facilitates an expansion of the carrier when it is pulled to shorten the carrier, and the control wire or pull/push wire facilitates a contraction of the carrier when it is pushed to lengthen the carrier.

15. The catheter apparatus according to claim 1, wherein the therapeutic member includes an insulated portion and an uninsulated portion, and only the uninsulated portion contacts a blood vessel wall.

16. The catheter apparatus according to claim 1, further comprising a RF wire, wherein

the RF wire is coupled to the therapeutic member; and

the RF wire is separate from the carrier, or is loosely or tightly coupled to, adhered to, wrapped around, or integrated into the carrier.

17. The catheter apparatus according to claim 1, wherein the carrier carries a plurality of therapeutic assemblies, and projections of the plurality of therapeutic assemblies on a longitudinal axis of the carrier do not overlap with each other.

18. The catheter apparatus according to claim 1, wherein the two immediately adjacent right-handed helical wires comprises a first right-handed helical wire and a second right-handed helical wire, the two immediately adjacent left-handed helical wires comprises a first left-handed helical wire and a second left-handed helical wire, the first left-handed helical wire is beneath the first right-handed helical wire while the second left-handed helical wire is above the first right-handed helical wire, and the first left-handed helical wire is above the second right-handed helical wire while the second left-handed helical wire is beneath the

second right-handed helical.

19. A method of stabilizing structural integrity of a carrier of a catheter apparatus comprising an elongated shaft having a proximal portion and a distal portion, and preventing tangling of helical wires of the carrier, wherein the carrier is located at, or proximate to, the distal portion of the elongated shaft, and wherein the therapeutic assembly comprises at least one therapeutic member for intravascular treatment; wherein the carrier is configured to vary between a delivery configuration and a deployed configuration; wherein the distal portion of the shaft is configured for intravascular delivery of the carrier; the method comprises:

simply intersecting or bi-axially weaving $m \geq 2$ right-handed helical wires and $n \geq 2$ left-handed helical wires into each other to prepare a carrier comprising at least one interstice that is defined by four helical wire segments from two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other, wherein at least one of the m right-handed helical wires and at least one of the n left-handed helical wires are made from one single wire having a first portion of right-handed helical wire and a second portion of left-handed helical wire by folding or bending the single wire at a point between the first portion and the second portion by an angle from about 160°to 180°, and wherein the catheter apparatus further comprises a multi-lumen bundler for converging the folded or bent helical wires at the folded or bent portion; and

wrapping at least one therapeutic assembly around at least one of the four helical wire segments to stabilize the at least one interstice, to maintain structural integrity of the carrier, and to prevent tangling of the helical wires, when the carrier is being distorted intravascularly.

20. The method according to claim 19, wherein the two immediately adjacent right-handed helical wires comprises a first right-handed helical wire and a second right-handed helical wire, the two immediately adjacent left-handed helical wires comprises a first left-handed helical wire and a second left-handed helical wire, the first left-handed helical wire is beneath the first right-handed helical wire while the second left-handed helical wire is above the first right-handed helical wire, and the first left-handed helical wire is above the second right-handed helical wire while the second left-handed helical wire is beneath the second right-handed helical.

21. A method of manufacturing the catheter apparatus according to claim 1, comprising:

(i) providing m right-handed helical wires and n left-handed helical wires, m≥2, and n≥2;

(ii) simply intersecting or bi-axially weaving the helical wires into a tubular structure as the carrier;

(iii) forming at least one interstice that is defined by four helical wire segments of two immediately adjacent right-handed helical wires and two immediately adjacent left-handed helical wires which are simply intersected or bi-axially woven into each other; and

(iv) wrapping at least one therapeutic assembly around at least one of the four helical wire segments to stabilize the interstice;

wherein step (i) comprises:

(iA) providing a number of wires, each of the wires having a first portion of right-handed helical wire and a second portion of left-handed helical wire;

(iB) folding or bending each of the wires at a point between the first portion and the second portion to provide a right-handed helical wire and a left-handed helical wire; and

(iC) bundling the wires together at ends of the bending points of the wires with a multi-lumen bundler, wherein the multi-lumen bundler has a cylinder body, and a number of lumens pass axially through the cylinder body along a longitudinal axis of the cylinder body; and wherein the first portion of right-handed helical wire and the second portion of left-handed helical wire from a same wire are inserted into and pass through two different lumens.

22. The method according to Claim 21, wherein the number of lumens is no less than the number of wires.

23. The method according to Claim 21, wherein step (ii) comprises: simply intersecting or bi-axially weaving the helical wires, around a bobbin having an array of holes, into a tubular structure as the carrier, wherein pins are inserted into at least some of the holes during weaving, and the pins are removed from the holes after the weaving is completed.

24. The method according to Claim 23, further comprising placing the multi-lumen bundler with wires bundled at one end and loose at the other end on a top tip of the bobbin, before the weaving of the wires starts.

25. The method according to claim 21, wherein the two immediately adjacent right-handed helical wires comprises a first right-handed helical wire and a second right-handed helical wire, the two immediately adjacent left-handed helical wires comprises a first left-handed helical wire and a second left-handed helical wire, the first left-handed helical

wire is beneath the first right-handed helical wire while the second left-handed helical wire is above the first right-handed helical wire, and the first left-handed helical wire is above the second right-handed helical wire while the second left-handed helical wire is beneath the second right-handed helical.