

Claims

1. A docking station comprising:
 - an expandable frame configured to conform to an interior shape of blood vessel when expanded inside the blood vessel;
 - at least one sealing portion configured to contact an interior surface of the blood vessel; and
 - a valve seat, wherein the valve seat is configured to support an expandable transcatheter valve.
2. The docking station of claim 1, wherein the valve seat comprises a first portion of the expandable frame, and wherein links connect the first portion of the expandable frame to a second portion of the expandable frame, the second portion comprising an annular outer wall.
3. The docking station of claim 2, wherein the links are curved.
4. The docking station of claim 3 wherein the links are curved in a semi-circular shape
5. The docking station of any one of claims 2-4, wherein the outer wall of the expandable frame comprises a plurality of struts, and wherein a thickness of the links is less than a thickness of the struts.
6. The docking station of claim 5, wherein the links and the struts are integrally formed and wherein a transition portion transitions from the thickness of the links to the thickness of the struts.
7. The docking station of any one of claims 2-6, wherein the valve seat is located in radially inside the outer wall of the frame.
8. The docking station of claim 7, wherein the valve seat is coaxial with the outer wall of the frame.
9. The docking station of any one of claims 2-8, wherein an apex of the links is bent such that portions of the links on opposite sides of the apex extend away from each other at an acute angle.
10. The docking station of claim 9, wherein the apex of the links includes an upwardly extending circular portion.

11. The docking station of any one of claims 9-10, wherein the apex of the links includes a downwardly extending circular portion.
12. The docking station of any one of claims 2-11, wherein the links extend from the first portion of the expandable frame to the second portion at an angle with respect to a radial direction.
13. The docking station of any one of claims 2-12 wherein the links are twisted as they extend from the valve seat to the annular wall.
14. The docking station of any one of claims 1-13, wherein the expandable frame is configured to conform to an interior shape of an aorta when expanded inside the aorta.
15. The docking station of any one of claims 1-14, further comprising a tubular graft coupled to the expandable frame that extends axially beyond an end of the expandable frame.
16. The docking station of any one of claims 1-15, wherein the frame has a plurality of stent segments connected to a plurality of spring elements.
17. The docking station of claim 16, wherein the spring elements consist of spring wires, compression springs, torsion springs, tension springs, and combinations thereof.
18. The docking station of any one of claims 16-17, wherein struts of the expandable frame are integrally formed with the spring elements.
19. The docking station of any one of claims 1-18, wherein the sealing portion is integrally formed with the frame.
20. The docking station of any one of claims 1-19, wherein the valve seat is integrally formed with the frame.
21. The docking station of any one of claims 1-20, wherein the docking station is integrally formed with a valve.
22. The docking station of any one of claims 1-21, wherein the expandable frame includes a leg that extends proximally beyond the remainder of the frame.
23. The docking station of claim 22, further comprising an elongated leg that extends proximally further beyond an end of the leg.

- 24.** The docking station of any one of claims 1-23, wherein the expandable frame is configured to conform to the interior shape of the blood vessel, when expanded inside the blood vessel, such that the expandable frame can expand in multiple locations to conform to multiple bulges of the blood vessel and can contract in multiple locations to conform to multiple narrowed regions of the blood vessel.
- 25.** The docking station of any one of claims 1-24, wherein the frame is configured such that, when expanded inside the blood vessel, more than 50% of the docking station contacts an interior surface of the blood vessel and distributes the pressure on the blood vessel from the docking station over the more than 50% of the docking station.
- 26.** An expandable docking station frame comprising:
an annular valve seat having an end;
an annular outer wall comprising struts disposed around the valve seat,
links that connect the end of the annular valve seat to the annular outer wall; and
wherein a thickness of the links is less than a thickness of the struts.
- 27.** The expandable docking station frame of claim 26 wherein the links and the struts are integrally formed, wherein a transition portion transitions from the thickness of the links to the thickness of the struts.
- 28.** The expandable docking station frame of any one of claims 26-27 wherein the links are curved.
- 29.** The expandable docking station frame of claim 28 wherein the links are curved in a semi-circular shape.
- 30.** The expandable docking station frame of any one of claims 26-29 wherein an apex of the links is bent such that portions of the links on opposite sides of the apex extend away from each other at an acute angle.
- 31.** The expandable docking station frame of claim 30 wherein the apex of the links includes an upwardly extending circular portion.
- 32.** The expandable docking station frame of any one of claims 30-31 wherein the apex of the links includes a downwardly extending circular portion.

- 33.** The expandable docking station frame of any one of claims 26-32 wherein the links extend from the valve seat to the annular wall at an angle with respect to a radial direction.
- 34.** The expandable docking station frame of any one of claims 26-33 wherein the links are twisted as they extend from the valve seat to the annular wall.
- 35.** The expandable docking station frame of any one of claims 26-34, wherein the outer wall is configured to conform to an interior shape of blood vessel, when expanded inside the blood vessel, such that the outer wall can expand in multiple locations to conform to multiple bulges of the blood vessel and can contract in multiple locations to conform to multiple narrowed regions of the blood vessel.
- 36.** The expandable docking station frame of any one of claims 26-35, further comprising a leg that extends axially from an end of the outer wall.
- 37.** The expandable docking station frame of claim 26-36, further comprising an elongated leg that extends axially further from the end of the outer wall than the leg.
- 38.** An expandable docking station frame comprising:
an annular valve seat having an end;
an annular outer wall comprising struts disposed around the valve seat,
links that connect the end of the annular valve seat to the annular outer wall; and
wherein the links are twisted and/or angled as the links extend between the annular outer wall and the annular valve seat.
- 39.** The expandable docking station frame of claim 38 wherein the links and the struts are integrally formed.
- 40.** The expandable docking station frame of any one of claims 38-39 wherein the links are curved.
- 41.** The expandable docking station frame of claim 40 wherein the links are curved in a semi-circular shape.
- 42.** The expandable docking station frame of any one of claims 38-41 wherein a width of the links at an apex of the links is substantially the same as a thickness of the struts at a junction between the links and the annular outer wall.

- 43.** The expandable docking station frame of any one of claims 38-42 wherein a thickness of the links at an apex of the links is substantially the same as a width of the links at a junction between the links and the annular outer wall.
- 44.** The expandable docking station frame of claim 43 wherein a thickness of the links at the apex of the links is substantially the same as a width of the links at the junction between the links and the annular outer wall.
- 45.** The expandable docking station frame of any one of claims 42-44 wherein the apex of the links is bent such that portions of the links on opposite sides of the apex extend away from each other at an acute angle.
- 46.** The expandable docking station frame of any one of claims 42-45 wherein the apex of the links includes an upwardly extending circular portion.
- 47.** The expandable docking station frame of any one of claims 42-46 wherein the apex of the links includes a downwardly extending circular portion.
- 48.** The expandable docking station frame of any one of claims 38-47 wherein the links extend from the valve seat to the annular wall at an angle with respect to a radial direction.
- 49.** The expandable docking station frame of any one of claims 38-48, wherein the outer wall is configured to conform to an interior shape of blood vessel, when expanded inside the blood vessel, such that the outer wall can expand in multiple locations to conform to multiple bulges of the blood vessel and can contract in multiple locations to conform to multiple narrowed regions of the blood vessel.
- 50.** The expandable docking station frame of any one of claims 38-49, further comprising a leg that extends axially from an end of the outer wall.
- 51.** The expandable docking station frame of claim 50, further comprising an elongated leg that extends axially further from the end of the outer wall than the leg.
- 52.** An expandable docking station frame comprising:
an annular valve seat having an end;
an annular outer wall comprising struts disposed around the valve seat,
links that connect the end of the annular valve seat to the annular outer wall; and

wherein the links extend from the valve seat to the annular wall at an angle with respect to a radial direction.

53. The expandable docking station frame of claim 52 wherein the links and the struts are integrally formed.

54. The expandable docking station frame of any one of claims 52-53 wherein the links are curved.

55. The expandable docking station frame of claim 54 wherein the links are curved in a semi-circular shape.

56. The expandable docking station frame of any one of claims 52-55 wherein a thickness of the links at an apex of the links is substantially the same as a thickness of the struts at a junction between the links and the annular outer wall.

57. The expandable docking station frame of claim 56 wherein the apex of the links is bent such that portions of the links on opposite sides of the apex extend away from each other at an acute angle.

58. The expandable docking station frame of any one of claims 56-57 wherein the apex of the links includes an upwardly extending circular portion.

59. The expandable docking station frame of any one of claims 56-58 wherein the apex of the links includes a downwardly extending circular portion.

60. The expandable docking station frame of any one of claims 52-59, wherein the outer wall is configured to conform to an interior shape of blood vessel, when expanded inside the blood vessel, such that the outer wall can expand in multiple locations to conform to multiple bulges of the blood vessel and can contract in multiple locations to conform to multiple narrowed regions of the blood vessel.

61. The expandable docking station frame of any one of claims 52-60, further comprising a leg that extends axially from an end of the outer wall.

62. The expandable docking station frame of claim 61, further comprising an elongated leg that extends axially further from the end of the outer wall than the leg.

- 63.** A docking station assembly comprising:
- a graft configured to conform to an interior shape of a first portion of a blood vessel when expanded inside the blood vessel;
 - a docking station coupled to the graft, wherein the docking station comprises:
 - an expandable frame configured to conform to an interior shape of a second portion of the blood vessel when expanded inside the blood vessel;
 - at least one sealing portion configured to contact an interior surface of the blood vessel when expanded inside the blood vessel; and
 - a valve seat, wherein the valve seat is configured to support an expandable transcatheter valve.
- 64.** The docking station assembly of claim 63, wherein the graft is configured to conform to an interior shape of a first portion of an aorta when expanded inside the aorta the expandable frame is configured to conform to an interior shape of a second portion of the aorta when expanded inside the aorta.
- 65.** The docking station assembly of any one of claims 63-64, wherein the frame has a plurality of stent segments connected to a plurality of spring elements.
- 66.** The docking station assembly of claim 65, wherein the spring elements consist of spring wires, compression springs, torsion springs, tension springs, and combinations thereof.
- 67.** The docking station assembly of any one of claims 65-66, wherein the stent segments are integrally formed with the spring elements.
- 68.** The docking station assembly of any one of claims 63-67, wherein the sealing portion is integrally formed with the frame.
- 69.** The docking station assembly of any one of claims 63-68, wherein the valve seat is integrally formed with the frame.
- 70.** The docking station assembly of any one of claims 63-69, wherein the docking station is integrally formed with a valve.
- 71.** The docking station assembly of any one of claims 63-70 wherein a portion of the docking station engages an interior of the graft.

- 72.** The docking station assembly of any one of claims 63-71 wherein the graft is shaped to configured to an interior surface of an arch of the aorta.
- 73.** The docking station assembly of any one of claims 63-72 wherein the sealing portion comprises a fabric covering attached to the frame.
- 74.** A docking station comprising:
a frame configured to transition from a first configuration to a second configuration, wherein, when in the second configuration, at least a first portion of the frame is curled, and wherein the frame is configured such that as the frame transitions from the first configuration to the second configuration, the frame curls back on itself; and
a valve seat, wherein the valve seat is configured to support an expandable transcatheter valve.
- 75.** The docking station of claim 74, wherein the docking station is configured to capture native leaflets of a native valve as the frame curls back on itself.
- 76.** The docking station of claim 75, wherein the docking station is configured such that the native leaflets can be clamped between the valve seat and another portion of the docking station.
- 77.** The docking station of any one of claims 74-76, wherein, when in the second configuration, the first portion of the frame is curled at least 360 degrees.
- 78.** The docking station of any one of claims 74-77, wherein the first configuration of the frame is a straightened configuration.
- 79.** The docking station of any one of claims 74-78, wherein the frame can be held in the straightened configuration inside a delivery catheter and prevented from transitioning to the second configuration until exiting the delivery catheter.
- 80.** The docking station of any one of claims 74-79, wherein, when in the first configuration, no portion of the frame is curled.
- 81.** The docking station of any one of claims 74-80, wherein the valve seat is formed by inner struts that extend from a first end of the frame to a junction.

- 82.** The docking station of claim 81, wherein the inner struts form diamond shaped openings.
- 83.** The docking station of claim 81, wherein top and outer struts extend from the junction to a second end and form continuous openings.
- 84.** The docking station of any one of claims 74-83, wherein, when in the second configuration, the second end overlaps at least a portion of the first end.
- 85.** The docking station of any one of claims 74-84, wherein the frame comprises one or more legs that extend to an end of the frame.
- 86.** The docking station of claim 85, wherein the one or more legs extend from inner struts of the valve seat.
- 87.** The docking station of any one of claims 85-86, wherein the one or more legs comprise an elongated leg that extends axially further than a shorter leg of the one or more legs.
- 88.** The docking station of any one of claims 74-87, further comprising at least one sealing portion configured to contact an interior surface of a circulatory system.
- 89.** A docking station comprising:
a frame comprising a retaining portion circumscribing an inflow area and a valve seat configured to support an expandable transcatheter valve, wherein the retaining portion has a first diameter larger than a second diameter of the valve seat, and wherein a tapered region transitions between the first diameter and the second diameter; and
at least one sealing portion configured to contact an interior surface of a circulatory system.
- 90.** The docking station of claim 89, wherein the tapered region transitions between the first diameter of the retaining portion and the second diameter of the valve seat in a direction from the inflow area to an outflow area.
- 91.** The docking station of any one of claims 89-90, wherein the frame comprises a plurality of metal struts that form cells.

- 92.** The docking station of any one of claims 89-91, wherein a band extends about the valve seat causing the valve seat to be unexpandable or substantially unexpandable.
- 93.** The docking station of any one of claims 89-92, wherein the valve seat does not radially overlap any of the retaining portion.
- 94.** The docking station of any one of claims 89-93, wherein the valve seat is positioned entirely to one axial side of the retaining portion.
- 95.** The docking station of any one of claims 89-94, further comprising an atraumatic outer segment that extends radially outwardly from the valve seat.
- 96.** The docking station of claim 95, wherein the outer segment is toroidal.
- 97.** The docking station of any one of claims 95-96, wherein the outer segment comprises a plurality of struts that form cells.
- 98.** The docking station of any one of claims 95-97, wherein the outer segment comprises a foam material.
- 99.** The docking station of any one of claims 89-98, wherein the docking station comprises a first sealing portion configured to inhibit blood flow between an atrium-vein junction in the body and the docking station when implanted, and comprises a second sealing portion configured to inhibit blood flow between the valve seat and a transcatheter valve implanted at the valve seat.
- 100.** The docking station of any one of claims 89-99, wherein the frame is configured to conform to an interior shape of blood vessel, when expanded inside the blood vessel, such that the frame can expand in multiple locations to conform to multiple bulges of the blood vessel and multiple narrowed regions of the blood vessel to distribute the pressure on the blood vessel from the docking station over most of the length of the docking station.
- 101.** The docking station of any one of claims 89-100, further comprising a leg that extends axially at an end of the retaining portion.
- 102.** The expandable docking station frame of claim 101, further comprising an elongated leg that extends axially further from the remainder of the retaining portion than the leg.

- 103.** A system comprising:
- a first docking station having a first valve seat;
 - a second docking station having a second valve seat, wherein each of the first valve seat and the second valve seat is configured to support an expandable valve; and
 - a connecting portion connecting the first docking station and the second docking station together to form a dual docking station.
- 104.** The system of claim 103, further comprising at least one sealing portion configured to contact an interior surface of a circulatory system.
- 105.** The system of any one of claims 103-104, wherein the dual docking station is configured such that the first docking station can be implanted in an inferior vena cava of a body and the second docking station can be deployed in a superior vena cava of the body, with a first valve expanded within the first valve seat and a second valve expanded within the second valve seat.
- 106.** The system of any one of claims 103-104, wherein the dual docking station is configured such that the first docking station can be implanted in an inferior vena cava of a body and the second docking station can be deployed in a superior vena cava of the body, with only one of the first docking station and the second docking station receiving an expandable valve therein.
- 107.** The system of any one of claims 103-105, further comprising a first valve expandable within the first valve seat such that the first valve is securely held in the first valve seat and a second valve expandable within the second valve seat such that the second valve is securely held in the second valve seat.
- 108.** The system of any one of claims 103-107, wherein the connecting portion is configured to allow blood to freely flow through the connecting portion when the system is implanted in a body.
- 109.** The system of any one of claims 103-108, wherein the connecting portion is integrally formed with the first docking station and the second docking station.

110. The system of any one of claims 103-109, wherein the dual docking station is configured to be adjustable in overall length inside a circulatory system at an implantation site.

111. A docking device deployment system, comprising:

- a catheter defining a delivery passage and having a distal opening;
- a self-expandable docking station capable of being radially compressed and expanded, wherein the docking station can be held in a compressed configuration inside the delivery passage of the catheter; and
- a retention device releasably connectable to the docking station such that the retention device inhibits the docking station from jumping distally out of the catheter.

112. The system of claim 111, wherein the retention device is a pusher having a distal end connectable to a proximal end of the docking station.

113. The system of any one of claims 111-112, wherein the retention device is configured to maintain the axial position of the docking station until the docking station is fully expanded at an implantation site.

114. The system of any one of claims 111-113, wherein the docking station includes at least one leg that extends proximally at a proximal end of the docking station and is releasably connectable to the retention device.

115. The system of any one of claims 111-114, wherein the docking station includes multiple legs that extends proximally at a proximal end of the docking station, the multiple legs spaced evenly around the proximal end of the docking station.

116. The system of any one of claims 111-113, wherein the docking station includes only one leg that extends proximally at a proximal end of the docking station and is releasably connectable to the retention device, such that the docking station can fully expand while the one leg is connected to the retention device and then be released.

117. The system of any one of claims 111-113, wherein the docking station includes a first leg and a second leg that each extend proximally at a proximal end of the docking station and are releasably connectable to the retention device, wherein the first leg is longer than the second leg.

118. The system of claim 117, wherein the retention device, the first leg, and the second leg are configured such that during delivery the retention device first releases the second leg to allow docking station to fully expand while the first leg is still connected to the retention device.

119. The system of any one of claims 114-118, wherein the retention device comprises a lock and release connector having a body and a door, wherein the door is moveable from a first position to a second position.

120. The system of claim 119, wherein the lock and release connector has a second door moveable from a third position to a fourth position, and wherein the lock and release connector is configured such that it can hold a first leg of the docking station between the door and the body in the first position and can hold a second leg of the docking station between the second door and the body in the third position.

121. The system of any one of claims 114 and 116, wherein the retention device comprises a lock and release connector having a body and a door, wherein the door is moveable from a first position to a second position, and wherein the retention device is connected to the docking station when the leg is between the door and the body and the door is in the first position.

122. The system of claim 121, wherein the retention device is configured to release the leg when the door is moved to the second position.

123. The system of any one of claims 111-113, wherein the retention device comprises a retaining line usable to maintain the position of the docking station as the docking station is deployed from the catheter and fully radially expanded.

124. The system of any one of claims 111-123, wherein the retention device comprises a pin that extends inside of at least a proximal end of the docking station to inhibit the docking station from jumping out of a distal end of the catheter.

125. The system of any one of claims 124, wherein the pin inhibits the docking station from jumping out of the distal end of the catheter by inhibiting the proximal end of the docking station from angling out of parallel.