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Methods and devices for ventricular reshaping and heart valve reshaping

Abstract

Systems, apparatuses, and methods disclosed herein are provided for medical treatment, including transcatheter medical treatments and/or for treatment of dilated hearts (e.g., dilated left ventricle) or functional mitral valve regurgitation within a human heart. The systems, apparatuses, and methods disclosed herein may include applying one or more heart splints to the patient's heart to apply pressure to the heart to reshape the heart. Anchors disclosed herein may be utilized in plugs for treating openings in a septum between two chambers of a heart, e.g., ventricular septal defects (VSD), atrial septal defects (ASD), and patent foramen ovale (PFO). In addition, the anchors disclosed herein may be utilized to reshape an annulus of a patient's heart valve, including a tricuspid valve of a patient's heart. The anchors disclosed herein may also be utilized to reposition a heart valve leaflet to reduce heart valve leaflet prolapse.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application claims the benefit of U.S. Patent Application No. 62/723,924, filed Aug. 28, 2018, and U.S. Patent No. 62/839,298, filed Apr. 26, 2019, the entire disclosures which are incorporated by reference herein.

BACKGROUND
(1) Heart failure can occur when the left ventricle of the heart becomes enlarged and dilated as a result of one or more of various etiologies. Initial causes of heart failure can include chronic hypertension, myocardial infarction, mitral valve incompetency, and other dilated cardiomyopathies. With each of these conditions, the heart is forced to overexert itself in order to provide a cardiac output demanded by the body during various demand states. The result can be an enlarged left ventricle.
(2) A dilated or enlarged heart, and particularly a dilated or enlarged left ventricle, can significantly

increase tension and stress in heart walls both during diastolic filling and systolic contraction, which contributes to further dilatation or enlargement of chambers of the heart. In addition, mitral valve incompetency or mitral valve regurgitation is a common comorbidity of congestive heart failure. As the dilation of the ventricle increases, valve function generally worsens, which results in a volume overload condition. The volume overload condition further increases ventricular wall stress, thereby advancing the dilation process, which further worsens valve dysfunction.

(3) In heart failure, the size of the valve annulus (particularly the mitral valve annulus) increases while the area of the leaflets of the valve remains constant. This may lead to reduced coaptation area between the valve leaflets, and, as a result, eventually to valve leakage or regurgitation. Moreover, in normal hearts, the annular size contracts during systole, aiding in valve coaptation. In heart failure, there is poor ventricular function and elevated wall stress. These conditions tend to reduce annular contraction and distort annular size, often exacerbating mitral valve regurgitation. In addition, as the chamber dilates, the papillary muscles (to which the leaflets are connected via the chordae tendineae) may move radially outward and downward relative to the valve, and relative to their normal positions. During this movement of the papillary muscles, however, the various chordae lengths remain substantially constant, which limits the full closure ability of the leaflets by exerting tension prematurely on the leaflets. This condition is commonly referred to as “chordal tethering.” The combination of annular changes and papillary changes results in a poorly functioning valve.

(4) A concept for treating heart failure includes applying one or more splints onto the heart, to reduce myocardial muscular stresses encountered during pumping. One example includes a transventricular splint placed across the left ventricle. The splint may include a tension member extending across the ventricle with anchors disposed on opposite ends of the tension member and placed on the external surface of the heart.

(5) However, currently available methods of applying a splint, or performing mitral valve repair or replacement typically require opening the chest and/or heart, e.g., to gain direct access to the valve and its annulus or another portion of the heart. This type of access typically necessitates a use of cardiopulmonary bypass, which can introduce additional complications to the surgical procedure. Since the implantation of the splints themselves do not require the patient to be on cardiopulmonary bypass, it would be advantageous to devise a technique that could improve the mitral valve function without any need for cardiopulmonary bypass. The ability to improve the mitral valve function without the need for cardiopulmonary bypass would be an advantage. In addition, a splint may be utilized to reduce stresses on the ventricular wall, thereby relieving load from the ventricle (including the left ventricle). Indeed, it would be desirable to have systems, apparatuses, and methods capable of a deploying a splint using a less invasive, or minimally invasive procedure.

(6) Other maladies of the heart include expansion of a heart valve annulus, including a tricuspid valve annulus. Expansion of the heart valve annulus may lead to functional heart valve regurgitation, including tricuspid regurgitation (TR). Current methods for addressing expansion of a heart valve annulus are invasive and typically involve an annuloplasty process. Other conditions affecting a heart valve may include prolapse of a heart valve leaflet such as a mitral valve leaflet. Such a condition, if left untreated may lead to functional heart valve regurgitation, including mitral regurgitation. Current methods for addressing mitral valve leaflet prolapse may include providing anchors for the prolapsing leaflet. However, such current methods are often complicated to perform and may damage the prolapsing leaflet.

SUMMARY

(7) Systems, apparatuses, and methods disclosed herein are provided for medical treatment, including transcatheter medical treatments and/or for treatment of dilated hearts (e.g., dilated left ventricle) or functional mitral valve regurgitation within a human heart. The treatments may include reshaping a ventricle of the heart, including the left ventricle of the heart. The portion of

the patient's heart may be dilated due to a myocardial infarction or other cardiomyopathy. The treatment may comprise beating-heart repair of left ventricles with ischemic cardiomyopathy.
(8) The systems, apparatuses, and methods disclosed herein may include applying one or more heart splints to the patient's heart to apply pressure to the heart to reshape the heart. The heart splints may include anchors connected by a tension member that is tensioned to apply pressure to the patient's heart. The anchors may be positioned in desired locations to reshape the heart at particular locations (e.g., the mitral annulus, or the papillary heads of the left ventricle, among other locations).
(9) Preferably, the systems, apparatuses, and methods disclosed herein may be utilized in a minimally invasive procedure, to access the heart and apply the heart splint without requiring a full sternotomy.
(10) The anchors disclosed herein may not only be utilized in heart splints, but may also be utilized in plugs for treating openings in a septum between two chambers of a heart, e.g., ventricular septal defects (VSD), atrial septal defects (ASD), and patent foramen ovale (PFO). In addition, the anchors disclosed herein may be utilized to reshape an annulus of a patient's heart valve, including a tricuspid valve of a patient's heart. The anchors disclosed herein may also be utilized to reposition a heart valve leaflet to reduce heart valve leaflet prolapse. The anchors disclosed herein may also be utilized to reposition one or more papillary muscles of a patient's heart, to draw the papillary muscles towards the mitral valve. The anchors disclosed herein may be utilized with a heart valve implant, which may comprise a heart valve prosthetic or a heart valve repair implant.
(11) Any or all of the treatment methods, operations, or steps described herein may be performed on a living human or non-human subject, or on a human or non-human cadaver or portion(s) thereof (e.g., heart, body part, tissue, etc.), simulator, or anthropomorphic ghost, for example, for educational or training purposes.
(12) A heart anchor of the present disclosure may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, a first portion of the ring overlapping a second portion of the ring in the ring-shaped configuration. The heart anchor may include a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration.
(13) A heart anchor of the present disclosure may be for a heart splint, and may include a first support pad and a second support pad. A bridge may couple the first support pad to the second support pad. A receiver may couple to the bridge and be configured to receive a tension member. A lock may couple to the bridge and be configured to vary from an unlocked state in which the tension member is unlocked in the receiver to a locked state in which tension member is locked in the receiver.
(14) An access apparatus of the present disclosure may be for gripping an external surface of a patient's heart. The access apparatus may include a housing and a head configured to contact the external surface of the patient's heart and including one or more lumens configured to apply vacuum suction to the external surface of the patient's heart to grip the external surface of the patient's heart, the one or more lumens configured to pass a puncture device from the head through the external surface of the patient's heart. An elongate neck may couple the head to the housing and may include one or more lumens for passing the vacuum suction therethrough and for passing the puncture device therethrough to the head, the elongate neck being configured to deflect to move the head. A control mechanism may be configured to deflect the elongate neck to move the head.
(15) A deployment apparatus of the present disclosure may be for deploying a heart anchor to an external surface of a patient's heart. The deployment apparatus may include a housing and a head configured to retain the heart anchor. An elongate neck may couple the head to the housing, the elongate neck being configured to deflect to move the head. A control mechanism may be configured to deflect the elongate neck to move the head.
(16) A system of the present disclosure may comprise a heart splint system. The system may

include a first heart anchor including a first support pad, a second support pad, and a bridge coupling the first support pad to the second support pad. A second heart anchor may be configured to move from an unexpanded configuration to an expanded configuration. A tension member may be configured to couple the first heart anchor to the second heart anchor.

(17) A system of the present disclosure may comprise a heart splint system. The system may include a first heart anchor including a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The system may include a second heart anchor including a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring of the second heart anchor and extending inward from the ring of the second heart anchor in the ring-shaped configuration. The system may include a third heart anchor, and a first tension member for coupling the first heart anchor to the third heart anchor, and a second tension member for coupling to the second heart anchor to the third heart anchor.

(18) A system of the present disclosure may be for treating a dilated heart condition or functional heart valve regurgitation of a patient. The system may include an access apparatus for penetrating through an external surface of the patient's heart and into an interior chamber of the patient's heart. The system may include a first heart anchor including a first support pad, a second support pad, and a bridge coupling the first support pad to the second support pad. The system may include a second heart anchor, a tension member configured to couple the first heart anchor to the second heart anchor, and a deployment apparatus configured to deploy the second heart anchor in an interior chamber of the patient's heart.

(19) A method of the present disclosure may include a method for treating a dilated heart condition or functional heart valve regurgitation of a patient. The method may include deploying a first heart anchor to a position on an external surface of the patient's heart, the first heart anchor including a first support pad, a second support pad, and a bridge coupling the first support pad to the second support pad. The method may include deploying a second heart anchor to a position on an interventricular septum of the patient's heart. The method may include tensioning a tension member for coupling the first heart anchor to the second heart anchor. The method may include locking the tension member in tension between the first heart anchor and the second heart anchor.

(20) A method of the present disclosure may include a method for treating a dilated heart condition or functional heart valve regurgitation of a patient. The method may include deploying a first heart anchor to a position on an external surface of the patient's heart and adjacent the left ventricle. The first heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The method may include deploying a second heart anchor to a position on an external surface of the patient's heart and adjacent the left ventricle. The second heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring of the second heart anchor and extending inward from the ring of the second heart anchor. The method may include deploying a third heart anchor to a position that is on an external surface of the patient's heart and adjacent the right ventricle or to a position that is on the interventricular septum of the patient's heart. The method may include tensioning a first tension member for coupling the first heart anchor to the third heart anchor. The method may include locking the first tension member in tension between the first heart anchor and the third heart anchor. The method may include tensioning a second tension member for coupling the second heart anchor to the third heart anchor. The method may include locking the second tension member in tension between the second heart anchor and the third heart anchor.

(21) A method of the present disclosure may include a method for treating an opening in a septum of a patient's heart. The method may include deploying a first heart anchor to a position on the

septum adjacent the opening and in a chamber of the heart. The first heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The method may include deploying a second heart anchor to a position on the septum and in a chamber of the heart on an opposite side of the septum and adjacent the opening, the second heart anchor being coupled to the first heart anchor with a tension member extending through the opening. The second heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring of the second heart anchor and extending inward from the ring of the second heart anchor in the ring-shaped configuration.

(22) A system of the present disclosure may include a system for reshaping an annulus of a tricuspid valve of a patient's heart. The system may include a first heart anchor configured to be positioned on a free wall of a right atrium of the patient's heart, a second heart anchor configured to be positioned on an interatrial septum of the patient's heart, and a tension member configured to couple the first heart anchor to the second heart anchor and extend within the right atrium.

(23) A system of the present disclosure may include a system for reshaping an annulus of a tricuspid valve of a patient's heart. The system may include a first heart anchor configured to be positioned on a free wall of a right atrium of the patient's heart, a second heart anchor configured to be positioned within a coronary sinus of the patient's heart, and a tension member configured to couple the first heart anchor to the second heart anchor and extend within the right atrium.

(24) A method of the present disclosure may include a method for reshaping an annulus of a tricuspid valve of a patient's heart. The method may include deploying a first heart anchor to an interatrial septum or a coronary sinus of the patient's heart. The method may include deploying a second heart anchor to a free wall of a right atrium of the patient's heart. The method may include tensioning a tension member for coupling the first heart anchor to the second heart anchor. The method may include locking the tension member in tension between the first heart anchor and the second heart anchor.

(25) A system of the present disclosure may include a system for repositioning a leaflet of a valve of a patient's heart. The system may include a first heart anchor configured to be positioned on a leaflet of a valve in a patient's heart. The first heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. A second heart anchor may be configured to be positioned on a portion of the patient's heart. A tension member may be configured to couple the first heart anchor to the second heart anchor and provide a tension that repositions the leaflet.

(26) A method of the present disclosure may include a method for repositioning a leaflet of a valve of a patient's heart. The method may include deploying a first heart anchor to a leaflet of a valve in a patient's heart. The first heart anchor may include a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The method may include deploying a second heart anchor to a portion of the patient's heart. The method may include tensioning a tension member for coupling the first heart anchor to the second heart anchor to reposition the leaflet. The method may include locking the tension member between the first heart anchor and the second heart anchor.

(27) A system of the present disclosure may include a system for repositioning one or more papillary muscles of a left ventricle of a patient's heart. The system may include a first heart anchor configured to be positioned on a mitral annulus of a patient's heart and including two or more lobes extending outward from a central portion of the first heart anchor. The system may include a second heart anchor configured to apply a force to the one or more papillary muscles of the left ventricle of the patient's heart. The system may include a tension member configured to couple the

first heart anchor to the second heart anchor and extend within the left ventricle.
(28) A system of the present disclosure may include a system for repositioning one or more papillary muscles of a left ventricle of a patient's heart. The system may include a first heart anchor configured to be positioned on a mitral annulus of a patient's heart and including a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The system may include a second heart anchor configured to apply a force to the one or more papillary muscles of the left ventricle of the patient's heart. The system may include a tension member configured to couple the first heart anchor to the second heart anchor and extend within the left ventricle.
(29) A method of the present disclosure may include a method for repositioning one or more papillary muscles of a left ventricle of a patient's heart. The method may include deploying a first heart anchor to a mitral annulus in the patient's heart, the first heart anchor including a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration. The method may include deploying a second heart anchor to a portion of the patient's heart such that the second heart anchor is configured to apply a force to the one or more papillary muscles. The method may include tensioning a tension member for coupling the first heart anchor to the second heart anchor to reposition the one or more papillary muscles. The method may include locking the tension member between the first heart anchor and the second heart anchor.
(30) A method of the present disclosure may include a method for repositioning one or more papillary muscles of a left ventricle of a patient's heart. The method may include deploying a first heart anchor to a mitral annulus in the patient's heart, the first heart anchor including two or more lobes extending outward from a central portion of the first heart anchor. The method may include deploying a second heart anchor to a portion of the patient's heart such that the second heart anchor is configured to apply a force to the one or more papillary muscles. The method may include tensioning a tension member for coupling the first heart anchor to the second heart anchor to reposition the one or more papillary muscles. The method may include locking the tension member between the first heart anchor and the second heart anchor.
(31) A system of the present disclosure may include one or more of a heart valve prosthetic or a heart valve repair implant. The system may include a heart anchor configured to be positioned on a ventricular wall of a patient's heart. The system may include a tension member configured to couple the one or more of the heart valve prosthetic or the heart valve repair implant to the heart anchor.
(32) A method of the present disclosure may include deploying one or more of a heart valve prosthetic or a heart valve repair implant to a heart valve of a patient's heart. The method may include anchoring, with a tension member, the one or more of the heart valve prosthetic or the heart valve repair implant to a heart anchor positioned on a ventricular wall of the patient's heart.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) Features and advantages of the systems, apparatuses, and methods as disclosed herein will become appreciated as the same become better understood with reference to the specification, claims, and appended drawings wherein:
(2) FIG. **1**A illustrates a side view of an access apparatus according to an embodiment of the present disclosure.
(3) FIG. **1**B illustrates a cross sectional view of the access apparatus shown in FIG. **1**A.

(4) FIG. **1**C illustrates a perspective view of the head of the access apparatus shown in FIG. **1**A.
(5) FIG. **1**D illustrates a cross sectional view of the head of the access apparatus shown in FIG. **1**A.
(6) FIG. **1**E illustrates a side view of the elongate neck of the access apparatus shown in FIG. **1**A.
(7) FIG. **1**F illustrates a cross sectional view of the access apparatus shown in FIG. **1**A with the head of the access apparatus rotated from the position shown in FIG. **1**A.
(8) FIG. **2**A illustrates a front view of a ring of a heart anchor according to an embodiment of the present disclosure.
(9) FIG. **2**B illustrates a side view of the ring of a heart anchor shown in FIG. **2**A.
(10) FIG. **2**C illustrates a top view of an unfolded cover of a heart anchor according to an embodiment of the present disclosure.
(11) FIG. **2**D illustrates a top view of the cover shown in FIG. **2**C folded.
(12) FIG. **2**E illustrates a side view of the folded cover shown in FIG. **2**D.
(13) FIG. **2**F illustrates an alternate configuration of a cover of a heart anchor according to an embodiment of the present disclosure.
(14) FIG. **2**G illustrates a heart anchor according to an embodiment of the present disclosure.
(15) FIG. **2**H illustrates the heart anchor shown in FIG. **2**G in a linearized configuration.
(16) FIG. **3**A illustrates a side view of a deployment apparatus according to an embodiment of the present disclosure.
(17) FIG. **3**B illustrates a cross sectional view of the deployment apparatus shown in FIG. **3**A.
(18) FIG. **4**A illustrates a side view of a delivery apparatus according to an embodiment of the present disclosure.
(19) FIG. **4**B illustrates a cross sectional view of the delivery apparatus shown in FIG. **4**A.
(20) FIG. **5** illustrates a side view of a delivery apparatus positioned within an introducer sheath according to an embodiment of the present disclosure.
(21) FIG. **6**A illustrates a side view of a snare according to an embodiment of the present disclosure.
(22) FIG. **6**B illustrates a close up view of the end of the snare shown in FIG. **6**A with a snare device expanded.
(23) FIG. **7**A illustrates a side view of a deployment apparatus according to an embodiment of the present disclosure.
(24) FIG. **7**B illustrates a cross sectional view of the deployment apparatus shown in FIG. **7**A.
(25) FIG. **7**C illustrates a side view of the elongate neck of the deployment apparatus shown in FIG. **7**A.
(26) FIG. **7**D illustrates a side view of the deployment apparatus shown in FIG. **7**A with a retainer rotated from the position shown in FIG. **7**A.
(27) FIG. **8**A illustrates a side view of a heart anchor according to an embodiment of the present disclosure.
(28) FIG. **8**B illustrates a bottom perspective view of the heart anchor shown in FIG. **8**A according to an embodiment of the present disclosure.
(29) FIG. **8**C illustrates a top perspective view of the heart anchor shown in FIG. **8**A according to an embodiment of the present disclosure.
(30) FIG. **8**D illustrates a cross sectional view of the heart anchor shown in FIG. **8**A according to an embodiment of the present disclosure.
(31) FIG. **8**E illustrates a cross sectional view of the heart anchor shown in FIG. **8**A according to an embodiment of the present disclosure.
(32) FIG. **8**F illustrates a side view of the heart anchor shown in FIG. **8**A according to an embodiment of the present disclosure.
(33) FIG. **9** illustrates a perspective view of an access apparatus being gripped to a portion of a patient's heart according to an embodiment of the present disclosure.
(34) FIG. **10** illustrates a side view of the proximal end of the access apparatus shown in FIG. **1**A.

(35) FIG. **11** illustrates a perspective view of the head of the access apparatus shown in FIG. **1**A.
(36) FIG. **12** illustrates a cross sectional view of a patient's heart with a sheath and puncture device being passed into the heart according to an embodiment of the present disclosure.
(37) FIG. **13** illustrates a side view of the proximal end of the access apparatus shown in FIG. **1**A.
(38) FIG. **14** illustrates a cross sectional view of a patient's heart with a snare and delivery apparatus being passed into the heart according to an embodiment of the present disclosure.
(39) FIG. **14**A illustrates a cross sectional view of a patient's heart with a snare, and a delivery apparatus being passed into the heart adjacent a spacer, according to an embodiment of the present disclosure.
(40) FIG. **15** illustrates a cross sectional view of a patient's heart with a snare entering the left ventricle according to an embodiment of the present disclosure.
(41) FIG. **16** illustrates a cross sectional view of a patient's heart with snares snaring each other according to an embodiment of the present disclosure.
(42) FIG. **17** illustrates a side view of a proximal end of a delivery apparatus according to an embodiment of the present disclosure.
(43) FIG. **18** illustrates a side view of a proximal end of an introducer sheath according to an embodiment of the present disclosure.
(44) FIG. **19** illustrates a side view of a proximal end of an introducer sheath according to an embodiment of the present disclosure.
(45) FIG. **20** illustrates a side view of a deployment apparatus positioned within an introducer sheath according to an embodiment of the present disclosure.
(46) FIG. **21** illustrates a side view of a heart anchor being passed out of a deployment apparatus according to an embodiment of the present disclosure.
(47) FIG. **22** illustrates a perspective view of a deployment member being withdrawn according to an embodiment of the present disclosure.
(48) FIG. **23** illustrates a perspective view of a heart anchor in an expanded configuration according to an embodiment of the present disclosure.
(49) FIG. **24** illustrates a cross sectional view of a patient's heart with a heart anchor in an expanded configuration in the patient's right atrium according to an embodiment of the present disclosure.
(50) FIG. **25** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on the patient's interventricular septum according to an embodiment of the present disclosure.
(51) FIG. **26** illustrates a side view of a heart anchor coupled to a deployment apparatus according to an embodiment of the present disclosure.
(52) FIG. **27** illustrates a side view of a proximal end of a deployment apparatus according to an embodiment of the present disclosure.
(53) FIG. **28** illustrates a side view of a proximal end of a deployment apparatus with an unlock ring coupled thereto according to an embodiment of the present disclosure.
(54) FIG. **29** illustrates a perspective view of a deployment apparatus being moved to a portion of a patient's heart according to an embodiment of the present disclosure.
(55) FIG. **30** illustrates a perspective view of a lock retainer member being cut according to an embodiment of the present disclosure.
(56) FIG. **31** illustrates a cross sectional view of a patient's heart with a heart anchor deployed according to an embodiment of the present disclosure.
(57) FIG. **32** illustrates a cross sectional view of a patient's heart with a puncture device and sheath being passed through the interventricular septum according to an embodiment of the present disclosure.
(58) FIG. **33** illustrates a cross sectional view of a patient's heart with snares extending towards each other in the right ventricle according to an embodiment of the present disclosure.
(59) FIG. **34** illustrates a side view of a deployment apparatus with an anchor partially extending

out of a deployment apparatus according to an embodiment of the present disclosure.
(60) FIG. **35** illustrates a side view of a deployment apparatus with an anchor extending out of a deployment apparatus according to an embodiment of the present disclosure.
(61) FIG. **36** illustrates a cross sectional view of a patient's heart with a deployment apparatus passing through the patient's heart according to an embodiment of the present disclosure.
(62) FIG. **37** illustrates a cross sectional view of a patient's heart with a heart splint being deployed to the heart according to an embodiment of the present disclosure.
(63) FIG. **38** illustrates a perspective view of a heart anchor positioned on an external surface of the patient's heart according to an embodiment of the present disclosure.
(64) FIG. **39** illustrates a perspective view of a representation of a heart anchor being deployed to a chamber of the patient's heart according to an embodiment of the present disclosure.
(65) FIG. **40** illustrates a perspective view of a representation of a heart anchor being deployed to another chamber of the patient's heart according to an embodiment of the present disclosure.
(66) FIG. **41** illustrates a perspective view of a representation of a plug being deployed to a patient's septum according to an embodiment of the present disclosure.
(67) FIG. **42** illustrates a cross sectional view of a patient's heart with an anchor being deployed in a chamber of the heart according to an embodiment of the present disclosure.
(68) FIG. **43** illustrates a cross sectional view of a patient's heart with a plug deployed to the heart according to an embodiment of the present disclosure.
(69) FIG. **44** illustrates a cross sectional view of a patient's heart with a plug deployed to the heart according to an embodiment of the present disclosure.
(70) FIG. **45** illustrates a cross sectional view of a patient's heart showing the tricuspid and mitral valves.
(71) FIG. **46** illustrates a representation of expansion of a tricuspid valve.
(72) FIG. **47** illustrates a cross sectional view of a patient's heart showing a deployment apparatus passing through an interatrial septum according to an embodiment of the present disclosure.
(73) FIG. **48** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on an interatrial septum according to an embodiment of the present disclosure.
(74) FIG. **49** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on an interatrial septum and a snare passing into the right atrium according to an embodiment of the present disclosure.
(75) FIG. **50** illustrates a cross sectional view of a patient's heart with a tension member extending across the right atrium according to an embodiment of the present disclosure.
(76) FIG. **51** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(77) FIG. **52** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(78) FIG. **53** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on an interatrial septum and a puncture device penetrating the free wall of the right atrium according to an embodiment of the present disclosure.
(79) FIG. **54** illustrates a cross sectional view of a patient's heart with a tension member extending across the right atrium according to an embodiment of the present disclosure.
(80) FIG. **55** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(81) FIG. **56** illustrates a cross sectional view of a patient's heart with a deployment member passing through the free wall of the right atrium and the interatrial septum according to an embodiment of the present disclosure.
(82) FIG. **57** illustrates a cross sectional view of a patient's heart with a tension member extending across the right atrium according to an embodiment of the present disclosure.
(83) FIG. **58** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the

heart according to an embodiment of the present disclosure.
(84) FIG. **59** illustrates a cross sectional view of a patient's heart showing a deployment apparatus passing through an interatrial septum according to an embodiment of the present disclosure.
(85) FIG. **60** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on an interatrial septum and a deployment apparatus directed towards the free wall of the right atrium according to an embodiment of the present disclosure.
(86) FIG. **61** illustrates a cross sectional view of a patient's heart with a heart anchor positioned on an interatrial septum and a heart anchor positioned on the free wall of the right atrium according to an embodiment of the present disclosure.
(87) FIG. **62** illustrates a cross sectional view of a patient's heart with a lock positioned between a heart anchor positioned on an interatrial septum and a heart anchor positioned on the free wall of the right atrium according to an embodiment of the present disclosure.
(88) FIG. **63** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(89) FIG. **64** illustrates a cross sectional view of a patient's heart with a snare passing through the interatrial septum and a snare passing through the free wall of the right atrium according to an embodiment of the present disclosure.
(90) FIG. **65** illustrates a cross sectional view of a patient's heart with a tension member extending across the right atrium according to an embodiment of the present disclosure.
(91) FIG. **66** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(92) FIG. **67** illustrates a cross sectional view of a patient's heart with a snare passing through the interatrial septum and through the free wall of the right atrium according to an embodiment of the present disclosure.
(93) FIG. **68** illustrates a cross sectional view of a patient's heart with a deployment apparatus passing through the interatrial septum and through the free wall of the right atrium according to an embodiment of the present disclosure.
(94) FIG. **69** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(95) FIG. **70** illustrates a cross sectional view of a patient's heart with a heart anchor directed to a coronary sinus according to an embodiment of the present disclosure.
(96) FIG. **71** illustrates a cross sectional view of a patient's heart with a heart anchor positioned within a coronary sinus and a snare passing through the free wall of the right atrium according to an embodiment of the present disclosure.
(97) FIG. **72** illustrates a cross sectional view of a patient's heart with a heart anchor positioned within a coronary sinus and a tension member extending across the right atrium according to an embodiment of the present disclosure.
(98) FIG. **73** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(99) FIG. **74** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(100) FIG. **75** illustrates a cross sectional view of a patient's heart with a heart anchor positioned within a coronary sinus and a puncture device passing through the free wall of the right atrium according to an embodiment of the present disclosure.
(101) FIG. **76** illustrates a cross sectional view of a patient's heart with a heart anchor positioned within a coronary sinus and a deployment apparatus directed to the free wall of the right atrium according to an embodiment of the present disclosure.
(102) FIG. **77** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(103) FIG. **78** illustrates a cross sectional view of a patient's heart showing a prolapsing leaflet of a

heart valve according to an embodiment of the present disclosure.
(104) FIG. **79** illustrates a cross sectional view of a patient's heart showing a deployment apparatus passing through a prolapsing leaflet according to an embodiment of the present disclosure.
(105) FIG. **80** illustrates a cross sectional view of a patient's heart showing a heart splint deployed to the heart according to an embodiment of the present disclosure.
(106) FIG. **81** illustrates a cross sectional view of a patient's heart with an anchor deployed to a heart valve leaflet according to an embodiment of the present disclosure.
(107) FIG. **82** illustrates a cross sectional view of a patient's heart showing a heart splint deployed to the heart according to an embodiment of the present disclosure.
(108) FIG. **83** illustrates a cross sectional view of a patient's heart with a deployment apparatus passing through a prolapsing leaflet according to an embodiment of the present disclosure.
(109) FIG. **84** illustrates a cross sectional view of a patient's heart with a deployment apparatus directed to a wall of the patient's heart according to an embodiment of the present disclosure.
(110) FIG. **85** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(111) FIG. **86** illustrates a cross sectional view of a patient's heart with multiple heart splints deployed to the heart according to an embodiment of the present disclosure.
(112) FIG. **87** illustrates a cross sectional view of a patient's heart with multiple heart splints deployed to the heart according to an embodiment of the present disclosure.
(113) FIG. **88** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(114) FIG. **89** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(115) FIG. **90** illustrates a cross sectional view of a patient's heart with multiple heart splints deployed to the heart according to an embodiment of the present disclosure.
(116) FIG. **91** illustrates a cross sectional view of a patient's heart with multiple heart splints deployed to the heart according to an embodiment of the present disclosure.
(117) FIG. **92** illustrates a cross sectional view of a patient's heart with a deployment apparatus passing through a mitral annulus of the patient's heart according to an embodiment of the present disclosure.
(118) FIG. **93** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(119) FIG. **94** illustrates a cross sectional view of a patient's heart with a heart splint deployed to the heart according to an embodiment of the present disclosure.
(120) FIG. **95** illustrates a perspective view of a head of an access apparatus according to an embodiment of the present disclosure.
(121) FIG. **96** illustrates a bottom view of the head shown in FIG. **95**.
(122) FIG. **97** illustrates a top perspective cross sectional view of the head shown in FIG. **95**.
(123) FIG. **98** illustrates a side cross sectional view along a mid-line of the head shown in FIG. **95**.
(124) FIG. **99** illustrates a front view of the head shown in FIG. **95**.
(125) FIG. **100** illustrates the head shown in FIG. **95** in position on a portion of a patient's heart.
(126) FIG. **101** illustrates a side view of an apparatus according to an embodiment of the present disclosure, with a portion of a shaft cut away.
(127) FIG. **102** illustrates a bottom perspective view of the apparatus shown in FIG. **101**.
(128) FIG. **103** illustrates a side perspective view of the apparatus shown in FIG. **101** in position on a portion of a patient's heart.
(129) FIG. **104** illustrates a side view of an apparatus according to an embodiment of the present disclosure.
(130) FIG. **105** illustrates a side view of the apparatus shown in FIG. **104** with a heart anchor shown in cross section.

(131) FIG. **106** illustrates a bottom perspective view of the apparatus shown in FIG. **104**.
(132) FIG. **107** illustrates a side perspective view of the apparatus shown in FIG. **104** in position on a portion of a patient's heart.
(133) FIG. **108** illustrates a side view of an apparatus according to an embodiment of the present disclosure.
(134) FIG. **109** illustrate a side view of the apparatus shown in FIG. **108** with a hood shown in cross section.
(135) FIG. **110** illustrates a bottom perspective view of the apparatus shown in FIG. **108**.
(136) FIG. **111** illustrates a side perspective view of the apparatus shown in FIG. **108** in position on a portion of a patient's heart.
(137) FIG. **112** illustrates a side perspective view of an apparatus according to an embodiment of the present disclosure.
(138) FIG. **113** illustrates a side view of a deployment apparatus according to an embodiment of the present disclosure.
(139) FIG. **114** illustrates an exploded perspective view of the head of the deployment apparatus shown in FIG. **113**.
(140) FIG. **115** illustrates an exploded perspective view of components of a pulley system of the deployment apparatus shown in FIG. **113**.
(141) FIG. **116** illustrates a side view of the deployment apparatus shown in FIG. **113**.
(142) FIG. **117** illustrates a perspective close up view of a proximal portion of a pulley system of the deployment apparatus shown in FIG. **113**.
(143) FIG. **118** illustrates a close-up perspective view of the components of FIG. **117** with the control knob excluded from view.
(144) FIG. **119** illustrates a schematic view of a patient's heart having a heart splint with a tension member therein according to an embodiment of the present disclosure.
(145) FIG. **120** illustrates a schematic view of a patient's heart having a heart splint with a tension member therein according to an embodiment of the present disclosure.
(146) FIG. **121** illustrates a perspective view of a heart anchor that is puncturable by a puncture device according to an embodiment of the present disclosure.
(147) FIG. **122** illustrates a cross sectional schematic view of layers of a heart anchor according to an embodiment of the present disclosure.
(148) FIG. **123** illustrates a perspective view of a heart anchor according to an embodiment of the present disclosure.
(149) FIG. **124** illustrates a side view of the heart anchor shown in FIG. **123** according to an embodiment of the present disclosure.
(150) FIG. **125** illustrates a side schematic view of a robotic grasper according to an embodiment of the present disclosure.
(151) FIG. **126** illustrates a representation of a heart anchor upon a portion of a patient's heart applied by a robotic arm, according to an embodiment of the present disclosure.
(152) FIG. **127** illustrates a perspective cross sectional view of a patient's heart including a heart implant positioned therein.
(153) FIG. **128** illustrates a cross sectional view of a patient's heart with a heart implant positioned therein and anchored to a heart splint according to an embodiment of the present disclosure.
(154) FIG. **129** illustrates a cross sectional view of a patient's heart with a heart implant positioned therein and anchored to a heart anchor according to an embodiment of the present disclosure.
(155) FIG. **130** illustrates a cross sectional view of a patient's heart with a heart implant positioned therein and anchored to a heart anchor according to an embodiment of the present disclosure.
(156) FIG. **131** illustrates a cross sectional view of a patient's heart with a heart implant positioned therein and anchored to multiple heart anchors according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

(157) Various aspects of the present disclosure generally relate to systems, apparatuses, and methods for medical treatment and/or treating heart conditions, including, by way of example, treating dilation/dilatation (including a dilated left ventricle), valve incompetencies (including mitral valve regurgitation), one or more openings in one or more septums of the heart, and other similar heart conditions. The systems, apparatuses, and methods may be adapted for transcatheter medical treatments that may not require full, open surgery, and can be minimally invasive. The systems, apparatus, and methods may be utilized to reshape a heart valve annulus, including a tricuspid valve annulus. The systems, apparatus, and methods may be utilized to reposition a heart valve leaflet to reduce heart valve leaflet prolapse. The systems, apparatus, and methods may be utilized to reposition one or more papillary muscles of a patient's heart, to draw the papillary muscles towards the mitral valve. The systems, apparatus, and methods may include use of a heart valve implant, which may comprise a heart valve prosthetic or a heart valve repair implant.

(158) In certain embodiments, the present disclosure involves geometric reshaping of the heart and treating valve incompetencies. In certain aspects of the present disclosure, substantially an entire chamber geometry is altered so as to return the heart to a more normal state of stress. Geometric reshaping according to the present disclosure may reduce the stress in the walls of the heart chamber to increase the heart's pumping efficiency, as well as to stop further dilatation of the heart.

(159) FIG. **1**A illustrates an embodiment of an access apparatus **100** that may be used in the systems and methods disclosed herein. The access apparatus **100** may include a head **102**, an elongate neck **104**, and a housing **106**. The access apparatus **100** may include a control mechanism **108** for controlling movement of the elongate neck **104** and movement of the head **102**. The access apparatus **100** may be configured for gripping an external surface of a patient's heart. The access apparatus **100** may be configured to penetrate through an external surface of a patient's heart and into an interior chamber of the patient's heart.

(160) FIG. **1**B illustrates a cross sectional view of the access apparatus **100** shown in FIG. **1**A. FIG. **1**C illustrates a close-up perspective view of the head **102**, and FIG. **1**D illustrates a cross sectional perspective view of the head **102**.

(161) Referring to FIGS. **1**A, **1**B, **1**C, and **1**D, the head **102** may include a proximal end **110** and a distal end **112**. The head **102** may be configured to contact an external surface of the patient's heart. The head **102** may include an application portion **114** for being applied to a portion of a patient's heart. The application portion **114** may include a planar face **116** and a contact surface **118**. The contact surface **118** may extend around the periphery of the planar face **116**. The contact surface **118** may be configured to contact the portion of the patient's heart, and the planar face **116** may also be configured to contact the portion of the patient's heart depending on the amount of pressure applied by the head **102** to the patient's heart.

(162) The head **102** may include a connector portion **120** that extends from the application portion **114** to the proximal end **110** of the head **102**. The connector portion **120** may comprise a curved body extending from the application portion **114**. The body may curve at an angle of about 90 degrees from the planar face **116** of the head **102** to an opening **122** at the proximal end **110** of the head **102**, or may curve for a different amount as desired.

(163) The head **102** may include a lumen **124** for devices to pass through. The lumen **124** may be disposed centrally in the application portion **114** and may end at an opening **126** in the planar face **116** of the head **102**. The lumen **124** may extend from the opening **126** and through the connector portion **120**, to the opening **122** at the proximal end **110** of the head **102**. The devices that may pass through the lumen **124** may include a puncture device or other devices that may be disclosed herein.

(164) The head **102** may include a lumen **128** for applying vacuum suction to the portion of the patient's heart to grip the portion of the patient's heart. The lumen **128** may end at multiple openings **130** that allow the vacuum suction to be applied to the portion of the heart. The openings

130 may extend through the planar face **116** at the application portion **114** of the head **102** and may comprise a pattern of cut-outs in the planar face **116**. The four openings **130** shown in FIG. **1**C, for example, include four wedge shaped cut-outs spaced about the central opening **126** such that the remaining portion of the planar face **116** has a cross-shape.

(165) The lumen **128** may extend through the connector portion **120** of the head. The lumen **128** may be positioned around the central lumen **124**. The lumen **128** may couple to the opening **122** at the proximal end **110** of the head **102** through an opening **132** (shown in FIG. **1**D) in the lumen **124** that allows the vacuum suction to pass therethrough. The lumen **124** and vacuum lumen **128** may connect to each other through the opening **132** in the lumen **124**. In other embodiments, the lumen **128** may remain separate from the lumen **124**. For example, the lumen **128** may remain a separate channel that extends along the head **102** and the elongate neck **104** to couple to a port for receiving vacuum suction. One or more lumens may be utilized to apply the vacuum suction to the external surface of the patient's heart to grip the external surface of the patient's heart, and to pass a puncture device from the head through the external surface of the patient's heart.

(166) The contact surface **118** may comprise a seal **134** that extends around the outer periphery of the head **102**. The seal **134** may comprise a skirt that is configured to seal the connection with a portion of the patient's heart upon the vacuum suction being applied. The seal **134** may be flexible, and may be made of a rubberized or elastomeric material to allow the seal **134** to conform to the shape of the patient's heart and form a sealed connection with the patient's heart. In other embodiments, the seal **134** may have a different form than shown. The sealed connection may be sufficient to maintain the vacuum suction that may be sufficient to secure the head **102** to the desired portion of the patient's heart and resist the force of a puncture device being passed through a surface of the patient's heart.

(167) The head **102** may include a location marker **136**. The location marker **136** may be positioned in the application portion **114** of the head **102** and may be positioned in the planar face **116** of the head **102**. The location marker **136** may be positioned adjacent and around the opening **126** in the planar face **116** of the head **102**. The location marker **136** may be configured for a user to determine the location of the head **102** and particularly the opening **126**. The location marker **136** may be a radio-opaque marker that forms a target for a user to visualize to determine the location of the head **102** and particularly the opening **126**. In other embodiments, the location marker **136** may have a different configuration than shown.

(168) Referring to FIGS. **1**A and **1**B, the elongate neck **104** may have a proximal end **138** and distal end **140** and a body extending from the proximal end **138** to the distal end **140**. The distal end **140** of the elongate neck **104** may couple to the proximal end **110** of the head **102**. One or more bearing surfaces **111** may be positioned between the head **102** and the elongate neck **104** so that the head **102** may rotate relative to the elongate neck **104** and about an axis of the elongate neck **104**.

(169) The elongate neck **104** may include a lumen **142** that may extend the length of the elongate neck **104**. The lumen **142** may be configured for devices to pass through, and may be configured to pass the vacuum suction from the head **102**. The lumen **142** may couple to the opening **122** of the head **102** shown in FIGS. **1**C and **1**D and may be configured to pass the vacuum suction from the lumen **128**, and may be configured to pass devices through the lumen **124**. The devices may be puncture devices or other devices for passing through the lumen **124** and the opening **126**. The elongate neck **104** may include one or more lumens that may be utilized to pass the vacuum suction therethrough and to a puncture device therethrough.

(170) The elongate neck **104** may include a lumen **144** that one or more control members **146** may pass through. The lumen **144** may be positioned exterior of the lumen **142** and may surround the lumen **142**. The elongate neck **104** may include an outer sheath **148** that extends around the lumens **142**, **144** and forms the outer surface of the elongate neck **104**. The outer surface may be smooth to allow for a smooth entry into the patient's body.

(171) The one or more control members **146** may be elongate members that extend along the length

of the elongate neck **104**. The control members **146** may comprise wires or rods, or other forms of control members. The control members **146** may couple to a portion of the elongate neck **104** or head **102**. The control members **146** may be configured to deflect the elongate neck **104**. For example, the control members **146** may be configured such that one control member is pulled along the elongate neck **104**. The movement of the control member **146** may cause the elongate neck **104** to deflect along its length. In other embodiments, other forms of control may be applied, for example, one or more control members **146** may be configured to rotate to cause the elongate neck **104** to deflect, or other forms of control may be utilized. In one embodiment, one control member **146** may be configured to be pushed while the other control member is pulled along the elongate neck **104**, to cause the elongate neck **104** to deflect. In one embodiment, only one control member **146** may be pushed or pulled along the length of the elongate neck **104** to control deflection of the elongate neck **104**.

(172) The elongate neck **104** may be flexible and configured to deflect along its length. The deflection may comprise a curvature of the elongate neck **104**. Referring to FIG. **1**E, the elongate neck **104** is shown deflecting along its length, and curving to vary the orientation of the head **102**. The elongate neck **104** may be configured to curve such that the head **102** rotates by approximately 180 degrees, and the planar face **116** may face the elongate neck **104**. The elongate neck **104** may be configured to curve at only a portion of the elongate neck **104**, for example a distal portion of the elongate neck **104**, or a portion proximate to the head **102**. The elongate neck **104** may include a first portion and a second portion that is more proximate to the head **102** than the first portion, with the second portion configured to curve to a greater extent than the first portion. As such, a desired portion of the elongate neck **104** (proximal the head **102**) may curve. The amount of deflection, or curvature, may vary as desired. The deflection may occur in multiple planes of the elongate neck **104**, for example, if multiple control members **146** are pulled at various orientations along the lumen **142**. The elongate neck **104** may deflect in a downward direction as shown in FIG. **1**E, or may deflect in a relative upward direction or right direction (into the page in FIG. **1**E) or left direction (out of the page in FIG. **1**E). Combinations of directions of movement may occur based on the orientation and movement of the control members **146**.

(173) Referring to FIGS. **1**A and **1**B, the housing **106** may be positioned at the proximal end **138** of the elongate neck **104**. The housing **106** may couple to the elongate neck **104** and may be configured for a user to grip. The housing **106** may be configured as a handle including an outer surface **150** for the user to grip. The housing **106** may have a proximal end **152** and a distal end **154**.

(174) The lumen **142** may extend through the housing **106**. The lumen **142** in the housing **106** may comprise a separate and distinct lumen, or may comprise the lumen **142** that extends through the elongate neck **104**. The housing **106** may include a port **156** at the proximal end **152** of the housing **106**. The port **156** may be configured for devices, such as a puncture device or other devices for passing through the lumen **142** and the lumen **124** and the opening **126** of the head **102**. The housing **106** may include a lock **158** at the port **156** that may lock the devices passing therethrough in position. The lock **158** may comprise a lock-knob or other form of lock.

(175) The housing **106** may include a vacuum port **160** at the proximal end **152** of the housing **106**. The vacuum port **160** may be configured to couple to a vacuum device for producing the vacuum suction at the head **102** and may pass the vacuum suction from the lumen **128**. The lumen of the vacuum port **160** may be coupled to the lumen **142** of the port **156**. At least one port may be utilized to pass vacuum suction therethrough and for passing a puncture device or other device therethrough to the head **102**.

(176) The housing **106** may include a control device **162**. The control device **162** may be configured for a user to manipulate or otherwise control the deflection of the elongate neck **104** to move the head **102**. The control device **162** may comprise a rotatable body (as shown in FIGS. **1**A and **1**B) and may be rotated to control the deflection of the elongate neck **104** and resulting

orientation of the head **102**. In other embodiments, other forms of control devices may be utilized. The control device **162** may be coupled to the one or more control members **146**. The control device **162** may be configured to control the one or more control members **146** to control the elongate neck **104** and head **102** in a manner discussed herein. For example, the control device **162** may pull or otherwise tension one or more control members **146** to deflect the elongate neck **104**. The control device **162** may be configured to engage the one or more control members **146**. The control device **162** may include a gear drive **164** or other form of engagement, for engaging and moving the one or more control members **146**. The gear drive **164** may pull the control member **146** to deflect the elongate neck, and to result in the curve shown for example in FIG. **1**E. In other embodiments, other forms of control may be utilized. For example, the gear drive **164** may be configured to push one of the control members **146** while another control member **146** is being pulled, to deflect the neck.

(177) The housing **106** may include a control device **163**. The control device **163** may be configured to control a rotation of the head **102**. The head **102** may be configured to rotate in position relative to the bearing surface **111**. FIG. **1**F for example, illustrates the head **102** rotating in position relative to the bearing surface **111** and accordingly relative to the elongate neck **104**. The application portion **114** accordingly rotates in position as well. The rotation of the head **102** may allow for a variety of orientations of the application portion **114**, and may be utilized in combination with the deflection of the elongate neck **104**. The head **102** may rotate for 360 degrees, or a different amount as desired.

(178) The control device **163** may be coupled to the lumen **142** of the elongate neck **104** such that rotation of the control device **163** and accordingly the lumen **142** may cause the head **102** to rotate relative to the elongate neck **104**. In other embodiments, a separate control member may extend from the control device **163** to the head **102** to rotate the head **102** relative to the elongate neck **104**. The control device **163** may comprise a rotatable body, similar to the control device **162**.

(179) The housing may include a cavity **166** for the one or more control members **146** to extend in. The cavity **166** may extend around the lumen **142**.

(180) The control devices **162**, **163** and one or more control members **146** may comprise a control mechanism **108** for deflecting the elongate neck **104** to move the head **102** (which may include curving the elongate neck **104**), and for rotating the head **102** as discussed. In other embodiments, other forms of control mechanisms may be used.

(181) The access apparatus **100** may include a puncture device **168** as shown in FIG. **11**. The puncture device **168** may be configured to pass through the lumen **124** and the opening **126** of the head **102** and puncture a surface of the patient's heart. The puncture device **168** may comprise a needle or other form of puncture device. The access apparatus **100** may include a sheath **170** (shown in FIG. **11**) that extends around the puncture device **168**. The puncture device **168** may extend within the lumen of the sheath **170**. The sheath **170** may be a relatively small sized sheath, for example, the sheath may be an about 5 Fr (French) sized sheath, or other sizes as desired.

(182) The access apparatus **100** may be utilized to control the orientation of the head **102** to move into a desired position. The access apparatus **100** as used in the systems and methods herein may be configured to be inserted into the patient's body from the front of the patient with the head **102** directed to a posterior portion of the patient's heart. Percutaneous entry of the patient's body may be utilized. The housing **106** may remain exterior to the insertion point of the access apparatus **100**. The elongate neck **104** may be deflected to vary the orientation of the head **102** and the head **102** may be rotated such that the application portion **114** and contact surface **118** contact the desired posterior portion of the patient's heart. The elongate neck **104** in this configuration may have a curvature that is similar or less than the curvature shown in FIG. **1**E, with the remainder of the elongate neck **104** extending around or along or curling around the patient's heart. The access apparatus **100** may accordingly allow for access to a posterior portion of the patient's heart from an anterior access location such as a sub xiphoid incision or anterior thoracotomy.

(183) The user may operate the control mechanism **108** to vary the position of the head **102** until the head is in the desired position. The head **102** may also be rotated to a desired orientation. The location marker **136** may be utilized to determine that the head **102** is in the desired position. Vacuum suction may be applied by the head **102** to grip the head **102** to the desired portion of the patient's heart. The vacuum suction may be applied though the lumen **128** of the head **102** and passed by the lumen **142** and vacuum port **160**. The vacuum suction may be released if the user determines the head **102** is in the incorrect position, and then reapplied upon the head **102** being moved to the desired position. Upon the vacuum suction gripping the head **102** to the patient's heart, the puncture device **168** may be passed through the lumen **124** and opening **126** to puncture the patient's heart. The puncture device **168**, or the sheath **170**, or other devices may be passed through the lumen **124** and opening **126** and into the patient's heart.
(184) Upon the desired procedure being applied to the patient's heart, the vacuum suction of the head **102** may be released to release the access apparatus **100** from the patient's heart. The access apparatus **100** may be withdrawn from the patient's body, and the elongate neck **104** may be deflected to vary the orientation of the head **102** in a reverse operation as the entry procedure.
(185) The access apparatus **100** may beneficially provide a minimally invasive manner to access the posterior portion of the patient's heart, without requiring a full sternotomy to be performed. The deflection of the elongate neck may allow the head **102** to reach the posterior portion of the patient's heart with a frontal entry of the patient's body. The rotation of the head **102** may also increase the variety of positions on the heart that the access apparatus **100** may access. The access apparatus **100** may beneficially allow for the vacuum suction to be applied and released, to allow the user to secure and release the head **102** to the patient's heart until the head **102** is in the desired position. The vacuum suction may also provide an effective manner to release the head **102** from the patient's heart when the desired procedure is complete. In other embodiments, the access apparatus **100** may have a different configuration than the configuration shown in FIGS. **1**A-**1**F.
(186) FIG. **2**A illustrates an embodiment of a ring **200** that may be used in a heart anchor, as may be used in the systems and methods disclosed herein. A heart anchor **202** as may be used in the systems and methods disclosed herein is illustrated in FIG. **2**G. The heart anchor **202** may be utilized in a heart splint (for example the splint **3100** shown in FIG. **31**, or other splints) or utilized in a plug (for example the plug **4100** shown in FIG. **44**) among other uses.
(187) The ring **200** may include a body having a first end **204** and a second end **206** (shown in FIG. **2**A in dashed lines, and shown in FIG. **2**B). The ring **200** may be configured to move from a linearized configuration (as shown in FIG. **2**H) to a ring-shaped configuration, as shown in FIG. **2**A. The first end **204** may include an opening **208** extending through the ring **200** at or proximal the first end **204** and an opening **210** (shown in FIGS. **2**A and **2**B in dashed lines) extending through the ring **200** at or proximal the second end **206**. The openings **208**, **210** may comprise couplers for coupling to the cover **212** (shown in FIGS. **2**G and **2**H).
(188) FIG. **2**B illustrates a side view of the ring **200** in the ring-shaped configuration shown in FIG. **2**A. Portions **214**, **216** of the ring **200** may overlap when the ring **200** is in the ring-shaped configuration. The portions **214**, **216** may overlap in the axial dimension **218**, as opposed to the radial dimension **220**. The portions **214**, **216** may overlap such that the portions **214**, **216** that overlap include the ends **204**, **206**. From a top view (as shown in FIG. **2**A), the portions may overlap such that the edges of the body of the ring **200** have a matching profile as viewed from the top. The edges of the body of the ring **200** may be aligned with each other in the radial dimension **220**. The edges of the body of the ring are not offset from each other at the overlapping portions in the radial dimension **220**. Thus, the ring **200** may appear as a continuous ring, which may have a circular shape or other shape as desired. Some examples of the ring include any suitable closed shape, which can be generally flat, as illustrated in FIGS. **2**A and **2**B, or can have a three-dimensional shape, for example, that accommodates one or more anatomical features.
(189) In some examples, a first end portion of the ring can overlap a second end portion of the ring

where at least one of the first end portion or the second portion is adjacent to or spaced from the respective end. For example, in some rings, at least one edge of the first end portion is offset or at an angle to at least one edge of the second end portion at the overlap. In other examples, the overlapping portions can include both ends of the first and second end portions where at least one edge of the first end portion is offset from an edge of the second end portion.

(190) The overlapping portions **214**, **216** may contact each other, and one of the overlapping portions may provide a support against force for the other overlapping portion. For example, a force applied to portion **214** may be resisted by portion **216** at the overlap, and a force applied to portion **216** may be resisted by portion **214** at the overlap. The overlapping portions **214**, **216** may provide support for the ring **200** upon a force being applied in the axial dimension.

(191) The overlapping portions **214**, **216** may overlap to a desired amount. In one embodiment, the overlapping portions **214**, **216** may overlap to at least about 5 degrees of the ring **200**. In one embodiment, the overlapping portions **214**, **216** may overlap to at least about 10 degrees, to at least about 20 degrees, to at least about 40 degrees, or to at least about 60 degrees of the ring **200**, or to a different amount as desired. In one embodiment, the entirety of the ring **200** may overlap such that the overlapping portions **214**, **216** comprise the entirety of the ring, for example, about 360 degrees, or even greater than 360 degrees. In one embodiment, the ring **200** may be configured to have a single overlap, as shown in FIG. **2**A, which may reduce the amount of material comprising the ring **200** and may ease the transition between the linearized configuration and the ring-shaped configuration. As will be apparent in the discussion below, the degree of overlap can change when the ring is in use. For example, tensioning and/or applying a load to the cover can reduce a diameter/circumference of the ring, thereby increasing the overlap in some examples.

(192) The ring **200** may have a thickness **222** (in the axial dimension **218**) and may have a width **224** (in the radial dimension **220**) (as marked in FIG. **2**A). The thickness **222** may be between about 0.2 and about 0.4 millimeters, although in other embodiments other thicknesses **222** may be utilized. In one embodiment, the thickness **222** may be about 0.3 millimeters. In some examples, the thickness can be non-uniform along a length/circumference of the ring. For example, in some rings, at least one of the overlapping portions can be thinner than a non-overlapping portion of the ring. The width **224** may be between about 0.3 and about 0.5 millimeters, although in other embodiments other widths **224** may be utilized. In one embodiment, the width **224** may be about 0.4 millimeters. In some examples, the width is non-uniform along a length/circumference of the ring, for example, wider at at least one of the overlapping portions. The ring **200** may be sized as desired, and may be configured to be a relatively thin ring that is flexible to allow for ease of movement of the ring **200**.

(193) Referring to FIG. **2**B, the ring **200** may have a flattened shape with a substantially planar top surface **226** and a substantially planar bottom surface **228** facing opposite the top surface **226**. The ring **200** at the overlapping portions **214**, **216** may have the top surface **226** of portion **216** face towards the bottom surface **228** of portion **214**. The terms “top” and “bottom” may be used interchangeably. Side surfaces **230** may connect the top surface **226** to the bottom surface **228**. The body of the ring **200** may have a rectangular profile when viewed in cross section.

(194) The ring **200** may be made of a material that is flexible, such that the ring may move from the linearized configuration (as shown in FIG. **2**H) to the ring-shaped configuration (as shown in FIG. **2**A). The ring **200** may be made of an elastic material to move from one configuration to the other relaxed or default configuration. In one embodiment, the ring **200** may be made of a super elastic or shape-memory material, which may include a shape-memory alloy, to allow the ring to move from the linearized configuration to the ring-shaped configuration. The shape-memory material may be a material such as nitinol or another shape-memory material. The ring **200** may be configured to automatically move from the linearized configuration to the ring-shaped configuration, as the shape-memory material may automatically move to the shape-set ring-shaped configuration.

(195) A linearized configuration is shown in FIG. **2**H. In this configuration, the portions **214**, **216** of the ring **200** may be separated from each other and do not overlap. The ends **204**, **206** of the ring **200** do not overlap. The ring **200** in FIG. **2**H may be in one form of linearized configuration, however, other forms may be utilized. For example, two opposite portions of the ring **200** in the ring-shaped configuration may be squeezed together towards a center portion of the ring such that the opposite portions of the ring-shaped body come together at the center portion and the ring **200** is linearized. Other forms of linearization may be utilized. The ring **200** in the linearized configuration may not be entirely straightened, although in other embodiments, the ring **200** may be entirely straightened (as shown in FIG. **2**H). As such, the term "linearized" refers to any configuration that is suitable for delivery and deployment through a catheter or other minimally invasive or percutaneous delivery system, and does not require that the ring or any portion thereof is substantially straight or linear. In some examples, no portion of the ring is substantially straight or linear in the linearized configuration. For example, all or a portion of a ring can adopt a helical, sinusoidal, and/or other curved shape in the linearized configuration. Consequently, the terms "delivery configuration" and "open configuration" can also be used to describe some examples. The ring **200** in the linearized configuration may be configured to fit within the lumen of a deployment apparatus **300**, as marked in FIG. **2**H.
(196) FIG. **2**C illustrates a top view of the cover **212** unfolded. The cover **212** may include a top edge **232** and an opposite bottom edge **234**. Side edges **236**, **238** may extend from the top edge **232** to the bottom edge **234**. The terms "top" and "bottom" may be used interchangeably.
(197) The cover **212** may include a plurality of cut-outs **240** defining openings **242** in the cover **212**. The cut-outs **240** may be in the form of a pattern of shapes. The shapes, as shown in FIG. **2**C, may be asymmetric diamonds. The asymmetric diamonds may include opposite triangular portions **244**, **246**. The triangular portions **244** may have an angle and side lengths from the central vertex **248** that is different than the angle and side lengths from the central vertex **250** of the triangular portion **246**. The angle from the central vertex **248** is greater than the angle from the central vertex **250**, and the side lengths from the central vertex **248** are shorter than the side lengths from the central vertex **250**. The side lengths of the triangular portions **244**, **246** extend to straight side portions **252**, **254**.
(198) The cut-outs **240** may leave the remaining portion of the cover **212** with trapezoidal portions **256**, **258** having differing heights and side lengths. The height and side lengths of the trapezoidal portions **256** may be less than the height and side lengths of the trapezoidal portions **258**. The trapezoidal portions **256**, **258** may be connected with rectangular portions **260**.
(199) The pattern of cut-outs **240** may be repeated along the length of the cover **212**. The shape and pattern of cut-outs **240** and shape and pattern of the remaining portions of the cover **212** may be varied from the shapes and pattern shown in FIG. **2**C as desired. In examples in which the ring has a non-circular ring-shaped or closed configuration, the particular details of the cover can differ, for example, the patterns of shapes defined by the cut-outs and/or their dimensions.
(200) The cover **212** may include a fold portion **262** marked in dashed lines in FIG. **2**C. The cover **212** may be configured to fold at the fold portion **262**. The portion of the cover **212** shown above the fold portion **262** may comprise an overlapping portion **264** and the portion of the cover **212** shown below the fold portion **262** and above the dot-dashed line may comprise an overlapping portion **266**. The overlapping portion **266** may overlap the overlapping portion **264** when the cover **212** is folded at the fold portion **262**. The cover **212** may include a fold portion **263** marked in dot-dashed lines in FIG. **2**C. The cover **212** may include an overlapping portion **268** indicated below the dot-dashed line in FIG. **2**C. The overlapping portion **268** may be configured to overlap the top edge **232** of the cover **212** and a portion of overlapping portion **264** when the cover **212** is folded upon the fold portion **262**.
(201) The dimensions of the cover **212** may be set as desired. The dimensions may include a length **270**. The length **270** may extend from the side edge **236** to the side edge **238**. The length **270** may

be between about 100 millimeters and about 70 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the length **270** may be about 88 millimeters. The dimensions may include a width **272** of the unfolded cover **212**. The width **272** may extend from the top edge **232** to the bottom edge **234**. The width **272** may be between about 20 millimeters and about 30 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the width **272** may be about 22 millimeters.

(202) The dimensions may include a width **274** of the cover **212** from the bottom edge **234** to the lower end of the cut-outs **240**. The width **274** may be between about 4 millimeters and about 7 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the width **274** may be about 5.5 millimeters. The dimensions may include a width **275** of the cut-outs **240**. The width **275** may be between 10 about millimeters and about 15 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the width **275** may be about 13.5 millimeters. The dimensions may include a width **276** of the rectangular portions **260**. The width **276** may be between about 3 millimeters and about 7 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the width **276** may be about 5 millimeters. The dimensions may include a width **277** of the cover **212** from the top edge **232** to the upper end of the cut-outs **240**. The width **277** may be between about 1 millimeter and about 5 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the width **277** may be about 3 millimeters.

(203) The dimensions may include a thickness **278** of the rectangular portions **260**. The thickness **278** may be between about 1 millimeter and about 5 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the thickness **278** may be about 3 millimeters. The dimensions may include a thickness **279** of the cut-outs **240**. The thickness **279** may be between about 3 millimeters and about 8 millimeters, and in other embodiments, may have a greater or lesser size as desired. In one embodiment, the thickness **279** may be about 6 millimeters.

(204) FIG. **2**D illustrates the cover **212** having been folded at the fold portion **262**. The overlapping portion **266** overlaps the overlapping portion **264** (and the overlapping portion **264** overlaps the overlapping portion **266**). The overlapping portions **264**, **266** form respective layers, including a first layer **280** and a second layer **282** that overlap and may be in contact with each other. The cover **212** may be folded such that the central vertices **250** may be brought towards the central vertices **248**, and the trapezoidal portions **258** overlap the rectangular portions **260**. The triangular portions **246** of the cut-outs may form triangular-shaped gaps between the trapezoidal portions **258**. The cover **212** in this configuration includes a plurality of protrusions **247** extending from a connecting portion **249** of the cover **212**.

(205) The cover **212** at the fold portion **262** may form a coupler **284** for coupling the cover **212** to a tension member **286** (as shown in FIG. **2**G). The cover **212** at the fold portion **263** may form a coupler **287** (marked in FIG. **2**E) for coupling to the ring **200**. The couplers **284**, **287** may comprise folded material at the fold portions **262**, **263** that the respective tension member **286** and ring **200** may be passed through.

(206) FIG. **2**E illustrates a side view of the cover **212** in the configuration shown in FIG. **2**D. The position of the tension member **286** (if coupled to the cover **212**) is shown in dashed lines at the top of the cover **212** and the position of the ring **200** (if coupled to the cover **212**) is shown in dashed lines at the bottom of the cover. The overlapping layers **280**, **282** are visible. The overlapping portion **268** overlaps the edge **232** of the cover **212**. The overlap of the overlapping portion **268** forms the coupler **287** in the form of a loop at a bottom end of the cover **212**. The bottom end, when the ring **200** is in the ring-shaped configuration, may comprise a peripheral portion of the cover **212**. Connectors **288** may extend through the layers **280**, **282** and overlapping portion **268** to secure the loop in position at the bottom end of the cover **212**. The connectors **288** may comprise sutures or other form of stitching, or another form of connector that connects the overlapping layers

280, **282** and overlapping portion **268**. The connectors **288** may pass through the openings **208**, **210** in the ring **200** to securely connect the ring **200** to the cover **212**. The ring **200** may be positioned between the connectors **288** and the fold portion **263**, and sandwiched between the layers **280**, **282**.
(207) The cover **212** at the fold portion **262** forms a coupler **284** in the form of a loop at the top end of the cover **212**. The top end, when the ring **200** is in the ring-shaped configuration, may comprise a central portion of the cover **212**. The tension member **286** may pass through the coupler **284** and may be sandwiched between the layers **280**, **282**.
(208) FIG. **2**F illustrates an embodiment of a cover **281** having a different configuration of cut-outs than shown in the embodiment of FIGS. **2**C-**2**E, **2**G and **2**H. The cut-outs in the embodiment of FIG. **2**F are symmetrical as folded upon the fold portion **289**. The remaining portions of the cover **281** include a first layer **290** and a second layer **291** that have the same symmetrical shapes of trapezoidal portions coupled to rectangular portions (that include the fold portion **289**). An overlapping portion **292** may overlap the layers **290**, **291** and may form a coupler for coupling to the ring **200**, in a similar manner as the embodiment of FIGS. **2**C-**2**E, **2**G and **2**H. The fold portion **289** may form a coupler for coupling to the tension member **286**, in a similar manner as the embodiment of FIGS. **2**C-**2**E, **2**G and **2**H. The configuration of cover **281** may be utilized with the systems and methods disclosed herein, in a similar manner as cover **212**. The shape and configuration of the covers **212**, **281** shown in FIGS. **2**C-**2**H may be varied as desired.
(209) The covers **212**, **281** may be flexible and configured to move with the ring **200** as it moves from the linearized configuration to the ring-shaped configuration. The covers **212**, **281** may be made of a flexible material, which may include, for example, a cloth or fabric. The flexible material may be woven or non-woven. The flexible material may include materials such as ultra-high-molecular-weight polyethylene (UHMwPE) (for example, DYNEEMA® fabric or laminate, Koninklijke DSM, the Netherlands) or polyethylene terephthalate (PET, for example, DACRON® fabric, Invista, Wilmington, Delaware). In other embodiments, other flexible materials may be utilized.
(210) FIG. **2**G illustrates the ring **200** in a ring-shaped configuration, with the ring **200** coupled to the cover **212**, and the tension member **286** coupled to the cover **212**. Portions of the ring **200** coupled to the cover **212** may overlap, in a manner discussed previously. Portion **245** comprises an overlapping portion of the ring **200** and the cover **212**. The cover **212** extends inward from the ring **200** in the ring-shaped configuration.
(211) The tension member **286** is coupled to the cover **212** at the fold portions **262**. The tension member **286** is drawn away from the cover **212** such that the cover **212** is drawn towards a central opening **293** of the cover **212**. The tension member **286** accordingly may cinch the cover **212** towards the central opening **283**. In some examples, the cover **212** can in turn pull on the ring **200**, reducing a diameter/circumference thereof. The cover **212** is in a disc-shaped configuration. The cover **212** in this configuration includes a central portion **294** and a peripheral portion **295**. The overlapping layers of material of the cover **212** (the layers **280**, **282**) extend from the peripheral portion **295** to the central portion **294**. The fold portions **262** are positioned at the central portion **294**, and the ring **200** is positioned in the peripheral portion **295**.
(212) The trapezoidal portions **258** of the layer **280** may be placed adjacent each other such that the gaps between the trapezoidal portions **258** shown in FIG. **2**D are closed. The cover **212** accordingly may comprise a closed surface extending from the peripheral portion **295** to the central portion **294**. The protrusions **247** are adjacent each other and extend from the peripheral portion **295** to the central portion **294**.
(213) The tension member **286** may comprise a portion of a heart splint, and may be configured to provide tension between the anchors of a heart splint. The tension member **286** may comprise a tether, and may be in the form of a cord, or other form of tension member. The tension member **286** may be made of a flexible material, which may include ultra-high-molecular-weight polyethylene (UHMwPE) (for example, FORCE FIBER® suture, Teleflex, Wayne, Pennsylvania or

DYNEEMA® fiber, Koninklijke DSM, the Netherlands), among other flexible materials. The tension member **286** may include a body, and may include a coupling device **296** at its end that may couple the tension member **286** to itself. The coupling device **296** may comprise a loop that the body of the tension member **286** passes through, such that as the body of the tension member **286** is pulled, a size of a loop **297** formed by the tension member **286** being threaded through the fold portions **289** of the cover **212** reduces in size. The portion of the tension member **286** forming the loop **297** passes through the coupler **284** (marked in FIG. **2**D) positioned at the central portion **294** of the cover **212**. Thus, as the tension member **286** is pulled, the size of the loop **297** reduces, and accordingly the cover **212** is cinched and pulled radially towards the central opening **293** of the cover **212**. The anchor **202** in the configuration shown in FIG. **2**G may have a diameter of between about 20 millimeters and about 25 millimeters, although other diameters may be utilized as desired. In one embodiment, the anchor **202** may have a diameter of about 22 millimeters.

(214) The cover **212** may be configured to be drawn towards the central opening **293** such that the central opening **293** entirely closes. The tension member **286** may extend from the cover **212** at the central portion **294** of the cover **212**.

(215) FIG. **2**H illustrates the ring **200** in a linearized configuration. The ring **200** is extended such that the ends **204**, **206** are separated from each other. The tension member **286** is visible extending through the coupler **284** of the central portion **294**. The anchor **202** is in a linearized configuration.

(216) A deployment member **306** may be utilized to deploy the cover **212** of the anchor **202**. The deployment member **306** may comprise a tether, and may be in the form of a cord, or other form of deployment member. The deployment member **306** may be looped, and may be coupled to the cover **212** at the coupler **284**. The deployment member **306** may be looped through the coupler **284** in a manner shown in FIG. **2**H. The deployment member **306** may be pulled to cinch or draw the cover **212** towards the central opening **293** of the cover **212** in a similar manner as discussed above regarding the tension member **286**. The anchor **202**, upon being positioned in the lumen of a deployment apparatus, may have the cover **212** flattened, as shown in FIG. **21**. The deployment member **306** may close or otherwise cinch the cover **212**. The anchor **202** may be held against the end of the deployment apparatus **300** when the deployment member **306** is pulled, to support the anchor **202** in position. The ring **202**, however, may also be configured to automatically move to or towards the ring-shaped configuration.

(217) The anchor **202** may accordingly be configured to move from an unexpanded configuration to an expanded configuration. The unexpanded configuration may comprise the configuration in which the ring **202** is in the linearized configuration, and the anchor **202** is accordingly linearized. The expanded configuration may be the configuration in which the ring **202** is in the ring-shaped configuration and the cover **212** is in a disc-shaped configuration. In other embodiments, other unexpanded and expanded configurations may be utilized. In an expanded configuration, an anchor may have a larger diameter or other dimensions. In unexpanded configuration, the anchor may have a smaller diameter or other dimensions and may be configured to fit within the lumen of a deployment apparatus. The configurations of anchor may vary from that shown in FIGS. **2**G and **2**H.

(218) The anchor **202** may beneficially be configured such that the cover **212** bears the majority of the force against the anchor **202** when the tension member **286** is tensioned. The ring **200** may be configured to provide support for the shape of the cover **212**, but otherwise may bear a lesser portion of the force against the anchor **202**. The overlapping portions of the ring **200** may beneficially provide enhanced strength for the ring **200**.

(219) The relatively thin shape of the ring **200** may allow the ring **200** to be flexible to fit within the lumen of a deployment apparatus. The ring **200** may be able to be positioned within the lumen of a deployment apparatus with a relatively low force, and may be positioned within the lumen manually. The ring **200** may be sufficiently flexible to be hand-loaded into a deployment apparatus.

(220) The anchor **202** may have a variety of uses, including use as a portion of a heart splint as may

be disclosed herein. The anchor **202** may also be used as a portion of a plug to seal an opening in a patient's heart septum, among other uses.
(221) FIG. **3**A illustrates an embodiment of a deployment apparatus **300** that may be used in the systems and methods disclosed herein. The deployment apparatus **300** may include a deployment catheter **302**, a push device **304**, and a deployment member **306**. The deployment apparatus **300** may be configured to deploy an anchor, such as the anchor **202** shown in FIGS. **2**G and **2**H, in an interior chamber of the patient's heart.
(222) FIG. **3**B illustrates a cross sectional view of the deployment apparatus **300** (with the pull device **308** not shown in cross section).
(223) Referring to FIGS. **3**A and **3**B, the deployment catheter **302** may include a proximal end **310**, a distal end **312** and a body extending between the proximal end **310** and the distal end **312**. The deployment catheter **302** may include a lumen **313** positioned therein. A housing **314** may be positioned at the proximal end **310** of the catheter **302**. The housing **314** may be configured to be manipulated by a user. The deployment catheter **302** may have an about 8 Fr size, although other sizes may be utilized as desired.
(224) The housing **314** may include a lock **316** and two portions **318**, **320** for controlling the lock **316**. The lock **316** may be configured to lock movement of the push device **304** positioned within the lumen **313**. The lock **316** may comprise threaded portions of the housing **314** that are pressed as the portions **318**, **320** are rotated relative to each other. The portion **320** may be constricted to press against the push device **304** to lock movement of the push device **304** within the lumen **313**.
(225) The lumen **313** of the deployment catheter **302** may be configured to hold the anchor **202** in the lumen **313**, in a portion **321** marked in dashed lines in FIG. **3**B. The lumen **313** may hold the anchor **202** in the unexpanded or linearized configuration in the lumen **313**. The deployment catheter **302** may include a tip **322** for the anchor **202** to be pressed against as the deployment member **306** is pulled, in a manner discussed herein.
(226) The push device **304** may include a distal end **324**, a proximal end **326**, and a body extending between the distal end **324** and the proximal end **326**. The push device **304** may include a lumen **328** for the deployment member **306** to extend in.
(227) A housing **330** may be positioned at the proximal end **326** of the push device **304**. The housing **330** may be configured to form a grip for a user.
(228) The push device **304** may be sized to fit within the lumen **313** of the deployment catheter **302**. The push device **304** may be configured to slide within the lumen **313** of the deployment catheter **302** and may be configured to push the anchor **202** in the linearized configuration out of the lumen **313** and distal end **312** of the deployment catheter **302**.
(229) The deployment member **306**, as previously discussed, may comprise a tether, and may be in the form of a cord, or other form of deployment member. The deployment member **306** may be looped, with ends of the deployment member coupled to a pull device **308**. The deployment member **306** may be looped through a coupler of the anchor **202**, as previously discussed. The deployment member **306** may be configured to extend in the lumen **313** of the deployment catheter **302** and the lumen **328** of the push device **304**.
(230) The pull device **308** may comprise a handle for being pulled, or may comprise another form of pull device **308**. The pull device **308** may be configured for a user to grip and pull. Pulling the pull device **308** may draw the deployment member **306** in a proximal direction through the deployment catheter **302** and the push device **304**.
(231) FIG. **4**A illustrates an embodiment of a delivery apparatus **400** that may be used in the systems and methods disclosed herein. The delivery apparatus **400** may include an elongate sheath **402** and a housing **404**. The delivery apparatus **400** may include a control mechanism **406** for controlling movement of the elongate sheath **402**.
(232) FIG. **4**B illustrates a cross sectional view of the delivery apparatus **400**.
(233) Referring to FIGS. **4**A and **4**B, the elongate sheath **402** may include a distal end **408** and a

proximal end **410** and a body extending between the distal end **408** and the proximal end **410**. The elongate sheath **402** may include a lumen **412**. The lumen **412** may allow devices to be passed therethrough. The elongate sheath **402** may include an opening **414** at the distal end **408** for devices to be passed through to exit the lumen **412**.

(234) The elongate sheath **402** may be flexible and configured to deflect along its length. The elongate sheath **402** may be configured to curve, and may deflect and curve in a similar manner as the elongate neck **104** of the access apparatus **100** discussed in regard to FIGS. **1**A-**1**F.

(235) The elongate sheath **402** may include a lumen **416** that one or more control members **418** may pass through. The lumen **416** may be positioned exterior of the lumen **412** and may surround the lumen **412**. The elongate sheath **402** may include an outer sheath **419** that extends around the lumens **412**, **416** and forms the outer surface **415** of the elongate sheath **402**. The outer surface **415** may be configured to be smooth to allow for a smooth entry into the vessels of the patient's body, including the chambers of the patient's heart. The one or more control members **418** may be configured similarly as the control members **146** discussed in regard to FIGS. **1**A-**1**F.

(236) The housing **404** may be positioned at the proximal end **410** of the elongate sheath **402**. The housing **404** may couple to the elongate sheath **402** and may be configured for a user to grip. The housing **404** may be configured as a handle include an outer surface **417** for the user to grip. The housing **404** may have a proximal end **421** and a distal end **423**.

(237) The lumen **412** may extend through the housing **404**. The lumen **412** in the housing **404** may comprise a separate and distinct lumen, or may comprise the lumen **412** that extends through the elongate sheath **402**. The housing **404** may include a port **424** at the proximal end **421** of the housing **404** for a device to be inserted into the lumen **412**. A valve **425** may be positioned at the proximal end of the delivery apparatus **400** to prevent fluid such as blood from exiting the lumen **412** in the proximal direction.

(238) The housing **404** may include a control device **420**. The control device **420** may be configured for a user to manipulate or otherwise control the elongate sheath **402**. The control device **420** may comprise a rotatable body and may be rotated to control the elongate sheath **402**. In other embodiments, other forms of control devices may be utilized. The control device **420** may be configured to control the one or more control members **418** in a similar manner as discussed in regard to the control device **162** discussed in regard to FIGS. **1**A-**1**F. The control device **420** may be configured to move the one or more control members **418** to deflect the elongate sheath **402** in a similar manner as discussed regarding elongate neck **104**. In other embodiments, other forms of control may be utilized.

(239) The housing **404** may include a cavity **422** for the one or more control members **418** to extend in.

(240) The control device **420** and one or more control members **418** may comprise a control mechanism **406** for deflecting the elongate sheath **402** varying the orientation of the opening **414** at the end **408** of the elongate sheath **402**. The control mechanism **406** may operate in a similar manner as the control mechanism **108** discussed in regard to FIGS. **1**A-**1**F. In other embodiments, other forms control mechanisms may be used.

(241) The delivery apparatus **400** may be utilized to control the orientation of the distal end **408** of the elongate sheath **402** to move the distal end **408** into a desired position. A device may then be passed through the opening **414** at the distal end **408** at the desired position. The deflection and curvature of the elongate sheath **402** may be controlled with the control mechanism **406** to place the opening **414** in the desired position. The delivery apparatus **400** may be used in the systems and methods disclosed herein to deliver a device to a desired location, which may include a chamber of the patient's heart and may include a position adjacent the interventricular septum. The delivery apparatus **400** may have other configurations than shown in FIGS. **4**A and **4**B.

(242) FIG. **5** illustrates an embodiment of an introducer sheath **500** that may be used in the systems and methods disclosed herein. The introducer sheath **500** includes a proximal end **502**, a distal end

504 and a body extending between the proximal end **502** and the distal end **504**. The sheath **500** may include a lumen **506**, as shown in cut-away in FIG. **5**. The sheath **500** may include a housing **508** at the proximal end **502** of the sheath **500**. A valve **510** may be coupled to the housing **508** via tubing **512**, and the valve **510** may control fluid flow through the sheath **500**. The sheath **500** may be sized as an about 14 Fr sized sheath, although other sizes may be utilized as desired.

(243) The introducer sheath **500** may be configured to be inserted into the patient's body via an introducer and may be configured to serve as an entry-way into the patient's body, and particularly the vessels of the patient's body leading to the patient's heart. The introducer sheath **500** may be configured for a neckline introduction into the patient's blood vessels, and particularly the patient's superior vena cava. The introducer sheath **500** may be configured to allow devices to pass through the lumen **506**, including devices disclosed in this application. Such devices may include the delivery apparatus **400**, as shown in FIG. **5** extending through the lumen **506**. The introducer sheath **500** may have other configurations than shown in FIG. **5**.

(244) FIG. **6**A illustrates an embodiment of a snare **600** that may be used in the systems and methods disclosed herein. The snare **600** may include a longitudinal body having a distal end **602** and a proximal end **604**. A snare control **606** may be positioned at the proximal end **604** of the snare **600** and may be configured to control the operation of a snare device **608** that may be positioned at the distal end **602** of the snare **600**, as shown in FIG. **6**B. The snare control **606** may comprise a plunger **610** for being pushed to extend the snare device **608** from the distal end **602** of the snare **600**. The plunger **610** may be biased to retract the snare device **608** from the distal end **602** of the snare **600**. A force against the bias of the plunger **610** may extend the snare device **608** from the distal end **602** of the snare **600**. In other embodiments, other forms of snare control **606** may be utilized.

(245) The snare device **608** may comprise a device for snaring other components of the systems disclosed herein. As shown in FIG. **6**B, the snare device **608** may comprise a loop that may extend and retract into the distal end **602** of the snare **600** depending on the operation state of the snare control **606**. The snare device **608** may retract into the body of the snare **600** for an unexpanded configuration (as shown in FIG. **6**A), and may expand into the expanded configuration shown in FIG. **6**B. The snare device **608** may loop around another component of the system and then be retracted to the distal end **602** of the snare **600** to snare the other component. The snare device **608** may include a puncture device **612** at a tip of the snare device **608**. The puncture device **612** may comprise a needle or other form of puncture device for puncturing a portion of a patient's heart. The snare device **608** may be configured such that the puncture device **612** extends out from the distal end **602** of the snare **600** without the remainder of the snare device **608** being expanded. In this manner, the snare **600** may be configured to puncture portions of the patient's heart without the remainder of the snare device **608** being fully expanded.

(246) The snare **600** may be configured to be flexible and may be configured to pass through portions of the patient's heart, including the interventricular septum and the exterior wall of the heart. The snare device **608** may be configured to be expanded in chambers of the patient's heart, including the left or right ventricle.

(247) In other embodiments, the configuration of the snare device **608** or puncture device **612** may be varied as desired. Multiple snares may be utilized in the systems and methods disclosed herein. Like snares, and like components of such snares, may be indicated with a prime symbol following a reference number, such as **600**′.

(248) FIG. **7**A illustrates an embodiment of a deployment apparatus **700** that may be used in the systems and methods disclosed herein. The deployment apparatus **700** may include a head **702**, an elongate neck **704**, and a housing **706**. The deployment apparatus **700** may include housings **708** and **710**. The deployment apparatus **700** may be configured to deploy a heart anchor, such as the heart anchor **800** shown in FIGS. **8**A-**8**F to an external surface of a patient's heart.

(249) FIG. **7**B illustrates a cross sectional view of the deployment apparatus **700**.

(250) Referring to FIGS. **7**A and **7**B, the head **702** may include a proximal end **703** and a distal end **705**. The head **702** may be configured to retain the heart anchor. The head **702** may include a retainer **712** and a connection portion **713**.
(251) The retainer **712** may be configured to retain an anchor to the deployment apparatus **700**. The retainer **712** may comprise a portion of the head **702**. The retainer **712** may include side walls **714** that extend on opposite sides of the anchor to retain the anchor to the deployment apparatus **700**. The anchor may be positioned in a gap **716** positioned between the side walls **714**. In other embodiments, the retainer **712** may have a different configuration than shown in FIGS. **7**A and **7**B.
(252) The retainer **712** may include an opening **718** of a lumen **720**. The lumen **720** may be configured to pass a device therethrough, such as a snare **722** or a tension member (such as tension member **286** shown in FIG. **2**G), or a lock retainer member **856** as shown in FIG. **8**A. The lumen **720** may be configured to receive the snare **722** and the tension member. The body of a snare **722**, for example, is shown passing through the lumen **720** and the opening **718** in FIG. **7**B.
(253) The retainer **712** may be configured to rotate in position. A bearing surface **711** may be positioned between the retainer **712** and the remaining portion of the head **702** to allow the retainer **712** to rotate. The retainer **712** may be configured to rotate about the axis of the end of the lumen **720** at the opening **718**. The rotation of the retainer **712** may cause the anchor coupled thereto to rotate, to vary the orientation of the anchor relative to a portion of the patient's heart for the anchor to be deployed upon. The retainer **712** may be configured to rotate for 360 degrees, or a different amount as desired. FIG. **7**D illustrates the rotation of the retainer **712**.
(254) The connection portion **713** of the head **702** may connect the retainer **712** to the elongate neck **704**. The connection portion **713** may be angled to angle the position of the retainer **712** relative to the elongate neck **704**. The connection portion **713** may be curved, as shown in FIG. **7**B. The connection portion **713** may be configured to be angled at about 90 degrees, as shown in FIG. **7**B, or may be angled to a greater or lesser amount as desired. The connection portion **713** may include a lumen **724** that the lumen **720** may pass through.
(255) The elongate neck **704** may include a proximal end **726** and distal end **728** and a body extending from the proximal end **726** to the distal end **728**. The distal end **728** of the elongate neck **704** may couple to the proximal end **703** of the head **702**. The elongate neck **704** may include a lumen **730** that may extend the length of the elongate neck **704**. The lumen **730** may be configured for devices to pass through, such as the snare **722** or a tension member (such as tension member **286** shown in FIG. **2**G), or a lock retainer member **856** as shown in FIG. **8**A. The lumen **730** may couple to the opening **718** and may be configured to pass devices through the lumen **720** and opening **718**. The lumen **730** may be separate from the lumen **720** or may be integral with the lumen **720**.
(256) The elongate neck **704** may include a lumen **732** that one or more control members **734** may pass through. The lumen **732** may be positioned exterior of the lumen **730** and may surround the lumen **730**. The elongate neck **704** may include an outer sheath **736** that extends around the lumens **730**, **732** and forms the outer surface of the elongate neck **704**. The outer surface may be configured to be smooth to allow for a smooth entry into the patient's body.
(257) The one or more control members **734** may be elongate members that extend along the length of the elongate neck **704**. The control members **734** may comprise wires or rods, or other forms of control members. The control members **734** may couple to a portion of the elongate neck **704** or head **702**. The control members **734** may be configured to deflect the elongate neck **704** to move the head **702** in a similar manner as discussed in regard to elongate neck **104** of FIGS. **1**A-**1**F. For example, the control members **734** may be configured such that one control member is pulled along the elongate neck **704**. The movement of the control member **734** along the elongate neck **704** may cause the elongate neck **704** to deflect or curve along its length. In other embodiments, other forms of control may be applied, for example, one or more control members **734** may be configured to rotate to cause the elongate neck **704** to deflect or curve, or other forms of control may be utilized.

In one embodiment, one control member **734** may be configured to be pushed while the other control member is pulled along the elongate neck **704**, to cause the elongate neck **704** to deflect or curve. In one embodiment, only one control member **734** may be pushed or pulled along the length of the elongate neck **704** to control deflection of the elongate neck **704**.

(258) The elongate neck **704** may be flexible and configured to deflect along its length. The elongate neck **704** may be configured to curve. The deflection of the elongate neck **704** may operate similarly as the deflection of the elongate neck **104** shown in FIG. **1**E. FIG. **7**C, for example, illustrates the deflection of the elongate neck **704**. The elongate neck **704** may be configured to curve such that the head **702** rotates by approximately 180 degrees, and the retainer **712** may face the elongate neck **704**. The elongate neck **704** may be configured to curve at only a portion of the elongate neck **704**, for example a distal portion of the elongate neck **704**, or a portion proximate to the head **702**. The amount of deflection, or curvature, may vary as desired. The deflection may occur in multiple planes of the elongate neck **704**, for example, if multiple control members **734** are pulled at various orientations along the lumen **730**. The elongate neck **704** may deflect in a downward direction as shown in FIG. **7**C, or may deflect in a relative upward direction or right direction (into the page in FIG. **7**C) or left direction (out of the page in FIG. **7**C). Combinations of directions of movement may occur based on the orientation and movement of the control members **734**.

(259) The housing **706** may be positioned at the proximal end **726** of the elongate neck **704**. The housing **706** may couple to the elongate neck **704** and may be configured for a user to grip. The housing **706** may be configured as a handle including an outer surface **738** for the user to grip. The housing **706** may have a proximal end **740** and a distal end **742**.

(260) The lumen **730** may extend through the housing **706**. The lumen **730** in the housing **706** may comprise a separate and distinct lumen, or may comprise the lumen **730** that extends through the elongate neck **704**.

(261) The housing **706** may include a control device **744**. The control device **744** may be configured for a user to manipulate or otherwise control the elongate neck **704**. The control device **744** may comprise a rotatable body (as shown in FIGS. **7**A and **7**B) and may be rotated to control the elongate neck **704**. In other embodiments, other forms of control devices may be utilized. The control device **744** may be configured to control the one or more control members **734** to control the elongate neck **704**. The control device **744** may operate similarly as control device **162** of FIGS. **1**A-**1**F. For example, the control device **744** may move the one or more control members **734** to deflect the elongate neck **704**. The control device **744** may be configured to engage the one or more control members **734**. The control device **744** may include a gear drive **746** or other form of engagement, for engaging and moving the one or more control members **734**. The gear drive **746** may pull or tension the control members **734** to deflect the elongate neck **704**. In embodiment, the gear drive **746** may alternatively move the control members **734** in opposite directions to deflect the elongate neck. In other embodiments, other forms of control may be utilized. In one embodiment, a single control member **734** may be pushed and pulled to deflect the elongate neck **704**.

(262) The housing may include a cavity **748** for the one or more control members **734** to extend in.

(263) The control device **744** and one or more control members **734** may comprise a control mechanism **747** for deflecting the elongate neck **704** and varying the orientation of the retainer **712** as discussed. In other embodiments, other forms of control mechanisms may be used.

(264) The deployment apparatus **700** may include a tension mechanism **749**. The tension mechanism **749** may be configured to tension a tension member of the anchor (such as tension member **286** shown in FIG. **2**G). The tension mechanism **749** may include the housing **708**, the housing **710**, and the lock **750**.

(265) The housing **708** may include a proximal end **752**, a distal end **754**, and a body extending from the proximal end **752** to the distal end **754**. The distal end **754** of the housing **708** is coupled

to the proximal end **740** of the housing **706**. The housing **708** may include a rotation device **756** at the distal end **754** of the housing **706**. The rotation device **756** may comprise a rotation ring that may be inserted into a receiver **758** positioned at the proximal end **740** of the housing **706**. The receiver **758** may comprise a slot positioned at the proximal end **740** of the housing **706**. The rotation device **756** may be configured to rotate within the slot to rotate relative to the housing **706**. A proximal end of the rotation device **756** may be coupled to the housing **708** such that the housing **708** rotates with the rotation device **756**. For example, the rotation device **756** may couple to the housing **708** with a threaded coupling or other form of secure coupling. The configuration of the rotation device **756** and receiver **758** may vary from the configuration shown in FIGS. **7**A and **7**B.

(266) The proximal end **752** of the housing **708** may include a control device **760**. The control device **760** may comprise a rotatable body (as shown in FIGS. **7**A and **7**B) and may be rotated to move the housing **710** relative to the housing **708**. The control device **760** may comprise a knob or other form of rotatable body for control by a user. In other embodiments, other forms of control devices may be utilized. The control device **760** may include a gear drive **762** or other form of engagement, for engaging and moving the housing **710**. The gear drive **762** may comprise threading on the interior surface of the control device **760**. The gear drive **762** may move the housing **710** in a proximal direction when the control device **760** is rotated in one direction, and may move the housing **710** is a distal direction when the control device **760** is rotated in an opposite direction. In other embodiments, other forms of control may be utilized.

(267) The housing **708** may include a cavity **764** for receiving the housing **710**. The lumen **730** may extend through the housing **706** and may extend into cavity **764**. The lumen **730** in the housing **708** may comprise a separate and distinct lumen, or may comprise the lumen **730** that extends through the elongate neck **704**.

(268) The housing **710** may include a distal end **766** and a proximal end **768** and a body extending from the distal end **766** to the proximal end **768**. An outer surface of the housing **710** may include a gear drive **765** configured to engage the gear drive **762** of the control device **760**. The gear drive **765** may comprise threading on the outer surface of the control device **760**. As the gear drive **762** of the control device **760** is rotated, the engagement of the gear drives **762**, **765** may cause the housing **710** to slide within the housing **708**. The housing **710** may include a lumen **770**. The lumen **770** in the housing **710** may comprise a separate and distinct lumen, or may comprise the lumen **730** that extends through the elongate neck **704**. The housing **710** may include a port **772** at the proximal end of the housing **710** for devices to pass through the lumen **770** and lumen **730**, such as the snare **722** or a tension member (such as tension member **286** shown in FIG. **2**G).

(269) A protrusion **769** may extend outward from the housing **710**. The protrusion **769** may be configured to contact inner walls of the housing **708** to limit movement of the housing **710** relative to housing **708**.

(270) The lock **750** may be coupled to the housing **710**. The lock **750** may include a rotatable body **774** and a biasing device **776**. The rotatable body **774** may be pivotally coupled to the housing **710** such that the rotatable body **774** may pivot within the lumen **770** and relative to the housing **710**. The rotatable body **774** may rotate about a pivot. The biasing device **776** may bias the rotatable body **774** to a locked state, in which the rotatable body **774** is pressed towards a surface of the lumen **770** (as shown in FIG. **7**B). The rotatable body **774** in the locked state may press a device against a surface of the lumen **770** to prevent movement of the device. For example, as shown in FIG. **7**B, the body of the snare **722** is pressed by the rotatable body **774** and locked in position. Other devices, such as a tension member (such as tension member **286** shown in FIG. **2**G) may be locked in position in a similar manner. The opposite end of the rotatable body **774** may comprise a protrusion **778** that extends outward from the outer surface of the housing **710** when the lock **750** is in the locked state. The protrusion **778** may be pressed with an unlock ring **780** (as shown in FIG. **27**) that may be slid over the outer surface of the housing **710** to move the lock **750** to the unlocked state. The rotatable body **774** may be rotated away from the surface of the lumen **770** in the

unlocked state and a device may be released to slide within the lumen **770**. In other embodiments, other forms of locks may be utilized as desired.
(271) The tension mechanism **749** may be configured such that the lock **750** locks a device in position relative to housing **710**. As discussed, the device may be a tension member of the anchor (such as tension member **286** shown in FIG. **2**G). Upon the lock **750** locking the device in position, the control device **760** may be operated to vary a position of the housing **710** relative to housing **708**. The housing **710** may be moved proximally to accordingly draw the device positioned therein proximally. The opposite end of a device passing through the lumens **730**, **720** may be drawn proximally. The opposite end may be fixed to another anchor or a portion of the patient's heart. The device may be tensioned by the device being drawn proximally. The tension mechanism **749** may have a different configuration than shown in FIGS. **7**A and **7**B in other embodiments.
(272) The deployment apparatus **700** may include a lock control mechanism **781**. The lock control mechanism **781** may be configured to control a lock of an anchor (such as the lock **838** shown in FIG. **8**D) remotely and set a locked or unlocked state of the anchor. The lock control mechanism **781** may include a receiver **782**.
(273) The receiver **782** may be configured to receive a lock retainer member **856** of an anchor, such as the lock retainer member **856** shown in FIG. **8**A. The receiver **782** may be configured to move along the length of the housing **708** to move the relative position of the lock retainer member **856**. The receiver **782** may comprise a ring **783** with an opening that the lock retainer member **856** is passed through and may be looped around. The receiver **782** may include a slide body **784** coupled to the ring **783** for sliding the ring **783** relative to the housing **708**. The slide body **784** may be configured such that a portion of the slide body **784** rotates upon the outer surface of the housing **708**, while a portion coupled to the ring **783** does not rotate. The slide body **784** may be threaded to threading on the outer surface of the housing **708**, such that rotation of the slide body **784** causes the slide body **784** to slide. The non-rotating portion of the slide body **784** may prevent the ring **783** from rotating as slide body **784** slides upon the housing **708**.
(274) The lock control mechanism **781** may include a stop **785**. The stop **785** may be configured to stop the movement of the receiver **782** along the outer surface of the housing **708**. The stop **785** may be configured to be variably positioned on the housing **708**. The stop **785** may comprise a ring body that may threaded to threading on the outer surface of the housing **708**. The stop **785** may abut the receiver **782** along the outer surface of the housing **708** to stop movement of the receiver **782**.
(275) The lock control mechanism **781** may operate, as a lock retainer member **856** may pass from the anchor through the lumen **720**, **730**. The lock retainer member **856** may then pass through an opening **786** in a wall of the housing **708** and couple to ring **783**. As the receiver **782** is moved towards the distal end **742** of the housing **706** and away from the opening **786**, the lock retainer member **856** may be pulled through the lumen **720**, **730** and away from the anchor to move a lock of an anchor to an unlocked state. The receiver **782** may be moved away from the distal end **742** of the housing **706** and towards the opening **786** to slide the lock retainer member **856** through the lumen **720**, **730** and towards the anchor to move a lock of an anchor to a locked state. The movement of the receiver **782** accordingly controls the operation of a lock of an anchor.
(276) The lock control mechanism **781** may include the lock retainer member **856**. FIG. **8**A illustrates the lock retainer member **856**. The lock retainer member **856** may comprise a tether, and may be in the form of a cord, or other form of lock retainer member. The lock retainer member **856** may be looped around the ring **783** of the receiver **782**, and may pass through the opening **786** and through the lumen **720**, **730** and through the opening **718** to the anchor. In other embodiments, other forms of lock retainer members may be utilized.
(277) The deployment apparatus **700** may include a control mechanism for controlling rotation of the retainer **712**. The control mechanism may include the housing **708** and the rotation device **756**. The housing **708** may be coupled to the lumen **730** such that the rotation of the housing **708** rotates

the lumen **730** within the outer sheath **736** of the elongate neck **704**. The lumen **703** may be coupled to the retainer **712** such that the rotation of the housing **708** rotates the portion of the head **702** comprising the retainer **712** in position relative to the connection portion **713** of the head **702**. FIG. **7**D, for example, illustrates the portion of the head **702** comprising the retainer **712** rotating in position relative to the connection portion **713** of the head **702**. The housing **706** may remain non-rotational during such movement. The housing **708** may be configured to rotate relative to the housing **706** due to the rotation of the rotation device **756** in the housing **706**, as previously described. In other embodiments, a separate control device, similar to the control device **163** discussed in regard to the access apparatus **100** of FIGS. **1**A and **1**B, may be utilized to rotate the retainer **712** in position.

(278) The control mechanism for controlling rotation of the receiver **712** may operate together with the control mechanism **747** to comprise a control mechanism for controlling the deflection of the elongate neck **704** and controlling the rotation of the retainer **712**. In such a manner, the user may be able to control the deflection of the elongate neck **704** and the rotation of the retainer **712** independently, to position an anchor in a desired position on the patient's heart.

(279) The deployment apparatus **700** may include the snare **722**. The snare **722** may include a proximal end **788** and a distal end **789** and a body extending between the proximal end **788** and the distal end **789**. The snare **722** may include a snare device **790** at the distal end **789** of the snare **722**. The snare device **790** may comprise a loop, or may have another form as desired. The snare device **790** may be configured to couple to a tension member of an anchor (such as tension member **286** shown in FIG. **2**G). A handle **791** may be positioned at the proximal end **788** of the snare **722**. The handle **791** may be configured for a user to pull the snare **722** through the lumen **720**, **730**, **770**. The snare **722** may be pulled through the lumen **720**, **730**, **770** upon a tension member of an anchor being coupled to the snare device **790**, so that the tension member is drawn through the lumen **720**, **730**, **770**. The tension member drawn through the lumen **720**, **730**, **770** may be engaged with the lock **750** and tensioned with the tension mechanism **749**.

(280) The deployment apparatus **700** may be configured to deploy an anchor at a desired orientation due to the deflection of the elongate neck **704** and the rotation of the retainer **712**. The snare **722** may be utilized to pass a tension member of an anchor through the lumen of the deployment apparatus **700**. The tension mechanism **749** may be used to tension the tension member positioned within the lumen of the deployment apparatus **100**. The lock control mechanism **781** may be configured to set the lock of the anchor in a locked state upon the tension mechanism **749** tensioning the tension member to a desired degree. The deployment apparatus **700** may then be released from the anchor, which may be in position on a portion of a patient's heart. In other embodiments, the configuration of the deployment apparatus **700** may vary from the configuration shown in FIGS. **7**A and **7**B.

(281) FIG. **8**A illustrates an embodiment of a heart anchor **800** that may be used in the systems and methods disclosed herein. The heart anchor **800** may be utilized in a heart splint (for example the splint **3100** shown in FIG. **31**, or other splints).

(282) The heart anchor **800** may include a first support pad **802** and a second support pad **804**. The anchor **800** may include a bridge **806** coupling the first support pad **802** to the second support pad **804**.

(283) The support pads **802**, **804** may each be configured to press against a surface of the heart. The support pads **802**, **804** may each include respective pressing surfaces **808**, **810** for pressing against the surface of the heart. The pressing surface **808**, **810** may be configured to be planar, or may have another shape as desired. The first support pad **802** may include a side wall **812** that extends away from the pressing surface **808** to a coupling surface **814** (marked in FIG. **8**C) that faces opposite the pressing surface **808**. The second support pad **804** may similarly include a side wall **816** that extends away from the pressing surface **810** to a coupling surface **818** (marked in FIG. **8**C) that faces opposite the pressing surface **810**.

(284) The support pads **802**, **804** may include respective covers **820**, **822** that form the outer surface of the respective support pads **802**, **804**. The covers **820**, **822** may be made of a cloth or other material, and the material of the covers may be suitable for contacting a portion of a patient's heart. In other embodiments, the covers **820**, **822** may not be utilized. FIG. **8**B for example, shows the support pads **802**, **804** without the covers **820**, **822** such that the outer surface of the support pads **802**, **804** comprise the pressing surfaces **808**, **810**. The support pads **802**, **804** may include location markers **811** that may allow the position of the anchor **800** in the patient's body to be determined and verified. The location markers **811** may be radio-opaque markers that may extend around an outer periphery of the support pads **802**, **804** and may be constructed as part of the support pads **802**, **804**.
(285) The support pads **802**, **804** may have a circular shape, or in other embodiments may have a different shape as desired. The support pads **802**, **804** may be configured to be sufficiently firm to apply a force to a portion of a patient's heart. The support pads **802**, **804** may be sized to distribute the force to a relatively large portion of the outer surface of the patient's heart.
(286) The bridge **806** may extend from the first support pad **802** to the second support pad **804**. The bridge **806** may comprise a laterally extending body. The bridge **806** may comprise a bar that extends between the first support pad **802** and the second support pad **804**. The bridge **806** may include a first end portion **824** and a second end portion **826**, and a central portion **828** positioned between the end portions **824**, **826**. The bridge **806** may have a top surface **830** (marked in FIG. **8**C) that has a curved profile. The curved profile may allow the shape of the bridge **806** to be atraumatic to the surrounding portion of the patient's body when the anchor **800** is implanted.
(287) The bridge **806** may couple to the first support pad **802** at the first end portion **824** of the bridge **806** and may couple to the second support pad **804** at the second end portion **826** of the bridge **806**. The bridge **806** may couple to central portions of the respective support pads **802**, **804**. The bridge **806** may couple to the support pads **802**, **804** such that the support pads **802**, **804** face the same direction and may each apply a force to the same surface. The bridge **806** may be offset from the support pads **802**, **804**. Referring to FIG. **8**C, a width **832** of the bridge may be less than the diameter of each support pad **802**, **804**.
(288) The bridge **806** may have a strength sufficient to firmly press both the support pad **802**, **804** upon a tension member **286** being tensioned at the central portion **828** of the bridge **806**. The bridge **806** may comprise a rigid body.
(289) FIG. **8**B illustrates a bottom perspective view of the anchor **800**. The covers **820**, **822** are not shown in FIG. **8**B. The bottom surface **834** of the bridge **806** is visible including opening **836**. The bridge **806** may include one or more side walls **837** extending from the bottom surface **834** to the top surface **830**. Another side wall **839** is visible in FIG. **8**F.
(290) FIG. **8**C illustrates a top perspective view of the anchor **800**. A lock **838** is visible within a receiver **840** of the anchor **800**.
(291) FIG. **8**D illustrates a cross sectional view of the anchor **800**. A cross sectional view of the lock **838** and the receiver **840** is provided. The receiver **840** may be coupled to the bridge **806** and configured to receive the tension member **286**.
(292) The receiver **840** may include an opening **842** in the top surface **830** of the bridge **806** and may include the opening **836** in the bottom surface **834** of the bridge **806**. The receiver **840** may include one or more side walls **844** that define a cavity **846** in the bridge **806**. One of the side walls **844** may include a locking surface **848**. The locking surface **848** may comprise a surface for the tension member **286** to be pressed against upon operation of the lock **838**. The locking surface **848** may include a grip surface, which may include ridges or another gripping structure that may improve a grip of the locking surface **848**.
(293) The lock **838** may be positioned within the receiver **840**. The lock **838** may be coupled to the bridge **806**. The lock **838** may be configured to vary from an unlocked state in which the tension member **286** is unlocked in the receiver **840** to a locked state in which the tension member **286** is

locked in the receiver **840**. The lock **838** may be configured to move from the locked state to the unlocked state.
(294) The lock **838** may include a rotatable body **850**, which may be configured to rotate about a pivot. The pivot may comprise an axle extending through the rotatable body **850**, or another form of pivot. The rotatable body **850** may be configured to rotate within the cavity **846** of the receiver **840**. The rotatable body **850** may comprise a cam body with a surface of the body **850** comprising a locking surface **852**. The cam body may allow the force from the lock **838** against the tension member **286** to increase as tension is increased upon the tension member **286**. The locking surface **852** may comprise a surface to press against the tension member **286**, and press the tension member **286** against the locking surface **848**, to lock the tension member **286** in position within the receiver **840**. The locking surface **852** may include a grip surface, which may include ridges or another gripping structure that may improve a grip of the locking surface **852**.
(295) The lock **838** may include a connector **854** for coupling with the lock retainer member **856**. The connector **854** may include an aperture for the lock retainer member **856** to be passed through.
(296) The lock **838** may include a biasing device **858**. The biasing device **858** may bias the lock **838** to a locked state, in which the rotatable body **850** is pressed towards the locking surface **848**. The rotatable body **850** in the locked state may press the tension member **286** against the locking surface **848** to prevent movement of the tension member **286** and to lock the tension member **286** to the anchor **800**. The biasing device **858** may comprise a spring, or other form of biasing device as desired.
(297) The lock retainer member **856** may be pulled to oppose the biasing force of the biasing device **858** and may retain the lock **838** in an unlocked state. The lock retainer member **856** may be configured to couple to the rotatable body **850** to hold the rotatable body **850** in the unlocked state. Such an unlocked state is shown in FIG. **8**D. The locking surface **852** of the rotatable body **850** is pulled away from the locking surface **848** of the receiver **840** and the tension member **286** may slide within the receiver **840** and through the openings **836**, **842**.
(298) The tension member **286** may be slid within the receiver **840** to tension the tension member **286** before the lock **838** is moved to the locked state. The tension member **286** may be tensioned with a mechanism such as the tension mechanism **749** of the deployment apparatus **700**, while the anchor **800** is coupled to the retainer **712** of the deployment apparatus **700**. Upon a desired amount of tension being reached, the lock retainer member **856** may be moved towards the anchor **800** with a mechanism such as the lock control mechanism **781** of the deployment apparatus **700**. The movement of the lock retainer member **856** towards the anchor **800** may allow the biasing device **858** to move the lock **838** to the locked state.
(299) FIG. **8**E illustrates the lock **838** in the locked state. The biasing device **858** has moved the rotatable body **850** to press against the tension member **286** against the locking surface **848** (the ridges in the locking surface **848** are not shown for clarity). The lock **838** in the locked state presses the tension member **286** against a wall of the receiver **840**. The tension member **286** is locked in position. If desired, the lock **838** may again be moved to the unlocked state by the lock retainer member **856** being pulled away from the anchor **800**. The lock **838** may move to an unlocked state as shown in FIG. **8**D.
(300) The position of the lock **838** and the receiver **840** may be varied as desired. For example, the lock **838** and receiver **840** may be positioned in a support pad or other location of the anchor **800**, yet remain coupled to the bridge **806**. Multiple receivers **840** and locks **838** may be utilized if multiple tension members are utilized.
(301) FIG. **8**F illustrates an embodiment of the anchor **800** in which a seal **860** may be positioned between the bridge **806** and the portion of the patient's heart being supported. The seal **860** may comprise a body that is positioned at the central portion **828** of the bridge **806** and may plug the opening of the heart that the tension member **286** passes through. The tension member **286** may pass through the central portion **828** of the bridge **806** and through the seal **860**. The seal **860** may

reduce the possibility of bleeding through the opening of the heart and may comprise a biocompatible material for sealing the opening of the heart. In other embodiments, the seal **860** may not be utilized.

(302) The anchor **800** may be configured to beneficially support a portion of the patient's heart in two positions, utilizing the two support pads **802**, **804**. In other embodiments, a greater number of support pads may be utilized, including three or possibly more pads. A bridge may connect the pads. The anchor **800** beneficially includes the lock **838** that may be movable between the locked state and the unlocked state. As such, the tension member **286** may be tensioned at the anchor **800** and the tension member **286** may be locked in position at the anchor **800**.

(303) The apparatuses and other components disclosed herein may comprise one or more systems. The systems may be utilized in a variety of methods. The methods may include the methods disclosed herein. The methods may include a method for treating ventricular dilation and/or mitral regurgitation. The methods may include deploying a heart splint.

(304) The steps disclosed herein are illustrative, and may be modified, varied, reordered, or excluded as desired. The “steps” referred to herein may include multiple steps, or may comprise portions of steps.

(305) FIG. **9** illustrates a step in a method of deploying a heart splint to a patient's heart **900**. The resulting heart splint **3100** is shown in FIG. **31**. The method may be for treating a dilated heart condition or functional heart valve regurgitation of a patient. The method may be for treating ventricular dilation and/or mitral regurgitation. The method may include reshaping a ventricle of the heart by applying pressure to the heart to reshape the geometry of heart. The method may include supporting a ventricle of the heart to reduce the presence of ventricular dilation and prevent further dilation.

(306) The step may include accessing the patient's heart **900**. An access apparatus, such as the access apparatus **100** may be inserted through a small sub-xiphoid incision into the patient's body or thoracotomy incision or intercostal incision, or possibly a more invasive incision such as a sternotomy. The access apparatus **100** may be passed through the patient's body and towards the desired portion of the external surface **902** of the patient's heart. As discussed previously, the elongate neck **104** may be configured to deflect to place the head **102** in position proximate a posterior portion of the patient's heart **900**. The elongate neck **104** may be configured to wrap around a portion of the patient's heart **900** such that the posterior portion of the heart **900** is accessible even with a frontal entry of the patient's body. FIG. **9**, for example, illustrates the elongate neck **104** wrapping around the patient's heart **900** and positioning the head **102** on the desired posterior portion of the heart **900**. The application portion **114** of the head **102** may additionally be rotated, in a manner discussed previously, to place the head **102** in the desired position. The control mechanism **108** may be utilized to deflect the elongate neck **104** and rotate the head **102** to place the head **102** in the desired position, as discussed previously.

(307) A user may utilize the location marker **136** (marked in FIG. **1**C) to determine the location of the head **102** within the patient's body and to identify the correct position of the head **102** against the external surface **902** of the patient's heart. For example, the user may utilize an imaging system to visualize the radio-opaque location marker **136** to visualize the position of the head **102**. Echo guidance or fluoroscopic guidance or both may be utilized to guide the head **102**, and/or guide other components in the systems and methods disclosed herein.

(308) The application portion **114** (marked in FIG. **1**C) of the head **102** may be placed against the external surface **902** of the patient's heart via movement of the elongate neck **104** and the head **102**. The application portion **114** may pass through the pericardium and contact the myocardium (the external surface **902**). The application portion **114** may rest upon the myocardium. Upon the application portion **114** being placed in the desired position, vacuum suction may be applied by the head **102** to grip the head **102** to the external surface **902** of the patient's heart. The vacuum suction may be provided by the vacuum lumen **128** (marked in FIG. **1**D) in the head **102**. The vacuum

suction may be provided in a manner discussed previously. For example, as shown in FIG. **10**, a vacuum hose **1000** may be coupled to the vacuum port **160**, and a valve **1002** may be opened to allow vacuum suction to be conveyed through the vacuum lumen **128** (marked in FIG. **1**D) and the lumen **142** (marked in FIG. **1**B). The application portion **114** may be positioned on the desired external surface **902** of the patient's heart, with the opening **126** (marked in FIG. **1**C) adjacent the desired external surface **902** of the patient's heart.

(309) If the user determines that the head **102** is gripped to an undesired position on the patient's heart **900**, the vacuum suction may be released and the head **102** may be repositioned on the external surface **902** of the patient's heart as desired, and gripped again to the patient's heart **900**. For example, if the user determines that the head **102** is gripped to a coronary or the like, the head **102** may be removed from that position so that the puncture device does not puncture a coronary. The location marker **136** may be utilized to confirm the head **102** is in the correct position on the patient's heart. The position may be verified through fluoroscopy.

(310) The head **102** may be positioned on a portion of the patient's heart **900** that is exterior of the left ventricle of the heart **900** and between the position of the mitral annulus and the papillary heads of the left ventricle. Such a position is shown in FIG. **12**. In other embodiments, the head **102** may be positioned on a different portion of the patient's heart **900** as desired.

(311) FIG. **10** illustrates a view of the proximal end **152** of the housing **106** of the access apparatus **100**. The head **102** is gripped to the external surface **902** of the patient's heart. As discussed, vacuum suction may be provided by a vacuum hose **1000** to provide the vacuum suction for the head **102**. A puncture device **168** and sheath **170** may be locked in position to the port **156**. Upon the head **102** being gripped to the external surface **902** of the patient's heart, a puncture device **168** and sheath **170** may be passed through the port **156** to pass through the lumen **142** and the lumen **124** of the head **102** (marked in FIG. **1**B). The puncture device **168** may be positioned within the sheath **170** and may be locked to the sheath **170**.

(312) FIG. **11** illustrates a view of the puncture device **168** and sheath **170** passing through the opening **126** of the head **102**. At this step in the process, the head **102** may be gripped to the external surface of the patient's heart, which is not shown in FIG. **11**. The puncture device **168** and sheath **170** may be passed through the port **156** shown in FIG. **10** and passed through the lumens **142**, **124** of the elongate neck **104** (marked in FIG. **1**B) and head **102** to exit the opening **126** as shown in FIG. **11**. The puncture device **168** may protrude slightly from the sheath **170**, such that the puncture device **168** is exposed for puncturing a wall of the patient's heart.

(313) FIG. **12** illustrates a cut-away portion of the patient's heart **900** illustrating the puncture device **168** and sheath **170** advancing into the left ventricle **1200** of the patient's heart **900** from the head **102**. The puncture device **168** and sheath **170** pass through the myocardium. The head **102** is shown gripped to the external surface **902** of the patient's heart **900**. The puncture device **168** and sheath **170** pass through an outer wall **1202** of the patient's heart **900** comprising the myocardium. Additional portions of the patient's heart **900** are illustrated, including the right ventricle **1204**, the right atrium **1206**, the left atrium **1208**, and the interventricular septum **1210**. The tricuspid valve **1212**, the mitral valve **1214** and mitral annulus **1216** and the papillary heads **1218** of the left ventricle **1200** are additionally shown. The superior vena cava **1220** is also shown.

(314) The puncture device **168** and sheath **170** may be advanced into the left ventricle **1200** to a desired amount. For example, the puncture device **168** and sheath **170** may be advanced to a distance of about two centimeters, although other distances may be utilized as desired. The advance of the puncture device **168** and the sheath **170** may be controlled by sliding the puncture device **168** and the sheath **170** locked together through the port **156** at the proximal end **152** of the housing **106** as shown in FIG. **10**.

(315) Upon the puncture device **168** and sheath **170** reaching the desired position within the left ventricle **1200**, the puncture device **168** may be withdrawn from the sheath **170** entirely by being pulled proximally out of the end of the sheath **170** shown in FIG. **10**. The puncture device **168** may

be unlocked from the sheath **170** in this procedure. Referring to FIG. **13**, a snare, such as snare **600** may be inserted through the sheath **170** from the proximal end of the sheath. The snare **600** may extend through the lumen of the sheath **170** and pass through the head **102** to reach the left ventricle **1200**.

(316) FIG. **14** illustrates the snare **600** positioned within the left ventricle **1200** and passing through the sheath **170**. The snare device **608** may protrude slightly from the end of the snare **600**.

(317) An introducer sheath, such as introducer sheath **500**, may be introduced into the patient's body for access to the right ventricle **1204**. The introducer sheath **500** may be introduced in a neckline access procedure and pass through the superior vena cava **1220**. The introducer sheath **500** may be entered into the patient's body through endovascular entry. In other embodiments, other access points and methods may be utilized.

(318) The distal end **504** of the introducer sheath **500** may be positioned in the right atrium **1206**. In other embodiments, the distal end **504** may be positioned in an alternate position.

(319) A delivery apparatus, such as the delivery apparatus **400**, may be inserted into the sheath **500**. The sheath **402** of the delivery apparatus **400** may be passed through the lumen of the introducer sheath **500**.

(320) Upon the delivery apparatus **400** being passed through the sheath **500**, the distal end **408** of the delivery apparatus **400** may be positioned or moved to the right ventricle **1204**. The sheath **402** of the delivery apparatus **400** may extend through the tricuspid valve **1212** to reach the right ventricle **1204**. The distal end **408** of the delivery apparatus **400** may be controlled to deflect to a position proximate the interventricular septum **1210**. A control mechanism, such as the control mechanism **406** (marked in FIG. **4**B), may be utilized to deflect the sheath **402** to the position proximate the interventricular septum **1210**. The sheath **402** may be deflected such that a device passing through the lumen **412** of the sheath **402** and exiting the opening **414** (marked in FIG. **4**B) will contact the interventricular septum **1210**.

(321) In one embodiment, a spacer may be utilized to assist with the positioning of the delivery apparatus **400**. Referring to FIG. **14**A, a spacer **1400** may be positioned within the right ventricle **1204**, and may be positioned between the apex **1404** of the right ventricle **1204** and the desired puncture point of the interventricular septum **1210** or the location of the interventricular septum **1210** that the heart anchor will be positioned upon. The spacer **1400** may be utilized to take up volume within the right ventricle **1204**, which may block the distal end **408** of the delivery apparatus **400** from extending into the apex **1404** of the right ventricle **1204**, and accordingly may assist to position the distal end **408** of the delivery apparatus **400** adjacent to the position of the spacer **1400** and at a desired location proximate the interventricular septum **1210**.

(322) The spacer **1400** may have a variety of forms. As shown in FIG. **14**A, the spacer **1400** may comprise a balloon that may be inflated within the right ventricle **1204** to take up volume within the right ventricle **1204**. The balloon may have a variety of shapes, including frustoconical as shown in FIG. **14**A, or round, or a variety of other shapes. The balloon may be shaped to contour to the shape of the right ventricle **1204**, and may have a shape that is specifically contoured to the shape of the patient's right ventricle **1204**. The balloon may be configured for the distal end **408** of the delivery apparatus **400** to contact, in order to position the distal end **408** of the delivery apparatus **400** at the desired location proximate the interventricular septum **1210**. The balloon may be coupled to a catheter **1402** that is configured to provide fluid to and from the balloon to inflate and deflate the balloon respectively. In one embodiment, one or more balloons may be utilized as the spacer **1400**.

(323) The spacer **1400** in one embodiment may comprise a frame that is configured to take up volume within the right ventricle **1204**. The frame may include a plurality of supports that may be configured to bound a volume. The frame may be configured to be moved between an unexpanded state and an expanded state. The frame may move from the unexpanded state to the expanded state to increase the volume of the frame. The frame may be configured for the distal end **408** of the

delivery apparatus **400** to contact, in order to position the distal end **408** of the delivery apparatus **400** at the desired location proximate the interventricular septum **1210**. An example of a frame that may be utilized is an Amplatzer™ Septal Occluder, by Abbott Laboratories, Abbott Park, Illinois, in which the occluder may be expanded within the right ventricle (and not necessarily within a septal hole) to block off and take up volume within the right ventricle **1204**. An example of such a device is disclosed in U.S. Pat. No. 5,944,738, the entire disclosure of which is incorporated by reference. Other forms of frames may be utilized as desired. The frame may be made of a shape memory material such as nitinol or another shape-memory material, or another material as desired. The frame may be coupled to a catheter **1402** that is configured to deploy the frame to the expanded state, and to collapse the frame to the unexpanded state for removal from the right ventricle **1204**.

(324) In use, the spacer **1400** may be deployed to the right ventricle **1204** in an unexpanded state. Referring to FIG. **14**A, the spacer **1400** may be coupled to the catheter **1402** that may be passed through a sheath, such as the introducer sheath **500**, to a desired location in the right ventricle **1204**. For example, as shown in FIG. **14**A, the catheter **1402** may be inserted into the right ventricle **1204** until it contacts the wall of the apex **1404** of the right ventricle **1204**. The spacer **1400** may then be expanded to a desired expanded size.

(325) The spacer **1400** may be located within the right ventricle **1204** and expanded to a desired size such that the distal end **408** of the delivery apparatus **400** will be placed at the desired location proximate the interventricular septum **1210** when contacting the spacer **1400**. For example, a user may visualize the location of the spacer **1400** and the expansion of the spacer **1400** to determine if a position adjacent the spacer **1400** will be the desired location of puncture of the interventricular septum **1210**. In an embodiment in which the spacer **1400** is a balloon, the balloon may be inflated. In an embodiment in which the spacer **1400** is a frame, the frame may be expanded to a desired size. In one embodiment, a distance of the spacer **1400** from the end of the catheter **1402** may be set so that the length of the exposed end of the catheter **1402** (distal the spacer **1400**) sets the height of the top of the spacer **1400**.

(326) In certain embodiments, the size or other configuration of the spacer **1400** may be selected based on the desired location of puncture of the interventricular septum **1210**. For example, a series of sizes or configurations of the spacers **1400** may be provided, and a user may select the desired size or configuration based on the patient's particular anatomy and the desired position of puncture on the interventricular septum **1210**.

(327) With the spacer **1400** in the desired position in the right ventricle **1204**, the distal end **408** of the delivery apparatus **400** will be placed at the desired location proximate the interventricular septum **1210** when contacting the spacer **1400**. The spacer **1400** beneficially prevents the distal end **408** of the delivery apparatus **400** from dropping into the apex **1404** of the right ventricle **1204**, which may be undesired. Upon the desired operation of the delivery apparatus **400** being performed, the spacer **1400** may be reduced to the unexpanded state, and then withdrawn from the right ventricle **1204** with the catheter **1402** being withdrawn.

(328) The spacer **1400** may optionally be utilized with the steps of the methods disclosed herein, and may not be utilized in certain embodiments as desired. The spacer **1400** may be utilized in any embodiment in which a heart anchor is deployed to the interventricular septum **1210** within the right ventricle **1204**, or any other embodiment as desired. A spacer may also be used in another heart chamber or body cavity, for example, a left ventricle, for assisting in positioning a delivery apparatus.

(329) Referring to FIG. **15**, upon the distal end **408** of the delivery apparatus **400** being positioned proximate the interventricular septum **1210**, a snare **600′**, which may be configured similarly as the snare **600**, may be passed through the lumen **412** (marked in FIG. **4**B) of the delivery apparatus **400** (and accordingly the lumen of the introducer sheath **500**). The snare **600′** may include a puncture device **612′** at the end of the snare device **608′**. The puncture device **612′** and snare device **608′** may

be configured similarly as the respective puncture device **612** and snare device **608** shown in FIG. **6**B. The snare **600**′ may be advanced through the lumen of the sheath **402** such that the puncture device **612**′ punctures through the interventricular septum **1210**, as shown in FIG. **15**. The snare **600**′ may be passed through the interventricular septum **1210** and into the left ventricle **1200**. The snare **600** may be referred to as a left snare **600**, and the snare **600**′ may be referred to as a right snare **600**′, for identification purposes.

(330) Upon the right snare **600**′ and left snare **600** being positioned in the left ventricle **1200**, the right snare **600**′ may snare the left snare **600**. FIG. **16** illustrates the right snare **600**′ snaring the left snare **600**. The snare device **608**′ of the right snare **600**′ may be deployed and may snare the snare device **608** of the left snare **600**. The snare device **608** of the left snare **600** may also be deployed. In an embodiment in which the snare device **608**′ is a loop, the loop may extend around and capture the snare device **608** of the left snare **600**. The snare device **608** may then be closed upon the snare device **608** of the left snare **600**. In one embodiment, either the left snare **600** or right snare **600**′, or both, may snare the respective other snare. For example, the snare device **608** of the left snare **600** may be deployed and may snare the snare device **608**′ of the right snare **600**′. Upon the snares **600**′, **600** being coupled together, the right snare **600**′ may be pulled and withdrawn from the delivery apparatus **400**.

(331) FIG. **17** illustrates the proximal end of the delivery apparatus **400** with the right snare **600**′ being withdrawn from the housing **404** of the delivery apparatus **400**, and accordingly withdrawn from the right ventricle **1204**. The snare device **608** of the left snare **600** is withdrawn from the delivery apparatus **400** and may be accessible by a user. The left snare **600** extends through the left ventricle **1200** and the right ventricle **1204**. The delivery apparatus **400** may then be withdrawn from the introducer sheath **500**, with the snare device **608** of the left snare **600** remaining accessible by a user.

(332) FIG. **18** illustrates the left snare **600** being positioned exterior to the proximal end **502** of the introducer sheath **500** (as the delivery apparatus **400** has been withdrawn from the introducer sheath **500**). The snare device **608** of the left snare **600** may couple to a tension member of a heart anchor, such as the tension member **286** of the heart anchor **202** (as shown in FIG. **2**G).

(333) Upon the left snare **600** coupling to the tension member **286**, the left snare **600** may then be withdrawn in a distal direction through the introducer sheath **500** and may be withdrawn through the right ventricle **1204** and the left ventricle **1200** and withdrawn in a proximal direction through the access apparatus **100** while pulling the tension member **286** along with the snare **600**. The tension member **286** accordingly may extend through the introducer sheath **500** and the right ventricle **1204**, and may pass through the interventricular septum **1210**, and may extend through the left ventricle **1200** and the lumen **124**, **142** of the access apparatus **100** (marked in FIG. **1**B). The tension member **286** may extend from the introducer sheath **500** to exit at the port **156** of the access apparatus **100** (marked in FIG. **1**B). A portion of the tension member may extend exterior of the left ventricle of the patient's heart.

(334) As or after the tension member **286** is pulled through the ventricles **1204**, **1200**, a deployment apparatus, such as the deployment apparatus **300** may be advanced towards the proximal end **502** of the introducer sheath **500**. The deployment apparatus **300** may include an anchor, such as the heart anchor **202** (as shown in FIG. **2**H) in a linearized configuration and positioned within the lumen **313** of the deployment apparatus **300**, and specifically the lumen **313** of the deployment catheter **302** (for example in portion **321** as marked in FIG. **3**B), with the tension member extending from the lumen **313**. The tension member **286** may extend from the heart anchor **202** and distally from the tip **322** (marked in FIG. **3**B) of the deployment apparatus **300**.

(335) FIG. **19** illustrates the deployment apparatus **300** being advanced towards the proximal end **502** of the introducer sheath **500**. The slack in the tension member **286** may be drawn through the ventricles **1204**, **1200** and the access apparatus **100** as the deployment apparatus **300** advances towards the proximal end **502** of the introducer sheath **500** and passes through the lumen **506** of the

introducer sheath **500** (marked in FIG. **5**).
(336) The deployment apparatus **300** may be advanced through lumen **506** of the introducer sheath **500** to a desired position. FIG. **20** illustrates the deployment apparatus **300** having been advanced until the housing **314** of the deployment apparatus **300** contacts the housing **508** at the proximal end **502** of the introducer sheath **500**.
(337) The deployment apparatus **300** may be configured with the lock **316** (marked in FIG. **3**B) locking the push device **304** in position relative to the deployment catheter **302** (marked in FIG. **3**B). The lock **316** may remain locked as the deployment apparatus **300** is advanced through the lumen **506** of the introducer sheath **500**. The lock **316** may then be unlocked when the deployment apparatus **300** is in the desired position, to allow the push device **304** to slide relative to the deployment catheter **302** and push the heart anchor **202** out of the distal end of the deployment apparatus **300**.
(338) Upon the distal end **312** of the deployment apparatus **300** being in a desired position, the lock **316** (marked in FIG. **3**B) may be unlocked and the push device **304** may be advanced through the lumen **313** of the deployment catheter **302** to push the heart anchor **202** out of the distal end **312** of the deployment catheter **302**. FIG. **21** illustrates the heart anchor **202** exiting the distal end **312** of the deployment catheter **302**. The ring **200** (marked in FIG. **2**H) of the heart anchor **202** may automatically move to a ring-shaped configuration. The cover **212** of the anchor **202** has not yet been drawn towards its central opening **293** (marked in FIG. **2**G).
(339) The distal end **312** of the deployment catheter **302** may be positioned in the chambers of the patient's heart when the heart anchor **202** is pushed out of the distal end **312** of the deployment catheter **302**. The distal end **312** of the deployment catheter **302** may be positioned in the right atrium **1206** (marked in FIG. **16**). The right atrium **1206** may be selected for deployment of the heart anchor **202** so that the possibility of hooking the heart anchor **202** on one or more chordae in the right ventricle **1204** is reduced. In other embodiments, the heart anchor **202** may be deployed in a different location in the patient's heart.
(340) Upon the heart anchor **202** being pushed out of the deployment catheter **302**, the deployment member **306** may be pulled to draw or cinch the cover **212** of the anchor **202** towards its central opening **293** (marked in FIG. **2**G). FIG. **22** illustrates the deployment member **306** being pulled proximally to draw the cover **212** of the anchor **202** towards its central opening **293**. The pull device **308** may be pulled in a direction away from the housing **330**, in a manner discussed previously. The deployment member **306** may be routed through the cover **212** of the anchor **202** in a manner shown in FIG. **2**H. As such, the proximal movement of the deployment member **306** may draw the cover **212** of the anchor **202** towards its central opening **293** and may close the central opening **293**.
(341) FIG. **23** illustrates the cover **212** of the anchor **202** drawn towards its central opening **293** and the anchor **202** in its expanded configuration. The ring **200** is in its ring-shaped configuration. Portions of the ring **200** overlap each other in a manner discussed in regard to FIGS. **2**A-**2**H. The anchor **202** may move from the unexpanded configuration to the expanded configuration adjacent the distal end of the deployment apparatus **300**, to provide support to the anchor **202** as the cover **212** of the anchor **202** is drawn towards its central opening **293** (marked in FIG. **2**G). The anchor **202** may be pressed against the tip **322** (marked in FIG. **3**B) of the deployment apparatus **300** as the deployment member **306** is withdrawn to expand the cover **212**.
(342) FIG. **24** illustrates the position of the anchor **202** in the right atrium **1206** of the patient's heart **900** as the anchor **202** moves from the unexpanded configuration to the expanded configuration adjacent the distal end **312** of the deployment apparatus **300**. With the anchor **202** in the position shown in FIG. **24**, the deployment member **306** (marked in FIG. **22**) may be released from the anchor **202**. The deployment member **306** may then be pulled away from the anchor **202** and separated from the anchor **202**. The deployment member **306** may be released by being cut along its length. Due to the looped configuration of the deployment member **306** (shown in FIG.

2H), the cut deployment member **306** may be pulled through the deployment apparatus **300** and entirely removed from the deployment catheter **302**.
(343) The deployment apparatus **300** may be withdrawn from the introducer sheath **500**. The introducer sheath **500** may be withdrawn from the patient's body.
(344) The tension member **286** may be pulled through the interventricular septum **1210** and the left ventricle **1200** and the lumen **142** (marked in FIG. **1**B) of the access apparatus **100** further, to draw the free heart anchor **202** to the puncture position **2400** on the interventricular septum **1210**. The heart anchor **202** may be pressed against the surface of the interventricular septum **1210** in the right ventricle.
(345) FIG. **25** illustrates the heart anchor **202** positioned against the surface of the interventricular septum **1210**. The heart anchor **202** is accordingly deployed to a position on the interventricular septum **1210**. The tension member **286** may seal the puncture in the interventricular septum **1210**, and the cover **212** (marked in FIG. **24**) may provide the strength to prevent the anchor **202** from passing through the interventricular septum **1210** or collapsing upon a tension force being applied to the tension member **286**.
(346) The sheath **170** may then be withdrawn from the left ventricle **1200** and the lumen **142** (marked in FIG. **1**B) of the access apparatus **100**. The access apparatus **100** may have its grip on the external surface **902** of the patient's heart **900** released by the vacuum suction of the head **102** being removed or reduced. The access apparatus **100** may be withdrawn from the external surface **902** of the patient's heart **900** and may be deflected in a manner discussed herein to avoid interfering with the patient's heart **900** upon withdrawal. The portion of the tension member **286** extending exterior of the patient's heart **900** remains accessible by a user.
(347) FIG. **26** illustrates the portion of the tension member **286** extending exterior of the patient's heart **900** coupled to a snare of a deployment apparatus, such as deployment apparatus **700**. The tension member **286** may be coupled to the snare device **790** of the snare **722** with a knot or other form of coupling.
(348) An anchor, such as anchor **800**, may be coupled to the receiver **712**. The anchor **800** may be positioned between the side walls **714** (marked in FIG. **7**B) of the receiver **712** and within gap **716**.
(349) The snare **722** may extend through the receiver **840** (shown in FIG. **8**D) of the anchor **800**, and may pass through the lumen **720**, **730**, **770** of the deployment apparatus **700** in a manner shown in FIG. **7**B. The snare **722** may be locked to lock **750** (shown in FIG. **7**B) in a manner discussed herein. The lock **838** of the anchor **800** may be in an unlocked state, to allow the snare **722** to slide within the receiver **840** (shown in FIG. **8**D). The lock retainer member **856** may retain the lock **838** in the unlocked state, and may be coupled to the receiver **782** of the lock control mechanism **781** (shown in FIG. **7**B). The connection of the lock retainer member **856** with the anchor **800** may additionally assist to secure the anchor **800** to the retainer **712**.
(350) FIG. **27** illustrates the proximal end of the deployment apparatus **700**. The snare **722** is coupled to the tension member **286** as shown in FIG. **26** and is locked in the lumen **720**, **730**, **770** (marked in FIG. **7**B) of the deployment apparatus **700**. The unlock ring **780** may be slid over the housing **710** to press the rotatable body **774** of the lock **750** and unlock the snare **722**.
(351) FIG. **28** illustrates the unlock ring **780** positioned around the housing **710** to unlock the snare **722**. The handle **791** may then be withdrawn from the deployment apparatus **700**, drawing the snare **722** through the lumen **720**, **730**, **770** (marked in FIG. **7**B) of the deployment apparatus **700** and drawing the tension member **286** through the lumen **720**, **730**, **770** as well. The tension member **286** may then be positioned within the lumen **720**, **730**, **770** of the deployment apparatus.
(352) The deployment apparatus **700**, with the anchor **800** coupled thereto, may then be advanced to the position on the external surface **902** of the patient's heart **900** where the tension member extends therethrough. The portion of the tension member **286** extending exterior of the patient's heart **900** may be withdrawn through the receiver **840** of the anchor **800** and the lumen **720**, **730**, **770** of the deployment apparatus, to remove slack as the deployment apparatus **700** is advanced.

(353) The deployment apparatus **700** may be passed through the patient's body in a similar manner of entry as discussed with the access apparatus **100**. As discussed previously, the elongate neck **704** may be configured to deflect to place the anchor **800** in position at a posterior portion of the patient's heart **900**. The elongate neck **704** may be configured to wrap around a portion of the patient's heart **900** such that the posterior portion of the heart **900** is accessible even with a frontal entry of the patient's body. FIG. **29**, for example, illustrates the elongate neck **704** wrapping around the patient's heart **900** and positioning the anchor **800** on the desired posterior portion of the heart **900**. The retainer **712** may additionally be rotated, in a manner discussed previously, to place the anchor **800** in the desired position. The control mechanism of the elongate neck **704** and retainer **712** may be utilized to deflect the elongate neck **704** and rotate the retainer **712** to place the anchor **800** in the desired position, as discussed previously.
(354) The anchor **800** may be positioned at the puncture point of the external surface **902** of the patient's heart **900**. The anchor **800** may be oriented as desired, and may have a pad **804** positioned adjacent the mitral annulus **1216** (as shown in FIG. **31**), and may have a pad **802** positioned adjacent the papillary muscle head origins **1218**. The anchor **800** may be deployed to the left ventricle free wall. The anchor **800** may be positioned on the posterior surface of the heart on the external surface **902**. The location markers **811** of the anchor **800** may be utilized to verify the position of the anchor **800** on the correct position of the patient's body.
(355) Upon the anchor **800** being positioned on the desired position of the patient's heart, the tension member **286** for coupling the heart anchors **800**, **202** may be tensioned to a desired amount. The tensioning may include applying a force to the external surface of the patient's heart and accordingly applying a force to the interventricular septum (via the resisting force of the anchor **202**). The tension mechanism **749** (marked in FIG. **7**B) of the deployment apparatus **700** may be utilized to tension the tension member **286** to a desired amount. The tension mechanism **749** may operate with the lock **750** of the tension mechanism **749** locking the tension member **286** in position. The unlock ring **780** shown in FIG. **27** may be removed from the housing **710** to allow the biasing device **776** to rotate the rotatable body **774** against the tension member **286** positioned in lumen **770** (marked in FIG. **7**B). The tension member **286**, locked in the lumen **770**, may then be tensioned by the tension mechanism **749** in a manner discussed herein. The control device **760** (shown in FIG. **27**) of the tension mechanism **749** may be operated to pull the locked tension member **286** relative to the housing **706** and relative to the head **702** and anchor **800**. The control device **760** may be controlled by the user to set a precise desired amount of tension in the tension member **286**.
(356) The tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics and left ventricle reduction. The user may monitor the ventricular diameter and mitral regurgitation.
(357) Upon the desired tension being reached, the lock control mechanism **781** may be released to lock the lock **838** (marked in FIG. **8**E) of the anchor **800** in the locked state in a manner discussed herein with the tension member **286** in tension between the anchors **800**, **202**. Upon the lock **838** moving to the locked state, the tension of the tension mechanism **749** may be released slightly to confirm that proper tension is maintained in the heart splint. If the tension is incorrect, the lock **838** may be unlocked again, and the tension of the tension member **286** may be reset.
(358) Referring to FIG. **30**, upon the desired tension being reached, the lock retainer member **856** may be cut from the receiver **782** and withdrawn from the lumen **720**, **730** of the deployment apparatus **700**. Due to the double cord structure of the lock retainer member **856**, the lock retainer member **856** may be entirely pulled away from the anchor **800** and the lumen **720**, **730** of the deployment apparatus **700** when cut.
(359) The deployment apparatus **700** may then be withdrawn from the patient's body and may be deflected in a manner discussed herein to avoid interfering with the patient's heart **900** upon withdrawal. The portion of the tension member **286** extending exterior of the anchor **800** may then

be cut.
(360) FIG. **31** illustrates the anchor **800** in position on the external surface **902** of the patient's heart, and the anchor **202** in position on the interventricular septum **1210**. The tension member **286** extends through the interventricular septum **1210** and between the anchor **202** and the anchor **800**. The anchors **202**, **800** and the tension member **286** together form a splint **3100** for treating ventricle dilation and/or mitral regurgitation. The anchor **800** may apply a supporting force to the patient's heart to reduce the possibility of regurgitation and support the papillary heads **1218** and reshape the ventricle.
(361) The methods disclosed in regard to FIGS. **9-31** may beneficially provide for treating a dilated ventricle of the heart, while providing a minimally invasive procedure. Under the methods disclosed in regard to FIGS. **9-31**, a full sternotomy may not be required, and entry into the right ventricle may comprise an endovascular entry into the patient's heart. The application of the splint may comprise a beating-heart repair of the left ventricle. The method may include reshaping a ventricle of the heart by applying pressure to the heart to reshape the geometry of heart. Endovascular or transcatheter methods may be utilized. Percutaneous entry of the patient's body may occur. In one embodiment, a full sternotomy may be performed if desired. The anchor **800** may beneficially provide two support locations for supporting the heart, in a configuration that is believed to provide enhanced therapeutic effects for the patient. The anchor **202** may be configured to easily deploy to the expanded configuration, and may be moved to the unexpanded or linearized configuration with a low force. The cover **212** of the anchor **202** may bear the majority of the force against the anchor **202** while the overlapping portions of the ring **200** may provide support to the ring **200**.
(362) FIGS. **32** and **33** illustrate an alternative method for deploying the heart splint **3100**. In this method, the snaring of the snares **600**, **600′** may occur in the right ventricle **1204**. The method is similar to steps discussed in regard to FIGS. **9-12**, however, the sheath **170** and the puncture device **168**, upon entering the left ventricle **1200** (as shown in FIG. **12**) may continue to advance through the interventricular septum **1210** and into the right ventricle **1204**. FIG. **32** illustrates the puncture device **168** and sheath **170** extending through the interventricular septum **1210** and into the right ventricle **1204**. The puncture device **168** and sheath **170** may be advanced slowly to reach the interventricular septum **1210** and the position of the puncture device **168** and sheath **170** may be tracked with echo and/or fluoroscopic guidance. The puncture location in the interventricular septum **1210** may be approximately halfway between the right ventricular apex and the tricuspid annulus and centered laterally. If needed, the access apparatus **100** may be moved for the puncture device **168** to reach the desired position.
(363) After puncturing the interventricular septum **1210**, the puncture device **168** may be withdrawn in a proximal direction from the sheath **170** and access apparatus **100**.
(364) The introducer sheath **500** may be introduced into the patient's body in a similar manner as discussed in regard to FIG. **14**.
(365) Referring to FIG. **33**, the left snare **600′** may be passed through the introducer sheath **500** until positioned in the right ventricle **1204**. The right snare **600** may be passed through the sheath **170** until positioned in the right ventricle **1204**. The snaring may occur in a similar manner as discussed in regard to FIG. **16** (although in the right ventricle **1204**), and the left snare **600′** may be withdrawn from the sheath **500** in a similar manner as discussed in regard to FIGS. **16** and **17**. The anchor **202** may be deployed utilizing the deployment apparatus **300** and the processes discussed in regard to FIGS. **17-23**. The introducer sheath **500** may then be withdrawn. The anchor **202** may be drawn to the tip of the sheath **170** in the right ventricle **1204**, and then the sheath **170** may be removed from the patient's body via the access apparatus **100**. The remaining steps of FIGS. **25-31** may then occur.
(366) In an embodiment in which snaring occurs in the right ventricle **1204**, the path of the puncture device **168** may beneficially provide a straighter line extending through the outer wall

1202 of the patient's heart **900** and the interventricular septum **1210** than may occur with snaring in the left ventricle **1200**. This is because the puncture device **168** may pass straight from the outer wall **1202** of the patient's heart through the interventricular septum **1210**. The straighter path may result in less bending of the tension member **286** when coupled between the anchors **800**, **202**. However, in an embodiment in which snaring occurs in the left ventricle **1200**, the user may have greater precision in the location of the interventricular septum puncture (as shown in FIG. **15**), because the distal end **408** of the delivery apparatus **400** may be better controlled to be proximate a desired position on the interventricular septum **1210**.

(367) FIG. **34** illustrates an embodiment of a deployment apparatus **3400** including a body portion **3402** and a distal end **3404**. The deployment apparatus **3400** may be utilized in a method of applying heart anchors to a patient's heart. The method may be for treating a dilated heart condition or functional heart valve regurgitation of a patient. The method may be for treating ventricular dilation and/or mitral regurgitation. The method may include reshaping a ventricle of the heart by applying pressure to the heart to reshape the geometry of heart. The method may include supporting a ventricle of the heart to reduce the presence of ventricular dilation and prevent further dilation. The method may include deploying a heart splint to a patient's heart **900**. The resulting heart splints are shown in FIG. **37**.

(368) The distal end **3404** of the deployment apparatus **3400** may include a puncture device **3406**. The deployment apparatus **3400** may include an internal lumen **3408** and may include an opening **3410** along the body portion **3402** positioned adjacent the puncture device **3406**. The deployment apparatus **3400** may include a push device **3412** for passing through the lumen **3408** for pushing anchor **202** out of the opening **3410**. The push device **3412** may be configured similarly as the push device **304** discussed in regard to FIGS. **3**A and **3**B.

(369) The body portion **3402** may have the shape of an elongate rod. The body portion **3402** may be sufficiently rigid to withstand the force of penetrating through a portion of a patient's heart.

(370) The push device **3412** may be configured to pass through the lumen **3408** with an internal lumen to allow the tension member **286** to pass through the lumen **3408** and the internal lumen, and be accessible for tensioning by a user.

(371) The lumen **3408** may be configured to retain the anchor **202** in the unexpanded or linearized configuration within the lumen **3408**. The anchor **202** may be positioned within the lumen **3408** such that as the anchor **202** is pushed out of the lumen **3408** with the push device **3412**, the tension member **286** remains in the lumen **3408** and a portion of the tension member **286** remains accessible to be pulled to move the cover **212** towards the central opening **293** of the cover **212** as discussed herein. The ring **200** (marked in FIG. **2**G) of the anchor **202** may be configured to automatically move to the ring-shaped configuration, as discussed herein.

(372) The anchor **202** may be configured to move from the unexpanded configuration to the expanded configuration adjacent the opening **3410**. In one embodiment, multiple anchors **202** may be positioned within the lumen **3408** and may be pushed out in sequence.

(373) FIG. **35** illustrates the anchor **202** passed out of the opening **3410** and in the expanded configuration in which the ring **200** (marked in FIG. **2**G) of the anchor **202** is in the ring-shaped configuration.

(374) FIGS. **36** and **37** illustrate one or more methods of deploying the anchor **202** utilizing the deployment apparatus **3400**. As shown in FIG. **36**, the deployment apparatus **3400** may be passed in a direction through the outer wall **3600** of the right ventricle **1204** and through the interventricular septum **1210** to the left ventricle **1200**. The deployment apparatus **3400** may then be passed through the outer wall **1202** of the left ventricle **1202** and may position the opening **3410** exterior of the left ventricle **1200**. The puncture device **3406** may penetrate through the portions of the patient's heart **900**. With the opening **3410** exterior of the left ventricle **1202**, the push device **3412** (shown in FIG. **34**) may be utilized to push the anchor **202** out of the deployment apparatus **3400**. The anchor **202** may move from the unexpanded configuration to the expanded

configuration, and the tension member **286** (shown in FIG. **37**) may be withdrawn to expand the cover **212** of the anchor **202**. The anchor **202** may be deployed to a position on an external surface of the patient's heart and adjacent the left ventricle. Referring to FIG. **37**, the deployment apparatus **3400** may be withdrawn from the puncture points with the tension member **286** trailing from the deployment apparatus **3400**. The tension member **286** may pass out of the opening **3410** to pass the tension member **286** through the puncture point **3700** of the outer wall **3600** and leave a portion of the tension member **286** exterior of the patient's heart at the puncture point **3700** of the outer wall **3600**.

(375) Referring back to FIG. **36**, an additional puncture of the patient's heart **900** may be made by the deployment apparatus **3400′**, with like elements as deployment apparatus **3400** marked with a prime symbol. The deployment apparatus **3400′** may comprise the same deployment apparatus as deployment apparatus **3400** or may comprise a separate deployment apparatus. In an embodiment in which the same deployment apparatus is utilized, the anchor **202′** may be positioned in series in the deployment apparatus **3400′** with the deployment apparatus **3400**. The deployment apparatus **3400′** is marked in dashed lines to distinguish from the movement of the deployment apparatus **3400**. The deployment apparatus **3400′** may similarly be passed in a direction through the outer wall **3600** of the right ventricle **1204** and through the interventricular septum **1210** to the left ventricle **1200**. The deployment apparatus **3400′** may then be passed through the outer wall **1202** of the left ventricle **1200** and may position the opening **3410′** exterior of the left ventricle **1200**. With the opening **3410′** exterior of the left ventricle **1200**, a push device may be utilized to push the anchor **202′** (which may be configured similarly as anchor **202**) out of the deployment apparatus **3400′**. The anchor **202′** may be deployed in the same manner as anchor **202**. The anchor **202′** may be deployed to a position on an external surface of the patient's heart and adjacent the left ventricle. Referring to FIG. **37**, the deployment apparatus **3400′** may be withdrawn from the patient's heart **900** with the tension member **286′** (which may be configured similarly as tension member **286**) trailing, to leave a portion of the tension member **286′** exterior of the patient's heart at the puncture point **3700** of the outer wall **3600**.

(376) In other embodiments, the position of deployed anchors **202**, **202′** may be varied as desired. A different number of anchors may be deployed, such as three or four or more as desired. For example, an anchor may be deployed adjacent each papillary head muscle, with a third anchor deployed adjacent the mitral annulus.

(377) The portions of the tension members **286**, **286′** positioned exterior of the patient's heart at the puncture point **3700** may be coupled to an anchor **3702**. The anchor **3702** may be configured to support the portion of the patient's heart to which it is applied. The anchor **3702** may comprise a pad configured to press against the patient's heart. The anchor **3702** may include one or more locks for locking a tension member coupled to the anchor **3702**. The one or more locks may include a first lock **3704** and a second lock **3706** that may be configured similarly as the first lock **3704**. The locks **3704**, **3706** may be configured to press a tension member to hold the tension member in position, or may comprise other forms of locks. The one or more locks may be configured to move from an unlocked state to a locked state for locking the respective tension members to the anchor **3702**.

(378) The anchor **3702** may be configured to independently control the tension of the tension member **286** and the tension member **286′**. One of the locks **3704** may be configured to lock the tension of the tension member **286** while the other lock **3706** may be configured to independently lock the tension member **286′**. In this manner, the tension of the tension member **286** and the tension member **286′** may be set independently and locked independently. The force applied to the different portions of the heart by anchor **202** and **202′** may accordingly be independently set and may be varied depending on the therapeutic effect desired for the patient. The resulting heart splint (anchors **3702**, **202**, **202′** and tension members **286**, **286′**) may have different tension on each tension member **286**, **286′**.

(379) FIG. **38** illustrates the anchor **3702** positioned on the external surface of the patient's heart adjacent the right ventricle, coupled to tension members **286** and **286′**.
(380) In an embodiment shown in dashed lines in FIG. **37**, the anchor **3702′** (which may be configured similarly as anchor **3702**) may be positioned on the interventricular septum **1210** of the patient's heart. The anchors **202**, **202′** in this configuration may be positioned on the outer wall **1202** of the left ventricle **1200** utilizing a deployment apparatus **3400** passed endovascularly into the right ventricle **1204** (for example via the superior vena cava **1220** and the right atrium **1206**) and then puncturing the interventricular septum **1210** and the outer wall **1202** of the left ventricle **1200**. The deployment apparatus **3400** may be configured to have a flexible body portion to allow for movement within the patient's vasculature. The anchors **202**, **202′** may be deployed in sequence to the external surface of the left ventricle **1200** in a similar manner as discussed in regard to the embodiment shown in solid lines in FIG. **37**. The portions of the tension members **286″** and **286‴** (which each may be configured similarly as tension members **286** and **286′**) passing through the interventricular septum **1210** may be coupled to the anchor **3702′** and may be independently tensioned as discussed in regard to anchor **3702**. The anchor **3702′** may be deployed endovascularly to the right ventricle **1204** and the portions of the tension members **286″** and **286‴** passing through the interventricular septum **1210** may be coupled to the anchor **3702′**. The anchor **3702** thus may be either deployed to a position on the external surface of the patient's heart adjacent the right ventricle or may be deployed to a position that is on the interventricular septum. The tension members may be tensioned and locked in tension between the respective anchor **3702**, **3702′** and the anchors on the external surface of the left ventricle. The respective tension members may be tensioned independently, and locked in tension.
(381) In one embodiment, the anchors **202** and **202′** may be separately deployed to the interventricular septum **1210** utilizing the methods of FIGS. **9-33**. Separate deployments of the anchors **202** and **202′** to the side of the interventricular septum **1210** in the right ventricle **1204** may be made. The portions of the tension members **286**, **286′** extending through the outer wall **1202** of the left ventricle **1200** may be coupled to separate anchors **3702**, **3702′** that may be positioned where the anchors **202**, **202′** are shown to be positioned in FIG. **37**. The tension members **286**, **286′** may be independently tensioned at the anchors **3702**, **3702′**. In this manner, the force applied to the outer wall **1202** of the left ventricle **1200** by anchors **3702**, **3702′** may accordingly be independently set and may be varied depending on the therapeutic effect desired for the patient.
(382) The methods discussed in regard to FIGS. **36** and **37** may beneficially allow for the force applied to portions of the patient's heart to be independently set based on the therapeutic effect desired for the patient. The resulting heart splints (anchors and tension members) may have different tension on each tension member. The methods of FIGS. **36** and **37** are not limited to the number of anchors shown in FIGS. **36** and **37**, but may extend to a variety of numbers of anchors, and a variety of positions of anchors. A variety of numbers of anchors may have tension members with tension independently set.
(383) The use of the heart anchors disclosed herein may not be limited to use for heart splints, but may be utilized to seal an opening between chambers of a patient's heart. The opening may be in a septum, which may comprise the patient's interventricular septum **1210**. However, in other embodiments, the opening may be in any septum, and between any chambers of the heart. The opening may comprise a ventricular septal defect (VSD), an atrial septal defect (ASD), or a patent foramen ovale (PFO). Here, the opening is referred to as an opening in the interventricular septum as an example, although the apparatuses and methods may apply to any opening between chambers of the heart. The method may result in a plug **4100** shown in FIG. **44** extending through and sealing the opening in the septum.
(384) FIG. **39** illustrates a representation of the patient's interventricular septum **1210** and right ventricle **1204** and left ventricle **1200**. The interventricular septum **1210** may include an opening **3900**, which may have been caused by various maladies of the patient or another cause.

(385) A deployment apparatus **3902** may include a lumen **3904** and an opening at a distal end **3906** of the deployment apparatus **3902**. The deployment apparatus **3902** may include a push device **3908** configured to push an anchor **202** through the lumen **3904** with a tension member **286** trailing from the heart anchor **202**, in a similar manner as discussed in regard to deployment apparatus **3400**. The push device **3908** may be configured similarly as the push device **304** discussed in regard to FIGS. **3**A and **3**B. The deployment apparatus **3902** may be configured to deploy multiple anchors **202**, **202**′ from the lumen **3904**.
(386) The deployment apparatus **3902** may be configured to pass through the opening in the interventricular septum **1210** and push an anchor **202** into a chamber of the patient's heart. The anchor **202** may deploy in a similar manner as discussed in regard to the anchor **202** in FIGS. **36** and **37**. FIG. **39** illustrates the anchor **202** deployed in a left ventricle **1200** of the patient.
(387) FIG. **42**, for example, illustrates an embodiment of the anchor **202** being deployed in the left ventricle **1200** of the patient's heart with the deployment apparatus **3902** passing through the opening **3900** in the interventricular septum **1210**. The introducer sheath **500** and the delivery apparatus **400** may additionally be utilized to position the deployment apparatus **3902** in the desired position. The deployment apparatus **3902** may be advanced to the interventricular septum **1210** endovascularly (for example via the superior vena cava **1220** and the right atrium **1206**). A spacer such as the spacer disclosed in regard to FIG. **14**A may be utilized as desired.
(388) Upon the anchor **202** being deployed to a position on the septum **1210** adjacent the opening **3900** and in a chamber of the heart, the deployment apparatus **3902** may be retracted through the interventricular septum **1210** with the tension member **286** trailing from the deployment apparatus **3902**. The heart anchor **202**′ may then be deployed from the deployment apparatus **3902** in the chamber of the heart on the opposite side of the interventricular septum **1210** (the right ventricle **1204** as shown in FIG. **40**). The heart anchor **202**′ may be deployed to a position on the septum **1210** and in a chamber of the heart on an opposite side of the septum **1210** and adjacent the opening **3900**. FIG. **40** illustrates the anchor **202**′ deployed to the interventricular septum **1210** in the right ventricle **1204**. The anchors **202**, **202**′ may have a cloth positioned on one or more side to aid in sealing and to promote tissue attachment.
(389) The deployment apparatus **3902** may then be withdrawn with the tension member **286** trailing from the deployment apparatus **3902**. The tension member **286** may couple the anchors **202**, **202**′ to each other and may extend through the opening **3900**. The tension member **286** may then be pulled to tension the tension member **286** and draw the anchors **202**, **202**′ towards each other. Forces may be applied to opposite sides of the septum **1210**.
(390) FIG. **43**, for example, illustrates the deployment apparatus **3902** withdrawn from the left ventricle **1200** with the anchor **202**′ positioned in the right ventricle **1204** on the interventricular septum **1210**. The tension member **286** may extend exterior of the patient's heart for tensioning.
(391) FIG. **41** illustrates the anchors **202**, **202**′ positioned on opposite sides of the intraventricular septum **1210** and drawn together to seal the opening in the intraventricular septum **1210**. The combination of anchors **202**, **202**′ and tension member **286** may form a plug of the opening.
(392) A lock **4102** may extend from the anchors **202**, **202**′ to prevent the tension member **286** from slipping after being set. The lock may comprise a clip, autoknotter device, or another form of lock (for example, as described in U.S. Pat. No. 9,498,202 or 7,628,797, the entire disclosures of which are incorporated by reference). The remaining portion of the tension member **286** may then be cut and the deployment apparatus **3902** withdrawn from the patient's body, leaving the plug **4100** in position sealing the opening in the intraventricular septum **1210**.
(393) FIG. **44** illustrates the deployed plug **4100** plugging the opening **3900** in the interventricular septum **1210**.
(394) FIG. **44** illustrates an embodiment shown in dashed lines in which the anchor **800** may be coupled to the plug **4100**. In this embodiment, the plug **4100** may be deployed in a manner similar to the procedure shown in FIG. **32**. For example, a puncture device **168** and sheath **170** as shown in

FIG. **32** may be passed through the right ventricle **1200** and to the opening **3900** in the interventricular septum **1210**. The puncture device **168** may be withdrawn, and the deployment apparatus **3902** may be passed through the sheath **170** and opening **3900**. The deployment apparatus **3902** may first deploy the anchor **202′** in the right ventricle **1204** and then deploy the anchor **202** in the left ventricle **1200**. The deployment apparatus **3902** and sheath **170** and access apparatus **100** may then be withdrawn with the tension member **286** extending out of the puncture in the external surface of the patient's left ventricle **1200**. The anchor **800** may then be deployed in a similar manner as discussed in regard to FIGS. **26-31**. The tension member **286** may be tensioned at the anchor **800** and locked in position, as discussed herein. The tensioned tension member **286** may tension and seal the plug **3900**.

(395) The methods discussed in regard to FIGS. **39-44** may beneficially utilize the anchors **202**, **202′** to treat an opening in a septum positioned between chambers of the heart, and may provide an anchoring system for the anchor **800**.

(396) Heart anchors may be utilized to reshape an annulus of a tricuspid valve of a patient's heart. FIG. **45** illustrates a cross sectional view of a heart showing a right atrium **1206**, a left atrium **1208**, the tricuspid valve **1212**, and the mitral valve **1214**. The interatrial septum **4500**, the coronary sinus **4502**, the annulus **4504** of the tricuspid valve **1212** and the free wall **4506** of the right atrium are also shown. The aortic valve **4508** and pulmonary valve **4510** are also visible.

(397) The tricuspid valve **1212** includes three leaflets. The three leaflets include the septal leaflet **4512**, the anterior leaflet **4514**, and the posterior leaflet **4516**. A condition that may affect the tricuspid valve **1212** is expansion of the tricuspid valve annulus **4504**. This condition may occur for a variety of reasons, including general poor health of the patient as well as dilation of one or more of the right chambers **1206**, **1204** of the patient's heart.

(398) The expansion of the tricuspid valve annulus **4504** may lead to functional heart valve regurgitation of the tricuspid valve **1212**.

(399) FIG. **46** illustrates a representation of a tricuspid valve **1212** that is affected by expansion of the tricuspid valve annulus **4504**. The direction of expansion is represented by the arrow **4600** and may be in a direction from septal to lateral. The expansion may be in a direction towards the anterior and posterior commissure of the tricuspid valve **1212**. The inner dot-dash line **4602** in FIG. **46** may represent the original size of the tricuspid valve annulus **4504**. The outer dash-dash line **4604** may represent an expanded size of the annulus **4504** due to expansion of the tricuspid valve annulus **4504**. The size of the leaflets **4512**, **4514**, **4516** does not significantly increase during expansion of the tricuspid valve annulus **4504**, which may lead to areas of poor coaptation between the leaflets as shown in FIG. **46**. The poor coaptation may cause functional heart valve regurgitation of the tricuspid valve **1212** (functional tricuspid regurgitation (FTR)).

(400) A heart splint may be utilized that is configured to reshape the annulus **4504** of the tricuspid valve **1212** of the patient's heart. The heart splint may utilize components disclosed herein, including heart anchors and a tension member for coupling the heart anchors together. A heart splint may be deployed to exert a force that opposes a direction of expansion. For example, a heart splint may be deployed to exert a force that is opposite the direction of expansion (marked by arrow **4600**) shown in FIG. **46**. The resulting force may serve to reshape the tricuspid valve annulus **4504** and improve coaptation of the valve leaflets **4512**, **4514**, **4516**. The improved coaptation may reduce the functional heart valve regurgitation of the tricuspid valve **1212**.

(401) The heart splint, or any of the components of the heart splint (e.g., a heart anchor), may be deployed in a less invasive, or minimally invasive manner, and may utilize techniques previously disclosed in this application. For example, a heart anchor may be deployed endovascularly and another heart anchor may be deployed via a small surgical access to the patient's heart. In embodiments, both heart anchors may be deployed endovascularly, via a neckline access procedure or the like.

(402) FIGS. **47-51** illustrate steps in a method for reshaping an annulus **4504** of a tricuspid valve

1212 of a patient's heart. FIG. **47** illustrates a side cross sectional view of a patient's heart showing the right atrium **1206**, the left atrium **1208**, and the right ventricle **1204**. The interatrial septum **4500** and the free wall **4506** of the right atrium **1206** are also shown. A side view of the tricuspid valve **1212** is shown, with poor coaptation between leaflets of the tricuspid valve **1212**.

(403) A heart anchor **202** (marked in FIG. **48**) may be deployed to the interatrial septum **4500**. The heart anchor **202** may be configured to be positioned on the interatrial septum **4500** of the patient's heart. The heart anchor **202** may comprise the heart anchor shown and discussed in regard to FIG. **2**A-**2**H. The heart anchor **202** as shown in FIGS. **2**A-**2**H includes a ring **200** having two ends (**204**, **206**) and configured to move from a linearized configuration to a ring-shaped configuration. A cover **212** is coupled to the ring **200** and extends inward from the ring **200** in the ring-shaped configuration. The ring **200** includes a first portion and a second portion **214**, **216**, and the first portion overlaps the second portion in the ring-shaped configuration.

(404) The heart anchor **202** may be deployed through use of a deployment apparatus **4700**. The deployment apparatus **4700** may be configured similarly as the deployment apparatus **3400** shown in FIG. **34**. The deployment apparatus **4700** may be configured to deploy the heart anchor **202** to the interatrial septum **4500** of the patient's heart. The deployment apparatus **4700** may be configured to flex and curve to allow for endovascular passage into the right atrium **1206** and to allow for direction to the interatrial septum **4500** as shown in FIG. **47**. The deployment apparatus **4700** may include a puncture device **4702** (which may be configured similarly as puncture device **3406**) and may include an opening **4704** (which may be configured similarly as opening **3410**). The opening **4704** may be configured to pass the anchor **202** through the opening **4704**. The deployment apparatus **4700** may include an internal lumen (which may be configured similarly as lumen **3408**) configured to retain the anchor **202** in the unexpanded or linearized configuration within the lumen. A push device (which may be configured similarly as push device **3412**) may be configured to pass through the lumen of the deployment apparatus **4700** for pushing anchor **202** out of the opening **4704**, in a similar manner as push device **3412**.

(405) The deployment apparatus **4700** may be passed into the right atrium endovascularly, for example, via a neckline introduction into the patient's blood vessels, and particularly through the patient's superior vena cava **1220** as shown in FIG. **47**. An introducer sheath **500**, similar to the introducer sheath disclosed in regard to FIG. **5** may be utilized for access to the patient's blood vessels. A delivery apparatus **400**, similar to the delivery apparatus disclosed in regard to FIG. **4** may be utilized to direct the deployment apparatus **4700** to a desired position. For example, the distal end **408** of the delivery apparatus **400** may be controlled to deflect to a position proximate the interatrial septum **4500**.

(406) The deployment apparatus **4700** may be passed through the interatrial septum **4500** to reach the left atrium **1208**. The puncture device **4702** may be used to puncture the interatrial septum **4500**. In other embodiments, a separate puncture device may be utilized to puncture the interatrial septum **4500**, among other methods of accessing the left atrium **1208**. In certain embodiments, passing through the interatrial septum **4500** may occur through the foramen ovale if the foramen ovale is in the desired location.

(407) The heart anchor **202** may be deployed to the interatrial septum **4500** by being passed out of the opening **4704**. The heart anchor **202** may be deployed in a similar manner as discussed in regard to FIGS. **34**-**37**. For example, the heart anchor **202** may be positioned in a lumen of the deployment apparatus **4700** in an unexpanded configuration, with the ring of the heart anchor **202** linearized. The heart anchor **202** may be pushed out of the opening **4704** with a push device or other device. The heart anchor **202** may be configured to automatically move from the unexpanded configuration to the expanded configuration, with the ring of the heart anchor **202** having a ring-shaped configuration. A tension member **286** (shown in FIG. **37**) may be withdrawn to expand the cover of the anchor **202**. In other embodiments, a deployment member or the like (as shown in FIG. **2**H as deployment member **306**) may be utilized to expand the cover of the anchor **202**.

(408) The heart anchor **202** may be deployed to the interatrial septum **4500** at a desired location that serves to oppose a direction of expansion of the tricuspid annulus **4504** (such as a direction represented by the arrow **4600** in FIG. **46**). The deployment apparatus **4700** may be passed through the interatrial septum **4500** at this location. The heart anchor **202** may be deployed on the interatrial septum **4500** in the left atrium **1208** at this location. The heart anchor **202** may be securely pressed against the interatrial septum **4500** by the user pulling the tension member **286** or a deployment member or the like.
(409) FIG. **48** illustrates the heart anchor **202** having been deployed to the interatrial septum **4500**. The deployment apparatus **4700** may be withdrawn, with the tension member **286** trailing from the deployment apparatus **4700** (and extending through the sheath **500**).
(410) The tension member **286** may be brought to the corresponding desired position in the free wall **4506** of the right atrium **1206** in a variety of methods.
(411) FIG. **49** illustrates a method of bringing the tension member **286** to a corresponding desired position in the free wall **4506** of the right atrium **1206** utilizing external access of the right atrium **1206**. The method may utilize a snare **4900** or other method of drawing the tension member **286** to the free wall **4506** of the right atrium **1206**.
(412) As shown in FIG. **49**, a puncture of the free wall **4506** of the right atrium **1206** may be made. A puncture device **4902** at the tip of a snare **4900**, or other form of puncture device may be utilized to enter the right atrium **1206** through the free wall **4506**. The puncture may be made at a desired location to position the heart anchor **5100** (marked in FIG. **51**) on the external surface of the free wall **4506**. The puncture may be made at a location that the tension member **286** is drawn through to define the direction of force between the heart anchor **202** and the heart anchor **5100**.
(413) Upon the puncture of the free wall **4506** being made, the snare **4900** may be advanced into the right atrium **1206**. The snare **4900** may pass through a sheath **4904** or other device for allowing smooth entry into the right atrium **1206**. The snare **4900** may be utilized to snare the tension member **286**, either directly or by snaring another snare **4906** as shown in FIG. **49**. The snare **4906** may be coupled to the tension member **286**, as represented by the loop at the top of FIG. **49**.
(414) Upon the tension member **286** being snared, the tension member **286** may be withdrawn through the puncture in the free wall **4506** of the right atrium **1206** in a configuration shown in FIG. **50**. In an embodiment in which the tension member **286** is coupled to a snare **4906**, then the snare may be withdrawn through the puncture as well. The tension member **286** may be brought outside of the patient's body or may otherwise be accessible for coupling to a heart anchor such as the heart anchor **5100** shown in FIG. **51**. The heart anchor **5100** may be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** as shown in FIG. **51**. The heart anchor **5100** may be deployed to the external surface of the patient's heart on the free wall **4506**. The heart anchor **5100** may be deployed adjacent to the tricuspid annulus.
(415) FIG. **51** illustrates the heart anchor **5100** in position on the free wall **4506** of the right atrium **1206**. The heart anchor **5100** is configured to be positioned on the free wall **4506** of the right atrium **1206**. The heart anchor **5100** may include a lock **5102**. The lock **5102** may be configured similarly as the lock **838** shown in FIG. **8**D, and may be configured to set a locked or unlocked state of the heart anchor **5100**. The lock **5102** may be for locking the tension member **286** to the heart anchor **5100**. The lock **5102** may include a rotatable body **5104** and a locking surface **5106** that operate similarly as the respective rotatable body **850** and locking surface **848** of the lock **838**. The rotatable body **5104** may comprise a cam body that operates similarly as the rotatable body **850** discussed in regard to FIGS. **8**D and **8**E. The heart anchor **5100** may comprise a pad, as shown in FIG. **38** with anchor **3702**, or may have another configuration as desired.
(416) The user may tension the tension member **286** for coupling the heart anchor **202** to the heart anchor **5100**. The user may set a tension of the tension member **286** by pulling the tension member **286** through the lock **5102** of the heart anchor **5100** to a desired amount. The user accordingly may set a length of the tension member **286** between the heart anchors **202**, **5100** and a distance between

the heart anchors **202**, **5100**. The tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics. The user may monitor the diameter of the tricuspid annulus and tricuspid regurgitation. The tensioning and monitoring may occur in real-time.

(417) Preferably, the tensioning of the tension member **286** counteracts the expansion of the tricuspid valve annulus and improves coaptation of the tricuspid valve leaflets. The diameter of the tricuspid valve annulus may be reduced. The tricuspid valve annulus may be moved in a septal direction (from lateral). Upon the tension member **286** having the desired amount of tension, the user may lock the tension member **286** in tension between the heart anchor **202** and the heart anchor **5100**. The lock **5102** may be locked to secure tension member **286** to the heart anchor **5100**. The remaining portion of the tension member **286** may be cut by the user as desired. The resulting heart splint **5104** may be left in position to therapeutically counteract the expansion of the tricuspid valve annulus.

(418) FIG. **52** illustrates a top cross-sectional view of the patient's heart with the heart splint **5104** in position. The heart splint **5104** extends across the right atrium **1206**. The tension member **286** couples the heart anchor **202** to the heart anchor **5100** and extends within the right atrium **1206** and extends over at least a portion of the tricuspid valve **1212**. As shown in FIG. **52**, preferably the tension member **286** extends in a direction that counteracts the direction of expansion of the tricuspid valve annulus.

(419) The heart splint **5104** may be deployed in a variety of methods that are not limited to the method shown in FIGS. **47-51**. In addition, the components comprising the heart splint may vary in other embodiments.

(420) FIGS. **53-55** illustrate an embodiment in which the heart splint **5104** is deployed in a method in which the free wall **4506** of the right atrium **1206** is punctured from inside the right atrium **1206**. FIG. **53** illustrates a configuration in which the heart anchor **202** has been deployed to the interatrial septum, for example, in a manner as shown in FIGS. **47** and **48**. A puncture may then be made of the free wall **4506** of the right atrium **1206** from inside the right atrium **1206**.

(421) FIG. **53** illustrates a puncture device **5300** that may be used to puncture the free wall **4506** of the right atrium **1206** from inside the right atrium **1206**. The puncture device **5300** may comprise a curved or directable needle device that may puncture the free wall **4506** at the desired location. In other embodiments, other forms of puncture devices may be utilized. The puncture device **5300** may be coupled to the tension member **286**, as represented by the loop shown at the top of FIG. **53**. The puncture device **5300** may then be drawn through the free wall **4506** of the right atrium **1206** and may be accessed via surgical access of the exterior of the patient's heart. The puncture device **5300** may exit the patient's heart with the tension member **286** trailing, to allow the user to access the tension member **286**.

(422) In one embodiment, the deployment apparatus **4700** shown in FIG. **47** may be utilized to puncture the free wall **4506** from inside the right atrium **1206**. For example, after the interatrial septum **4500** is punctured as shown in FIG. **47** and the heart anchor **202** is deployed to the interatrial septum **4500**, then the deployment apparatus **4700** may be rotated to puncture the free wall **4506** from inside the right atrium **1206** (in a similar manner as shown in FIG. **60**). A puncture device **4702** at the tip of the deployment apparatus **4700** may be utilized to puncture the free wall **4506** from inside the right atrium **1206**. The deployment apparatus **4700** may be passed outside of the patient's heart with the tension member **286** trailing, to allow the user to access the tension member **286**.

(423) The tension member **286** extends outside of the patient's heart, as shown in FIG. **54**. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as discussed in regard to FIGS. **50-51**. FIG. **55** illustrates the heart splint **5104** in position, with the tension member **286** extending across the tricuspid valve **1212**.

(424) FIGS. **56-58** illustrate an embodiment in which the heart splint **5104** is deployed in a method in which the free wall **4506** of the right atrium **1206** is punctured from outside the right atrium **1206** and the interatrial septum **4500** is punctured in a direction from the right atrium **1206** to the left atrium **1208**. The free wall **4506** and the interatrial septum **4500** may each be punctured by a deployment apparatus **3400** passing through both the free wall **4506** and the interatrial septum **4500**.

(425) FIG. **56** illustrates the deployment apparatus **3400** having entered the right atrium **1206** from outside the free wall **4506** of the right atrium and passing through the interatrial septum **4500** into the left atrium **1208**. The heart anchor **202** may be deployed to the interatrial septum **4500** in a similar manner as described in regard to FIGS. **34-37**. The deployment apparatus **3400** may then be withdrawn from the right atrium **1206** with the tension member **286** trailing out of the puncture **5600** of the free wall **4506** of the right atrium **1206**. A configuration as shown in FIG. **57** may result. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as discussed in regard to FIGS. **50-51**. FIG. **58** illustrates the heart splint **5104** in position, with the tension member **286** extending across the tricuspid valve **1212**.

(426) FIGS. **59-63** illustrate an embodiment in which a heart splint **6300** is deployed that uses multiple of the heart anchors **202** (the second heart anchor is configured similarly as heart anchor **202** and is designated as heart anchor **202**′). FIG. **59** illustrates that the deployment apparatus **4700** may be utilized to puncture the interatrial septum **4500** in a similar manner as discussed regarding FIG. **47**. The deployment apparatus may deploy the heart anchor **202** to the interatrial septum **4500** in the left atrium **1208**.

(427) The deployment apparatus **4700** may be loaded with at least two heart anchors **202**, **202**′ or otherwise configured to deploy at least two heart anchors **202**, **202**′. The heart anchors **202**, **202**′ may be connected with a common tension member **286**.

(428) FIG. **60** illustrates the deployment apparatus **4700** may be passed to the free wall **4506** of the right atrium **1206** with the tension member **286** trailing the opening **4704** of the deployment apparatus **4700**. The deployment apparatus **4700** may puncture the free wall **4506** of the right atrium **1206** with the puncture device **4702**. The deployment apparatus **4700** may deploy the heart anchor **202**′ to the external surface of the free wall **4506** of the right atrium **1206**. The deployment apparatus **4700** may then be withdrawn from the right atrium **1206** with the tension member **286** trailing.

(429) FIG. **61** illustrates the deployment apparatus **4700** having been withdrawn from the right atrium **1206** with the tension member **286** trailing. The tension member **286** may then be tensioned to a desired amount by a user. Multiple methods of tensioning the tension member **286** may be utilized. The tensioning may include drawing the portions of the tension member **286** coupled to the respective heart anchors **202**, **202**′ towards each other. A lock **6200** as shown in FIG. **62** may be placed along the tension member **286** and may allow a central portion **6100** of the tension member **286** to be withdrawn to draw the heart anchors **202**, **202**′ towards each other.

(430) FIG. **62** illustrates a lock **6200** in position on the tension member **286** between the heart anchors **202**, **202**′. A sheath **6202** or other device may hold the lock **6200** in position while the central portion **6100** of the tension member **286** is withdrawn to draw the heart anchors **202**, **202**′ towards each other. The lock **6200** may comprise a releasable lock, and may be configured similarly as the lock **5102**, to allow for the lock **6200** to be set once the tension in the tension member **286** is set to the desired amount. The tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics. The user may monitor the diameter of the tricuspid annulus and tricuspid regurgitation. The tensioning and monitoring may occur in real-time.

(431) Upon the desired tension being provided in the tension member **286**, the remaining portion of the tension member **286** may be cut. FIG. **63** illustrates the heart splint **6300** in position, with the

tension member **286** extending across the tricuspid valve **1212**. The lock **6200** may be positioned centrally as shown in FIG. **63**, or may be positioned proximate one of the heart anchors **202**, **202′** in other embodiments. The lock **6200** in certain embodiments may be positioned out of the flow path of the tricuspid valve **1212** to reduce the possibility of disrupting the flow through the tricuspid valve **1212**.

(432) FIGS. **64-66** illustrate an embodiment in which a puncture is made in the interatrial septum **4500** from the left atrium **1208** to the right atrium **1206**. The left atrium **1208** may be accessed in a variety of methods. Such methods may include puncture of the left atrium **1208** from outside the patient's heart as well as vascular access. Such vascular access may be provided through the mitral valve **1214** for example.

(433) FIG. **64** illustrates a puncture device **6400** may be passed from the left atrium **1208** to the right atrium **1206** through the interatrial septum **4500**. The puncture device **6400** may comprise a portion of a snare **6402**. A puncture may be made of the free wall **4506** of the right atrium **1206** via a puncture device **6404**. The puncture device may comprise a portion of a snare **6406**. The snares **6402**, **6406** may snare each other, and may both be withdrawn outside the patient's body through the puncture in the free wall **4506** of the right atrium **1206**. The snare **6402** may be coupled to a tension member **286** that is drawn through the puncture in the free wall **4506** of the right atrium **1206** for access by a user. The opposite end of the tension member **286** may be coupled to the anchor **202**, which may be deployed at the interatrial septum **4500** in the left atrium **1208** using a deployment apparatus such as the deployment apparatus **300**.

(434) FIG. **65** illustrates the anchor **202** having been deployed at the interatrial septum **4500** in the left atrium **1208**, with the tension member **286** extending through the right atrium **1206** and the free wall **4506** of the right atrium **1206**. The user may then access the tension member **286**. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as discussed in regard to FIGS. **50-51**. The resulting heart splint **5104** is shown in FIG. **66**.

(435) FIG. **67** illustrates a similar method as shown in FIGS. **64-66**, however, here the puncture device **6400** passes from the left atrium **1208** through the interatrial septum **4500** and through the free wall **4506** of the right atrium **1206**. A user may access the puncture device **6400** that may be coupled to a tension member **286**. The user may withdraw the puncture device **6400** and tension member **286** outside the patient's body through the puncture in the free wall **4506** of the right atrium **1206**. The opposite end of the tension member **286** may be coupled to the anchor **202**, which may be deployed at the interatrial septum **4500** in the left atrium **1208** using a deployment apparatus such as the deployment apparatus **300**. The configuration shown in FIG. **65** may result. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as discussed in regard to FIGS. **50-51**. The heart splint **5104** shown in FIG. **66** may result.

(436) FIG. **68** illustrates an embodiment in which a heart splint **6900** is deployed that uses multiple of the heart anchors **202** (the second heart anchor is configured similarly as heart anchor **202** and is designated as heart anchor **202′**). A deployment apparatus **3400** may be passed from the left atrium **1208** through the interatrial septum **4500** and through the free wall **4506** of the right atrium **1206**. The deployment apparatus **3400** may deploy the heart anchor **202** to the external surface of the free wall of the right atrium **1206** in a similar manner as described in regard to FIGS. **34-37**. The deployment apparatus **3400** may then be withdrawn into the right atrium **1206** with the tension member **286** trailing out of the puncture **6800** of the free wall **4506** of the right atrium **1206**. The deployment apparatus **3400** may then be withdrawn into the left atrium **1208** and may deploy the anchor **202′** to the interatrial septum **4500**. The tension member **286** may be cinched between the two anchors **202**, **202′** until a desired tension of the tension member **286** is reached. The tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics. The user may monitor the diameter of the tricuspid annulus and tricuspid

regurgitation. The tensioning and monitoring may occur in real-time.
(437) A resulting heart splint **6900** is shown in FIG. **69**. A lock **6902** may be set at the anchor **202** to lock the tension of the tension member **286**. The lock **6902** may comprise a clip, autoknotter device, or another form of lock (for example, as described in U.S. Pat. No. 9,498,202 or 7,628,797, the entire disclosures of which are incorporated by reference). The remaining portion of the tension member **286** may then be cut.
(438) FIGS. **70-73** illustrate an embodiment of deploying a heart splint **7300** (marked in FIG. **73**) that utilizes a heart anchor **7000** configured to be positioned within the coronary sinus **4502** of the patient's heart. The position of the coronary sinus **4502** is represented in FIG. **45**. The coronary sinus **4502** may comprise an anchoring point for the heart anchor **7000** of the heart splint **7300**.
(439) The heart anchor **7000** may comprise a stent configured to be positioned within the coronary sinus **4502**. In other embodiments, other forms of heart anchors configured to be positioned within the coronary sinus **4502** may be utilized, including barbs, prongs, hooks, or other forms of heart anchors.
(440) FIG. **70** illustrates the heart anchor **7000** as a stent that may be deployed to the coronary sinus **4502**. The stent may be an expandable stent and may be configured to move from an unexpanded configuration to an expanded configuration. The unexpanded configuration may be a configuration in which the outer profile of the stent is reduced until the stent is deployed in the coronary sinus **4502**. FIG. **70** illustrates that the stent may be positioned on a deployment apparatus **7002** in the form of an expandable body such as a balloon or the like that the stent may extend over. The expandable body may expand to move the stent from the unexpanded configured to the expanded configuration.
(441) The deployment apparatus **7002** may be passed into the right atrium endovascularly, for example, via a neckline introduction into the patient's blood vessels, and particularly the patient's superior vena cava **1220** as shown in FIG. **70**. An introducer sheath **500**, similar to the introducer sheath disclosed in regard to FIG. **5** may be utilized for access to the patient's blood vessels. A delivery apparatus **400**, similar to the delivery apparatus disclosed in regard to FIG. **4** may be utilized to direct the deployment apparatus **7002** to a desired position. For example, the distal end **408** of the delivery apparatus **400** may be controlled to deflect to a position proximate the coronary sinus **4502**.
(442) The heart anchor **7000** may have a tension member **286** (marked in FIG. **71**) coupled to the heart anchor **7000**. The heart anchor **7000** may be deployed within the coronary sinus **4502** and then have the delivery apparatus **400** withdrawn to leave the tension member **286** trailing.
(443) The tension member **286** may be brought to the corresponding desired position in the free wall **4506** of the right atrium **1206** in a variety of methods.
(444) FIG. **71** illustrates a method of bringing the tension member **286** to a corresponding desired position in the free wall **4506** of the right atrium **1206** utilizing external access of the right atrium **1206**. The method may utilize a snare **7100** or other method of drawing the tension member **286** to the free wall **4506** of the right atrium **1206**.
(445) As shown in FIG. **71**, a puncture of the free wall **4506** of the right atrium **1206** may be made. A puncture device **7102** at the tip of a snare **7100**, or other form of puncture device may be utilized to enter the right atrium **1206** through the free wall **4506** in a similar manner as discussed in regard to FIG. **49**. FIG. **72** illustrates the tension member **286** being drawn outside of the patient's heart, in a similar manner as discussed in regard to FIG. **50**. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as described in regard to FIG. **51**. The heart splint **7300** is shown in FIG. **73**.
(446) The position of the heart anchor **7000** within the coronary sinus **4502** may vary the direction that the tension member **286** has over the tricuspid valve **1212**. FIG. **74** illustrates a top cross-sectional view of the patient's heart. The heart anchor **7000** in the form of a stent is shown positioned within the coronary sinus **4502**.

(447) FIG. **75** illustrates an embodiment in which a puncture device **5300** may be used to puncture the free wall **4506** of the right atrium **1206** from inside the right atrium **1206**. The puncture device **5300** may be used to pass the tension member **286** outside the right atrium in a similar manner as discussed in regard to FIGS. **53-55**. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to the free wall of the right atrium **1206** in a similar manner as described in regard to FIG. **51**. The resulting heart splint **7300** is shown in FIG. **73**.
(448) FIGS. **76-77** illustrate an embodiment in which a heart splint **7700** is deployed that uses the heart anchor **202**. The heart anchor **202** may be deployed in a similar manner as the heart anchor **202**′ described in regard to FIGS. **59-63**. The resulting splint **7700** is shown in FIG. **77**, with a lock **6300** positioned between the heart anchor **202** and anchor **7000**.
(449) The heart splints of the embodiments of FIGS. **45-77**, or any of the components of the heart splint (e.g., a heart anchor), may be deployed in a less invasive, or minimally invasive manner, and may utilize techniques previously disclosed in this application. For example, in the embodiments of FIGS. **47-52**, **53-55**, **56-58**, **64-66**, **67**, **70-74**, and **75**, a small surgical access may be made to the patient's body (such as through a thoracotomy, including a small right anterior thoracotomy, or mini-thoracotomy) to deploy the anchor **5100**. In the embodiments of FIGS. **59-63**, **68-69**, and **76-77**, both heart anchors **202**, **202**′ may be deployed endovascularly. Endovascular deployment may include access through the jugular or femoral vein. Transcatheter and percutaneous deployment may be utilized. Other forms of deployment may be utilized as desired. The reshaping of the heart valve annulus may include a beating heart reshaping.
(450) The heart splints of the embodiments of FIGS. **45-77** may beneficially serve to reshape an annulus of a tricuspid valve of the patient's heart. In an embodiment in which a heart anchor **202** (or **202**′) is utilized, the heart anchor may beneficially distribute the force applied to the heart anchor over a relatively large area. The cover **212** may bear a majority of the force applied to the heart anchor **202**. In an embodiment in which anchor **5100** is utilized, the anchor **5100** may beneficially distribute the force applied to the heart anchor **5100** over a relatively large area. In other embodiments, other forms of heart anchors may be utilized as desired (e.g., barbs, prongs, hooks, or other forms of heart anchors).
(451) The position of the heart anchors (including heart anchors **202**, **5100**) may be set to provide a desired direction of force applied to the tricuspid valve annulus. The direction of force preferably opposes the direction of expansion of the tricuspid annulus. The direction of force may be in a septal direction.
(452) The sizes of the heart anchors utilized may be set at desired. In one embodiment a heart anchor **202** deployed on an interatrial septum may have a diameter of between about 10 mm and about 20 mm, and may have a diameter of about 15 mm. In one embodiment, a heart anchor **5100** for positioning on the free wall of the right atrium may have a diameter of between about 20 and about 25 mm, and may be about 23 mm in certain embodiments.
(453) Although the embodiments of FIGS. **45-77** are described in relation to reshaping an annulus of a tricuspid valve of the patient's heart, it is contemplated that the devices, systems, and methods may be utilized to reshape other heart annuluses or other portions of the heart or body generally. The devices, systems, and methods may be utilized to treat functional heart valve regurgitation and other valve incompetencies. The devices disclosed herein may comprise systems for reshaping an annulus of a tricuspid valve of the patient's heart.
(454) Heart anchors may be utilized to reposition a valve leaflet of a mitral valve of a patient's heart. FIG. **78** illustrates a cross sectional view of a left ventricle **1200**, a left atrium **1208** and a mitral valve **1214** of a patient's heart. The aortic valve **7800** is also visible.
(455) The mitral valve **1214** may be suffering from prolapse, in which the leaflet **7802** is bulging into the left atrium **1208**. The leaflet **7802** may bulge relative to the position of the leaflet **7804**, which may result in functional heart valve regurgitation of the mitral valve **1214**. It may be beneficial to reposition the leaflet **7802**, to bring the leaflet **7802** to the plane of the leaflet **7804**

and improve the coaptation of the leaflets **7802**, **7804**.
(456) A heart splint may be utilized to reposition the leaflet **7802**. The heart splint may utilize heart anchors disclosed herein, including the anchor **202** shown and discussed in regard to FIG. **2**A-**2**H. The heart anchor may be configured to be positioned on a leaflet of a valve in a patient's heart. The heart anchor **202** as shown in FIGS. **2**A-**2**H includes a ring **200** having two ends (**204**, **206**) and configured to move from a linearized configuration to a ring-shaped configuration. A cover **212** is coupled to the ring **200** and extends inward from the ring **200** in the ring-shaped configuration. The ring **200** includes a first portion and a second portion **214**, **216**, and the first portion overlaps the second portion in the ring-shaped configuration.
(457) FIGS. **79**-**80** illustrate steps in a method for repositioning a heart valve leaflet. In FIG. **79**, a deployment apparatus **3400** may be passed through the left ventricle **1200** and may puncture the leaflet **7802**. The deployment apparatus **3400** may be configured similarly as shown in FIGS. **34** and **35** and may include a puncture device **3406** and an opening **3410** for passing the heart anchor **202** out of a central lumen. The heart anchor **202** may be deployed in a similar manner as described in regard to FIGS. **34** and **35**.
(458) The deployment apparatus **3400** may be passed into the left ventricle **1200** by being passed through the outer wall of the left ventricle **1200**. The puncture device **3406** of the deployment apparatus **3400** may be used to puncture the outer wall of the left ventricle **1200**. The deployment apparatus **3400** may puncture the outer wall of the left ventricle **1200** at a desired position for a heart anchor to be deployed. The position may be determined based on the desired angle that a resulting tension member will have between the heart anchor **202** and the heart anchor on the outer wall of the left ventricle **1200**. In one embodiment, the position may be near the left ventricle apex, adjacent the papillary muscles.
(459) The deployment apparatus **3400** may puncture the leaflet **7802** with the puncture device **3406** of the deployment apparatus **3400**. In other embodiments, other methods of puncturing the outer wall of the left ventricle **1200** and puncturing the leaflet **7802** may be utilized.
(460) Upon the deployment apparatus **3400** puncturing the leaflet **7802**, the heart anchor **202** may be deployed to the leaflet **7802**. The heart anchor **202** may be deployed to the leaflet such that it rests against the surface of the leaflet **7802**. The deployment apparatus **3400** may then be withdrawn with the tension member **286** trailing out of the opening **3410** in the deployment apparatus **3400**.
(461) Referring to FIG. **80**, the deployment apparatus **3400** may continue to be withdrawn from the left ventricle **1200** and out of the puncture **8000** in the left ventricle **1200** with the tension member **286** trailing out of the puncture **8000**. The tension member **286** positioned outside of the left ventricle **1200** may be accessible by a user. The heart anchor **5100** may then be coupled to the tension member **286** and deployed to a portion of the patient's heart. The portion may comprise the exterior surface of the left ventricle **1200** as shown in FIG. **80**.
(462) The heart anchor **5100** may be configured to be positioned on a portion of a patient's heart. The heart anchor **5100** may include a pad configured to be positioned on an exterior surface of the patient's heart and may include lock **5102** for locking the tension member **286** to the heart anchor **5100**. The tension member **286** may be configured to couple the heart anchor **202** to the heart anchor **5100** and provide a tension that repositions the leaflet.
(463) The tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics. The user may monitor the position of the leaflet **7802** and the mitral valve regurgitation. The tensioning and monitoring may occur in real-time. The user may pull the prolapsing leaflet **7802** to a desired state of coaptation by tensioning the tension member **286** to reposition the leaflet.
(464) The prolapse of the leaflet may be reduced. Upon the tension in the tension member **286** being set to the desired amount, the lock **5102** may be set to lock the tension member **286** to the heart anchor **5100** and set the length of the heart anchor **202** from the heart anchor **5100** to a length

that repositions the leaflet **7802**. The resulting heart splint **8002** is shown in FIG. **80**.
(465) FIG. **81** shows a top cross-sectional view of the patient's heart with the heart splint **8002** in position. The heart anchor **202** is shown in position on the leaflet **7802**. The position of the heart anchor **202** on the leaflet **7802** may be varied in other embodiments.
(466) The heart splint **8002**, and particularly the tension member **286**, may be configured to allow the mitral valve **1214** to open and function substantially similar to its normal operation. FIG. **82**, for example, illustrates that the tension member **286** may be flexible, to allow the tension member **286**, the heart anchor **202**, and the leaflet **7802** to move towards the heart anchor **5100**. Thus, during diastole, the mitral valve **1214** may open due to the flexible configuration of the tension member **286**. During systole, the tension member **286** may resist movement of the leaflet **7802** beyond a desired state of coaptation of the leaflets **7802**, **7804**. The tension member **286** may resist movement of the tension member **286** in a direction towards the heart anchor **202** and may resist movement of the leaflet **7802** in a direction away from the tension member in order to reduce the prolapse of the leaflet **7802**. The heart splint **8002** during systole may have a configuration as shown in FIG. **80**.
(467) FIGS. **83-85** illustrate an embodiment that uses multiple of the heart anchors **202** (the second heart anchor is configured similarly as heart anchor **202** and is designated as heart anchor **202′**). Both heart anchors **202**, **202′** may be deployed endovascularly. The entry to the patient's left ventricle **1200** may be via the aortic valve **7800**.
(468) Referring to FIG. **83**, a deployment apparatus **8300** may be utilized that is configured similarly as the deployment apparatus **3400** shown in FIG. **34**. The deployment apparatus **8300** may be configured to flex and curve to allow for endovascular passage into the left ventricle **1200** and to allow for direction to the mitral valve leaflet **7802** and the wall of the left ventricle **1200**. The deployment apparatus **8300** may include a puncture device **8302** (which may be configured similarly as puncture device **3406**) and may include an opening **8304** (which may be configured similarly as opening **3410**). The opening **8304** may be configured to pass the anchor **202** through the opening **8304**. The deployment apparatus **8300** may include an internal lumen (which may be configured similarly as lumen **3408**) configured to retain the anchor **202** in the unexpanded or linearized configuration within the lumen. A push device (which may be configured similarly as push device **3412**) may be configured to pass through the lumen of the deployment apparatus **8300** for pushing anchor **202** out of the opening **8304**, in a similar manner as push device **3412**.
(469) The deployment apparatus **8300** may be loaded with at least two heart anchors **202**, **202′**. The heart anchors **202**, **202′** may be connected with a common tension member **286**.
(470) As shown in FIG. **83**, the deployment apparatus **8300** may be directed to puncture the leaflet **7802** and deploy the heart anchor **202** to the leaflet **7802** in a similar manner as discussed in regard to FIGS. **79** and **80**.
(471) Referring to FIG. **84**, upon deployment of the heart anchor **202** to the leaflet **7802**, the deployment apparatus **8300** may be directed to puncture the outer wall of the left ventricle **1200**. The tension member **286** may trail from the opening **8304** as the deployment apparatus **8300** punctures the outer wall of the left ventricle **1200**. The deployment apparatus **8300** may puncture the outer wall of the left ventricle **1200** in the desired location. The deployment apparatus **8300** may then deploy the second heart anchor **202′** to a position on the outer wall of the left ventricle **1200**.
(472) The tension member **286** may then be tensioned. Referring to FIG. **85**, multiple methods of tensioning the tension member **286** may be utilized. For example, a method may be utilized similar to the method disclosed in regard to FIGS. **62** and **63**. The tensioning may include drawing the portions of the tension member **286** coupled to the respective heart anchors **202**, **202′** towards each other. A lock **6200** may be placed along the tension member **286** and may allow a central portion of the tension member **286** to be withdrawn to draw the heart anchors **202**, **202′** towards each other. The tension member **286** may be tensioned to a desired amount with the user simultaneously

verifying proper hemodynamics. A sheath **8402** or other device may hold the lock **6200** in position while the central portion of the tension member **286** is withdrawn to draw the heart anchors **202**, **202** towards each other. The user may monitor the monitor the position of the leaflet **7802** and the mitral valve regurgitation. The lock **6200** may comprise a releasable lock, and may be configured such as the lock **5800**, to allow for the lock **6200** to be set once the tension in the tension member **286** is set to the desired amount.

(473) FIG. **85** illustrates a lock **6200** in position on the tension member **286** between the heart anchors **202**, **202**′. Upon the desired tension being provided in the tension member **286**, the remaining portion of the tension member **286** may be cut. The heart splint **8500** is shown in position in FIG. **85**, with the tension member **286** extending through the left ventricle **1200**.

(474) In the embodiments of FIGS. **78-85**, the location of the heart anchor that is not deployed to the leaflet may be positioned as desired for the desired therapeutic effect. For example, the location may be set to provide a particular direction of the tension applied to the tension member **286**. Although the anchoring location is shown as the wall of the left ventricle in FIGS. **78-85**, other locations may be utilized as desired such as the interventricular septum. Other anchoring locations are contemplated as well.

(475) In the embodiments of FIGS. **78-85**, preferably a single heart anchor **202** may be deployed to the leaflet to be repositioned. The configuration of the heart anchor **202** may beneficially distribute the force applied to the heart anchor over a relatively large area, thus allowing only one heart anchor **202** to be deployed to the leaflet and reposition the leaflet. This is in contrast to other known anchoring systems that may utilize multiple (e.g., three or more) anchors to reposition the leaflets. A single tension member **286** may be utilized to set the position of the leaflet, which would simplify the process over tensioning multiple tension members to set the position of the leaflet. Further, a single tension member **286** may allow for more precise tensioning of the tension member **286**. In other embodiments, multiple heart anchors **202** may be deployed to the heart valve leaflet as desired.

(476) Although a single leaflet of the mitral valve is shown to be repositioned in FIGS. **78-85**, in other embodiments heart anchors may be applied to both leaflets as desired. In addition, although the embodiments of FIGS. **78-85** are discussed in regard to the mitral valve, repositioning of other leaflets of valves or other portions of the heart or body are contemplated. For example, one or more leaflets of the tricuspid valve may be repositioned in certain embodiments. The devices, systems, and methods may be utilized to treat functional heart valve regurgitation and other valve incompetencies.

(477) The heart splints of the embodiments of FIGS. **78-85**, or any of the components of the heart splint (e.g., a heart anchor), may be deployed in a less invasive, or minimally invasive manner, and may utilize techniques previously disclosed in this application. For example, in the embodiments of FIGS. **78-81** a small surgical access may be made to the patient's body (through a thoracotomy, or mini-thoracotomy) to deploy the anchor **5100**. In the embodiments of FIGS. **83-85**, both heart anchors **202**, **202**′ may be deployed endovascularly. Transcatheter and percutaneous deployment may be utilized. Other forms of deployment may be utilized as desired. The devices disclosed herein may comprise systems for repositioning a leaflet of a heart valve.

(478) Heart anchors may be utilized to reposition one or more papillary muscles of a patient's heart, including the papillary muscles of the left ventricle. FIG. **86** illustrates a cross sectional view of a left ventricle **1200**, a left atrium **1208**, and a mitral valve **1214** of a patient's heart. The mitral annulus **1216** and papillary muscle head bases **8600**, **8602** are also depicted in FIG. **86**. The aortic valve **7800** is also visible.

(479) The left ventricle **1200** may be suffering from dilation, which may have resulted from a medical condition such as an ischemic event. The ischemic event may have produced structural changes in the myocardium, which may include the wall of the left ventricle **1200** expanding in the posteriolateral and apical directions which in turn increases the distance of the papillary muscles

from the mitral valve **1214**. Such an increase in distance may cause chordae of the left ventricle **1200** to exert a force on the mitral valve **1214** leaflets to the point where the leaflets can no longer coapt properly during systole. Such failure of coaptation may result in functional mitral valve regurgitation (FMR). It may be beneficial to reposition the papillary muscles such that the papillary muscles are drawn towards the mitral valve **1214**, thus reducing the tension of the chordae, improving coaptation, and reducing functional mitral valve regurgitation.

(480) A heart splint may be utilized to reposition the one or more papillary muscles. The heart splint may utilize heart anchors that are utilized to draw the papillary muscles towards the mitral valve **1214**. Referring to FIG. **86**, a heart anchor **8604** may include two lobes **8606**, **8608** that are each formed by a loop of material. The heart anchor **8604** may be configured similarly as, and may comprise, the heart anchor referred to as a bulky knot implant **131** (or **131′**) in U.S. Pat. No. 9,681,864, titled Method and Apparatus for Transapical Procedures on a Mitral Valve, filed Dec. 29, 2014, the entire contents of which are incorporated herein for all purposes. The lobes **8606**, **8608** may comprise the lobes of the implant **131′** shown in FIG. 3 of U.S. Pat. No. 9,681,864. The lobes **8606**, **8608** may extend outward from a central portion **8601** to provide a width of the heart anchor **8604**. The lobes **8606**, **8608** may support the heart anchor **8604** on the portion of the heart to which it is applied, and may prevent the heart anchor **8604** from passing back through a puncture hole that the heart anchor **8604** has been passed through. The looped material may include a cloth material or other form of flexible material that allows the heart anchor **8604** to be flexed into a smaller profile to be deployed via a catheter or the like, before expanding after deployment. The heart anchor **8604** may be larger in diameter than the implant **131′** shown in FIG. 3 of U.S. Pat. No. 9,681,864, and may be made of a material such as ultra-high-molecular-weight polyethylene (UHMwPE) (for example, DYNEEMA® fabric or laminate, Koninklijke DSM, the Netherlands). The looped material may form a knotted structure as shown in FIG. 3 of U.S. Pat. No. 9,681,864. The heart anchor **8604** may be configured to be positioned on a mitral annulus of a patient's heart and may include two or more lobes **8606**, **8608** that extend outward from the central portion **8601** of the heart anchor **8604**.

(481) The anchor **8604** may be deployed by a deployment apparatus that is utilized to deploy the heart splint and the heart anchor **8604**, to draw the papillary muscles towards the mitral valve **1214**. The deployment apparatus may comprise an apparatus for deploying an implant **131** as disclosed in U.S. Pat. No. 9,681,864, and similar methods may be utilized to deploy the heart anchor **8604**. A deployment apparatus may be passed through the left ventricle **1200** and may include a puncture device and an opening for passing the heart anchor **8604** out of a central lumen.

(482) The deployment apparatus may be passed into the left ventricle **1200** by being passed through the outer wall of the left ventricle **1200**. A puncture device of the deployment apparatus may be used to puncture the outer wall of the left ventricle **1200**. The deployment apparatus may puncture the outer wall of the left ventricle **1200** at a desired position for a heart anchor to be deployed. The position may be adjacent a papillary muscle head base **8600**. A puncture **8609** adjacent a papillary muscle head base **8600** is shown in FIG. **86**. In other embodiments, other locations of puncture may be utilized.

(483) The deployment apparatus may be advanced to puncture the mitral annulus **1216**. The ipsilateral mitral annulus may be punctured near the fibrous trigone. Other locations of puncture may be utilized in other embodiments. Upon the deployment apparatus puncturing the mitral annulus **1216**, the heart anchor **8604** may be deployed to the mitral annulus **1216** as shown in FIG. **86**. Methods of deployment may include those disclosed in U.S. Pat. No. 9,681,864. The heart anchor **8604** may expand outward with the lobes **8606**, **8608** extending radially outward to increase the width and contact surface area of the heart anchor **8604**. The heart anchor **8604** may be deployed to the mitral annulus **1216** such that it rests against the surface of the mitral annulus **1216**. The deployment apparatus may then be withdrawn with the tension member **286** trailing out of the opening in the deployment apparatus. The tension member **286** may be configured to couple the

heart anchor **8604** to the heart anchor **8611** and extend within the left ventricle. The tension member **286** may couple to the central portion **8601** of the heart anchor **8604**.
(484) The deployment apparatus may continue to be withdrawn from the left ventricle **1200** and out of the puncture **8609** in the left ventricle **1200** with the tension member **286** trailing out of the puncture **8609**. The tension member **286** positioned outside of the left ventricle **1200** may be accessible by a user. The heart anchor **8611** may then be coupled to the tension member **286** and deployed to a portion of the patient's heart. The heart anchor **8611** may be deployed to a location on an external wall portion of the patient's heart and proximate the papillary muscle base **8600**. The heart anchor **8611** may be deployed to a portion of a patient's heart such that the heart anchor **8611** is configured to apply a force to one or more of the papillary muscles. The portion may comprise the exterior surface of the left ventricle **1200** as shown in FIG. **86**, and may be proximate the papillary muscle as shown in FIG. **86**. The heart anchor **8611** may take a variety of forms and may comprise a pledget or the like. The heart anchor **8611** may be configured to apply a force to one or more of the papillary muscles of the left ventricle of the patient's heart.
(485) Prior to or after the tension member **286** being coupled to the heart anchor **8611**, the tension member **286** may be tensioned to a desired amount with the user simultaneously verifying proper hemodynamics. The user may monitor the position of the mitral annulus **1216** and the papillary muscle adjacent the puncture of the left ventricle **1200** and the mitral valve regurgitation. The tensioning and monitoring may occur in real-time. Such measurement may occur as the patient's heart is beating. The user may pull the tension member to draw the papillary muscle and mitral valve annulus **1216** towards each other to a desired state of coaptation of the mitral valve leaflets, and a desired distance between the papillary muscle and mitral valve annulus **1216**, by tensioning the tension member **286**. The papillary muscle may be repositioned. A distance between one or more of the papillary muscles and the mitral annulus may be reduced.
(486) The mitral valve regurgitation may be reduced. Upon the tension in the tension member **286** being set to the desired amount, the tension may be set by locking the tension member **286** to heart anchor **8611**, which may occur by tying the tension member **286** in position to the heart anchor **8611** or another form of securement. The resulting heart splint **8610** is shown in FIG. **86**.
(487) FIG. **87** shows a top cross-sectional view of the patient's heart with the heart splint **8610** in position. The heart anchor **8604** is shown in position on the mitral annulus **1216**. The position of the heart anchor **8604** on the mitral annulus **1216** may be varied in other embodiments.
(488) Another heart splint may be deployed in a similar manner as the heart splint **8610**. Referring back to FIG. **86**, a second heart splint **8610′** may be deployed by puncturing the left ventricle **1200** adjacent a contralateral papillary muscle head base **8602**. A heart anchor **8604′** configured similarly as heart anchor **8604** may be positioned on the mitral annulus **1216** on an opposite side of the mitral annulus **1216** than the heart anchor **8604**, or at a different location as desired. A heart anchor **8611′** may be configured similarly as the heart anchor **8611** and positioned on the left ventricle wall. The resulting heart splint **8610′** may be tensioned similarly as the heart splint **8610**, to reduce the mitral valve regurgitation. The tension in the tension member **286′** may then be set and locked between the anchors **8604′**, **8611′**.
(489) FIG. **87** shows a top cross-sectional view of the patient's heart with the heart splint **8610′** in position. The heart anchor **8604′** is shown in position on the mitral annulus **1216** opposite the mitral valve **1214** from the heart anchor **8604**. The position of the heart anchor **8604′** on the mitral annulus **1216** may be varied in other embodiments.
(490) The number of heart splints and heart anchors utilized may be varied as desired. For example, multiple heart splints may be applied to each of the papillary heads, or each papillary head may include its own heart splint. In one embodiment, a single heart anchor may reposition one or more papillary muscles. The location of the heart anchors and heart splints may be varied as desired to achieve the desired therapeutic effect.
(491) The type of heart anchor utilized with the heart splints may be varied as desired. For

example, referring to FIG. **88**, a heart anchor positioned to support the papillary muscle head base **8600** may comprise a heart anchor **5100** in the form of a pad configured to be positioned on an exterior surface of the patient's heart and may include lock **5102** for locking the tension member **286** to the heart anchor **5100**. The heart anchor **5100** may be configured to apply a force to one or more of the papillary muscles of the left ventricle of the patient's heart. The tension member **286** may be configured to couple the heart anchor **8604** to the heart anchor **5100** and provide a tension that draws the papillary muscle head base **8600** to the mitral annulus **1216**. The lock **5102** may be set to lock the tension member **286** to the heart anchor **5100** and set the length of the heart anchor **8604** from the heart anchor **5100** to a length that repositions the papillary muscle head base **8600**.
(492) FIG. **89** illustrates an embodiment in which a heart anchor positioned to support the papillary muscle head base **8600** may comprise a heart anchor **202** shown and discussed in regard to FIG. **2**A-**2**H. The heart anchor may be configured to be positioned to support and reposition a papillary muscle head base **8600**. The heart anchor **202** may be configured to apply a force to one or more of the papillary muscles of the left ventricle of the patient's heart. The heart anchor **202** as shown in FIGS. **2**A-**2**H includes a ring **200** having two ends (**204**, **206**) and configured to move from a linearized configuration to a ring-shaped configuration. A cover **212** is coupled to the ring **200** and extends inward from the ring **200** in the ring-shaped configuration. The ring **200** includes a first portion and a second portion **214**, **216**, and the first portion overlaps the second portion in the ring-shaped configuration.
(493) The heart anchor **202** shown in FIG. **89** may be deployed to the surface of the left ventricle in a similar manner as shown in FIGS. **84-85**, which may include use of a lock **6200** that may be placed along the tension member **286** and may allow a central portion of the tension member **286** to be withdrawn to draw the heart anchors **202**, **8604** towards each other.
(494) Other forms of heart anchors may be utilized on the mitral annulus **1216**. FIG. **90**, for example, illustrates an embodiment of a heart anchor **9000** that is similar as the heart anchor **8604**, but includes four lobes **9002**, **9004**, **9006**, **9008** that are each formed by a loop of material. The lobes **9002**, **9004**, **9006**, **9008** may extend radially outward from a central portion **9001** to provide a width of the heart anchor **9000** in transverse dimensions. The tension member **286** may couple to the central portion **9001** of the heart anchor **9000**. The lobes **9002**, **9004**, **9006**, **9008** may extend radially outward from the central connection portion in different directions and may form an “X” or clover pattern. The lobes **9002**, **9004**, **9006**, **9008** may support the heart anchor **9000** on the portion of the heart to which it is applied, and may prevent the heart anchor **9000** from passing back through a puncture hole that the heart anchor **9000** has been passed through. The looped material may include a cloth material or other form of flexible material that allows the heart anchor **9000** to be flexed into a smaller profile to be deployed via a catheter or the like, before expanding after deployment. The heart anchor **9000′** may be configured similarly as heart anchor **9000**, and may include similarly configured lobes **9002′**, **9004′**, **9006′**, **9008′**. In other embodiments, a different number of lobes (e.g., 3, 5, 6, or more) may be utilized as desired. The heart anchor **9000** may be configured to be positioned on a mitral annulus of a patient's heart and may include at least four lobes **9002**, **9004**, **9006**, **9008** (or four or more lobes) that extend outward from a central portion **9001** of the heart anchor **9000**.
(495) FIGS. **91-94** illustrate embodiments in which heart anchors utilized on the mitral annulus **1216** comprise a heart anchor **202** shown and discussed in regard to FIG. **2**A-**2**H. The heart anchor **202** may be configured to be positioned upon a mitral annulus. The heart anchor **202** as shown in FIGS. **2**A-**2**H includes a ring **200** having two ends (**204**, **206**) and configured to move from a linearized configuration to a ring-shaped configuration. A cover **212** is coupled to the ring **200** and extends inward from the ring **200** in the ring-shaped configuration. The ring **200** includes a first portion and a second portion **214**, **216**, and the first portion overlaps the second portion in the ring-shaped configuration. The heart anchor **202′** may be configured similarly as the heart anchor **202**.
(496) FIG. **92** illustrates that the heart anchor **202** may be deployed to the mitral annulus via a

deployment apparatus **3400** that may be passed into the left ventricle **1200** by being passed through the outer wall of the left ventricle **1200** in a similar manner as shown in FIG. **79**. The puncture device **3406** of the deployment apparatus **3400** may be used to puncture the outer wall of the left ventricle **1200**. The deployment apparatus **3400** may puncture the outer wall of the left ventricle **1200** at a desired position for a heart anchor to be deployed, and may puncture the mitral annulus at the location for deployment of the heart anchor **202**.

(497) Referring to FIG. **93**, a heart anchor **5100** on an exterior surface of the left ventricle **1200** may be utilized with a heart anchor **202** to form a heart splint for treating mitral valve regurgitation in the same manner as the heart splints shown in FIGS. **86-90**. The heart anchor **5100** may be in the form of a pad configured to be positioned on an exterior surface of the patient's heart and may include lock **5102** for locking the tension member **286** to the heart anchor **5100**. The tension member **286** may be configured to couple the heart anchor **202** to the heart anchor **5100** and provide a tension that draws the papillary muscle head base **8600** to the mitral annulus **1216**. The lock **5102** may be set to lock the tension member **286** to the heart anchor **5100** and set the length of the heart anchor **202** from the heart anchor **5100** to a length that repositions the papillary muscle head base **8600**.

(498) FIG. **94** illustrates a heart anchor **202**′ on an exterior surface of the left ventricle **1200** that may be utilized with heart anchor **202** to form a heart splint for treating mitral valve regurgitation in the same manner as the heart splints shown in FIGS. **86-90**. The heart anchor **202**′ may be configured to apply a force to one or more of the papillary muscles of the left ventricle of the patient's heart. The heart anchor **202**′ may be deployed to the surface of the left ventricle in a similar manner as shown in FIGS. **84-85**, which may include use of a lock **6200** that may be placed along the tension member **286** and may allow a central portion of the tension member **286** to be withdrawn to draw the heart anchors **202**, **202**′ towards each other.

(499) The systems, devices, apparatuses, and methods shown in FIGS. **86-94** may provide improved methods of treating functional mitral valve regurgitation. The methods utilized to reposition the papillary muscles towards the mitral valve annulus may provide a therapeutic effect for the patient, and the heart anchors disclosed may distribute the tension force of the heart splints along a relatively wide surface of the mitral annulus and outer surface of the left ventricle. In addition, although the embodiments of FIGS. **86-94** are discussed in regard to the mitral valve, repositioning of other leaflets of valves, or papillary muscles, or other portions of the heart or body are contemplated. For example, one or more leaflets of the tricuspid valve, or papillary muscles of the tricuspid valve, may be repositioned in certain embodiments. The devices, systems, and apparatuses and methods may be utilized to treat other valve incompetencies.

(500) The heart splints of the embodiments of FIGS. **86-94**, or any of the components of the heart splint (e.g., a heart anchor), may be deployed in a less invasive, or minimally invasive manner, and may utilize techniques previously disclosed in this application. For example, in the embodiments of FIGS. **86-94** a small surgical access may be made to the patient's body (through a thoracotomy, or mini-thoracotomy) to deploy the anchor **5100**. In the embodiments of FIGS. **86-94**, both the heart anchors may be deployed endovascularly. Transcatheter and percutaneous deployment may be utilized. Other forms of deployment may be utilized as desired. The devices disclosed herein may comprise systems for repositioning one or more papillary muscles of a heart valve.

(501) FIGS. **95-100** illustrate an embodiment of a head **9500** of an access apparatus, which may comprise an access apparatus **100** as shown in FIGS. **1**A-**1**F. The head **9500** may be utilized in lieu of the head **102**, or in substitution with the head **102**, shown in FIGS. **1**A-**1**F, and may be positioned at a distal end of the elongate neck **104**. The head **9500** may be utilized in other embodiments with other types of apparatuses, including catheters. Such apparatuses may be utilized to provide a suction force to a surface of a patient's body.

(502) Referring to FIG. **95**, the head **9500** includes a plurality of chambers **9502***a-f* that are each configured to contact a portion of the patient's body (such as an external surface of the patient's

heart) and apply a suction force to a surface of a patient's body (such as the external surface of the patient's heart). Each chamber **9502***a-f* may include a front face surface or contact surface **9503***a-f*, for contacting the portion of the patient's body and forming the contact surface of the head **9500**. The contact surfaces **9503***a-f* may form a planar contact surface for the head **9500**, with each contact surface **9503***a-f* extending in the same plane. The plurality of chambers **9502***a-f* may form an application portion of the head **9500**. The front face surfaces or contact surfaces **9503***a-f* may extend circumferentially about the respective chamber **9502***a-f*, forming the outer perimeter of the respective chamber.

(503) Each chamber may have a dome-shape, or a half sphere shape. Each chamber may form an internal dome-shaped volume that allows vacuum suction to be applied to the surface of the patient's heart. In other embodiments, other shapes of chambers may be utilized. Each chamber **9502***a-f* may include a respective opening **9504***a-f* (marked in FIGS. **96** and **97**) that allows vacuum suction to be applied by the respective chambers **9502***a-f*. The respective openings **9504***a-f* connect the interior cavity of the chambers **9502***a-f* to lumens or suction channels **9700**, **9702** (marked in FIG. **97**) that allow suction to be provided from the suction channel **9700** to openings **9504***a*, **9504***b*, **9504***c*, and allow suction to be provided from the suction channel **9702** to openings **9504***f*, **9504***e*, **9504***d* as shown in FIG. **97**. Each suction channel **9700**, **9702** accordingly couples to openings of multiple chambers **9502***a-f*. The set of chambers **9502***a-c* accordingly forms a set of chambers that applies the vacuum suction from the suction channel **9700** and the set of chambers **9502***d-f* accordingly forms a set of chambers that applies the vacuum suction from the suction channel **9702**. Each of the plurality of openings **9504***a-f* couples one of the respective plurality of chambers **9502***a-f* to the respective suction channel **9700**, **9702** and is configured to pass the vacuum suction through the opening to allow the respective one of the plurality of chambers **9502***a-f* to apply the vacuum suction from the respective suction channel **9700**, **9702**. The suction channels **9700**, **9702** may be positioned within respective manifolds **9506**, **9508** (marked in FIGS. **95-97**) of the head **9500** that couple to the chambers **9502***a-f*.

(504) Each suction channel **9700**, **9702** may couple to a suction lumen **9512** (marked in FIGS. **97** and **98**), which may exert a suction force through the suction channel **9700**, **9702**. Such a lumen **9512** may be positioned within an elongate neck of the device to which the head **9500** is coupled to, which may comprise the elongate neck **104**. Such a lumen may be positioned within another structure to which the head **9500** couples.

(505) Referring to FIG. **97**, each opening **9504***a-f* may have a diameter that is smaller than a diameter of the respective lumen or suction channel **9700**, **9702** to which it is coupled. Such a feature may allow the suction channel **9700**, **9702** to exert a greater suction force than would be provided through a single one of the openings **9504***a-f*, or that would be lost if a single one of the chambers **9502***a-f* lost its seal with the surface of the patient's body. As such, the plurality of openings **9504***a-f* is sized such that a loss of vacuum suction by one of the plurality of chambers **9502***a-f* allows another of the plurality of chambers **9502***a-f* to allow the vacuum suction from the respective suction channel **9700**, **9702**. Such a feature may provide a benefit of allowing the head **9500** to remain suctioned to the surface of the patient's body even if a suction seal between one of the chambers **9502***a-f* and the surface of the patient's body was lost. Multiple of the chambers **9502***a-f* may lose a suction force, and the respective suction channel **9700**, **9702** may continue to exert a suction force great enough to secure the head **9500** to the patient's body with at least one of the chambers **9502***a-f*. This feature may reduce the possibility of the head **9500** undesirably and inadvertently detaching from the surface of the patient's body if one or more of the chambers **9502***a-f* lost its seal with the surface of the patient's body.

(506) Referring to FIG. **95**, the head **9500** may include a central lumen **9510** for allowing a puncture device to pass therethrough to pass through an external surface of the patient's heart. The lumen **9510** may be positioned within a central portion **9514** of the head **9500** or may be positioned in another location as desired. The lumen **9510** may be positioned such that the chambers **9502***a-f*

are positioned around the lumen **9510**, which may be radially positioned as shown in FIG. **95**. The chambers **9502***a-f* may be spaced radially from the central portion **9514** of the head **9500**. The chambers **9502***a-f* may be positioned around the lumen **9510** such that securement around the lumen **9510** is provided by the suction force of the chambers **9502***a-f*, so that when the puncture device passes through the lumen **9510** into a portion of the patient's body, the puncture device is supported on multiple sides or all sides of the lumen **9510**.

(507) In other embodiments, other configurations of the chambers **9502***a-f* may be utilized, including extending linearly along both sides of the central lumen **9510**, or in another configuration. The number of the chambers **9502***a-f* and the number of suction channels to which each of the chambers couple may be varied as desired (e.g., a greater or lesser number may be utilized). For example, a single suction channel may couple to at least two of the chambers, or a different number a desired. A single suction channel may be utilized, or a greater number of suction channels may be utilized. Although six chambers are shown in FIGS. **95-100**, a greater or lesser number may be utilized as desired. The openings **9504***a-f* may have a diameter of 0.5 millimeters in certain embodiments, although in other embodiments the size may vary as desired.

(508) FIG. **98** illustrates that the lumen **9510** may extend upward from the head **9500** in a curve to allow the puncture device to smoothly transition at a 90-degree angle, or other angle to puncture the portion of the patient's body.

(509) FIG. **99** illustrates a front view of the head **9500**. FIG. **100** illustrates the head **9500** being suctioned to a portion of a patient's body. The head **9500** may be compliant to allow for flexibility upon placement on the portion of the patient's body, and to conform to irregularities. The head **9500** may be compliant such that a flexible skirt or the like is not needed in certain embodiments.

(510) The head **9500** may be utilized according to methods disclosed herein in a similar manner as the head **102** shown in FIGS. **1**A-**1**F. The apparatus **100** shown in FIGS. **1**A-**1**F may be modified to allow for a vacuum port to provide the suction through the head **9500**. The head **9500** may be utilized to access a portion of a patient's heart for deployment of a heart splint as disclosed herein, with a puncture device passing through the lumen **9510** for access to the interior of the patient's heart. The head **9500** may be utilized for other purposes, and may be utilized with other devices other than access apparatuses.

(511) FIGS. **101-112** illustrate embodiments of apparatuses that provide a combination of functions, including serving to secure the apparatus to a portion of a patient's body, and providing access to a portion of a patient's body, and deploying a heart anchor to a patient's body. Securing the apparatus to a portion of a patient's body may include applying a suction force to the portion of the patient's body.

(512) The apparatuses shown in FIGS. **101-112** may provide combined functionality of the access apparatus **100** shown in FIGS. **1**A-**1**F and the deployment apparatus **700** shown in FIGS. **7**A-**7**D, and may be used in similar manners as described herein for the access apparatus **100** and the deployment apparatus **700**. The apparatuses shown in FIGS. **101-112** may comprise a modification of the deployment apparatus **700** shown in FIGS. **7**A-**7**D, and may be utilized in lieu of, or in substitution of the head **702** of the deployment apparatus **700**, with the remainder of the deployment apparatus **700** being utilized to serve the functions of the deployment apparatus **700** (e.g., tensioning of a tension member and deployment of a heart anchor, among other functions). In other embodiments, the apparatuses shown in FIGS. **101-112** may be utilized for other purposes.

(513) Each of the embodiments of FIGS. **101-112** illustrates an embodiment including a suction device that is configured to apply vacuum suction to an external surface of a patient's heart to grip the external surface of the patient's heart. FIG. **101** illustrates an embodiment in which an apparatus **10100** includes a suction device **10102** coupled to a shaft **10104** of the apparatus **10100** (which may comprise the neck **704** shown in FIGS. **7**A-**7**D). The suction device **10102** may comprise a suction head that is configured to contact the external surface of the patient's heart to apply the vacuum suction to the external surface of the patient's heart. The suction head may be configured

similarly as the head **102** shown in FIG. **1**A, although the suction device **10102** may lack a lumen for passing a puncture device therethrough. The suction device **10102** may include a pliant skirt **10103** that may enhance the suction coupling between the device **10102** and the portion of the patient's body. The suction device **10102** may receive suction via a suction lumen **10107** contained within the shaft **10104**.

(514) A heart anchor retainer **10105** may be positioned at a distal portion of the shaft **10104** and distal of the suction device **10102**. The heart anchor retainer **10105** may be coupled to the shaft **10104** at a position adjacent to the suction device **10102**. The heart anchor retainer **10105** may couple to the heart anchor **800**, which may be configured as shown in FIGS. **8**A-**8**F. The heart anchor retainer **10105** may include a central lumen (similar to lumen **720** of FIGS. **7**A-**7**D) that may allow a puncture device to pass therethrough, and may allow a tether such as tension member **286** to pass therethrough, as shown in FIG. **29** for example. The heart anchor retainer **10105** may be configured to be rotatable, and rotate the heart anchor **800**, in a similar manner as disclosed regarding the retainer **712**. The rotation of the heart anchor retainer **10105** may allow the orientation of the heart anchor **800** to be varied as desired. The heart anchor **800** may extend longitudinally in line with the longitudinal axis of the shaft **10104**.

(515) FIG. **102** illustrates a perspective view of the apparatus **10100**, displaying the interior chamber **10110** of the suction device **10102**.

(516) FIG. **103** illustrates the apparatus **10100** suctioned onto a portion of a patient's body, with the anchor **800** in position to be deployed.

(517) FIG. **104** illustrates an embodiment in which an apparatus **10400** includes a suction device **10402** (marked in FIG. **105**) positioned within a heart anchor **10404** for deployment to a surface of a patient's heart. The apparatus **10400** may include a shaft **10406** and a heart anchor retainer **10408** positioned at a distal portion of the shaft **10406**. The heart anchor retainer **10408** may be configured similarly as the retainer **10105** shown in FIG. **101**, and may include a central lumen for passing a puncture device therethrough and may be configured to rotate according to certain embodiments.

(518) The heart anchor **10404** may be configured similarly as the heart anchor **800**, but may include a suction device **10402** in the form of two suction heads or chambers **10409** that form the pads of the heart anchor **10404**. The suction chambers **10409** may include pliant skirts **10411** extending around the suction chambers **10409**. The suction chambers **10409** may be configured to apply a supporting force to a portion of the patient's body as well, and may provide the same functionality as the pads of the heart anchor **800**. The heart anchor **10404** may include an interior suction lumen **10410** (marked in FIG. **105**). The interior suction lumen **10410** may be configured to transmit a suction force through the suction chambers **10409**, which may include a plurality of openings **10412** that provide support for the suction chambers **10409** but also allow a suction force to pass therethrough. The interior suction lumen **10410** may couple to a suction lumen **10414**, shown in FIGS. **104** and **105** as a tube, that may allow suction force to be transmitted from a suction lumen of the shaft **10406** to the interior suction lumen **10410** of the heart anchor **10404**.

(519) The suction channel **10414** may be configured to removably couple from the heart anchor **10404**, such that as the heart anchor **10404** is fixed in position via a tension member **286** or the like, the suction lumen **10414** may be removed to separate from the heart anchor **10404**.

(520) FIG. **106** illustrates a perspective view of the apparatus **10400**, showing the plurality of openings **10412** of the suction chambers **10409**.

(521) FIG. **107** illustrates the apparatus **10400** suctioned onto a portion of a patient's body.

(522) FIG. **108** illustrates an embodiment in which an apparatus **10800** includes a suction device **10802** comprising a suction head in the form of a hood positioned around a head **10805** of the apparatus including a heart anchor retainer **10804** and a heart anchor **800**. The head **10805** of the apparatus may be configured similarly as the head **702** shown in FIGS. **7**A-**7**D. The apparatus **10800** may include a shaft **10806** and the heart anchor retainer **10804** positioned at a distal portion

of the shaft **10806**. The heart anchor retainer **10804** may be configured similarly as the retainer **10105** shown in FIG. **101**, and may include a central lumen for passing a puncture device therethrough and may be configured to rotate according to certain embodiments.
(523) The suction device **10802** may cover the heart anchor retainer **10804** and a heart anchor **800**, and may include an interior suction cavity **10808** (marked in FIG. **109**) that allows the suction force to be transmitted along a suction lumen **10810** of the shaft **10806**. The suction device **10802** may form the head of the apparatus **10800**.
(524) FIG. **110** illustrates a perspective view of the apparatus **10800** showing the heart anchor **800** positioned within the hood of the suction device **10802**.
(525) FIG. **111** illustrates the apparatus **10800** suctioned onto a portion of a patient's body.
(526) FIG. **112** illustrates an embodiment in which an apparatus **11200** includes a suction device configured as the suction head **9500** shown in FIGS. **95-100**. The apparatus **11200**, however, includes a heart anchor retainer **11204** that retains the heart anchor **800** therein. Chambers **11202***a-f* of the suction device may operate similarly as the chambers **9502***a-f* of FIGS. **95-100**, and may operate in a similar manner. The chambers **11202***a-f* may be positioned around the heart anchor **800**, and the apparatus **11200** may include a central lumen similar to lumen **9510** of FIGS. **95-100** that allows a puncture device to pass therethrough and through the heart anchor **800**. The number and configuration of the chambers **11202***a-f* may be varied from the number and configuration shown in FIG. **112**.
(527) The apparatuses disclosed in FIGS. **101-112** may operate in a manner in which the apparatuses are directed to an outer surface of a patient's heart, with the suction device then applying suction to secure the apparatuses to the outer surface. The suction device may serve a similar purpose as the head **102** shown in FIG. **1**A, which provides a suction force to secure an apparatus to an outer surface of a patient's heart. The interior lumens of the apparatuses may allow a puncture device to pass therethrough, to allow for similar functionality as the head **102** shown in FIG. **1**A.
(528) The interior lumens may then pass one or more snares therethrough, to allow a tension member **286** to pass through the interior lumens for securing to the heart anchor coupled to the respective apparatuses, in a similar manner as the apparatus **700**. Upon the tension member **286** being tensioned, the tension may be locked by the heart anchor coupled to the apparatuses, and the heart anchor may be deployed from the apparatus, in a similar manner as with the apparatus **700**. The suction force provided by the apparatuses may be reduced to allow the apparatuses to separate from the heart anchors. As such, the apparatuses disclosed in FIGS. **101-112** may provide combined functionality of the access apparatus **100** shown in FIGS. **1**A-**1**F and the deployment apparatus **700** shown in FIGS. **7**A-**7**D, and may be used in similar manners as described herein for the access apparatus **100** and the deployment apparatus **700**. The number of apparatuses inserted into the patient's body accordingly may be reduced in the procedures disclosed herein. In other embodiments, the apparatuses shown in FIGS. **101-112** may be utilized for other purposes.
(529) FIG. **113** illustrates a distal portion of an embodiment of a delivery apparatus **11300** having a heart anchor retainer **11302** that rotates. The delivery apparatus **11300** may be utilized in a similar manner and for similar purposes as the delivery apparatus **700** shown in FIGS. **7**A-**7**D. The delivery apparatus **11300**, however, has a head **11304** that provides a lower height profile than the head of the delivery apparatus **700** shown in FIGS. **7**A-**7**D. The apparatus shown in FIGS. **113-118** may comprise a modification of the deployment apparatus **700** shown in FIGS. **7**A-**7**D, and may be utilized in lieu of, or in substitution of the head **702** of the deployment apparatus **700**, with the remainder of the deployment apparatus **700** being utilized to serve the functions of the deployment apparatus **700** (e.g., tensioning of a tension member and deployment of a heart anchor, among other functions). The pulley assembly disclosed herein may be integrated with the deployment apparatus **700** shown in FIGS. **7**A-**7**D, or may be utilized with a different apparatus as desired.
(530) The delivery apparatus **11300** may include a pulley assembly configured to rotate a heart

anchor retainer **11302** that is configured to retain a heart anchor and is positioned on the head **11304** of the delivery apparatus **11300**. FIG. **114** illustrates a portion of a pulley assembly that may allow the head **11304** to have a lower height profile than the head of the delivery apparatus **700** shown in FIGS. **7**A-**7**D. The pulley assembly may include a pulley wheel **11306** that may be positioned to rotate in a plane that the heart anchor retainer **11302** rotates in. FIG. **115** illustrates a close-up perspective view of the pulley wheel **11306** and the heart anchor retainer **11302**. Referring to FIG. **115**, the pulley wheel **11306** may include a channel **11307** (marked in FIG. **115**) that one or more cables **11303***a, b* may extend along, to couple to a pin **11305** that may be held in a pin support **11312**. The pin **11305** may couple to the distal portions or ends of the one or more cables **11303***a, b*, such that cables **11303***a, b* extend around both sides of the channel **11307** on both sides of the pulley wheel **11306**. In one embodiment a single cable may be looped around the pulley wheel **11306** to form two cables extending from the pulley wheel **11306**. In other embodiments two or more separate cables may be utilized with distal portions or ends coupled to the pin **11305**.
(531) The pulley wheel **11306** may be coupled to the heart anchor retainer **11302** (which may be configured similarly as the retainer **712** shown in FIGS. **7**A-**7**D) and walls **11311**, **11313** of the heart anchor retainer **11302** may extend from the pulley wheel **11306** perpendicular to the plane that the pulley wheel **11306** extends in. The pulley wheel **11306** may include a central lumen **11309** (similar to lumen **720** of FIGS. **7**A-**7**D) that tension members, snares, puncture devices, or other devices disclosed in regard to the apparatus **700** may pass through, to pass through the anchor **800**.
(532) Referring back to FIG. **114**, the pulley wheel **11306** may be positioned within the head **11304** of the apparatus **11300**. The pulley wheel **11306** may be positioned within an interior chamber of the head, which may include a rotation gimbal **11315** that may allow the pulley wheel **11306** to rotate within the head.
(533) FIG. **116** illustrates a side view of the apparatus **11300** illustrating the handle **11314** coupled to a proximal portion of an elongate shaft **11316** that the cables from the pulley wheel **11306** extend within. The apparatus **11300** may include a pulley control mechanism that may include a control knob **11318** coupled to the handle **11314** that couples to proximal portions of the cables and allows movement of the control knob **11318** to cause movement of the cables and thus rotate the pulley wheel **11306** and the heart anchor retainer **11302**. Distal portions of the cables **11303***a, b* may couple to the pulley wheel **11306** and proximal portions of the cables **11303***a, b* may couple the pulley wheel **11306** to the pulley wheel control mechanism. The cables **11303***a, b*, may extend along the elongate shaft **11316** or elongate neck of the apparatus **11300**.
(534) FIG. **117** illustrates a close-up perspective view of the control knob **11318** and a pulley wheel **11320** that is coupled to the control knob **11318**. The pulley wheel **11320** may be configured to rotate with the rotation of the control knob **11318**. The pulley wheel **11320** may include a channel **11322** that the proximal portions of the cables **11303***a, b* extend in and extend along to couple to a pin (similar to pin **11305**) that may be held in a pin support **11324**. The pin may couple to the ends of one or more cables, such that the proximal portions of the cables extend around both sides of the channel **11322** on both sides of the pulley wheel **11320**. With distal portions of the cables coupled to the pulley wheel **11306** in the head of the apparatus, and proximal portions of the cables coupled to the pulley wheel **11320** in the handle of the apparatus, the movement of the pulley wheel **11320** may cause movement of the other pulley wheel **11306** via the forces transmitted by the cables **11303***a, b*. The pulley assembly is configured to allow the retainer **11302** to rotate about an axis transverse to a longitudinal axis of the elongate shaft **11316** or elongate neck of the apparatus **11300**, to accordingly rotate the heart anchor **800**.
(535) The pulley wheels **11306**, **11320** may be configured to have the same diameters, such that a one-to-one ratio of rotation of one pulley wheel causes the same rotation of the other pulley wheel. Such a one-to-one ratio may provide for improved control of rotation of the heart anchor retainer **11302** by a user. In other embodiments, the pulley wheels **11306**, **11320** may have different diameters to produce a desired scaling of control of rotation between the two pulley wheels **11306**,

11320.
(536) Detents may be utilized to maintain a position of the control knob **11318** yet allow for rotation of the control knob **11318**. FIG. **118**, for example, illustrates a portion of the handle **11314** shown in FIG. **117** with the control knob **11318** excluded from view. Detents **11326** may be positioned circumferentially around a supporting surface **11327**, with the control knob **11318** engaging the detents **11326** via spring supported pins **11328** or other biased structures. As such, the biased structures may hold the control knob **11318** and the pulley wheel **11320** in position, until a user applies sufficient force to move the control knob **11318** relative to the detents **11326** to allow the control knob **11318** and pulley wheel **11320** to rotate.
(537) The apparatus shown in FIGS. **113-118** may be utilized in methods disclosed herein, and may be utilized in a similar manner as the apparatus **700** disclosed in regard to FIGS. **7**A-**7**D. The use of the pulley system may reduce the profile of the head of the apparatus **11300** from the head shown in FIGS. **7**A-**7**D, and may allow for improved control of rotation of the heart anchor retainer of the apparatus **11300**. The pulley system disclosed in FIGS. **113-118** may be utilized in any embodiment disclosed herein in which a head or heart anchor retainer or other portion of an apparatus is configured to rotate.
(538) FIG. **119** illustrates an embodiment of a tension member **11900** that may be utilized in lieu of, or in substitution with, the tension members **286** disclosed in this application. The tension member **11900** may include a spring **11902**. All or a portion of the tension member **11900** may comprise the spring **11902**. The spring **11902** may be configured to produce a linear force upon movement of the spring, or, as shown in FIG. **119**, may be configured to produce a non-linear force upon movement of the spring. The spring **11902** may be configured to produce variable, non-linear, tension as the spring **11902** is extended. A tension of the spring **11902** may be configured to increase non-linearly as the spring **11902** is extended.
(539) Such variable, non-linear, tension may be utilized to accommodate for a variety of properties, including movement of the patient's heart. For example, during diastole, as the left ventricle fills with blood, the spring **11902** may be configured to extend with a lesser tension force produced, to allow the left ventricle to more easily fill with blood. At the end of diastole (peak distention) the spring **11902** may be configured to apply a greater tension force that aids the left ventricle to eject blood during systole. The transition of the lesser force to the greater force may be non-linear and may increase significantly at the end of diastole. The spring **11902** may be configured to compress in phase with systolic contraction, to possibly provide a more complete ejection of blood. The variable, non-linear, tension produced by the spring **11902** accordingly may accommodate a movement of the patient's heart, and may assist with desired movement of the patient's heart. A variety of configurations of tension strength of the spring **11902** may be provided according to various movements of the patient's heart or other properties.
(540) A force profile of one or more of the anchors to which the spring **11902** is coupled to may be set by setting a non-linear tension force of the spring **11902**, based on the desired force profile to by applied to the patient's heart by the anchors during one or more of diastole or systole. For example, the times at which certain forces are to be applied during diastole or systole may be determined and set in the spring **11902**.
(541) The spring **11902** may be tuned to match the desired profile of expansion and contraction of the patient's heart, and may be specific for the particular patient having the heart splint. The force applied by the spring **11902** may be set by varying a property of the spring **11902** according to the desired expansion and contraction profile. The property of the spring **11902** may comprise one or more of material properties of the spring or a shape of the spring. For example, the shape of the spring, such as the shape of loops of the spring, or another feature of loops of a spring may be set to produce the desired non-linear force. For example, as shown in FIG. **119**, a spring **11902** may have a larger outer diameter at a central portion of the spring **11902**, with smaller outer diameters at end portions of the spring **11902**. The spring **11902** may taper in profile down from a central portion to

end portions. Further, the shape of the spring may also be varied by varying the wire outer diameter at different locations of the spring, thinning the wire to reduce the spring constant and thickening the wire to increase the constant. In certain embodiments, the material properties of the spring **11902** may be set by altering a selection of materials comprising the spring. The spring **11902** may comprise a composite of different types of materials having different spring constants.

(542) The spring **11902** may be utilized to match a profile of expansion and contraction, or in other embodiments may generally be utilized to dampen the loading of the heart anchors (e.g., anchor **202** and anchor **800**) to which the spring **11902** is coupled.

(543) In certain embodiments, the spring may have uniform characteristics along the length of the spring, and may be configured to have a linear force produced according to the movement of the spring. FIG. **120**, for example, illustrates an embodiment of a tension member **12000** that includes a spring **12002** having a linear tension force as the spring **12002** is extended. Further, the spring **12002** may be covered by a sheath **12004** that may prevent the spring from interfering with portions of the patient's heart, which may comprise chordae or other structures.

(544) Although the springs of FIGS. **119** and **120** are shown as coils, in other embodiments the springs may have any other shape or configuration as desired. The spring may be made of a shape memory material such as nitinol or another shape-memory material, or another material as desired, for example, spring steel or stainless steel. The spring may also include an elastomer, for example, a silicone, a polyurethane, or a thermoplastic elastomer.

(545) The springs of FIGS. **119** and **120** may be deployed by being compressed in an unexpanded or undeployed configuration within a delivery apparatus, which may include a lumen as disclosed herein. For example, a delivery apparatus **400** as shown in FIG. **14** may be brought proximate the interventricular septum **1210**. A spacer such as disclosed in regard to FIG. **14**A may be utilized if desired. The springs of FIGS. **119** and **120** may be positioned within the delivery apparatus **400**. The heart anchor **202** may be deployed proximate the interventricular septum **1210** and the springs of FIGS. **119** and **120** may be deployed through the interventricular septum **1210** into the left ventricle **1200**, and expanded within the left ventricle **1200**.

(546) In one embodiment, the springs of FIGS. **119** and **120** may be positioned such that at least a portion of the spring is disposed within the anchor **800**. Such a position may allow the springs to provide their desired force profiles, yet also not necessarily need to be deployed into the left ventricle **1200** (whether deployed partially or wholly into the left ventricle **1200**). The tension member may provide a linear or non-linear force with the spring positioned exterior of the left ventricle **1200**.

(547) The springs may be utilized in any embodiment of tension member disclosed herein.

(548) FIG. **121** illustrates an embodiment of a heart anchor **12101** that may be configured similarly as the heart anchor **202** shown in FIGS. **2**A-**2**H. The heart anchor **12101**, however, may include a cover **12100** composed of a knitted material that may allow a puncture device **12102** to pass therethrough, between the openings of the knitted material. The cover **12100** may thus be puncturable by a puncture device. Such a feature may allow a puncture device **12102** to be able to penetrate through the cover **12100** if passage through the cover **12100** is desired. For example, if the heart anchor **12101** occludes an area of the patient's heart such as foramen ovale, or another area that may require additional penetration at a later time for medical purposes, then the cover **12100** may be configured to be penetrated by such a puncture device **12102** to allow passage through the cover (and the area of the patient's heart to which the heart anchor **12101** is deployed). A knitted material may include a cloth or a knitted polymer, and may include knitted polytetrafluoroethylene (PTFE) or another polymer as desired. The cover **12100** may be made of polyethylene terephthalate (PET) if desired. The cover may be tearable to allow for other access through the cover.

(549) FIG. **122** illustrates a cross sectional view of an embodiment of layers of a heart anchor, which may be configured similarly as the heart anchor **202** shown in FIGS. **2**A-**2**H, but may

include an additional mesh layer **12204** coupled to membrane layers **12200**, **12202** that form the cover of the heart anchor. The cover may be formed of a membrane that may be puncturable by a puncture device **12102**, and may be made of a cloth or a polymer. The mesh layer **12204** may support the membrane layers **12200**, **12202** and may include openings that allow a puncture device to pass therethrough. As such, the configuration of layers shown in FIG. **122** serves a similar purpose as the configuration of the heart anchor shown in FIG. **121**, to allow a puncture device to pass therethrough. The configuration of layers may be tearable to allow for other access through the heart anchor.

(550) The features shown in FIGS. **121** and **122** may be utilized with any embodiment of heart anchor disclosed herein.

(551) The embodiments of methods disclosed herein may be performed manually by a user, yet in other embodiments a robot, such as a surgical robot may be utilized to perform such methods. FIGS. **123** and **124** illustrate a variation of the heart anchor **800**, in which the heart anchor **800′** includes a flange **12300** that is configured for grasping by a grasper of a surgical robot. Such a flange **12300** may be positioned on and extend outward from a dorsal surface of the heart anchor **800′** or another surface as desired. The robotic graspers may be able to more easily manipulate and place the heart anchor **800′** in position.

(552) FIG. **125**, for example, illustrates a representation of a grasper **12500** of a surgical robot that may be configured to grasp the grasping flange **12300** shown in FIGS. **123** and **124**. The grasper may include arms **12501**, **12503** having grip surfaces **12505**, **12507** that allow the arms **12501**, **12503** to better grasp apparatuses of the systems disclosed herein, including the grasping flange **12300**. The arms **12501**, **12503** may be configured to articulate to move towards and away from each other to facilitate grasping. The grasper **12500** may be coupled to a robotic arm **12502** via one or more pivots **12504**, which may allow the grasper **12500** to move in various directions. The pivots **12504** may allow for rotation or other movement in the x- and y-dimensions and about the z-dimension relative to the robotic arm **12502**. Other combinations of directions of articulation, or other directions of articulation may be produced as desired. In other embodiments, the configuration of the grasper **12500** may vary from the configuration shown in FIG. **125**.

(553) In operation, a robot, such as a surgical robot, such as Totally Endoscopic Coronary Artery Bypass (TECAB) surgical robot may access desired portions of the patient's heart with visualization provided by the robot. FIG. **126** for example, illustrates a representation of a robotic arm **12502** having a robotic grasper at a distal portion of the arm **12502**. The grasper may be configured similarly as the grasper **12500** shown in FIG. **125**. The robotic arm **12502** may be configured to have a greater variety of access points to the patient's heart, including access points closer to the desired location of the heart anchor **800′**. The robotic arm **12502** may be utilized to perform the methods disclosed herein that would be manually performed by a user. The robotic arm **12502** may be configured to grasp the heart anchor **800′** and hold it against the free wall of the left ventricle, for example, prior to entry of the patient's heart to simulate the therapeutic contraction of the left ventricle. A position for the anchor **800′** may be determined based on the monitored therapeutic result provided by the anchor **800′**. The robotic arm **12502** may be utilized to perform the other methods disclosed herein of applying a heart splint to a patient's heart, including entry of the left ventricle for implantation of the anchor **800′**. Any method or portion of a method disclosed herein may be performed by a robot, such as a surgical robot, such as Totally Endoscopic Coronary Artery Bypass (TECAB) surgical robot.

(554) The methods, apparatuses, and systems disclosed herein may be utilized with one or more heart implants, which may be utilized for heart valve replacement or repair. Heart valve replacement may include use of a heart valve prosthetic, such as a prosthetic mitral valve or a prosthetic tricuspid valve, among other prosthetics. Heart valve repair may be utilized to provide therapeutic effects for the heart valve, without entirely replacing the heart valve. Heart valve repair may include use of annuloplasty devices or other repair devices.

(555) FIG. **127**, for example, illustrates a heart valve prosthetic in the form of a prosthetic mitral valve **12700** that may be utilized with the methods, apparatuses, and systems disclosed herein. The prosthetic mitral valve **12700** may comprise an expandable prosthetic valve that is deployed within the patient's heart and positioned in place of the mitral valve. The prosthetic mitral valve **12700** may include one or more anchors **12702** that couple to leaflets of the mitral valve, to secure the prosthetic mitral valve **12700** in position within the mitral valve annulus.
(556) FIG. **128** illustrates that the prosthetic mitral valve **12700** may be utilized in combination with a heart splint as disclosed herein. The heart splint may include the heart anchor **202**, the heart anchor **800**, and the tension member **286**, as disclosed herein, for example in FIG. **31**. The heart anchor **202** may be configured as the heart anchor **202** shown in FIGS. **2**A-**2**H, and may include a ring **200** having two ends (**204**, **206**) and configured to move from a linearized configuration to a ring-shaped configuration. A cover **212** is coupled to the ring **200** and extends inward from the ring **200** in the ring-shaped configuration. The ring **200** includes a first portion and a second portion **214**, **216**, and the first portion overlaps the second portion in the ring-shaped configuration. The heart anchor **800** may include support pads **802**, **804** and a bridge **806** coupling the support pads **802**, **804** together.
(557) The heart anchors **202**, **800** may both be configured to be positioned on a ventricular wall of the patient's heart (with the heart anchor **202** positioned on the interventricular septum **1210** and the heart anchor **800** positioned on the free wall of the left ventricle **1200**). The tension member **286** may extend transventricular to couple the heart anchor **202** to the heart anchor **800** and may have a tension that is set to provide a therapeutic effect for the left ventricle **1200**, as disclosed herein. The prosthetic mitral valve **12700**, however, may include a tension member **12800**. The tension member **12800** may couple to the frame of the prosthetic mitral valve **12700** (for example, three points of connection are shown, although in other embodiments a greater or lesser number of connection points may be utilized). The tension member **12800** may also couple to the tension member **286**, to couple and anchor the prosthetic mitral valve **12700** to each of the heart anchors **202**, **800**. The tension member **12800** for example, may include a coupler **12802** at its end, such as a loop or a hook or other form of coupler for coupling the tension member **12800** to the tension member **286**.
(558) Coupling the prosthetic mitral valve **12700** to the heart splint including the heart anchor **202**, the heart anchor **800**, and the tension member **286**, may beneficially allow for enhanced anchoring of the prosthetic mitral valve **12700** within the mitral valve annulus. The force upon the prosthetic mitral valve **12700** in the atrial direction during systole is particularly high, and as such additional anchoring of the prosthetic mitral valve **12700** to a location within the left ventricle **1200** that opposes the atrial direction of force during systole may be beneficial. The heart anchor **202**, the heart anchor **800**, and the tension member **286** may provide therapeutic effects for the patient's heart disclosed herein, and may also serve as an anchoring point for the prosthetic mitral valve **12700** within the left ventricle **1200**.
(559) A variety of methods may be utilized to anchor the prosthetic mitral valve **12700** to the heart splint and accordingly to the heart anchor **202** and the heart anchor **800**. In an embodiment in which the prosthetic mitral valve **12700** is first deployed to the heart valve of the patient's heart, the tension member **12800** may be left as a tether positioned within the left ventricle **1200** or elsewhere within the patient's heart. The heart splint may then be deployed according to methods disclosed herein, which may additionally include snaring the tension member **12800** and passing the tension member **286** of the heart splint through the coupler **12802** of the tension member **12800**. The heart anchors **202** and **800** may otherwise be deployed and tensioned according to the methods disclosed herein.
(560) In an embodiment in which the heart splint is first deployed to the left ventricle **1200**, the prosthetic mitral valve **12700** may be deployed to the mitral valve annulus with the tension member **12800** hooking or otherwise being coupled to the tension member **286** that extends transventricular. The tension member **12800** may be tensioned utilizing the deployment apparatus that deployed the

prosthetic mitral valve **12700**, or with another apparatus.
(561) FIG. **129** illustrates an embodiment in which a single heart anchor **202** may be utilized as an anchor for the prosthetic mitral valve **12700**. The heart anchor **202** may be positioned on a ventricular wall of the patient's heart, particularly the interventricular septum **1210**. The tension member **12900** may couple to the heart anchor **202** to allow the heart anchor **202** to anchor the prosthetic mitral valve **12700** to the ventricular wall. As such, the heart anchor **202** serves as an anchoring point for the prosthetic mitral valve **12700** within the left ventricle **1200**, to oppose the atrial direction of force upon the prosthetic mitral valve **12700** during systole.
(562) A variety of methods may be utilized to anchor the prosthetic mitral valve **12700** to the heart anchor **202** positioned upon the ventricular wall of the patient's heart. In one embodiment, the deployment apparatus that deploys the prosthetic mitral valve **12700** within the mitral valve annulus may first be extended through the mitral valve annulus in a ventricular direction to puncture the interventricular septum **1210**. The heart anchor **202** may be deployed in a similar manner as shown in FIGS. **34** and **35**, by being passed out of an opening in the deployment apparatus on the right ventricle side of the interventricular septum **1210**. The deployment apparatus may then be retracted from the puncture in the interventricular septum **1210**, with the tension member **12900** trailing into the left ventricle **1200**. The deployment apparatus may then deploy the prosthetic mitral valve **12700** to the mitral valve, with the tension member **12900** coupled to the heart anchor **202** positioned on the interventricular septum **1210** and coupled to the prosthetic mitral valve **12700**. The deployment apparatus may then tension the tension member **12900** if desired to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202**.
(563) In one embodiment, the heart anchor **202** may be deployed to the interventricular septum **1210** in a similar manner as shown in FIGS. **9-25**. The tension member **286** provided in FIGS. **9-25** may comprise the tension member **12900** shown in FIG. **129**. The tension member **12900** may be positioned within the left ventricle **1200** after deployment of the heart anchor **202**, and may be snared by a deployment apparatus that deploys the prosthetic mitral valve **12700** to the mitral valve. The deployment apparatus may couple the tension member **12900** to the prosthetic mitral valve **12700**, thus anchoring the prosthetic mitral valve **12700** to the heart anchor **202**. The deployment apparatus may then tension the tension member **12900** if desired to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202**.
(564) In one embodiment, the prosthetic mitral valve **12700** may be first deployed to the mitral valve, with the tension member **12900** left as a tether positioned within the left ventricle **1200** or elsewhere within the patient's heart. A snare such as snare **600**′ shown in FIG. **15** may be passed through the interventricular septum **1210** from the right ventricle **1204** and into the left ventricle **1200** as described herein. A spacer as described in regard to FIG. **14**A may be utilized if desired. The snare **600**′ may snare the tension member **12900**, which may be drawn back through the puncture of the interventricular septum **1210**. The heart anchor **202** may be coupled to the tension member **12900**, and may be deployed to the interventricular septum **1210** as shown in FIG. **129**. The tension member **12900** may be tensioned by pulling the tension member **12900** through the interventricular septum **1210** further, to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202**. The tensioning may also occur at the prosthetic mitral valve **12700** if desired via a deployment apparatus for the prosthetic mitral valve **12700** or another device. In one embodiment, the heart anchor **202** may include a lock that may extend from the anchor **202** to prevent the tension member **12900** from slipping after being set. The lock may comprise a clip, autoknotter device, or another form of lock (for example, as described in U.S. Pat. No. 9,498,202 or 7,628,797, the entire disclosures of which are incorporated by reference). The remaining portion of the tension member **12900** may then be cut. In one embodiment, the heart anchor **202** may be deployed in a similar manner but may comprise a pad, similar to the heart anchor **5100** shown in FIG. **93**, and configured to be positioned on a surface of the ventricular wall of the patient's heart. The heart anchor **5100** may include a lock **5102** for locking the tension member **12900** to the heart

anchor **5100**. The tension member **12900** may be tensioned, and the lock **5102** may be set to securely anchor the prosthetic mitral valve **12700** to the heart anchor **5100** positioned on the interventricular septum **1210**.

(565) In one embodiment, the heart anchor **202** and/or prosthetic mitral valve **12700** may be deployed in a similar manner as shown in FIGS. **83-85**. For example, aortic entry of the left ventricle **1200** may occur, with a deployment apparatus puncturing the interventricular septum **1210** from the left ventricle **1200**, and deploying the heart anchor **202** to the interventricular septum **1210** within the right ventricle **1204** in the location shown in FIG. **129**. The deployment apparatus may also deploy the prosthetic mitral valve **12700** to the mitral valve, or may snare the tension member **12900** that may extend from a prosthetic mitral valve **12700** that is already deployed to the mitral valve. The deployment apparatus may couple the tension member extending from the heart anchor **202** to the tension member **12900** of the prosthetic mitral valve **12700**, or such tension members may already be coupled to each other as shown, for example, with the tension member shown in FIGS. **84-85**. The deployment apparatus may tension the tension member to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202** positioned on the interventricular septum **1210** in the location shown in FIG. **129**, and may set a lock **6200** (similar to the lock shown in FIG. **85**) on the tension member to lock the tension between the prosthetic mitral valve **12700** and the heart anchor **202**.

(566) FIG. **130** illustrates an embodiment in which a single heart anchor **202** may be utilized as an anchor for the prosthetic mitral valve **12700**, and may be positioned on the ventricular wall comprising the free wall of the left ventricle. As such, the heart anchor **202** serves as an anchoring point for the prosthetic mitral valve **12700** within the left ventricle **1200**, to oppose the atrial direction of force upon the prosthetic mitral valve **12700** during systole. The heart anchor **202** may also provide a compressive force to the left ventricle **1200** to provide a therapeutic compression to the left ventricle **1200** as disclosed herein.

(567) The methods that may be utilized to anchor the prosthetic mitral valve **12700** to the heart anchor **202** positioned upon the free wall of the left ventricle are similar to the methods disclosed in regard to FIG. **129**. For example, the deployment apparatus that deploys the prosthetic mitral valve **12700** within the mitral valve annulus may first be extended through the mitral valve annulus in a ventricular direction to puncture the free wall of the left ventricle **1200**. The heart anchor **202** may be deployed in a similar manner as shown in FIGS. **34** and **35**, by being passed out of an opening in the deployment apparatus exterior of the left ventricle **1200**. The deployment apparatus may then be retracted from the puncture in the free wall, with the tension member **12900** trailing into the left ventricle **1200**. The deployment apparatus may then deploy the prosthetic mitral valve **12700** to the mitral valve, with the tension member **12900** coupled to the heart anchor **202** positioned on the free wall of the left ventricle **1200** and coupled to the prosthetic mitral valve **12700**. The deployment apparatus may then tension the tension member **12900** if desired to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202**.

(568) In one embodiment, the prosthetic mitral valve **12700** may be first deployed to the mitral valve, with the tension member **12900** left as a tether positioned within the left ventricle **1200** or elsewhere within the patient's heart. A snare such as snare **600** shown in FIG. **15** may be passed through a puncture in the free wall of the left ventricle **1200** (the location of puncture shown in FIG. **130**) and into the left ventricle **1200** as described herein. The snare **600** may snare the tension member **12900**, which may be drawn back through the puncture of the free wall of the left ventricle **1200**. The heart anchor **202** may be coupled to the tension member **12900**, and may be deployed to the free wall of the left ventricle **1200** as shown in FIG. **130**. The tension member **12900** may be tensioned by pulling the tension member **12900** through the free wall further, to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202**. The tensioning may also occur at the prosthetic mitral valve **12700** if desired via a deployment apparatus for the prosthetic mitral valve **12700** or another device. In one embodiment, the heart anchor **202** may include a lock that may

extend from the anchor **202** to prevent the tension member **12900** from slipping after being set. The lock may comprise a clip, autoknotter device, or another form of lock (for example, as described in U.S. Pat. No. 9,498,202 or 7,628,797, the entire disclosures of which are incorporated by reference). The remaining portion of the tension member **12900** may then be cut. In one embodiment, the heart anchor **202** may be deployed in a similar manner but may comprise a pad, similar to the heart anchor **5100** shown in FIG. **93**, and configured to be positioned on a surface of the ventricular wall of the patient's heart. The heart anchor **5100** may include a lock **5102** for locking the tension member **12900** to the heart anchor **5100**. The tension member **12900** may be tensioned, and the lock **5102** may be set to securely anchor the prosthetic mitral valve **12700** to the heart anchor **5100** positioned on the free wall of the left ventricle **1200**.

(569) In one embodiment, the heart anchor **202** and/or prosthetic mitral valve **12700** may be deployed in a similar manner as shown in FIGS. **83-85**, and as described in regard to FIG. **129**. For example, aortic entry of the left ventricle **1200** may occur. The deployment apparatus may tension the tension member to securely anchor the prosthetic mitral valve **12700** to the heart anchor **202** positioned on the free wall of the left ventricle **1200** in the location shown in FIG. **130**, and may set a lock **6200** (similar to the lock shown in FIG. **85**) on the tension member to lock the tension between the prosthetic mitral valve **12700** and the heart anchor **202**.

(570) FIG. **131** illustrates an embodiment in which multiple heart anchors **202**, **202′** are utilized as anchors for the prosthetic mitral valve **12700**. The heart anchor **202** may be positioned on a ventricular wall comprising the interventricular septum **1210** and the heart anchor **202′** may be positioned on a ventricular wall comprising the free wall of the left ventricle **1200**. As such, the heart anchor **202** serves as an anchoring point for the prosthetic mitral valve **12700** within the left ventricle **1200**, and the heart anchor **202′** serves as an anchoring point with the tension member **12900′** extending therefrom to the prosthetic mitral valve **12700**, to oppose the atrial direction of force upon the prosthetic mitral valve **12700** during systole. The heart anchors **202**, **202′** may also provide a compressive force to the left ventricle **1200** to provide a therapeutic compression to the left ventricle **1200** as disclosed herein. In one embodiment, a transventricular tension member may couple the heart anchors **202**, **202′** together to enhance a compressive force applied by the heart anchors **202**, **202′** to the left ventricle **1200**.

(571) The heart anchor **202** may be deployed in a manner disclosed in regard to FIG. **129**. The heart anchor **202′** may be deployed in a manner disclosed in regard to FIG. **130**.

(572) Although the methods, systems, and apparatuses of FIGS. **127-131** are disclosed in regard to use of a prosthetic mitral valve **12700**, other forms of heart implants may be utilized, including any heart implants for heart valve replacement or repair. For example, the methods, systems, and apparatuses of FIGS. **127-131** may include use of a heart valve repair implant, such as an annuloplasty device (e.g., an annuloplasty ring) that anchors to the heart anchors disclosed herein. A heart valve repair implant may have the form of the annuloplasty device shown in U.S. Pat. No. 4,917,698, the entire disclosure of which is incorporated by reference. Other forms of heart valve prosthetics or heart valve repair implants (or combinations of heart valve prosthetics or heart valve repair implants) may be utilized. One or more of a heart valve prosthetic or heart valve repair implant may be utilized.

(573) In one embodiment, a prosthetic tricuspid valve, or a tricuspid heart valve repair implant, such as an such as an annuloplasty device (e.g., an annuloplasty ring), may be utilized. One or more heart anchors **202**, **202′** may be configured to be positioned on a ventricular wall of the patient's heart, which may comprise a free wall of the right ventricle or the interventricular septum, to anchor the prosthetic tricuspid valve, or the tricuspid heart valve repair implant, in a similar manner as disclosed in regard to FIGS. **127-131**. The one or more heart anchors **202**, **202′** may serve as an anchoring point for the prosthetic tricuspid valve within the right ventricle **1204**, to oppose the atrial direction of force upon the prosthetic tricuspid valve during systole.

(574) The heart valve prosthetics and heart valve repair implants may be for other valves of the

heart (e.g., aortic valve) in other embodiments. In other embodiments, one or more of a heart valve prosthetic or a heart valve repair implant may be utilized without coupling to a heart anchor. For example, a heart splint as shown in FIG. **128** may be utilized without coupling to the prosthetic mitral valve **12700**. The heart splint and prosthetic mitral valve **12700** may both produce therapeutic effects without coupling to each other. Any combination of heart splints, heart valve prosthetics, heart valve repair implants, or other devices, systems, or apparatuses disclosed herein may be utilized as desired.

(575) The “user” as discussed herein may comprise a user of the systems and apparatuses disclosed herein, which may include a surgeon, or another individual such as a medical professional who may operate the systems and apparatuses disclosed herein, without limitation.

(576) The present disclosure offers numerous advantages over existing treatments for various heart conditions, including valve incompetencies. The devices disclosed herein do not require the highly invasive procedures of current surgical techniques. For instance, the treatments described herein do not require removing portions of heart tissue, nor do they necessarily require opening the heart chamber or stopping the heart during operation. The methods of the present disclosure may comprise beating-heart repair of or treatment of the patient's heart. For these reasons, the treatments and techniques for implanting the devices of the present disclosure convey a reduced risk to the patient as compared with other techniques. The less invasive nature of the treatments and techniques and tools of the present disclosure may further allow for earlier intervention in patients with heart failure and/or valve incompetencies. While often discussed herein in terms of mitral valve treatments, the systems, devices, methods, etc. may be used to treat other heart valves, heart conditions, enlargement of other organs, etc.

(577) Although the present disclosure is discussed in connection with treating the mitral valve and tricuspid valve of the heart, the present disclosure may be applied to various chambers of the heart and for other valves of the heart for similar purposes. More broadly, the systems, apparatuses, methods, etc. disclosed herein may be used in other applications to change the geometries and/or stresses of other parts of the body (e.g., a stomach, bladder, or other part of the body). It also is contemplated that the present disclosure may be used to support an infarcted heart wall so as to prevent further dilatation, or to treat aneurysms in the heart. It is further contemplated that the present disclosure may be placed relative to the heart without altering the shape of the chamber, and only altering the shape of the valve itself.

(578) The apparatuses and other devices disclosed herein may be practiced separately as desired. In addition, the methods herein are not limited to the methods specifically described, and may include methods of utilizing the systems, apparatuses, and devices disclosed herein.

(579) In closing, it is to be understood that although aspects of the present specification are highlighted by referring to specific embodiments, one skilled in the art will readily appreciate that these disclosed embodiments are only illustrative of the principles of the subject matter disclosed herein. Therefore, it should be understood that the disclosed subject matter is in no way limited to a particular methodology, protocol, and/or reagent, etc., described herein. As such, various modifications or changes to or alternative configurations of the disclosed subject matter can be made in accordance with the teachings herein without departing from the spirit of the present specification. Lastly, the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of systems, apparatuses, and methods as disclosed herein, which is defined solely by the claims. Accordingly, the systems, apparatuses, and methods are not limited to that precisely as shown and described.

(580) Certain embodiments of systems, apparatuses, and methods are described herein, including the best mode known to the inventors for carrying out the same. Of course, variations on these described embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventors intend for the systems, apparatuses, and methods to be practiced

otherwise than specifically described herein. Accordingly, the systems, apparatuses, and methods include all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described embodiments in all possible variations thereof is encompassed by the systems, apparatuses, and methods unless otherwise indicated herein or otherwise clearly contradicted by context.

(581) Groupings of alternative embodiments, elements, or steps of the systems, apparatuses, and methods are not to be construed as limitations. Each group member may be referred to and claimed individually or in any combination with other group members disclosed herein. It is anticipated that one or more members of a group may be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is deemed to contain the group as modified thus fulfilling the written description of all Markush groups used in the appended claims.

(582) Unless otherwise indicated, all numbers expressing a characteristic, item, quantity, parameter, property, term, and so forth used in the present specification and claims are to be understood as being modified in all instances by the term “about.” As used herein, the term “about” means that the characteristic, item, quantity, parameter, property, or term so qualified encompasses an approximation that may vary, yet is capable of performing the desired operation or process discussed herein.

(583) The terms “a,” “an,” “the” and similar referents used in the context of describing the systems, apparatuses, and methods (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., “such as”) provided herein is intended merely to better illuminate the systems, apparatuses, and methods and does not pose a limitation on the scope of the systems, apparatuses, and methods otherwise claimed. No language in the present specification should be construed as indicating any non-claimed element essential to the practice of the systems, apparatuses, and methods.

(584) All patents, patent publications, and other publications referenced and identified in the present specification are individually and expressly incorporated herein by reference in their entirety for the purpose of describing and disclosing, for example, the compositions and methodologies described in such publications that might be used in connection with the systems, apparatuses, and methods. These publications are provided solely for their disclosure prior to the filing date of the present application. Nothing in this regard should be construed as an admission that the inventors are not entitled to antedate such disclosure by virtue of prior invention or for any other reason. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicants and does not constitute any admission as to the correctness of the dates or contents of these documents.

Claims

1. A heart anchor comprising: a ring having two ends and configured to move from a linearized configuration to a ring-shaped configuration, the ring in the ring-shaped configuration having a thickness in an axial dimension and having a width in a radial dimension and having a length, the ring having a top surface and a bottom surface facing opposite the top surface in the axial dimension, the top surface and the bottom surface extending along an entirety of the length of the ring, and a first portion of the ring overlapping a second portion of the ring in the axial dimension in the ring-shaped configuration to form an overlapping portion at which the top surface faces towards the bottom surface, and the ring including a non-overlapping portion at which portions of the ring do not overlap, the thickness of the ring at the overlapping portion being at least double the

thickness of the ring at the non-overlapping portion, and wherein the bottom surface and the top surface are each planar along the entirety of the length of the ring and each surface is placed respectively and entirely within its own plane in the linearized configuration and in the ring-shaped configuration; and a cover coupled to the ring and extending inward from the ring in the ring-shaped configuration.

2. The heart anchor of claim 1, wherein the two ends of the ring include a first end and a second end, and the first portion of the ring includes the first end of the ring.

3. The heart anchor of claim 1, wherein the first portion of the ring does not overlap the second portion of the ring in the linearized configuration.

4. The heart anchor of claim 1, wherein the ring is configured to automatically move from the linearized configuration to the ring-shaped configuration.

5. The heart anchor of claim 4, wherein the ring is made of a shape-memory material.

6. The heart anchor of claim 1, wherein the cover includes at least one cut-out portion.

7. The heart anchor of claim 1, wherein the cover includes a central portion and a peripheral portion when the ring is in the ring-shaped configuration.

8. The heart anchor of claim 7, wherein the cover includes overlapping material extending from the peripheral portion to the central portion.

9. The heart anchor of claim 8, wherein the overlapping material includes a first layer and a second layer, the first layer including a pattern of cut-outs and the second layer including a pattern of cut-outs having a different shape than the pattern of cut-outs of the first layer.

10. The heart anchor of claim 7, wherein the central portion includes a coupler for coupling to a tension member and the peripheral portion includes a coupler for coupling to the ring.

11. The heart anchor of claim 1, wherein the cover is configured to be puncturable by a puncture device.

12. The heart anchor of claim 11, wherein the cover includes a knitted material having openings for the puncture device to pass through.

13. The heart anchor of claim 1, further comprising a mesh layer coupled to the cover.

14. The heart anchor of claim 1, wherein the two ends of the ring include a first end and a second end, and the first portion of the ring is configured to overlap the second portion of the ring such that the first end is offset along the length of the ring from the second end.

15. The heart anchor of claim 1, wherein the first portion of the ring is configured to overlap the second portion of the ring to at least 10 degrees of the ring.

16. The heart anchor of claim 1, wherein the first portion of the ring is configured to overlap the second portion of the ring to at least 20 degrees of the ring.

17. The heart anchor of claim 1, wherein the first portion of the ring overlapping the second portion of the ring comprises a single overlap.

18. The heart anchor of claim 1, wherein edges of the first portion and the second portion are aligned with each other in the radial dimension at the overlapping portion.

19. The heart anchor of claim 1, wherein a thickness of the ring between the top surface and the bottom surface in the axial dimension is uniform along the entirety of the length of the ring in the linearized configuration and in the ring-shaped configuration.

20. The heart anchor of claim 2, wherein the ring is unitary from the first end to the second end.