(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2018 (11.01.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/009868 A1

(51) International Patent Classification:
A61F 2/24 (2006.01)

(21) International Application Number:
PCT/US2017/041200

(22) International Filing Date:
07 July 2017 (07.07.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

62/360,160	08 July 2016 (08.07.2016)	US
15/643,229	06 July 2017 (06.07.2017)	US

(71) Applicant: EDWARDS LIFESCIENCES CORPORATION [US/US]; One Edwards Way, Irvine, CA 92614 (US).

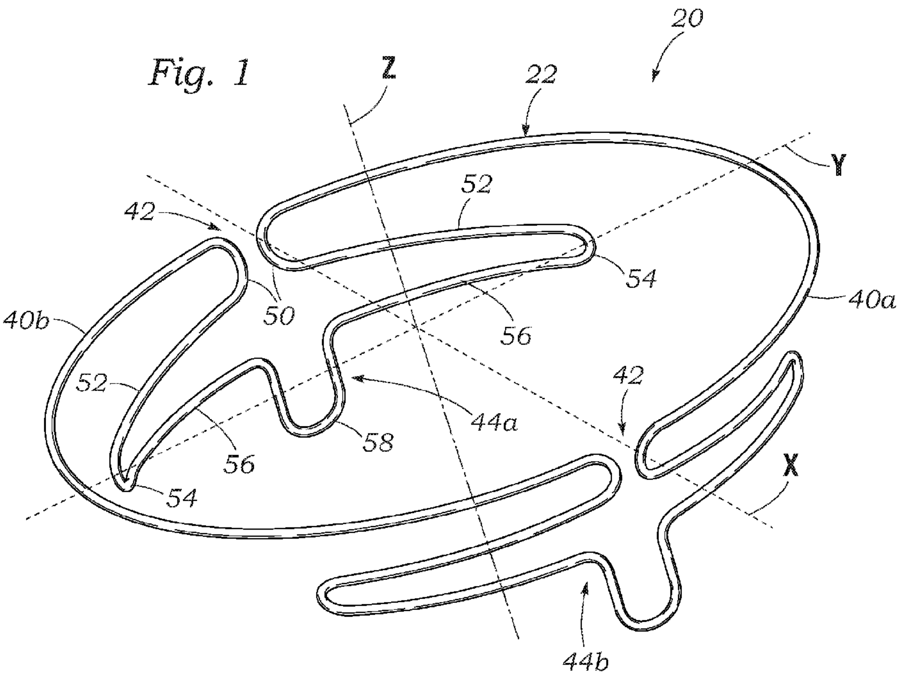
(72) Inventor: TAMIR, Ilan; Edwards Lifesciences, One Edwards Way, Legal Department, Irvine, CA 92614 (US).

(74) Agent: KAISER, Annemarie et al.; Edward Lifesciences, One Edwards Way, Irvine, CA 92614 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH,

(54) Title: DOCKING STATION FOR HEART VALVE PROSTHESIS



(57) Abstract: An anchoring device that can be positioned within a native valve, such as the native mitral valve, to secure a replacement prosthetic valve in place. The anchoring device can comprise a docking station formed of a super elastic wire-like member defining a continuous, closed shape. The docking station can have an upper or atrial ring with at least two ring portions or half rings that are spaced apart across gaps. Descending bends from the ends of the two ring portions lead to a pair of anchors. The anchors can include oppositely-directed rounded V-shaped arms that extend generally parallel to the upper ring. When installed by a delivery device, the anchors can be located in the subvalvular space or the region/vicinity of the native leaflets and pinch the leaflets and the annulus against the upper ring which is located on the other side of the annulus.

WO 2018/009868 A1

[Continued on next page]

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

DOCKING STATION FOR HEART VALVE PROSTHESIS

FIELD OF THE INVENTION

[0001] The present invention relates to anchoring devices that can be positioned within a native valve for securement of a replacement valve.

BACKGROUND OF THE INVENTION

[0002] Mitral valve regurgitation occurs when blood flows back through the mitral valve and into the left atrium when the ventricle contracts. Heart valve regurgitation can occur when the heart leaflets do not completely close when the heart contracts. For example, when the heart contracts, blood flows back through the improperly closed leaflets.

[0003] In some instances regurgitation occurs due to disease of the valve leaflets (e.g., primary, or "organic" regurgitation). Regurgitation can also be cause by dilatation of the left ventricle, which can lead to secondary dilatation of the mitral valve annulus. Dilation of the annulus spreads the mitral valve leaflets apart and creates poor tip cooptation and secondary leakage, or so-called "functional regurgitation."

[0004] Primary regurgitation can be corrected by attempting to remodel the native leaflets, such as with clips, sutures, hooks, etc., to allow them to close completely when the heart contracts. When the disease is too far advanced, the entire valve may need to be replaced with a prosthesis, e.g., mechanical or biologic. Based on the success of catheter-based aortic valve replacement, it would be beneficial to have options usable to replace the mitral valve non-invasively using similar types of replacement valves.

[0005] Unlike the aortic valve, however, the mitral valve annulus does not provide a good landmark for positioning a replacement mitral valve. The bulk of the aortic annulus is generally increased in the presence of degenerative disease associated with calcium formation, thus making it easier to properly secure a replacement aortic valve in place due to the reduced cross-sectional area of the aortic annulus. However, in mitral valves experiencing regurgitation, the mitral valve annulus is generally thinner not thicker, wider not narrower. The thinner, wider mitral valve annulus makes it relatively more difficult to properly seat a replacement mitral valve in the native mitral valve annulus. Further, the aortic annulus is anatomically pronounced, providing a larger "bump" to which a replacement aortic valve can be secured, whereas the smoother transition from the left atrium to the left ventricle defined by the mitral valve annulus makes it more difficult to properly anchor a replacement mitral valve in place.

[0006] Further, the larger mitral valve annulus makes it difficult to securely implant current percutaneously delivered valves in the native mitral position. Current replacement aortic valves are limited in the amount of radial expansion they can undergo during deployment and implantation. To provide a replacement aortic valve that has an expanded configuration such that it can be securely anchored in a mitral valve annulus would require that the collapsed delivery profile of the replacement aortic valve be increased. However, that would make endovascular delivery more dangerous for the patient and more difficult to navigate the vasculature with a larger diameter delivery system. Further, self-expanding stents that cause the valve to become anchored to the valve annulus may not be feasible for repair of a mitral valve due to the possibility that the self-expanding stent may occlude the left ventricle outflow tract for the adjacent aortic valve.

[0007] Some attempts have been made to first deliver and implant an anchor to the mitral valve and then a prosthetic valve into the anchor. For instance, U.S. Patent Nos. 8,657,872 to Seguin and 9,301,836 to Buchbinder disclose such systems, and these references are incorporated by reference herein in their entirety. However, these devices have not caught on with surgeons for a variety of reasons.

[0008] Despite certain advances in mitral valve replacement, there remains a need for new effective and safe anchoring devices that can be positioned near or within the native mitral valve and that is adapted to secure a replacement mitral valve in place.

SUMMARY OF THE INVENTION

[0009] This summary is meant to provide some examples and is not intended to be limiting of the scope of the invention in any way. For example, any feature included in an example of this summary is not required by the claims, unless the claims explicitly recite the features. Various features and steps as described elsewhere in this disclosure may be included in the examples summarized here, and the features and steps described here and elsewhere can be combined in a variety of ways.

[0010] The present application discloses a docking station meant to support, when implanted in a native valve, any kind of expandable prosthetic valve (e.g., self-expandable/balloon-expandable/mechanical/hydraulic/combination, etc.). The docking station is configured such that it does not significantly interfere with the native leaflets (e.g., the native mitral leaflets) after it is installed so it allows sufficient performance of the native valve during the time it takes to subsequently put in the prosthetic valve. When implanted in a native mitral valve, the docking station is configured to support the anterior mitral leaflet from its back side to prevent it from compromising flow through the left ventricular outflow tract (LVOT) or aorta during systole. The docking station is low profile and can be delivered through the femoral or radial vein in a trans-septal procedure.

[0011] A number of distinct benefits are provided by the docking station disclosed herein. First of all, the docking station has a very small profile to reduce the size of any delivery devices used for installation. Secondly, the placement and installation of the docking station is relatively simple and can be done with reduced imaging requirements, e.g., using left atrial imaging only. The docking station is configured to sit high in the native annulus (e.g., in a native mitral annulus), which allows for the installation of a larger prosthetic mitral valve. Also, there is no need to loop around chordae tendineae, as with some prior devices. The single piece docking station installs independently in the native annulus without any sutures or other such fasteners. The docking station is universal in that it may receive all kinds of prosthetic valves (e.g., self-expandable/balloon-expandable/mechanical/hydraulic/combination, etc.). Furthermore, when implanted in a native mitral valve, the docking station prevents LVOT or aorta obstruction by the native anterior leaflet or by deformation of the annulus

and/or aorta due pressure from an anchor, docking station, prosthetic valve, etc. Finally, the docking station permits continuing performance of the native leaflets after its installation so that no significant valve regurgitation (e.g., mitral regurgitation (MR)) is created during the period of time between the docking station placement and the prosthetic valve placement.

[0012] In one embodiment, a heart valve docking station (e.g., mitral heart valve docking station) comprises a super elastic wire-like member (e.g., a wire-like elongated member) forming a continuous, closed shape. The shape defines a first ring (e.g., an upper ring, an atrial ring, etc.) arranged around a central axis and sized to circumscribe a native annulus (e.g., a mitral annulus) including at least two ring portions (e.g., two half rings, such as a first half ring and a second half ring; three portions or three 1/3 ring portions; and so on) lying in a horizontal plane, the at least two portions (e.g., two half rings, etc.) being separated at two pairs of adjacent ends by gaps. A symmetric pair of descending bends on both pairs of adjacent ends of the at least two portions (e.g., two half rings, etc.) extend vertically downward from the adjacent ends and turning through an included angle of approximately 180°. A pair of generally V-shaped arcuate arms (e.g., V-shaped ventricular arms) extend from each pair of descending bends below the horizontal plane of the first ring (e.g., the upper ring or atrial ring) with apices pointed away from each other, and a lower strut on each arm (e.g., each ventricular arm) of each pair connects to the lower strut on the other arm (e.g., the other ventricular arm) of that pair.

[0013] The native heart valve docking station (e.g., native mitral valve docking station) can comprise a wire-like member (e.g., a wire-like elongated member) defining at least two portions (e.g., two half rings, three portions or three 1/3 ring portions, etc.) arranged around a central axis and separated at pairs of adjacent ends by gaps, the at least two portions (e.g., two half rings, etc.) defining an incomplete ring sized to fit around a native valve annulus (e.g., a mitral annulus). A pair of anchors (e.g., ventricular anchors) can be included and can each connect to a pair of adjacent ends of the ring portions (e.g., of the half rings) and be axially spaced from the ring portions (e.g., from the half rings). Each of the anchors (e.g., ventricular anchors) can have two arms (or another number of arms, e.g., 1, 3, 4, 5, 6 or more) extending away from each other, and each anchor (e.g., ventricular anchor) can be curved generally around the central axis and spaced radially inward from the ring portions (e.g., from the half rings).

[0014] The first ring (e.g., the upper ring or atrial ring) of any of the docking stations herein can form a circle interrupted by the gaps, such as, for example, an angular span of each ring portion (e.g., each half ring) being between 170-178° and the gaps can have a preferred width of between 1-6 mm. The arms (e.g., ventricular arms) can each be curved generally around the central axis, and each can have a radius of curvature less than a radius of the first ring (e.g., the upper ring or atrial ring). For instance, a diameter of the first ring (e.g., the upper ring or atrial ring) can be between about 25-33 mm, while the arms (e.g., ventricular arms) have a radius of curvature that is about 2-3 mm less than the radius of the first ring (e.g., the upper ring or atrial ring). The arms (e.g., ventricular arms) can each descend down below the horizontal plane of the first/upper ring (e.g., of the atrial ring) to a preferred depth of between about 10-15 mm. Though some exemplary measurements and ranges are listed herein, it should be understood that other measurements/ranges are also possible.

[0015] In any of the docking stations, the arms of each anchor (e.g., ventricular anchor) can have a rounded V-shape formed by an upper strut, a curved end defining an apex of the arm, and a lower strut, and the lower strut of each pair of arms can, optionally, connect to the lower strut on the other arm of that pair. Optionally, the lower strut on each arm (e.g., ventricular arm) of each pair can connect to the lower strut on the other arm (e.g., ventricular arm) of that pair via a downwardly curved bridge portion that extends downward from the lower struts. The member/elongated member can be formed from a single length of wire having two free ends connected by a crimp or, optionally, the member/elongated member can be formed by laser cutting the continuous form from a metallic tube such as a Nitinol tube.

[0016] Other features and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a perspective view of an exemplary valve docking station of the present application, while Figure 1A is a top plan view thereof;

[0018] Figure 2 is a perspective view of the docking station of Figure 1 installed at a mitral annulus, shown schematically;

[0019] Figures 3A-3C are top plan, front elevational, and side elevational views, respectively, of the docking station installed at the mitral annulus;

[0020] Figures 4A-4C illustrate several steps in an exemplary procedure for installing the docking station at a native annulus (e.g., mitral annulus) using a delivery tube/catheter;

[0021] Figure 5 illustrates an exemplary prosthetic expandable heart valve implanted by a delivery device at the native annulus (e.g., mitral annulus) in which the docking station has been installed; and

[0022] Figures 6A-6C illustrate an exemplary valve docking station of the present application.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0023] Figure 1 is a perspective view of an exemplary valve docking station 20 of the present application that can be used in a native valve of a heart (e.g., in a mitral valve, tricuspid valve, aortic valve, pulmonary valve). While the docking station may be described, for example, as a mitral valve docking station and may be described and shown as being used, for example, in a native mitral valve, it should be understood that the docking station and concepts herein are representative and can be adapted for use in other valves. The docking station 20 illustrated in Figure 1 comprises a super elastic (e.g., Nitinol) solid member or elongated member 22 that may be cut from a tube or be bent out of a wire. Indeed, the docking station 20 can comprise a continuous length of rod or wire, preferably circular in cross-section, which is highly flexible throughout, however, one or more non-continuous length(s) of rod or wire could also be used and could have one or more of a variety of cross-sectional shapes, e.g., oval, ovoid, square, rectangular, hexagonal, triangular, etc. Preferably, the member or elongated member 22 is a single length of round wire that is shaped (bent and possibly heat set) to the geometry described below and then its ends are welded or crimped together to form a closed “ring.” (A weld or crimp will preferably be located in a region of low elastic stress.) But a variety of arrangements and constructions are possible. Optionally, the docking station 20 can be made out of laser cut nitinol tube or cone. In this case the docking station 20 will comprises the same features (“springy” atrial ring and ventricular arms, as described) but the geometry will likely be changed to enable crimping of the rectangular cross section of the wire. The rectangular cross section may be smoothed somewhat with electropolishing or the like.

[0024] For the purpose of orientation, the docking station 20 has a shape that can be defined relative to an X-Y-Z coordinate system as shown in Figure 1. As will be explained, when installed the vertical or Z-axis corresponds to an approximate direction of flow through the valve annulus (e.g., a mitral valve annulus). The horizontal or X/Y plane corresponds to the “plane” of the annulus. While the mitral annulus is very rarely planar, and often has a saddle shape with an upward bow on two sides, the high flexibility of the wire-like docking station 20 permits it to conform to an irregular annulus. As stated elsewhere, a super-elastic wire-like member/elongated member 22 of between 0.5-1.0 mm is preferred, but other sizes are possible larger or smaller than this.

[0025] Prior to a detailed description of the shape of the docking station 20, the reader will note Figure 2 which is a perspective view of the docking station installed at a mitral annulus 30, shown schematically. The mitral annulus 30 is illustrated as a tissue ledge having a continuous somewhat D-shaped profile looking down from above (e.g., Figure 3A). A pair of flexible leaflets, namely a posterior leaflet 32 and an anterior leaflet 34 are shown extending inward toward each other from the peripheral annulus 30. The annulus 30 and leaflets 32, 34 are shown relatively smooth and idealized, and of course a natural mitral valve is often highly irregular; for instance, the leaflets are often broken into several scallops. Furthermore, the mitral valve exists between the right atrium and the left ventricle, and the tissue surrounding the mitral valve is not shown either. Finally, as will be described with respect to Figures 3B and 3C, the mitral annulus 30 is illustrated as being planar, but as mentioned above is often saddle shaped. The schematic illustration of the mitral valve herein should not be considered true for all anatomies, but the overall shape and position of the annulus and leaflets as shown is a good representative approximation.

[0026] With reference back to Figure 1, the docking station 20 has a first/upper side (e.g., an atrial side) and a second/lower side (e.g., ventricular side). When implanted at a mitral valve annulus, up or along the positive Z-axis is towards the left atrium and down or along the negative Z-axis is toward the left ventricle. When implanted, the direction of blood flow through the docking station 20 is down or from the first/upper side to the second/lower side.

[0027] With reference back to Figure 1 and the top plan view of Figure 1A, the docking station 20 shown is particularly well adapted/configured for use in a mitral valve annulus and will be discussed below in terms of use in a mitral valve annulus, but the docking station can also be used in other native valves and can be modified/configured for those other valve, e.g., with three anchors instead of two, adjusted spacing, etc. The docking station 20 is shown to be symmetric about the X/Z plane, and comprises on its first/upper side (e.g., atrial side) a nearly complete circular or oval ring 40 formed of two ring sections/halves 40a, 40b. As seen in the top plan view of Figure 1A, the ring halves 40a, 40b preferably lie in the X/Y plane and circumscribe an annular span of nearly 180° (e.g., 170-179°) each. The ends of each of the ring halves 40a, 40b are spaced apart from each other across opposed gaps 42 aligned along the X-axis. The gaps 42 are relatively small, e.g., 2-10°, such that the angular span of each ring half 40a, 40b is between 170-178° (atrial ring 40 diameter between 340-356°). In absolute terms, the gaps 42 may be between 1-6 mm. The rest of the member/wire 22 (e.g., elongated member) bends down to define two anchors 44a, 44b (e.g., ventricular anchors on the ventricular side of the X/Y plane or ventricular side of the mitral valve annulus) whose shape will be described below. The basic shape of the upper ring 40 is round or oval on the first/upper side or atrial side and the fingers-like design on the second/lower side or ventricular side provides compression without entangling with the chordae tendineae. An exemplary weld or crimp

28 is shown in dashed line in Figure 2 at a midpoint of the ring half 40a which is a point of low stress, but may be located at other places on the member/elongated member 22 or in multiple places. Optionally, additional anchors can be used, e.g., three or four anchors instead of the two anchors 44a and 44b shown and spaced evenly apart or around the circumference, and the docking station can have similar gaps to those discussed above. The anchors can be of a similar design and shape to the anchors shown herein, but would be smaller if extra anchors are used.

[0028] From the four ends of the ring sections/halves 40a, 40b (or of more than two ring sections, if more than two anchors are used), the member/wire 22 (e.g., elongated member/wire) forms approximately 180° descending bends 50 leading to diverging upper or primary struts 52. Stated another way, a symmetric pair of descending bends 50 on both pairs of adjacent ends of the two ring sections/halves 40a, 40b extend vertically downward from the adjacent ends and turn through an included angle of approximately 180°. The primary struts 52 extend from the bends 50 generally parallel to and below the adjacent portions of the ring halves 40a, 40b, and each extend around a circumferential span of approximately 45°. The struts 52 then transition into curved ends 54 that lead to lower or secondary struts 56. The curved ends 54 also turn through an included angle of approximately 180° such that the secondary struts 56 on both anchors 44a, 44b (e.g., ventricular anchors) converge toward each other. The secondary struts 56 can be separated by a short downwardly curved bridge portion 58 which completes the continuity of the member/elongated member 22. The curved bridge portion 58 can help with crimping of the docking station 20 by relieving some resistance to bending at that location.

[0029] As best seen in Figures 1 and 3C, each of the anchors 44a, 44b (e.g., ventricular anchors) can form something of a T-shape with the bridge portion 58 defining the vertical leg of the T. In the Figures, each of the anchors 44a, 44b defines oppositely directed and symmetric posterior and anterior arcuate arms (e.g., ventricular arms); wherein the arms are made up of the generally rounded V-shaped projection formed by a primary strut 52, a curved end 54, and secondary strut 56. V-shaped as used herein encompasses U-shaped and similar shapes. Both arms of each anchor (e.g., of the anchors 44a and 44b and any additional anchors used) curve within and generally concentric to the upper atrial ring 40 and are located slightly radially inward therefrom. Because these arms commence at the line of symmetry in the X/Z plane, which as will be explained corresponds to the point at which the two leaflets 32, 34 of a mitral valve come together, they project away from one another to the posterior and anterior sides of the subvalvular structure below the mitral valve. The curved ends 54 each form an apex of the respective V-shaped arm (e.g., ventricular arm) that points away from the apex of the symmetrically opposed arm (e.g., ventricular arm).

[0030] Now again with reference to Figure 2, the docking station 20 is shown installed at the mitral valve with the upper ring made up of the two ring halves 40a, 40b (anterior and posterior, respectively) extending around the mitral annulus 30 on the atrial side of the leaflets 32, 34. The two anchors 44a, 44b are shown as ventricular anchors that lie below the mitral annulus 30 on the ventricular side and extend under both posterior and anterior leaflets 32, 34. The 180° descending bends 50 extend down through commissure regions 60 of the mitral valve that are formed adjacent the mitral annulus 30 at the junction between the two leaflets 32, 34. Because of the T-shape of the ventricular anchors 44a, 44b, they diverge outward underneath the leaflets 32, 34. The leaflets 32, 34 are shown in coapting contact with one another corresponding to a valve closed configuration during systole, or when the left ventricle contracts and forces blood through the adjacent aortic valve. The anterior ventricular arms on both the ventricular anchors 44a, 44b extend under and prevent the anterior leaflet 34 from "inflating" or billowing, a condition that may compromise the left ventricular outflow tract (LVOT) during systole.

[0031] Figures 3A-3C further illustrate the positioning of the upper ring 40 and lower ventricular anchors 44 relative to the mitral annulus 30 and the leaflets 32, 34. The 180° descending bends 50 are seen passing between the leaflets 32, 34 at the commissures 60. Figure 3A shows that the anchors/ventricular anchors 44 are positioned slightly radially inward from the upper ring 40. In a preferred embodiment, the anchors/ventricular anchors 44 are generally aligned along a circle (or oval) having a diameter (or major and minor dimensions) that is approximately 80-90% of the diameter (or major and minor dimensions) of the upper ring 40. The anchors/ventricular anchors 44 can press against the "ceiling" of the left ventricle so as to pinch the leaflets 32, 34 and a portion of the annulus 30 against the upper ring 40.

[0032] Figures 4A-4C illustrate several steps in a procedure for installing the docking station 20 at a native annulus 30 (illustrated for example as a mitral annulus) using a delivery tube 70. Initially, the delivery tube 70 is inserted into the body and advanced via vasculature (e.g., via the femoral or radial vein) to a desired location/portion of the heart (e.g., initially to the right atrium when installing in a mitral annulus). If initially advanced to the right atrium and access to the mitral annulus is desired, an access port can then be formed in the septal wall between the right atrium and the left atrium. A variety of ways of forming such an access port are known in the art, and will not be described further herein. The delivery tube 70 can then be advanced in a transseptal procedure across the septal wall and into the left atrium, above the mitral annulus 30.

[0033] A distal end 72 of the delivery tube 70 can be guided or steered between leaflets of a native valve (e.g., to a subvalvular position) and/or be positioned at a commissure of a native valve. For example, Figure 4A shows a distal end 72 of the delivery tube 70 having been guided or steered between the mitral leaflets 32, 34 to a subvalvular position. The distal end 72 is positioned at one of the mitral valve commissures 60. Once properly positioned, the operator/health care provider/physician advances a pusher such as shown schematically at 74 through the delivery tube 70 to urge the docking station 20 distally such that it is partially expelled from the delivery tube. Figure 4A illustrates the configuration of the docking station 20 when compressed within the delivery tube 70 such that the upper ring 40 is collapsed about its line of symmetry and one of the anchors/ventricular anchors 44b is positioned distal to the other anchor/ventricular anchor 44a.

[0034] The distal most anchor/ventricular anchor 44b is then expelled from the delivery tube 70 on a first side of the native annulus 30 (e.g., below the level of the mitral annulus), and expands into position as seen in Figure 4B. The operator/health care provider/physician can then gradually expel the middle portion of the docking station 20, comprising the upper ring halves 40a, 40b, on a second side of the native annulus 30 (e.g., on the atrial side of the mitral annulus 30). After deployment of the upper ring 40, the docking station 20 is in the position of Figure 4B.

[0035] Finally, the distal end 72 of the delivery tube 70 can be advanced between the leaflets (e.g., between leaflets 32, 34 into a subvalvular position), and the pusher 74 can be used to expel the proximal anchor/ventricular anchor 44a (not shown). Ultimately, the proximal anchor/ventricular anchor 44a expands below the native annulus 30 (e.g., below the mitral annulus) and into the position shown in Figure 4C. The delivery tube 70 is retracted, as shown, and the docking station 20 is fully installed. Because the docking station 20 circumscribes the native leaflets (e.g., circumscribes the mitral leaflets 32, 34), and passes between them at the commissures 60 (see Figure 3A), it does not interfere with their functioning after being installed. Of course, a reason for implanting the docking station 20 is for use as an anchor for a subsequently implanted prosthetic heart valve, and thus a minimum amount of time preferably elapses after installation of the docking station and before the new valve is implanted.

[0036] Figure 5 illustrates an exemplary prosthetic expandable heart valve 80 having just been implanted by a delivery device 82 at the mitral annulus in which the docking station 20 has previously been installed. The heart valve 80 is shown schematically with just an expandable frame 84 as a representation of an exemplary prosthetic heart valve. Nonetheless, expandable heart valves usable with the docking stations herein can, for example, comprise an expandable frame, a cloth covering, and a plurality of bioprosthetic leaflets attached thereto. There are numerous types of expandable prosthetic heart valves that would benefit from anchoring within the docking station 20, including those made by Edwards Lifesciences of Irvine, California, Medtronic of Minneapolis, Minnesota, and St. Jude of Minneapolis, Minnesota.

[0037] The shape of the docking station 20 provides substantial elasticity along with spring stiffness for anchoring, thus it may also support prosthetic valves that get expanded to a particular diameter or to a fixed diameter (such as balloon expandable valves). A radial force induced between the docking station and the prosthetic valve can be sufficient to anchor an expandable prosthetic valve 80 inside the docking station 20. This force leverages the friction between the two (one expanding while the other contracting) to fix the prosthetic valve in place relative to the docking station 20, and since the native anatomy (e.g., leaflets) is pinched in between – the assembly is also fixed relative to the native anatomy. In order to generate this radial force, the ring/atrial ring 40 of the docking station 20 can expand and act like a spring. If the ring/atrial ring 40 was a simple Nitinol closed ring, it would require very high forces to expand (due to the stress vs strain properties of the nitinol), the fact that the first/upper portion or ring (e.g., the atrial member) here is made up of multiple ring portions or two half rings 40a, 40b with two openings 42 reduces the radial forces because these openings can be widened from expansion of the prosthetic valve. This allows the designer to control the radial force by changing the geometry of the atrial area of the ring. Further, the descending anchors/ventricular anchors 44a, 44b also contract inward against the prosthetic valve 80 and provide additional holding forces. Due to the axial dimension and curved shape, the anchors/ventricular anchors 44a, 44b provide a uniform holding force against a generally cylindrical outer frame of the prosthetic valve 80. Finally, as seen in Figure 1A and described below, the anchors/ventricular anchors 44a, 44b can be angled radially inward from the atrial ring 40 a small amount to enhance this frictional anchoring effect.

[0038] Figures 6A-6C illustrate another exemplary valve docking station 120 of the present application. As above, the docking station 120 is symmetric about the X/Z plane, and comprises on its first/upper side (e.g., atrial side) a nearly complete circular or oval ring 140 formed of two ring portions/halves 140a, 140b, though other shapes and numbers of ring portions (e.g., 3 ring portions or more) are also possible. The ring portions (e.g., ring portions/halves 140a, 140b) preferably lie in the X/Y plane and together circumscribe nearly a full 360° (e.g., if two are used, then ring portions/halves 140a, 140b can circumscribe an annular span of nearly 180° each). The ends of each of the ring portions (e.g., ring portions/halves 140a, 140b) can be spaced apart from each other across opposed gaps 142, e.g., gaps aligned along the X-axis. The rest of the member forming the docking station (e.g., an elongated member or wire) bends down to define two anchors 144a, 144b on a second/lower side (e.g., ventricular anchors on the ventricular side) of the X/Y plane whose shape will be described below. Implanted, for example, in the mitral annulus, the open round or oval upper ring 140 on the atrial side and fingers-like design on the ventricular side provides compression without entangling with the chordae tendinea.

[0039] With reference to Figure 6C, the four ends of the ring portions/halves 140a, 140b descend in approximately 180° bends 150 leading to diverging primary struts 152. Stated another way, a symmetric pair of descending bends 150 on both pairs of adjacent ends of the ring portions/halves 140a, 140b (and other portions, if included) extend vertically downward from the adjacent ends and turn approximately 180°. The primary struts 152 extend generally parallel to (or slightly angled downward) and below the adjacent portions of the ring portions/halves 140a, 140b, and each extend around a circumferential span of **θ** (e.g., about 45° or within a range of about 30-60º). The struts 152 then transition into curved ends 154 that lead to a secondary strut 156 that extends the width of the respective anchor 144a, 144b (e.g., a respective ventricular anchor). The curved ends 154 make approximately 180° turns. There is no short downward bridge portion included, as there is in the embodiment depicted in Figure 1. However, the anchors/ventricular anchors 144a, 144b each define two generally rounded V-shaped projections formed by the primary struts 152, the curved ends 154, and the bridging secondary strut 156. Both arms curve within the upper ring 140 (e.g., atrial ring) and are located slightly radially inward therefrom. In some embodiments, additional anchors can be used beyond the two anchors 144a and 144b shown, e.g., three or more anchors. The anchors can be the same as or similar to any other anchors described herein, and the docking station can be implanted using the same or similar steps to those discussed above.

[0040] Figures 6B and 6C include exemplary dimensions on the docking station 120 which also may apply to docking station 20 or any docking station embodiments herein. An overall diameter D is shown to the outside of the member/wire that forms the docking station. The diameter D may vary depending on the particular size of the native annulus and/or the size of the prosthetic valve 80, but generally ranges between about 25-33 mm. Of course, the outward force of the expandable valve may also affect the diameter D, with a balance being desired between under- and over-expanding the docking station. Preferably the expandable valve 80 makes contact with the docking station and expands a small degree more to create the secure frictional holding force.

[0041] Figures 6B and 6C also show the main dimensions of the exemplary anchors/ventricular anchors 144a, 144b – the angular span **θ** of each curved V-shaped arm, the radially inward diversion **A** from the atrial ring 140, and the axial depth **H** to which each anchor descends below the ring 140. As mentioned the angular span **θ** of each curved V-shaped arm is between about 30-60°, or in absolute terms between about 10-20 mm. (That means the ventricular anchors 144a, 144b extend around between 60-120°, or about 20-40 mm.) Each anchor/ventricular anchor 144a, 144b diverts radially inward a dimension **A** from the first/upper ring 140 of between about 2-3 mm. Stated another way, if the diameter of the first/upper ring 140 is between about 25-33 mm, the anchors/ventricular anchors 144a, 144b together can define a diameter that is between about 19-27 mm (diameter up to 6 mm less). Each anchor/ventricular anchor 144a, 144b drops down below the first/upper ring 140 the depth **H** of between about 10-15 mm. And finally, the thickness of the member/wire is preferably between 0.5-1.0 mm.

[0042] Retention of the docking station is achieved via several mechanisms:

[0043] **Systolic retention**: a) The docking station 20, 120 retention is achieved by the anchors/ventricular anchors 44, 144 that are pressed against the annulus or surrounding tissue (e.g., pressed against the left ventricle "ceiling" and/or possibly pinching the annulus with the first/upper ring). b) The retention of the prosthetic valve 80 deployed inside the docking station 20, 120 is achieved by sandwiching the native leaflets and/or chordae between its body and the anchors/ventricular anchors 44, 144. The relative radial force between the prosthetic valve 80 and the docking station 20, 120 prevents relative movement between the prosthetic valve 80 and the docking station 20, 120 (e.g., prevents relative axial movement).

[0044] **Diastolic retention**: a) The same radial force between the anchors/ventricular anchors 44, 144 and the prosthetic valve 80 keeps the valve in place during diastole by having both the prosthetic valve and ring "hanging" on or trapping the native leaflets. b) Additional retention may be achieved by the prosthetic valve design for example by having an atrial body that will support the prosthetic valve during diastole by leaning on the atrial floor.

[0045] While the invention has been described with reference to particular embodiments, it will understood that various changes and additional variations may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention or the inventive concept thereof. In addition, many modifications may be made to adapt a particular situation or device to the teachings of the invention without departing from the essential scope thereof. For example, the features described with respect to one embodiment can be incorporated into other embodiments and the steps described with respect to one method/embodiment may be used with other methods/embodiments. Also, steps can be omitted or rearranged as desired. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed herein, but that the invention will include all embodiments falling within the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A heart valve docking station, comprising:

a wire-like member forming a continuous, closed shape defining:

a first ring arranged around a central axis and sized to circumscribe a native annulus including at least two ring portions lying in a horizontal plane, the at least two ring portions each being separated at pairs of adjacent ends by gaps;

a symmetric pair of descending bends on the pairs of adjacent ends of the at least two ring portions extending downward from the adjacent ends and turning through an included angle of approximately 180°; and

a pair of generally V-shaped arcuate arms extending from each pair of descending bends below the horizontal plane of the first ring with apices pointed away from each other, wherein a lower strut on each arm of each pair of arcuate arms connects to the lower strut on the other arm of that pair.

2. The docking station of claim 1, wherein the first ring forms a circle interrupted by the gaps.

3. The docking station of any one of claims 1–2, wherein the arms are each curved generally around the central axis.

4. The docking station of claim 3, wherein the arms each have a radius less than a radius of the first ring.

5. The docking station of claim 4, wherein a diameter of the first ring is between about 25-33 mm, and the arms have a radius that is about 2-3 mm less than the radius of the first ring.

6. The docking station of claim 5, wherein the arms each descend down below the horizontal plane of the first ring to a depth of between about 10-15 mm.

7. The docking station of claim 1, wherein the first ring is an atrial ring and the arms are ventricular arms, and wherein each of the ventricular arms descend down below the horizontal plane of the atrial ring to a depth of between about 10-15 mm.

8. The docking station of any one of claims 1–7, wherein the at least two ring portions are two half rings and an angular span of each half ring is between 170-178°.

9. The docking station of any one of claims 1–8, wherein the lower strut on each arm of each pair of arcuate arms connects to the lower strut on the other arm of that pair via a downwardly curved bridge portion that extends downward from the lower struts.

10. The docking station of any one of claims 1–9, wherein the wire-like member is formed from a single length of wire having two free ends connected by a crimp.

11. The docking station of any one of claims 1–6 and 8–10, wherein the docking station is a mitral valve docking station, the first ring is an atrial ring, and the arms are ventricular arms.

12. A mitral heart valve docking station, comprising:

a wire-like elongated member defining:

two half rings arranged around a central axis and separated at two pairs of adjacent ends by gaps, the two half rings defining an incomplete ring sized to fit around a mitral annulus; and

a pair of ventricular anchors each connected to a pair of adjacent ends of the half rings and axially spaced from the half rings, each of the ventricular anchors having two arms extending away from each other, and each ventricular anchor being curved generally around the central axis and spaced radially inward from the half rings.

13. The docking station of claim 12, wherein the incomplete ring forms a circle interrupted by the gaps.

14. The docking station of any one of claims 12–13, wherein a diameter of the incomplete ring is between about 25-33 mm, and the ventricular anchors have a radius that is about 2-3 mm less than the radius of the incomplete ring.

15. The docking station of claim 14, wherein the ventricular anchors are each axially spaced from the half rings a distance of between about 10-15 mm.

16. The docking station of claim 11, wherein the ventricular anchors are each axially spaced from the half rings a distance of between about 10-15 mm.

17. The docking station of any one of claims 12–16, wherein an angular span of each half ring is between 170-178°.

18. The docking station of any one of claims 12–17, wherein the gaps have a width of between 1-6 mm.

19. The docking station of any one of claims 12–18, wherein the arms of each ventricular anchor have a rounded V-shape formed by an upper strut, a curved end defining an apex of the arm, and a lower strut, and the lower strut of each pair of arms connects to the lower strut on the other arm of that pair.

20. The docking station of claim 19, wherein the lower strut on each arm of each pair connects to the lower strut on the other arm of that pair via a downwardly curved bridge portion that extends downward from the lower struts.

21. The docking station of any one of claims 12–20, wherein the elongated member is formed from a single length of wire having two free ends connected by a crimp.

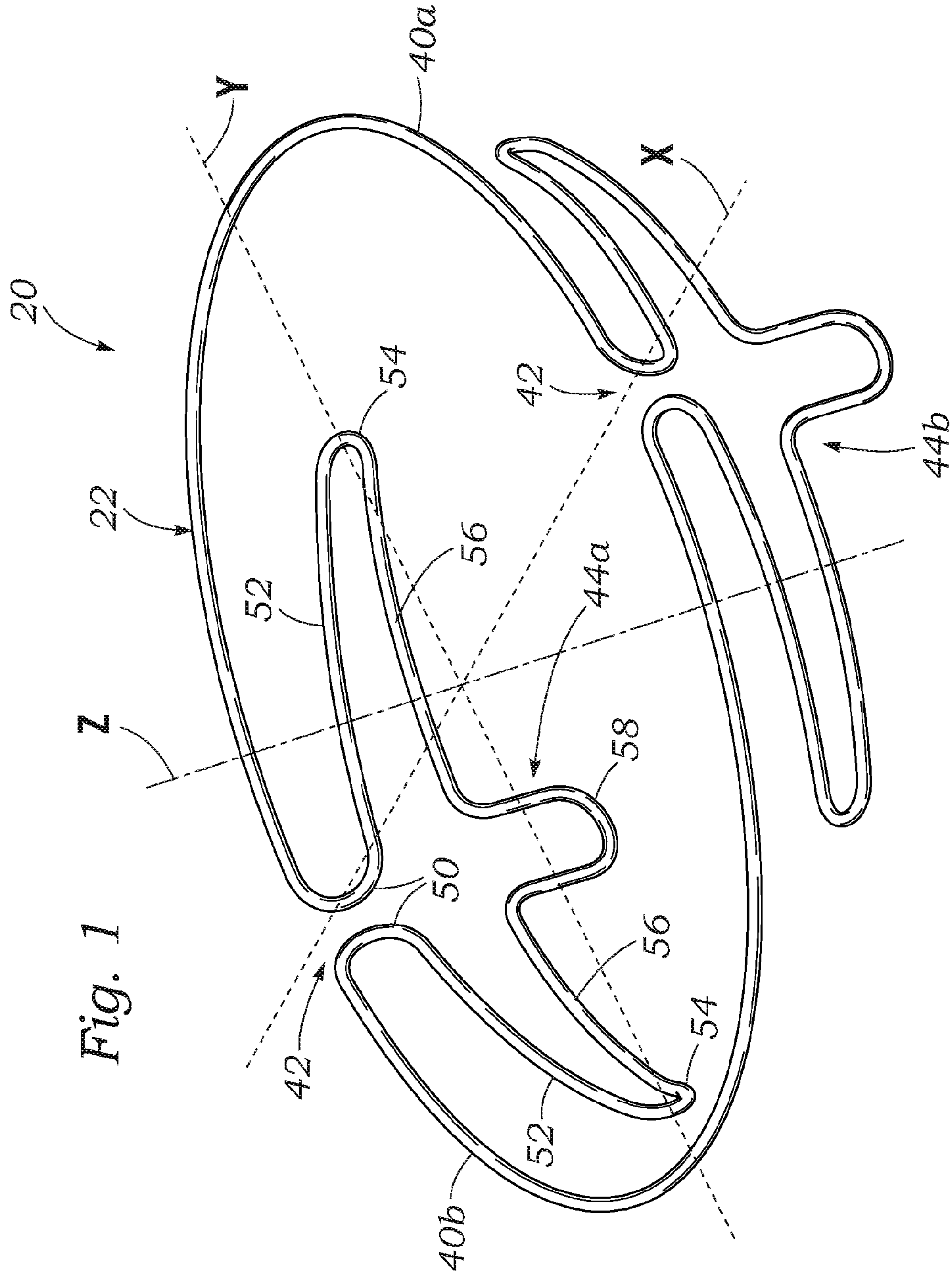
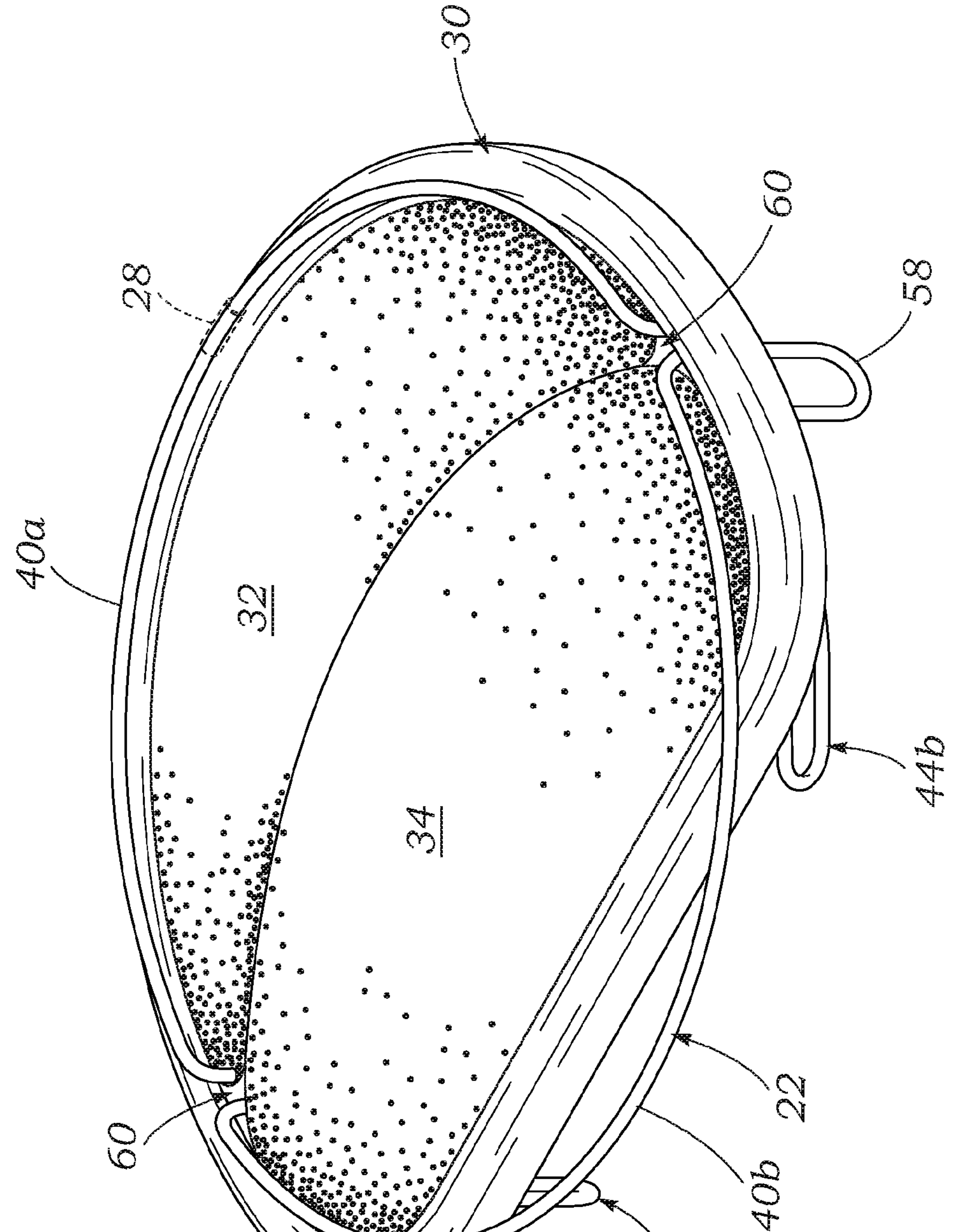


Fig. 1

Fig. 2



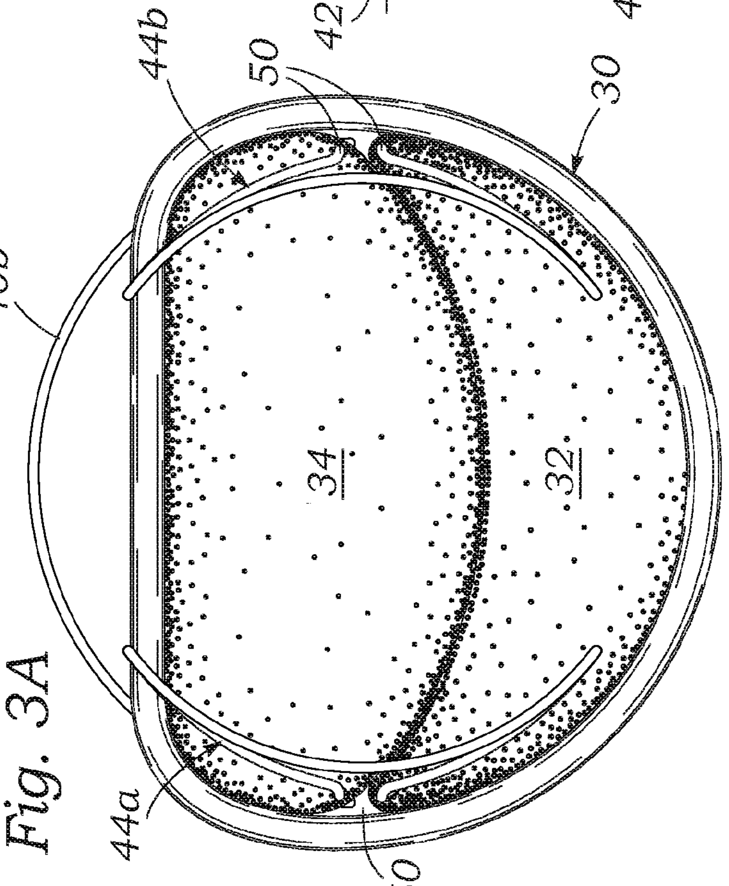


Fig. 3A

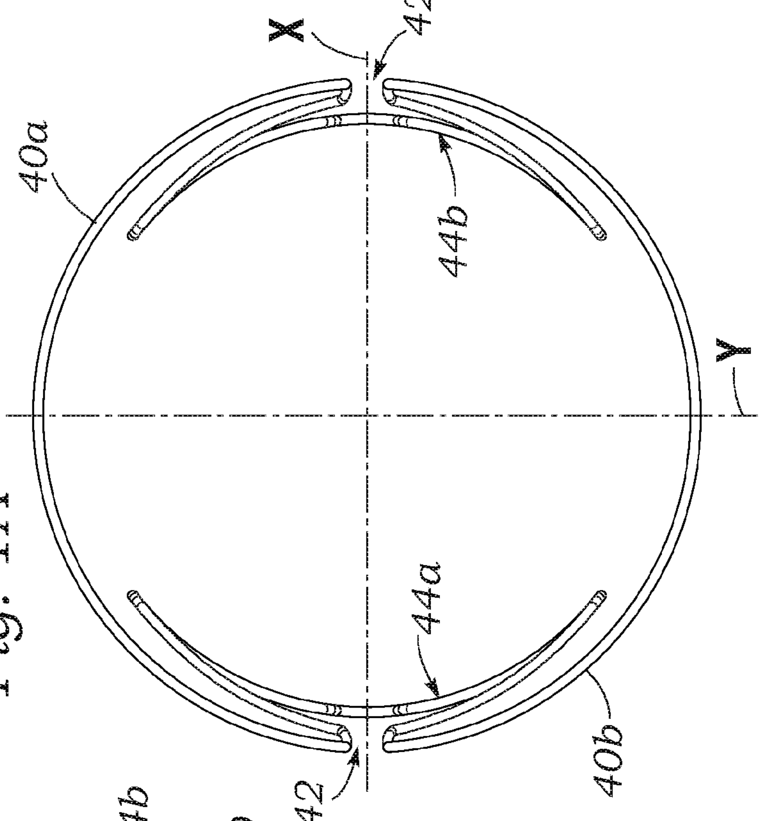


Fig. 1A

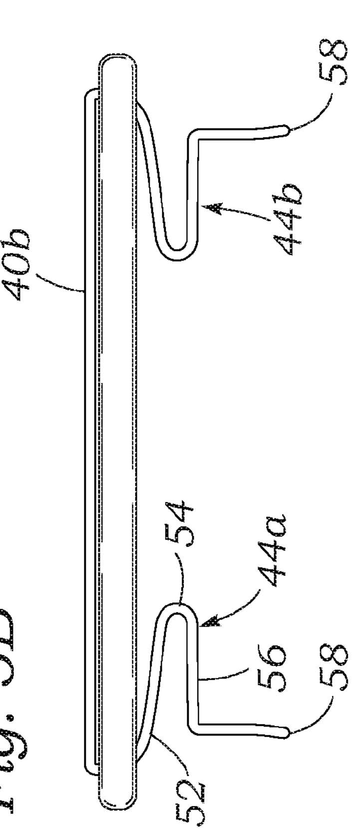


Fig. 3B

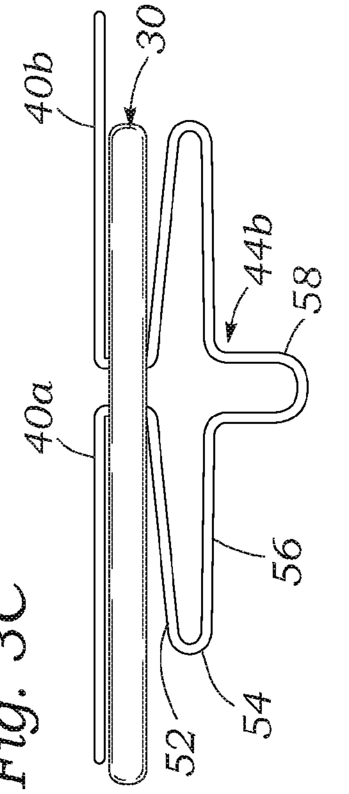


Fig. 3C

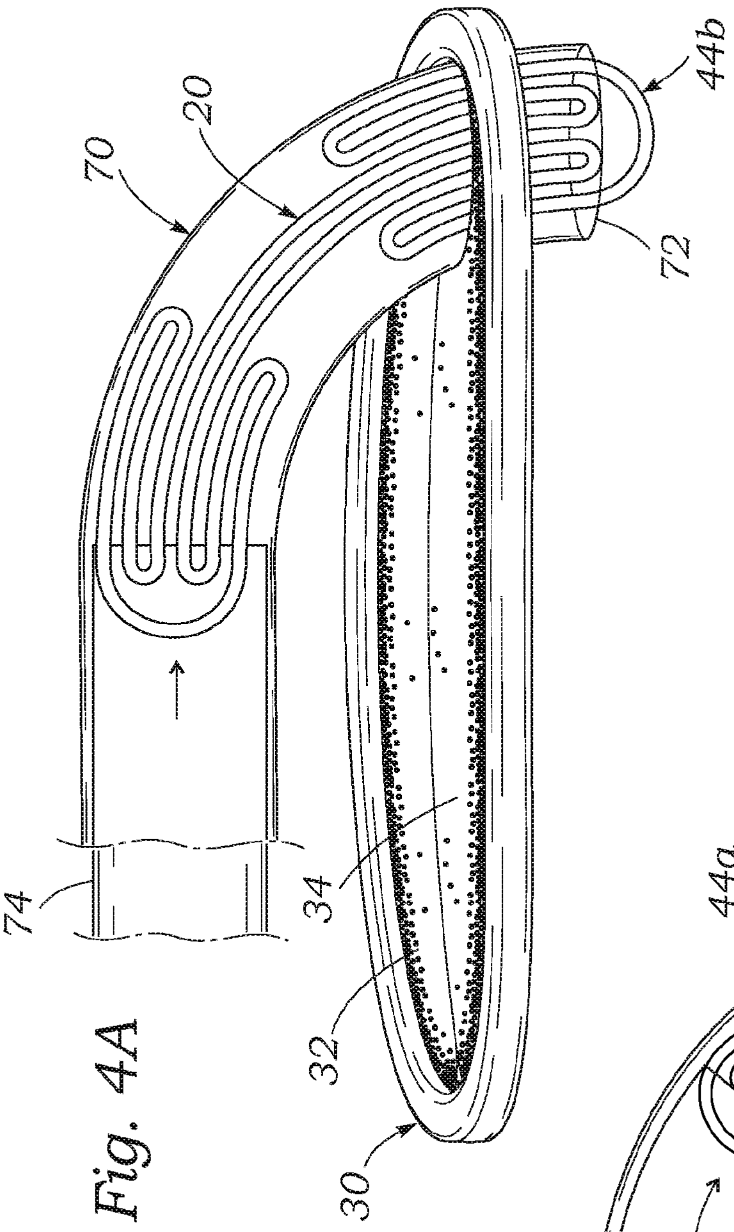


Fig. 4A

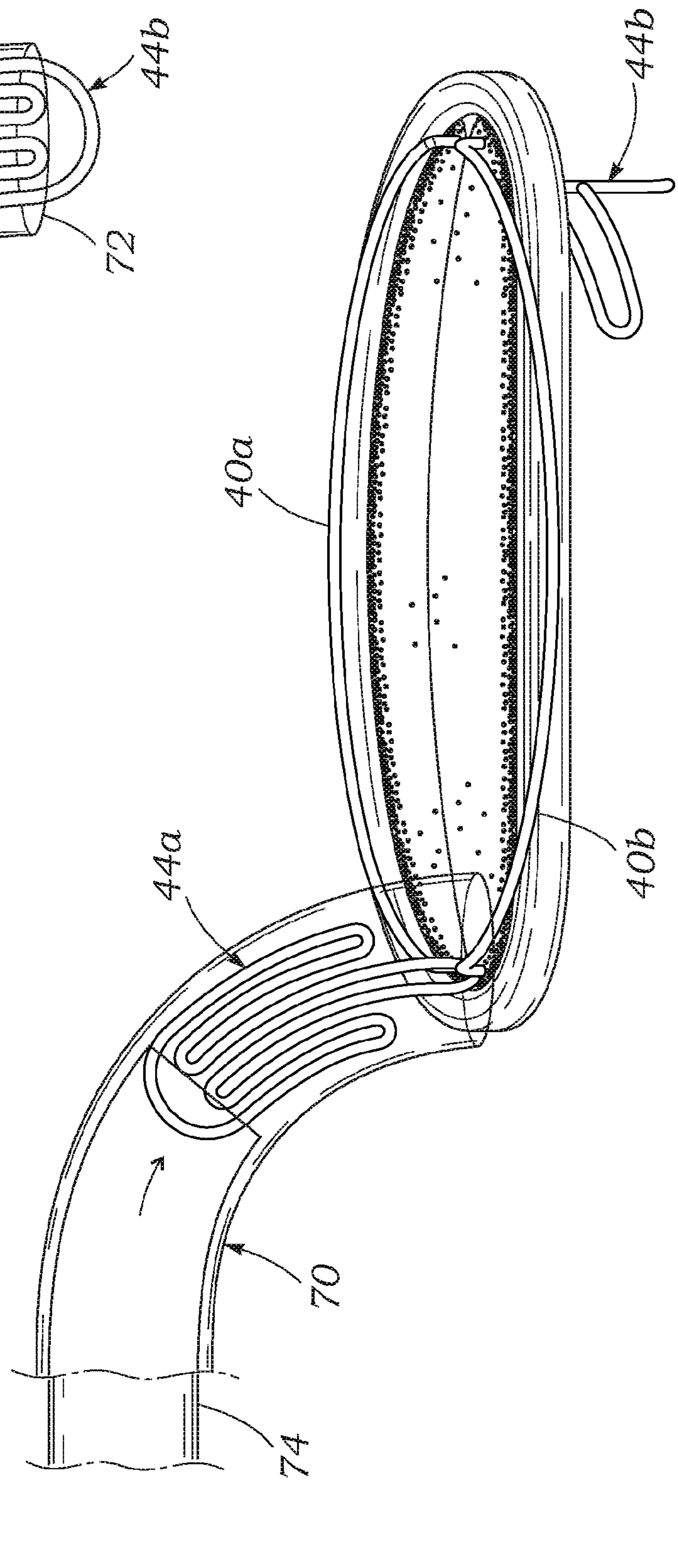


Fig. 4B

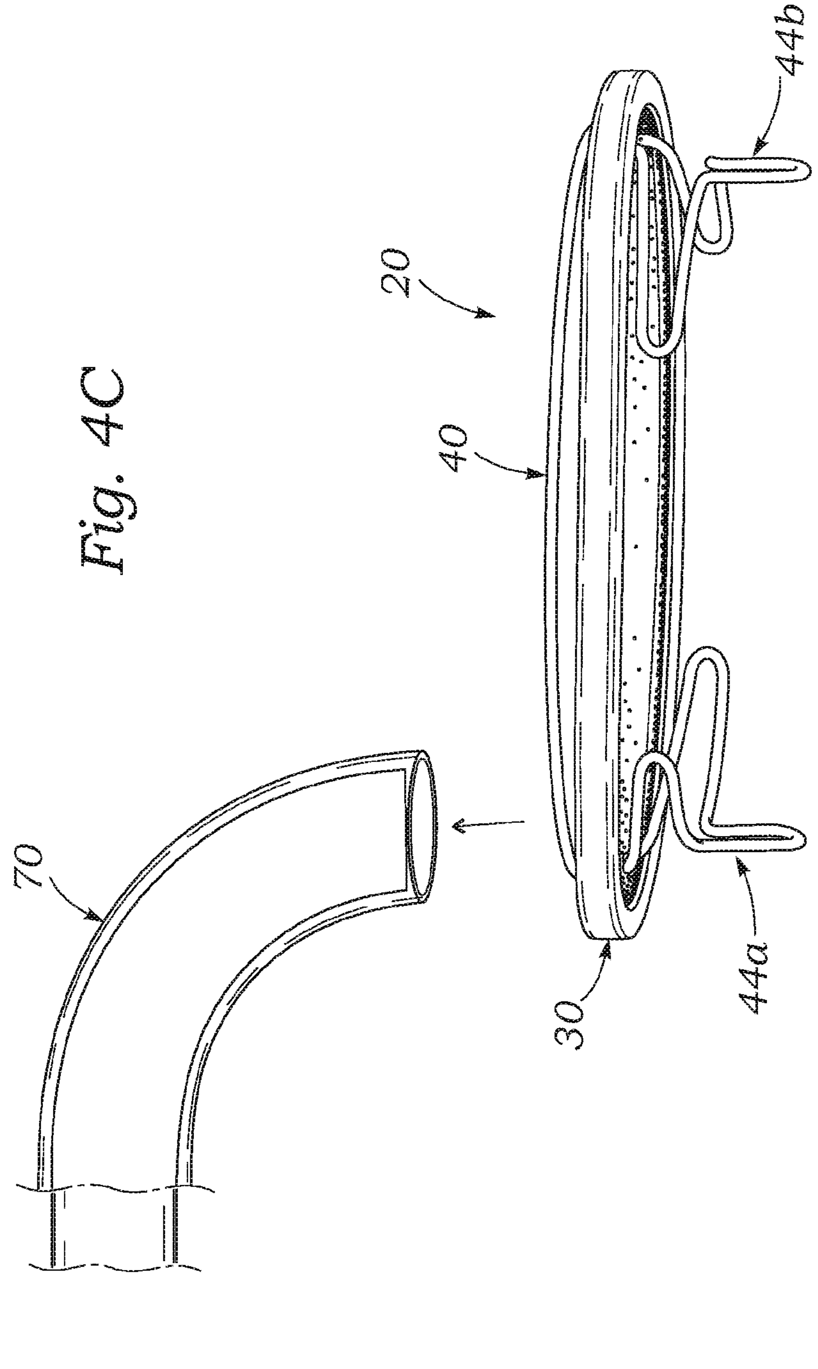


Fig. 4C

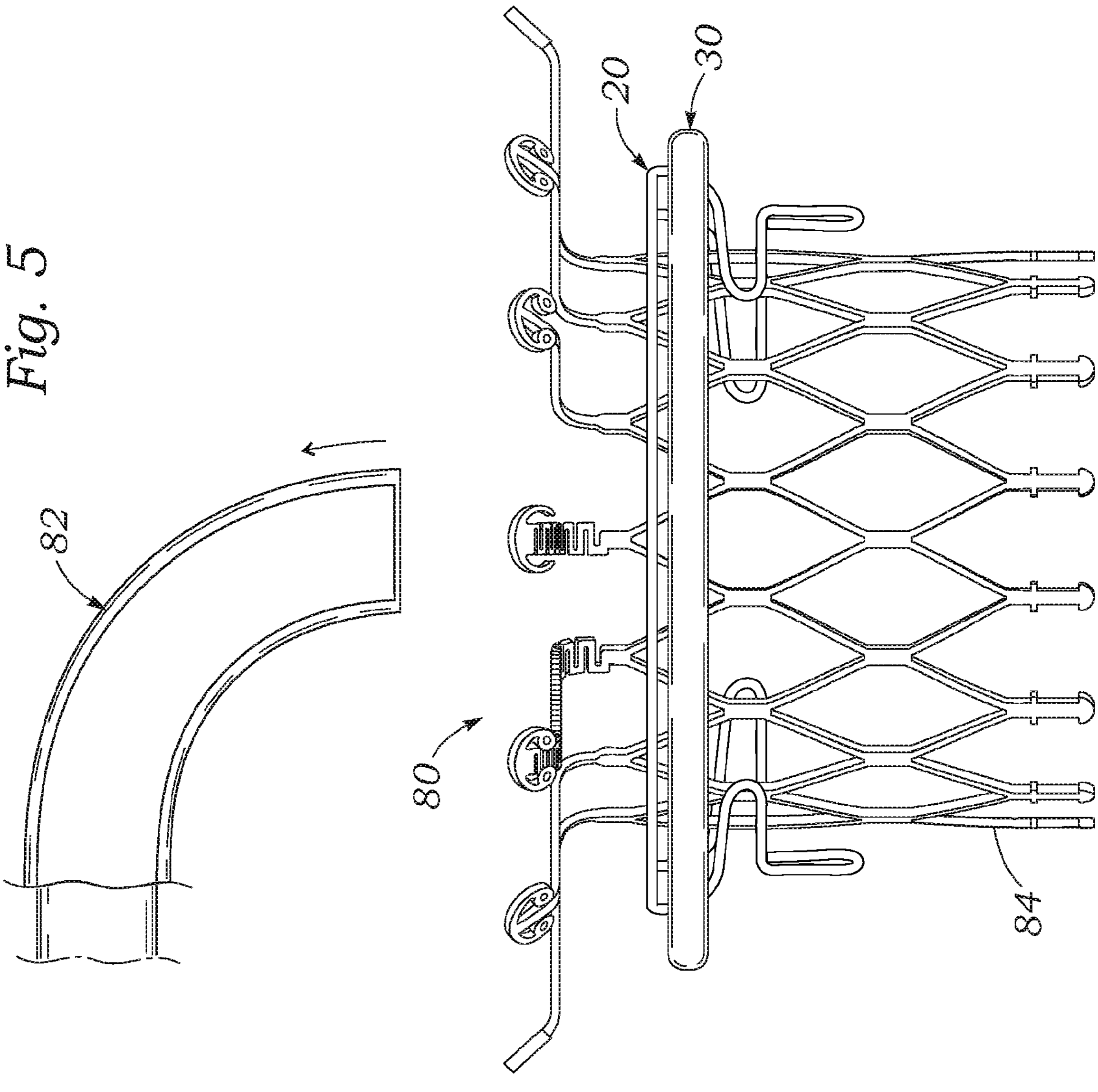


Fig. 5

Fig. 6A

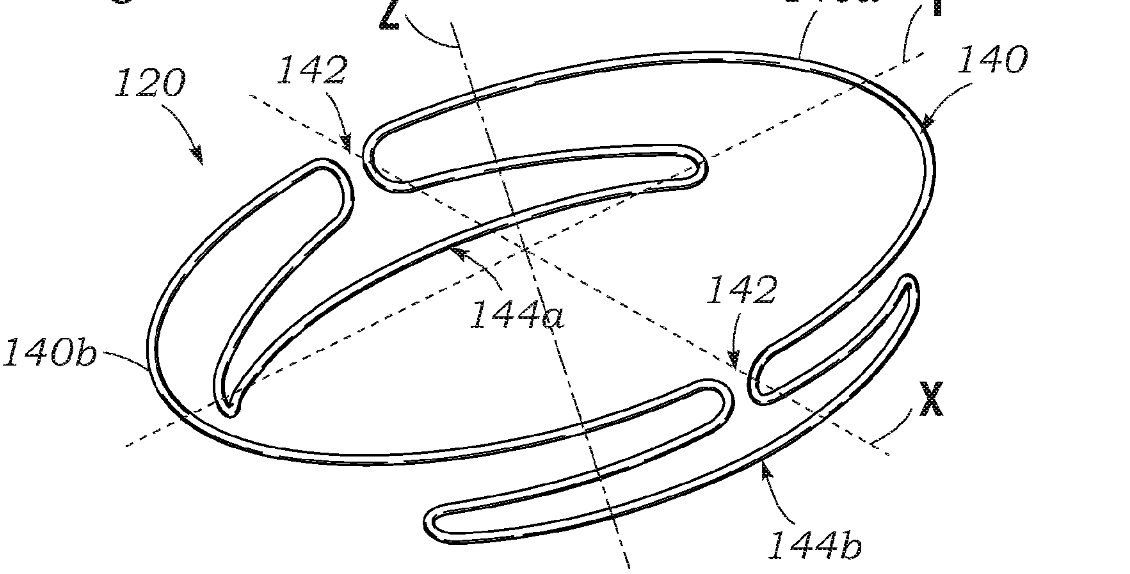


Fig. 6B

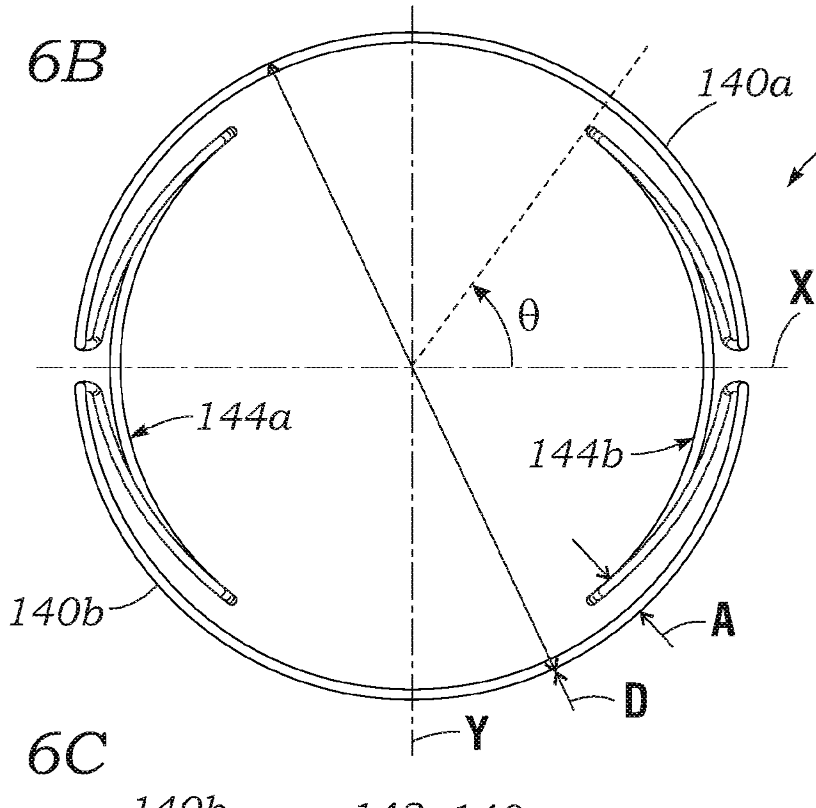
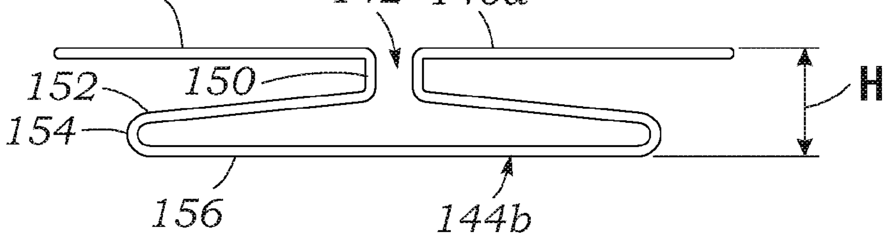


Fig. 6C



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/041200

A. CLASSIFICATION OF SUBJECT MATTER

A61F 2/24(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61F 2/24; A61F 2/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & keywords: heart valve, mitral valve, annuloplasty ring, wire, ring, anchor, symmetric, pair

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008-0140190 A1 (MACOVIAK, J. A. et al.) 12 June 2008 See claim 1; figures 17-21.	1-7,12-16
A	US 2014-0200662 A1 (MVALVE TECHNOLOGIES LTD.) 17 July 2014 See the entire document.	1-7,12-16
A	US 7329280 B2 (BOLLING, S. F. et al.) 12 February 2008 See the entire document.	1-7,12-16
A	US 2012-0078357 A1 (CONKLIN, B. S.) 29 March 2012 See the entire document.	1-7,12-16
A	US 8062355 B2 (FIGULLA, H. R. et al.) 22 November 2011 See the entire document.	1-7,12-16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 October 2017 (16.10.2017)	**16 October 2017 (16.10.2017)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer
HAN, Inho
Telephone No. +82-42-481-3362

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 20
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 20 refers to one of the unsearchable claims which does not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 8-11,17-19,21
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/041200

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008-0140190 A1	12/06/2008	AU 2002-362442 B2	07/08/2008
		AU 2003-277115 A1	23/04/2004
		AU 2003-277116 A1	23/04/2004
		AU 2003-277118 A1	23/04/2004
		AU 2005-244782 A1	01/12/2005
		AU 2005-275509 A1	23/02/2006
		AU 2006-230086 A1	05/10/2006
		AU 2006-230087 A1	05/10/2006
		CA 2455444 A1	10/04/2003
		CA 2462254 A1	10/04/2003
		CA 2498030 A1	15/04/2004
		CA 2563049 A1	01/12/2005
		CA 2573756 A1	23/02/2006
		CA 2601818 A1	05/10/2006
		CA 2602942 A1	05/10/2006
		EP 1434542 A2	07/07/2004
		EP 1434621 A2	07/07/2004
		EP 1562522 A2	17/08/2005
		EP 1562522 B1	31/12/2008
		EP 1748745 A2	07/02/2007
		EP 1748745 B1	23/12/2015
		EP 1788983 A2	30/05/2007
		EP 1865887 A1	19/12/2007
		EP 1865888 A1	19/12/2007
		JP 2005-504577 A	17/02/2005
		JP 2006-501033 A	12/01/2006
		JP 2007-536989 A	20/12/2007
		JP 2008-506494 A	06/03/2008
		JP 2008-534084 A	28/08/2008
		JP 2008-534085 A	28/08/2008
		JP 4458845 B2	28/04/2010
		US 2004-0127981 A1	01/07/2004
		US 2004-0127982 A1	01/07/2004
		US 2004-0138745 A1	15/07/2004
		US 2004-0243107 A1	02/12/2004
		US 2004-0260393 A1	23/12/2004
		US 2005-0010287 A1	13/01/2005
		US 2005-0055089 A1	10/03/2005
		US 2005-0216079 A1	29/09/2005
		US 2005-0222488 A1	06/10/2005
		US 2005-0222489 A1	06/10/2005
		US 2005-0228422 A1	13/10/2005
		US 2006-0106278 A1	18/05/2006
		US 2006-0106279 A1	18/05/2006
		US 2006-0252984 A1	09/11/2006
		US 2008-0065204 A1	13/03/2008
		US 2008-0091059 A1	17/04/2008
		US 2008-0091264 A1	17/04/2008
		US 2008-0140188 A1	12/06/2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2009-0069885 A1	12/03/2009
		US 2009-0228099 A1	10/09/2009
		US 2009-0287179 A1	19/11/2009
		US 2009-0306622 A1	10/12/2009
		US 2009-0326648 A1	31/12/2009
		US 2010-0130992 A1	27/05/2010
		US 2010-0161044 A1	24/06/2010
		US 2011-0015730 A1	20/01/2011
		US 2011-0137411 A1	09/06/2011
		US 2011-0251684 A1	13/10/2011
		US 2011-0295059 A1	01/12/2011
		US 2011-0319990 A1	29/12/2011
		US 2012-0035718 A1	09/02/2012
		US 2012-0185040 A1	19/07/2012
		US 2012-0209377 A1	16/08/2012
		US 2012-0232645 A1	13/09/2012
		US 2014-0222138 A1	07/08/2014
		US 2015-0157459 A1	11/06/2015
		US 2015-0182337 A1	02/07/2015
		US 2015-0289976 A1	15/10/2015
		US 2016-0045308 A1	18/02/2016
		US 2016-0067043 A1	10/03/2016
		US 2016-0374812 A1	29/12/2016
		US 6893459 B1	17/05/2005
		US 7291168 B2	06/11/2007
		US 7305717 B1	11/12/2007
		US 7381220 B2	03/06/2008
		US 7527646 B2	05/05/2009
		US 7691144 B2	06/04/2010
		US 7887583 B2	15/02/2011
		US 8016882 B2	13/09/2011
		US 8142494 B2	27/03/2012
		US 8163013 B2	24/04/2012
		US 8187207 B2	29/05/2012
		US 8690858 B2	08/04/2014
		US 8784482 B2	22/07/2014
		US 8858622 B2	14/10/2014
		US 8956407 B2	17/02/2015
		US 8979925 B2	17/03/2015
		US 9179896 B2	10/11/2015
		US 9498331 B2	22/11/2016
		US 9597184 B2	21/03/2017
		US 9610161 B2	04/04/2017
		WO 03-028558 A2	10/04/2003
		WO 03-028802 A2	10/04/2003
		WO 03-028802 A3	07/08/2003
		WO 2004-030568 A2	15/04/2004
		WO 2004-030568 A3	30/09/2004
		WO 2004-030569 A2	15/04/2004
		WO 2004-030569 A3	29/12/2004

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		WO 2004-030570 A2	15/04/2004
		WO 2004-030570 A3	01/07/2004
		WO 2005-112827 A2	01/12/2005
		WO 2005-112827 A3	24/05/2007
		WO 2006-019498 A2	23/02/2006
		WO 2006-019498 A3	07/12/2006
		WO 2006-105008 A1	05/10/2006
		WO 2006-105009 A1	05/10/2006
		WO 2009-038724 A1	26/03/2009
		WO 2009-038725 A1	26/03/2009
		WO 2010-033176 A1	25/03/2010
US 2014-0200662 A1	17/07/2014	AU 2013-227235 A1	06/09/2013
		AU 2013-245201 A1	10/10/2013
		CA 2809909 A1	08/03/2012
		CA 2865074 A1	06/09/2013
		CA 2869365 A1	10/10/2013
		EP 2611391 A2	10/07/2013
		EP 2819618 A1	07/01/2015
		EP 2833836 A1	11/02/2015
		EP 2945572 A1	25/11/2015
		EP 3003220 A1	13/04/2016
		EP 3174503 A1	07/06/2017
		JP 2013-539395 A	24/10/2013
		JP 2015-508004 A	16/03/2015
		JP 2016-503710 A	08/02/2016
		JP 2016-523606 A	12/08/2016
		JP 5970458 B2	17/08/2016
		US 2012-0059458 A1	08/03/2012
		US 2013-0304197 A1	14/11/2013
		US 2014-0005778 A1	02/01/2014
		US 2015-0094802 A1	02/04/2015
		US 2016-0106539 A1	21/04/2016
		US 2017-0216024 A1	03/08/2017
		US 9265606 B2	23/02/2016
		US 9301836 B2	05/04/2016
		WO 2012-031141 A2	08/03/2012
		WO 2012-031141 A3	07/06/2012
		WO 2013-128436 A1	06/09/2013
		WO 2013-150512 A1	10/10/2013
		WO 2014-111918 A1	24/07/2014
		WO 2014-191994 A1	04/12/2014
		WO 2016-020918 A1	11/02/2016
		WO 2016-027272 A1	25/02/2016
US 7329280 B2	12/02/2008	AU 2002-340469 B2	30/08/2007
		CA 2467766 A1	22/05/2003
		EP 1443877 A1	11/08/2004
		EP 1443877 B1	04/01/2012
		JP 2005-508702 A	07/04/2005

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/041200

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		JP 4235554 B2	11/03/2009
		US 2003-0093148 A1	15/05/2003
		US 2005-0049698 A1	03/03/2005
		US 2008-0097593 A1	24/04/2008
		US 6805710 B2	19/10/2004
		US 8236050 B2	07/08/2012
		WO 03-041617 A1	22/05/2003
US 2012-0078357 A1	29/03/2012	AU 2011-312517 A1	18/04/2013
		AU 2011-312517 B2	19/05/2016
		CA 2793916 A1	17/11/2011
		CA 2812536 A1	12/04/2012
		EP 2568924 A2	20/03/2013
		EP 2621409 A2	07/08/2013
		JP 2013-543399 A	05/12/2013
		US 2011-0276128 A1	10/11/2011
		US 2014-0364943 A1	11/12/2014
		US 2015-0230922 A1	20/08/2015
		US 8845720 B2	30/09/2014
		US 8986374 B2	24/03/2015
		WO 2011-143238 A2	17/11/2011
		WO 2011-143238 A3	29/03/2012
		WO 2012-047644 A2	12/04/2012
		WO 2012-047644 A3	07/06/2012
US 8062355 B2	22/11/2011	AU 2006-310681 A1	10/05/2007
		AU 2006-310681 B2	17/02/2011
		EP 1942834 A1	16/07/2008
		EP 1942834 B1	16/01/2013
		JP 2009-514628 A	09/04/2009
		JP 4904362 B2	28/03/2012
		US 2007-0142906 A1	21/06/2007
		US 2009-0222076 A1	03/09/2009
		WO 2007-051620 A1	10/05/2007