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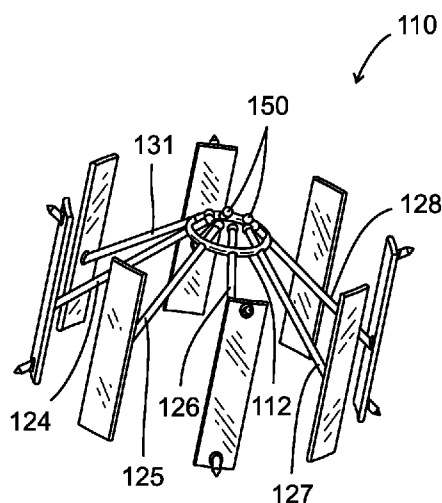


FIG. 4

(57) Abstract: A vascular implant including a tubular body of a polymeric material. The body has opposed filter body ends and a longitudinal axis. The body has a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open-ended bore. The body includes one or more filtering elements in the bore and in between filter ends. One or more filtering elements including a hub at the central longitudinal axis and multiple radially extending filtering arms extend radially between the hub and wall, wherein each arm connects to a wall panel. The tubular body end has anchors that prevent migration and/or tilting.



PATENT APPLICATION

TITLE OF THE INVENTION

VASCULAR IMPLANT

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10 CROSS-REFERENCE TO RELATED APPLICATIONS

N/A

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR
DEVELOPMENT

Not applicable

15 REFERENCE TO A "MICROFICHE APPENDIX"

Not applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to bioresorbable vascular implants such as filters
20 (e.g., vena cava filters), occlusion devices, stents and convertible stents. More particularly, the present invention relates to an improved vascular implant that bioresorbs into a patient's vascular system (e.g., inferior vena cava, iliofemoral vein, ovarian veins, splenic artery, uterine artery, hepatic artery or other vein/artery vessel). For example, the present invention bioresorbs into a patient's vascular system (e.g.
25 inferior vena cava or iliofemoral vein) after transient risk of pulmonary embolism (PE) has subsided. The entire implant structure could be made of bioresorbable material, such as a bioresorbable polymer so that no implant or implant remnant/element would ultimately be left behind as the entire implant would resorb into vascular tissue. In one or more preferred embodiments, the implant preferably has a body with a tubular outer
30 wall with an interior bore, a multi-panel outer wall, and filtering elements connecting the panels together.

In one or more embodiments, the filter preferably has a hub head that can be

annular, ring shaped or rounded, wherein the filtering element connects to the head, annular member or ring shaped hub.

2. General Background of the Invention

Vascular implants include various devices that are placed at a selected locale in a patient's blood vessel. One example is a vena cava filter. Other examples include occlusion devices, stents and convertible stents. Various patents have issued for vascular implants. Patents have also issued that relate in general to 3D printing of implants. Examples are listed in the following Table 1. Each patent listed in Table 1 is hereby incorporated herein by reference.

10

TABLE 1

PATENT OR PUBLICATION NO.	DESCRIPTION	ISSUE DATE (DD/MM/YYYY)
8,092,484	EMBOLUS BLOOD CLOT FILTER WITH POST DELIVERY ACTUATION	10/01/2012
8,092,485	RECOVERABLE INFERIOR VENA CAVA FILTER	10/01/2012
8,317,818	REMOVABLE BLOOD CLOT FILTER WITH EDGE FOR CUTTING THROUGH THE ENDOTHELIUM	27/11/2012
8,420,113	BIODEGRADABLE MEDICAL DEVICES WITH ENHANCED MECHANICAL STRENGTH AND PHARMACOLOGICAL FUNCTIONS	16/04/2013
8,518,072	JUGULAR FEMORAL VENA CAVA FILTER SYSTEM	27/08/2013
8,562,638	EMBOLUS BLOOD CLOT FILTER WITH FLOATING FILTER BASKET	22/10/2013
8,734,479	EMBOLUS BLOOD CLOT FILTER DELIVERY SYSTEM	27/05/2014
8,777,975	EMBOLUS BLOOD CLOT FILTER WITH BIO-RESORBABLE COATED FILTER MEMBERS	15/07/2014
8,795,351	MIGRATION RESISTANT EMBOLIC FILTER	05/08/2014
8,870,943	STENT STRUCTURE FOR IMPLANTABLE MEDICAL DEVICE	28/10/2014
8,992,562	FILTER DELIVERY SYSTEM	31/03/2015
9,220,588	SYSTEMS, METHODS AND DEVICE FOR EMBOLIC PROTECTION	29/12/2015
9,393,095	JUGULAR FEMORAL VENA CAVA	19/07/2016

PATENT OR PUBLICATION NO.	DESCRIPTION	ISSUE DATE (DD/MM/YYYY)
	FILTER SYSTEM	
9,421,081	EMBOLUS BLOOD CLOT FILTER DELIVERY SYSTEM	23/08/2016
9,445,895	INTRACARDIAC CAGE AND METHOD OF DELIVERING SAME	25/09/2016
9,456,888	REVERSIBLE VASCULAR FILTER DEVICES AND METHODS	04/10/2016
9,468,513	EMBOLUS BLOOD CLOT FILTER WITH BIO-RESORBABLE COATED FILTER MEMBERS	18/10/2016
9,561,094	DEVICES AND METHODS FOR TREATING VENOUS DISEASES	07/02/2017
9,597,435	MEDICAL DEVICES HAVING A BIORESORBABLE COATING LAYER WITH A PRE-DETERMINED PATTERN FOR FRAGMENTATION	21/03/2017
9,693,851	FILTER DELIVERY SYSTEM	14/07/2017
9,730,781	EMBOLUS BLOOD CLOT FILTER REMOVAL SYSTEM AND METHOD	15/08/2017
9,949,816	IVE FILTER RETRIEVAL SYSTEMS WITH MULTIPLE CAPTURE MODES	24/04/2018
9,980,804	VENA CAVA FILTER WITH FILAMENT	29/05/2018
10,105,206	INFERIOR VENA CAVA FILTER WITH STABILITY FEATURES	23/10/2018
10,188,496	VENA CAVA FILTER FORMED FROM A SHEET	29/01/2019
10,188,498	EMBOLUS BLOOD CLOT FILTER DELIVERY SYSTEM	29/01/2019
10,226,322	JUGULAR FEMORAL VENA CAVA FILTER SYSTEM	12/03/2019
10,258,454	VISUAL STABILIZER ON ANCHOR LEGS OF VENA CAVA FILTER	16/04/2019
10,279,078	CROSSLINKABLE 3D PRINTED BIOMATERIAL-BASED IMPLANTS AND METHODS OF MANUFACTURE THEREOF	07/05/2019
10,299,906	EMBOLUS BLOOD CLOT FILTER UTILIZABLE WITH SINGLE DELIVERY SYSTEM OR A SINGLE RETRIEVAL SYSTEM IN ONE OF A FEMORAL OR JUGULAR ACCESS	28/05/2019
10,342,654	IVC FILTER WITH TRANSLATING	09/07/2019

PATENT OR PUBLICATION NO.	DESCRIPTION	ISSUE DATE (DD/MM/YYYY)
	HOOKS	
10,368,972	EMBOLUS BLOOD CLOT FILTER WITH BIO-RESORBABLE COATED FILTER MEMBERS	06/08/2019
10,390,925	MIGRATION RESISTANT EMBOLIC FILTER	27/08/2019
10,441,689	METHODS AND DEVICES FOR THREE-DIMENSIONAL PRINTING OR ADDITIVE MANUFACTURING OF BIOACTIVE MEDICAL DEVICES	15/10/2019
10,470,865	VASCULAR FILTER DEVICE	12/11/2019
10,492,898	EMBOLUS BLOOD CLOT FILTER AND DELIVERY SYSTEM	03/12/2019
10,512,531	FILTER DELIVERY SYSTEM	24/12/2019
10,531,942	ABSORBABLE VASCULAR FILTER	14/01/2020
10,579,755	METHOD FOR 3-DAY PRINTING A CUSTOM BONE GRAFT	03/03/2020
10,624,731	VASCULAR FILTER SYSTEM	21/04/2020
10,729,527	REMOVABLE EMBOLUS BLOOD CLOT FILTER	04/08/2020
10,813,738	TUBULAR FILTER	27/10/2020
10,842,608	VENA CAVA FILTER WITH FILAMENT	24/11/2020
2007/064731	TRANSMISSION APPARATUS WITH FUNCTION OF MULTI-STEP BANDWIDTH ASSIGNMENT TO OTHER COMMUNICATION APPARATUSES	22/03/2007
2010/0074934	MEDICAL IMPLANTS WITH A COMBINATION OF COMPOUNDS	25/03/2010
2016/0166371	ENDOLUMINAL FILTER DESIGN VARIATIONS	16/06/2016
2016/0175085	ENHANCED FLUOROGENIC ENDOLUMINAL FILTER STRUCTURE	23/06/2016
2017/0105830	BIODEGRADABLE VASCULAR FILTER	20/04/2017
2017/0218228	THREE DIMENSIONAL PRINTING OF BIO-INK COMPOSITIONS	03/08/2017
2017/0249440	3D PRINTING SURGICAL REPAIR SYSTEMS	31/08/2017
2017/0340429	VASCULAR FILTER SYSTEM	30/11/2017

PATENT OR PUBLICATION NO.	DESCRIPTION	ISSUE DATE (DD/MM/YYYY)
2018/0168811	NOVEL BIODEGRADABLE AND NON-BIODEGRADABLE 3D PRINTED IMPLANTS AS A DRUG DELIVERY SYSTEM	21/06/2018
2018/0296343	3-D PRINTING OF POROUS IMPLANTS	18/10/2018
2018/0303616	3-D PRINTING OF BONE GRAFTS	25/10/2018
2018/0311028	VENA CAVA FILTER WITH FILAMENT	01/11/2018
2019/0110880	MEDICAL DEVICES AND ANCHORS THEREFOR	18/04/2020
2020/0001540	ADDITIVE MANUFACTURING ON UNCONSTRAINED FREEDOM SURFACES	02/01/2020
2020/0197150	VASCULAR FILTER SYSTEM	25/06/2020
WO2007064731	HELICAL VENA CAVA FILTER	07/06/2007
WO2011079287	REVERSIBLE VASCULAR FILTER DEVICES AND METHODS FOR USING SAME	30/06/2011
WO2016154148	ARTIFICIAL TYMPANIC MEMBRANE DEVICES AND USES	29/09/2016
WO2018117907	SHAPE MEMORY POLYMER COMPOSITE FOR 3D PRINTING OF MEDICAL ITEMS	28/06/2018
WO2018218085	THREE-DIMENSIONAL PRINTED ORGANS, DEVICES, AND MATRICES	29/11/2018
WO2019178086	ELECTROHYDRODYNAMIC BIOPRINTER SYSTEM AND METHOD	19/09/2019
WO2020123945	FABRIC MATERIAL FOR MEDICAL DEVICES	18/06/2020
EP2363156	METHOD OF FABRICATING BIODEGRADABLE MEDICAL DEVICES WITH ENHANCED MECHANICAL STRENGTH AND PHARMACOLOGICAL FUNCTIONS	07/09/2011

BRIEF SUMMARY OF THE INVENTION

The present invention provides a vascular implant preferably having a tubular body of a polymeric material, having opposed filter body ends and a central

5 longitudinal axis.

In one or more preferred embodiments, the body has a generally tubular

segmented side wall that preferably includes multiple spaced apart wall panels surrounding a central open ended bore. The segmented tubular wall allows the device to be compressed to fit inside a delivery system and reduces the amount of material that needs to be resorbed.

5 In one or more embodiments, the body preferably includes one or more filtering elements in said bore and in between filter body ends.

 In one or more embodiments, one or more filtering elements preferably include a hub at the central longitudinal axis and multiple radially extending filtering arms that extend between the hub and the wall, wherein each arm connects to the hub and a wall
10 panel.

 In one or more embodiments, the tubular body can have anchors that prevent migration and/or tilting.

 In one or more embodiments, the body is of a resorbable material.

 In one or more embodiments, the body is of a material that is too soft to be
15 machined.

 In one or more embodiments, the opposed ends of the body preferably include an upper end and a lower end.

 In one or more embodiments, one or more of the arms extend outwardly from the hub toward one of said ends.

20 In one or more embodiments, one or more of said arms extend from the hub upwardly toward the body upper end.

 In one or more embodiments, the body is of a polymeric material that has a durometer reading that is between 10 Shore A and 75 Shore D.

 In one or more embodiments, the body is of a polymeric material that has a
25 durometer reading that is between 35 Shore A and 75 Shore D.

 In one or more embodiments, the body is of a polymeric material that has a durometer reading that is between 10 Shore A and 40 Shore A.

 In one or more embodiments, the body and one or more filtering elements define a vena cava filter.

30 In one or more embodiments, the body and one or more filtering elements define an occlusion device.

 In one or more embodiments, the body and one or more filtering elements define

a convertible stent.

In one or more embodiments, the tubular body is of a polymeric material, has opposed filter body ends and a central longitudinal axis.

5 In one or more embodiments, the body preferably has a segmented side wall that includes multiple circumferentially spaced apart wall panels and a central bore. The body preferably includes one or more filtering elements in said bore and in between filter body ends.

10 In one or more embodiments, one or more filtering elements include a hub at a central longitudinal axis and multiple radially extending filtering arms that extend radially between the hub and the wall, wherein each arm connects to the hub and a wall panel.

In one or more embodiments, the tubular body preferably has anchors that prevent migration and/or tilting.

15 In one or more embodiments, the body and one or more filtering elements define a stent.

In one or more embodiments, each filtering arm preferably forms an acute angle with the central longitudinal axis.

20 In one or more embodiments, each filtering member/connecting member/strut/arm/appendage is connected to head/ring/annular member/hub via holes/sockets/bores and features a ball and socket connection.

In one or more embodiments, the holes through which each filtering member pass can be conically or frusto-conically shaped.

25 In one or more embodiments, each filtering member/connecting member/strut/arm/appendage has a ball and socket connection to both the central head/ring/annular member/hub and each outer wall section/panel.

In one or more embodiments, each outer wall section has a hole or socket or bore for a filter member to pass through.

30 In one or more embodiments, each hole or socket or bore on the outer wall can be open ended and can be conically or frusto-conically shaped in the same manner as the annular ring.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a further understanding of the nature, objects, and advantages of the present

invention, reference should be had to the following detailed description, read in conjunction with the following drawings, wherein like reference numerals denote like elements and wherein:

5 Figure 1 is a top view of a preferred embodiment of the apparatus of the present invention;

Figure 2 is a side, elevation view of a preferred embodiment of the apparatus of the present invention;

Figure 3 is a perspective view of a preferred embodiment of the apparatus of the present invention;

10 Figure 4 is a perspective view of a preferred embodiment of the apparatus of the present invention;

Figure 5 is a top view of a preferred embodiment of the apparatus of the present invention;

15 Figure 6 is a close up, perspective view showing the connection of the head, hub, ring or annular member with a filtering member, connecting member, strut, arm or appendage;

Figure 7 is perspective view of another preferred embodiment of the present invention; and

Figure 8 is a top view of the preferred embodiment of Figure 7.

20 DETAILED DESCRIPTION OF THE INVENTION

Figures 1-3 show a preferred embodiment of the apparatus of the present invention designated generally by the numeral 10. Vascular implant 10 includes an implant body 11 that can be of a polymeric material or polymeric resorbable material such as a bioresorbable polymer material. In this embodiment, the body 11 has a tubular shape with opposed filter body ends 34, 35 and a central longitudinal axis 14. Body 11 can be of a material that is too soft to be machined such as a durometer of below 20 Shore D. Body 11 can be of a material that has a durometer reading of between 10 Shore A and 40 Shore A. Body 11 has a head, hub, ring or annular member 12 with central opening or aperture 13. Implant body 11 has a central longitudinal axis 14 that extends generally through the center of opening 13 (see Figure 2). Head 12 could be of another shape such as circular, oval, rounded, polygonal or other shape that enables attachment of filter legs thereto.

Body 11 has a segmented side or outer wall 15 comprised of a plurality of circumferentially spaced apart wall sections or panels 16-23. The wall sections or panels 16-23 are distributed around the central longitudinal axis. The wall sections or panels 16-23 extend in this embodiment parallel to the central longitudinal axis. When placed
5 in a vessel, the outwards facing surface of the wall sections or panels 16-23 abut to the vessel and extend in a direction more or less parallel to the direction of blood-flow through the vessel. Due to the wall sections or panels 16-23, the implant can reduce the risk of damage to the vessel. In case the wall sections or panels 16-23 are of a (bio-)resorbable material, they will be resorbed into the vascular tissue after a certain period
10 of time. Panels or wall sections 16-23 can be generally rectangular in shape. Panels or wall sections 16-23 could be other shapes such as square, oval, rectangular, or provided with chamfer or fillets on corners of each of the square or rectangular shapes.

Each panel or wall section 16-23 can have a convex outer surface 32 and a concave inner surface 33, as seen in Figure 1. The concave surfaces 33 can track a
15 circular path or circle 40 as seen in Figure 1. Path 40 can also be an oval shape. Other shapes for outer wall 15 can be square or oval. The inner surfaces 33 form a central bore.

The panels 16-23 define a central bore in which one or more filtering elements extend. More specifically, these filtering elements extend in radial direction from the center of the tubular body 11 up to a respective wall section or panel 16-23 and lay in
20 axial direction between the filter body ends 34,35. Each wall section or panel 16-23 is connected to head, hub, ring or annular member 12 with a filtering member, connecting member, strut, arm or appendage 24, 25, 26, 27, 28, 29, 30 or 31 as seen in Figures 1-3. The head 12 can thus be seen as a hub at the central longitudinal axis, and the filtering members, connecting members, struts, arms or appendages 24-31 as multiple radially
25 extending filtering arms that extend radially between the hub and the segmented wall, in this embodiment from the hub up to the segmented wall. These members 24-31 act as filters that trap emboli at the downstream side of the filters, within the central bore illustrated with circle 40 in FIG. 1. Emboli can also be trapped by annular member, ring, hub, or head 12.

30 As is apparent from FIGs 2-3 for example, the members 24-31 may extend from the respective wall section or panel 16-23 upstream, in a direction of blood flow, and radially inwards to the hub 12. Thereby, the members 24-31 form a dome-shaped filter

in the bore that when placed in the vessel effectively retains blood-cloths. Head, hub, ring or annular member 12 can be located closer to the first end portion 34 than to the second end portion 35, and in this embodiment is located, in the axial direction at the first end portion 34. This provides for a large volume to retain blood clots, when the
5 implant 10 is placed in the vessel and the blood flows in the direction from second end portion 35 to first end portion 34 and reduces the risks that the flow of blood through the filter becomes obstructed.

In Figures 1-3, hub, head or annular member 12 connects to panel or wall section 16 with strut, filtering member, arm or appendage 24. Similarly, appendage 25 connects
10 panel 17 to hub or ring 12. Panel 18 connects to hub or ring 12 with member 26. Panel 19 connects to hub or ring 12 with member 27. In this fashion, panels 20, 21, 22 and 23 connect to ring 12 with members 28, 29, 30, 31 respectively.

One or more of the panels or wall sections 16-23 is preferably provided with one or more anchors. In Figures 1-3, panels 16, 18, 20 and 22 are each fitted or equipped
15 with two (2) anchors 36, 37. Filter body 11 has first end portion 34 and second end portion 35 (see Figure 2). Each anchor 36 extends toward first end 34 as seen in Figure 2. Each anchor 36 can form an acute angle with axis 14. Each anchor 37 can extend toward second end 35. Each anchor 37 can form an acute angle with axis 14. Each anchor can be provided with a sharp tip. Each anchor 36 has sharp point or tip 38. Each
20 anchor 37 has sharp point or tip 39 (see Figure 3).

Once implemented at a selected locale in a patient's vascular system (e.g., using a catheter), the anchors 36, 37 prevent migration and/or tilting of the filter body 11 in either direction (either toward end 34 or toward end 35). When of a bioresorbable material, the bioresorption starts as soon as the implant is exposed to the blood and like
25 many of the standard polymers degrades over time via polymer breakdown and absorption of the byproducts. This bioresorption can be tuned as needed to ensure the implant maintains structural filtering integrity until transient risk of pulmonary embolism has subsided. As noted, the segmented tubular wall reduces the amount of material that needs to be resorbed.

30 The implant 10 could be deployed with either a femoral or jugular approach. Such a deployment could employ a pusher or pusher apparatus/mechanism such as one specified in one or more of the patents listed in Table 1. An example is U.S. Patent No.

8,518,072 naming Jonathan Miller as inventor and assigned to C.R. Bard, Inc. Implant 10 could also be a balloon-mounted implant that is then expanded with balloon dilation, as seen, for example, in balloon expandable stents.

Filter body can be manufactured with 3D printing, such as a one piece polymeric body 11. For inferior vena cava pulmonary embolism prevention, the diameter of implant 10 can be between about 15-30 mm. For iliofemoral pulmonary embolism protection, the diameter of implant 10 can be between about 6-20 mm. For other smaller vessels for occlusion, implant 10 can have a diameter of between about 2-8 mm. The length of implant 10 can be between about 5-50 mm.

Figures 4-6 show another embodiment of the present invention designated generally by the numeral 110. Vascular implant 110 in Figures 4-5 is similar to vascular implant 10 shown in Figures 1-3 and except as noted, contains the same parts. In vascular implant 110, each filtering member/connecting member/strut/arm/appendage 124, 125, 126, 127, 128, 129, 130, and 131 is connected to head/ring/annular member/hub 112 via holes/sockets/bores 160 and features a ball 150 and socket 160 connection. The end of each filtering member/connecting member/strut/arm/appendage 124, 125, 126, 127, 128, 129, 130, and 131 contains ball 150 which prevents each filtering member from fully separating from hub 112. The hole/socket 160 through which each filtering member passes can be conically or frusto-conically shaped, as depicted in Figure 6, to allow for a change of angle of each filtering member 124-131 relative to hub 112 and accordingly, each wall section / panel 16-23. Hole/socket 160 is open ended and thus allows for each section/panel 16-23 to be pulled inward toward the annular ring 112, for example, when collapsing the vascular implant 110. The ball and socket connection or feature as shown in Figures 4-6 is preferably applicable when the body of the vascular implant is on the lower end of the durometer range, for example when the material has a hardness that is within a durometer reading of between about 10 Shore A and 40 Shore A.

In another embodiment, shown in Figures 7 and 8, each filtering member/connecting member/strut/arm/appendage 224-231 has a ball 150 and socket 160 connection to both the central head/ring/annular member/hub 212 and each outer wall section/panel 216-223. Vascular implant 210 is otherwise similar to vascular implant 110. Each outer wall section / panel 216-223 of vascular implant 223 has a hole or socket or bore 160 for the filtering member to pass through. Each hole or socket or bore 160 on

the outer wall is open ended and can be conically or frusto-conically shaped in the same manner as annular ring 112. The vascular implant of Figures 7 and 8 can be of a material that has a hardness of between 10 Shore A and 75 Shore D. When the material is on the higher end of the durometer range, for example when the material has a hardness that is within a durometer reading of between about 65 Shore A and 75 Shore D, a vascular implant with ball and socket features at both the central hub and outer walls, such as vascular implant 210 of Figures 7 and 8, is preferred. Any embodiment can be utilized when the vascular implant material is on the lower end of the durometer range, for example, between 10 Shore A and 40 Shore A. In Figures 7 and 8, the wall panels 216-223, when deployed, can move radially from hub 112 so as to engage with a vessel wall. Radial movement can be effected by balloon deployment, wedge, or inherent spring force (for example, if the filaments were attached but of sufficient elasticity to deform without breaking). Preferably, wall panels 216-223 when deployed move axially rather than radially when going from a transported to expanded configuration. Although struts 124-131 of Figures 4-5 and struts 224-231 of Figures 7-8 are shown extending through hub 112, hub 112 could alternatively be shaped so as to allow for angular motion only and not axial, of the struts. The embodiments shown which allow angular and axial motion would allow greater mobility. In Figures 7 and 8, balls 150 are shown extending outside of the plane of wall panels 216-223 in order to demonstrate that struts 224-231 can pass through the wall panels 216-223. However, when deployed and engaged with a vessel wall, the balls 150 for each strut 224-231 preferably are housed within sockets 160 of wall panels 216-225 so as to allow greater engagement of the wall panels 216, 218, 220, 222 with the vessel wall.

The vascular implant can thus be characterized by comprising:

- a) a tubular body of a polymeric material, comprising opposed filter body ends and a central longitudinal axis;
- b) said body comprising a segmented side wall that includes multiple spaced apart wall panels and that defines a central bore;
- c) said body comprising one or more filtering elements in said bore and in between filter body ends;
- d) said one or more filtering elements comprising a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially

between said hub and said wall, wherein each arm connects to said hub and a said wall panel;

e) said tubular body comprising anchors that prevent migration and/or tilting of the implant.

- 5 Without limitation, the implant may further be characterized by one or more of the following statements.

Statement 1: A vascular implant, comprising:

a) a tubular body of a polymeric material, comprising opposed filter body ends and a central longitudinal axis;

- 10 b) said body comprising a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore;

c) said body comprising one or more filtering elements in said bore and in between filter body ends;

- d) said one or more filtering elements comprising a hub at said central
15 longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel; and

e) said tubular body comprising anchors that prevent migration and/or tilting.

- 20 Statement 2: The vascular implant of statement 1 wherein the body is of a resorbable material.

Statement 3: The vascular implant of one or more of the preceding statements wherein the body is of a material that is too soft to be machined.

- Statement 4: The vascular implant of one or more of the preceding statements wherein
25 said opposed ends include an upper end and a lower end.

5: The vascular implant of one or more of the preceding statements wherein one or more of said arms extend from said hub toward one of said ends.

Statement 6: The vascular implant of statement 4 wherein one or more of said arms extend from said hub upwardly toward said upper end.

- 30 Statement 7: The vascular implant of one or more of the preceding statements wherein said polymeric material has a hardness that is a durometer reading of between about 35 Shore A and 75 Shore D.

Statement 8: The vascular implant of one or more of the preceding statements wherein said polymeric material is too soft to be machined.

Statement 9: The vascular implant of one or more of the preceding statements wherein the body and one or more filtering elements define a vena cava filter.

5 Statement 10: The vascular implant of one or more of the preceding statements wherein the body and one or more filtering elements define an occlusion device.

Statement 11: The vascular implant of one or more of the preceding statements wherein the body and one or more filtering elements define a convertible stent.

Statement 12: A vascular implant, comprising:

10 a) a tubular body of a polymeric material, comprising opposed filter body ends and a central longitudinal axis;

b) said body comprising segmented side wall that includes multiple circumferentially spaced apart wall panels and a central bore;

15 c) said body comprising one or more filtering elements in said bore and in between filter body ends;

d) said one or more filtering elements comprising a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel; and

20 e) said tubular body comprising anchors that prevent migration and/or tilting;

Statement 13: The vascular implant of statements 12 wherein the body is of a resorbable material.

25 Statement 14: The vascular implant of one or more of statements 12-13, wherein the body is of a material that is too soft to be machined.

Statement 15: The vascular implant of one or more of statements 12-14, wherein said polymeric material is too soft to be machined.

Statement 16: The vascular implant of one or more of statements 12-15, wherein the body and one or more filtering elements define a vena cava filter.

30 Statement 17: The vascular implant of one or more of statements 12-16, wherein the body and one or more filtering elements define an occlusion device.

Statement 18: The vascular implant of one or more of statements 12-17, wherein the

body and one or more filtering elements define a convertible stent.

Statement 19: The vascular implant of one or more of statements 12-18, wherein each filtering arm forms an acute angle with said central longitudinal axis.

Statement 20: A vascular implant, comprising:

- 5 a) a tubular body of a polymeric material, comprising opposed filter body ends and a central longitudinal axis;
- b) said body comprising a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore;
- c) said body comprising one or more filtering elements in said bore and in
10 between filter body ends;
- d) said one or more filtering elements comprising a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel;
- 15 e) wherein said arms are spaced circumferentially apart; and
- f) said tubular body comprising anchors that prevent migration and/or tilting.

20 The following is a list of parts and materials suitable for use in the present invention.

PARTS LIST

	<u>Part Number</u>	<u>Description</u>
	10	vascular implant
25	11	implant body/filter body
	12	head/ring/annular member/hub
	13	opening/aperture
	14	central longitudinal axis
	15	segmented wall/outer wall
30	16	wall section/panel
	17	wall section/panel
	18	wall section/panel

	19	wall section/panel
	20	wall section/panel
	21	wall section/panel
	22	wall section/panel
5	23	wall section/panel
	24	filtering member/connecting member/strut/arm/appendage
	25	filtering member/connecting member/strut/arm/appendage
10	26	filtering member/connecting member/strut/arm/appendage
	27	filtering member/connecting member/strut/arm/appendage
	28	filtering member/connecting member/strut/arm/appendage
15	29	filtering member/connecting member/strut/arm/appendage
	30	filtering member/connecting member/strut/arm/appendage
20	31	filtering member/connecting member/strut/arm/appendage
	32	convex outer surface
	33	concave inner surface
	34	first end portion
25	35	second end portion
	36	anchor
	37	anchor
	38	sharp point/tip
	39	sharp point/tip
30	40	circular path/circle
	110	vascular implant
	112	head/ring/annular member/hub

5	124	filtering member/connecting member/strut/arm/appendage
	125	filtering member/connecting member/strut/arm/appendage
	126	filtering member/connecting member/strut/arm/appendage
	127	filtering member/connecting member/strut/arm/appendage
	128	filtering member/connecting member/strut/arm/appendage
10	129	filtering member/connecting member/strut/arm/appendage
	130	filtering member/connecting member/strut/arm/appendage
	131	filtering member/connecting member/strut/arm/appendage
15	150	rounded end / ball
	160	hole / socket / conically shaped opening /
20	bore	
	210	vascular implant
	216	wall section/panel
	217	wall section/panel
	218	wall section/panel
25	219	wall section/panel
	220	wall section/panel
	221	wall section/panel
	222	wall section/panel
	223	wall section/panel
30	224	filtering member/connecting member/strut/arm/appendage
	225	filtering member/connecting member/strut/arm/appendage

	226	filtering member/connecting member/strut/arm/appendage
	227	filtering member/connecting member/strut/arm/appendage
5	228	filtering member/connecting member/strut/arm/appendage
	229	filtering member/connecting member/strut/arm/appendage
	230	filtering member/connecting member/strut/arm/appendage
10	231	filtering member/connecting member/strut/arm/appendage

15

All measurements disclosed herein are at standard temperature and pressure, at sea level on Earth, unless indicated otherwise. All materials used or intended to be used in a human being are biocompatible, unless indicated otherwise.

The foregoing embodiments are presented by way of example only; the scope of
20 the present invention is to be limited only by the following claims.

CLAIMS

1. A vascular implant, comprising:
 - a) a tubular body of a polymeric material, having opposed filter body ends and a central longitudinal axis;
 - 5 b) said body having a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore;
 - c) said body including one or more filtering elements in said bore and in between filter body ends;
 - d) said one or more filtering elements including a hub at said central
10 longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel; and
 - e) said tubular body having anchors that prevent migration and/or tilting.
2. The vascular implant of claim 1 wherein the body is of a resorbable
15 material.
3. The vascular implant of claim 1 wherein the body is of a material that is too soft to be machined.
4. The vascular implant of claim 1 wherein said opposed ends include an upper end and a lower end.
- 20 5. The vascular implant of claim 1 wherein one or more of said arms extend from said hub toward one of said ends.
6. The vascular implant of claim 4 wherein one or more of said arms extend from said hub upwardly toward said upper end.
7. The vascular implant of claim 1 wherein said polymeric material has a
25 hardness that is a durometer reading of between about 35 Shore A and 75 Shore D.
8. The vascular implant of claim 1 wherein said polymeric material is too soft to be machined.
9. The vascular implant of claim 1 wherein the body and one or more filtering elements define a vena cava filter.
- 30 10. The vascular implant of claim 1 wherein the body and one or more filtering elements define an occlusion device.
11. The vascular implant of claim 1 wherein the body and one or more

filtering elements define a convertible stent.

12. A vascular implant, comprising:
 - a) a tubular body of a polymeric material, having opposed filter body ends and a central longitudinal axis;
 - 5 b) said body having segmented side wall that includes multiple circumferentially spaced apart wall panels and a central bore;
 - c) said body including one or more filtering elements in said bore and in between filter body ends;
 - d) said one or more filtering elements including a hub at said central
10 longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel; and
 - e) said tubular body having anchors that prevent migration and/or tilting;
13. The vascular implant of claim 12 wherein the body is of a resorbable
15 material.
14. The vascular implant of claim 12 wherein the body is of a material that is too soft to be machined.
15. The vascular implant of claim 12 wherein said polymeric material is too soft to be machined.
- 20 16. The vascular implant of claim 12 wherein the body and one or more filtering elements define a vena cava filter.
17. The vascular implant of claim 12 wherein the body and one or more filtering elements define an occlusion device.
18. The vascular implant of claim 12 wherein the body and one or more
25 filtering elements define a convertible stent.
19. The vascular implant of claim 12 wherein each filtering arm forms an acute angle with said central longitudinal axis.
20. A vascular implant, comprising:
 - a) a tubular body of a polymeric material, having opposed filter body ends
30 and a central longitudinal axis;
 - b) said body having a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore;

c) said body including one or more filtering elements in said bore and in between filter body ends;

d) said one or more filtering elements including a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially
5 between said hub and said wall, wherein each arm connects to said hub and a said wall panel;

e) wherein said arms are spaced circumferentially apart; and

f) said tubular body having anchors that prevent migration and/or tilting.

21. The inventions substantially as shown and/or described herein.

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received by the International Bureau on 20 April 2023

- [Claim 1] [Currently Amended] A vascular implant, comprising:
- a) a tubular body of a polymeric material, having opposed filter body ends and a central longitudinal axis;
 - b) said body having a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore, each panel having a panel upper edge and a panel lower edge;
 - c) said body including one or more filtering elements in said bore and in between filter body ends;
 - d) said one or more filtering elements including a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and a said wall panel;
 - e) said tubular body having anchors that prevent migration and/or tilting; and
 - f) wherein each filtering element connects to a said panel in between panel upper and lower edges.
- [Claim 2] The vascular implant of claim 1 wherein the body is of a resorbable material.
- [Claim 3] The vascular implant of claim 1 wherein the body is of a material that is too soft to be machined.
- [Claim 4] The vascular implant of claim 1 wherein said opposed ends include an upper end and a lower end.
- [Claim 5] The vascular implant of claim 1 wherein one or more of said arms extend from said hub toward one of said ends.
- [Claim 6] The vascular implant of claim 4 wherein one or more of said arms extend from said hub upwardly toward said upper end.
- [Claim 7] The vascular implant of claim 1 wherein said polymeric material has a hardness that is a durometer reading of between about 35 Shore A and 75 Shore D.
- [Claim 8] The vascular implant of claim 1 wherein said polymeric material is too soft to be machined.
- [Claim 9] The vascular implant of claim 1 wherein the body and one or more filtering elements define a vena cava filter.
- [Claim 10] The vascular implant of claim 1 wherein the body and one or more filtering elements define an occlusion device.

- [Claim 11] The vascular implant of claim 1 wherein the body and one or more filtering elements define a convertible stent.
- [Claim 12] [Currently Amended] A vascular implant, comprising:
- a) a tubular body of a polymeric material, having opposed filter body ends and a central longitudinal axis;
 - b) said body having segmented side wall that includes multiple circumferentially spaced apart wall panels and a central bore, each panel having upper and lower edges;
 - c) said body including one or more filtering elements in said bore and in between filter body ends;
 - d) said one or more filtering elements including a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and to a said wall panel in between said upper and lower edges; and
 - e) said tubular body having anchors that prevent migration and/or tilting;
- [Claim 13] The vascular implant of claim 12 wherein the body is of a resorbable material.
- [Claim 14] The vascular implant of claim 12 wherein the body is of a material that is too soft to be machined.
- [Claim 15] The vascular implant of claim 12 wherein said polymeric material is too soft to be machined.
- [Claim 16] The vascular implant of claim 12 wherein the body and one or more filtering elements define a vena cava filter.
- [Claim 17] The vascular implant of claim 12 wherein the body and one or more filtering elements define an occlusion device.
- [Claim 18] The vascular implant of claim 12 wherein the body and one or more filtering elements define a convertible stent.
- [Claim 19] The vascular implant of claim 12 wherein each filtering arm forms an acute angle with said central longitudinal axis.
- [Claim 20] [Currently Amended] A vascular implant, comprising:
- a) a tubular body of a polymeric material, having opposed filter body ends and a central longitudinal axis;
 - b) said body having a generally tubular segmented side wall that includes multiple spaced apart wall panels surrounding a central open ended bore, each panel having spaced apart sides and spaced apart upper and lower edges;

- c) said body including one or more filtering elements in said bore and in between filter body ends;
- d) said one or more filtering elements including a hub at said central longitudinal axis and multiple radially extending filtering arms that extend radially between said hub and said wall, wherein each arm connects to said hub and to a said wall panel in between said upper and lower edges;
- e) wherein said arms are spaced circumferentially apart; and
- f) said tubular body having anchors that prevent migration and/or tilting.

[Claim 21]

[Cancelled]

STATEMENT UNDER ARTICLE 19 (1)

The claims have been amended to better distinguish from the prior art. No new matter has been added to the application.

FIG. 1

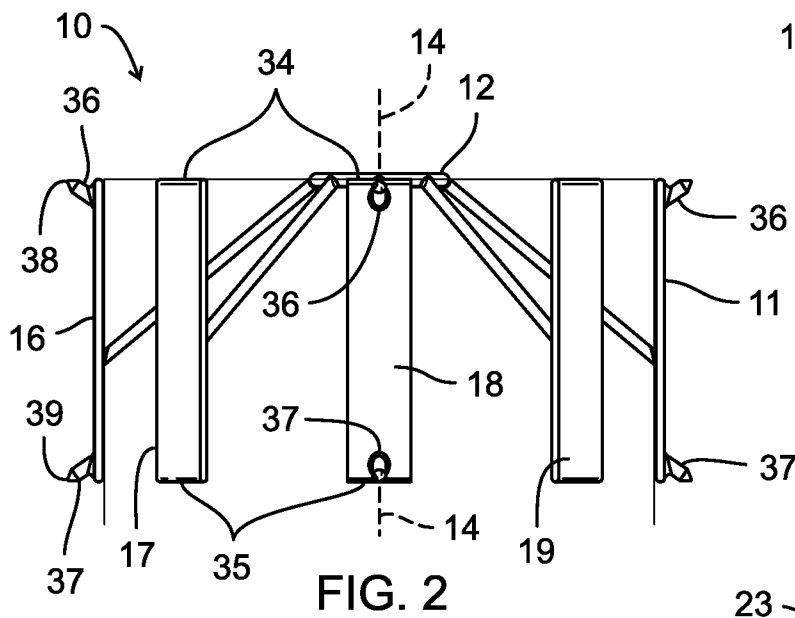
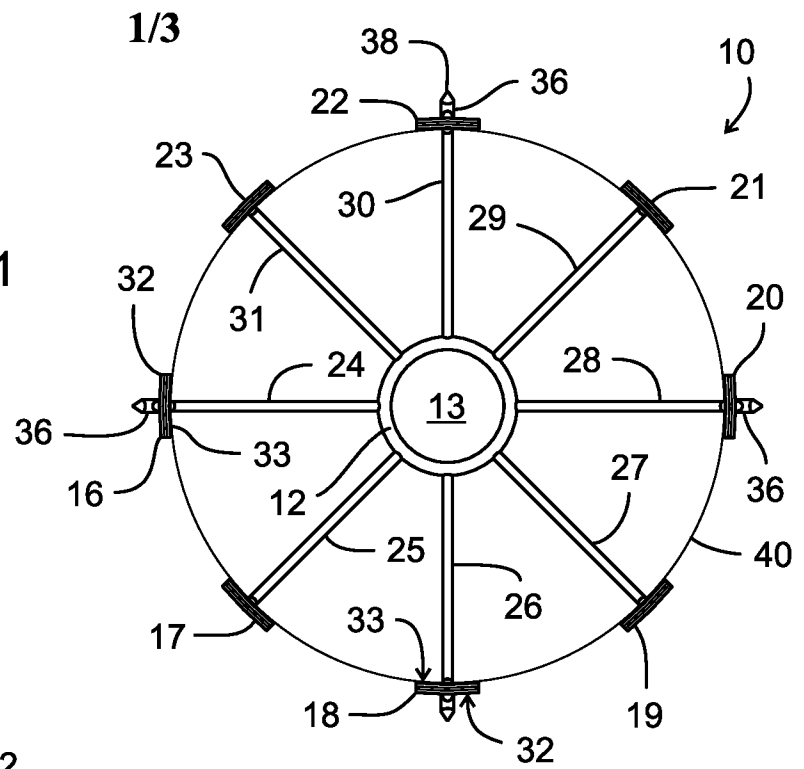


FIG. 2

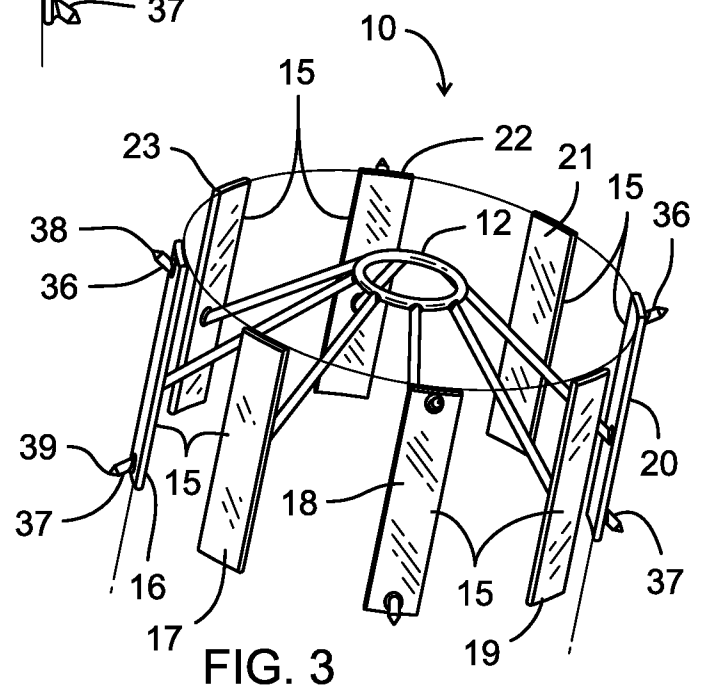


FIG. 3

2/3

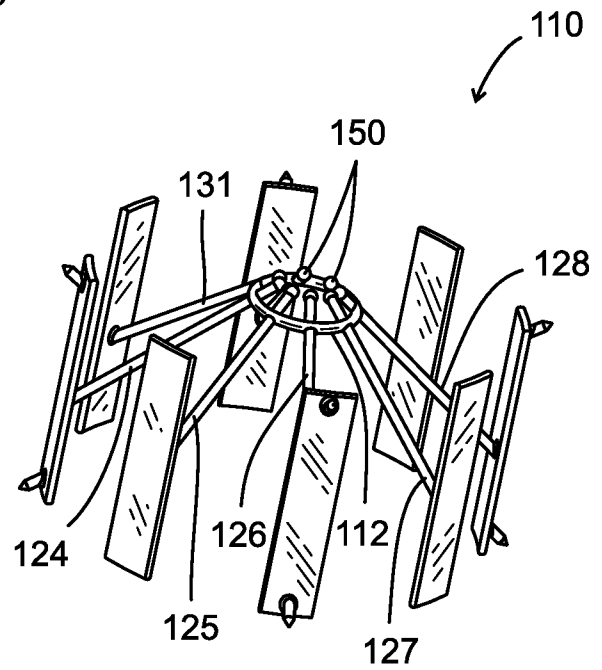


FIG. 4

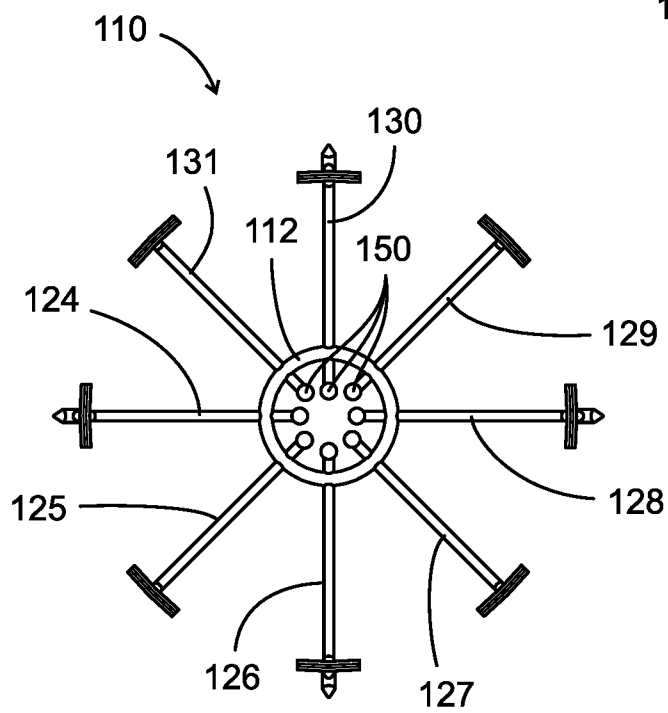


FIG. 5

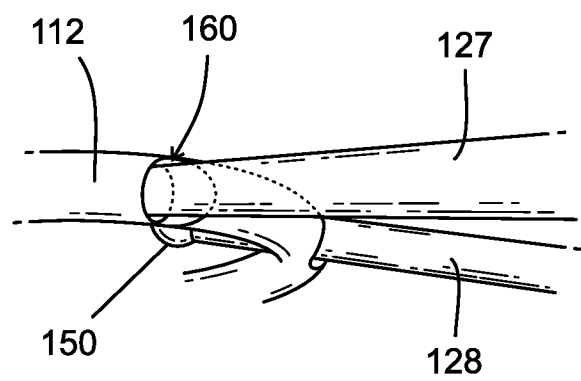


FIG. 6

3/3

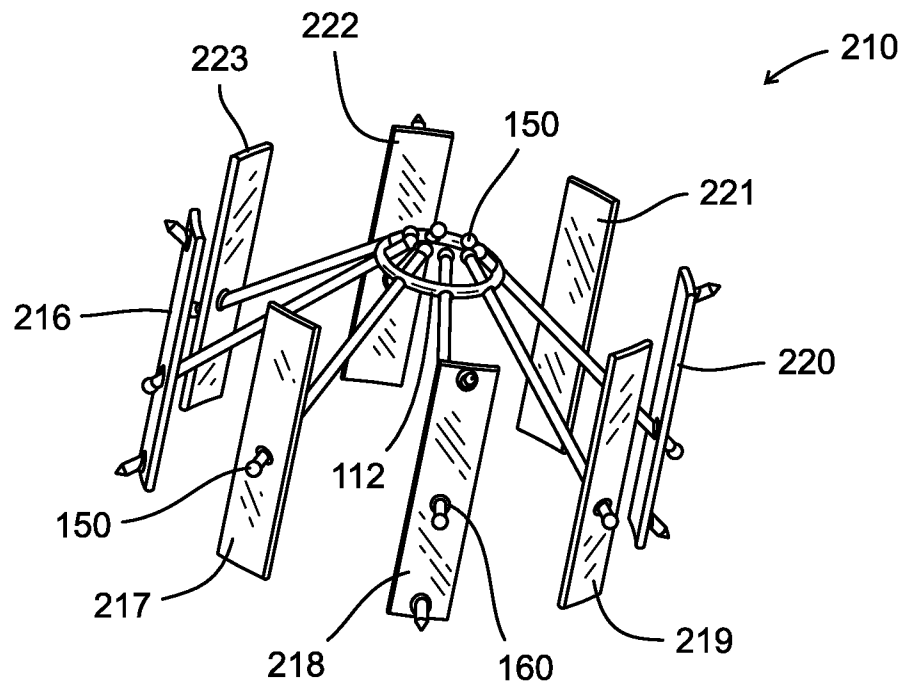


FIG. 7

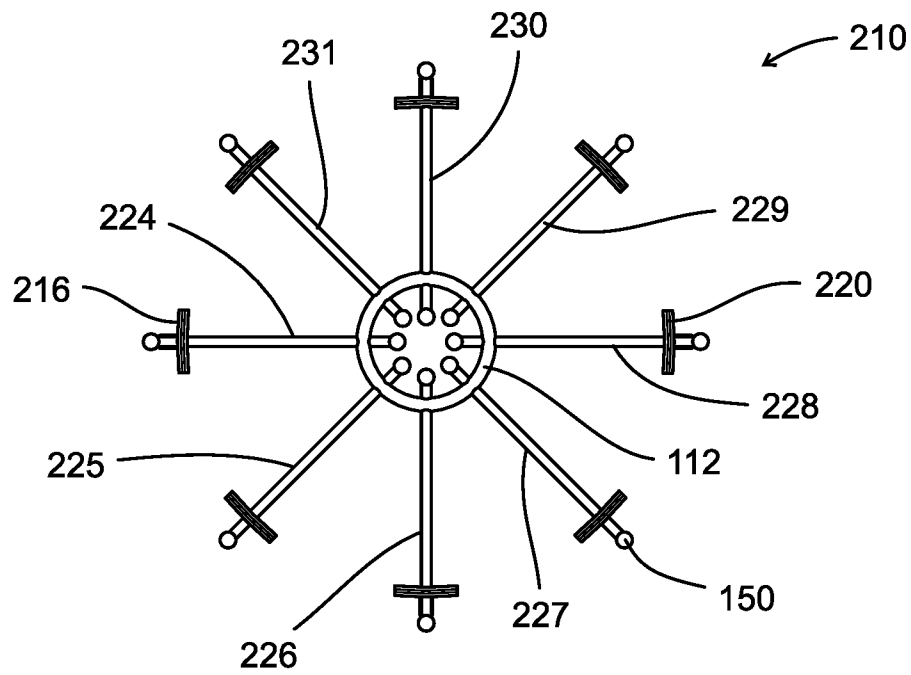


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2021/073176

A. CLASSIFICATION OF SUBJECT MATTER INV. A61F2/01 ADD.		
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 A61B B33Y		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00/66031 A1 (CONNELL PAUL T O [US]) 9 November 2000 (2000-11-09) page 13, line 25 - page 17, line 3; figures 3,4,12,19 -----	1-11
A	GB 2 513 921 A (MCCARTHY MATTHEW [GB]) 12 November 2014 (2014-11-12) the whole document -----	1-11
A	US 2008/275488 A1 (FLEMING JAMES A [US]) 6 November 2008 (2008-11-06) paragraphs [0018], [0020], [0028]; figure 6 -----	1-11
A	EP 3 158 973 A1 (COOK MEDICAL TECHNOLOGIES LLC [US]) 26 April 2017 (2017-04-26) paragraphs [0035] - [0037]; figures 1-16 -----	1-11
☐ 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 12 September 2022		Date of mailing of the international search report 20/09/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Geuer, Melanie

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2021/073176

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.: **12-21**
because they relate to subject matter not required to be searched by this Authority, namely:
see FURTHER INFORMATION sheet PCT/ISA/210
2. ☐ Claims Nos.:
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:
3. ☐ Claims Nos.:
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 additional 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 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.1

Claims Nos.: 12-21

1 The present application contains 21 claims of which 4 are independent. It contains 4 independent claims concerning a vascular implant. There is no clear distinction between the independent claims within one group because of overlapping scope. There are so many claims, and they are drafted and ordered in such a way that the claims as a whole are not in compliance with the provisions of clarity and conciseness of Article 6 PCT, as it is particularly burdensome for a skilled person to establish the subject-matter for which protection is sought. 2 There is a multitude of equally likely permutations of features providing as many fall-back positions, making it impossible to foresee to which subject-matter from the claims and the description are most likely to provide the basis for prosecution of the application. 3 Some of the most serious clarity issues are detailed further below: 3.1 Although entity claims 1, 12, 20 and 21 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT. 3.2 The claims and description are formulated to provide a multitude of permutations of features, providing as many equally likely fall-back positions, making it impossible to foresee to which subject-matter from the description and the claims are most likely to provide a basis for prosecution of the application. 4 The applicant has been informally invited to provide a clarification of the subject-matter which should be searched. The invention defined in the device claim and the invention defined in the method claim should meet the requirement of unity of invention under Rule 13 PCT. 5 Due to failure to provide a clarification, the search is limited to the subject-matter of claims 1-11 which represent the broadest claims, for the reasons mentioned above.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2021/073176

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0066031	A1	09-11-2000	AT 439099 T 15-08-2009
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		EP 1175185 A1 30-01-2002	
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		US 6517559 B1 11-02-2003	
		US 2003176888 A1 18-09-2003	
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EP 3158973	A1	26-04-2017	EP 3158973 A1 26-04-2017
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		US 2017105830 A1 20-04-2017	
