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15 May 2025 (15.05.2025)

(54) Title: **CARDIOVASCULAR SURGICAL DEVICES, SYSTEMS, AND METHODS**

(57) Abstract: A robotic surgical method for repair of an infrarenal aortic aneurysm with an aneurysm sac in an aorta of a patient includes introducing at least one arm and a camera of a robotic surgical system into designated ports of the patient. Then, a graft is attached to a proximal wall of the aorta. The aneurysm sac is decompressed by inflating an intravascular balloon and initiating flow in an arteriovenous circuit. Anterior posterior walls of the aneurysm sac are stapled and the robotic incisions are closed. A method for inserting a conduit includes deploying an intimal umbrella, partially expanding an expandable graft, deploying an adventitial umbrella, and fully inflating the expandable stent.

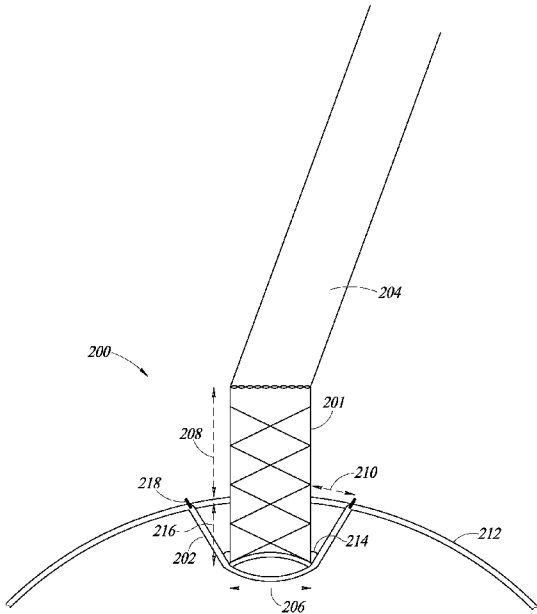


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 24/32430

A. CLASSIFICATION OF SUBJECT MATTER
 IPC - INV. A61B 34/30, A61F 2/07 (2024.01)
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CPC - INV. A61B 34/30, A61F 2/07

ADD. A61F 2/966, A61B 2034/302, A61B 2034/303, A61B 17/12109, A61F 2002/8486

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)
 See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2018/0263716 A1 (KONINKLIJKE PHILIPS N.V.) 20 September 2018 (20.09.2018), entire document	1-16
A	US 6,344,056 B1 (Dehdashtian) 05 February 2002 (05.02.2002), entire document	1-16
A	US 2007/0078506 A1 (McCormick et al.) 05 April 2007 (05.04.2007), entire document	1-16
A	US 5,211,683 A (Maginot) 18 May 1993 (18.05.1993), entire document	1-16
A	US 2005/0038502 A1 (Waysbeyn et al.) 17 February 2005 (17.02.2005), entire document	1-16
A	US 10,034,785 B1 (W.L. Gore and Associates Inc.) 31 July 2018 (31.07.2018), entire document	1-16
A	US 6,767,359 B2 (Weadock) 27 July 2004 (27.07.2004), entire document	1-16

☐ 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

"D" document cited by the applicant in the international application

"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

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 24/32430

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.:
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:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-16, directed to a robotic surgical method for repair of an infrarenal aortic aneurysm with an aneurysm sac in an aorta of a patient with a graft and an intravascular balloon.

Group II: Claims 17-35, directed to a surgical method for introduction of a suture-less conduit in an aortic wall of a patient comprising a suture less conduit, a balloon catheter, an intimal umbrella, an expandable stent, and an adventitial umbrella.

--- See Continuation Box ---

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 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.:
1-16

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.

Box III - Unity of Invention

The groups of inventions listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features:

Group I requires the special technical features of a robotic [surgical method] for repair of an infrarenal aortic aneurysm with an aneurysm sac in [an aorta of a patient], comprising: [introducing] at least one arm and a camera of a robotic surgical system [into designated incisions in the patient]; attaching a graft to a proximal [wall of the aorta]; decompressing the aneurysm sac by inflating [an intravascular balloon] and initiating flow in an arteriovenous circuit; stapling or suturing the anterior and posterior walls of the aneurysm sac; and [closing the incisions].

Group II requires the special technical features of a [surgical method] for introduction of a suture less conduit in [an aortic wall of a patient], comprising: [inserting] a suture less conduit and a balloon catheter through a sheath [in an aperture in the patient]; deploying an intimal umbrella and an expandable stent of the suture less conduit into the [aortic wall] of the patient; introducing an adventitial umbrella over the balloon catheter and deploying the adventitial umbrella; inflating the expandable stent; removing the balloon catheter; and [closing the aperture in the patient].

Common Technical Features:

Groups I and II share the technical feature of a surgical method involving an aorta of a patient, comprising: introducing components into designated incisions in the patient, a wall of the aorta, an intravascular balloon, and closing the incisions. However, these technical features are not unifying features because they are anticipated by US 5,211,683 to Maginot. Maginot teaches a surgical method involving an aorta of a patient (Figs. 3-24... method of the present invention are depicted of the implantation of a graft prosthesis to couple aorta to right common femoral artery, col 5, ln 36-39), comprising: introducing components into designated incisions in the patient (see 63 inserted into 17 and 26 inserted into an unlabeled incision to the right of 17, Fig. 15; surgical incision 17, col 6, ln 67; graft having a second end portion 63, col 8, ln 17-18; balloon tip catheter 26, col 6, ln 11), a wall of the aorta (see 62 interacting with an opening in the wall of 16, Fig. 15; graft has an outwardly extending flanged end portion 62, col 8, ln 8-9), an intravascular balloon (26 with 28, Fig. 15; balloon-tip catheter having a balloon 28 thereon, col 6, ln 11-12), and closing the incisions (see incision where 26 is inserted closed from Fig. 23 to Fig. 24; reasonably assuming all surgical incisions are closed once the surgery is complete, as is commonly known in the art). Groups I-II share no further technical features.

Accordingly, the inventions listed as Groups I-II above lack unity of invention under PCT Rule 13 because they do not share a same or corresponding special technical feature providing contribution over prior art.