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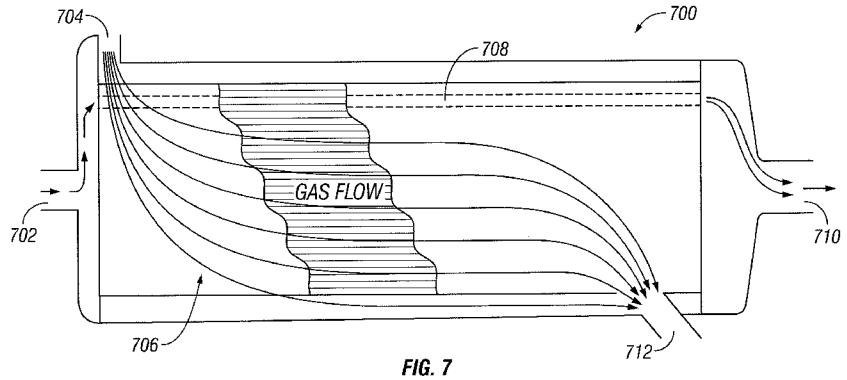


FIG. 7

(57) Abstract: According to some embodiments, a system may treat blood outside the body of a patient. The system may include one or more pumps configured to draw blood from a patient into a fluid flow path at a rate, for example, of 5-7 liters per minute. The system may include one or more heat exchangers coupled to the fluid flow path and configured to heat the blood, for example, to a temperature above 42 degrees Celsius and below 43.2 degrees Celsius.

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# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/16064

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B01D 61/24; A61M 1/14 (2015.01)
CPC - A61M 1/1698, 1/36, 1/369
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)
IPC(8): B01D 61/24, 61/26, 61/32; A61M 1/14 (2015.01); CPC: A61B 18/04, 2018/044, 2018/046; A61M 1/14, 1/16, 1/1698, 1/36, 1/369; USPC: 210/645, 646; 422/44, 46; 604/5.01, 5.04, 6.11, 6.13. 6.14, 19

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)
PatSeer (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); ProQuest; PubMed/Medline; Google/Google Scholar; Orbit. Search terms: blood, pump, buffer, cancer*, continuously, flow, convection, diffusion*, dialysis, exchange*, silane, heat, hyperthermia, liters, path, range, minute, tumor*, infection, ultrafil*, hemofiltrat*

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br>–<br>Y<br>–<br>A | US 5725776 A (KENLEY, RA et al.) March 10, 1998; abstract; figure 1; column 27, lines 2-5; column 50, lines 54-57 | 1, 2, 4-6, 9, 17, 18, 20-22, 25.<br>---<br>3, 7, 8, 10, 11, 13-16, 19, 23, 24, 26, 27, 29-36, 38-41<br>---<br>12, 28, 37, 42 |
| Y | US 2010/0198132 A1 (PESENTI, AM) August 05, 2010; paragraphs [0035], [0121]; claim 11 | 3, 7, 8, 14-16, 19, 23, 24, 30-32 |
| Y | US 6827898 B1 (FAUSSET, M et al.) December 07, 2004; column 1, lines 23-25; column 4, lines 8-9, 66-67; column 5, lines 1-4 | 10, 11, 15, 16, 26, 27, 35, 36, 40, 41 |
| Y | DE 4406106 A1 (WERTH, U Dr Med, et al.) August 31, 1995; TRANSLATION; abstract; page 4, second and third paragraphs | 13, 16, 29, 32 |
| Y | US 2001/0039441 A1 (ASH, SR) November 08, 2001; paragraph [0077] | 33, 34, 38, 39 |
| Y | US 3768977 A (BRUMFIELD, RC et al.) October 23, 1973; abstract; figure 1; column 4, lines 52-56; column 5, lines 26-30 | 11, 15, 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 |
|---|---|
| 14 June 2015 (14.06.2015) | 08 JUL 2015 |
| Name and mailing address of the ISA/<br>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-8300 | Authorized officer<br>Shane Thomas<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |

Form PCT/ISA/210 (second sheet) (January 2015)

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/16064

**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:

Group I: Claims 1-42 are directed toward a system and method comprising one or more dialysis modules coupled to the fluid flow path.

Group II: Claims 43-65 are directed toward a method for treating cancer comprising returning the blood in the fluid flow path to the human body after performing dialysis on at least a portion of the blood.

Group III: Claims 66-97 and 116-164 are directed toward a system and method comprising heat exchangers configured to heat the blood to a temperature of at least 42 degrees Celsius; and removing carbon dioxide from at least a portion of the blood.

Group IV: Claims 98-115 are directed toward a method for treating cancer comprising wherein the human body is heated to a temperature of at least 42 degrees Celsius for at least 30 minutes.

-***-Continued Within the Next Supplemental 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.:
1-42

**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/US15/16064

***Continuation of Box No. III - Observations where unity of invention is lacking:***

The inventions listed as Groups I-IV 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: the special technical features of Group I include one or more dialysis modules coupled to the fluid flow path, which are not present in Groups II-IV; the special technical features of Group II include returning the blood in the fluid flow path to the human body after performing dialysis on at least a portion of the blood, which are not present in Groups I and III-IV; the special technical features of Group III include one or more heat exchangers coupled to the fluid flow path and configured to heat the blood to a temperature of at least 42 degrees Celsius; one or more venting modules coupled to the fluid flow path, the one or more venting modules configured to remove carbon dioxide from at least a portion of the blood, which are not present in Groups I-II and IV; the special technical features of Group IV include wherein the human body is heated to a temperature of at least 42 degrees Celsius for at least 30 minutes, which are not present in Groups I-III.

The common technical features of Groups I-IV are pumping/removing blood from the human body into a fluid flow path at a rate of at least 4 liters per minute.

These common technical features are disclosed by US 5,730,720 A to Sites, et al. (hereinafter 'Sites'). Sites discloses pumping/removing blood from the human body into a fluid flow path at a rate of at least 4 liters per minute (blood-flow rates of between 2 and 4.5 liters per minute though ECC 300; figure 2A; column 40, lines 3-4).

Since the common technical features are previously disclosed by the Sites reference, the common features are not special and so Groups I-IV lack unity.

The additional common technical features of Groups I and II are performing dialysis on at least a portion of the blood at a rate of at least 0.5 liters per minute.

These common technical features are disclosed by US 4,695,385 A (BOAG). Boag discloses performing dialysis on at least a portion of the blood at a rate of at least 0.5 liters per minute (the dialysis machine M flow rate is preset at 500 milliliters per minute (at least 0.5 liters per minute); column 15, lines 65-67).

Since the common technical features are previously disclosed by the Boag reference, the common features are not special and so Groups I and II lack unity.

The additional common technical features of Groups I and IV are returning the blood to the human body.

These common technical features are disclosed by the Sites reference. Sites discloses returning the blood to the human body (a further length of blood tubing 302 is coupled for returning the blood to the patient; figures 2A-B; column 8, lines 35-37).

Since the common technical features are previously disclosed by the Sites reference, the common features are not special and so Groups I and IV lack unity.

The additional common technical features of Groups III and IV are heating at least a portion of the blood to a temperature of at least 42 degrees Celsius.

These common technical features are disclosed by the Sites reference. Sites discloses heating at least a portion of the blood to a temperature of at least 42 degrees Celsius (stabilize patient 99's temperature at a treatment temperature of 43.5 degrees Celsius; figure 5B; column 18, lines 9-13).

Since the common technical features are previously disclosed by the Sites reference, the common features are not special and so Groups III and IV lack unity.

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/16064

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | FORSTER, C et al. "Low-flow CO2 removal integrated into a renal-replacement circuit can reduce acidosis and decrease vasopressor requirements", Critical Care 2013, 17:R154; page 1, results [ downloaded from internet: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4056563/pdf/cc12833.pdf on June 20, 2015 ] | 27, 36, 41 |
| Y | US 5730720 A (SITES, JP et al.) March 24, 1998; figure 2B, 5B, 9; column 8, lines 55-62; column 18, lines 9-13 | 31, 32 |
| A | REHYDRATION PROJECT, "Unit 5 – Treatment of Dehydrated Patients Medical Education: Teaching Medical Students about Diarrhoeal Diseases", Meded, August 2, 2013; pages, 4, 5; Dowloaded from internet via Internet Archive: <https://web.archive.org/web/20140129091451/http://www.rehydrate.org/diarrhoea/tmsdd/5med.htm> | 12, 28, 37, 42 |