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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 April 2023 (27.04.2023)

WIPO | PCT

(10) International Publication Number
WO 2023/065026 A1

(51) International Patent Classification:
H01M 8/04276 (2016.01) *H01M 8/18* (2006.01)
B63H 21/17 (2006.01) *H01M 8/2455* (2016.01)
B63H 21/38 (2006.01) *H01M 8/2465* (2016.01)

(21) International Application Number:
PCT/CA2022/051537

(22) International Filing Date:
19 October 2022 (19.10.2022)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/262,717 19 October 2021 (19.10.2021) US

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(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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

WO 2023/065026 A1

(54) Title: SYSTEM FOR REPLENISHING AN ON-BOARD POWER SOURCE FOR A PROPULSION SYSTEM ON A VEHICLE SUCH AS A WATERCRAFT AND PROCESS

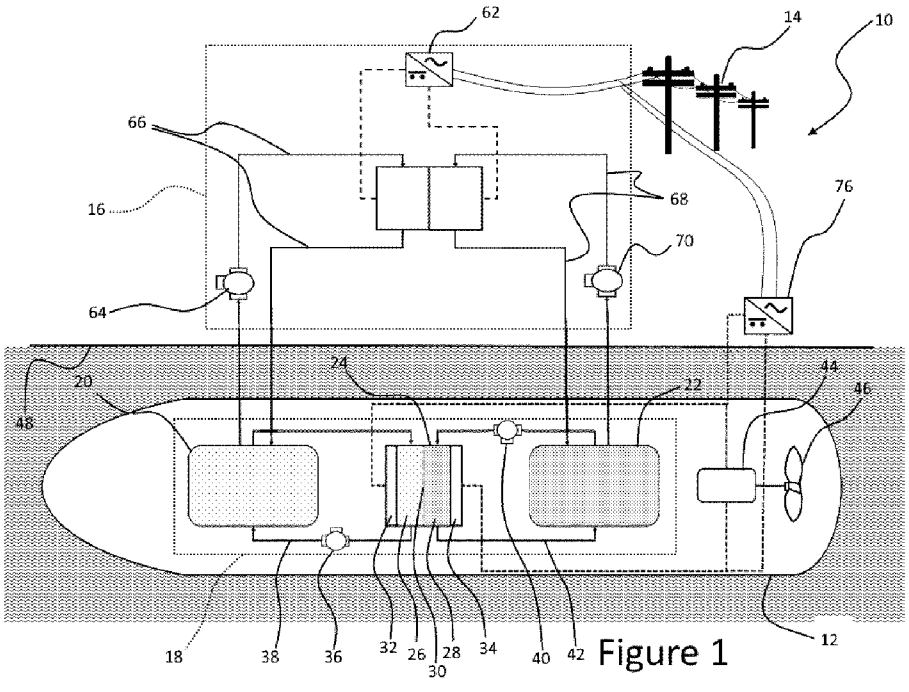


Figure 1

(57) Abstract: A system and a process for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft are disclosed herein. The power source comprises a first reservoir holding an anolyte and a second reservoir holding a catholyte. The system comprises a shoreside source of DC electricity; a shoreside series of one or more interconnected stacks; and a hydraulic circuit for circulating the anolyte and catholyte. In embodiments wherein two or more shoreside interconnected stacks are used, the stacks may be hydraulically connected in series or in parallel, and electrically connected in a parallel arrangement.

[Continued on next page]

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

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

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

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

TITLE

SYSTEM FOR REPLENISHING AN ON-BOARD POWER SOURCE FOR A PROPULSION SYSTEM ON A VEHICLE SUCH AS A WATERCRAFT AND PROCESS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application 63/262,717, filed October 19, 2021. The contents of the referenced application are incorporated into the present application by reference.

BACKGROUND

1. Field

[0002] This disclosure relates to a system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft and process.

2. Related Art

[0003] Re-chargeable batteries provide an attractive option for powering vehicles such as watercraft and trains or the like, provided they can hold enough energy to sustain typical motor loads between charges. In particular, redox flow batteries are seen as one solution since they present the feature of power/energy independent sizing making them easier to scale and to locate in a vehicle's hold.

[0004] Watercraft such as ocean bound vessels equipped with large tanks of electrolyte and a redox flow battery for powering an electric motor driving a propellor or the like have been disclosed. One drawback of these watercraft is that once depleted, the electrolyte is replaced by fresh, fully charged electrolyte, typically by pumping the depleted electrolyte out of the tanks and subsequently pumping the fresh charged electrolyte into the tanks. As the onboard stored electrolyte in some degree acts as ballast, this may lead to the watercraft becoming unstable or lead to significant differences in the height of the watercraft above the water line. This can be dangerous in the event, for example, that the electrolyte replenishment process needs to be terminated prior to completion, leaving the watercraft with reduced electrolyte volume and thus ballast. A further drawback of this replenishment process is that it requires the provision of large onshore tanks, to both hold the depleted electrolyte that is pumped out of the watercraft and the fresh, fully charged electrolyte to be pumped into the watercraft. These onshore tanks occupy significant amounts of space, in essence doubling the volume of the tanks that are present on the watercraft itself. Yet a further drawback of this replenishment process is that the redox flow battery on board the watercraft is unable to produce power during the

replenishment process because the tanks must be completely emptied of depleted electrolyte prior to the transfer of fresh, fully charged electrolyte.

SUMMARY

[0005] The present disclosure broadly relates to a system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft and process.

[0006] In an aspect, the present disclosure relates to a system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the system comprising: a shoreside source of DC electricity, a shoreside series of one or more interconnected stacks, each stack comprising at least one cell divided into a first half-cell compartment and a second half-cell compartment by a porous or ion selective membrane through which ions flow during a redox reaction, the at least one cell comprising a pair of electrodes, a first one of the electrodes in the first half-cell compartment and a second one of the electrodes in the second half-cell compartment; and a hydraulic circuit for circulating the anolyte from the first reservoir into the first half-cell compartment of the at least one cell and back into the reservoir tank and for circulating the catholyte from the second reservoir into the second half-cell compartment of the at least one cell and back into the second reservoir; wherein applying power from the source of DC electricity between the electrodes while operating the hydraulic circuit charges the anolyte and the catholyte.

[0007] In an embodiment of the present disclosure, the hydraulic circuit comprises at least one pump for circulating the anolyte from the first reservoir into each of the first half-cell compartment and back into the reservoir tank and for circulating the catholyte from the second reservoir into each of the second half-cell compartment and back into the second reservoir.

[0008] In an embodiment of the present disclosure, each of the stacks of the shoreside series of one or more interconnected stacks comprise at least two cells; each of the cells comprises two half-cell compartments separated by a porous or ion selective membrane; each of the half-cell compartments comprises an electrode. The cells in the one or more interconnected stacks are electrically connected in series, and the electrolyte flows in parallel through each of the cells; anolyte in one of the half-cell compartments and catholyte in the other of the half-cell compartments. In a further embodiment of the present disclosure, the system may comprise at least two stacks hydraulically connected in a series arrangement and electrically connected in a parallel arrangement.

[0009] In an embodiment of the present disclosure, the application of current from the DC

power source between the electrodes while operating the hydraulic pumping circuit charges the anolyte and the catholyte, whereas connecting an electrical load between the electrodes while operating the hydraulic pumping circuit discharges the anolyte and catholyte.

[0010] In an aspect, the present disclosure relates to a process for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the process comprising: pumping the anolyte out of the first reservoir and the catholyte out of the second reservoir into a shoreside series of one or more interconnected stacks, each stack comprising at least one cell comprising a pair of half-cell compartments separated from each other by a porous or ion selective membrane through which ions flow during a redox reaction; applying a current between a first electrode in a first of the half-cell compartments and a second electrode in a second of the half-cell compartments; and returning the anolyte to the first reservoir and the catholyte to the second reservoir.

[0011] In an embodiment of the present disclosure, the pumping of the anolyte out of the first reservoir and the catholyte out of the second reservoir into a shoreside series of one or more interconnected stacks is done simultaneously.

[0012] In an embodiment of the present disclosure, the shoreside series of one or more interconnected stacks may be electrically connected to the DC power source in a parallel arrangement. In this embodiment, the electrolyte (*i.e.*, anolyte and catholyte) flows from the watercraft into the shoreside series of one or more interconnected stacks, wherein the stacks are connected hydraulically in a series arrangement, such that the electrolyte flows from stack to stack sequentially. In this arrangement, the analyte and catholyte exit one stack and then enter the next stack of the series of interconnected stacks. When the analyte and catholyte exit the last of the series of interconnected stacks, the then charged electrolyte may be returned to their respective reservoirs on board the watercraft using the hydrolytic circuit. An advantage of this type of charging arrangement is that the electrolyte is being gradually charged when flowing from stack to stack. A further advantage of this type of charging arrangement is that the total volume of electrolyte flowing between the shoreside series of one or more interconnected stacks and the respective reservoirs on board the watercraft is limited, resulting in a more energy efficient pumping process relative to a configuration wherein the stacks are connected hydraulically in a parallel arrangement.

[0013] In an embodiment of the present disclosure, the shoreside series of one or more interconnected stacks may be electrically connected to the DC power source in a parallel arrangement. In this embodiment, the electrolyte (*i.e.*, anolyte and catholyte) flows from the

watercraft into the shoreside series of one or more interconnected stacks, wherein the stacks are connected hydraulically in a parallel arrangement, such that the electrolyte flows in parallel through the respective stacks before being returned to their respective reservoirs on board the watercraft using the hydrolytic circuit.

[0014] Also disclosed in the context of the present disclosure are embodiments 1 to 8. Embodiment 1 is a system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the system comprising: a shoreside source of DC electricity; a shoreside series of one or more interconnected stacks, each stack comprising at least one cell divided into a first half-cell compartment and a second half-cell compartment by a porous or ion selective membrane through which ions flow during a redox reaction, the at least one cell comprising a pair of electrodes, a first one of the electrodes in the first half-cell compartment and a second one of the electrodes in the second half-cell compartment; and a hydraulic circuit for circulating the anolyte from the first reservoir into the first half-cell compartment of the at least one cell and back into the reservoir tank and for circulating the catholyte from the second reservoir into the second half-cell compartment of the at least one cell and back into the second reservoir; wherein applying power from the source of DC electricity between the electrodes while operating the hydraulic circuit charges the anolyte and the catholyte. Embodiment 2 is the system of system 1, wherein the system comprises at least two shoreside interconnected stacks. Embodiment 3 is the system of embodiment 2, wherein the at least two shoreside interconnected stacks are hydraulically connected in a series arrangement and electrically connected in a parallel arrangement. Embodiment 4 is the system of embodiment 2, wherein the at least two shoreside interconnected stacks are hydraulically connected in a parallel arrangement and electrically connected in a parallel arrangement.

[0015] Embodiment 5 is a process for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the process comprising: pumping the anolyte out of the first reservoir and the catholyte out of the second reservoir into a shoreside series of one or more interconnected stacks, each stack comprising at least one cell comprising a pair of half-cell compartments separated from each other by a porous or ion selective membrane through which ions flow during a redox reaction; applying a current between a first electrode in a first of the half-cell compartments and a second electrode in a second of the half-cell compartments; and returning the anolyte to the first reservoir and the catholyte to the second reservoir. Embodiment 6 is the process of embodiment 5, wherein

the process comprises at least two shoreside interconnected stacks. Embodiment 7 is the process of embodiment 6, wherein the at least two shoreside interconnected stacks are hydraulically connected in a series arrangement and electrically connected in a parallel arrangement. Embodiment 8 is the process of embodiment 6, wherein the at least two shoreside interconnected stacks are hydraulically connected in a parallel arrangement and electrically connected in a parallel arrangement.

[0016] The word “a” or “an” when used in conjunction with the term “comprising” in the claims and/or the specification may mean “one”, but it is also consistent with the meaning of “one or more”, “at least one”, and “one or more than one” unless the content clearly dictates otherwise. Similarly, the word “another” may mean at least a second or more unless the content clearly dictates otherwise.

[0017] As used in this specification and claim(s), the words “comprising” (and any form of comprising, such as “comprise” and “comprises”), “having” (and any form of having, such as “have” and “has”), “including” (and any form of including, such as “include” and “includes”) or “containing” (and any form of containing, such as “contain” and “contains”), are inclusive or open-ended and do not exclude additional, unrecited elements or process steps.

[0018] As used in this specification and claim(s), the word “consisting” and its derivatives, are intended to be close ended terms that specify the presence of stated features, elements, components, groups, integers, and/or steps, and also exclude the presence of other unstated features, elements, components, groups, integers and/or steps.

[0019] The term “consisting essentially of”, as used herein, is intended to specify the presence of the stated features, elements, components, groups, integers, and/or steps as well as those that do not materially affect the basic and novel characteristic(s) of these features, elements, components, groups, integers, and/or steps.

[0020] The terms “about”, “substantially” and “approximately” as used herein mean a reasonable amount of deviation of the modified term such that the end result is not significantly changed. These terms of degree should be construed as including a deviation of at least ±5% of the modified term if this deviation would not negate the meaning of the word it modifies.

[0021] The foregoing and other advantages and features of the present disclosure will become more apparent upon reading of the following non-restrictive detailed description of illustrative embodiments thereof, with reference to the accompanying drawings/figures. It should be understood, however, that the detailed description and the illustrative embodiments, while indicating specific embodiments of the disclosure, are given by way of illustration only,

since various changes and modifications within the spirit and scope of the disclosure will become apparent to those skilled in the art from this description.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

[0022] The following figures/drawings form part of the present specification and are included to further demonstrate certain aspects of the present specification. The present specification may be better understood by reference to one or more of these figures/drawings in combination with the detailed description. In the appended drawings/figures:

[0023] **FIG. 1** illustrates a schematic diagram of a system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft in accordance with an illustrative embodiment of the present invention; and

[0024] **FIG. 2** illustrates a schematic diagram of a shoreside stack comprising a series of interconnected stacks in accordance with an illustrative embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0025] With reference to **FIG. 1**, a propulsion system for watercraft, generally referred to using the reference numeral **10**, will now be described. The system can be separated into a movable part consisting of the vessel **12** and its associated subsystems and a fixed part, typically located on land, and comprising a power source **14**, such as a windmill farm, solar panels, hydroelectric power, or the like, and a shoreside electrolyte replenishment facility **16**.

[0026] Still with reference to **FIG. 1**, the vessel **12** illustratively comprises a redox flow battery **18**. As known in the art, energy in the form of charged electrolyte for the redox flow battery **18**, may be contained in at least two (2) separated reservoirs, or tanks, **20**, **22**. A first reservoir **20** may contain the catholyte (*i.e.*, an electrolyte comprising redox ions which are in an oxidized state and are to be reduced during the discharge process or oxidized during the charge process), and a second reservoir **22** that may contain the anolyte (*i.e.*, an electrolyte comprising redox ions which are in a reduced state and are to be oxidized during the discharge process or reduced during the charge process). Additionally, the redox flow battery **18** comprises at least one flow cell or stack **24**, each such stack comprising a pair of half-cell compartments **26** and **28**, separated by a porous or ion selective membrane **30** through which ions flow during the redox reaction. Furthermore, the redox flow battery **18** comprises a pair of electrodes **32**, **34**. In an embodiment of the present disclosure, the electrodes may be carbon electrodes or the like. A first of the electrodes **32** is positioned within the first half-cell **26** and a second of the electrodes **34** is positioned within the second half-cell **28**.

[0027] Still with reference to **FIG. 1**, in operation charged electrolyte is circulated from the first reservoir **20** through the first half-cell compartment **26** under control of a first pump **36** and first hydraulic circuit **38**, and from the second reservoir **22** through the second half-cell compartment **28** under control of a second pump **40** and second hydraulic circuit **42**. When a load, such as a motor **44** connected to propellor **46** or the like, is connected between the electrodes **32** and **34**, circulation of charged electrolyte creates a current flow via the porous or ion selective membrane **30** and between the electrodes **32** and **34**. The current is supplied, for example, to the electric motor **44** on board the vessel **12** and which illustratively drives the propellor **46**. Additionally, other loads such as onboard systems (not shown) can be fed with the output of the redox flow battery **18**, such as lights, control equipment and the like (all not shown).

[0028] Still with reference to **FIG. 1**, once the energy provided by the electrolyte is depleted, the replenishing of the electrolyte may be performed while the vessel **12** is moored, for example at a dock **48**, outfitted with an electrolyte replenishment facility **16**.

[0029] With reference to **FIGs. 1** and **2**, the electrolyte replenishment facility **16** may comprise one or more stacks **50**. If more than one stack **50** is provided, the stacks may either be in a series arrangement or in a parallel arrangement. In embodiments where two or more stacks are hydrolytically connected in a series arrangement, the electrolyte flows from stack to stack sequentially. In this arrangement, the analyte and catholyte exit one stack and then enter the next stack of the series of interconnected stacks. Each stack may comprise one or more cells and their associated half-cell compartments. The electrolyte flows in parallel through the stack's one or more cells and associated half-cell compartments **52** and **54**, separated by a porous or ion selective membrane **56**. Moreover, each cell comprises a pair of electrodes **58** and **60**. A first of the electrodes **58** is held within each first half-cell compartment **52** and a second of the electrodes **60** is held within each second half-cell compartment **54**. Current supplied by a power source **14** may be conditioned, for example by *inter alia* converting a supplied AC to DC at a desired voltage range using a power converter **62** and supplied to the electrodes **58** and **60**.

[0030] Still with reference to **FIGs. 1** and **2**, depleted electrolyte (*e.g.*, catholyte) may be circulated out of the first reservoir **20** via a first hydraulic circuit **64** illustratively using a first circulating pump **66** into one or more of the first half-cell compartments **52**. Similarly, depleted electrolyte (*e.g.*, anolyte) may be circulated out of the second reservoir **22** via a second hydraulic circuit **68** illustratively using a second circulating pump **70** and into one or more of the second half-cell compartments **54**. During circulation, current from the power converter **62** may be supplied to the electrodes **58** and **60** of each of the stack(s) **50**, through which depleted

electrolyte (catholyte and anolyte) is being circulated, thereby replenishing both the catholyte and anolyte. The replenished electrolyte (catholyte and anolyte) may subsequently be circulated back to their respective reservoirs **20** and **22** via their respective hydraulic circuits **64** and **68**.

[0031] Still with reference to **FIGs. 1** and **2**, in an embodiment of the present disclosure, during the replenishment process the voltage across the electrodes **58** and **60** may be metered. The charging is completed once the metered voltage matches a desired voltage, indicating that the electrolyte in the system has been replenished to a desired state of charge. In embodiments where only a partial replenishment of the electrolyte is desired, a metered voltage corresponding to a desired partial charging may be determined.

[0032] Still with reference to **FIGs. 1** and **2**, in an embodiment of the present disclosure, the redox flow battery **18** on board the vessel **12** may be operated during the replenishment process, for example to provide energy to operate onboard systems and the like.

[0033] Still with reference to **FIGs. 1** and **2**, in an embodiment of the present disclosure, external power may additionally be supplied from a power source **14** directly to the vessel **12**, for example, via a second power convertor **76** or the like. The provision of external power to the vessel **12** allows the redox flow battery **18** on board the vessel **12** to contribute to the replenishment process.

[0034] While the present disclosure has been described with reference to specific embodiments, it is to be understood that the disclosure is not limited to the disclosed embodiments. To the contrary, the disclosure is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

CLAIMS

1. A system for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the system comprising:

a shoreside source of DC electricity;

a shoreside series of one or more interconnected stacks, each stack comprising at least one cell divided into a first half-cell compartment and a second half-cell compartment by a porous or ion selective membrane through which ions flow during a redox reaction, the at least one cell comprising a pair of electrodes, a first one of the electrodes in the first half-cell compartment and a second one of the electrodes in the second half-cell compartment; and

a hydraulic circuit for circulating the anolyte from the first reservoir into the first half-cell compartment of the at least one cell and back into the reservoir tank and for circulating the catholyte from the second reservoir into the second half-cell compartment of the at least one cell and back into the second reservoir;

wherein applying power from the source of DC electricity between the electrodes while operating the hydraulic circuit charges the anolyte and the catholyte.

2. The system of claim **1**, wherein the system comprises at least two shoreside interconnected stacks.

3. The system of claim **2**, wherein the at least two shoreside interconnected stacks are hydraulically connected in a series arrangement and electrically connected in a parallel arrangement.

4. The system of claim **2**, wherein the at least two shoreside interconnected stacks are hydraulically connected in a parallel arrangement and electrically connected in a parallel arrangement.

5. A process for replenishing an on-board power source for a propulsion system on a vehicle such as a watercraft, the power source comprising a first reservoir holding an anolyte and a second reservoir holding a catholyte, the process comprising:

pumping the anolyte out of the first reservoir and the catholyte out of the second reservoir into a shoreside series of one or more interconnected stacks, each stack comprising at least one cell comprising a pair of half-cell compartments separated from each other by a porous or ion selective membrane through which ions flow during a redox reaction;

applying a current between a first electrode in a first of the half-cell compartments and a second electrode in a second of the half-cell compartments; and

returning the anolyte to the first reservoir and the catholyte to the second reservoir.

6. The process of claim **5**, wherein the process comprises at least two shoreside interconnected stacks.

7. The process of claim **6**, wherein the at least two shoreside interconnected stacks are hydraulically connected in a series arrangement and electrically connected in a parallel arrangement.

8. The process of claim **6**, wherein the at least two shoreside interconnected stacks are hydraulically connected in a parallel arrangement and electrically connected in a parallel arrangement.

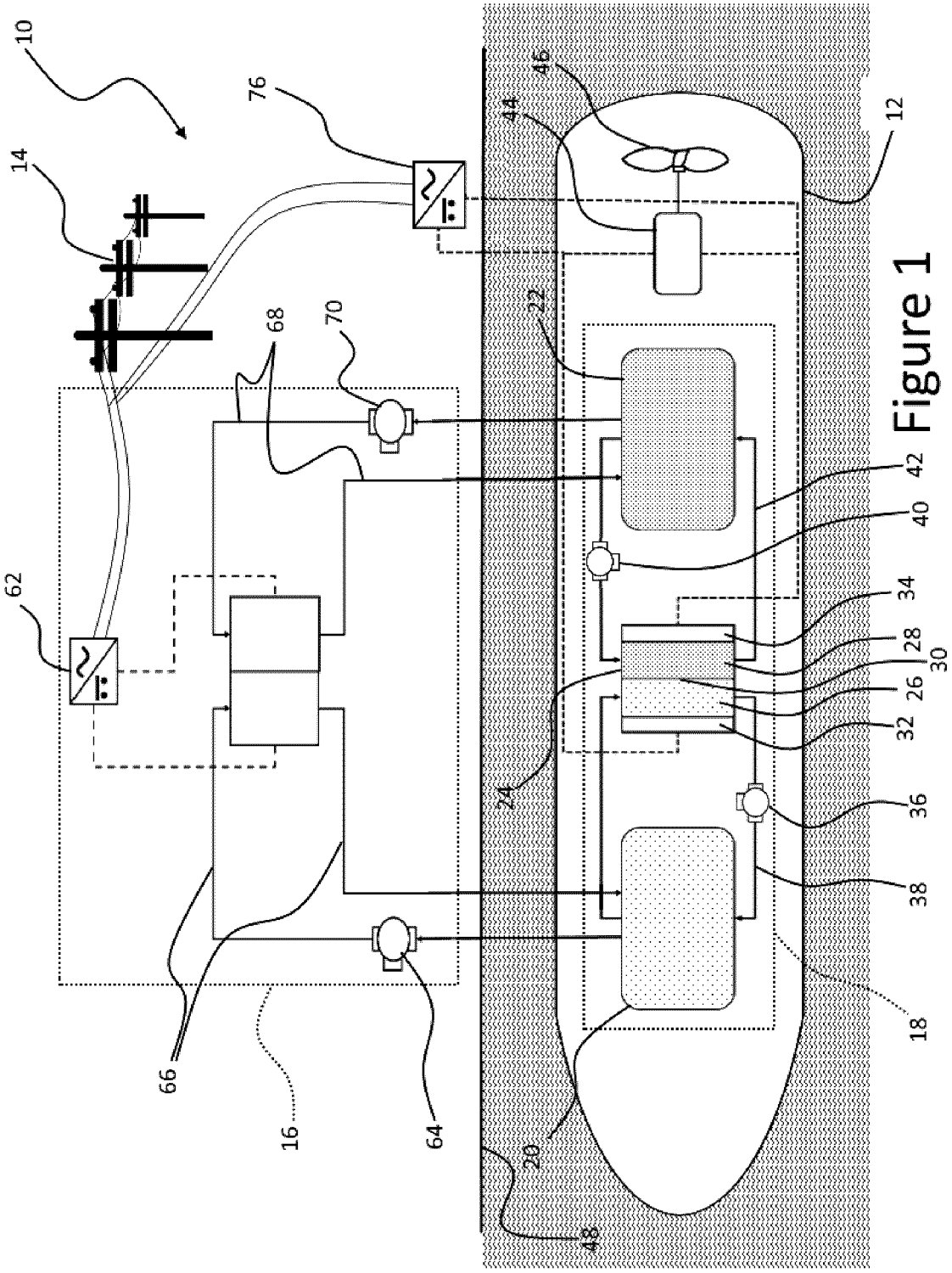

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Figure 1

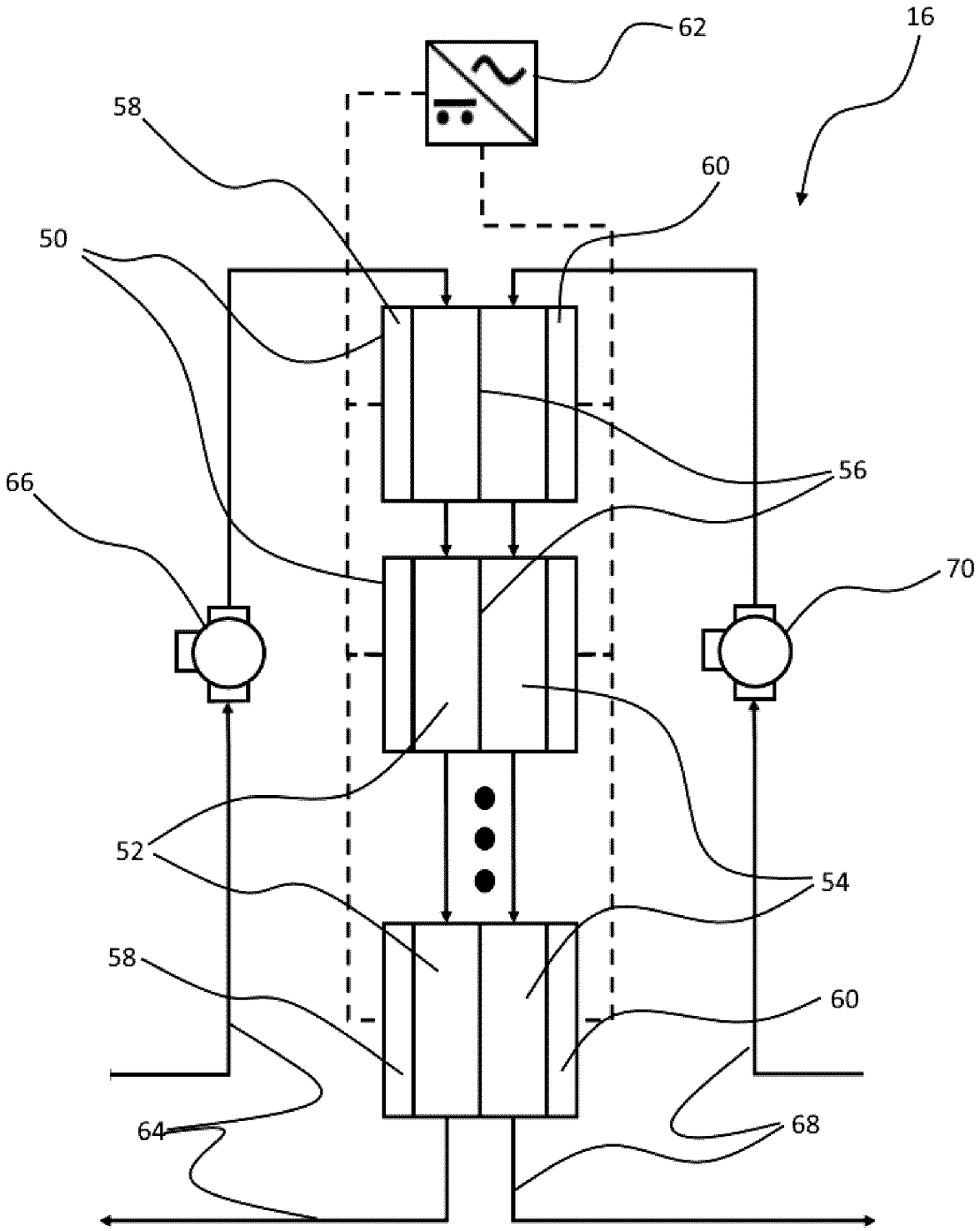


Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2022/051537

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***H01M 8/04276*** (2016.01), ***B63H 21/17*** (2006.01), ***B63H 21/38*** (2006.01), ***H01M 8/18*** (2006.01), ***H01M 8/2455*** (2016.01), ***H01M 8/2465*** (2016.01)

CPC: **H01M 8/04276** (2020.01), B63H 21/17 (2020.02), B63H 21/38 (2020.01), H01M 8/188 (2020.01), H01M 8/2455 (2020.01), H01M 8/2465 (2022.02)

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/CPC: H01M; B63H

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
QUESTEL-ORBIT (FAMPAT); GOOGLE; CANADIAN PATENT DATABASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Yoo S, Aguerrevere J, Jeong J, Jung W, Chang D. Hybrid marine propulsion power system with the redox flow batteries of comprehensive aging model. International Journal of Naval Architecture and Ocean Engineering. September 2021;13:674-690. https://doi:10.1016/j.ijnaoe.2021.08.006	
A	Sánchez-Díez E(1), Ferret R(1), Ventosa E(2,3), et al. Redox flow batteries: Status and perspective towards sustainable stationary energy storage. Journal of Power Sources. 2020;481. https://doi:10.1016/j.jpowsour.2020.228804	
A	US 2018/0366758 Al; FINKELSTEIN; 20 December 2018 (20-12-2018) Whole document	

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

*	Special categories of cited documents:	"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
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"D"	document cited by the applicant in the international application	"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
"E"	earlier application or patent but published on or after the international filing date	"&"	document member of the same patent family
"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		

Date of the actual completion of the international search 18 November 2022 (18-11-2022)	Date of mailing of the international search report 27 January 2023 (27-01-2023)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 819-953-2476	Authorized officer David Chamberlain (819) 639-8437

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2019/0322189 Al; ALLISON ET AL.; 24 October 2019 (24-11-2019) Whole document	
A	US 2005/0158615 A1; SAMUEL ET AL.; 21 July 2005 (21-07-2005) Whole document	
A	US 2008/0292964 A1; KAZACOS ET AL.; 27 November 2008 (27-11-2008) Whole document	
A	US 2020/0075985 Al; KOCHERGINSKY; 5 March 2020 (05-03-2020) Whole document	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2022/051537

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
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