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(54) Title: ELECTROLYTIC CELL FOR HEATING ELECTROLYTE BY A GLOW PLASMA FIELD IN THE ELECTROLYTE

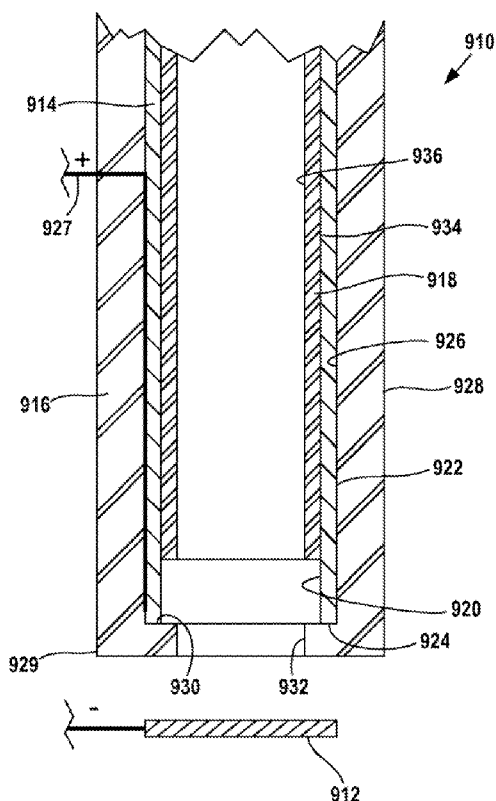


FIG. 16

(57) Abstract: An electrolytic cell for the generation of a plasma field in an electrolyte that heats the electrolyte forms part of a closed-loop heat transfer device, the electrolytic cell fluidly connected to a heat exchanger. A plasma electrode and a second electrode form part of the flow path of electrolyte from the tank to the heat exchanger. The electrolyte must flow through or along the electrodes when flowing from the tank to the heat exchanger.





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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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Declarations under Rule 4.17:

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

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/35579

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C25C 7/00 (2015.01)

CPC - C25B 9/06; C25D 17/02; C25F 7/00

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) - C25C 7/00 (2015.01)

CPC - C25B 9/06; C25D 17/02; C25F 7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 204/274, 204/242Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Patents, Google Scholar (without patents), Google (NLP), ProQuest Dialog (NLP)
Search term: electrolytic cell, plasma, electrolyte, tubular body, insulator, electrode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0145540 A1 (Hoffman et al.) 14 June 2012 (14.06.2012) para[0009]; para[0011]; para[0041]; para[0042]; para[0043]; para[0046]; para[0047]; para[0055]; para[0059]; para[0060]; para[0061]; para[0067]; para[0090]; para[0091]; para[0093]; para[0094]; para[0099]; Fig. 1; Fig. 4; Fig. 5; Fig. 13	1-13
A	US 2011/259757 A1 (Vancina et al.) 27 October 2011 (27.10.2011) entire document	1-13
A	WO 2011/002569 A1 (HEC Group LLC) 06 January 2011 (06.01.2011) entire document	1-13
A	US 2009/109141 A1 (Murase et al.) 30 April 2009 (30.04.2009) entire document	1-13
A	US 2011/048960 A1 (Sankaran et al.) 03 March 2011 (03.03.2011) entire document	1-13
A	US 2006/060464 A1 (Chang) 23 March 2006 (23.03.2006) entire document	1-13

☐ Further documents are listed in the continuation of Box C.

* 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

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/35579

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 examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-13, drawn to an electrolytic cell for the generation of a plasma field on an active surface of a plasma electrode in an electrolyte

Group II: Claims 14-20, drawn to a closed-loop heat transfer device comprising: a heat exchanger and an electrolytic cell

The inventions listed as Groups I, and II 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

-----please see continuation in 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.:
1-13

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.

In continuation of Box No. IV Lack of unity of invention:

Group I does not require a closed-loop heat transfer device comprising: a heat exchanger, an electrolytic cell, the electrolytic cell including a tank containing a liquid electrolyte, a first flow path extending from the electrolyte in the tank to the heat exchanger, and a second flow path extending from the heat exchanger to the electrolyte, as required by Group II

Group II does not require an electrolytic cell for the generation of a plasma field on an active surface of a plasma electrode in an electrolyte, the electrolytic cell comprising a first tubular body immersed in the electrolyte, a plasma electrode immersed in the electrolyte, a second electrode immersed in the electrolyte spaced from the plasma electrode, a power supply, and a circuit extending from the plasma electrode and the second electrode to the power supply and electrically connecting the plasma electrode, the second electrode, and the power supply; the plasma electrode being a tubular body comprising an inner wall defining an opening extending through the body and comprising a first end, the first end having a surface facing the second electrode, as required by group I

Shared Common Features

The only feature shared by Groups I, and II that would otherwise unify the groups is a plasma field on an active surface of a plasma electrode in an electrolyte, the electrolytic cell comprising: a vessel containing a liquid electrolyte, a first electrode and a second electrode, each electrode immersed in the electrolyte, a power supply, and a circuit electrically connecting the power supply with the plasma electrode. However, this shared technical feature does not represent a contribution over prior art, because the shared technical feature is anticipated by US 2012/145540 A1 to Hoffman et al. (hereafter 'Hoffman'). Hoffman discloses an electrolytic cell for the generation of a plasma field on an active surface of a plasma electrode in an electrolyte (para[0009]; The invention is an improved electrolytic cell to generate a plasma field in an electrolyte.), the electrolytic cell comprising: a vessel containing a liquid electrolyte (para[0041]; Electrolytic cell 10 generates a plasma field in an aqueous electrolyte 12 held in a vessel or tank 14.), a first tubular body (para[0091]; The cathode 712 and the anode 716 are mechanically supported by a tubular insulating body 720 formed preferably from virgin PTFE insulation (brand name TEFLON).) immersed in the electrolyte (Fig. 13; Fig. 14; Note: 710 includes tubular body 720 in Fig. 13 are immersed in electrolyte as shown in Fig. 14.), a plasma electrode immersed in the electrolyte (para[0042]; The plasma electrode is a cathode 16 immersed in the electrolyte 12.), a second electrode immersed in the electrolyte spaced from the plasma electrode (para[0042]; The anode 20 is shown partially immersed in the electrolyte 12), a power supply(para[0043]; A power supply 22), and a circuit extending from the plasma electrode and the second electrode to the power supply and electrically connecting the plasma electrode, the second electrode, and the power supply(para[0060]; circuit between the power supply 216 and the rod 218; Fig. 4; Note: Figure 4 shows a circuit connecting plasma electrode (cathode 212), the second electrode (anode 222) and the power supply (216)); the plasma electrode being a tubular body comprising an inner wall defining an opening extending through the body and comprising a first end, the first end having a surface facing the second electrode (para[0055]; The inner tube wall 122; para[0046]; The cathode 16 includes.....rods 28 each extend upwardly from the plate 30 to an upper free end having an end surface 32.), at least a portion of the inner wall being disposed in contact with the electrolyte (para[0047]; The end surfaces 32, however, are wetted by the electrolyte 12 and each forms a portion of the active electrode surface 18.); the first tubular body being an electrical insulator (para[0091]; a tubular insulating body 720 formed preferably from virgin PTFE insulation) and comprising an inner wall defining an opening through the first tubular body(para[0055]; The inner tube wall 122 is spaced from the rod 116 and defines an annular space or chamber 124 between the rod and tube), at least a portion of the inner wall of the first tubular body being disposed in contact with the electrolyte(para[0011]; The insulation covers all but the end of the rod immersed in the electrolyte.); the plasma electrode being in contact with the first tubular body; the said at least a portion of the inner wall of the first tubular body being adjacent to the said at least a portion of the inner wall of the plasma electrode (Fig. 1; plasma electrode (cathode 16); tubular body (insulator 34)) wherein the said wall portions cooperatively define a flow path extending there through that is surrounded by said wall portions(para[0096]; The electrolyte flowing through the cell bore 722; Fig. 13; Note: wall portion define the cell bore 722).

As the technical features were known in the art at the time of the invention, this cannot be considered a special technical feature that would otherwise unify the groups.

Groups I, and II therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.