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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))*

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

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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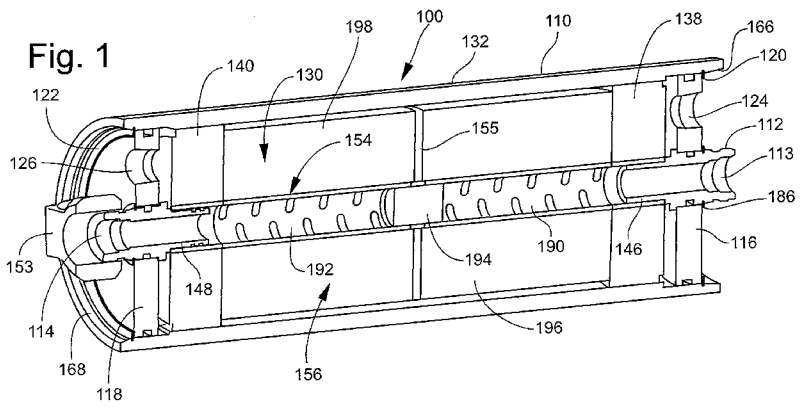
14 June 2012

(54) Title: LIQUID DEGASSING MEMBRANE CONTACTORS, COMPONENTS, SYSTEMS AND RELATED METHODS

Fig. 1



(57) Abstract: Contactors, modules, components, systems, and/or methods of manufacture, and/or methods of use including degassing liquids. The contactor or module is integrally potted, has planar, disc shaped end caps, and a cylindrical housing or shell receiving and supporting membrane structure. Each of the planar disc shaped end caps has a central opening therein adapted to receive a liquid end port or nozzle, another opening therein adapted to receive a gas end port or threaded pipe, and is held in place in the housing or shell by at least one retaining element such as a retaining or locking ring. The integrally potted membrane structure is potted in place in the housing or shell by an inverted potting process involving the use of a removable plunger or plug to recess the potting.

WO 2012/050870 A3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/53625

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B01D 53/22 (2012.01)
USPC - 95/46; 96/6
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 53/22 (2012.01)
USPC- 95/46; 96/6

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Patents and NPL (classification, keyword; search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWest (US Pat, PgPub, EPO, JPO), GoogleScholar (PL, NPL), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL); search terms: degas, liquid, fluid, hollow, lumen, fiber, fibre, membrane, filter, yarn, cylinder, tube, tubular, housing, shell, chamber, pot, disc, disk, annular, ring, circular, circle, end, cap, casing, skirt, recess, indent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0084720 A1 (DANNENMAIER et al.) 02 April 2009 (02.04.2009), Figs. 1, 11; para [0011]-[0014], [0067], [0071], [0110], [0111]	1-17
Y	US 2007/0144716 A1 (DOH et al.) 28 June 2007 (28.06.2007), Figs. 1A, 7A, 7B, 7C; para [0006], [0033]-[0042], [0051], [0063], [0069], [0084]	1-8, 17
Y	US 5,352,361 A (PRASAD et al.) 04 October 1994 (04.10.1994), Fig. 1; col 2, ln 46 to col 3, ln 28; col 6, ln 26-44; col 9, ln 12-38; col 15, ln 6-30	9-16
Y	US 2009/0301967 A1 (TAYLOR, et al.) 10 December 1999 (10.12.1999), para [0015], [0016], [0072]	1-16
Y	US 6,224,763 B1 (FENG et al.) 01 May 2001 (01.05.2001), col 2, ln 50-61; col 5, ln 16-34; col 7, ln 7-33	16, 17
Y	US 5,922,201 A (YAMAMORI et al.) 13 July 1999 (13.07.1999), Figs. 8, 9, 16; col 3-7	9-16
Y	US 5,366,625 A (PEDERSEN et al.) 22 November 1994 (22.11.1994), Figs. 1-11; col 7-18	17
Y	JP 62-250908 A (TAKAYUKI et al.) 31 October 1987 (31.10.1987), English Abstract only	1-9
Y	US 4,636,307 A (INOUE et al.) 13 January 1987 (13.01.1987), Figs. 5, 10; col 3-11	1-9
Y	US 4,207,192 A (COPLAN et al.) 10 June 1980 (10.06.1980), Figs. 1-15; col 2-15	1-16

☐ 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	Date of mailing of the international search report
04 April 2012 (04.04.2012)	20 APR 2012
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/53625

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:

-- Please see Extra Sheet --

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.:

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

International application No.
PCT/US 11/53625

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

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 1-8 directed to a liquid degassing membrane contactor or module, comprising:
a cylindrical housing or shell made of a length of modified pipe,
at least one integrally potted hollow fiber membrane structure in said cylindrical housing with the ends of said membrane structure recessed in said housing a recess of at least 1" from each end, and
respective disc shaped end caps adapted to be received in each open end of said housing.

Group II: claims 9-16 directed to a spiral-type hollow fiber membrane fabric-containing module or contactor, comprising:
a module housing made of a modified section of pipe;
a pair of end caps adapted to fit in the ends of said module housing;
liquid end ports in each of said end caps;
at least one gas port in at least one of said end caps or in the side of said module housing near one end thereof;
at least one membrane structure adapted to fit in said module housing, each membrane structure comprising:
a. a plurality of hollow fiber membranes each having a lumen, said membranes being formed into a fabric-like array in which the hollow fibers substantially are mutually parallel and constitute the fabric weft, and are held in spaced-apart relationship by filaments constituting the fabric warp;
b. the array being wound upon an axis which is substantially parallel to the hollow fibers into a spirally-wound membrane bundle having two bundle ends and a cylindrical exterior surface;
c. each of the two bundle ends being potted in resinous potting material serving to seal the bundle end into an adjacent monolithic tube sheet, a portion of the bundle between the two tube sheets being free from potting material to form a shell-side region, and the lumen ends of the hollow fibers constituting a first one of the bundle ends being exposed and communicating with the exterior of the bundle;
d. *the module shell, casing or housing having first and second housing ends and a cylindrical housing interior and being suitably shaped* to contain the membrane bundle, the tube sheet (potting) recessed relative to the first housing end sealing the first bundle end to the cylindrical housing interior, said module housing which contains the bundle defining two regions mutually communicating through the membrane including
(i) a shell-side space exterior to the portion of the bundle between the tube sheets and within
the housing, and (ii) a lumen-side space including the hollow fiber lumens and the first
bundle end;
wherein an interior face of a first of said end caps and an interior of said module housing adjacent the first tube sheet, together with the cylindrical housing interior and the first bundle end, seal a first module housing end and define a first chamber communicating with the membrane lumens;
wherein an interior face of a second of said end caps and an interior of said module housing adjacent a second tube sheet recessed from the second housing end, together with the cylindrical housing interior and a second bundle end, seal a second module housing end and define a second chamber communicating with the membrane lumens;
said liquid ends ports being operatively connected to the shell-side space of the membrane structure, and arranged to permit fluid injection and withdrawal there through; and
the at least one gas port communicating with at least one of the first and second chambers, and arranged to permit gas injection and withdrawal there through.

Group III: claim 17 directed to an integrally potted hollow fiber membrane contactor comprising:
planar, disc shaped end caps,
a high pressure cylindrical housing receiving and supporting a membrane element including a perforated core, a plurality of hollow fiber membranes, a tube sheet affixing each end of the hollow fibers and adhering to the interior of the housing,
each of the planar disc shaped end caps having a central opening therein adapted to receive a liquid end port, another opening therein adapted to receive a gas end port, and is adapted to be held in place in the cylindrical housing by at least one retaining element such as a retaining ring received in a groove in the interior of the cylindrical housing,
the integrally potted membrane structure is potted in place in the housing by an inverted potting process involving the use of a removable plunger to provide recessed potting and by trimming the end of the potting and opening the ends of the hollow fibers using an internal lathe means (which can preferably reach into the housing to trim the recessed potting or tube sheet), and
the housing including a larger diameter section for receiving the end cap, the groove for receiving the retaining ring, and a flared entrance for facilitating the insertion of the end cap and retaining ring.

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 technical features for the following reasons:

Groups II and III do not include the membrane structure recessed in said housing a recess of at least 1" from each end, as reqired by group I.

Groups I and III do not include the spirally-wound membrane bundle nor the extesive details of the spirally-wound membrane in the cylindrical pipe, as reqired by group II.

Groups I and II do not include the potting process, as reqired by group Iii.

The common features of groups I and II are taught by US 2009/0301967 A1 to Taylor et al. (10 December 2009) as follows :
a housing made of a length of modified pipe (para [0015]),
at least one integrally potted hollow fiber membrane structure in said cylindrical housing (para [0016]), and
end caps adapted to be received in each open end of said housing (para [0072]).

-- *Please see Extra Sheet* --

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/53625

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

The common features of groups II and III are taught by US 6,224,763 B1 to Feng et al. (1 May 2001) as follows:
potted hollow fiber membrane contactor (col 5, ln 16-34) comprising:
end caps (col 2, ln 50-54),
a plurality of hollow fiber membranes, a tube sheet affixing each end of the hollow fibers (col 5, ln 16-34);
a gas port; and a liquid port (col 2, ln 54-61; col 7, ln 7-33); therefore the common feature is not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.