

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference P2585PC01	FOR FURTHER ACTION		See item 4 below
International application No. PCT/US2019/061843	International filing date (<i>day/month/year</i>) 15 November 2019 (15.11.2019)	Priority date (<i>day/month/year</i>) 19 November 2018 (19.11.2018)	
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237			
Applicant BAKER HUGHES, A GE COMPANY, LLC			

1.	This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 <i>bis</i> . I(a).																								
2.	This REPORT consists of a total of 9 sheets, including this cover sheet.																								
In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.																									
3.	This report contains indications relating to the following items: <table style="width: 100%; border: none;"> <tr> <td style="width: 10%; text-align: center;">☒</td> <td style="width: 30%;">Box No. I</td> <td style="width: 80%;">Basis of the report</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td style="text-align: center;">☒</td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td style="text-align: center;">☐</td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td style="text-align: center;">☒</td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table>	☒	Box No. I	Basis of the report	☐	Box No. II	Priority	☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	☐	Box No. IV	Lack of unity of invention	☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	☐	Box No. VI	Certain documents cited	☐	Box No. VII	Certain defects in the international application	☒	Box No. VIII	Certain observations on the international application
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☒	Box No. VIII	Certain observations on the international application																							
4.	The International Bureau will communicate this report to designated Offices in accordance with Rules 44 <i>bis</i> .3(c) and 93 <i>bis</i> .1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44 <i>bis</i> .2).																								

	Date of issuance of this report 25 May 2021 (25.05.2021)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Agnès Wittmann-Regis e-mail pct.team6@wipo.int

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year)

30 MAR 2020

Applicant's or agent's file reference
P2585PC01

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US 19/61843

International filing date (day/month/year)

15 November 2019 (15.11.2019)

Priority date (day/month/year)

19 November 2018 (19.11.2018)

International Patent Classification (IPC) or both national classification and IPC

IPC - F04D 17/08, F04D 29/04, F04D 29/046, F04D 29/047, F04D 29/06 (2020.01)

CPC - F04D 29/0465, F04D 29/047, F04D 29/061, F05B 2240/52, F05C 2203/08, F04D 29/0462, F04D 29/628, F04D 13/086, F04D 29/606

Applicant

BAKER HUGHES, A GE COMPANY, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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. 571-273-8300

Date of completion of this opinion

19 FEBRUARY 2020

Authorized officer

Lee Young

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

- ☒ the international application in the language in which it was filed.
☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(b)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-4, 6, 9-16, and 18 lacks an inventive step under PCT Article 33(3) as being obvious over US 5,779,434 A to DE LONG.

Regarding claim 1, DE LONG discloses a surface pumping system (Fig.2; col 1, ln 66-67, "Referring to FIG. 2, the surface booster pump assembly of this invention includes a centrifugal pump 11") comprising:

a motor (19, Fig.2; col 2, ln 4-5, "Shaft 17 is coupled to a conventional electrical motor 19, which rotates shaft 17 to drive pump 11"); and a pump (11, 13, Fig.2) driven by the motor (19, Fig.2), wherein the pump (11, 13, Fig.2) comprises:

an inlet (31, Fig.1A) on a first end of the pump (11, 13, Fig.2 -- see the right end of the pump);

an outlet (11, Fig.2 -- see the left end of pump 11) on a second end of the pump (11, 13, Fig.2 -- see the left end of the pump), wherein the suction end (31, Fig.1A) is between the outlet (Fig.2 -- see the left end of pump 11) and the motor (19, Fig.2);

a plurality of stages (81, 83, Fig.1B; col 3, ln 22-23, "pump 11 is conventional. It contains a large number of stages, each having an

impeller 81 and a diffuser 83") between the outlet (11, Fig.2 -- see the left end of pump 11) and the inlet (31, Fig.1A), wherein each of the plurality of stages (81, 83, Fig.1B) comprises:

an impeller (81, Fig.1B); and

a diffuser (83, Fig.1B) that encases the impeller (81, Fig.1B), wherein each diffuser (83, Fig.1B) is an independent pressure vessel (Fig.1B -- see how each diffuser 83 is an independent pressure vessel),

but does not specifically teach a discharge on a first end of the pump; a suction end on a second end of the pump, wherein the discharge is between the suction end and the motor. It is known that reversal of components is an ordinary skill in the art. Accordingly, it would have been obvious to one of ordinary skill in the art to have rotated the pump 180 degrees and attach the opposite shaft end to the motor shaft and to have added a nozzle to the outlet to direct flow to one side to accommodate the shaft to the motor as desired by the user.

Regarding claim 2, the modified DE LONG discloses the surface pumping system of claim 1, wherein the surface pumping system (Fig.2) further comprises a shaft assembly (17, Fig.2) and wherein the shaft assembly (17, Fig.2) is driven by the motor (19, Fig.2) and wherein impeller (81, Fig.1B) of the plurality of stages (81, 83, Fig.1B) is connected to the shaft assembly (17, Fig.2; col 3, ln 25-26, "motor 19 will rotate shaft 17 to drive pump 11. Thrust created by impellers 81 transfers to shaft 17").

Regarding claim 3, the modified DE LONG discloses the surface pumping system of claim 1, wherein the diffuser (83, Fig.1B) of each stage does not include a separate housing around the diffuser (83, Fig.1B -- see how the each diffuser 83 does not includes their own separate housing).

Regarding claim 4, the modified DE LONG discloses the surface pumping system of claim 1, wherein at least one of the plurality of stages (81, 83, Fig.1B) is configured as a mixed flow stage (Fig.1B -- see how the plurality of stages are mixed flow stages).

Regarding claim 6, the modified DE LONG discloses the surface pumping system of claim 1, wherein the plurality of stages (81, 83, Fig.1B; col 3, ln 22-23, "pump 11 is conventional. It contains a large number of stages, each having an impeller 81 and a diffuser 83") comprises a first stage (Fig.1B -- see the left impeller and diffuser), a second stage (Fig.1B -- see the middle impeller and diffuser) and a third stage (Fig.1B -- see the right impeller and diffuser).

-*- See Supplemental Box -*-

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Regarding the specification and drawings it is noted that diffuser 118 and impeller 120, referred to, e.g., in paras [0017]-[0018] of the specification, do not appear to be present in the drawings, or at least are not called out by reference numeral in the drawings.

Claims 4: Regarding claim 4, the claim language is confusing and lacks clarity. Specifically the recitation "mixed flow" fails to particularly point out and distinctly claim the structure of the invention. The broadest interpretation of "mixed flow" would be flow that is part axial and part radial. Accordingly, for purposes of this opinion, the structure required for the claim language has been interpreted to be consistent with the broadest interpretation.

Claims 16: Regarding claim 16, the claim language is confusing and lacks clarity. Specifically the recitation "mixed flow" fails to particularly point out and distinctly claim the structure of the invention. The broadest interpretation of "mixed flow" would be flow that is part axial and part radial. Accordingly, for purposes of this opinion, the structure required for the claim language has been interpreted to be consistent with the broadest interpretation.

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

-*- Box V.2 - Citations and Explanations -*-

Regarding claim 9, DE LONG discloses a surface pumping system (Fig.2; col 1, ln 66-67, "Referring to FIG. 2, the surface booster pump assembly of this invention includes a centrifugal pump 11") comprising:
a motor (19, Fig.2; col 2, ln 4-5, "Shaft 17 is coupled to a conventional electrical motor 19, which rotates shaft 17 to drive pump 11"); and
a pump (11, 13, Fig.2) driven by the motor (19, Fig.2), wherein the pump (11, 13, Fig.2) comprises:
an inlet (13, 31, Fig.1A) on a first end of the pump (11, 13, Fig.2 -- see the right end of the pump);
an outlet (11, Fig.2 -- see the left end of pump 11) on a second end of the pump (11, 13, Fig.2 -- see the left end of the pump);
a plurality of stages (81, 83, Fig.1B; col 3, ln 22-23, "pump 11 is conventional. It contains a large number of stages, each having an impeller 81 and a diffuser 83") between the outlet (11, Fig.2 -- see the left end of pump 11) and the inlet (13, 31, Fig.1A), wherein each of the plurality of stages (81, 83, Fig.1B) comprises:
an impeller (81, Fig.1B); and
a diffuser (83, Fig.1B) that encases the impeller (81, Fig.1B), wherein each diffuser (83, Fig.1B) is an independent pressure vessel (Fig.1B -- see how each diffuser 83 is an independent pressure vessel),
but does not specifically teach a discharge on a first end of the pump; a suction end on a second end of the pump, wherein the discharge is between the suction end and the motor. It is known that reversal of components is an ordinary skill in the art. Accordingly, it would have been obvious to one of ordinary skill in the art to have rotated the pump 180 degrees and attach the opposite shaft end to the motor shaft and to have added a nozzle to the outlet to direct flow to one side to accommodate the shaft to the motor as desired by the user.

Regarding claim 10, the modified DE LONG discloses the surface pumping system of claim 9, wherein the discharge (13, 31, Fig.1A) is between the suction end (Fig.2 -- see the left end of pump 11) and the motor (19, Fig.2).

Regarding claim 11, the modified DE LONG discloses the surface pumping system of claim 9, wherein the pump further comprises a shaft seal module (69, Fig.1A; col 2, ln 56-61, "A conventional mechanical seal 69 locates at the rearward side of seal housing 65 for sealing around shaft 17 where it passes through seal housing 65. Mechanical seal 69 may be of a rotary face type, having ceramic bearing surfaces and biased by a spring") connected to the discharge of the pump (13, 31, Fig.1A -- see how the shaft seal 69 is attached to the discharge 13, 31 by shaft 17 and thrust chamber 15, 65).

Regarding claim 12, the modified DE LONG discloses the surface pumping system of claim 11, wherein the surface pumping system (Fig.2) further comprises a thrust chamber (15, 65, Fig.1A; col 2, ln 2-3, "A thrust chamber 15 bolts to the rearward end of intake chamber 13") between the motor (19, Fig.2) and the pump (11, 13, Fig.2) and wherein the shaft seal module (69, Fig.1A) is connected between the discharge of the pump (13, 31, Fig.1A) and the thrust chamber (15, 65, Fig.1A -- see how the shaft seal 69 is between the right side of the thrust chamber 65 and the discharge 13, 31).

-*- See Supplemental Box -*-

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

- Box V.2 - Citations and Explanations -

Regarding claim 13, DE LONG discloses a surface pumping system (Fig.2; col 1, In 66-67, "Referring to FIG. 2, the surface booster pump assembly of this invention includes a centrifugal pump 11") comprising:
a frame (20, 21, Fig.2; col 2, In 7-9, "Pump 11 is rigidly clamped to a support channel 18, which in turn is mounted to a skid 21 by a plurality of legs 20");
a motor (19, Fig.2; col 2, In 4-5, "Shaft 17 is coupled to a conventional electrical motor 19, which rotates shaft 17 to drive pump 11") mounted to the frame (20, 21, Fig.2);
a thrust chamber (15, 65, Fig.1A; col 2, In 2-3, "A thrust chamber 15 bolts to the rearward end of intake chamber 13") mounted to the frame (20, 21, Fig.2) adjacent to the motor (19, Fig.2);
a pump (11, 13, Fig.2) mounted to the frame (20, 21, Fig.2) adjacent to the thrust chamber (15, 65, Fig.1A) and wherein the pump (11, 13, Fig.2) comprises:
an inlet (13, 31, Fig.1A) on a first end of the pump (11, 13, Fig.2 -- see the right end of the pump);
a shaft seal module (69, Fig.1A; col 2, In 56-61, "A conventional mechanical seal 69 locates at the rearward side of seal housing 65 for sealing around shaft 17 where it passes through seal housing 65. Mechanical seal 69 may be of a rotary face type, having ceramic bearing surfaces and biased by a spring") connected between the inlet (13, 31, Fig.1A) and the thrust chamber (15, 65, Fig.1A -- see how the shaft seal 69 is between the right side of the thrust chamber 65 and the suction end 13, 31);
an outlet (11, Fig.2 -- see the left end of pump 11) on a second end of the pump (11, 13, Fig.2 -- see the left end of the pump), wherein the inlet (13, 31, Fig.1A) is between the outlet (11, Fig.2 -- see the left end of pump 11) and the motor (19, Fig.2); and
a plurality of stages (81, 83, Fig.1B; col 3, In 22-23, "pump 11 is conventional. It contains a large number of stages, each having an impeller 81 and a diffuser 83") between the outlet (Fig.2 -- see the left end of pump 11) and the inlet (31, Fig.1A), wherein each of the plurality of stages (81, 83, Fig.1B) comprises:
an impeller (81, Fig.1B); and
a diffuser (83, Fig.1B) that encases the impeller (81, Fig.1B), wherein each diffuser (83, Fig.1B) is an independent pressure vessel (Fig.1B -- see how each diffuser 83 is an independent pressure vessel); and
a shaft (17, Fig.2), wherein the shaft (17, Fig.2) extends from the motor (19, Fig.2) to the impellers (81, Fig.1B) through the thrust chamber (15, 65, Fig.1A) and the shaft seal module (69, Fig.1A).
but does not specifically teach a discharge on a first end of the pump; a shaft seal module connected between the discharge and the thrust chamber; a suction end on a second end of the pump, wherein the discharge is between the suction end and the motor. It is known that reversal of components is an ordinary skill in the art. Accordingly, it would have been obvious to one of ordinary skill in the art to have rotated the pump 180 degrees and attach the opposite shaft end to the motor shaft and to have added a nozzle to the outlet to direct flow to one side to accommodate the shaft to the motor as desired by the user.

Regarding claim 14, the modified DE LONG discloses the surface pumping system of claim 13, wherein the shaft (17, Fig.2) comprises a plurality of interconnected shaft segments (17, 17A, Fig.1A; col 2, In 23-29, "Shaft 17, which extends through intake chamber 13, has a forward portion 17a that extends through pump 11. A coupling 37 connects forward portion 17a to the remaining portion of shaft 17. Rearward wall 33 has a hole 35 through which shaft 17 passes. Hole 35 is considerably larger in diameter than shaft 17").

- See Supplemental Box -

**WRITTEN OPINION OF THE
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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

- Box V.2 - Citations and Explanations -

Regarding claim 15, the modified DE LONG discloses the surface pumping system of claim 14, wherein the diffuser (83, Fig.1B) of each stage does not include a separate housing around the diffuser (83, Fig.1B -- see how the each diffuser 83 does not includes their own separate housing).

Regarding claim 16, the modified DE LONG discloses the surface pumping system of claim 13, wherein at least one of the plurality of stages (81, 83, Fig.1B) is configured as a mixed flow stage (Fig.1B -- see how the plurality of stages are mixed flow stages).

Regarding claim 18, the modified DE LONG discloses the surface pumping system of claim 13, wherein the plurality of stages (81, 83, Fig.1B; col 3, ln 22-23, "pump 11 is conventional. It contains a large number of stages, each having an impeller 81 and a diffuser 83") comprises a first stage (Fig.1B -- see the left impeller and diffuser), a second stage (Fig.1B -- see the middle impeller and diffuser) and a third stage (Fig.1B -- see the right impeller and diffuser).

Claims 5, 7-8, 17, and 19-20 lack an inventive step under PCT Article 33(3) as being obvious over DE LONG in view of US 2012/0093636 A1 to HOMSTVEDT et al. (hereinafter "HOMSTVEDT").

Regarding claim 5, the modified DE LONG discloses the surface pumping system of claim 4, but does not specifically teach wherein at least one of the plurality of stages is configured as a radial flow stage. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 10, Fig.1, Fig.2) comprising impellers (8, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2) and a mixed flow stage (8, Fig.1, Fig.2). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include a radial flow stage to improve the stability of the surface pumping system by balancing out the axial forces.

Regarding claim 7, the modified DE LONG discloses the surface pumping system of claim 6, but does not specifically teach wherein the first stage comprises a diffuser having a first outer diameter and wherein the second stage comprises a diffuser having a second outer diameter that is smaller than the first outer diameter. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 9, 10, Fig.1, Fig.2) comprising impellers (8, 9, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 9, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2), a mixed flow stage (8, Fig.1, Fig.2), and an axial flow stage (9, Fig.1); wherein the axial flow stage (9, Fig.1) has a different diameter than the radial flow stage (10, Fig.1, Fig.2) and the mixed flow stage (8, Fig.1, Fig.2 -- see how the diameter of the axial flow stage is different than the diameter of mixed and radial flow stage). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include different diameters to improve the stability of the surface pumping system by balancing out the axial forces.

Regarding claim 8, the modified DE LONG discloses the surface pumping system of claim 6, but does not specifically teach wherein the first stage is configured as a mixed flow stage and the second stage is configured as a radial flow stage. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 10, Fig.1, Fig.2) comprising impellers (8, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2) and a mixed flow stage (8, Fig.1, Fig.2). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include a radial flow stage to improve the stability of the surface pumping system by balancing out the axial forces.

Regarding claim 17, the modified DE LONG discloses the surface pumping system of claim 16, but does not specifically teach wherein at least one of the plurality of stages is configured as a radial flow stage. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 10, Fig.1, Fig.2) comprising impellers (8, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2) and a mixed flow stage (8, Fig.1, Fig.2). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include a radial flow stage to improve the stability of the surface pumping system by balancing out the axial forces.

- See Supplemental Box -

**WRITTEN OPINION OF THE
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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

-*- Box V.2 - Citations and Explanations -*-

Regarding claim 19, the modified DE LONG discloses the surface pumping system of claim 18, but does not specifically teach wherein the first stage comprises a diffuser having a first outer diameter and wherein the second stage comprises a diffuser having a second outer diameter that is smaller than the first outer diameter. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 9, 10, Fig.1, Fig.2) comprising impellers (8, 9, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 9, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2), a mixed flow stage (8, Fig.1, Fig.2), and an axial flow stage (9, Fig.1); wherein the axial flow stage (9, Fig.1) has a different diameter than the radial flow stage (10, Fig.1, Fig.2) and the mixed flow stage (8, Fig.1, Fig.2 -- see how the diameter of the axial flow stage is different than the diameter of mixed and radial flow stage). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include different diameters to improve the stability of the surface pumping system by balancing out the axial forces.

Regarding claim 20, the modified DE LONG and HOMSTVEDT disclose the surface pumping system of claim 19, but DE LONG does not specifically teach wherein the first stage is configured as a mixed flow stage and the second stage is configured as a radial flow stage. However, HOMSTVEDT teaches a turbomachine (1, Fig.1, Fig.2; para[0027], "the turbomachine 1 comprises an inlet 2 and an outlet 3, a casing 4 and a rotatable shaft 5 arranged in the casing, diffusers 6 or similar operatively arranged in the turbomachine, and a means 7 for rotation operatively connected to the shaft. The illustrated turbomachine comprises three impellers 8 of a mixed flow type arranged on the shaft, the impeller having an inlet and an outlet, the inlet is closer to an axis of rotation than the outlet; three axial impellers 9 arranged upstream of the mixed flow type impeller and three radial impellers 10 arranged downstream of the mixed flow type impeller") comprising an inlet (2, Fig.1, Fig.2), an outlet (3, Fig.1, Fig.2), a shaft (5, Fig.1, Fig.2), a motor (5, Fig.1), and a plurality of stages (6, 8, 10, Fig.1, Fig.2) comprising impellers (8, 10, Fig.1, Fig.2) and diffusers (6, Fig.1, Fig.2); wherein the plurality of stages (6, 8, 10, Fig.1, Fig.2) comprises a radial flow stage (10, Fig.1, Fig.2) and a mixed flow stage (8, Fig.1, Fig.2). Accordingly, it would have been obvious to one of ordinary skill in the art to have modified the plurality of stages to include a radial flow stage to improve the stability of the surface pumping system by balancing out the axial forces.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.