PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

	Date of mailing *(day/month/year)* 16 February 2018 (16.02.2018)
Applicant´s or agent´s file reference P-WO106167V	**FOR FURTHER ACTION** See paragraph 2 below

International application No. PCT/FI2017/050628	International filing date *(day/month/year)* 06 September 2017 (06.09.2017)	Priority date *(day/month/year)* NONE

International Patent Classification (IPC) or both national classification and IPC
See supplemental box

Applicant
ROCSOLE LTD

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

- [x] 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
- [x] 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
- [ ] Box No. VI Certain documents cited
- [x] Box No. VII Certain defects in the international application
- [x] 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/FI Finnish Patent and Registration Office FI-00091 PRH, FINLAND Facsimile No. +358 29 509 5328	Date of completion of this opinion 07 February 2018 (07.02.2018)	Authorized officer Ville Möttönen Telephone No. +358 29 509 5000

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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(a))

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 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	9-14	YES
	Claims	1-8	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-14	NO
Industrial applicability (IA)	Claims	1-14	YES
	Claims	NONE	NO

2. Citations and explanations:

2.1 Documents cited in the International Search Report

D1: WO0062100 A2
D2: JP2013195343 A
D3: US2011025336 A1
D4: US2014013830 A1
D5: ES2211336 A1
D6: WO2017105432 A1
D7: US2002093348 A1

2.2 Claimed invention

The claimed invention, as described in **independent claim 1**, defines
(feature F1) an apparatus for determining, by electrical tomography, vertical profile of an electrical property of interest of material(s) present in a target volume in a container on the basis of measurements of a measurable electrical quantity dependent on said electrical property of interest,
(feature F2) the apparatus comprising a measurement probe arranged to be positioned at a plurality of different, vertically separate measurement levels in a target volume to carry out the measurements of the measurable electrical quantity at the different measurement levels,
(feature F3) the measurement probe comprising a plurality of measurement elements each having an interface surface arranged to be, with the measurement probe positioned within the target volume, in measurement connection with the material(s) present in the target volume;
(feature F4) each interface surface having a size, a shape, and a rotational position;
(feature F5) a measurement path for measurement of the measurable electrical quantity being formed, with the measurement probe in use, between two interface surfaces, the measurement path being dependent on the sizes of, the shapes of, and the rotational positions of the two interface surfaces, and the distance between the two interface surfaces along the surface of the measurement probe;
(feature F6) the locations, rotational positions, shapes, and sizes of the interface surfaces of the plurality of measurement elements being selected to provide at least two different measurement paths differing from each other in one or more of said sizes of, shapes of, rotational positions of, and distances between the associated interface surfaces.

Independent claims 10 and 13 define a corresponding method and computer program product.

In addition, **dependent claims 2-9, 11-12, and 14** specify embodiments of the invention.

2.3 Novelty under PCT Article 33(2)

Documents D1-D5 represent the most relevant prior art.

Document D1 discloses (page 1, first, sixth, seventh par.; page 2, third par.; figs. 1, 4, 7-9) tomographic methods and an apparatus for monitoring conditions within a process fluid inside a vessel. As shown in fig. 1 the apparatus is vertically movable thus enabling determining vertical profile of the process fluid

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Supplemental Box

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(*a process fluid, electrical conductivity, analysis of a capacitance or an electrical resistance, a vessel 1*; page 2, third par.; fig. 1) (feature F1). In addition, document D1 discloses
(features F2-F3) *a ceramic sleeve 5, electrodes 6* (clearly the apparatus can be positioned at different vertical levels) (page 3, second, third par.; fig. 1);
(feature F4) *rectangular electrodes 6 formed on the cylindrical ceramic sleeve 5* (page 3, second, third par.; fig. 1); and
(features F5 and F6) *measurement paths between different electrodes, electrical tomography* (page 4, fourth par.; page 5, second, third par.; claims 1, 7; figs. 1, 4, 7-9).
Therefore, document D1 discloses all features F1-F6 of **independent claim 1**. The subject matter of **independent claim 1** lacks novelty. The same holds for **dependent claims 3, 5, and 8** (see the ref. mentioned above).

Document D2 discloses (machine translation into English: par. [0007], [0014]-[0015]; figs. 1a-1b) a tomography apparatus and tomography measuring method for measuring distribution of the electric impedance of material (*A*) present in a target volume in a container (*a tank 22*). The probe (*i.e. electrodes 3 and supporting member 33*) can be positioned vertically inside the container (*i.e. the apparatus is suitable for determining vertical profile*; machine translation into English: par. [0007], [0020]; fig. 1a). The voltage between several different electrode pairs is measured for determining the distribution of the electric impedance in a measurement cross-section (*B*) (machine translation into English: par. [0025]-[0028]; figs. 1b, 5a-6d). Hence, feature F1 is disclosed. In addition, document D2 also comprises:
(feature F2) the vertically moveable probe which can be positioned vertically at desired measurement levels (machine translation into English: par. [0007], [0020]; fig. 1a; claim 1);
(feature F3) the probe comprising measurement elements (*electrodes 3*) (machine translation into English: par. [0007], [0014]; figs. 1a-1b);
(feature F4) (figs. 1a-2e);
(feature F5) measurement paths between interface surfaces (machine translation into English: par. [0025]-[0028]; figs. 1b);
(feature F6) at least two different measurement paths differing from each other (in distances) (machine translation into English: par. [0025]-[0028]; figs. 1b).
Thus, document D2 discloses all features F1-F6 of **independent claim 1**. The subject matter of **independent claim 1** lacks novelty. The same holds for **dependent claims 2-3 and 7-8** (cf. fictitious connecting lines; impedance distribution; see ref. mentioned above). Note that vertical profiling is not mentioned but the apparatus of document D2 is suitable for that use.

Document D3 discloses (par. [0014]; claims 1-2; figs. 1-4) a method and an apparatus for logging resistivity imaging in well boreholes filled with water-based or oil-based drilling fluid (mud). A downhole tool utilizes azimuthal or helical current injection and receiving, using pads (electrodes) generally disposed in a common plane, and with each pad preferably having at least two electrodes spaced vertically apart from one another. The pads may be utilized sequentially, with each pad in sequence acting as a current source with the remaining pads serving as returns (par. [0015]). The sequential operation allows for acquiring a “rotating” resistivity image (tomography), thus providing quasi-360° borehole wall coverage. Helical current injection in combination with straight (azimuthal or vertical) injection can improve the measurement device's sensitivity to layered variations in the formation (par. [0015], [0025]-[0026], [0036]-[0040]). The apparatus may be moved vertically (par. [0023]). Document D3 is considered to disclose features F1-F6 except that measurements are not done in a container.

Document D4 discloses (par. [0026], [0034], [0040]; figs. 1-6) an apparatus for determining vertical profile of an electrical property of interest of material(s) present in a target volume (*to measure water content of each horizontal medium layer within a medium tank in which multiphase medium is stored, a water content analyzer array*) in a container (*tank G1*) on the basis of measurements of a measurable electrical quantity dependent on said electrical property of interest (measurements corresponding electrical tomography, cf. par. [0040]). Hence, feature F1 is disclosed. In addition, document D40 also comprises:
(feature F2) the apparatus comprising a measurement probe arranged to be positioned at a plurality of different, vertically separate measurement levels in a target volume to carry out the measurements of the measurable electrical quantity at the different measurement levels (par. [0059], [0063]; figs. 1, 4-5);
(features F3 and F4) *“tubular conductive segment electrodes 101”, “a second electrode”, “the medium can freely get into and out of”* (par. [0030], [0035], [0037]; figs. 1-4); and

Continued to next page

Supplemental Box

Continuation of: Box V (2 / 3)

(features F5 and F6) *"The electric signals, such as capacitance, impedance and the like, which are measured in such a manner that each segment sensor is cooperated with the respective segment signal measuring circuit 105, have different properties and values. The signal and data processing unit 5 determines the property of a medium layer according to the difference between electric signals sent from each of the segment sub-electrodes 101, and further obtains water content of a medium layer."* (par. [0033], [0040]; figs. 1, 4).
Thus, document D4 discloses all features F1-F6 of **independent claim 1**. The subject matter of **independent claim 1** lacks novelty. The same holds for **dependent claims 6 and 8** (*"an uniform insulating layer 104"*, par. [0036], fig. 1; measuring impedance and the like, par. [0040]).

Document D5 discloses (machine translation into English: page 1, first par.; page 2, second-third par.; page 3, first-third par.; claim 1; figs. 1A-1B, 2B) a system for measuring the presence and concentration of various immiscible liquids in a sample by using a probe with multiple sensors. The measurement probe also comprises an electric insulating layer covering the sensors. It is clear that the probe with multiple sensors (fig. 2B) enables measuring the vertical profile of an electrical property of interest of material(s) present in a target volume in a container (i.e. carrying out electrical tomography) on the basis of measurements of a measurable electrical quantity dependent on said electrical property of interest (*"the stored voltage of the sensor capacitor equivalent", "dielectric constant of the products immiscible in the sample", "concentration of various immiscible liquids", a container 8, detectors Z1-Zx*). Document D5 is considered to disclose features F1-F6. Thus, **independent claim 1** lacks novelty. The same holds for **dependent claims 3-4, 6 and 8** (cf. *a dielectric constant*).

Documents D6-D7 represent the general state of the art.

Document D6 discloses (page 1, third par.; page 5, fourth par.-page 8, first par.; figs. 1-5) electrical impedance tomography (EIT) to map the spatial distribution of materials within the pipe, i.e. electrical properties of materials, such as electrical conductivity and electric permittivity. The EIT system comprises an embedded switchable array of electrodes 202 to measure impedance and flow characteristics of one or more fluids (including mixtures of liquids, gases, and/or solids that flow within the pipe). For example, the fluids may be oil, natural gas, water, cement slurry, drilling fluid, and the like.

Document D7 discloses (par. [0013]; claim 30; figs. 1) a device for detecting a bar-shaped or wire-shaped processing electrode of a machine tool. The detection is based on an impedance change in the measuring area which is caused by the processing electrode moving through the measuring area. The effect of possible contamination on the electrode is determined by measuring impedance change (par. [0032]).

None of the documents discloses all the features of **independent claims 10 and 13**. The subject matter of **independent claims 10 and 13** is therefore novel. Because the subject matter of **independent claims 10 and 13** is novel, **dependent claims 11-12 and 14** are also novel. The same holds for **dependent claim 9**.

2.4 Inventive step under PCT Article 33(3)

Since the subject matter of **claims 1-8** lacks novelty, it does not involve an inventive step either.

The subject matter of **independent claim 10** differs from the disclosure of document D1 (*carrying out measurements at different measurement levels is implicitly clear*) in that the effect of a possible contaminant on the surface of a measurement element is determined. The technical effect associated with the difference is that the effect of foreign matter on the vertical profiling measurements can be taken into account. The objective technical problem to be solved is therefore how to increase the reliability of the vertical profiling measurements. It is obvious to a person skilled in the art to determine different components of the material, including contamination, by applying several different measurement paths for increasing accuracy of the measurements (cf. e.g. D2: machine translation into English: par. [0049], figs. 6a-6d; D5: fig. 2B, D7: par. [0032]). Thus, it is obvious to a person skilled in the art to end up with the solution provided in **independent claim 10**. Hence, the subject matter of **independent claims 10 and 13 and dependent claims 9, 11, and 14** does not involve an inventive step in view of D1. In addition, the additional features (*know from the cited prior art*) of **claims 2, 4, 6-7, and 12** are obvious

Continued to next page

Supplemental Box

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design options to a person skilled in the art. Thus, also **claims 2, 4, 6-7, and 12** do not involve an inventive step in view of D1 either.

With the same reasoning the subject matter of **independent claims 10 and 13 and dependent claims 9, 11-12, and 14** does not involve an inventive step either in view of D2.

The subject matter of **independent claim 1** differs from the disclosure of document D3 in that measurements are carried out in a container. However, it is obvious to a person skilled in the art to apply the measurement method of document D3 for determining material properties of liquid by using the apparatus in a container comprising material to be measured. Hence, the subject matter of **claims 1-14** does not involve an inventive step in view of D3 (see also par. [0042]-[0043]; different shapes, using an insulating layer, taking into account a possible contaminant are straightforward design options for a person skilled in the art).

Furthermore, **claims 1, 6 and 8** lack novelty in view of document D4. Thus, *at least* these claims do not involve an inventive step in view of D4. The same holds for **claims 1, 3-4, 6, and 8** in view of D5. Concerning **independent claims 10 and 13** in light of D4 and D5, it is not considered obvious to carry out measurements at several different measurement levels and via at least two different measurement paths at least for one measurement level. Thus, the subject matter of **independent claims 10 and 13 and dependent claims 11-12 and 14** involves an inventive step in view of D4 or D5.

2.5 Industrial applicability under PCT Article 33(4)

Claims 1-14 meet the requirement of industrial applicability because the claimed subject matter can be made or used in industry.

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Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

No document reflecting the prior art described on pages 1-2 is identified in the description (PCT Rule 5.1(a)(ii)).

Independent claims are not drafted in the two-part form in accordance with PCT Rule 6.3(b), which in the present case would be appropriate, with those features known from the prior art placed in the preamble (PCT Rule 6.3(b)(i)) and the remaining features included in the characterising part (PCT Rule 6.3(b)(ii)).

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:

Independent claim 13 does not contain all the features that are essential for describing the computer program product for performing the method of **independent claim 10** and therefore does not meet the requirements of PCT Article 6 in conjunction with PCT Rule 6.3(b) in that each independent claim must include all the technical features essential to the definition of the invention. Just by referring to **independent method claim 10** it is not clear which equipment the computer program controls and which process steps are required (cf. the description, p. 25, line 14-page 32, line 23) for implementing the method since the computer program is blind to the physical configuration of the apparatus.

Supplemental Box

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

Continuation of: International Patent Classification (IPC)

IPC
G01N 27/07 (2006.01)
G01N 27/22 (2006.01)
G01N 33/28 (2006.01)
G01R 27/26 (2006.01)
G01R 27/22 (2006.01)
G01N 33/02 (2006.01)
G01N 33/34 (2006.01)