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(54) **Assembly and method for detection of submerged objects.**

(57) The invention relates to a detection assembly for detecting an object submerged in a covering material, said assembly comprising a mobile electrode movable over a surface of the covering material and adapted to make continuous electrical contact therewith during such movement, a reference electrode contacting the covering material, potential difference measuring means conductively connected to said electrodes and arranged for measuring a potential difference between the mobile and the reference electrode, indicator means arranged for indicating a change in measured potential difference during movement of the mobile electrode. Additionally the invention relates to a method for using such an assembly.

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Assembly and method for detection of submerged objects

BACKGROUND

The invention relates to an assembly and method for detection of submerged objects such as objects located below a ground surface and/or water surface.

SUMMARY OF THE INVENTION

According to a first aspect the present invention provides a detection assembly for detecting an object submerged in a covering material, said assembly comprising a mobile electrode movable over a surface of the covering material and adapted to make continuous electrical contact therewith during such movement, a reference electrode contacting the covering material, potential difference (PD) measuring means conductively connected to said electrodes and arranged for measuring a potential difference between the mobile and the reference electrode, and indicator means arranged for indicating a change in measured potential difference during movement of the mobile electrode. Advantageously the mobile electrode can be moved across several patches of area to be investigated while performing measurements. The changes in measured PDs are instantly available and may immediately be used to decide where to dig or survey next, or may be recorded for later processing, for example to build a map of the area under

investigation. Contrary to devices using an induced potential, there is no additional risk to an person operating this embodiment of the detection assembly, as the assembly uses very small currents and the PDs between electrodes caused by spontaneous potentials are in the millivolt range (typically between 10 and 100 mV), which is not even sufficient to penetrate human skin. Indeed, this embodiment may improve safety during digging and surveying operations as the mobile electrode can be used to detect a contour of electrical cables in a much more precise manner, making them easier to avoid.

In an embodiment the reference electrode is arranged to be placed stationary with respect to the covering material and said mobile electrode is movable with respect to the stationary reference electrode. The stationary and mobile electrodes may be connected to the potential difference measuring means using insulated cables of sufficient length to span the distance between the electrodes while still allowing some slack for the cables. This embodiment allows the use of a stationary reference electrode without significantly affecting the mobility of the mobile electrode.

According to a second aspect, the invention provides a detection assembly for detecting an object submerged in a covering material, said assembly comprising a plurality of mobile electrodes movable over a surface of the covering material and adapted to make continuous electrical contact therewith during such movement, potential difference measuring means conductively connected to selected electrodes of the plurality of mobile electrodes and configured for measuring a potential difference there between, configuration means arranged for configuring connections between electrodes from the plurality of mobile electrodes and the potential difference measuring means, and indicator means arranged for indicating a change in measured potential difference during movement of the mobile electrodes. In this embodiment all electrodes may be mobile,

thus avoiding the need to interrupt measuring PDs to displace a stationary or fixed electrode and facilitating measuring PDs in different areas. Typically thousands of measurements may be performed per second, enabling relatively high speed movement of the electrodes while obtaining a high resolution image of subsurface structures. An A/D converter can be used to convert analog measurements of PDs between electrodes into digital signals suitable for further processing such as digital map creation and/or calculations by a computer. The connections between electrodes and the measuring means are configured by the configuration means which may, for each measurement, enable or disable individual connections, reverse two connections to the measuring means and/or connect several individual electrodes together to form a combined electrode. Advantageously the configuration means allow measurements between any pair of electrodes or groups thereof, providing a way to measure over different areas in the neighborhood of the electrodes without having to move the electrodes.

In an embodiment the configuration means are further arranged for selecting one of the plurality of electrodes as a measuring electrode and combining the other electrodes from the plurality of electrodes for providing a reference potential.

In an embodiment the configuration means are arranged for combining the other electrodes for providing a reference potential as an average of potential difference measurements made between the measuring electrode and the other electrodes. Such an average can help to cancel out noise in individual measurements.

In an embodiment the configuration means are further arranged for cyclically selecting each of the plurality of electrodes as the measuring electrode. For example, if an embodiment of the detection assembly comprises 7 electrodes $e_1..e_7$ and the potential differences between electrodes i and j is given by $p_{i,j}$, then electrode e_1 is first selected by the configuration means as the

measuring electrode. The PDs between e_1 and the other electrodes are then measured, resulting in values for $p_{1,j}$. These values may then be averaged to provide an average potential difference for e_1. During the following cycle e_2 is selected as the measuring electrode and potential differences are measured between e_2 and the other electrodes. This process continues until all 7 electrodes have been selected as a measuring electrode.

In an embodiment the detection assembly further comprises tool for displacing covering material, said tool comprising a part arranged for movably contacting the covering material, wherein said part comprises the mobile electrode or the mobile electrodes. When excavating, for example at an archeological dig or at a construction site, is especially useful to be able to keep on excavating without having to stop every so often to check the current position on maps of earlier surveys for submerged objects. It is also desirable to be able to start digging right away, without having to meticulously survey the area but without the risk of hitting a submerged object. The present invention integrates the measuring electrodes with a part of tool which contacts the material to be excavated so that at the moment the tool contacts the covering material, but before it substantially pierces the material, a measurement of PD can be done to determine whether or not a subsurface object is present.

In an embodiment the tool further comprises a shaft and/or a handle on or near which indicator means are located, said tool preferably comprising a spade or a rake. This embodiment provides a portable tool for moving material, which can instantly give its operator information about the material under the surface he or she is working on. The fact that the assembly according to the invention requires only low voltages to work and is capable of rapidly detecting relatively small objects thanks to the many measurements per square meter that can be made, makes this embodiment a safe and convenient solution especially when

digging in close quarters or small areas.

An embodiment further comprises a frame arranged for supporting said electrodes in a substantially fixed position with respect to the frame during movement of the frame. Such a frame may be a flexible frame which can adapt to some extend to the surface is dragged along, or a more rigid frame when the surface to be inspected is relatively smooth. Preferably the electrodes are arranged in a row on the frame said row preferably oriented perpendicular to the direction of movement of the frame. An alternative exemplary embodiment comprises a harrow-like structure which can be towed behind a vehicle, the tines of the harrow comprising the electrodes. The known position of the electrodes relative to each other can be used in further processing of data obtained using the assembly. Also, in case of availability of GPS receivers for surveying, one GPS receiver would be needed on the frame to be able to derive the position for each electrode.

In an embodiment the frame is made from a substantially anti-static material. The use of a anti-static material provides an advantage when the frame is dragged through a field. When using other materials the friction of the frame with the surface could lead to a build up of static electricity which in turn might affect or distort the accuracy measurements of PDs between electrodes.

In an embodiment the electrodes have indicator means associated with them. In an further embodiment the indicator means are arranged spatially closer to their associated electrodes than to other electrodes. A magnitude of the indication given off by an indicator means may thus advantageously provide information about the subsurface structure closer to said indicator means than to any other indicator means. For instance, when the indicator means comprise LEDs mounted on or close to associated electrodes of supported by a frame as mentioned in an earlier embodiment, a quick look at the indicator means is sufficient to form an approximation of the subsurface

structures lying under said frame. When searching for buried pipes or cables, the frame may be used to get a rough idea of where to look, after which a hand held tool according to the invention can be used to expose the pipe or cables. Extra data processing steps can thus be omitted, providing a simple solution for locating submerged objects.

In an embodiment at least several of the electrodes are positioned with respect to each other in a configuration substantially non-collinear with the direction of movement, preferably perpendicular to the direction of movement. The total area covered by the electrodes during and after movement is thus larger than when the electrodes are placed in a line parallel to the direction of movement.

In an embodiment the indicator means are adapted to give off a warning indication when an absolute difference between measured potential differences exceeds a threshold value. Besides the continuously available indication of the change in measured PDs, this embodiment provides a separate warning when the change in PDs indicates for example that an operator using a spade according to the invention is close to hitting a submerged object.

In an embodiment at least some, preferably all electrodes have similar metallurgical and/or electrochemical properties. By using electrodes with similar metallurgical properties, such as a similar standard potential, measurement of a PD between the electrodes will be less likely to be influenced by reduction or oxidation reactions between the electrodes themselves. Conversely, known differences between standard potentials of electrodes with dissimilar metallurgical properties may be used to improve the accuracy of measurements. For instance it is conceivable to choose electrodes which are best suited for a specific covering material, as might be empirically determined or be based on properties of the covering material such as its pH value.

According to a third aspect the invention provides a method for detecting an object submerged in a covering

material using a detection assembly as described herein, said method comprising the steps of placing the reference electrode in a stationary position in conductive contact with the covering material, contactingly moving the mobile electrode over the surface of the covering material, and measuring a potential difference between the mobile electrode and the stationary electrode. For example, the typical manner in which a person digging in an area in which pipes and cables are buried might work is to insert one or more reference electrodes (e.g. metal pins) into the ground close to the area where he wants to dig. He then lightly contacts the surface of the area he wants to dig with the blade of a spade according to the invention, and subsequently drags the blade of the spade towards himself. If the indicator means indicate that an absolute difference between PDs measured during movement is above a threshold value then it is likely that there is an object submerged near the blade and the spot can be avoided or, conversely the object can be dug up.

An embodiment of the method for detecting an object submerged in a covering material comprises the steps of placing the plurality of mobile electrodes in conductive contact with the covering material, contactingly moving these mobile electrodes over a surface of the covering material, selecting one of the plurality of electrodes as a measuring electrode and combining the other electrodes for providing a reference, determining a potential difference between the measuring electrode and the reference. It may be advantageous to combine electrodes, for instance when measurements for single electrode are very noisy. The larger surface of combined electrodes may help to cancel out such noise.

An embodiment of the method for detecting an object submerged in a covering material comprises the steps of placing the plurality of mobile electrodes in conductive contact with the covering material, contactingly moving these mobile electrodes over a surface of the covering

material, selecting one of the plurality of electrodes as a measuring electrode and selecting another one of the plurality of electrodes as a reference electrode, measuring a potential difference between the measuring electrode and the reference electrode. Multiple measurements can thus be obtained for further processing.

An embodiment of the method further comprises the steps of cyclically selecting each of the other electrodes as a reference electrode, measuring for each of the selected reference electrodes a potential difference between said reference electrode and the measuring electrode, and determining an average of the measured potential differences for said measuring electrode. In this manner, an average potential difference is determined between a measuring electrode and all other electrodes, i.e. all electrodes except the measuring electrode.

In an embodiment the method further comprises the step of cyclically selecting each of the plurality of electrodes as a measuring electrode. I.e. each of the electrodes is used at least once as a measuring electrode.

In an embodiment the method further comprises the step of determining an average potential of the other electrodes for providing an average reference potential.

The various aspects and features described and shown in the specification can be applied, individually, wherever possible. These individual aspects, in particular the aspects and features described in the attached dependent claims, can be made subject of divisional patent applications.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be elucidated on the basis of an exemplary embodiment shown in the attached drawings, in which:

Figure 1a shows a detection assembly according to

the present invention in a first position removed from a submerged object,

figure 1b shows the detection assembly of figure 1a moved to a second position closer to a submerged object,

figure 1c shows said detection assembly moved to a third position removed from the submerged object.

figure 2a shows a schematic diagram of a detection assembly according to the invention, having a stationary electrode conductively connected to a covering material surface and a mobile electrode, both electrodes being connected to a potential difference measuring means,

figure 2b shows a schematic diagram of a detection assembly similar to the assembly show in figure 2a, however comprising a plurality of mobile electrodes,

figure 2c shows a schematic diagram of a detection assembly comprising a plurality of mobile electrodes,

figure 3 shows an exemplary embodiment of a detection assembly according to the invention,

figure 4a shows another exemplary embodiment of a detection assembly according to the invention,

figure 4b shows a graph of potential differences as may be measured by the embodiment in figure 4a.

DETAILED DESCRIPTION OF THE INVENTION

A volume of earth in which an object with differing electrical properties, in this case a plastic pipe 2, is buried is shown in figure 1a, along with a detection assembly according to the invention. The detection assembly comprises a spade 3 for displacing the earth, said spade comprising a handle 4, a shaft 5, and a blade 6. The blade comprises or forms a mobile electrode 7, which is conductively connected to potential difference measuring means 8, by means of an insulated wire 9. The potential difference measuring means are also conductively connected to a reference electrode 10, in this case a metal pin having

metallurgical properties similar to the reference electrode, placed contactingly and stationary with the earth.

The shaft and the handle are electrically insulated from the mobile electrode so that the mobile electrode may only form an electrical circuit with the reference electrode through the earth. Though the PD measuring means shown in this exemplary embodiment are positioned at the stationary electrode they may just as well be integrated in the spade, as long as they are conductively placed between both electrodes. The spade may further comprise a GPS receiver or the like for determining an approximate location of the blade. The handle of the spade comprises indicating means (not shown) arranged to indicate a change in measured PD during movement of the spade. When an operator drags the blade of the spade across the earth along a direction D, at some point the blade will be close enough to the submerged object for the object to influence the PD measured between the electrode on the blade and the stationary electrode, as is the case in figure 1b. As a result the indicating means give off an indicating signal 11, in this case sound, to warn the operator of a change in structure in the ground beneath the blade of the spade. Such a sound might have a frequency proportional to the detected change in PD. Alternatively the indicating means may comprise a graphical display showing the difference in PD as well as other data useful during digging, such as location and a map of known structures. When the absolute difference between recently measured and earlier measured PDs exceeds a predetermined or adaptively calculated threshold value, the indicator means may also give a more obtrusive warning to alert an operator of changes in the subsurface structure.

In figure 1c the blade of the spade has moved to a third position which is again sufficiently removed from the submerged plastic pipe 2 for the absolute difference between measured PDs not to exceed the threshold, and therefore not giving off a warning.

If figure 2a a schematic diagram of a detection

assembly according to the invention is show. A stationary reference electrode e_0 is conductively to the ground and to potential difference measuring means 23. The potential difference measuring means in turn are conductively connected to mobile electrode e_1 and arranged to measure a PD between the reference electrode and the mobile electrode. The connections may be made using insulated conductive wires.

In figure 2b, a similar detection assembly is show, however comprising multiple mobile electrodes e_1-e_4 and associated potential difference measuring means for measuring a PD between the reference electrode and mobile electrodes. It is also conceivable that only one potential difference measuring means is used, of which the connections are rapidly switched to different electrodes in order to make measurements between different electrode pairs. Advantageously these measurements can be averaged to cancel out noise. Furthermore in case one of the mobile electrodes is damaged or does not make contact with the covering material during measurement, there are still other mobile electrodes from which data can be obtained.

In figure 2c the stationary electrode has been dispensed with altogether. The assembly according to this embodiment may calculate an average potential difference for each of the electrodes with the other electrodes. I.e. the average potential difference for mobile electrode e_3 is the average of the measured potential differences $p_{3,1}$ uptil $p_{3,7}$. In figure 3 an embodiment according to the invention is shown in the form of a rake 31 comprising a multitude of tines 32, each of which may comprise an electrode. The rake can be connected to a stationary electrode as was the spade from figures 1a-1c, but may also comprise a plurality of mobile electrodes instead. In the latter case the rake may advantageously comprise configuration means for configuring connections of the electrodes; in this manner multiple measurements can be made of PDs between multiple pairs of electrodes. For example, if the PD between electrodes e_5 and

e_4 is significantly larger that the PD between other pairs of neighboring electrodes it is likely that there is a change in subsurface structure close to the position of the electrode e_5 and/or e_4. Additionally, indicator means may be placed on upper part of the tines of the rake, preferably LEDs, which indicate the relative PDs of neighboring pairs of electrodes. It is thus possible to survey the subsurface at a glance without having to use a fixed or difficult to move electrode, simply by raking the surface.

In figure 4 another exemplary embodiment according to the invention is shown, this particular embodiment being more suitable for surveying larger areas in detail. The embodiment shown has a frame 40 made from a substantially non-conductive and anti-static material. On the frame a plurality of electrodes 41, preferably arranged equidistantly, is supported. Each of the electrodes has associated indicator means 43, in this case LEDs, for indicating a PD measured between the electrode and other electrodes. The LEDs are connected to amplifiers (not show), which amplify the measured PDs and supply a current to power the LEDs. When the frame is placed stationary on surface area to be inspected, the LEDs give an indication of the distribution of the PD under the surface covered by the frame. When the frame is dragged behind a vehicle, using tow-eye 42 to attach the frame to the vehicle, larger areas of ground can consecutively be covered. Though in principle a single row of electrodes perpendicular to the direction of movement of the frame suffices to gather data for building a map, in may also be convenient to have several of such rows placed next to each other in the direction of movement. In figure 4A this would be after the cut-off line. In such a case, when the frame moves over a pipe or cable, the light signals from the LEDs seem to propagate over the rows, providing a much more intuitive representation of the subsurface than when the electrodes are arranged in a single row.

Figure 4B shows a PD graph superimposed on an

image of a pipe buried in the ground. Along the z-axis an indication of the change in measured PD is given. The x- and y-axis represent coordinates on the surface of covering material. The surface in question may be a flat surface; the z-coordinate shows the measured PD-values, not the height of the surface. As can clearly be seen, there is a sudden change in measured PD values in the area under which the pipe is buried. This change in PD can be used successfully to detect submerged objects.

Obviously, these exemplary embodiments may be elaborated upon, for example by adding several kinds of locating means, storage for measured data and advanced signal processing devices. Such elaborations are widely known in the art and are included herein implicitly.

Furthermore, although the above described examples are all related to the survey for items buried in a volume of earth, the device and method is also applicable to survey for items submerged in water and/or buried in a volume of earth submerged in water.

It is to be understood that the above description is included to illustrate the operation of the preferred embodiments and is not meant to limit the scope of the invention. From the above discussion, many variations will be apparent to one skilled in the art that would yet be encompassed by the spirit and scope of the present invention.

CONCLUSIES

1. Detectiesamenstel voor het detecteren van een object verzonken in een bedekkend materiaal, waarbij het samenstel omvat:

een beweegbare elektrode beweegbaar over een oppervlak van het bedekkende materiaal en ingericht om continu elektrisch contact daarmee te maken gedurende zulk een beweging,

een referentie-elektrode welke het bedekkende materiaal contacteert,

middelen voor het meten van een potentiaal verschil geleidend verbonden met de elektrodes en ingericht voor het meten van een potentiaal verschil tussen de beweegbare en de referentie-elektrode,

aanduidingsmiddelen ingericht voor het aanduiden van een verandering in gemeten potentiaalverschil.

2. Detectiesamenstel volgens conclusie 1, waarin de referentie-elektrode is ingericht om stationair geplaatst te worden ten opzichte van het bedekkende materiaal en de beweegbare elektrode beweegbaar is ten opzichte van de stationaire referentie-elektrode.

3. Detectiesamenstel voor het detecteren van een object verzonken in een bedekkend materiaal, waarbij het samenstel omvat:

een veelvoud aan beweegbare elektroden beweegbaar over een oppervlak van het bedekkende materiaal en ingericht om continu elektrisch contact daarmee te maken gedurende zulk een beweging,

middelen voor het meten van een potentiaal verschil geleidend verbonden met geselecteerde elektroden uit het veelvoud van beweegbare elektroden en ingericht voor het meten van een potentiaal verschil daartussen,

configuratiemiddelen ingericht voor het configureren van verbindingen tussen elektroden van het veelvoud aan beweegbare elektroden en de middelen voor het meten van een potentiaal verschil,

aanduidingsmiddelen ingericht voor het aanduiden van een verandering in gemeten potentiaalverschil.

4. Detectiesamenstel volgens conclusie 3, waarin de configuratiemiddelen verder zijn ingericht voor het selecteren van één uit het veelvoud aan elektroden als een meetelektrode en het combineren van de andere elektroden uit het veelvoud aan elektroden om een referentiepotentiaal te verschaffen.

5. Detectiesamenstel volgens conclusie 4, waarin de configuratiemiddelen zijn ingericht voor het combineren van de andere elektroden om een referentiepotentiaal te verschaffen als een gemiddelde van potentiaalverschilmetingen die zijn gedaan tussen de meetelektrode en de andere elektroden.

6. Detectiesamenstel volgens conclusie 5, waarin de configuratiemiddelen verder zijn ingericht voor het cyclisch als de meetelektrode selecteren van elk van het veelvoud aan elektroden.

7. Detectiesamenstel volgens één der voorgaande conclusies, verder omvattend een gereedschap voor het verplaatsen van bedekkend materiaal, waarbij het gereedschap een deel omvat ingericht voor het beweegbaar contact maken met het bedekkende materiaal, waarin het deel de beweegbare elektrode of beweegbare elektroden omvat.

8. Detectiesamenstel volgens conclusie 7, waarin het gereedschap verder een steel en/of een handvat omvat op of nabij waar de aanduidingsmiddelen zijn geplaatst, waarbij het gereedschap bij voorkeur een schop of een hark omvat.

9. Detectiesamenstel volgens één der voorgaande conclusies, waarin het samenstel verder een frame omvat ingericht voor het ondersteunen van elektroden in een in hoofdzaak vaste positie ten opzichte van het frame

gedurende beweging van het frame.

10. Detectiesamenstel volgens conclusie 9, waarin het frame is gemaakt van een in hoofdzaak antistatisch materiaal.

11. Detectiesamenstel volgens één der voorgaande conclusies, waarin elektroden aanduidingsmiddelen hebben die met de elektroden geassocieerd zijn.

12. Detectiesamenstel volgens conclusie 11, waarin de aanduidingsmiddelen ruimtelijk dichter bij hun geassocieerde elektroden zijn gerangschikt dan bij andere elektroden.

13. Detectiesamenstel volgens één der voorgaande conclusies, waarin ten minste een verscheidene van de elektroden ten opzichte van elkaar zijn geplaatst in een configuratie in hoofdzaak niet-collineair met de beweegrichting, bij voorkeur loodrecht op de beweegrichting.

14. Detectiesamenstel volgens één der voorgaande conclusies, waarin de aanduidingsmiddelen zijn ingericht om een waarschuwingsaanduiding te geven wanneer een absoluut verschil tussen gemeten potentiaalverschillen een drempelwaarde overschrijdt.

15. Detectiesamenstel volgens één der voorgaande conclusies, waarin ten minste enkelen van de elektroden overeenkomstige metallurgische eigenschappen hebben, bij voorkeur alle elektroden.

16. Werkwijze voor het detecteren van een object verzonken in een bedekkend materiaal gebruikmakend van een detectiesamenstel zoals beschreven in conclusie 1 of conclusie 2, waarbij de werkwijze de stappen omvat van:

het in een vaste positie plaatsen van de referentie-elektrode in geleidend contact met het bedekkende materiaal,

het contactmakend bewegen van de beweegbare elektrode over de oppervlak van het bedekkende materiaal,

het meten van een potentiaalverschil tussen de beweegbare elektrode en de vaste elektrode.

17. Werkwijze voor het detecteren van een object verzonken in een bedekkend materiaal gebruikmakend van een detectiesamenstel zoals beschreven in conclusie 3, waarbij de werkwijze de stappen omvat van:

het plaatsen van het veelvoud aan beweegbare elektroden in geleidend contact met het bedekkende materiaal,

het contactmakend bewegen van deze beweegbare elektroden over een oppervlak van het bedekkende materiaal,

het selecteren van één uit het veelvoud aan elektroden als een meetelektrode en het combineren van de andere elektroden om een referentie te verschaffen,

het bepalen van een potentiaalverschil tussen de meetelektrode en de referentie.

18. Werkwijze voor het detecteren van een object verzonken in een bedekkend materiaal gebruikmakend van een detectiesamenstel zoals beschreven in conclusie 3, waarbij de werkwijze de stappen omvat van:

het plaatsen van het veelvoud aan beweegbare elektroden in geleidend contact met het bedekkend materiaal,

het contactmakend bewegen van deze beweegbare elektroden over een oppervlak van het bedekkende materiaal,

het selecteren van één uit het veelvoud aan elektroden als een meetelektrode en het selecteren van ten minste één van de andere elektroden uit het veelvoud aan elektroden als een referentie-elektrode,

het meten van een potentiaalverschil tussen de meetelektrode en de referentie-elektrode.

19. Werkwijze volgens conclusie 18, verder omvattend de stappen van:

het cyclisch als een referentie-elektrode selecteren van elk van de andere elektroden,

het voor elk van de geselecteerde referentie-elektroden meten van een potentiaalverschil tussen de referentie-elektrode en de meetelektrode,

het bepalen van een gemiddelde van de gemeten

potentiaalverschillen voor de meetelektrode.

20. Werkwijze volgens conclusie 17, 18 of 19, verder omvattend de stap van het cyclisch als een meetelektrode selecteren van elk van het veelvoud aan elektroden.

21. Werkwijze volgens conclusie 20, verder omvattend de stap van het bepalen van een gemiddelde potentiaal van de andere elektroden om een gemiddelde referentiepotentiaal te verschaffen.

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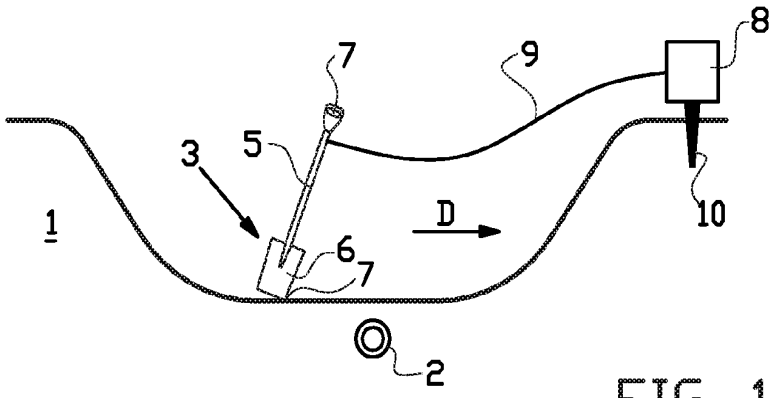

FIG. 1A

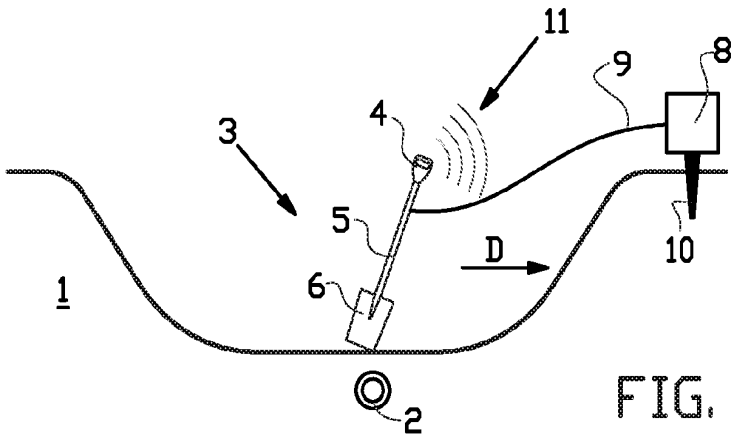

FIG. 1B

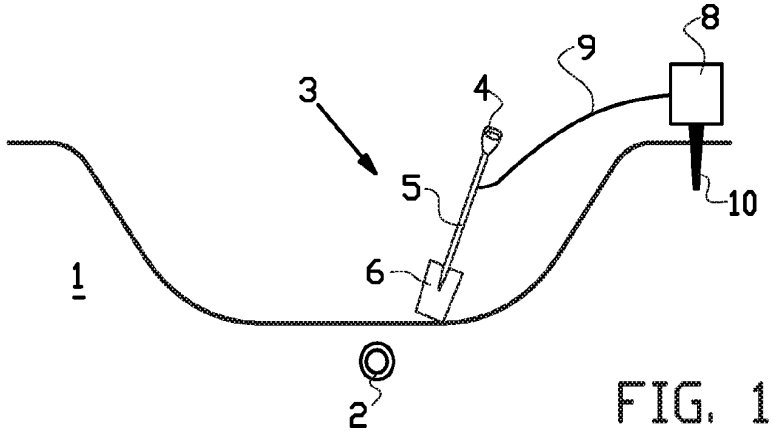

FIG. 1C

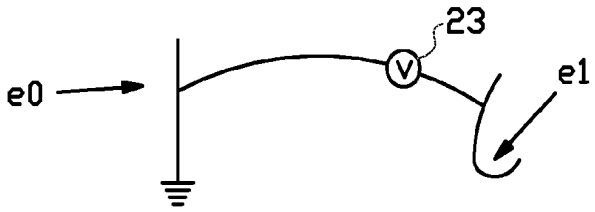

FIG. 2A

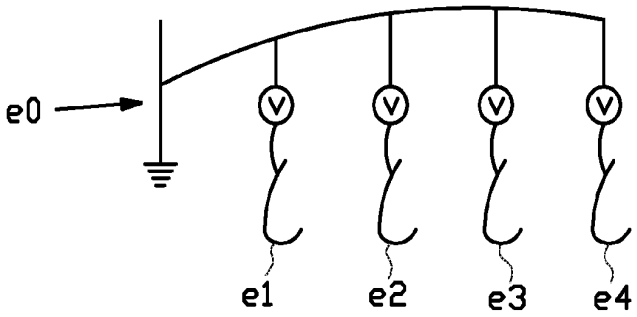

FIG. 2B

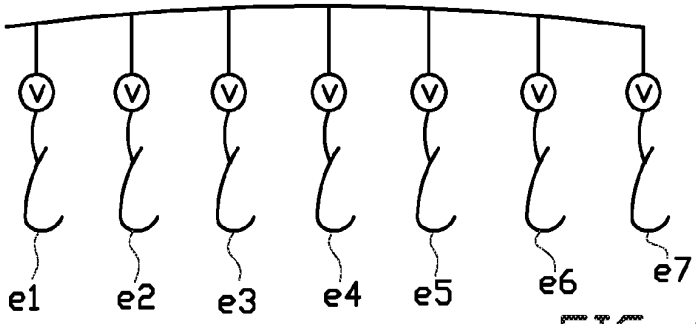

FIG. 2C

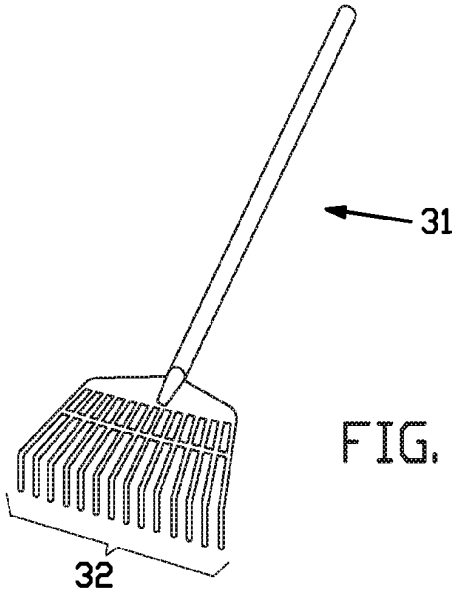

FIG. 3

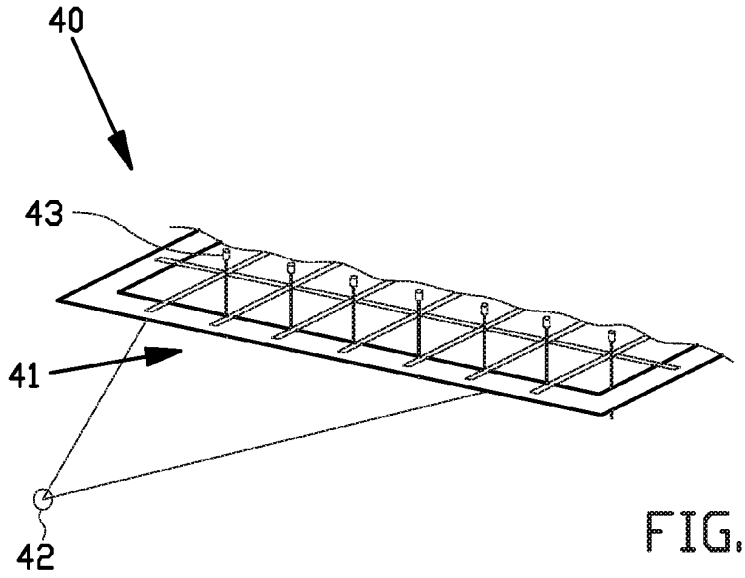

FIG. 4A

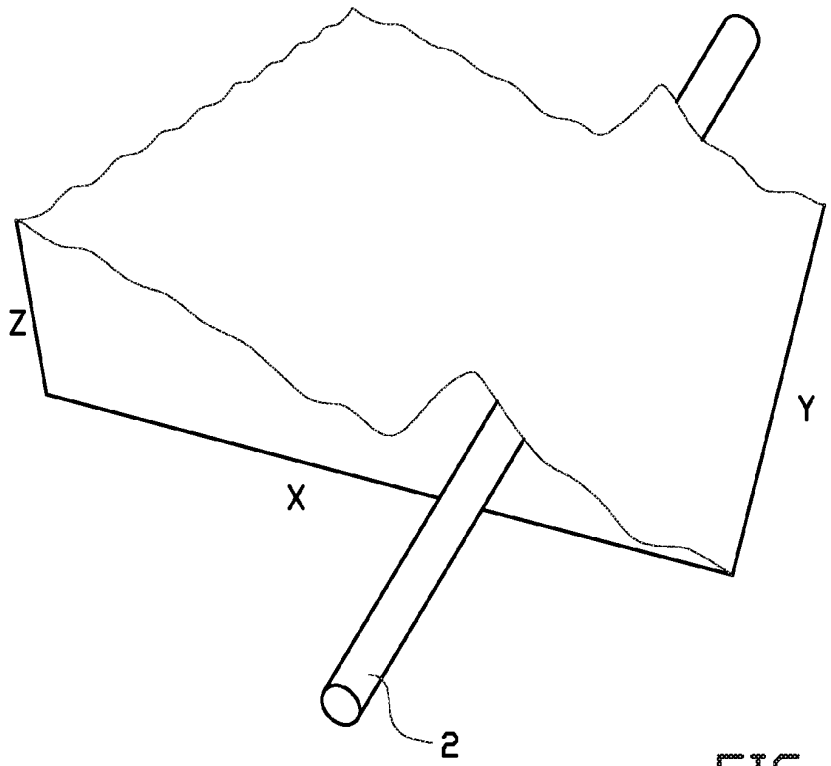

FIG. 4B

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	NLP183988A
Nederlands aanvraag nr. **2002124**	Indieningsdatum **22-10-2008**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Groundtracer B.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **29-12-2008**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN 51482**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

G01V3/08 **G01V3/15**

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC 8	**G01V** **A01D**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III. ☐ **GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES** (opmerkingen op aanvullingsblad)

IV. ☐ **GEBREK AAN EENHEID VAN UITVINDING** (opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2002124

A. CLASSIFICATIE VAN HET ONDERWERP
INV. G01V3/08 G01V3/15

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte miminum documentatie (classificatie gevolgd door classificatiesymbolen)
G01V A01D

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	FR 457 661 A (CONRAD SCHLUMBERGER [FR]) 23 september 1913 (1913-09-23)	1,2,7, 11,15,16
A	het gehele document	8,12,14

X	DE 196 24 323 A1 (RAMMNER RUDOLF [DE]) 2 januari 1998 (1998-01-02)	3,13,17, 18
Y	conclusies 3,4	4-6, 19-21
A		7-12

Y	DE 43 13 773 C1 (PRAKLA SEISMOS GMBH [DE]) 1 september 1994 (1994-09-01) samenvatting; figuur 1 het gehele document	4-6, 19-21

	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

° Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
10 September 2009	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	De Bekker, Ruben

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Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2002124

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	WO 94/29752 A (APEX DATA SYSTEMS LTD [GB]; SCOTT ROY [GB]) 22 december 1994 (1994-12-22) samenvatting; figuren 1,3 bladzijde 3, regel 1 - regel 18 bladzijde 4, regel 15 - regel 21	4-6
X	DD 225 512 A1 (GEISELTAL BRAUNKOHLENWERK [DD]) 31 juli 1985 (1985-07-31) het gehele document samenvatting; conclusie 1; figuur 1	1-3, 7-10, 15-18
X	US 2 256 742 A (JAY JAKOSKY JOHN) 23 september 1941 (1941-09-23) figuren 2,3	3,9,10
X	EP 0 426 563 A (SCHLUMBERGER LTD [US]; SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBERGER) 8 mei 1991 (1991-05-08) het gehele document	1-3,9, 10,13, 16-18
X	DATABASE WPI week 198521 Thomson Scientific, London, GB; AN 1985-127389 XP002545069 -& SU 1 123 000 A (S YUZHMORGEOLOGIYA) 7 november 1984 (1984-11-07) samenvatting	3,16
X	US 3 916 298 A (ULRICH DONALD E) 28 oktober 1975 (1975-10-28) kolom 2, regel 19 - regel 48	1,11,12, 14
A	FR 2 514 153 A (CENTRE NAT RECH SCIENT [FR]) 8 april 1983 (1983-04-08) het gehele document	1-21

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2002124

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
FR 457661	A	GEEN	
DE 19624323	A1	02-01-1998 GEEN	
DE 4313773	C1	01-09-1994 GEEN	
WO 9429752	A	22-12-1994 AT 163482 T	15-03-1998
		AU 6685494 A	03-01-1995
		DE 69408690 D1	02-04-1998
		DE 69408690 T2	01-10-1998
		EP 0729590 A1	04-09-1996
DD 225512	A1	31-07-1985 GEEN	
US 2256742	A	23-09-1941 GEEN	
EP 0426563	A	08-05-1991 AU 635081 B2	11-03-1993
		AU 6570190 A	09-05-1991
		DE 69015778 D1	16-02-1995
		DE 69015778 T2	17-08-1995
		DK 0426563 T3	19-06-1995
		NO 904445 A	02-05-1991
		US 5008625 A	16-04-1991
SU 1123000	A	07-11-1984 GEEN	
US 3916298	A	28-10-1975 GEEN	
FR 2514153	A	08-04-1983 GEEN	

OCTROOICENTRUM NEDERLAND

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN51482	22.10.2008		NL2002124

International Patent Classification (IPC)
INV. G01V3/08 G01V3/15

Applicant
Groundtracer B.V. te Harfsen

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 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 application
- ☐ Box No. VIII Certain observations on the application

Examiner
De Bekker, Ruben

Application number

WRITTEN OPINION

NL2002124

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

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

4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	4-6,19-21
	No:	Claims	1-3,7-18
Inventive step	Yes:	Claims	
	No:	Claims	1-21
Industrial applicability	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Reference is made to the following documents:

D1: FR 457 661 A (CONRAD SCHLUMBERGER [FR]) 23 September 1913 (1913-09-23)
D2: DE 196 24 323 A1 (RAMMNER RUDOLF [DE]) 2 januari 1998 (1998-01-02)
D3: DE 43 13 773 C1 (PRAKLA SEISMOS GMBH [DE]) 1 September 1994 (1994-09-01)
D4: WO 94/29752 A (APEX DATA SYSTEMS LTD [GB]; SCOTT ROY [GB]) 22 December 1994 (1994-12-22)
D5: DD 225 512 A1 (GEISELTAL BRAUNKOHLENWERK [DD]) 31 juli 1985 (1985-07-31)
D6: US-A-2 256 742 (JAY JAKOSKY JOHN) 23 September 1941 (1941-09-23)
D7: EP-A-0 426 563 (SCHLUMBERGER LTD [US]; SCHLUMBERGER SERVICES PETROL [FR]; SCHLUMBERGER) 8 mei 1991 (1991-05-08)
D8: DATABASE WPI week 198521 Thomson Scientific, London, GB; AN 1985-127389 XP002545069 -& SU 1 123 000 A (S YUZHMORGEOLOGIYA) 7 november 1984 (1984-11-07)
D9: US-A-3 916 298 (ULRICH DONALD E) 28 oktober 1975 (1975-10-28)
D10: FR-A-2 514 153 (CENTRE NAT RECH SCIENT [FR]) 8 April 1983 (1983-04-08)

2. Independent Claims

2.1 Claim 1

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.
The document D1 discloses a detection system for detecting submerged subjects in a covering material (the references in parentheses applying to this document) whereby the system comprises:
- a movable electrode capable of contacting the covering material (fig. 1 and 2);
- a reference electrode contacting the covering materia(fig. 1 and 2);
- means to measure the potential (fig.1 #G#);
- means to indicate a change in the measured potential.

2.2 Claim 3

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

The document D2 discloses a detection system for detecting submerged subjects in a covering material (the references in parentheses applying to this document) whereby the system comprises:
- a plurality of movable electrode capable of contacting the covering material (fig.1);
- means to measure the potential difference between said electrodes (fig.1, 2, 3);
- means to configure the connections of the electrodes to measure potential differences there between (abstract and claim 4);
- means to indicate a change in the measured potential (fig. 3).

2.3 Claims 16, 17 and 18

The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claims 16 (corresponding to claim 1), 17 and 18 (corresponding to claim 3), which therefore are also considered not new/inventive.

3. Dependent claims

3.1 Dependent claims 2, 4-15, 19-21 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, see documents D1-D10 and the corresponding passages cited in the search report.