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(54) **METHOD TO CONTROL THE FUNCTIONING OF A HEATING APPARATUS**

VERFAHREN ZUR STEUERUNG DER FUNKTION EINER HEIZUNGSVORRICHTUNG

PROCÉDÉ POUR COMMANDER LE FONCTIONNEMENT D'UN APPAREIL DE CHAUFFAGE

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Description

FIELD OF THE INVENTION

[0001] The present invention concerns a method to control the functioning of a heating apparatus, which is advantageously used to reduce phenomena of corrosion connected to the continued use of said apparatus.

[0002] In particular, the method according to the present invention can be implemented in a heating apparatus that comprises electric cathodic protection devices against the corrosion of containers, tanks or metal parts containing water, such as for example boilers.

BACKGROUND OF THE INVENTION

[0003] Devices are known, for the cathodic protection of heating apparatuses against corrosion, applicable to boilers or water-heaters.

[0004] In particular, a boiler-type apparatus is known for heating water, in which an electrode, also called anode, made for example of titanium, is immersed in the water contained in the boiler. An electric energy generator is connected with the positive pole to the anode and with the negative pole to the boiler to be protected from corrosion.

[0005] The current that is established between the anode and the boiler is periodically varied over time, in its intensity, for a determinate interval, with respect to the normal operating value and, during this variation, the difference in potential that is established between the two poles of the generator is measured.

[0006] The difference in potential measured is compared with a predetermined reference value, corresponding to a known value at which corrosion is impeded; any deviation with respect to this reference value is used to determine a current intensity to be applied between anode and boiler in order to obtain a difference in potential substantially equal to the predetermined reference value.

[0007] The known difference in potential value, hereafter referred to as protection potential, is determined in a known manner for example with reference to the Pourbaix diagram, or potential/pH diagram, which is a representation of the possible stable conditions at balance of an electrochemical system in aqueous solution. This model is used to predict the behavior of a metal material regarding corrosion, in this case referred to iron alloys but also applicable for other metals, although with the adoption of different potentials.

[0008] Knowing the material that the boiler is made of, it is therefore possible to determine the protection potential to be applied between anode and boiler.

[0009] This method of protection, although it guarantees adequate protection against corrosion in the boiler, is a system that is closed upon itself, and is not able to detect possible influences due to factors outside the heating apparatus, such as for example electrostatic loads, electric dispersions or other.

[0010] The prior art documents WO 2009/029287 A1, WO 2007/010335 A2 and US 6.080.973 A describe systems to control corrosion and/or other functioning anomalies for water tanks and heaters.

[0011] One purpose of the present invention is to perfect a method to control the functioning of a heating apparatus that is efficient and that allows to increase the working life of the heating apparatus in which it is applied.

[0012] Another purpose of the present invention is to perfect a method that increases the safety of the heating apparatus.

[0013] The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

[0014] The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

[0015] In accordance with the above purposes, a method according to the present invention is applied to control the functioning of a heating apparatus in which the heating apparatus comprises:

- a tank containing an electrolytic solution, for example water,
- an electrode immersed in the electrolytic solution,
- an electric energy generator connected to the electrode and to the tank,
- a controller provided with a measurer which measures at least one electric quantity which is established between the electrode and the tank.

[0016] The method provides to regulate the electric energy generator so as to keep in the electrolytic solution a protection potential having a first known value, substantially constant over time, suitable to guarantee the tank is protected from corrosion.

[0017] According to the present invention, the method comprises a step of detecting electric dispersions present in the tank, during which the measurer measures at least one electric quantity and the controller processes the at least one electric quantity in order to determine the presence of electric dispersions, which are to be avoided since they are the cause of the corrosive effect generated on the walls of the tank.

[0018] The detection step provides to detect alternating currents of electric dispersion.

[0019] The electric quantity measured is an electric current measured. In this case, the detection step comprises:

- a first step in which the electric energy generator alternates cyclically, between the electrode and the tank, a variation of potential that varies between a

first potential and a second potential, less than the value of the first potential, to establish the protection potential in the electrolytic solution;

- a second step in which the measurer performs a plurality of measurements of the current circulating between the electrode and the tank;
- a third step in which the controller verifies whether the values measured of the current circulating between the electrode and the tank remain variable around a balanced current and, in this case, the controller recognizes a condition wherein there is an absence of stray currents;
- a fourth step in which, if the values measured of the current circulating between the electrode and the tank are outside a balanced current, the controller verifies whether the frequency of the values of variation of the currents measured corresponds to the cyclicity of the stray currents and, in this case, recognizes the presence of electric dispersions deriving from alternating currents in the tank.

[0020] The present invention also concerns an electric cathodic protection device to be associated with a heating apparatus comprising a tank containing an electrolytic solution. The device comprises an electrode immersed during use in the electrolytic solution, an electric energy generator connected to the electrode and, during use, to the tank, and a controller provided with a measurer configured to measure an electric quantity which is established between the electrode and the tank. According to one feature of the invention, the controller comprises a processing unit configured to receive the data of the electric quantity detected by the measurer and to process the electric quantity in order to determine the presence of electric dispersions. The device also comprises indicators associated to the controller in order to indicate the presence of electric dispersions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a schematic representation of a heating apparatus that uses a control method according to the present invention;
- fig. 2a is a graph showing the development of potential over time that is applied to the heating apparatus during normal functioning, according to a first form of embodiment that is not part of the present invention;
- fig. 2b is a graph showing the difference of potential over time that is measured in the heating apparatus according to the first form of embodiment;
- fig. 3a is a graph showing the development of poten-

tial over time that is applied to the heating apparatus during normal functioning, according to a form of embodiment;

- fig. 3b is a graph showing the development of electric currents over time, which is detected in the heating apparatus according to the form of embodiment and in a functioning condition;
- fig. 3c is a graph showing the development of electric currents over time, which is detected in the heating apparatus according to the form of embodiment and in another functioning condition.

[0022] To facilitate comprehension, the same reference numbers have been used, where possible, to identify identical common elements in the drawings. It is understood that elements and characteristics of one form of embodiment can conveniently be incorporated into other forms of embodiment without further clarifications.

DETAILED DESCRIPTION OF SOME FORMS OF EMBODIMENT

[0023] A heating apparatus according to the present invention is indicated in its entirety by the reference number 10 and comprises an electric cathodic protection device 11 against corrosion.

[0024] In particular, the heating apparatus 10 comprises a tank 12 having a metal surface in contact with an electrolytic solution, such as water.

[0025] The electric cathodic protection device 11 in turn comprises an electrode 13 or anode, an electric energy generator 14 and a controller 16.

[0026] The electrode 13 can comprise a titanium bar, possibly activated with noble materials.

[0027] One form of embodiment that is not part of the present invention provides that the electric energy generator is a generator controlled in direct current, indicated hereafter as current generator 14.

[0028] The current generator 14 is in turn connected to the controller 16 which controls and manages the functioning of the current generator 14, and possibly signals particular functioning conditions of the heating apparatus 10, like the presence of electric dispersions.

[0029] More specifically, the controller 16 is provided with a measurer 15 that measures at least one electric quantity, configured to detect, for example, the values of current or electric voltage that are established in the electric cathodic protection device 11, in this case between the electrode 13 and the tank 12.

[0030] The measurer 15 can be a voltmeter, an amperometer, a wattmeter or simply a device to compare at least one of the electric quantities that are to be detected.

[0031] Some forms of embodiment provide that the controller 16 comprises a processing unit 19, provided to process the data detected by the measurer 15 and to signal possible anomalous functioning conditions due to the presence of electric dispersions.

[0032] To this purpose, the controller 16 can be associated to indicators 17, for example luminous indicators, each of which identifies a functioning condition of the heating apparatus 10.

[0033] In order to guarantee adequate protection against corrosion of the tank 12, during normal functioning of the heating apparatus 10, the current generator 14 maintains, between the electrode 13 and the tank 12, a protection potential that is substantially constant over time, indicated in fig. 2a as protection potential V_p .

[0034] The protection potential V_p is a known value, determined as described above as a function of the material that the tank 12 is made of, and with reference to the Pourbaix diagram.

[0035] Merely by way of example, if the tank 12 is made of steel, the protection potential V_p assumes a value comprised between 900mV and 1200mV.

[0036] The protection potential V_p to be established in the electrolytic solution can be generated iteratively by regulating the current supplied by the current generator 14 and detecting with the measurer 15 the establishment of electric currents inside the electric cathodic protection device 11.

[0037] The detection of electric currents identifies an unstable condition of the potential in the tank 12.

[0038] If the measurer 15 detects a considerable deviation in the electric currents with respect to the previous measurement, the controller 16 regulates the current supplied by the current generator 14 to take it to a constant value corresponding to a balanced current. With reference to figs. 2a, 2b, 3a, 3b and 3c, a method is described to control the functioning of the heating apparatus 10 and, in particular, to detect possible electric dispersions, for example stray currents that affect the tank 12 and that can contribute significantly to the corrosion inside it.

[0039] The stray currents may be small in entity, and therefore not produce a direct intervention of the electric safety devices, such as circuit breakers normally provided in the electric network.

[0040] Although they do not prejudice the overall safety of the electric network or the heating apparatus 10, stray currents are an important factor with regard to the creation of corrosive phenomena.

[0041] Such problems occur both with dispersions of direct current and also with dispersions of alternating current.

[0042] With reference to figs. 2a and 2b, a first form of embodiment is described of the method that is not according to the present invention, used to detect electric dispersions in direct current.

[0043] During the normal functioning of the heating apparatus 10, the controller 16 regulates the current supplied by the current generator 14, as described above, to maintain a balanced condition of the protection potential V_p between the electrode 13 and the tank 12.

[0044] There then follows a step to detect electric dispersions during which a controlled variation of the electric

energy supplied by the current generator is provided.

[0045] As shown in fig. 2a, the detection step occurs for an interval of time T shorter than the overall functioning time of the heating apparatus 10 according to the invention. Merely by way of example, it may be provided that the time interval T lasts about one minute and is executed with a cyclicity of twelve hours, that is, the detection is performed periodically twice a day.

[0046] Some forms of embodiment provide that, during the detection step, the supply of electric current to the current generator 14 is temporarily interrupted, and a measurement is made by the measurer 15.

[0047] It is clear that a temporary interruption of the time interval T , in the normal functioning of the heating apparatus 10, does not influence the protective effect against corrosion normally performed by the heating apparatus 10.

[0048] Other forms of embodiment provide only a reduction in the current supplied by the current generator 14, and not an interruption thereof.

[0049] During the detection, the measurer 15 detects the difference in potential, indicated hereafter as measured potential V_m . The measured potential V_m corresponds to the residual potential that is established between the electrode 13 and the tank 12.

[0050] From experiment analysis, Applicant has found that, in the absence of electric dispersions, the measured potential V_m or residual potential quickly moves to an asymptotic value substantially stable over time, as shown in fig. 2b, similarly to the curve in which the measured potential V_{m1} is detected.

[0051] If there are electric dispersions in the heating apparatus 10, it should be noted that the development of the measured potential V_m , instead of moving to an asymptotic potential over time, rapidly decreases, consequently facilitating corrosive action. This condition is shown by the curve in fig. 2b, in which the potential value V_{m2} is detected.

[0052] On the basis of these observations, the method not according to the present invention provides that the value of measured potential V_m is compared by the controller 16 with a reference potential V_r . Merely by way of example, the reference potential V_r is comprised between 20% and 40% of the protection potential V_p .

[0053] If the measured potential V_m is greater than the reference potential V_r , the controller 16 recognizes a functioning condition within the norm. To this end, in fig. 2b, the measured potential is indicated as V_{m1} and it can be seen that $V_{m1} > V_r$.

[0054] If the measured potential V_m is less than the reference potential V_r , the controller 16 recognizes the presence of harmful electric dispersions in the tank 12 and commands the activation of the indicators 17. In this condition, in fig. 2b the measured potential is indicated as V_{m2} and it can be seen that $V_{m2} < V_r$.

[0055] One form of embodiment of the present invention provides that the potential is measured after a period of time S from the moment when the controlled variation

of the protection potential V_p is commanded. The period of time S is evaluated, using theoretical experiments, also in relation to the stabilization time of the potential to move to the asymptotic value as described above.

[0056] One form of embodiment not according to the present invention provides that the period of time S is comprised between 30secs and 60secs. The period of time S , before measuring, prevents the detection of transitory effects and allows to temporarily stabilize the functioning of the heating apparatus 10.

Example

[0057]

- Value of the protection potential maintained during normal functioning of the heating apparatus 10, $V_p = -1000\text{mV}$;
- Value of the measured potential V_m , 60secs after the temporary interruption of the current generator 14, without direct current dispersions: $V_{m1} = -750\text{mV}$;
- Value of the measured potential V_m , 60secs after the temporary interruption of the current generator 14, in the presence of direct current dispersions: $V_{m2} = -290\text{mV}$.

[0058] Once the measured potential V_m has been measured, that is, after time interval T (fig. 2a), the heating apparatus 10 resume normal functioning, returning the difference in potential to the value of protection potential V_p .

[0059] With reference to figs. 3a, 3b and 3c, a form of embodiment of the method according to the present invention is described, used to detect electric dispersions in alternating current.

[0060] During the normal functioning of the heating apparatus 10, the controller 16 commands the current generator 14 to generate, between the electrode 13 and the tank 12, a difference in potential with a desired development and variable over time.

[0061] In particular, the current generator 14 alternates in very short times, that is, about every $200\mu\text{s}$, the generation of a first potential V_1 , and a second potential V_2 with a reduced intensity compared to the first potential V_1 .

[0062] The values of the first potential V_1 and the second potential V_2 are determined so as to obtain a polarization of the electrolytic solution to a value corresponding to the protection potential V_p .

[0063] Some forms of embodiment provide that the second potential V_2 is comprised between 30% and 70% of the first potential V_1 .

[0064] The variation in potential between the first potential V_1 and the second potential V_2 can occur with a square wave development of period P which can be for example about $200\mu\text{s}$ (fig. 3a).

[0065] In the normal functioning of the heating apparatus 10 and in the absence of electric dispersions due

to alternating currents, the controller 16 acts by modulating the current to be supplied to the current generator 14 so as to guarantee said protection potential V_p in the electrolytic solution.

[0066] During this step, the measurer 15 measures the electric quantities, in this case the current circulating in the electric cathodic protection device 11, to evaluate whether a balanced condition has been reached. The currents measured by the measurer 15 are indicated in figs. 3b and 3c, by I_m .

[0067] The balanced condition is represented by the consecutive detection of measured currents I_m substantially uniform over time (fig. 3b).

[0068] The measurements are taken by the measurer 15 when the potential at the heads of the current generator 14 assumes the value of said second potential V_2 .

[0069] In the absence of stray currents, therefore, the measured current values I_m are not subjected to big deviations, and remain confined in a band of values 18 that vary around a balanced current I_e as represented in fig. 3b.

[0070] In the presence of alternating current dispersions, the measurer 15 detects a fluctuation in the measured currents I_m which varies with a periodicity near or comparable to that of the alternating currents of electric dispersion.

[0071] To this purpose the data detected by the measurer 15 on each occasion are transmitted to the processing unit 19 to reconstruct the development over time of the measured currents I_m . The processing unit 19 is able to identify the cyclicity of the values detected which, in the presence of stray alternating currents, vary with a frequency substantially equal to, or a multiple of, the latter, for example with a frequency of 50Hz or 60Hz or multiples thereof.

[0072] It is quite clear that to allow a correct acquisition of the cyclicity of the stray currents, the frequency at which the measurements are made must be greater than the frequency of the stray currents.

[0073] If the processing unit 19 identifies a cyclical development of the measurements performed as indicated above, it commands the activation of the indicators 17 to signal to the user a condition of anomalous functioning.

[0074] Some forms of embodiment of the present invention can provide that the light indicators comprise a plurality of light sources, in this case (fig. 1) a red led 17a, a green led 17b and a yellow led 17c, each of which identifies a particular functioning condition of the heating apparatus 10.

[0075] The controller 16 described above can also provide a function of counting the working time of the electric cathodic protection device 11.

[0076] For example, it may provide that in the first electric feed to the heating apparatus 10, the indicators 17 indicate to the user said working time, for example an indication of the years of work that corresponds to the number of flashes of the red led 17a, and an indication of the months of work that corresponds to the number of

flashes of the green led 17b. To this purpose it may be provided that the controller 16 also comprises timer means to determine the working time.

[0077] In the normal functioning of the heating apparatus 10, and if no electric dispersions are detected, the green led 17b remains switched on. 5

[0078] If electric dispersions are detected, the yellow led 17c switches on and remains on until a maintenance operation is requested.

[0079] The red led 17a can be used to indicate conditions of excessive electric absorption by the heating apparatus 10, or to indicate short circuit conditions or an open circuit in the heating apparatus 10. 10

[0080] It is clear that modifications and/or additions of parts may be made to the method to control the functioning of a heating apparatus as described heretofore, without departing from the field and scope of the present invention. 15

[0081] It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of method to control the functioning of a heating apparatus, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby. 20 25

Claims

1. Method to control the functioning of a heating apparatus (10) which comprises a tank (12) containing an electrolytic solution inside it, an electrode (13) immersed in said electrolytic solution, an electric energy generator (14) connected to said electrode (13) and to said tank (12), and a controller (16) provided with a measurer (15) which measures at least one electric quantity which is established between said electrode (13) and said tank (12), said method providing at least a step in which said electric energy generator (14) is regulated to maintain, between said electrode (13) and said tank (12), a protection potential with a first value (V_p), known and substantially constant over time, suitable to guarantee the protection of said tank (12) from corrosion, **characterized in that** it comprises at least a step of detecting alternating currents of electric dispersions present in said tank (12), wherein said detection step comprises: 30 35 40 45

- a first step in which said electric energy generator (14) alternates cyclically, between said electrode (13) and said tank (12), a variation of potential that varies between a first potential value (V_1) and a second potential value (V_2), less than the value of said first potential (V_1), to establish said protection potential (V_p) in said electrolytic solution; 50
- a second step in which said measurer (15) performs a plurality of measurements of the cur-

rents circulating between said electrode (13) and said tank (12);

- a third step in which said controller (16) verifies whether the values measured (I_m) of the current circulating between said electrode (13) and said tank (12) remain variable around a balanced current with value (I_e) and, in this case, said controller (16) recognizes a condition wherein there is an absence of stray currents;

- a fourth step in which, if the values measured (I_m) of the current circulating between said electrode (13) and said tank (12) are outside a balanced current with value (I_e), said controller (16) verifies whether the frequency of the values of variation of said currents measured corresponds to the cyclicity of said stray currents and, in this case, recognizes the presence of electric dispersions deriving from alternating currents in said tank (12). 15 20 25

2. Method as in claim 1, **characterized in that** the measurements of said measured currents (I_m) are carried out when the potential assumes the value of said second potential (V_2). 25

3. Method as in claim 1 or 2, **characterized in that** said second potential (V_2) is comprised between 30% and 70% of said first potential (V_1). 30

Patentansprüche

1. Verfahren zur Steuerung der Funktionsweise einer Heizvorrichtung (10), welche einen Behälter (12) mit einer darin beinhaltenen Elektrolytlösung, eine in die Elektrolytlösung eintauchende Elektrode (13), einen mit der Elektrode (13) und dem Behälter (12) verbundenen elektrischen Energieerzeuger (14), und eine Steuereinheit (16), die mit einem Messgerät (15) versehen ist, welches wenigstens eine zwischen der Elektrode (13) und dem Behälter (12) angelegte elektrische Strommenge misst, umfasst, wobei das Verfahren wenigstens einen Schritt umfasst, in dem der elektrische Energieerzeuger (14) so gesteuert wird, dass er zwischen der Elektrode (13) und dem Behälter (12) ein Schutzpotenzial auf einem bekannten und zeitlich im Wesentlichen konstanten ersten Wert (V_p) hält, um einen Korrosionsschutz des Behälters (12) sicherzustellen, **dadurch gekennzeichnet, dass** es wenigstens einen Detektionsschritt von Wechselströmen der im Behälter (12) vorhandenen elektrischen Dispersionen umfasst, wobei der Detektionsschritt umfasst: 35 40 45 50

- einen ersten Schritt, in welchem der elektrische Energieerzeuger (14) eine Potentialänderung zwischen der Elektrode (13) und dem Behälter (12) zyklisch wechselt, um das Schutzpotenzial

(Vp) in der Elektrolytlösung zu erzielen, wobei die Potentialänderung zwischen einem ersten Potenzialwert (V1) und einem zweiten Potenzialwert (V2), der geringer als der Wert des ersten Potentials (V1) liegt, variiert;

- einen zweiten Schritt, in welchem das Messgerät (15) mehrere Messungen des zwischen der Elektrode (13) und dem Behälter (12) zirkulierenden Stroms durchführt;

- einen dritten Schritt, in welchem die Steuereinheit (16) verifiziert, ob die gemessenen Werte (Im) des zwischen der Elektrode (13) und dem Behälter (12) zirkulierenden Stroms rund um einen ausgeglichenen Wert mit einem Wert (Ie) herum variabel bleiben, und in diesem Falle erkennt die Steuereinheit (16) eine Bedingung, in der Leckströme bzw. Streuströme nicht vorhanden sind;

- einen vierten Schritt, in welchem die Steuereinheit (16), falls die gemessenen Werte (Im) des zwischen der Elektrode (13) und dem Behälter (12) zirkulierenden Stroms außerhalb eines ausgeglichenen Werts mit dem Wert (Ie) liegen, verifiziert, ob die Frequenz der Änderungswerte der gemessenen Ströme den Zyklen der Leckströme bzw. Streuströme entsprechen, und in diesem Falle erkennt die Steuereinheit (16) das Vorhandensein von elektrischen Dispersionen, die von Wechselströmen in dem Behälter (12) stammen.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet, dass** die Messungen der gemessenen Strömen (Im) durchgeführt werden, während das Potenzial den Wert des zweiten Potentials (V2) annimmt.

3. Verfahren gemäß Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das zweite Potenzial (V2) zwischen 30 % und 70 % des ersten Potentials (V1) liegt.

Revendications

1. Procédé de commande du fonctionnement d'un appareil de chauffage (10) comprenant un réservoir (12) contenant une solution d'électrolyte à l'intérieur, une électrode (13) immergée dans ladite solution d'électrolyte, un générateur d'énergie électrique (14) connecté à ladite électrode (13) et audit réservoir (12) et un dispositif de contrôle (16) pourvu d'un dispositif de mesure (15) lequel mesure au moins une quantité d'électricité qui s'établit entre ladite électrode (13) et ledit réservoir (12), ledit procédé prévoyant au moins une étape dans laquelle ledit générateur d'énergie électrique (14) est réglé pour maintenir, entre ladite électrode (13) et ledit réservoir (12), un

potentiel de protection avec une première valeur (Vp) connue et sensiblement constante dans le temps, apte à garantir la protection dudit réservoir (12) contre la corrosion, **caractérisé en ce qu'il** comprend au moins une étape de détection de courants alternatifs de dispersions électriques présentes dans ledit réservoir (12), cette étape de détection comprenant :

- une première étape dans laquelle ledit générateur d'énergie électrique (14) fait alterner cycliquement, entre ladite électrode (13) et ledit réservoir (12), une variation de potentiel qui varie entre une première valeur de potentiel (V1) et une seconde valeur de potentiel (V2) inférieure à la valeur dudit premier potentiel (V1), pour établir ledit potentiel de protection (Vp) dans ladite solution d'électrolyte ;

- une seconde étape dans laquelle ledit dispositif de mesure (15) réalise une pluralité de mesures des courants circulant entre ladite électrode (13) et ledit réservoir (12) ;

- une troisième étape dans laquelle ledit dispositif de contrôle (16) vérifie si les valeurs mesurées (Im) du courant circulant entre ladite électrode (13) et ledit réservoir (12) restent variables autour d'un courant équilibré ayant une valeur (Ie) et, dans ce cas, ledit dispositif de contrôle (16) reconnaît un état dans lequel il a absence de courants vagabonds ;

- une quatrième étape dans laquelle, si les valeurs mesurées (Im) du courant circulant entre ladite électrode (13) et ledit réservoir (12) sont à l'extérieur d'un courant équilibré ayant la valeur (Ie), ledit dispositif de contrôle (16) vérifie si la fréquence des valeurs de variation desdits courants mesurés correspond au caractère cyclique desdits courants vagabonds, et, dans ce cas, reconnaît la présence de dispersions électriques dérivant de courants alternatifs dans ledit réservoir (12).

2. Procédé selon la revendication 1, **caractérisé en ce que** les mesures desdits courants mesurés (Im) sont réalisées lorsque le potentiel prend la valeur dudit second potentiel (V2).

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** ledit second potentiel (V2) est compris entre 30% et 70% dudit premier potentiel (V1).

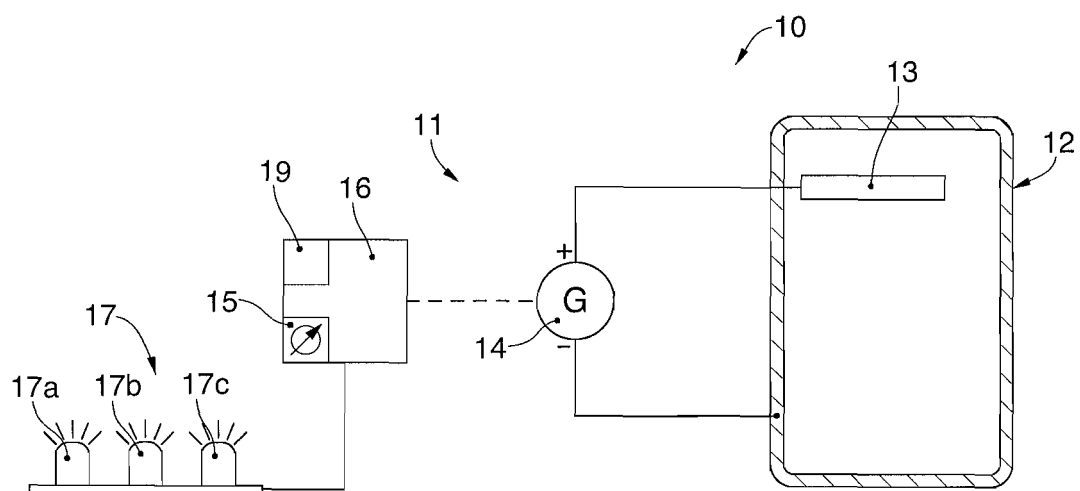


fig. 1

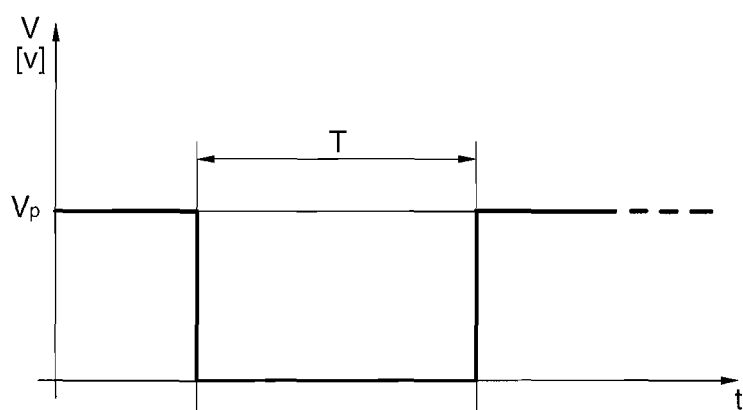


fig. 2a

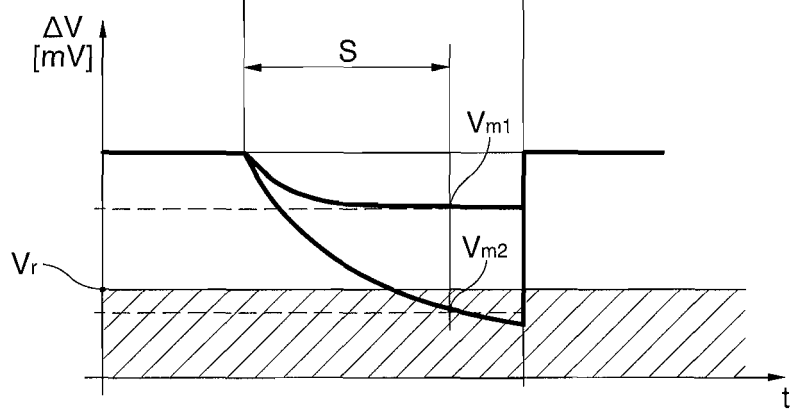
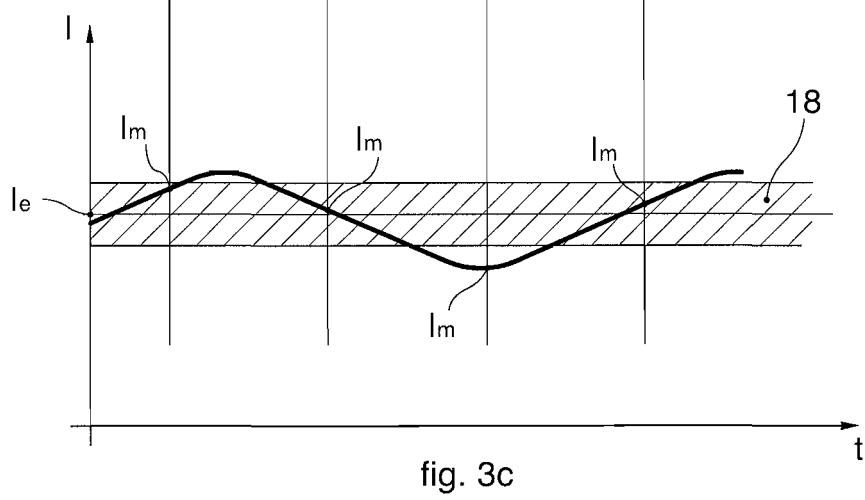
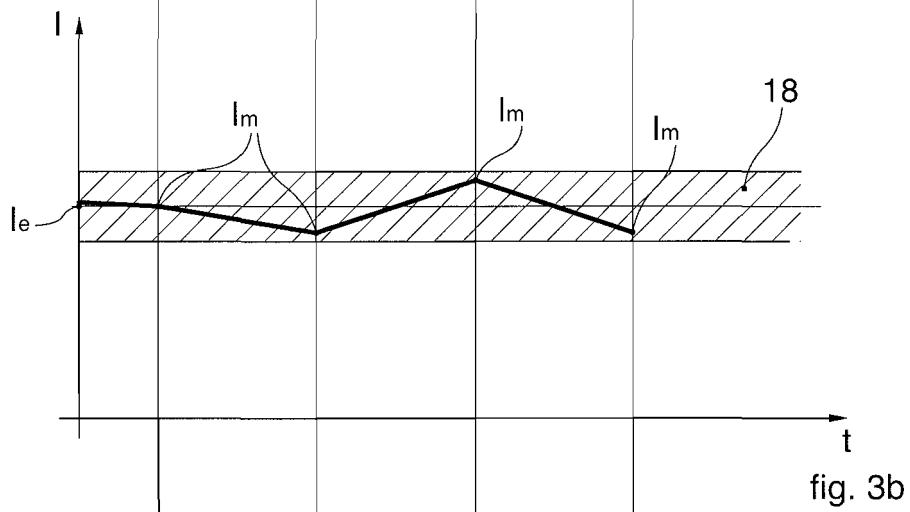
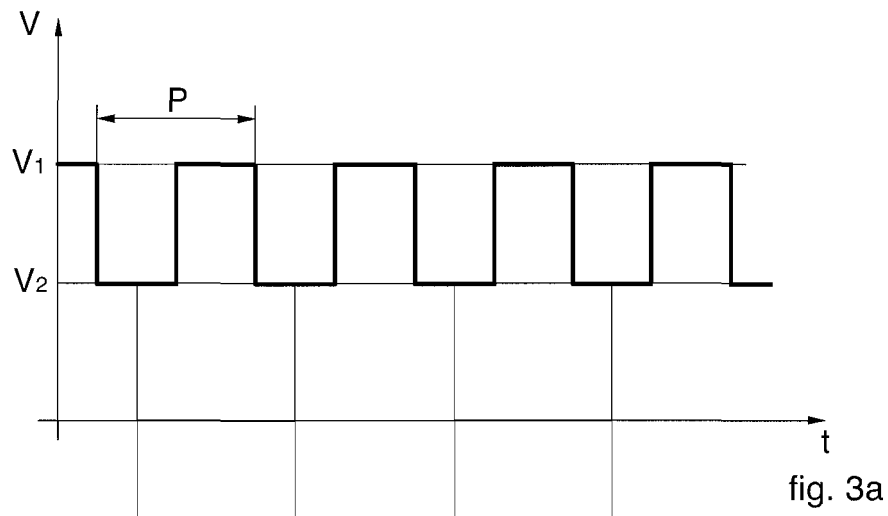


fig. 2b



REFERENCES CITED IN THE DESCRIPTION

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