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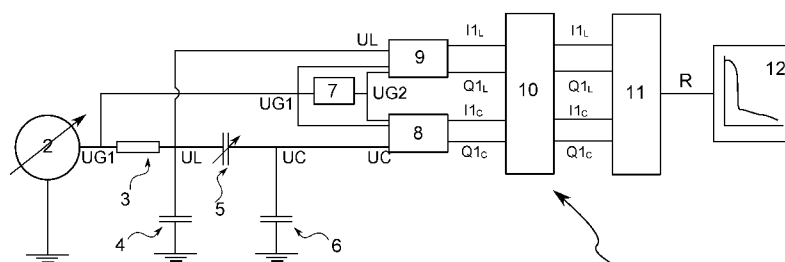
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(54) **Title:** MEASURING DEVICE FOR MEASURING CHANGE IN DIELECTRIC PROPERTIES IN AN ENVIRONMENT WITH VARIABLE DIELECTRIC PROPERTIES

**FIG.1**

(57) **Abstract:** The present invention relates a measuring device (1) for measuring change in the dielectric properties of an environment, comprising • a capacitive measuring circuit provided with an input and output electrical connection, wherein the measuring circuit comprises one or more coupled measuring capacitors (4, 5, 6) which are placeable in the environment and wherein the capacitance of the measuring capacitor (5) can be influenced by the dielectric properties of the environment, • an electric alternating signal generator (2) for applying a first electric alternating signal with a specific base frequency and a specific signal shape between the input and output connection of the measuring circuit, • a first signal processing means (7) for deriving a second electric alternating signal from the first signal, wherein the second signal has the same base frequency and signal shape as the first signal and is shifted 90° in phase relative to the first signal, • a first quadrature determining means (8) for calculating the inphase component I_{1c} and quadrature component Q_{1c} of an output voltage U_c across the output connection of the measuring circuit, wherein the first signal and second signal function as reference signals, • a second quadrature determining means (9) for calculating the inphase component I_{1L} and quadrature component Q_{1L} of an output voltage U_L across the input connection of the measuring circuit, wherein the first signal and second signal function as reference signals, • a calculation circuit (11) configured to calculate a ratio of the inphase components (I_{1c} , I_{1L}) and the quadrature components (Q_{1c} , Q_{1L}).

MEASURING DEVICE FOR MEASURING CHANGE IN DIELECTRIC PROPERTIES IN AN ENVIRONMENT WITH VARIABLE DIELECTRIC PROPERTIES

5 The present invention relates to a measuring device for measuring change
in the dielectric properties of an environment, comprising

- a capacitive measuring circuit provided with an input and output electrical
connection, wherein the measuring circuit comprises one or more coupled
measuring capacitors which are placeable in the environment and wherein the
- 10 capacitance of each of the measuring capacitors can be influenced by the dielectric
properties of the environment,
- an electric alternating signal generator for applying a first electric alternating signal
with a specific base frequency and a specific signal shape between the input and
output connection of the measuring circuit,
- 15 - a first signal processing means for deriving a second electric alternating signal
from the first signal, wherein the second signal has the same base frequency and
signal shape as the first signal and is shifted 90° in phase relative to the first signal,
- first quadrature determining means for calculating the in-phase component $I1_c$ and
quadrature component $Q1_c$ of an output voltage U_c across the output connection of
- 20 the measuring circuit, wherein the first signal and second signal function as
reference signals.

A measuring device according to the preamble is known in the field. The known measuring device is described in the European patent application EP 0922963.

25 The known measuring device is applied for the purpose of analysing the properties of liquids, such as for instance to determine the ageing of lubricating oils or moisture measurement in the ground.

The magnitude of the output voltage is defined by the formula:

$$30 \quad \text{Magnitude} = \sqrt[2]{I1_L^2 + Q1_L^2}$$

The change in magnitude of the output voltage U_C is a measure of the change in the capacitance of the measuring circuit, and thereby in the properties of liquids.

35 The known measuring device has the drawback that in many cases the

measuring device is not sufficiently accurate. Small changes in the dielectric properties of the environment result in a very small change in the in-phase component I_{1c} and quadrature component Q_{1c} , whereby the known measuring device is not accurate enough for many applications.

5 An example of an application for which the known measuring device is not suitable is the measurement of changes in synthetic resin in a resin infusion process as applied in the manufacture of a blade of a wind turbine. The changes in the dielectric properties of synthetic resin are very small, whereby the known measuring device misses subtle changes in the production process.

10 It is an object of the invention to provide a measuring device which is much more accurate than the known measuring device.

The invention provides for this purpose a device according to the preamble, characterized in that the measuring device is provided with

15 - second quadrature determining means for calculating the in-phase component I_{1L} and quadrature component Q_{1L} of an input voltage U_L across the input connection of the measuring circuit, wherein the first signal and second signal function as reference signals,

20 - a calculation circuit configured to calculate a ratio of the in-phase components (I_{1L} , I_{1c}) and quadrature components (Q_{1L} , Q_{1c}) of the output voltage (U_L) and input voltage (U_c).

The invention is based on the insight that the in-phase component and quadrature component of the output voltage are not only influenced by the measuring circuit, but that the measuring circuit itself also influences the input voltage. By determining said ratio only the influence of the measuring circuit, i.e. the change in the capacitance of the measuring capacitors, is determined.

In a first embodiment of the measuring device according to the invention the following formula is determinant for calculating the ratio:

$$RATIO = \sqrt{\frac{I1_L^2 + Q1_L^2}{I1_C^2 + Q1_C^2}}$$

35 The ratio calculates the relation between the magnitudes of the vectors in the phasor diagram of the input and output voltage. The change in the capacitance of the measuring capacitors resulting from the change in the dielectric can hereby be

tracked in advantageous manner.

In order to increase the dynamic range of the calculated ratio, in a second embodiment of the measuring device according to the invention the signal generator is provided with

- 5 - a second signal processing means for deriving a third electric alternating signal from the first signal, wherein the third signal has the same base frequency and signal shape as the first signal and is shifted 180° in phase relative to the first signal,
- a third signal processing means for deriving a fourth electric alternating signal from
- 10 the first signal, wherein the fourth signal has the same base frequency and signal shape as the first signal and is shifted 270° in phase relative to the first signal,
- third quadrature determining means for calculating the in-phase component $I2_c$ and quadrature component $Q2_c$ of an output voltage U_c across the output connection of the measuring circuit, wherein the third signal and fourth signal
- 15 function as reference signals,
- fourth quadrature determining means for calculating the in-phase component $I2_L$ and quadrature component $Q2_L$ of an input voltage U_L across the input connection of the measuring circuit, wherein the third signal and fourth signal function as reference signals,
- 20 wherein the calculation circuit is configured to calculate a ratio of the in-phase components ($I1_L$, $I2_L$, $I1_c$, $I2_c$) and quadrature components ($Q1_L$, $Q2_L$, $Q1_c$, $Q2_c$) of the output voltage (U_L) and input voltage (U_c).

As a result of these measures the cosine component of the input and output voltage is included as well as the sine component in the calculation of the ratio.

- 25 In this second embodiment the following formula is preferably determinant for calculating the ratio:

$$RATIO = \sqrt{\frac{(|I1_L| + |I2_L|)^2 + (|Q1_L| + |Q2_L|)^2}{(|I1_c| + |I2_c|)^2 + (|Q1_c| + |Q2_c|)^2}}$$

- 30 The calculation circuit of the measuring device according to the invention preferably comprises one or more analog to digital converters for converting the analog in-phase signals and analog quadrature signals to digital in-phase and digital quadrature signals, and one or more programmed circuits for calculating the ratio with the digital in-phase and quadrature signals.

- 35 In order to better track the changes in the ratio, the calculation circuit of the

measuring device according to the invention is preferably also configured to calculate a differential quotient of the ratio.

In order to also track the overall change in the ratio in a specific interval the calculation circuit of the measuring device is preferably also configured to calculate
5 an integral of the ratio over a fixed time interval.

In order to enable comparison to previous measurements, the measuring device according to the invention preferably comprises storage means for storing a ratio, differential of the ratio and/or integral of the ratio in relation to time during a measurement, and comparing means for comparing a ratio to a stored ratio.

10 All computational operations for calculating the ratio, differential quotient of the ratio and/or integral of the ratio are preferably performed in a programmable unit. The calculation circuit of the measuring device according to the invention preferably comprises for this purpose a computer, wherein the computer is configured to calculate data relating to the ratio, the differential quotient of the ratio
15 and/or the integral of the ratio, to display the data, store the data and compare the data to the stored data.

In the measuring device according to the invention the first signal preferably has a block-type signal shape. This signal shape is easy to generate using an electronic on/off switch.

20 In order to apply the measuring device according to the invention in industrial environments, the input and output electrical connection of the capacitive measuring circuit with identical components is protected against electrostatic discharge. Because of the use of identical components interference in the input voltage and output voltage, for instance phase shifts, is the same across the
25 measuring circuit, and thereby not relevant for the calculation of the ratio.

The measuring device according to the invention preferably comprises 1,..., n measuring capacitors which are each plate-like, wherein each measuring capacitor is formed by a first and a second flat conductor having a non-conductive material therebetween, wherein the first conductor of each measuring capacitor is
30 formed by a shared flat conductor, and the second conductors are arranged in a series on the non-conductive material, wherein the 1st, 3rd, 5th, etc. second conductors are connected electrically to each other, and the 2nd, 4th, 6th, etc. second conductors are connected electrically to each other. Each second conductor forms together with the first conductor a capacitor with a constant capacitance, while the
35 1st, 3rd, 5th, etc. second conductors and the 2nd, 4th, 6th, etc. second conductors

together form a capacitor with a variable capacitance, this capacitance being dependent on the dielectric properties of the environment.

The invention will be further elucidated with reference to the following figures, in which:

Figure 1 shows a schematic overview of the preferred embodiment of the measuring device according to the invention.

Figure 2A shows a measuring circuit for application in a measuring device according to Figure 1.

Figure 2B shows a top view of the measuring circuit according to Figure 2A.

Figure 3 shows a ratio R measured as a function of time using the measuring device according to the invention.

The same components are designated in different figures with the same reference numerals.

Figure 1 shows a schematic overview of the preferred a monument of measuring device 1 according to invention. Measuring device 1 is intended for the purpose of measuring change in the dielectric properties in an environment. Measuring device 1 comprises for this purpose a capacitive measuring circuit provided with an input and output electrical connection. The capacitive measuring circuit is formed by capacitors 4, 5 and 6, wherein the capacitance of capacitor 5 is variable and the capacitance of capacitors 4,6 is fixed. The capacitance of capacitor 5 can be influenced by the dielectric properties of the environment in which capacitor 5 is placed. Measuring device 1 further comprises an electric alternating signal generator 2 for applying a first electric alternating signal UG_1 with a specific base frequency and a specific signal shape between the input and output connection of the measuring circuit. The signal UG_1 is preferably a block wave with a frequency of 500-600 kHz.

The signal UG_1 from signal generator 2 is further transmitted via a complex impedance as signal UL to the input connection of the measuring circuit. The measured signal UC can be determined at the output connection of the measuring circuit.

Measuring device 1 further comprises a first signal processing means 7 which shifts an input signal 90° in phase. Using first signal processing means 7 a second electric alternating signal UG_2 is derived from the first signal UG_1 , wherein the second signal has the same base frequency and signal shape as the first signal

UG2 and is shifted 90° in phase relative to the first signal UG1.

Measuring device 1 further comprises first quadrature determining means 8 for calculating the in-phase component $I1_C$ and quadrature component $Q1_C$ of an output voltage U_C across the output connection of the measuring circuit, wherein the first signal UG1 and second signal UG2 function as reference signals.

Measuring device 1 additionally comprises second quadrature determining means 9 for calculating the in-phase component $I1_L$ and quadrature component $Q1_L$ of an input voltage U_L across the input connection of the measuring circuit, wherein the first signal UG1 and second signal UG2 function as reference signals.

Measuring device 1 comprises an analog to digital converter 11 for converting the analog components ($I1_L$, $I1_C$, $Q1_L$, $Q1_C$) to a digital variant.

The digital components ($I1_L$, $I1_C$, $Q1_L$, $Q1_C$) are transmitted to a calculation circuit 11 configured to calculate a ratio R of the in-phase components ($I1_L$, $I1_C$) and quadrature components ($Q1_L$, $Q1_C$) of the output voltage (U_L) and input voltage (U_C) in accordance with the formula:

$$RATIO = \sqrt{\frac{I1_L^2 + Q1_L^2}{I1_C^2 + Q1_C^2}}$$

The calculated ratio is subsequently transmitted to visual means 12 for displaying the calculated ratio R to a user of measuring system 1.

The calculation circuit can also be configured to calculate a differential quotient R' of the ratio R or an integral $\int R$ of the ratio over a fixed time interval.

Visual means 12 preferably comprise storage means for storing a ratio R , differential of the ratio R' and/or integral $\int R$ of the ratio in relation to time during a measurement, and comparing means for comparing a ratio to a stored ratio.

Figure 2A shows a measuring circuit 10 for application in a measuring device according to Figure 1, wherein measuring circuit 6 comprises measuring capacitors 10-1,..., 10-6, which are each plate-like. Each measuring capacitor 10-n is formed by a first shared conductor 11 and a second flat conductor 12-n with a non-conductive material 14 therebetween. The second conductors 12-1,..., 12-6 are arranged in a series on the non-conductive material 14. Conductors 12-1, 12-3 and 12-5 are connected electrically to each other by means of bridge 13-1. In addition, conductors 12-2, 12-4 and 12-6 are connected electrically to each other by means of bridge 13-2.

It will be apparent to the skilled person that conductor 11 and conductors 12-1,..., 12-6 form six separate capacitors.

However, the mutually adjacent conductors 12-1,..., 12-6 also form separate capacitors, the dielectric of which is formed by the environment around the
5 conductors 12-n. The electrical field is indicated in the figure by means of the dotted curved lines.

As soon as the dielectric properties in the electric field have changed, the capacitance of the formed capacitor changes.

Figure 2B shows a top view of measuring circuit 10 according to Figure 2A.
10 The strip-like conductors 12-1,..., 12-6 are shown more clearly in this figure.

Figure 3 shows a measured ratio R as a function of time using the measuring device according to the invention. The measurement has taken place in a resin infusion moulding process as applied for instance in the manufacture of blades of wind turbines. The graph of R shows different moments which cannot be
15 detected with known measuring means. The measurement shows the measured ratio R from a measuring device according to the invention, wherein the measuring circuit is arranged in the mould just below the contact surface between mould and the synthetic resin. The synthetic resin influences the capacitance of the measuring circuit in this process.

20 The graph shows the following moments:

- 100 - compression of the materials arranged in the mould by means of vacuum
- 101 - start of synthetic resin infusion
- 102 - infusion speed
- 103 - permeability
- 25 104 - vacuum reduction (decompression)
- 105 - cross-linking
- 106 - approaching glass transition temperature (T_g).

The above moments in a resin infusion process cannot be determined with any other measuring method.

30 Most quality measurements for processes in plastic processing take place after the process and are usually destructive, this in contrast to the measuring device according to the invention, which can measure during the plastic processing and can be built in.

The measuring device according to the invention is so sensitive that the
35 measuring circuit can be provided with a thin protective layer. The measuring circuit

need not therefore come into direct contact with the environment to be measured. This is a significant drawback of current measuring devices, since measurement takes place during the process by placing the measuring circuit in the (casting) moulds.

5 By applying high-frequency techniques and ESD-protected electronics and low measuring impedance of the measuring device caused by the high frequency the measuring device according to the invention is able to determine with high accuracy the dielectric changes in a process and transmit these to subsequent systems. As a result the ratio of the change is calculated on the subsequent system
10 and used in the process control of the subsequent system.

The invention is of course not limited to the described and shown preferred embodiment, but extends to any embodiment falling within the scope of protection as defined in the claims and as seen in the light of the foregoing description and accompanying drawings.

15

CLAIMS

- 1). Measuring device for measuring change in the dielectric properties in an environment, comprising
- 5 - a capacitive measuring circuit provided with an input and output electrical connection, wherein the measuring circuit comprises one or more coupled measuring capacitors which are placeable in the environment and wherein the capacitance of each of the measuring capacitors can be influenced by the dielectric properties of the environment,
- 10 - an electric alternating signal generator for applying a first electric alternating signal with a specific base frequency and a specific signal shape between the input and output connection of the measuring circuit,
- a first signal processing means for deriving a second electric alternating signal from the first signal, wherein the second signal has the same base frequency and
- 15 signal shape as the first signal and is shifted 90° in phase relative to the first signal,
- first quadrature determining means for calculating the in-phase component $I1_C$ and quadrature component $Q1_C$ of an output voltage U_C across the output connection of the measuring circuit, wherein the first signal and second signal function as reference signals,
- 20 **characterized in that** the measuring device is provided with
- second quadrature determining means for calculating the in-phase component $I1_L$ and quadrature component $Q1_L$ of an input voltage U_L across the input connection of the measuring circuit, wherein the first signal and second signal function as reference signals,
- 25 - a calculation circuit configured to calculate a ratio of the in-phase components ($I1_L$, $I1_C$) and quadrature components ($Q1_L$, $Q1_C$) of the output voltage (U_L) and input voltage (U_C).
- 2). Measuring device as claimed in claim 1, wherein the following formula is
- 30 determinant for calculating the ratio:

$$RATIO = \sqrt{\frac{I1_L^2 + Q1_L^2}{I1_C^2 + Q1_C^2}}$$

- 35 3). Measuring device as claimed in claim 1, wherein the signal generator is provided

with a second signal processing means for deriving a third electric alternating signal from the first signal, wherein the third signal has the same base frequency and signal shape as the first signal and is shifted 180° in phase relative to the first signal,

- 5 - a third signal processing means for deriving a fourth electric alternating signal from the first signal, wherein the fourth signal has the same base frequency and signal shape as the first signal and is shifted 270° in phase relative to the first signal,
- third quadrature determining means for calculating the in-phase component I_{2c} and quadrature component Q_{2c} of an output voltage U_c across the output
- 10 connection of the measuring circuit, wherein the third signal and fourth signal function as reference signals,
- fourth quadrature determining means for calculating the in-phase component I_{2L} and quadrature component Q_{2L} of an input voltage U_L across the input connection of the measuring circuit, wherein the third signal and fourth signal function as
- 15 reference signals,
- wherein the calculation circuit is configured to calculate a ratio of the in-phase components (I_{1L} , I_{2L} , I_{1c} , I_{2c}) and quadrature components (Q_{1L} , Q_{2L} , Q_{1c} , Q_{2c}) of the output voltage (U_L) and input voltage (U_c).

- 20 4). Measuring device as claimed in claim 3, wherein the following formula is determinant for calculating the ratio:

$$RATIO = \sqrt{\frac{(|I_{1L}| + |I_{2L}|)^2 + (|Q_{1L}| + |Q_{2L}|)^2}{(|I_{1c}| + |I_{2c}|)^2 + (|Q_{1c}| + |Q_{2c}|)^2}}$$

- 25 5). Measuring device as claimed in any of the foregoing claims, wherein the calculation circuit comprises one or more analog to digital converters for converting the analog in-phase signals and analog quadrature signals to digital in-phase and digital quadrature signals, and one or more programmed circuits for calculating the ratio with the digital in-phase and quadrature signals.

30

- 6). Measuring device as claimed in any of the foregoing claims, wherein the calculation circuit is also configured to calculate a differential quotient of the ratio.

- 7). Measuring device as claimed in any of the foregoing claims, wherein the
- 35 calculation circuit is also configured to calculate an integral of the ratio over a fixed

time interval.

8). Measuring device as claimed in any of the foregoing claims, wherein the measuring device comprises storage means for storing a ratio, differential of the
5 ratio and/or integral of the ratio in relation to time during a measurement, and comparing means for comparing a ratio to a stored ratio.

9). Measuring device as claimed in claim 8, to the extent dependent on claim 5,
10 wherein the calculation circuit comprises a computer, wherein the computer is configured to calculate data relating to the ratio, the differential quotient of the ratio and/or the integral of the ratio, to display the data, store the data and compare the data to the stored data.

10). Measuring device as claimed in any of the foregoing claims, wherein the first
15 signal has a block-type signal shape.

11). Measuring device as claimed in any of the foregoing claims, wherein the input and output electrical connection of the capacitive measuring circuit with identical components is protected against electrostatic discharge.

20

12). Measuring device as claimed in any of the foregoing claims, wherein the device comprises 1,..., n measuring capacitors which are each plate-like, wherein each measuring capacitor is formed by a first and a second flat conductor having a non-conductive material therebetween, wherein the first conductor of each measuring
25 capacitor is formed by a shared flat conductor, and the second conductors are arranged in a series on the non-conductive material, wherein the 1st, 3rd, 5th, etc. second conductors are connected electrically to each other, and the 2nd, 4th, 6th, etc. second conductors are connected electrically to each other.

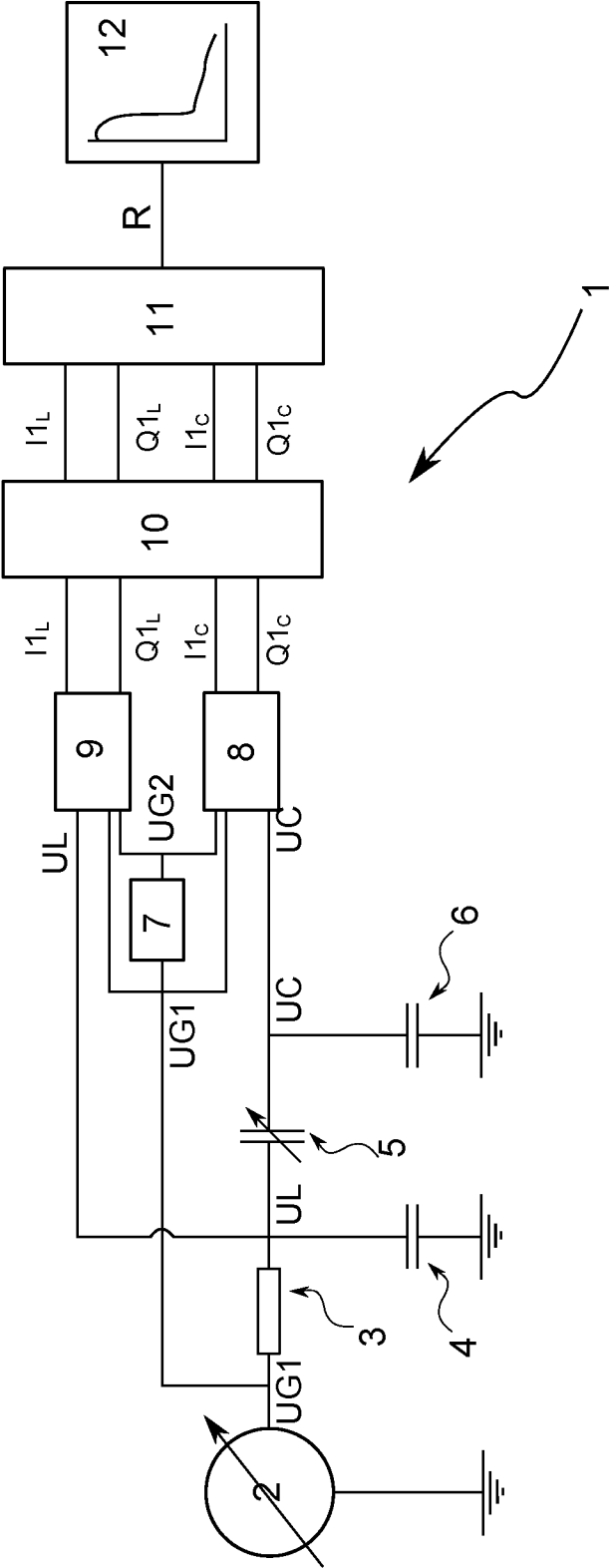
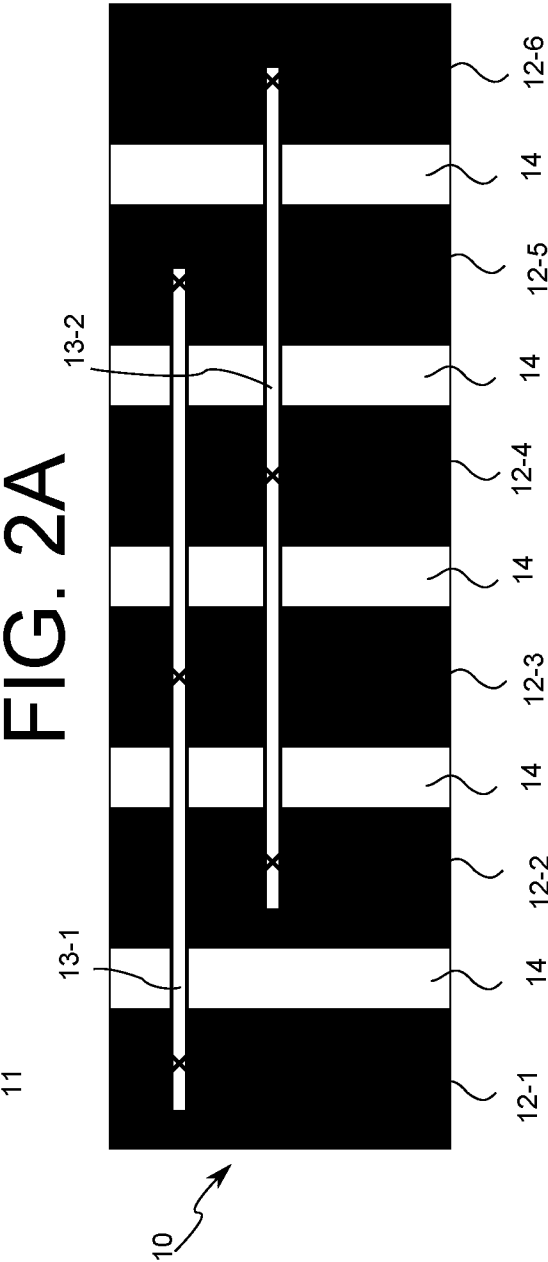
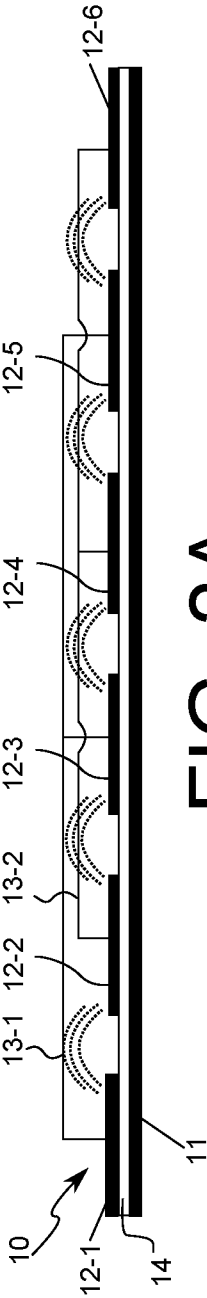
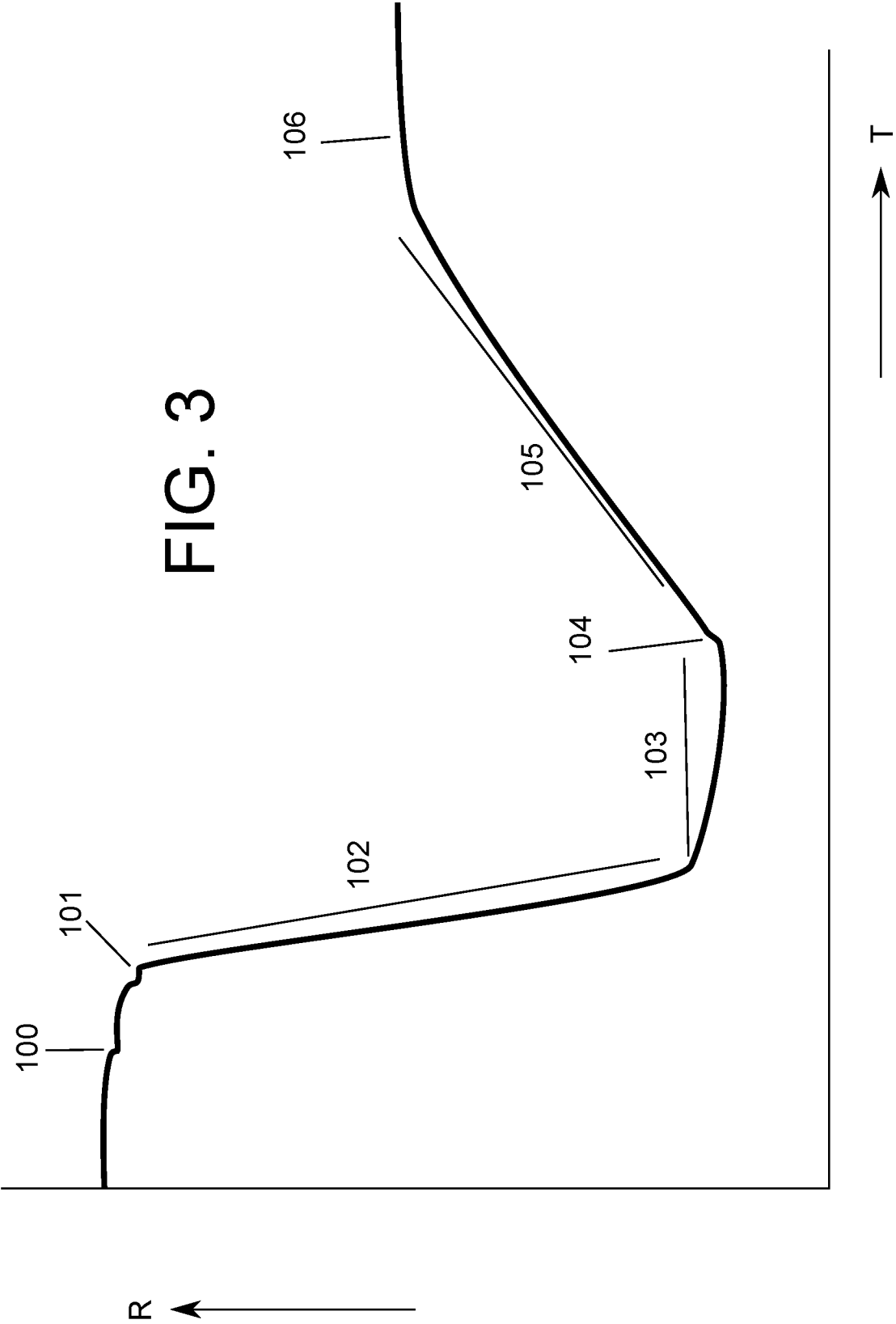


FIG.1





INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. G01N27/22 G01N33/44
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Huan L Lee: "The Handbook of Dielectric Analysis and Cure Monitoring", 2014, XP055250111, Boston, USA Retrieved from the Internet: URL: http://www.lambient.com/docs/DielectricAnalysisCureMonitoringHandbook.pdf [retrieved on 2016-02-15] Chapter 13	1-12
A	EP 0 922 963 A2 (FRAUNHOFER GES FORSCHUNG [DE]) 16 June 1999 (1999-06-16) cited in the application abstract	1-12



Further documents are listed in the continuation of Box C.



See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
EP 0922963	A2	16-06-1999	DE 19755417 A1	01-07-1999
			EP 0922963 A2	16-06-1999
