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(54) Benævnelse: **SENSOR ARRANGEMENT FOR POTENTIOMETRIC MEASUREMENT OF A LEVEL IN A CONTAINER**

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Wikipedia: "Buffer Amplifier", Wikipedia, 6. Juni 2017 (2017-06-06), XP055536597, Gefunden im Internet: URL:https://en.wikipedia.org/w/index.php?t itle=Buffer_amplifier&oldid=784124319 [gefunden am 2018-12-19]

Description

[0001] The invention relates to a sensor array for the potentiometric measurement of a fill level in a container.

[0002] Such sensor arrays have been known for a long time and are used, for example, to measure container contents in the chemical industry or in the food industry. With this measuring principle, the ratio of the voltage between one electrode end and the container wall or the counter electrode to the voltage fed between the two electrode ends is measured. A prerequisite for this is at least low conductivity of the filling material.

[0003] If an alternating voltage is used at a sufficiently high frequency, the aforementioned potentiometric measurement method can also be implemented purely physically via the dielectric behavior of the filling material, that is to say with the effect of its electrical capacitance.

[0004] Known from the publication EP 1 067 368 A1 is a level measuring device for measuring the level of a liquid medium located in a container with an essentially rod-shaped electrical probe which is, depending on the level, immersed to a greater or lesser extent in the medium to be measured during operation. Measuring electronics interacting with the probe include a feeding device for applying alternating electric current to the probe and a converter device. The converter device detects a level-dependent electrical measured value between the probe and the container containing the medium. An electrical output signal representing the electrical measurement quantity and thus the level is generated.

[0005] However, it is disadvantageous that the oscillator arrangement which generates the alternating voltage has a certain parasitic capacity to the electrode arrangement and to the environment and, due to asymmetries which are practically always present, overcouples a common mode component of the alternating voltage into the measurement voltage. For measurements on filling goods that have a low dielectric constant and thus a low capacity, the measurement becomes very inaccurate as the parasitic capacity of the oscillator arrangement can be compared with the capacity of the filling material and the error therefore increases very strongly, especially when the filling level drops. Furthermore, parasitic capacities, arising for example from shielding measures, have an incriminating effect on the measurement signal. In addition to the parasitic capacitive effects, inductive disturbances can also couple into the measurement signal, especially when using inductive components. The purpose of the invention is to provide a solution with which filling material with a low dielectric constant, which is

practically electrically non-conductive, such as pure alcohol or deionized water can be measured reliably, especially at low levels.

[0006] The scope of the invention is defined by the claims.

[0007] According to the invention, this is solved by a sensor array for the potentiometric measurement of a fill level in a container, comprising an oscillator arrangement for generating an alternating voltage, the oscillator arrangement being at least partially arranged in an electromagnetic shield arrangement, the potential of which is dependent on the potential of the container.

[0008] Due to the inventive solution, no voltage difference can form between the container, which, due to its size, represents the environment well, and the screen arrangement, so that any parasitic capacity that may be present cannot take effect.

[0009] For the measurement, the sensor array according to the invention has an electrode connected to the oscillator arrangement and designed to be insertable into the container and which protrudes from the shield arrangement.

[0010] In order to make the coupling of the container to the shield arrangement efficient, the shield arrangement is connected to the container via an impedance converter.

[0011] According to the invention, a distal end of the electrode is connected to an internal reference mass of the impedance converter.

[0012] The solution according to the invention can be further improved with the following refinements and developments, each of which is advantageous in itself and can be combined with one another as desired.

[0013] The potential of the screen arrangement can track the potential of the container. Such a solution is particularly simple and effective. For this purpose, a tracking device can be present which tracks the potential of the screen arrangement to the potential of the container. Tracking here means that the potential of the screen arrangement is coupled to the potential of the container via a predetermined equation or a predetermined law. In particular, there may be a constant difference between the two.

[0014] In particular, the screen arrangement can be at the potential of the container when the measurement signal is zero. The measurement signal can be zero, for example, if the oscillator arrangement is not in operation or if the container has a certain filling level, for example completely full or completely empty. For testing, the measurement signal can of course also be artificially brought to zero.

[0015] The oscillator arrangement can comprise an alternating voltage source, the alternating voltage source being arranged in the shield arrangement in order to achieve a good shielding effect.

[0016] Furthermore, the oscillator arrangement can comprise a transformer arrangement, the transformer arrangement being arranged in the shield arrangement in order to achieve a good shielding effect.

[0017] In particular, the oscillator arrangement can be arranged completely in the shield arrangement. The coupling to the outside is therefore minimal.

[0018] To achieve the best possible shielding, the entire electronics of the sensor array are arranged in the shield arrangement.

[0019] In an advantageous embodiment, the oscillator arrangement is at least partially, preferably completely, arranged outside the electrode. As a result, the electrode can be designed particularly small and compact. Other parts of the electronics can also be arranged outside the electrode. In particular, only one current conductor of the oscillator arrangement and / or one feedback conductor used for voltage tapping can be arranged in the electrode.

[0020] The impedance converter can be arranged in the shield arrangement. The impedance converter can be connected to the container at an input. The input can be high-impedance. Furthermore, the impedance converter can be connected at its output to the shield arrangement. The output can be low-resistance. The impedance converter can be a tracking device for tracking the potential of the shield arrangement.

[0021] If the container is connected to the input of the impedance converter at the same time, a decoupled measurement signal can be tapped at the output, which has the internal reference mass as the base potential.

[0022] In order to reduce an inductive coupling, a current conductor of the oscillator arrangement and / or a feedback conductor serving for voltage tapping can be guided in the electrode at a small distance from a wall of the electrode, in particular via insulation adjacent to the electrode. To prevent crosstalk between the two, they can be guided so that their distance from each other is maximum.

[0023] In an advantageous embodiment, the sensor array can be designed in such a way that a temperature measurement at the distal end of the electrode is also possible. For this purpose, the sensor array can comprise at least a first electrically conductive element made of a first material and at least a second electrically conductive element made of a second material, the first electrically conductive element and the second electrically conductive element lying one

behind the other along a current path, with a transition point arranged between the first electrically conductive element and the second electrically conductive element at a distal end of the electrode and further transition points arranged at least at one temperature reference point distanced from the distal end. Further transition points can be arranged outside the electrode or at an upper end of the electrode.

[0024] Such further transition points can in particular have a constant temperature, for example by being tempered. The temperature can be determined by measuring the voltage between the two elements.

[0025] In order to amplify the signal for the temperature measurement, an amplifier arrangement can be present.

[0026] The first material can be constantan, the second material can be stainless steel.

[0027] Furthermore, the sensor array can have a DC voltage filter for separating the DC voltage from the signal for the temperature measurement, as preferably only this is used to determine the temperature.

[0028] In an embodiment that is particularly compact, the electrode can comprise the first electrically conductive element. Therefore there is no need for a separate element. The first electrically conductive element can be formed by the electrode or at least by part of the electrode.

[0029] In order to determine the temperature, the sensor array can comprise a temperature measurement module with an input, which is configured to tap the voltage between the first electrically conductive element and the second electrically conductive element, wherein at an output at the temperature measurement module an output signal can be issued which is representative of the temperature.

[0030] In another embodiment, the raw signal can be routed to the outside and an analysis can only be carried out outside.

[0031] As interference signals are different in phase from the alternating voltage of the oscillator arrangement, the sensor array can have a filter module that filters out from the measuring voltage a part of the alternating voltage which is in phase with the oscillator arrangement and / or a part of the alternating voltage that is out of phase. This makes it possible to analyze only the measurement signal or only the interference signal.

[0032] Such a filter module can be implemented, for example, with electrical components or can be designed as a software module, in which a separation of the in-phase part and the out-of-phase part takes place in one software.

[0033] For evaluation, the sensor array can have an analysis unit that evaluates the in-phase part and/or the out-of-phase part.

[0034] For the voltage supply of parts lying within the shield arrangement, the sensor array can have a transformer which has a primary side lying outside the shield arrangement and a secondary side lying inside the shield arrangement. The primary side and the secondary side are advantageously galvanically isolated from each other. For example, there may be an air gap between the primary side and the secondary side. Electromagnetic coupling can take place via the air gap. A primary coil may be present on the primary side, and a secondary coil may be present on the secondary side. The primary coil can have a shield, which in particular can be at the potential of the container. The secondary coil can have a shield, which can be at the potential of the shield arrangement. In particular, each of the shields can comprise a thin-layer metal film. Such a voltage supply can in particular also be designed wirelessly.

[0035] In the following, the invention is explained in more detail by means of examples of advantageous embodiments with reference to the drawings. The advantageous further developments and embodiments shown here are independent of each other and can be combined with each other as required in the application.

[0036] It shows:

Fig. 1 a schematic representation of an embodiment; and

Fig. 2 a schematic representation of a detail of the embodiment from Fig. 1.

[0037] Fig. 1 shows a version of a sensor array 1 for potentiometric measurement of a level 2 in a vessel 3. For this purpose, an alternating voltage is generated between an upper or proximal end 46 and a lower or distal end 45 of an electrode 4 by an oscillator arrangement 5, which comprises an unspecified alternator 51 and an unspecified transformer arrangement 52.

[0038] The electrode 4 protrudes into the container 3 and is immersed in the filling material, which for example is here a liquid. The fill level 2 can be determined by comparing the voltage drop between a lower electrode potential 27 and an upper electrode potential 28 with the voltage between the lower electrode potential 27 and the container 3 and evaluating the result. As these voltages are low, amplifiers 12 and 10 are used to prepare them for a subsequent evaluation circuit, for example with a µprocessor with ADC.

[0039] The problem here is that the signal is relatively weak and normally parasitic capacities which occur in relation to the environment influence the signal.

[0040] According to the invention, this is prevented or reduced as the oscillator arrangement 5 is arranged within a shield arrangement 7, the potential of which is tracked to the potential of the container 3. The potential of the screen arrangement 7 is therefore dependent on the potential of the container 3. The parasitic capacities are still there, but they no longer interfere with the measurement due to the lack of potential difference.

[0041] According to the invention, this is solved in that the lower electrode potential 27 is connected to the internal reference mass 17 of an impedance converter 6. The input of the impedance converter 6 is connected to the potential 16 of the container 3, the container 3, due to its size, is representing the environment well. It should be noted here that the container 3 is normally very large compared to the sensor array 1.

[0042] The shield arrangement 7 is connected to the output of the impedance converter 6. With a measurement signal of zero, the shield arrangement 7 is therefore at the same potential as the container 3.

[0043] The entire sensor array 1 lies within the shield arrangement 7, i.e. in an interior space 26, which is formed by the shield arrangement 7. An evaluation unit 100 lies outside the shield arrangement 7 and is connected to the sensor array 1 via an energy transmission arrangement 60 with an energy sending arrangement 61 and an energy reception arrangement 62 and via a signal transmission arrangement 70 with a signal sending arrangement 71 and a signal reception arrangement 72. The energy transmission arrangement 60 and the signal transmission arrangement 70 can each be designed so that transmission takes place without electrical contact, for example via light, in particular laser.

[0044] The output of the impedance converter 6 is also connected to the input of a measurement signal amplifier 10, which amplifies and issues the measurement signal. A reference mass 37, which is the same as the internal reference mass 17, serves as the reference of the measurement signal amplifier 10. The level signal UL, which is evaluated, is the potential between the output of the measurement signal amplifier 10 and the internal reference mass 37 or 17.

[0045] To also enable a temperature measurement at the distal end 45 of the electrode 4, a feedback conductor 18 for the lower electrode potential 27 is made of a different material than the electrode 4. The feedback conductor 18 provides a first element 91 from a first material, such as constantan, which is connected to a second element 92, namely a part 41 of the wall 44 of the electrode 4, which is made of a second material such as stainless steel. The first element 91 and the second element 92 are connected to one another at a first transition point 81 located at the distal end 45 of the electrode 4 and lie one behind the other along a current

path 93. A second transition point 82 is located outside the container 3 at the upper or proximal end 46 of the electrode. A largely constant temperature prevails at the proximal end 46, whereas the temperature at the distal end 45 can change depending on the temperature of the liquid or the filling material. As the second element 92 is made of a different material than the first element 41, there is a potential difference between the first transition point 81 and the second transition point 82, which can be used to determine the temperature. Only the direct voltage component of the measurement voltage is used. A temperature measuring module 85 has a reference voltage amplifier 12, which amplifies the direct voltage measured between the first element 91 and the second element 92 and applied at input 86. The reference voltage UR at the output 87 with respect to a reference mass 47, which is again the same as the internal reference mass 17, is representative of the measured temperature.

[0046] Apart from the current conductor 25 of the oscillator arrangement 5 and the feedback conductor 18 serving for voltage tapping, all parts of the electronics, in particular the oscillator arrangement 5, are arranged outside the electrode 4.

[0047] In an embodiment not shown, a filter module can also be present, which filters out a part in-phase with the oscillator arrangement and/or an out-of-phase part of the alternating voltage from the measurement voltage. The in-phase component is the useful signal and the in-phase component is the interference component. Such a filter module can be implemented by electrical components. In another embodiment, a filtering process can also be carried out using software.

[0048] A cross section through the electrode 4 is shown in Fig. 2. In order to keep interference signals as small as possible, the feedback conductor 18 for the lower electrode potential 27 and the current conductor 25, with which the alternating voltage is brought to the lower electrode potential 24, should be arranged as close as possible to the wall 44 of the electrode 4. In addition, the distance 19 between the two should be as large as possible to keep crosstalk low.

Nye krav

1. Sensoranordning (1) til potentiometrisk måling af et niveau (2) i en beholder (3), som omfatter en oscillatoranordning (5) til frembringelse af en vekselspænding, hvorved oscillatoranordningen (5) i det mindste til dels er placeret i en elektromagnetisk afskærmende afskærmningsanordning (7), hvis potential er afhængig af beholderens (3) potential, hvorved sensoranordningen (1) indeholder en med oscillatoranordningen (5) forbundet elektrode (4), der er udformet således, at den kan sættes ind i beholderen (3) og rager ud af afskærmningsanordningen (7),

   kendetegnet ved, at

   afskærmningsanordningen (7) via en impedansomformer (6) er forbundet med beholderen (3) og en distal ende (42) af elektroden (4) er forbundet med en intern referencemasse (17) i impedansomformeren (6).

2. Sensoranordning (1) i henhold til krav 1, **kendetegnet ved, at** afskærmningsanordningens (7) potentiale er ført efter beholderens (3) potentiale.

3. Sensoranordning (1) i henhold til et af kravene 1 eller 2, **kendetegnet ved, at** oscillatoranordningen (5) omfatter en transformeranordning (52) og/eller en vekselspændingskilde (51) og transformeranordningen (52) og/eller vekselspændingskilden (51) er placeret i afskærmningsanordningen (7).

4. Sensoranordning (1) i henhold til et af kravene 1 til 3, **kendetegnet ved, at** sensoranordningen (1) omfatter en transformer, der har en uden for afskærmningsanordningen (7) liggende primærside og en inden for afskærmningsanordningen (7) liggende sekundærside, hvorved primærsiden og sekundærsiden er galvanisk adskilt fra hinanden.

5. Sensoranordning (1) i henhold til et af kravene 1 til 4, **kendetegnet ved, at** sensoranordningen (1) omfatter mindst et elektrisk ledende element (91) i et første materiale og mindst et andet elektrisk ledende element (92) i et andet materiale, hvorved det første elektrisk ledende element (91) og det andet elektrisk ledende element (92) ligger langs med en strømbane (93), hvorved et overgangspunkt (81) mellem det første elektrisk ledende element (91) og det andet elektrisk ledende element (92) er placeret i

en distal ende (45) af elektroden (4), og yderligere overgangspunkter (82) er placeret i et temperaturreferencepunkt med afstand fra den distale ende (45).

6. Sensoranordning (1) i henhold til krav 5, **kendetegnet ved, at** sensoranordningen (1) omfatter et temperaturmålemodul (85) med en indgang (86), der er udformet til at udtage spændingen mellem det første elektrisk ledende element (91) og det andet elektrisk ledende element (92), hvorved der på en udgang (87) af temperaturmålemodulet (85) kan udgives et udgangssignal, der er repræsentativ for temperaturen

7. Sensoranordning (1) i henhold til et af kravene 1 til 6, **kendetegnet ved, at** sensoranordningen(1) omfatter et filtermodul, som filtrerer en vekselspænding ud af målespændingen, der er i fase og/ eller ikke i fase med oscillatoranordningen (5).

DRAWINGS

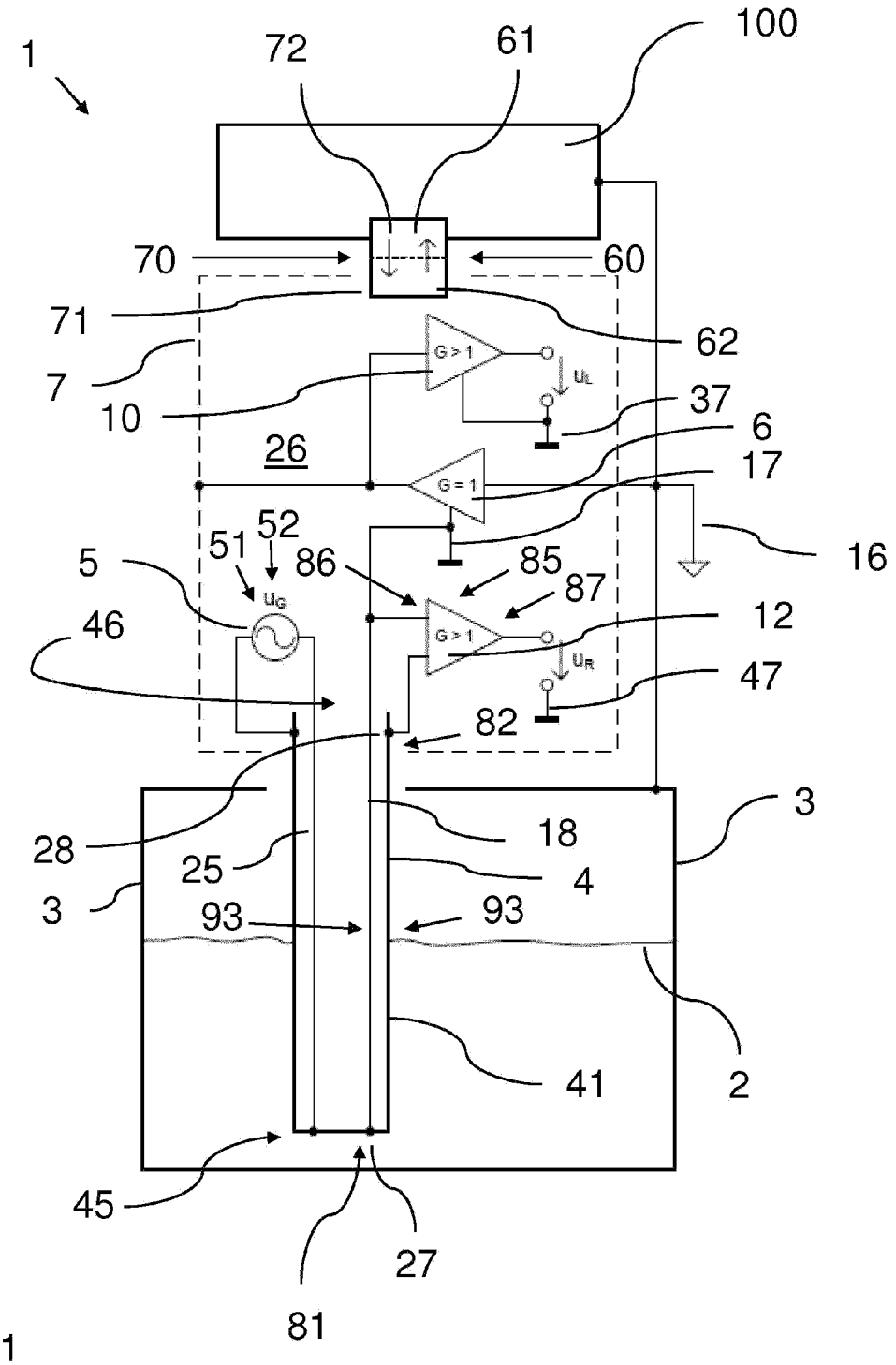

Fig. 1

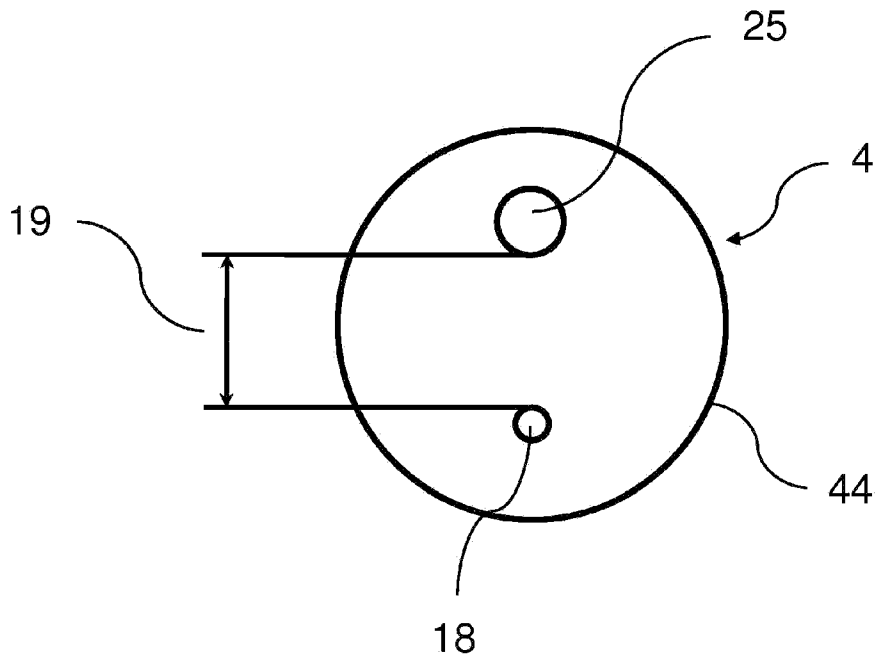

Fig. 2