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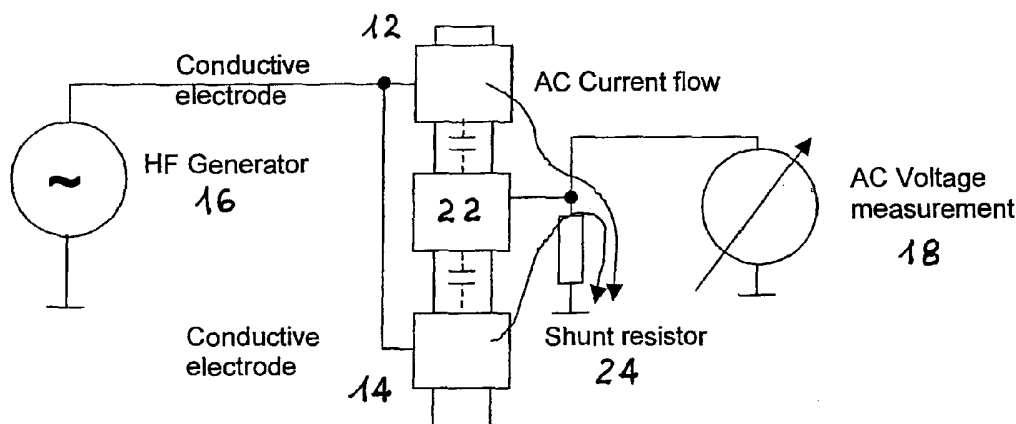
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(54) Title: A CONTACTLESS WATER CONDUCTIVITY MEASURING DEVICE



(57) Abstract: A contactless water conductivity measuring device comprising at least two conducting electrodes which are applied on the external surface of the pipeline 10 wherein the water flows and are connected in an electric circuit comprising an HF generator. The conducting electrodes (12,14) consist each of a metallic strip wrapped around the pipeline (10) and are spaced apart each other along the longitudinal axis of the pipeline.

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A CONTACTLESS WATER CONDUCTIVITY MEASURING DEVICE

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The present invention refers to a new contactless water conductivity measuring device, which may be employed in many technical field, particularly in appliances like washing machines and similar.

As it is known, conductivity is normally measured by using two metal
15 electrodes by means of which a voltage is applied, while the current flowing through a solution, as generated by such voltage application, is at the same time measured by means of said electrodes. However, when the electrodes are plunged in the solution, serious drawbacks occur like corrosion of electrodes, oxidation, electrolysis and potential electrical
20 hazard for eventual circuit faults.

EP 1010976 discloses a non-contact measuring device for measuring the specific conductivity of electrolytic solutions. The device comprises two coupling electrodes, each consisting of a good conducting substrate on whose sensor side a very thin layer of ceramic dielectric is applied. This
25 means that the ceramic layer works as an electric insulation and as a protection against the liquid being measured. Indeed, the device may be also used as an immersion sensor.

The described electrode is complex to manufacture and the process to control the correct insulation is critical too. Moreover, the measurement is
30 carried out at a frequency in the low frequency range, wherein the flowing electric current is assessed on the basis of the voltage drop at a measuring resistance. Therefore, the device sensibility is poor.

US 5,017,879 discloses an apparatus for use in the capacitive

measurement of the void fraction in a flowing liquid. An assembly of at least two electrodes is spaced apart around the exterior of the body defining a flow passage such that the capacitance of the electrode assembly is a function of the dielectric constant of the material within the passageway. Apart from the different technical field of application, this apparatus teaches to use electrodes whose surfaces are diametrically faced each other with respect to the longitudinal axis of the flow passage. Such an assembly does not allow an easy regulation of the distance between two electrodes, so as it is quite difficult to set the apparatus sensibility.

A first scope of the present invention is to provide a contactless water conductivity measuring device in which coupling capacities are improved thanks to the shape of the electrodes, and the electric field inside the measurement volume is thus regular, with little fringes, and can create a high displacement current inside the liquid under measurement.

Another scope is to provide a device to get a linear, reproducible, high-sensitivity responses.

Again a scope of the invention is to provide a device which uses a very simple and reliable kind of electrodes, but securing a high degree of insulation in order to satisfy stringent requirements for different applications.

These and other scopes of the present invention are obtained by the device as defined in claim 1 and in the subsequent dependent claims.

Features and advantages of the present invention will be clearly apparent from the following description, given as non limiting example, with reference to the annexed drawings, wherein:

- Figure 1 shows a schematic view of a first embodiment of the present invention;
- Figure 2 shows a schematic view of a second embodiment of the present invention;
- Figure 3 shows a functional block diagram of a contactless water conductivity measuring device according to the present invention.

The basic principle of a contactless water measuring device according

the present invention is to measure the capacitive current flowing through the water at high frequency.

A first embodiment of the device is shown in Figure 1, wherein in a pipeline 10, made of a non conductive material, water or a similar fluid flows and its conductivity should be measured in order to obtain valuable information for the functioning of an associated apparatus. For instance, in a washing machine or a dishwasher it is possible to check the presence of detergent in the washing water and, consequently, to set the rinsing cycle appropriately. Another example is represented by the use of a device according to the present invention in an ice-maker to detect the quantity of salts within the inlet water.

As shown in Figure 1, two electrodes 12 and 14, each made in the shape of a flat metallic strip, are wrapped around the external surface of the pipeline 10, spaced apart each other along the longitudinal axis of the pipeline. Preferably, copper foil strips are used as electrodes. However, copper wires are also usable; in this case each electrodes should be done by few turns over pipeline (about 10 mm. width).

As a result, the pipeline and the electrodes become a capacitor. High frequency (few MHz) is applied to the capacitor by means of an electric circuit comprising an HF generator 16 and is measured by an AC measuring apparatus (ammeter) 18. Such a circuit is a direct current measurement circuit and the electric current will depend from the pipeline characteristics (size and material) and from water conductivity.

Figure 2 shows a second embodiment of the device according to the invention. This embodiment utilises three electrodes 12, 14, 22 and measure the voltage drop on a shunt resistor 24 by means of an AC voltage measurement apparatus (voltmeter) 26. The shunt resistor 24 is connected to the third electrode 22. Voltage drops on the resistor 24 are proportional to the current through the pipeline 10.

In each embodiment an electronic board (not represented), to which the electrodes are connected, controls the signals and the measuring system. The electronic board is of known kind and is adjusted following the different type of apparatus to which the device has to be applied.

Figure 3 shows a functional block diagram of a device according to the present invention. The diagram shows a first part (comprising a voltage source, a frequency divider and a filter) which is common to the different embodiments of Figure 1 and Figure 2. Then, starting from the electrode, the diagrams branches out in two ways corresponding to the two embodiments referred to in Figure 1 and Figure 2, respectively. Of course, the two different embodiments are alternative each other and the choice of the right one has to be made according to the convenience.

The advantages of a device as described are quite evident.

Electrodes are insulated and kept physically away from the environment in which the measured specimen is contained. The layout avoids common problems of conductivity measurements with immersed electrodes as: corrosion, oxidation, chemical reaction on their surface, scale and/or contaminant deposition. These kinds of phenomena are known to be the major causes of reduction of linearity, repeatability and lifetime of common sensors because they modify the sensing unit characteristics thus impairing measurements.

Safety is increased since electrical components are sealed and not in contact with water or any other liquid subject to measurement.

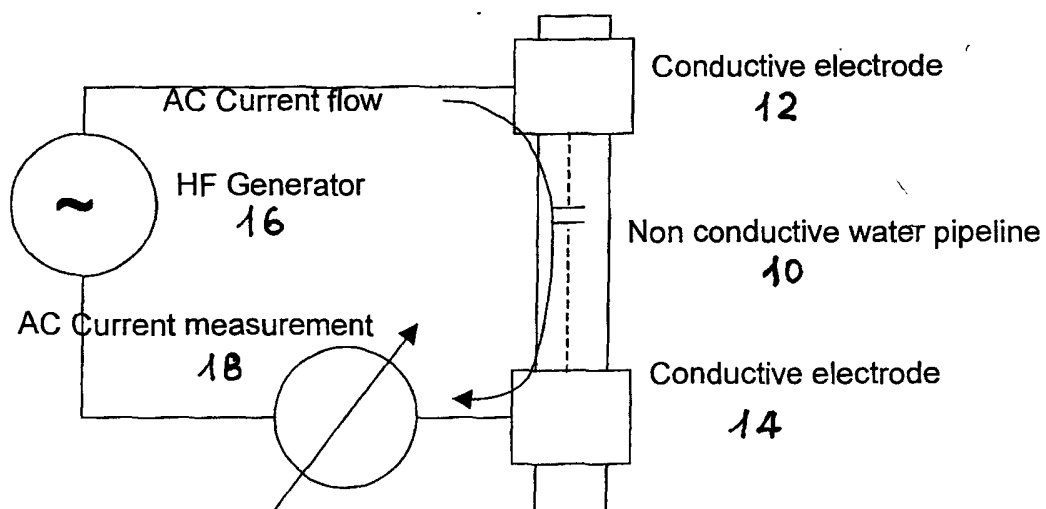
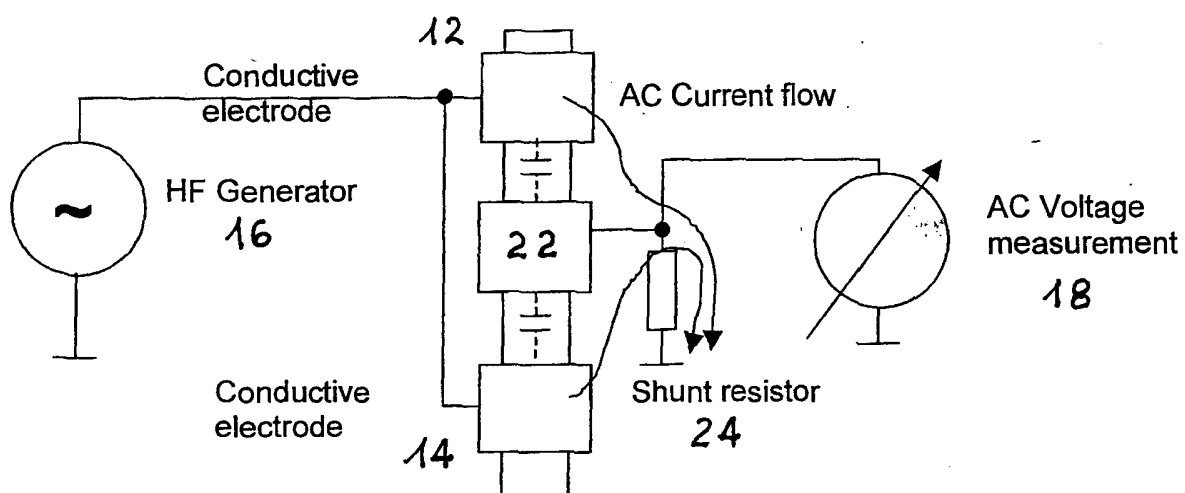
Chosen measurement frequency grants optimal performances for water measurements since it is tuned regarding the ion species normally present in water.

The proposed electrodes arrangement allows having excellent measurement cell when installed on pipes, if compared to common facing shields layout. The measurement cell results bigger than usual, its dimensions can be easily adjusted by sliding electrodes along the piping for matching the optimal sensitivity, shielding is extremely convenient and the electric field path through the measured fluid is increased and well controlled.

Knowing the statistical relation between hardness and conductivity in household water distribution system one can also say that the sensor can be used with good confidence to perform water hardness measurements.

CLAIMS

- 5 1. A contactless water conductivity measuring device comprising at least two
conducting electrodes which are applied on the external surface of the
pipeline, made of a non conductive material, wherein the water flows and are
connected in an electric circuit comprising an HF generator, **characterised in**
10 **that** the conducting electrodes (12,14) consist each of a conductive strip
wrapped around the pipeline (10) and are spaced apart each other along the
longitudinal axis of the pipeline.
2. A contactless water conductivity measuring device according to claim 1,
characterised in that the conducting electrodes (12,14) consist of a copper foil
or copper wires.
- 15 3. A contactless water conductivity measuring device according to claim 1 or 2,
characterised in that the electric circuit to measure the water conductivity
comprises an AC measurement apparatus (18).
- 20 4. A contactless water conductivity measuring device according to claim 1 or 2,
comprising three conducting electrodes, **characterised in that** the electric
circuit to measure the water conductivity comprises an AC voltage
measurement apparatus (24) which is connected to the third electrode (22) by
means of a shunt resistor (26).

FIG. 1FIG. 2

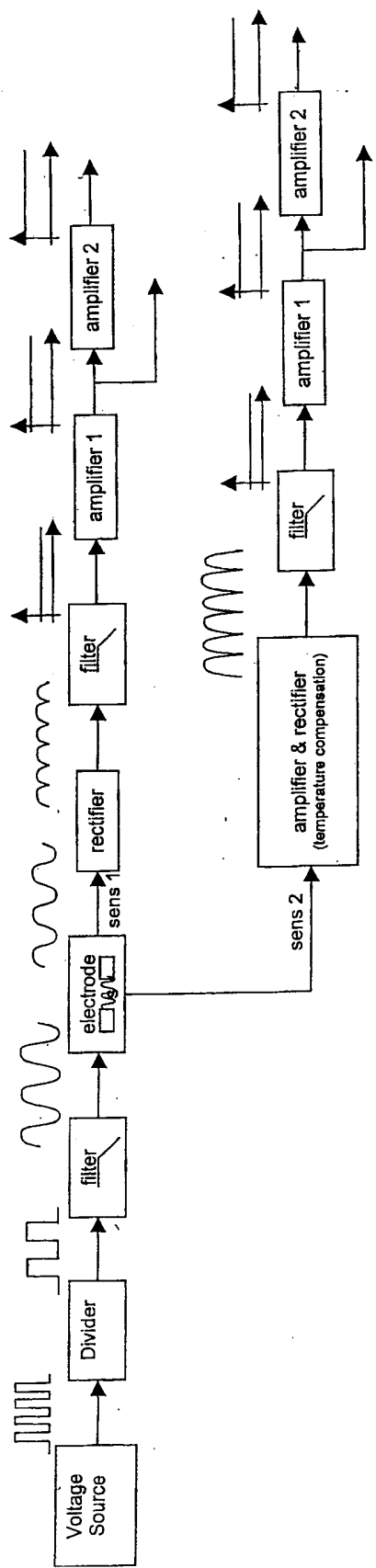


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

G01N33/18 G01N27/06

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 practical, search terms used)

EPO-Internal, WPI Data, INSPEC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/222664 A1 (GOOR TOM A VAN DE ET AL) 4 December 2003 (2003-12-04) the whole document	1-4
A	EP 1 010 976 A (SITA MESSTECHNIK GMBH) 21 June 2000 (2000-06-21) cited in the application the whole document	1-4
A	US 5 017 879 A (LUCAS ET AL) 21 May 1991 (1991-05-21) cited in the application the whole document	1-4
A	DE 42 16 176 A1 (FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG EV, 8) 18 November 1993 (1993-11-18) the whole document	1-4
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Further documents are listed in the continuation of Box C.



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O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

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X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 198 41 568 A1 (MIELE & CIE GMBH & CO, 33332 GUETERSLOH, DE) 27 May 1999 (1999-05-27) the whole document -----	1-4
A	US 5 266 899 A (BULL ET AL) 30 November 1993 (1993-11-30) the whole document -----	1-4
A	US 2002/067174 A1 (MCALLISTER WILLIAM H) 6 June 2002 (2002-06-06) the whole document -----	1-4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2005/056556

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2003222664	A1	04-12-2003	DE	10307939 A1	18-12-2003
EP 1010976	A	21-06-2000	DE	19857152 A1	06-07-2000
US 5017879	A	21-05-1991	CA	1300227 C	05-05-1992
			DE	3879338 D1	22-04-1993
			DE	3879338 T2	07-10-1993
			EP	0308004 A2	22-03-1989
			NO	884124 A	20-03-1989
DE 4216176	A1	18-11-1993	NONE		
DE 19841568	A1	27-05-1999	NONE		
US 5266899	A	30-11-1993	CA	2088002 A1	01-08-1993
US 2002067174	A1	06-06-2002	DE	10157005 A1	01-08-2002