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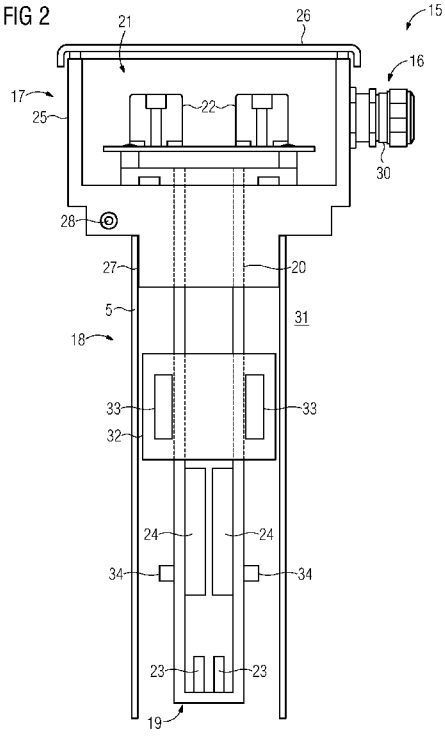
(54) **Title:** EQUIPMENT FOR MONITORING THE TEMPERATURE AND THE LEVEL OF AN INSULATING LIQUID IN A TANK OF A HIGH-VOLTAGE DEVICE

FIG 2



(57) **Abstract:** Equipment for monitoring the temperature and the level of an insulating liquid in a tank of a high-voltage device Equipment (15) for monitoring the temperature and the level of an insulating liquid (3) in a tank (2) of a high-voltage device (1) comprising - temperature sensors (23) for measuring the temperature of the insulation fluid (3) and - insulation liquid level indicators (32,24) each of which is provided with a switch (24) and also having a float (32) adapted to swim on the surface of the said insulation fluid (3); - wherein at least one of the switches (24) is a magnetic reed switch (24) and the float (32) actuates at least two of the said switches (24).

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Description

Equipment for monitoring the temperature and the level of an insulating liquid in a tank of a high-voltage device

The present invention relates to an equipment for monitoring the temperature and the level of an insulating liquid in a tank of a high-voltage device.

Such an equipment is known to a person skilled in the art. High-voltage devices, for example, high-voltage transformer or high-voltage reactors, typically comprise a tank filled with an insulating fluid like mineral oil, ester liquid or the like. The insulating fluid insulates and cools an active part of the transformer which is also arranged inside the tank. The active part includes a magnetizable core and at least one winding surrounding a section of the said core. During operation the said winding is connected with a high-voltage power grid. The said equipment monitors the temperature and the level of the insulating fluid in the tank.

Due to increased customer requests for digitalization, it is necessary to have redundancy of signals, one for customer transformer protection and one for SCADA, monitoring or digitalization system. Up to now, this problem has been solved by duplicating the devices installed on the high-voltage device. However, this is, especially in view of the insulating liquid level sensor, an expensive solution.

It is therefore an object of the invention to provide an equipment for monitoring the temperature and the level of an insulating fluid in a tank of a high-voltage device wherein the said equipment is cheap, compact and easy to maintain.

The equipment according to the present invention achieves the aforementioned object in that it comprises several temperature sensors for measuring the temperature of the insulation fluid and several insulation liquid level indicators each of which is provided with a switch and also having a float adapted to swim in the said insulation fluid; wherein at least one of the switches is a magnetic reed switch and the float actuates at least two of the said switches.

The limitation for manufacturers regarding the oil level indicator is the usage of "mechanical" micro switches to be actuated by the force of the float. In case of two or more switches, it is necessary to double or further multiply the force from the float to actuate the switches. Due to space limitations inside the high-voltage device, e.g. a high-voltage transformer, it is not possible to use a bigger float to increase the activation force. Instead of using “mechanical” micro switches, the invention teaches to use magnetic reed switches that are actuated by magnets fixed on the float, so it is not necessary to apply mechanical force directly on switches to actuate them.

According to the invention several, e.g. two, switches for insulation liquid level and two or more temperature sensors are available in one equipment. Thus, the customer can use separate signals for protection on the one hand and for digitalization/monitoring on the other hand. Therefore, the equipment according to the invention is cheap and compact.

According to a preferred embodiment of the present invention, all switches are magnetic reed switches. This simplifies the set-up of the equipment even further and helps to keep the costs down. Only one kind of switch may be used.

Advantageously the float is equipped with magnets each of which actuates one corresponding switch of the insulation liquid level indicators. Instead of using a mechanical force to actuate the switches, the invention makes use of magnetic forces. The switches are actuated when the magnets come close to the switches. Since the float swims at the insulating liquid's surface, the switches are mounted inside the tank at a threshold level. Thus, the switches will be actuated when the insulating liquid level reaches the said threshold level. The threshold level is the lowest possible level of the liquid in the tank. If the level of the liquid sinks below the threshold level, the high-voltage device might be seriously damaged.

Advantageously, the float provides, for each switch, a corresponding magnet. If, for example, two switches are provided, the float is equipped with two magnets. Advantageously the magnets are permanent magnets.

According to another embodiment of the present invention, each temperature sensor is an ohmmeter, especially a PT100 sensor. Ohmmeters, especially PT100 sensors, are well accepted in the market as being cheap, robust and fail-safe.

Moreover, according to another embodiment of the invention, the equipment comprises two temperature sensors and two insulation liquid level indicators. The insulation liquid level indicators comprise only one float.

According to a most preferred embodiment of the present invention, the equipment provides a housing wherein each temperature sensor and each insulation liquid level indicator is arranged in the said housing. This ensures an easy replacement at site. Due

to the housing, the switches and the level indicators can be maintained without draining and filing insulating liquid like mineral oil, ester liquid and the like.

Furthermore, according to an embodiment of the present invention the housing comprises fastening means for mounting the housing to the high-voltage device and a tube section with extends from the fastening means to a closed end of the tube section, each temperature sensor and each insulation liquid level indicator being located in the said tube section. When the equipment is fastened to the high-voltage device, the elongated tube or pipe section extends through an opening of the tank's core inside the tank of the high-voltage device, e.g. transformer. Since the tube section is closed at its free end, no insulation liquid enters the tube section. According to this embodiment, there is no contact between the insulation liquid and the temperature sensors or the level indicators. The sensors and switches are arranged in an elongated pocket formed by the tube section. Due to the liquid-tight pocket, it is possible to replace the complete active part quite easily without draining and refilling insulating liquid.

Furthermore, the float can be provided with an opening whose inner diameter is larger than the outer diameter of the tube section; wherein the tube section extends through the said opening; the float being able to slide up and down the tube section. According to this embodiment of the present invention, the float is arranged outside the tube section and uses the tube section as guiding part. During operation, it slides up and down the pipe section depending on the level of the insulating liquid. In order to avoid friction between the float and the pipe section, a clearance is provided between the outer pipe wall and the inner wall of the opening in the float.

According to one advantageous embodiment of the present invention, the tube section is provided with float stoppers blocking the movement of the float along the tube section in direction, i.e. in direction to the free end.

Advantageously, the tube section is secured to a header comprising the fastening means; the header defining a cave in which terminals are provided for connecting the temperature sensor and the insulation liquid level indicators with at least one cable. Due to the hollow header, which can be opened without removing the equipment form the high-voltage device, the inner tube section is easily accessible from the outside.

According to a preferred embodiment of the invention the housing comprises a shielding and the tube section and the float are arranged in the said shielding. The shielding is a magnetic shielding. A magnetic shielding consists for example of steel. Since the temperature sensor and insulating liquid level indicators are arranged in the said shielding they are protected against magnetic fields generated by an active part of the high voltage device, which may be a transformer. This prevents for false alarms in the reed switches.

The above-mentioned and other features of the invention will now be addressed with reference to the accompanying drawings of the present invention. The illustrated embodiments are intended to illustrate, but not limit the invention.

The present invention is further described hereinafter with reference to illustrated embodiments shown in the accompanying drawings, in which:

FIG 1 schematically illustrates a transformer using an embodiment of the equipment according to the invention in a perspective view.

FIG 2 schematically illustrates an embodiment of the equipment according to the present invention.

The embodiments are described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description for the purpose of explanation, numerous specific details are set forth in order to provide thorough understanding of one or more embodiments. It may be evident that such embodiments may be practiced without these specific details.

Figure 1 schematically illustrates a transformer 1 as a high-voltage device. The transformer 1 is a hermetically closed transformer. It comprises a corrugated tank 2, which is filled with an ester fluid 3. Inside the transformer, an active part is shown comprising a core 7 with three core legs 8, 9 and 10. The said core legs 8, 9, 10 are connected by an upper 11 and lower 12 yoke. Each core leg 8, 9, 10 extends through a set of windings 13, which comprises an outer primary winding and an inner secondary winding inductively coupled with one another. The said windings are electrically connected with bushings. In figure 1, only the high-voltage bushings 14 are shown. They are provided with an air insulated connection terminal (not shown) for connecting an air-insulated phase of a high-voltage AC grid. Furthermore, an equipment 15 is shown, which is used for monitoring the temperature and the level of the ester liquid 3 inside transformer tank 2. The equipment can be mounted in the filling pipe of the transformer 1 (not shown).

Figure 2 shows the said equipment 15 in detail, which is an embodiment of the equipment according to the invention.

The equipment 15 comprises a housing 16, which in turn comprises a header 17 and a tube section 18, which extends from the header 17 to a free end 19 of the tube section 18. The free end 19 is closed so that no ester fluid 3 can enter the inner hollow part of the tube section 18. The tube section 18 has a cylindrical shape. At the end opposite of the free end 19, the tube section 18 is provided with a thread for connection with the header 17.

The header 17 defines a cavity 21, in which terminal blocks 22 are located. The terminal blocks 22 are electrically connected with temperature sensors 23 located at the free end 19 of the tube section 18. Furthermore, two magnet reed sections 24 are shown, which are also located inside the tube section 18 and connected with the terminal boxes 22. The cavity 21 is confined by aluminum walls 25 and a cover 26, which is made of a suitable plastic material. For the connection with the cover of the tank 2, the header 17 is provided with fastening means 27, which are shown in figure 2 as threads 27. Furthermore, a breather cock 28 is provided, which is arranged outside the tank and provides for a connection of the inner tube section with the atmosphere.

Cable glands 30 are shown. They are adapted to receive signal cables and to lead the cables inside the cavity 21 to connect them with the terminal blocks 22.

The elongated tube section 18 extends through an opening 31 of a float 32, which is equipped with two permanent magnets 33. Finally, stoppers 34 are provided, which extend from the outside of the tube section in radial direction. The stoppers 34 block the movement of the float 32 along the tube section in direction to the free and 19.

The float 32 consists of a material, which is lighter than the ester fluid 3. Thus, the float 32 swims on the surface of the ester fluid 3. If the level of ester fluid 3 is such as shown in figure 1, the float is pressed against at the inner cover wall of the tank 2 due to hydrostatic forces. However, if the level of the ester fluid 3 lowers, the float 32 moves in direction to the free end 19 of the pipe section 18. If the permanent magnets 33 of the float 32 come close to the magnet switches 24, the magnet switches 24 are actuated due to the magnetic forces. A corresponding switching signal is generated and transmitted via an electrical connection (not shown) of the magnetic switches 24 with the terminal blocks 22, which in turn are connected by cables (as explained above) with an outer SCADA system and/or protection unit. Likewise, the temperature sensors 23 are connected by cable connections with the terminal blocks 22. They detect the temperature of the metal, which is in turn in contact with the ester fluid inside the tank 2.

The tube section 18 consists of a material with a high heat conductivity, for example metal, especially aluminum, so that the temperature of the insulating unit equals the temperature of the metal of the tube section 18.

Due to its closed end, the tube section 18 forms a pocket for the temperature sensors and the switches. Although two switches 24 are provided, only one float 32 is necessary to actuate them both. Thus, according to the invention, redundant temperature sensors and redundant insulating liquid level indicators are provided by providing only one equipment 15. The equipment 15 can be mounted very quickly to the transformer 1 and is accessible from outside. The maintenance of the equipment 15 according to the invention is fast and simple.

For protection against magnetic stray fields generated by the set of windings 13 the equipment 15 comprises a magnetic shielding 5 made of steel. The magnetic shielding 5 has a tubular shape. In the embodiment shown in Figure 2 the magnetic shielding is a shielding pipe which is made of steel. The said shielding pipe 5 is attached to the header 17 and extends from the header 17 or its fastening means 27 to a free end. The free end of the shielding pipe is open so that the inner hollow part of the shielding pipe communicates with the inner part of the tank 2 (see Figure 1). The tube section 18 and the float 32 are located inside the shielding pipe 5. Thus, the temperature sensors 23 and the insulation liquid level indicators 24, 32 are protected by the shielding pipe against magnetic stray fields generated by the set of windings 13.

The biggest advantage of the equipment 15 according to the invention is that in case of a replacement the temperature sensors and/or switches, the whole active part of the equipment, i.e. terminals 22, sensors 23 and switches 24, can be replaced without opening the transformer. This means that the equipment stays assembled and the said active part can be removed by a new one. In case of maintenance no sealing or any inner parts of the tank 2 have to be touched.

Patent claims

1. An equipment (15) for monitoring the temperature and the level of an insulating liquid (3) in a tank of a high-voltage device comprising
   - temperature sensors (23) for measuring the temperature of the insulation fluid (3) and
   - insulation liquid level indicators (24,32) each of which is provided with a switch (24) and also having a float (32) adapted to swim on the surface of the said insulation fluid;
   - wherein at least one of the switches is a magnetic reed switch (24) and the float (32) actuates at least two of the said switches.

2. The equipment (15) according to claim 1, wherein each of the said switches is a magnetic reed switch (24).

3. The equipment (15) according to any one of the aforementioned claims, wherein for the float (32) is equipped with at least one magnet (33) which actuates all switches (24) of the insulation liquid level indicators (32,24).

4. The equipment (15) according to claim 4 wherein, the float provides a corresponding magnet (32) for each switch (24).

5. The equipment (15) according to claim 3 wherein, for each switch, the float (32) provides a corresponding magnet (33).

6. The equipment (15) according to any one of the aforementioned claims, wherein each temperature sensor is an Ohmmeter, especially a PT100 sensor.

7. The equipment (15) according to any one of the aforementioned claims, wherein two temperature sensors (23) and two insulation liquid level indicators (32,24) are provided.

8. The equipment (15) according any one of the aforementioned claims, wherein
- the equipment (15) is provided with a housing (16) and
- each temperature sensor (23) and each insulation liquid level indicator (32,24) is arranged in the said housing (16).

9. The equipment (15) according to claim 8, wherein the housing (16) comprises fastening means (27) for mounting the housing (16) to the high-voltage device (1) and a tube section (18) with extends from the fastening means (27) to a closed end (19), each temperature sensor and each switch of the insulation liquid level indicators (32,24) being located in the said tube section (18).

10. The equipment (15) according to claim 9, wherein the float (32) is provided with an opening (31) whose inner diameter is slightly larger than the outer diameter of the tube section (18); wherein the tube section extends through the said opening (31); the float (32) being able to slide up and down the tube section (18).

11. The equipment (15) according to claim 9, wherein the tube section (18) is provided with float stoppers (34) blocking the movement of the float (32) along the tube section in direction to the free end (19).

12. The equipment (15) according any one of the claims 8 to 11, wherein the tube section (18) is secured to a header (17) comprising the fastening means (27); the header (17) defining a cave (21) in which terminals (22) are provided for connecting

the temperature sensor (23) and the insulation liquid level indicators (32,24) with a corresponding cable.

13. The equipment (15) according any one of the claims 8 to 11, wherein the housing (16) comprises a shielding (5) and the tube section (18) and the float (32) are arranged in the said shielding (5).

14. The equipment (15) according to claim 13, wherein the shielding (5) has a tubular shape and extends form the fastening means (27) to on open free end.

FIG 1

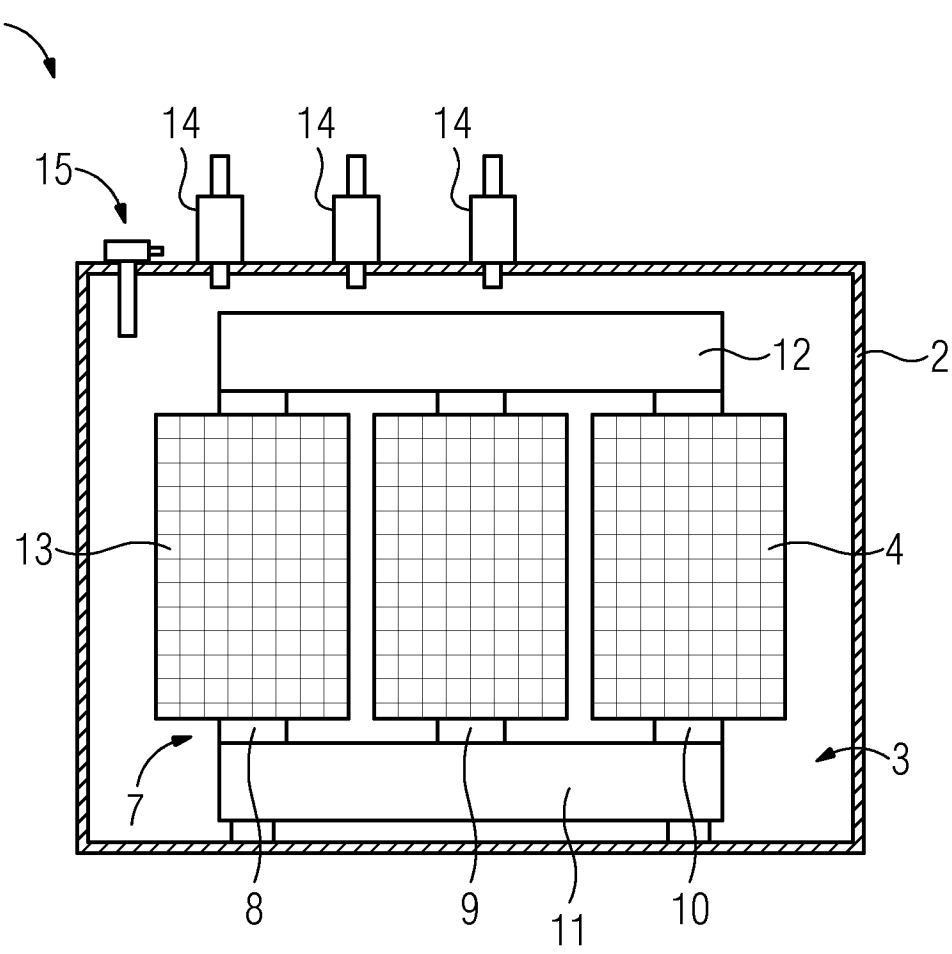
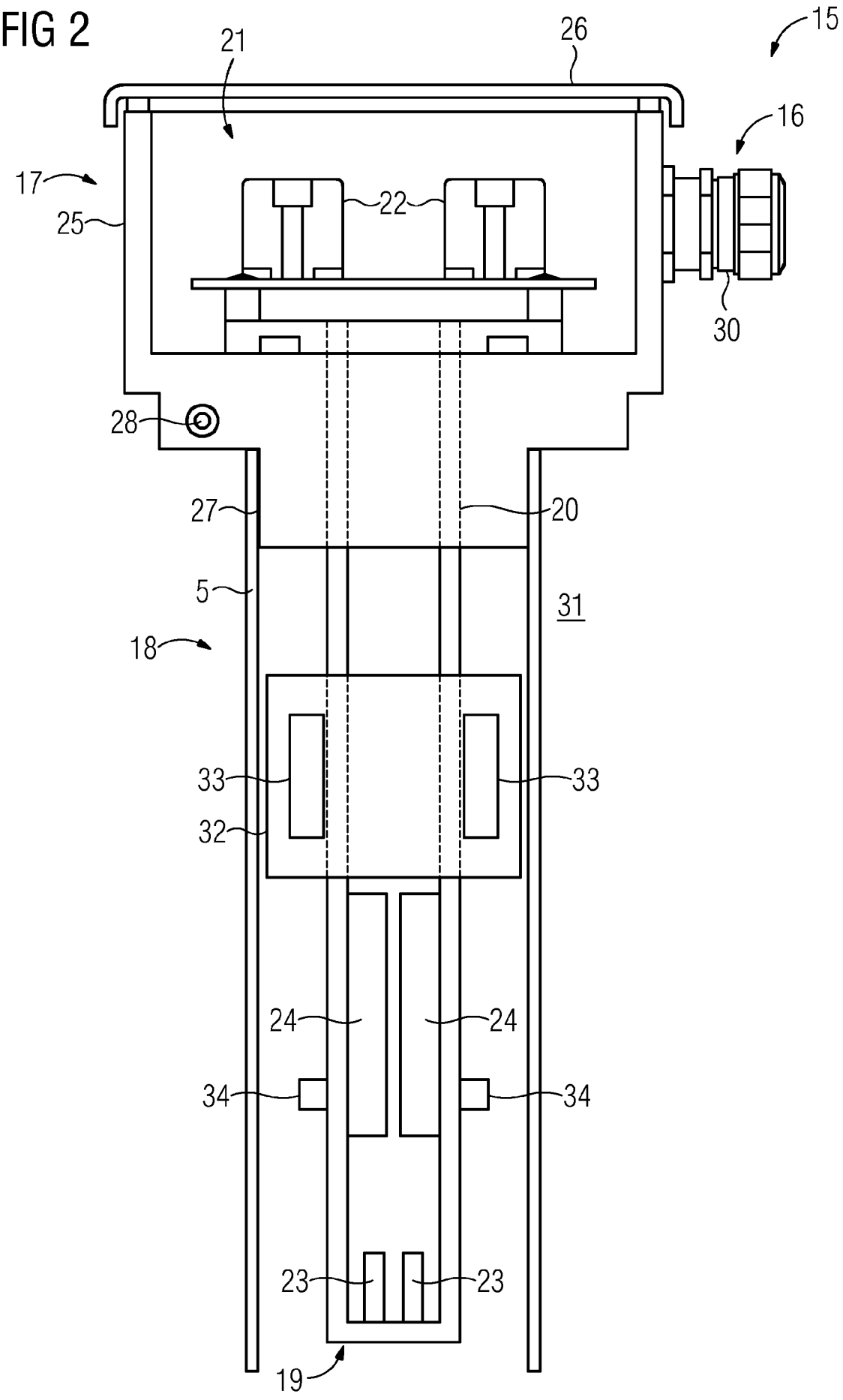


FIG 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/064093

A. CLASSIFICATION OF SUBJECT MATTER
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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)
G01K G01F

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.
X	US 5 347 864 A (SENGHAAS KARL A [US] ET AL) 20 September 1994 (1994-09-20) abstract figure 1 column 2, line 64 - column 6, line 41	1-14
A	US 2013/064716 A1 (FUKUOKA TAKESHI [JP] ET AL) 14 March 2013 (2013-03-14) abstract figures 1A, 3-5 paragraphs [0031], [0039] - [0045]	1-14
A	US 5 627 523 A (BESPROZVANNY LEONID R [US] ET AL) 6 May 1997 (1997-05-06) abstract figures 1-7 column 3, line 20 - column 5, line 12	1-14

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Form PCT/ISA/210 (second sheet) (April 2005)

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	CN 103 674 187 A (NO 709 RES INST CHINA CSIC) 26 March 2014 (2014-03-26) the whole document	1-14
A	EP 2 688 081 A1 (ABB TECHNOLOGY AG [CH]) 22 January 2014 (2014-01-22) abstract figures 1-7 paragraphs [0019] - [0054]	1-14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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