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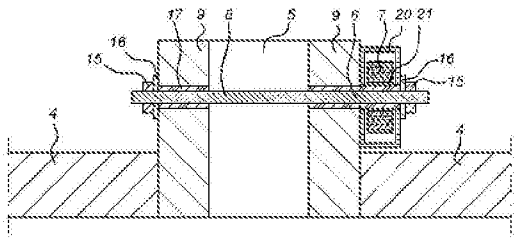
(54) **Measurement system for monitoring gas insulated system**

(57) Measurement system for monitoring a gas insulated system, the gas insulated system comprising at least two GIS segments (2). Each of the at least two GIS segments (2) has a central conductor (3) and an outer conductor (4) coaxially positioned around the central conductor (3). An insulating spacer (5) is positioned between two adjacent outer conductors (4) of the at least two GIS segments (2), and an electrical conducting element (6) is in electrical connection with the two adjacent outer cylindrical conductors (4). The measurement system (1) further has a current sensor (7) in measuring relationship with the at least one electrical conducting element (6), which is e.g. formed by one of a plurality of fixing rods (8) extending through the spacer (5).



NL B1 2018552

Dit octrooi is verleend ongeacht het bijgevoegde resultaat van het onderzoek naar de stand van de techniek en schriftelijke opinie. Het octrooischrift komt overeen met de oorspronkelijk ingediende stukken.

Measurement system for monitoring gas insulated system

Field of the invention

The present invention relates to a measurement system for monitoring a gas insulated system (GIS), the gas insulated system comprising at least two GIS segments, each of the at least two GIS segments comprising a central conductor and an outer conductor coaxially positioned around the central conductor, and an insulating spacer positioned between two adjacent outer conductors of the at least two GIS segments.

Background art

The international patent publication WO2007/097491 discloses a system for partial discharge (PD) detection of gas insulated switchgear, using an ultra-high frequency (UHF) antenna installed in a recess formed in an insulating spacer of the switchgear. In general, using a UHF antenna for PD detection requires the presence of a window in an outer side of the switchgear, which allows transmission of radiofrequency (RF) radiation to detect RF radiation inside the gas insulated switchgear originating from a PD event.

US patent publication US2016/349343 discloses PD detection using a slot antenna, parts of which are formed by bolts connecting end flanges of GIS compartments with an insulating spacer in between. Although the insulating spacer is here used to accommodate the antenna, this system still only allows to detect the radiation caused by a partial discharge event.

Summary of the invention

The present invention seeks to provide an improved measurement system for detecting partial discharges in a gas insulated system.

According to the present invention, a measurement system as defined above is provided, the gas insulated system further comprising an electrical conducting element in electrical connection with the two adjacent outer cylindrical conductors, and the measurement system comprising a current sensor in measuring relationship with the at least one electrical conducting element. This measurement system allows to measure a current caused by a partial discharge event in one of the at least two GIS segments. This would furthermore allow to evaluate the pulse charge by means of partial discharge charge evaluation techniques.

Short description of drawings

The present invention will be discussed in more detail below, with reference to the attached drawings, in which

Fig. 1 shows a schematic view of a gas insulated system having multiple segments;

Fig. 2 shows a partial cross sectional view of a first embodiment of the present invention measurement system;

Fig. 3 shows a partial cross sectional view of a second embodiment of the present invention measurement system;

Fig. 4 shows a partial cross sectional view of a third embodiment of the present invention measurement system; and

Fig. 5 shows a schematic view of a measurement system according to an embodiment of the present invention.

Description of embodiments

The present invention relates to a measurement system 1 for gas insulated systems (GIS) or Gas insulated lines (GIL) as employed in distribution of electrical energy, e.g. as an underground cable. The measurement system 1 is particularly suited for detecting a partial discharge event in a GIS or GIL (which in the description hereinafter will be indicated in general by the term ‘GIS’).

Fig. 1 shows a schematic view of a gas insulated system having multiple GIS segments 2. Each GIS segment 2 comprises an inner or central conductor 3 and an outer conductor 4. Two adjacent GIS segments 2 are connected to each other by means of an insulating spacer 5 and a plurality of fixing rods (or bolts) 8. The space between the central conductor 3 and outer conductor 4 are filled with an insulating gas in operation, allowing transport of high voltage energy through the GIS segments 2. The arrangement of central conductor 3 and outer conductor 4 can be fully symmetrical, and in case of a cylindrical outer conductor 4 this results in a coaxial arrangement. Alternatively, several central conductors 3 may be present in an arrangement allowing maximum spacing from the outer conductor 4.

A complete GIS installation is a combination of various GIS segments 2, in the form of GIS sections, such as non-switching compartments, gas insulated lines, and elements like bushings, spacers, circuit breakers, disconnector switches, earthing switches, voltage and current measuring transformers. In a GIS segment 2, an insulation defect may occur during operation, which usually results in a partial discharge (PD), indicated by reference numeral 10 in Fig. 1. When a PD occurs at a certain location of the insulation system, resulting PD current pulses 11a, 11b propagate along the GIS as the GIS behaves as a transmission line for the (high frequency content) PD pulses.

In existing GIS installations, UHF antennas are used to detect electromagnetic waves created by the PD pulse and propagating along the GIS segments 2. This necessitates placement of openings or dielectric windows in a GIS segment 2 in which antennas can be placed to pick up the radiated signal produced by a PD event.

According to the present invention embodiments, PD induced current pulses are measured in the outer conductors 4 of a GIS installation. This is possible as the arrangement of a GIS segment 2 having a central (or inner) conductor 3 and an outer conductor 4, i.e. a coaxial structure, acts as receiving electrodes of current pulses 11a, 11b induced by a PD event 10 within the GIS segment 2.

As shown in the general structure of the GIS installation of Fig. 1, the insulating spacers 5 which are used to connect two GIS segments 2 together, would interrupt the coaxial structure, and the PD current pulses would flow through the fixing rods 8 connecting two end parts of two adjacent outer conductors 4. The current which would be homogeneously distributed over the outer conductor 4 is split into several current paths, i.e. over the plurality of (metallic) fixing rods 8 extending through the insulating spacer 5. By measuring the current through one of the fixing rods 8, or in more general terms (see also the embodiment described with reference to Fig. 4 below) through an electrical conducting element 6 connecting two adjacent outer conductors 4, it is then possible to detect the PD current pulses 11a, 11b.

In a generic sense, the present invention embodiments relate to a measurement system 1 for monitoring a gas insulated system (e.g. for detecting partial discharges in the gas insulated system), the gas insulated system comprising at least two GIS segments 2, each of the at least two GIS segments 2 comprising a central conductor 3 and an outer conductor 4 coaxially positioned around the central conductor 3, an insulating spacer 5 positioned between two adjacent outer conductors 4 of the at least two GIS segments 2, and an electrical conducting element 6 in electrical connection with the two adjacent outer cylindrical conductors 4. The measurement system 1 comprising a current sensor 7 in measuring relationship with the at least one electrical conducting element 6. The measuring relationship of the current sensor 7 with the at least one electrical conducting element 6 may be implemented using different techniques and structures, as will be explained with reference to the embodiments as shown in Fig. 2-4.

Fig. 2 shows a partial cross sectional view of a first embodiment of the present invention measurement system, wherein the current sensor 7 is integrated into the insulating spacer 5. The current sensor 7 e.g. comprises a casing 20 with an insulating inner sleeve 21, in combination encasing a ferrite core and sensor coil.

In this embodiment, the at least one electrical conducting element 6 is one of the plurality of fixing rods 8, mechanically connecting adjacent end parts 9 of the two adjacent outer conductors 4 and extending through the insulating spacer 5. As shown in this exemplary embodiment, the end part 9 comprises a flange 9 extending radially from the respective outer conductor 4. This allows to easily and effectively connect the two outer conductors 4 in a mechanically strong manner, e.g. by providing holes in the flanges 9 and spacer 5, and fastening the fixing rods 8 using a nut 15 and ring 16. As indicated in Fig. 2, an insulating sleeve 17 may be provided in the hole in flange 9 serving dielectric purposes as well as mechanical purposes, e.g. to allow easy insertion of the fixing rods 8. If the plurality of fixing rods 8 is provided evenly distributed over the circumference of the end part 9, a proper sealing and structural integrity of two adjacent GIS segments 2 is ensured.

Fig. 3 shows a partial cross sectional view of a second embodiment of the present invention measurement system, wherein the insulating spacer 5 is not modified to include the current sensor 7. In this embodiment (and in the embodiment shown in Fig. 2), the at least one electrical conducting element 6 is one of the plurality of fixing bolts 8. In other words, the current sensor 7 is provided as a coaxial arrangement around one of the fixing rods 8.

In the embodiment shown in Fig. 3, the flow of the current originating from the partial discharge event will follow the entire length of the (conducting) fixing rod 8 because of the insulating sleeve 17, in order to have the total current flow through the core of the current sensor 7. In order to minimize disadvantageous effects (because of the added path length for the current) the width of the current sensor 7 is chosen to be as low as possible. With reference to Fig. 3, the two outer conductors 4 of adjacent GIS segments 2 are attached to each other with an insulating spacer 5 in between by sixteen fixing rods 8. Without the nuts 15 and rings 16 there would be no electrical connection between the fixing rods 8 and the outer conductors 4, because of the insulating sleeve 17. In the embodiment shown in Fig. 3 (with the installed nuts 15 and rings 16) the current coming from one outer conductor 4 flows through the (metallic) fixing rod 8 and the current sensor 7, and passes to the other outer conductor 4 via the housing 20 of the current sensor 7. As at the location of the current sensor 7 the partial discharge induced current flows through an inner conductor (fixing rod 8) and returns through an outer conductor (housing 20 of current sensor 7), this configuration is also dubbed a coaxial arrangement.

In a specific embodiment, the current sensor 7 comprises a magnetic core surrounding the at least one electrical conducting element 6, a coil being wound around the magnetic (e.g. ferrite) core. The current sensor 7 may be a high frequency current transformer (HFCT), wherein the at least one conducting element 6 can be seen as the primary winding, and the coil around the magnetic core as the secondary winding. In alternative arrangements, the current sensor 7 comprises a magnetic field sensor positioned in vicinity of the at least one electrical conducting element 6, e.g. attached to an outer surface of the insulating spacer 5. In high voltage systems, it is possible to implement this embodiment specifically using a Rogowsky coil. In general, the current sensor 7 is in a measuring relationship with the at least one electrical conducting element 6, and transforms a current flowing in the at least one electrical conducting element into a measurement voltage across terminals of the current sensor 7.

Fig. 4 shows a partial cross sectional view of an example of a third embodiment of the present invention measurement system, wherein the at least one electrical conducting element 6 is an external conductor 6 connecting adjacent end parts 9 of the two adjacent outer conductors 4, and is positioned external to the insulating spacer 5. Compared to the embodiment shown in Fig. 2, the external conductor 6 may be connected in electrical connection to the end parts 9 using the nut 15 to secure the external conductor 6 to the surface of the end part 9. If the fixing rod 8 is a metallic material bolt, the external conductor 6 shunts the fixing rod 8, and the current induced by a PD pulse normally running through that fixing rod 8, will spread in two separate current paths, still allowing to detect the PD current pulse in the path of the external conductor 6.

In a further embodiment, one of the plurality of fixing rods 8 is an insulating rod, and the external conductor 6 is mechanically connected to the insulating rod (and electrically to the end part 9). In this case, depending on the (HF) impedance of the external conductor 6, a larger current part will flow through the external conductor 6 allowing easier detection of a PD pulse.

In both embodiments, the external conductor 6 may be selected from the group comprising a flexible cable (e.g. a braided wire, a Litze wire, etc.), a metal strip (in the form of a jumper, clip, etc.), or a stack of metal strips.

Furthermore, in all embodiments described above, the part of the current flowing through the at least one electrical conducting element 6 may be enhanced by properly selecting the material of the at least one electrical conducting element 6, as well as the material of the remaining ones of the plurality of fixing rods 8. E.g. in the exemplary embodiments shown in Fig 2 and 3, the fixing rod 8 acting as the at least one electrical conducting element 6 may be made of a better conducting material, such as copper.

Fig. 5 shows a schematic view of a measurement system according to an embodiment of the present invention, wherein one of the above described arrangements of current sensor 7 is applied. The measurement system 1 further comprises an evaluation unit 12 connected to the current sensor 7, the evaluation unit 12 being arranged to execute a charge evaluation of detected current pulses. A charge evaluation of the detected current pulse can to a predetermined level of uncertainty result in a reliable and robust detection of a partial discharge (or in a further alternative of an insulation defect) in one of the GIS segments 2. It is noted that normally, charge evaluation is not used for detection, but to assess the severity of the defect causing the partial discharge. In the standards, the maximum amount of charge is specified (normally in picoCoulomb (pC)) that is allowed in factory tests. The present invention measurement system has the advantage that it is possible to calculate a charge, as a result of which it is possible to compare on-line field measurements with laboratory tests. To ensure proper detection the current sensor 7 and evaluation unit 12 circuitry have appropriate characteristics, such as a lower cut-off frequency of30kHz and an upper cut-off frequency above 60 MHz. In short a compromise will be selected with a trade-off between sensitivity and bandwidth.

In a further embodiment, the evaluation unit 12 is further arranged to determine the ratio of measurement current (or charge) through the at least one electrical conducting element 6 and a current (or charge) through the outer conductor 4 caused by a pulse event (such as a partial discharge pulse or an insulation defect). From this ratio, which can be determined by (electromagnetic) simulation, or by calibration, the original pulse shape can be reconstructed and hence a proper charge estimation can be accomplished. Calibration can be implemented using a controlled current injection and measurement. E.g. a PD calibrator may be placed at a location in a GIS segment 2, and connected between the central conductor 3 and outer conductor 4. Note that for such calibration standards may apply, such as IEC60270. A predetermined current of a known charge value is then injected, and the current sensor 7 is used to measure the resulting current at the measurement location, allowing the evaluation unit 12 to calculate the associated charge. The ratio of the measured charge and the injected charge is then the ratio of the charge measured by the current sensor 7 to the total charge flowing in the outer conductor 4. Knowing this ratio of charges, the total charge flowing through the fixing rods 8 and at least one electrical conducting element 6 of the insulating spacer 5, and thus through the outer conductor 4 can be estimated.

As an example, the measurement system 1 may be applied to measure at the location of an insulating spacer 5 between two GIS segments 2 which are mechanically connected to each other using sixteen rods 8 at a circumference of the associated outer conductors 4. It is noted that the measurement system 1, and especially the form and type of combination of current sensor 7 and at least one conducting element 6, may be of an influence on how the current pulse 11a, 11b originating from the partial discharge 10 spreads over the outer surface of outer conductors 4 and through each of the rods 8. In this respect, especially the resistance and inductance from the current sensor 7 play a role. The ratio in an exemplary embodiment using sixteen rods 8, and a current sensor 7 in a coaxial relation to one of the rods 8, has been determined using the injection calibration method to be 3%. In a further embodiments, where the at least one conducting element 6 was embodied as a stack of ten copper mutually isolated strips and electrically connected to two adjacent outer conductors 4 at the position of an isolating rod 8, in combination with an HFCT sensor 7, the ratio was determined to be 1.5% (again using the injection calibration method).

In an even further embodiment (as shown in the exemplary schematic view of Fig. 5), the measurement system further comprises at least one additional current sensor 7a connected to the evaluation unit 12, the at least one additional current sensor 7a being associated with an additional insulating spacer 5a between two further GIS segments 2. If current pulses are detected at several spacers 5, 5a, it is possible to determine the location of a partial discharge, e.g. by evaluating the polarity of the current pulses. As shown in the embodiment of Fig. 5, a PD will cause a left travelling half pulse 11a and a right travelling half pulse 11b. If all current sensors 7, 7a are installed with the same polarity, a PD pulse from a GIS segment 2 outside of all current sensors 7, 7a will have the same polarity. A PD pulse from a GIS segment 2 within all current sensors 7, 7a will cause a different polarity in some of the current sensors 7, 7a, allowing determination of the PD event location.

Also further complex determinations can be made by proper testing protocols being executed by the evaluation unit 12. E.g. the evaluation unit 12 may be further arranged to detect a position of a partial discharge in one of the GIS segments 2 by measuring timing differences between congruent current pulses as detected by the current sensor 7 and one or more additional sensors 7a.

Furthermore, these embodiment would allow even better detection of a partial discharge event in one of the associated GIS segments 2, as the measurements by the current sensor 7 and at least one additional current sensor 7a may be used in a redundant manner.

Alternatively or additionally, the evaluation unit may be further arranged to detect a faulty GIS segment 2 by matching current pulse measurements from the current sensor 7 and one or more additional sensors 7a. A faulty GIS segment 2 may e.g. be caused by the presence of a leakage current, or a short circuit. In general such events cause currents which are several orders of magnitude larger than a current pulse caused by a PD event. This may be detected and evaluated by the evaluation unit 12. The measured current magnitude in several measurement locations (current sensors 7, 7a) will indicated the location of the faulty GIS segment 2.

These more complex measurement methods (location determination of a PD and fault detection) may be advantageously used when gas insulated lines (GIL) are employed, which typically have a larger dimension in length, and which (in operation) may be much more difficult to access physically.

The present invention embodiments may be summarized as the following interdependent embodiments:

Embodiment 1. Measurement system for monitoring a gas insulated system, the gas insulated system comprising

at least two GIS segments (2), each of the at least two GIS segments (2) comprising a central conductor (3) and an outer conductor (4) coaxially positioned around the central conductor (3),

an insulating spacer (5) positioned between two adjacent outer conductors (4) of the at least two GIS segments (2), and

an electrical conducting element (6) in electrical connection with the two adjacent outer conductors (4),

the measurement system (1) comprising a current sensor (7) in measuring relationship with the at least one electrical conducting element (6).

Embodiment 2. Measurement system according to embodiment 1, wherein the at least one electrical conducting element (6) is one of a plurality of fixing rods (8) mechanically connecting the two adjacent outer conductors (4) and the insulating spacer (5).

Embodiment 3. Measurement system according to embodiment 1 or 2, wherein the current sensor (7) comprises a magnetic core surrounding the at least one electrical conducting element (6).

Embodiment 4. Measurement system according to embodiment 3, wherein the current sensor (7) comprises a high frequency current transformer (HFCT).

Embodiment 5. Measurement system according to embodiment 1 or 2, wherein the current sensor (7) comprises a magnetic field sensor positioned in vicinity of the at least one electrical conducting element (6).

Embodiment 6. Measurement system according to embodiment 5, wherein the current sensor (7) comprises a Rogowsky coil.

Embodiment 7. Measurement system according to any one of embodiments 1-6, wherein the current sensor (7) is integrated into the insulating spacer (5).

Embodiment 8. Measurement system according to embodiment 1 or 2, wherein the at least one electrical conducting element (6) is an external conductor (6) connecting adjacent end parts (9) of the two adjacent outer conductors (4), and is positioned external to the insulating spacer (5).

Embodiment 9. Measurement system according to embodiment 8, further comprising

a plurality of fixing rods (8) mechanically connecting the two adjacent outer conductors (4) and the insulating spacer (5), wherein one of the plurality of fixing rods (8) is an insulating rod, and the external conductor (6) is mechanically connected to the insulating rod.

Embodiment 10. Measurement system according to embodiment 8 or 9, wherein the external conductor (6) is selected from the group comprising:

a flexible cable, a metal strip, a stack of metal strips.

Embodiment 11. Measurement system according to any one of embodiments 1-10, wherein the measurement system (1) further comprises an evaluation unit (12) connected to the current sensor (7), the evaluation unit (12) being arranged to execute a charge evaluation of detected current pulses.

Embodiment 12. Measurement system according to embodiment 11, wherein the evaluation unit (12) is further arranged to determine a ratio of measurement current through the at least one electrical conducting element (6) and a current through the outer conductor (4) caused by a pulse event.

Embodiment 13. Measurement system according to embodiment 12, wherein the evaluation unit (12) is further arranged to determine the ratio by simulation.

Embodiment 14. Measurement system according to embodiment 12, wherein the evaluation unit (12) is further arranged to determine the ratio by calibration.

Embodiment 15. Measurement system according to any one of embodiments 11-14, further comprising at least one additional current sensor (7a) connected to the evaluation unit (12), the at least one additional current sensor (7a) being associated with an additional insulating spacer (5a) between two further GIS segments (2).

The present invention has been described above with reference to a number of exemplary embodiments as shown in the drawings. Modifications and alternative implementations of some parts or elements are possible, and are included in the scope of protection as defined in the appended claims.

Conclusies

1. Meetsysteem voor bewaken van een met gas geïsoleerd systeem (GIS),

waarbij het met gas geïsoleerd systeem (GIS) omvat

ten minste twee GIS segmenten (2), waarbij elk van de ten minste twee GIS segmenten (2) een centrale geleider (3) omvat en een buitenste geleider (4) die coaxiaal rond de centrale geleider (3) is geplaats,

een isolerend afstandselement (5) dat tussen twee naast elkaar liggende buitenste geleiders (4) van de ten minste twee GIS segmenten (2) is geplaatst, en

een elektrisch geleidend element (6) dat in elektrische verbinding staat met de twee naast elkaar liggende buitenste geleiders (4),

waarbij het meetsysteem (1) een stroomsensor (7) omvat die in een metende relatie is met het ten minste ene elektrisch geleidend element (6).

2. Meetsysteem volgens conclusie 1, waarbij het ten minste ene elektrisch geleidend element (6) één is van een veelvoud van vastzetstaven (8) die mechanisch de twee naast elkaar liggende buitenste geleiders (4) en het isolerend afstandselement (5) verbindt.

3. Meetsysteem volgens conclusie 1 of 2, waarbij de stroomsensor (7) een magnetische kern omvat die het ten minste ene elektrisch geleidend element (6) omgeeft.

4. Meetsysteem volgens conclusie 3, waarbij de stroomsensor (7) een hoogfrequent stroomomzetter (HFCT) omvat.

5. Meetsysteem volgens conclusie 1 of 2, waarbij de stroomsensor (7) een magnetische-veldsensor omvat die gepositioneerd is in nabijheid van het ten minste ene elektrisch geleidend element (6).

6. Meetsysteem volgens conclusie 5, waarbij de stroomsensor (7) een Rogowsky-spoel omvat.

7. Meetsysteem volgens één van de conclusies 1-6, waarbij de stroomsensor (7) geïntegreerd is in het isolerend afstandselement (5).

8. Meetsysteem volgens conclusie 1 of 2, waarbij het ten minste ene elektrisch geleidend element (6) externe geleider (6) is die naast elkaar liggende einddelen (9) van de twee naast elkaar liggende buitenste geleiders (4) verbindt, en buiten het isolerend afstandselement (5) is gepositioneerd.

9. Meetsysteem volgens conclusie 8, verder omvattend een veelvoud van vastzetstaven (8) die mechanisch de twee naast elkaar liggende buitenste geleiders (4) en het isolerend afstandselement (5) verbindt, waarbij één van het veelvoud van vastzetstaven (8) een isolerende staaf is, en de externe geleider (6) mechanisch is verbonden met de isolerende staaf.

10. Meetsysteem volgens conclusie 8 of 9, waarbij de externe geleider (6) geselecteerd is uit de groep omvattend: een flexibele kabel, een metaalstrip, een stapel metaalstrips.

11. Meetsysteem volgens één van de conclusies 1-10, waarbij het meetsysteem (1) verder omvat een evaluatie-eenheid (12) die verbonden is met de stroomsensor (7), en de evaluatie-eenheid (12) is ingericht om een ladingevaluatie van gedetecteerde stroompulsen uit te voeren.

12. Meetsysteem volgens conclusie 11, waarbij de evaluatie-eenheid (12) verder is ingericht voor het bepalen van een verhouding van meetstroom door het ten minste ene elektrisch geleidend element (6) en een stroom door de buitenste geleider (4) die veroorzaakt is door een pulsgebeurtenis.

13. Meetsysteem volgens conclusie 12, waarbij de evaluatie-eenheid (12) verder is ingericht om de verhouding te bepalen door simulatie.

14. Meetsysteem volgens conclusie 12, waarbij de evaluatie-eenheid (12) verder is ingericht om de verhouding te bepalen door kalibratie.

15. Meetsysteem volgens één van de conclusies 11-14, verder omvattend ten minste één additionele stroomsensor (7a) die verbonden is met de evaluatie-eenheid (12), waarbij de ten minste ene additionele stroomsensor (7a) behoort bij een additioneel isolerend afstandselement (5a) tussen twee verdere GIS segmenten (2).

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Fig. 1

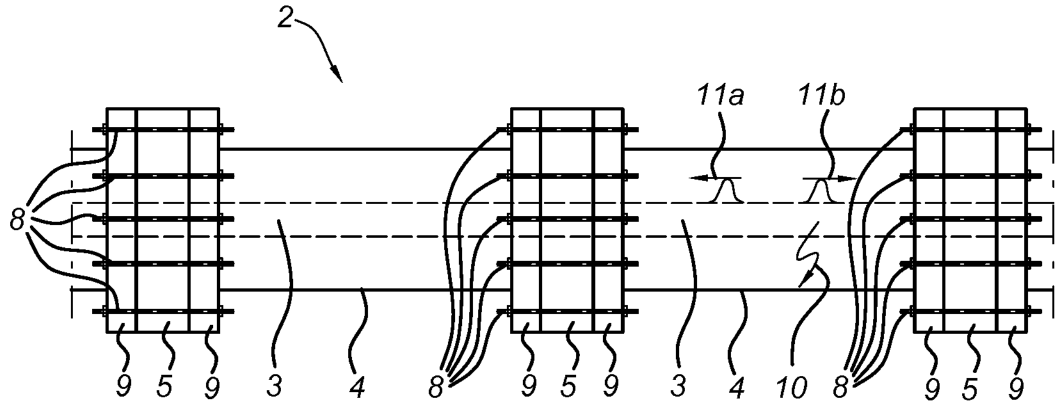


Fig. 2

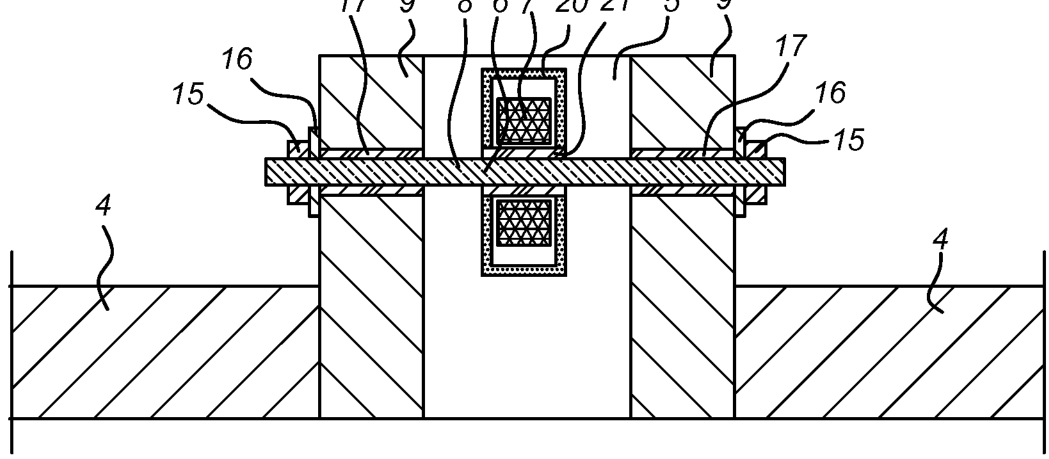


Fig. 3

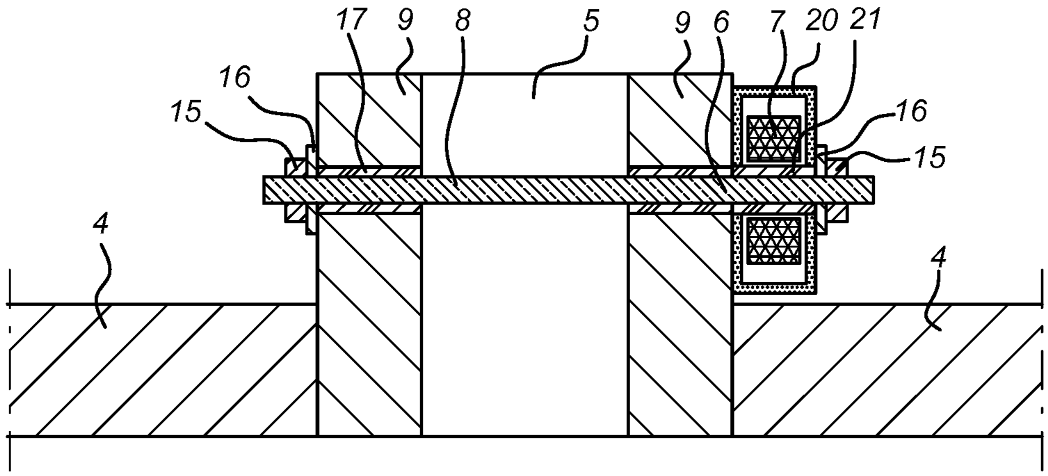


Fig. 4

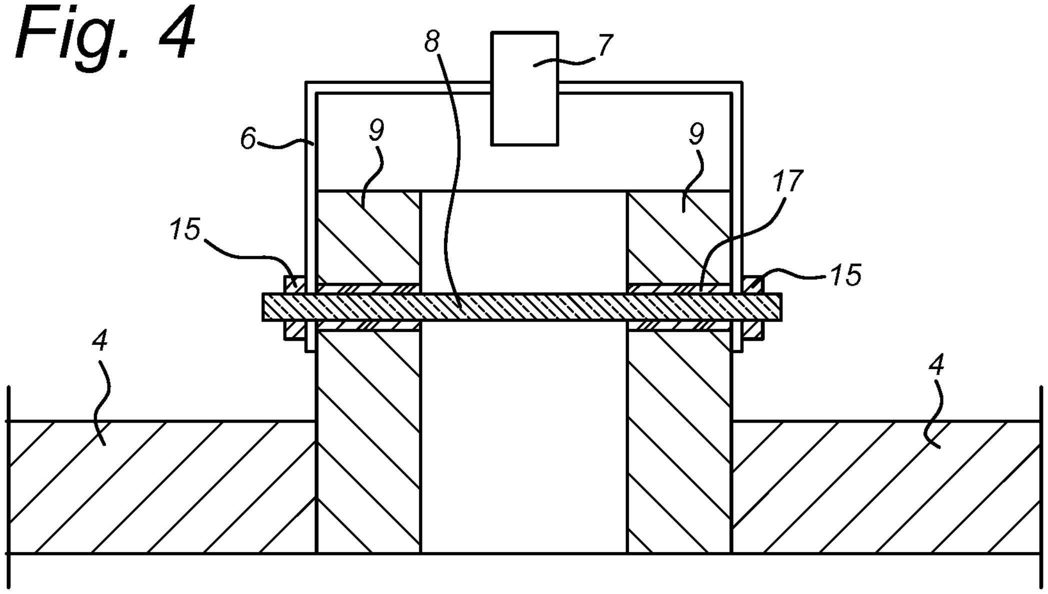
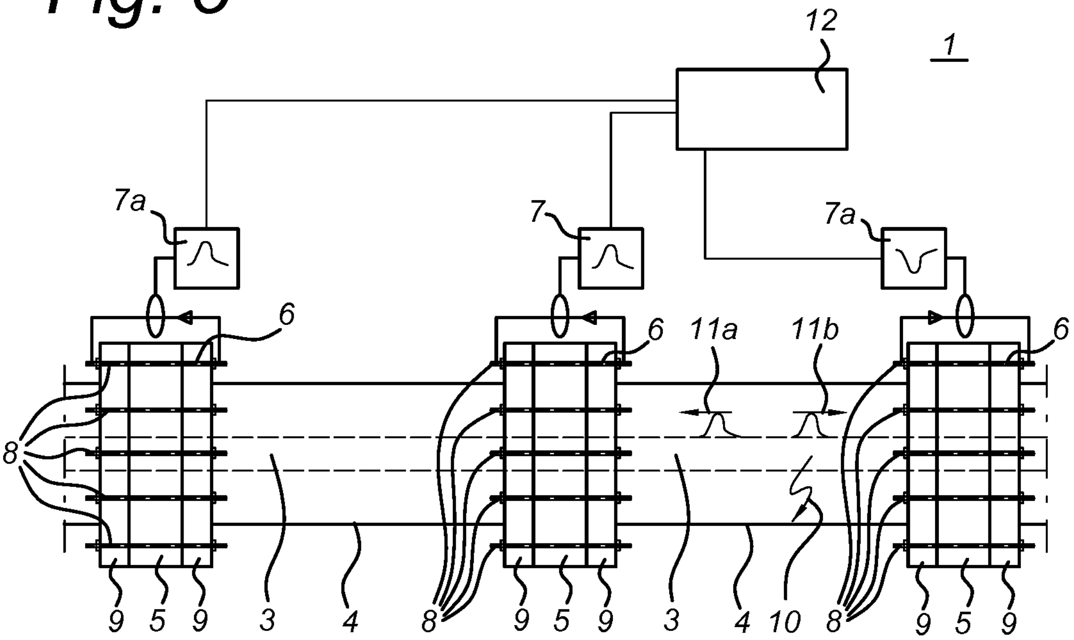


Fig. 5



Abstract

Measurement system for monitoring a gas insulated system, the gas insulated system comprising at least two GIS segments (2). Each of the at least two GIS segments (2) has a central conductor (3) and an outer conductor (4) coaxially positioned around the central conductor (3). An insulating spacer (5) is positioned between two adjacent outer conductors (4) of the at least two GIS segments (2), and an electrical conducting element (6) is in electrical connection with the two adjacent outer cylindrical conductors (4). The measurement system (1) further has a current sensor (7) in measuring relationship with the at least one electrical conducting element (6), which is e.g. formed by one of a plurality of fixing rods (8) extending through the spacer (5).

[Fig. 3]

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE **P6066275NL**
Nederlands aanvraag nr. **2018552**	Indieningsdatum **20-03-2017**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Technische Universiteit Delft**	
Datum van het verzoek voor een onderzoek van internationaal type **17-06-2017**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN69144**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

H01R31/00

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**G01R;H01R**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	☐	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	☐	**GEBREK AAN EENHEID VAN UITVINDING**	(opmerkingen op aanvullingsblad)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018552

A. CLASSIFICATIE VAN HET ONDERWERP
INV. H01R31/00
ADD.

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte mimimum documentatie (classificatie gevolgd door classificatiesymbolen)
G01R H01R

Onderzochte andere documentatie dan de mimimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)

EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X A	GB 2 444 613 A (TOSHIBA KK [JP]) 11 juni 2008 (2008-06-11) * figuur 1 * * bladzijde 2, regels 2-16 * -----	1,2,4-8, 10-15 3
A	US 2007/115008 A1 (BARTH JON E [US] ET AL) 24 mei 2007 (2007-05-24) * figuur 1 * * alinea [0042] * -----	1-15
A	US 7 741 853 B2 (ROCKWELL AUTOMATION TECH INC [US]) 22 juni 2010 (2010-06-22) * figuur 1 * -----	1-15
A	GB 2 538 199 A (MITSUBISHI ELECTRIC CORP [JP]) 9 november 2016 (2016-11-09) * figuren 1, 2 * -----	1-15
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
8 december 2017	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Kuchenbecker, J

2

Formulier PCT/ISA/201 (tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Nummer van het verzoek om een onderzoek naar de stand van de techniek
NL 2018552

C.(Vervolg). VAN BELANG GEACHTE DOCUMENTEN

Categorie °	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
A	US 2015/204936 A1 (FUKASAWA TORU [JP] ET AL) 23 juli 2015 (2015-07-23) * figuur 1 * -----	1-15
A	GB 2 474 125 A (TOSHIBA KK [JP]) 6 april 2011 (2011-04-06) * figuur 1 * -----	1-15

2

Formulier PCT/ISA/201 (vervolg tweede blad) (Januari 2004)

ONDERZOEKSRAPPORT BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar de stand van de techniek

NL 2018552

In het rapport genoemd octrooigeschrift		Datum van publicatie	Overeenkomend(e) geschrift(en)			Datum van publicatie
GB 2444613	A	11-06-2008	CN	101202425	A	18-06-2008
			GB	2444613	A	11-06-2008
			JP	5105841	B2	26-12-2012
			JP	2008139207	A	19-06-2008
			US	2009027062	A1	29-01-2009
US 2007115008	A1	24-05-2007	US	2007115008	A1	24-05-2007
			WO	2007027985	A2	08-03-2007
US 7741853	B2	22-06-2010	US	2009085573	A1	02-04-2009
			US	2010271037	A1	28-10-2010
			US	2010271038	A1	28-10-2010
GB 2538199	A	09-11-2016	CN	106104287	A	09-11-2016
			GB	2538199	A	09-11-2016
			JP	6091700	B2	08-03-2017
			JP	WO2015132821	A1	30-03-2017
			US	2016349303	A1	01-12-2016
			WO	2015132821	A1	11-09-2015
US 2015204936	A1	23-07-2015	CN	104115355	A	22-10-2014
			JP	5693782	B2	01-04-2015
			JP	WO2013124886	A1	21-05-2015
			US	2015204936	A1	23-07-2015
			WO	2013124886	A1	29-08-2013
GB 2474125	A	06-04-2011	CN	102033191	A	27-04-2011
			GB	2474125	A	06-04-2011
			JP	5491819	B2	14-05-2014
			JP	2011083054	A	21-04-2011
			US	2011080161	A1	07-04-2011

WRITTEN OPINION

File No.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN69144	20.03.2017		NL2018552

International Patent Classification (IPC)
INV. H01R31/00

Applicant
Technische Universiteit Delft

This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the application
- ☐ Box No. VIII Certain observations on the application

Examiner
Kuchenbecker, J

Application number

WRITTEN OPINION

NL2018552

Box No. I Basis of this opinion

1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

   ☐ a sequence listing

   ☐ table(s) related to the sequence listing

   b. format of material:

   ☐ on paper

   ☐ in electronic form

   c. time of filing/furnishing:

   ☐ contained in the application as filed.

   ☐ filed together with the application in electronic form.

   ☐ furnished subsequently for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty	Yes:	Claims	3, 5-7, 9-15
	No:	Claims	1, 2, 4, 8
Inventive step	Yes:	Claims	3, 9
	No:	Claims	1, 2, 4-8, 10-15
Industrial applicability	Yes:	Claims	1-15
	No:	Claims	

2. Citations and explanations

   see separate sheet

WRITTEN OPINION

Box No. VII Certain defects in the application

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1 GB 2 444 613 A (TOSHIBA KK [JP]) 11 juni 2008 (2008-06-11)

D2 US 2007/115008 A1 (BARTH JON E [US] ET AL) 24 mei 2007 (2007-05-24)

D3 US 7 741 853 B2 (ROCKWELL AUTOMATION TECH INC [US]) 22 juni 2010 (2010-06-22)

D4 GB 2 538 199 A (MITSUBISHI ELECTRIC CORP [JP]) 9 november 2016 (2016-11-09)

D5 US 2015/204936 A1 (FUKASAWA TORU [JP] ET AL) 23 juli 2015 (2015-07-23)

D6 GB 2 474 125 A (TOSHIBA KK [JP]) 6 april 2011 (2011-04-06)

D7 WO 2007/097491 A1 (KOO JA YOON [KR]; JUNG SEUNG YUNG [KR]; KIM YONNG HONG [KR]; RYU CHEOL) 30 augustus 2007 (2007-08-30)

D8 US 2003/214307 A1 (KANG CHANG-WON [KR] ET AL) 20 november 2003 (2003-11-20)

1 Independent claim 1:

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

Document D1 (see fig. 1) discloses a

"Meetsysteem voor bewaken van een met gas geïsoleerd systeem (GIS),

waarbij het met gas geïsoleerd systeem (GIS) omvat

a) ten minste twee GIS segmenten (2, 3), waarbij elk van de ten minste twee GIS segmenten (2, 3) een centrale geleider (5) omvat en een buitenste geleider (2, 3) die coaxiaal rond de centrale geleider (5) is geplaatst,

b) een isolerend afstandselement (4) dat tussen twee naast elkaar liggende buitenste geleiders (2, 3) van de ten minste twee GIS segmenten (2, 3) is geplaatst, en

c) een elektrisch geleidend element (6) dat in elektrische verbinding staat met de twee naast elkaar liggende buitenste geleiders (2, 3),

d) waarbij het meetsysteem (1) een stroomsensor (7, 8, 9) omvat die in een metende relatie is met het ten minste ene elektrisch geleidend element (5).

The "elektrisch geleidend element" is identified by reference (6), see also D1, page 11, lines 1-5.

2 Dependent claims 2 and 4-15:

Dependent claims 2 and 4-15 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, see D1-D8.

2.1 Claims 2, 8 and 9: see D1, fig. 1, bolts (6).

2.2 Claim 4: see page 13, line 21 - page 14, line 6.

2.3 Claim 5: the use of a magnetic field sensor is not considered to be inventive because this sensor is known in this technical domain.

2.4 Claim 6: a Rogowsky coil is also not inventive; it would be used by the person skilled in the art if necessary.

2.5 Claim 7: the current sensor would probably be implemented into the spacer because to miniaturize the system.

2.6 Claim 10: the use of a metal strip would be expectable in this technical domain.

2.7 Claims 11-14: see D1, fig. 1.

2.8 Claim 15: the use of an additional current sensor would also be implemented if necessary.

3 Dependent claim 3:

The combination of the features of dependent claim 3 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows:

As the flow of the current originating from the partial discharge event will follow the entire length of the conducting and fixing rod, the total of the current flow will flow through the sensor if the sensor is provided as a coaxial arrangement around on the the fixing rods. This leads to less loss and to a higher accuracy of the measurement. The skilled person would readily try to miniaturize the whole system and put the sensor into the insulating spacer but he would find no incentive in the available prior art to choose the relatively complicated arrangement proposed in fig. 2.

Re Item VII

Certain defects in the application

1 The relevant background art disclosed in documents D1-D6 is not mentioned in the description, nor are these documents identified therein.