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(72) Inventor: **Mähönen, Pentti**
65320 Vaasa (FI)

(74) Representative: **Peltonen, Antti**
Kolster Oy Ab,
Iso Roobertinkatu 23
00120 Helsinki (FI)

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(71) Applicant: **ABB Technology AG**
8050 Zürich (CH)

(54) **Insulator**

(57) The invention relates to an insulator, such as a bushing insulator, which comprises a body (1) made of an insulating material, an opening for receiving a primary current conductor (2), a Rogowski sensor (3) arranged around the opening and a screening cover (5)

which is made of a conductive material, receives windings or coils (4) of the Rogowski sensor and is arranged to form a loop with a closed cross section, **characterized** in that the screening cover (5) is provided with at least one ear (8) for receiving a fitting part (6), which is used to support the screening cover in place.

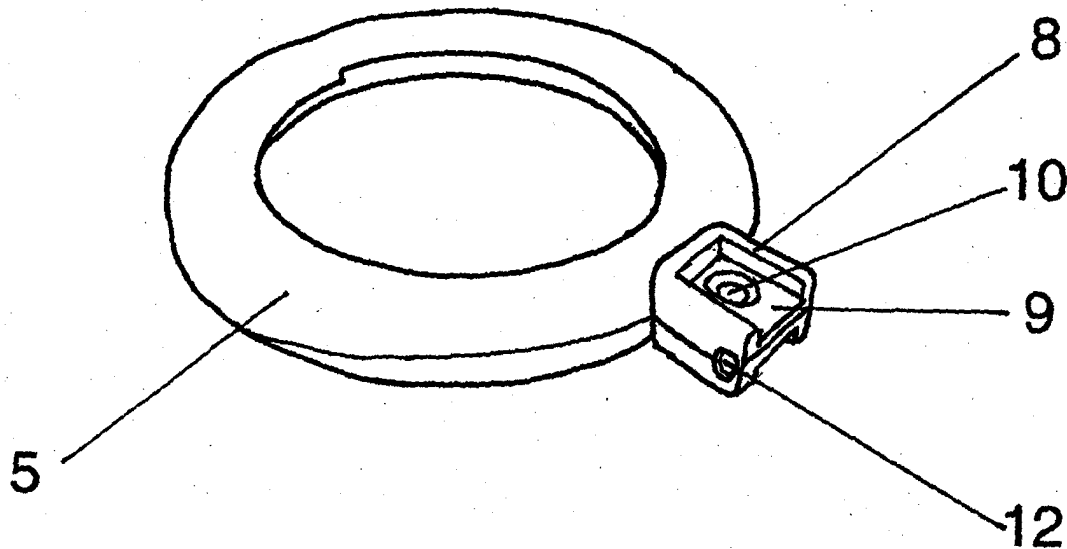


Fig. 3

Description

BACKGROUND OF THE INVENTION

[0001] The invention relates to an insulator which comprises a body moulded from an insulating material, an opening for receiving a primary current conductor and an element for measuring the current, which is arranged around the opening and comprises a Rogowski sensor and a screening cover structure around the Rogowski sensor.

[0002] In connection with the present invention, the insulator comprising a body moulded from an insulating material, such as epoxy resin, and an opening for receiving a primary current conductor refers to various devices used in electricity distribution technology, particularly in switchgears, such as pin insulators, bushing insulators or switches provided with a current measuring sensor. For the sake of clarity, the invention will be described in the following only in connection with a bushing insulator.

[0003] In medium voltage switchgears, in particular, the conventional current transformer is nowadays often replaced with a Rogowski sensor since, thanks to its small size, it is easy to arrange in various switchgears, such as bushing insulators, which provides considerable space savings. A Rogowski sensor typically comprises one air-core circular coil, but the coil may also be formed from several air-core coils connected in series. The coil or coils are typically arranged in a screening cover surrounding them to reduce the error voltage induced by surrounding conductors and components.

[0004] A protective casing for suppressing external interference is known from EP 0917157. The protective casing is formed of two halves pressed from an aluminium sheet and shaped so that the coils are exactly equally spaced on the circle's circumference and remain in place until the whole sensor has been moulded in resin. The halves of the protective casing are shaped so that there is at least one breakpoint between the halves to prevent the casing from forming a loop with a closed cross section.

[0005] A Rogowski sensor arranged in an electrostatic cover made of a non-magnetic metal, such as copper or aluminium, is known from US 4,611,191. The cover has the shape of a cylindrical ring and surrounds the core and coil of the Rogowski sensor from every direction.

[0006] In prior art solutions, it has been difficult to align a screening cover and keep it in place, at least until the Rogowski sensor has been moulded in insulating material. The Rogowski sensor has been supported against the mould or primary current conductor either with loose cardboard pieces or pressboard pieces or fixed supports have been attached to the screening cover by welding their one end to the sleeves of the fastening screws in the insulator, for example.

BRIEF DESCRIPTION OF THE INVENTION

[0007] The object of the present invention is to provide an insulator, in particular a bushing insulator where the above-mentioned problems have been solved by implementing the support of a Rogowski sensor in a simple manner and where the effect of interference on the Rogowski sensor has been minimized. This is achieved by a structure which is characterized by what is disclosed in independent claim 1. Preferred embodiments of the invention are disclosed in the dependent claims.

[0008] The invention is based on a Rogowski sensor which comprises either a circular coil or one or more air-core coils arranged in a screening cover, which is made of a non-magnetic metal and is preferably formed from two identical halves, which are arranged against each other so that they form a substantially enclosed screening cover.

[0009] It should be noted, in particular, that a compact metal casing which is not provided with a conventional breakpoint forms a closed loop and is thus unideal in terms of electrotechnics since the solution suppresses the amplitude of the Rogowski sensor's output signal and causes a phase error in the measurement result. Thus the upper limit of the useful frequency range of the Rogowski sensor will be lower than in the cover of a screening structure provided with a breakpoint, but the frequency response will be sufficient for most measurements in electricity distribution technology. Zinc, in particular alloy Zn Al 4 Cu 1, is a light material whose moulding properties are well suited for the solution according to the invention. The resistivity of zinc is approximately 2.5-fold compared to that of aluminium, in which case sufficient interference suppression is achieved by zinc or zinc alloy. Yet the magnetic field of the primary current that is to be measured and affects the Rogowski sensor is not suppressed too much.

[0010] When the screening cover is enclosed, it suppresses the crosstalk caused by the voltages of the adjacent phases and the interference caused by the electric field of the primary current conductor considerably more effectively than the conventional structure provided with a breakpoint. In respect of product control and manufacture, it is most advantageous to form the screening cover of two identical castings, in which case only one kind of mould is needed and one distinctive name is sufficient for the component. One and the same screening cover type of the Rogowski sensor can be used for different insulators, such as bushing insulators, pin insulators, etc., since the sensor can be adjusted to different insulators by means of a fitting part, which is attached to the case. It is easy to make the fitting part so firm that it alone supports the Rogowski sensor. Unlike in prior art solutions, it is unnecessary to use several supporting arms welded to the case. When welded supporting arms are used, various screening covers are needed, depending on the mechanical dimensions of the insulator in question. In respect of the manufacturing

technique, it is further advantageous that the screening cover does not need to be provided with an air gap. By moulding the screening cover from zinc, it can be provided with a very good dimensional accuracy. In addition, it is easy to treat the surface of the zinc casting by sandblasting, for example, to obtain a surface roughness which allows the insulating material, such as cast resin, to stick well to the surface, in which case no undesired separating surface is formed.

DESCRIPTION OF THE FIGURES

[0011] In the following, the invention will be described in greater detail by means of embodiments with reference to the accompanying figures, in which

Figure 1 illustrates a cross section of an exemplary embodiment of the invention, i.e. a bushing insulator;

Figure 2 illustrates cross section A-A of the insulator according to Figure 1;

Figure 3 is a perspective view of the screening cover illustrated in Figures 1 and 2;

Figure 4 is a partial perspective view of the inner surface of one half of the screening cover;

Figure 5 illustrates a cross section of one half of the screening cover.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Figures 1 and 2 illustrate a bushing insulator of a medium voltage switchgear according to the invention. The bushing insulator comprises a body (1), which is made of an insulating material and provided with a primary current conductor (2) in the middle. The primary current conductor (2) is typically mounted in place before the part made of insulating material is moulded, and thus the primary current conductor is a fixed part of the bushing insulator. Coils (4) of a Rogowski sensor (3) are arranged inside a substantially enclosed screening cover (5) made of a metal, preferably zinc or zinc alloy.

[0013] The screening cover (5) is supported in place during casting by a fitting part (6), whose one end is attached to an earthing connector (7). The fitting part (6) is dimensioned according to the insulator used so that the Rogowski sensor (3) will be around the primary current conductor in the middle of it. The fitting part (6) is made of an electrically conductive material, and thus no separate earthing connector is needed between the screening cover (5) and the earthing connector (7). The earthing connector (7) is arranged in the mould so that the Rogowski sensor stays firmly and accurately in place during casting.

[0014] Figures 3 and 4 illustrate a screening cover (5) which is formed of two halves (5a, 5b). The halves (5a, 5b) are preferably identical parts cast in the same mould, in which case it is easy to store and install them compared to the case where two different halves are

used. The screening cover (5) is preferably made of zinc or zinc alloy, which is light, but another electrically conductive material, for example aluminium, may also be used. The outer surface of the screening cover (5) is annular and its cross section is substantially round. The screening cover comprises at least one ear (8), which preferably protrudes from the outer circumference and is provided with a cavity (9) for receiving the fitting part (6). Furthermore, the ear (8) is provided with a hole (10) for receiving an attachment member of the fitting part (6), such as a bolt and a nut or a rivet (not shown in the figure).

[0015] The attachment member of the fitting part (6), such as a bolt and a nut or a rivet, is also arranged to attach the halves (5a, 5b) of the screening cover to each other and thus form an electrically conductive case which surrounds the coils (4) of the Rogowski sensor (3).

[0016] The outer surface of the halves (5a, 5b) of the screening cover can be roughened e.g. by sandblasting so that epoxy resin sticks well to the outer surface and no separating surface is formed, which might cause undesired partial discharges due to the influence of the electric field.

[0017] The inside of the annular wall of the screening cover is provided with support flanges (11) for accurate mounting of the cylindrical coils (4). The ends of the coil formers (4a) of the coils (4) made of insulating material rest on the support flanges (11) so that the coils are placed at equal distances in a plane perpendicular to the axial direction of the primary current conductors and form a polygon.

[0018] The windings (4b) of the current measuring coils (4) are wound onto the coil former (4a) and the windings are electrically connected in series. The conductor at one end of the last coil of the series is arranged to be taken out of the screening cover (5) as a return conductor via the hubs of the hollow coil formers in the same manner as the first connecting wire of the Rogowski sensor via the hole (12) in the ear (8). The hole (12) is formed by semicircular cavities (13) provided in both halves (5a, 5b).

[0019] Figure 5 illustrates overlap provided at the edges of the halves (5a, 5b) of the screening cover (5). The overlap is formed as follows: on the first side of the symmetry axis passing through the centre of the ear (8), the flange extends from the outer surface (14) on the inner and outer circumferences a distance corresponding to slightly less than half of the material thickness of the wall, and on the second side, the flange extends from the inner surface (15) on the inner and outer circumferences substantially the same distance corresponding to slightly less than half of the material thickness of the wall. When the two halves (5a, 5b) are attached together, the joint areas overlap, which improves the quality of screening. It is also easy to align the halves to each other mechanically, in which case it is sufficient to attach the halves to each other only at one point. It is essential

to provide the overlap in the annular section which protects the current measuring coils (4), whereas overlap is less important at the ear (8).

[0020] Even though only one embodiment was described above, it is to be understood that a person skilled in the art can easily apply the invention to different devices used in distribution of electricity. 5

Claims

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1. An insulator, such as a bushing insulator, which comprises a body (1) made of an insulating material, an opening for receiving a primary current conductor (2), a Rogowski sensor (3) arranged around the opening and a screening cover (5) which is made of a conductive material, receives winding or coils (4) of the Rogowski sensor and is arranged to form a loop with a closed cross section, **characterized in that** the screening cover (5) is provided with at least one ear (8) for receiving a fitting part (6), which is used to support the screening cover in place. 15 20
2. An insulator according to claim 1, **characterized in that** the screening cover (5) is formed of two halves (5a, 5b). 25
3. An insulator according to claim 2, **characterized in that** the halves (5a, 5b) of the screening cover (5) are moulded from zinc or zinc alloy. 30
4. An insulator according to claim 3, **characterized in that** the screening cover (5) is in particular made of zinc alloy Zn Al 4 Cu 1. 35
5. An insulator according to claims 2 to 4, **characterized in that** both halves (5a, 5b) of the screening cover have substantially the same shape. 40
6. An insulator according to any one of claims 2 to 5, **characterized in that** the parts of the halves (5a, 5b) of the screening cover (5) that are against each other are arranged to overlap where relevant. 45
7. An insulator according to any one of claims 1 to 6, **characterized in that** the fitting part (6) is made of a conductive material for earthing the screening cover (5). 50

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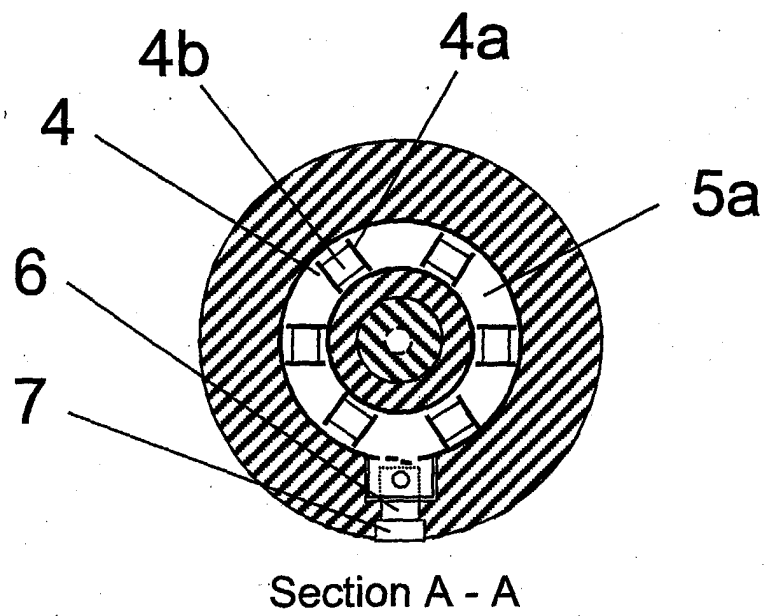
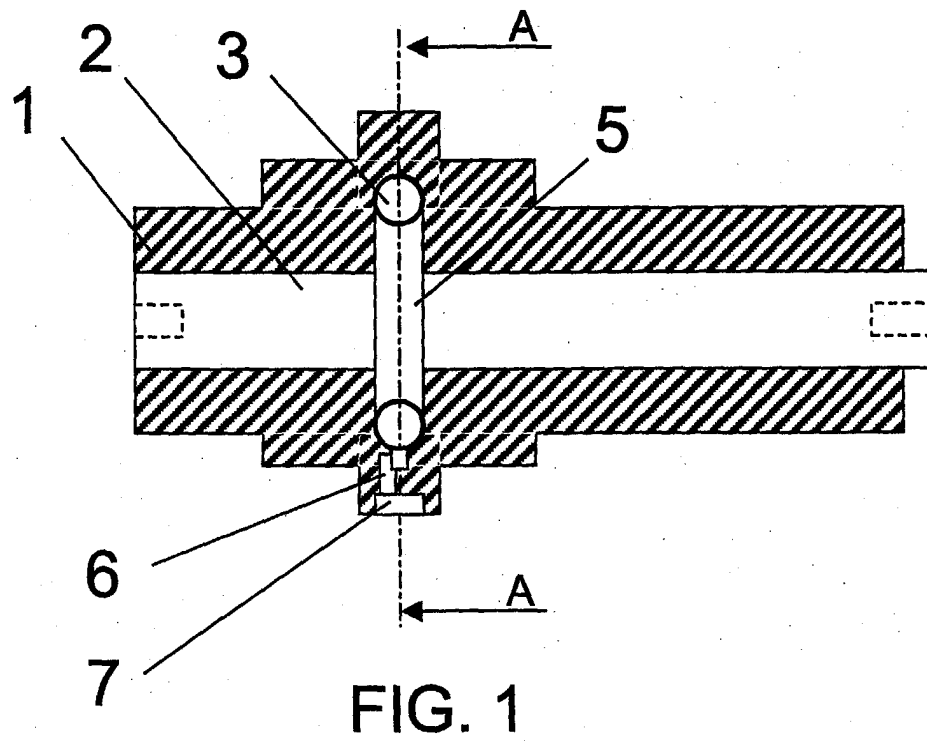


FIG. 2

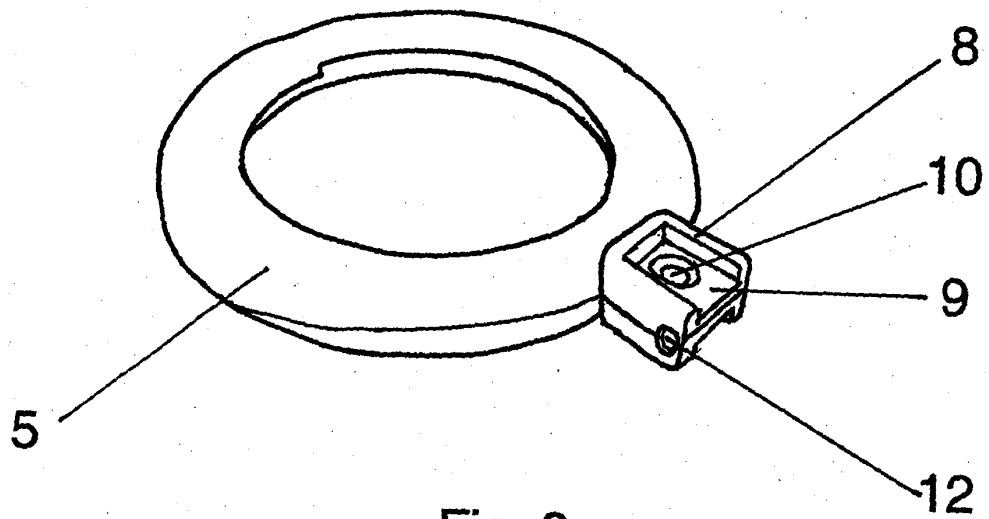


Fig. 3

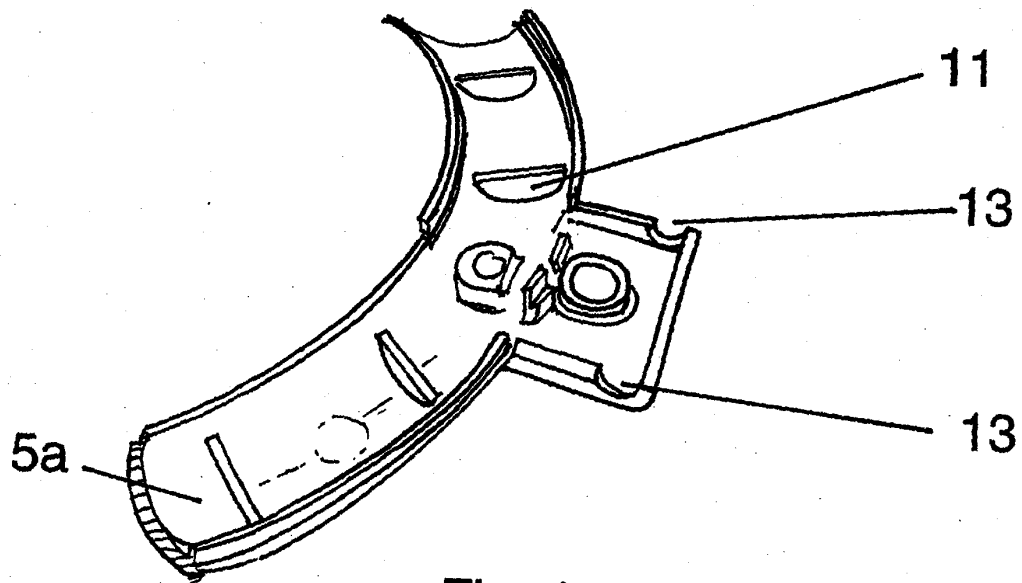


Fig. 4

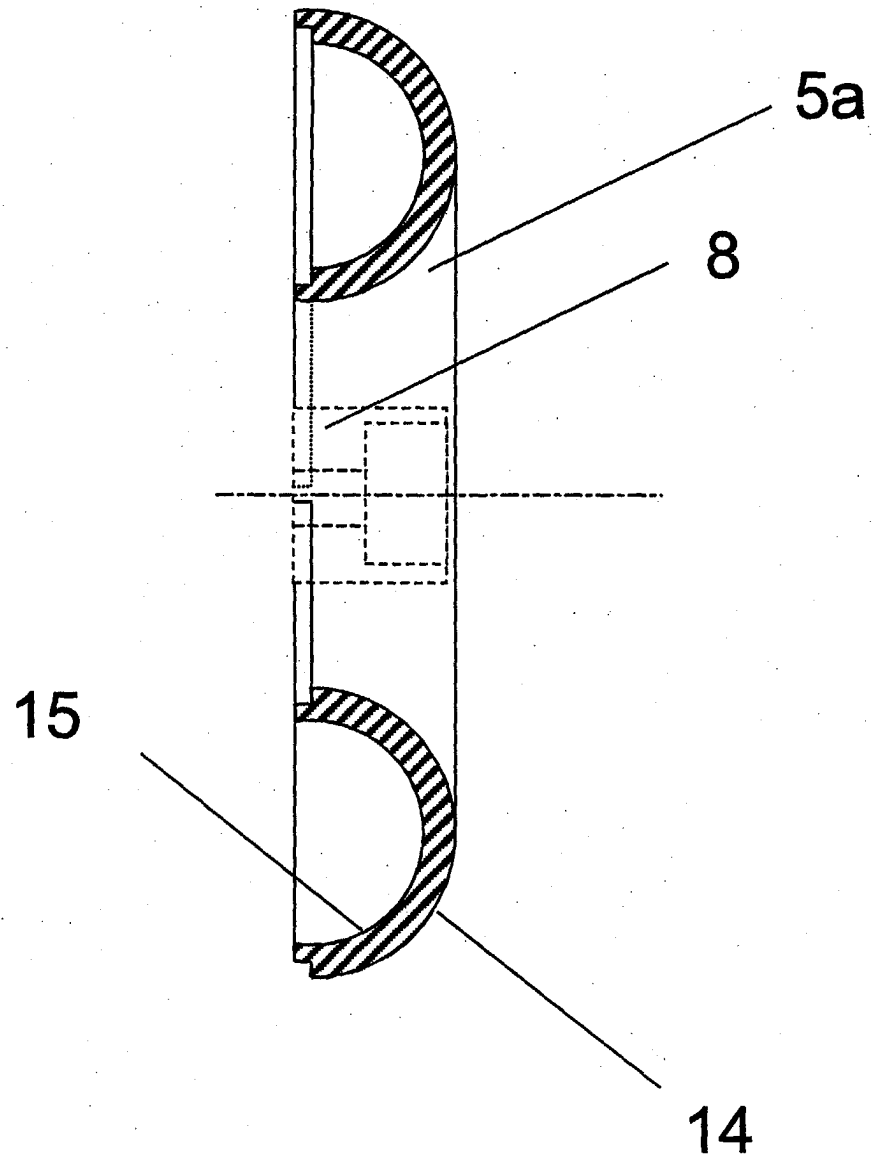


Fig. 5