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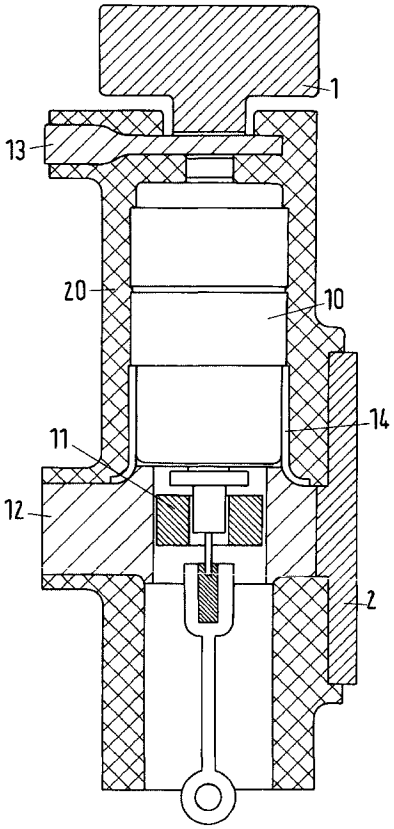
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(54) Title: POLE PART OF A MEDIUM-VOLTAGE OR HIGH-VOLTAGE SWITCHGEAR ASSEMBLY, AND METHOD FOR ITS PRODUCTION



(57) Abstract: The invention relates to a low-voltage, medium-voltage or high-voltage switchgear assembly as claimed in the preamble of patent claim 1, 9 and 10. In order to ensure in this case that heat that is created is dissipated better to the exterior for convection, the invention in this case proposes that a thermally conductive heat transmission element in the form of a cylindrical casing is provided between the vacuum interrupter chamber, a contact holder and the encapsulation casing, the inner surface of which heat transmission element rests on the vacuum interrupter chamber and the contact holder, and the outer surface of which heat transmission element rests on the encapsulation casing inner surface. Furthermore, a heat transmitter is proposed which can be produced from a thermally conductive plastic using the injection-molding or molding-compound production process. This can then be connected to the pole part through openings. A further option is to fit these heat transmitters before the encapsulation of an assembly with dn encapsulation compound, and then to also cast them in.

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Pole part of a medium-voltage or high-voltage switchgear assembly, and method for its production

The invention relates to a pole part for a medium-voltage or high-voltage switchgear assembly, and to a method for producing it, as claimed in the preamble of patent claims 1, 9 and 10.

Pole parts for medium-voltage or high-voltage switchgear assemblies have to have a high current carrying capacity. In this case, contact resistances are kept as low as possible. The high currents that flow in the connected state (load case) may, however, produce significant amounts of thermal energy, even when the contact resistances are low. These must be dissipated in a suitable manner.

For reasons relating to dielectric hermetic sealing of a pole part such as this, the vacuum interrupter chambers are normally composed of ceramic with quite a low thermal conductivity, and the majority of the thermal energy is dissipated out of the chamber by the supply lines (generally composed of copper material), and is concentrated in this area. The vacuum interrupter chamber is encapsulated overall in an electrically insulating encapsulation casing. The electrical insulation characteristic of the encapsulation casing also, of course, reduces the heat transmission as such.

The invention is therefore based on the object of improving a pole part of this generic type, and a method for producing it, such that heat that is created is dissipated better to the outside for convection.

In the case of a pole part according to the preamble of patent claim 1, the stated object is achieved according to the invention by the distinguishing features of patent claim 1.

Further advantageous refinements are specified in the dependent claims 2 to 8.

With regard to a method, the stated object according to the invention is achieved by the distinguishing features of patent claim 9.

The essence of the invention in this case is that an electrically insulating or else conductive and in consequence thermally conductive heat transmission element, which is in the form of a cylindrical casing, is provided between the vacuum interrupter chamber and the encapsulation casing, the inner surface of which heat transmission element rests on a contact holder which passes on the thermal flow from here so that, with its outer surface, the thermal conduction on the encapsulation casing inner surface can be transmitted over a large area to the insulation material. This contact holder dissipates the heat flow from one of the two supply lines of a vacuum interrupter chamber outwards, and passes the rated current via the connections to the outside, interface to the pole part, passes on the thermal flow from here such that, with its outer surface, the thermal conduction on the encapsulation casing inner surface can be transmitted over a large area to the insulation material. That means, that the thermal coupling element is located between a metal part and an insulator, which is made of thermal conductive material.
The thermal conductive element can also be suited for injection moulding and will be embedded within a second moulding process.

In comparison to the known type, in which the vacuum interrupter chamber is directly encapsulated in the encapsulation compound or is encapsulated with the injection-molding compound, a thermally conductive heat transmission element in the form of a cylindrical casing will now transmit between the contact holder on which the current and heat transmission from the vacuum interrupter chamber predominantly takes place to the thermally conductive heat transmitter element, and therefore via the casing outer surface to the pole part material, the encapsulation casing. This measure creates a larger, and in particular effective, thermally transmissive intermediate layer. This effectively increases the thermal power transported from the inside outwards and likewise enlarges the heat transmitter area on the outside of the pole part.

In a further advantageous refinement, the outer surface of the heat transmission element which is in the form of a cylindrical casing is folded. This considerably increases the effective area for heat transmission on the side of the encapsulation casing.

As an alternative to this, the outer surface of the heat transmission element which is in the form of a cylindrical casing may be corrugated or roughened.

In one advantageous refinement, the heat transmission element which is in the form of a cylindrical casing may be composed of metal, preferably of copper or a copper alloy, or as an alternative to this, of aluminum or an aluminum alloy, or of a ceramic which is sufficiently thermally conductive for this purpose.

A further highly advantageous refinement consists in that the heat transmission element which is in the form of a cylindrical casing is composed of an electrically conductive plastic (filled or else unfilled). Partial

layers may be electrically insulating. This makes it possible to produce a thermal conductivity gradient.

In a further refinement, the heat transmission element which is in the form of a cylindrical casing is formed in layers from a two-component material, in which an outer material component has a high thermal conductivity, and an inner material component has a lower thermal conductivity.

With regard to a method for producing a pole part such as this, the essence of the invention consists in that the vacuum interrupter chamber and/or the respective contact holder is provided with a heat transmission element before being encapsulated in an external encapsulation casing, which heat transmission element is in the form of a cylindrical casing, is fitted to the outer surface of the vacuum interrupter chamber and is then also surrounded or extrusion coated with the encapsulation casing compound.

Further advantageous refinements are specified in the other dependent claims.

One exemplary embodiment of the invention will be described in more detail in the following text and is illustrated in the drawing.

The figure shows one exemplary embodiment of the invention, illustrating a pole part as is used in a medium-voltage or high-voltage switchgear assembly, which is not illustrated in any more detail.
The vacuum interrupter chamber, in which at least one moving contact, and in consequence if required a stationary contact, are arranged, is arranged within the pole part.
The vacuum interrupter chamber is embedded in an encapsulation casing which is formed either from epoxy-

resin encapsulation, plastic injection molding or press molding, or from an encapsulation compound (polyurethane, silicone ...).

The material of the vacuum interrupter chamber is normally composed of ceramic, and metallic covers are also integrated at the ends. In order to dissipate heat to the outside, on the one hand the casing surface of the encapsulation material and on the other hand a heat transmitter in the form of a heat sink are provided, with the latter being arranged, for example, on or adjacent to a pole part and being provided from the outside.

The thermal flow coming from the inside must, however, first of all be passed outwards. The heat transmission element according to the invention, which is in the form of a cylindrical casing, can be and is used for this purpose. This is also encapsulated in the pole part in the form of a thermally conductive metal sheet or a film.

The heat transmission element according to the invention may be composed of metal, or else of a plastic material which has adequate thermal conductivity for the intended purpose.

However, the heat transmission element may also be formed from a multilayer composite material composed of electrically conductive and electrically insulating plastic, or from a metallically coated plastic. The heat transmission element may also be produced using the press-molding or injection-molding process, and can then be introduced as normal at the appropriate point.

A further option is to also encapsulate the heat transmission element directly in a pole part (even without any gap).

The figure in this case shows the manufacture of a pole part with a heat transmission element, preferably but

not exclusively composed of sheet copper, thus resulting in the capability to pass the heat from the contact connecting piece via a component of, for example, a vacuum interrupter chamber to the ceramic material of the vacuum interrupter chamber. The aim is "large-area" distribution of the heat created at the contact connection to the cast-resin component for heat dissipation to the exterior by convection.

Furthermore, the thermal conductivity of the vacuum interrupter chamber ceramic (Al_2O_3) is higher than that of (SiO_2) (low-cost epoxy filler) and likewise carries the thermal flow further in an appropriate form, thus making it possible to transmit a greater energy flow from the pole part to the surrounding area.

Overall, the advantages which result from this are:

considerable improvement in the area of heat transmission as well as in the encapsulation technology; a completely closed pole part can be produced with heat transmission elements, in one step. This can be done using either casting and casting-resin technology or else injection-molding technology.

This leads to a considerable reduction in the component costs for the heat transmission element, since it need not be produced from a "metal block" composed of copper or aluminum, but from sheet metal or film, or as an injection-molded component.

Considerably more complex heat transmission element geometries can be achieved, thus improving the heat transmission by convection.

The heat transmission element may be composed of two different materials, production using the two-component process --> two-component process: in this case, a

plastic 1 with a relatively high thermal conductivity (for example also electrically conductive) is first extrusion coated with a material 2 with a lower thermal conductivity (with a plastic, for example, also electrically non-conductive). It is also possible to produce the material 1 from a plastic with low conductivity (unfilled or filled) and the material 2 from a more conductive plastic.

The heat transmission element may also be provided with a plastic coating, for dielectric reasons. This is not required for heat transmission elements which are designed to be "electrically insulating". (In this case, the plastic can be filled with **C**, Al_2O_3 or else with **AlN**).

This allows heat transmission elements to be fitted both to the fixed-contact mount area and in the switching contact area of a pole part, then to be screwed on, and/or then also to be completely encapsulated as well. Comparatively compact pole parts can thus be produced using encapsulation technology, and are suitable for a high rated current.

If heat transmission elements are used, then the weight of the overall component can likewise be reduced. Furthermore, the heat transmitters can also be used in areas adjacent to the flexible strip or a moving current transmission piston (or the corresponding socket), with little influence on the mechanical behavior of the component.

If a conductive foil or a strip (also formed from two or more layers) is inserted into the pole part, then the heat can be transmitted "over a large area" to the pole part. Overall, this allows a greater energy flow to be transmitted outwards to the surrounding area.

Patent Claims:

1. A pole part of a low-voltage, medium-voltage or high-voltage switchgear assembly having a vacuum interrupter chamber which is encapsulated in an external encapsulation casing, is composed of a composite material and is closed at both ends by metallic cover elements,
wherein
a thermally conductive heat transmission element in the form of a cylindrical casing is provided between the vacuum interrupter chamber, a contact holder and the encapsulation casing, the inner surface of which heat transmission element rests on or in the vicinity of the vacuum interrupter chamber outer surface and the contact holder, and the outer surface of which heat transmission element rests on the encapsulation casing inner surface or is located within the encapsulation casing.

2. The pole part as claimed in claim 1,
wherein
the outer surface of the heat transmission element which is in the form of a cylindrical casing is folded.

3. The pole part as claimed in claim 1,
wherein
the outer surface of the heat transmission element which is in the form of a cylindrical casing is corrugated.

4. The pole part as claimed in claim 1,
wherein
the outer surface of the heat transmission element which is in the form of a cylindrical casing is roughened.

5. The pole part as claimed in one of claims 1 to 4,

wherein
the heat transmission element which is in the form of a cylindrical casing is composed of metal, preferably of copper or a copper alloy.

6. The pole part as claimed in one of claims 1 to 4, **wherein**
the heat transmission element which is in the form of a cylindrical casing is composed of aluminum or an aluminum alloy.

7. The pole part as claimed in one of claims 1 to 4, **wherein**
the heat transmission element which is in the form of a cylindrical casing is composed of a thermally conductive plastic.

8. The pole part as claimed in one of claims 1 to 4, **wherein**
the heat transmission element which is in the form of a cylindrical casing is formed in layers from a two-component, three-component or multiple-component material, in which an outer material component has a high thermal conductivity, and an inner material component has a lower thermal conductivity.

9. A method for producing a pole part of a low-voltage, medium-voltage or high-voltage switchgear assembly having a vacuum interrupter chamber which is encapsulated in an external encapsulation casing, is composed of a composite material and is closed at both ends by metallic cover elements,
wherein
the vacuum interrupter chamber is provided with a heat transmission element before being encapsulated in an external encapsulation casing, which heat transmission element is fitted to the outer surface of the vacuum interrupter chamber and is then also surrounded or

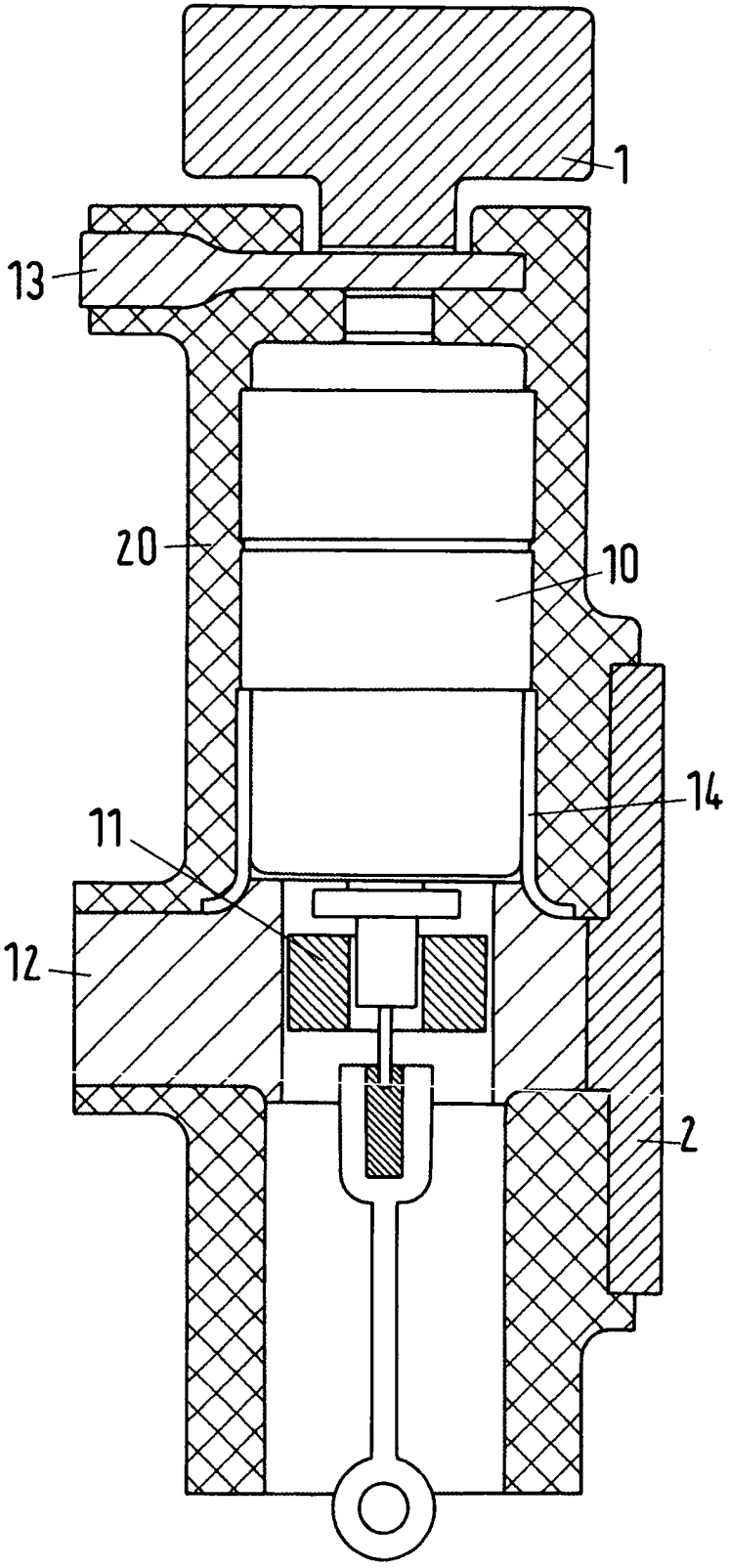
extrusion coated with the encapsulation casing compound.

10. A method for producing a pole part of a low-voltage, medium-voltage or high-voltage switchgear assembly having a vacuum interrupter chamber (equipped with ceramic or glass insulators) which is encapsulated in an external encapsulation casing, is composed of a composite material and is closed at both ends by metallic cover elements,
wherein
a heat transmitter composed of a thermally conductive plastic is produced using an injection-molding, casting or molding compound process, and is then also encapsulated in the encapsulation casing compound or, after encapsulation, is screwed on through openings to the pole part, in which case this plastic can be filled with a filler.

11. The pole part as claimed in claim 10,
wherein
the subsequently applied heat transmitter is connected closely to the pole part via adhesive, with an electrically close joint being produced.

12. The pole part as claimed in claims 10 and 11,
wherein
the subsequently applied heat transmitter, is connected to the pole part via a screw connection with one or more inner components, via screw unions.

13. The pole part as claimed in claims 10 to 12,
wherein
the subsequently applied heat transmitter, with the pole part, is closely connected to the pole part via a sealing system (O-ring, flat-ring seal or the like), with an electrically close joint being produced.


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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/004541

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H33/66 H01H9/52

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)
H01H

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 618 749 A (BOEHME KLAUS [DD] ET AL) 21 October 1986 (1986-10-21) column 3, line 31 - line 39 column 3, line 57 - line 65; figures 1-3	1-13
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X	WO 2004/038748 A (SIEMENS AG [DE]; HERING UWE [DE]; VOLKMAR RALF-REINER [DE]) 6 May 2004 (2004-05-06) page 5, line 22 - line 23; figure 1	1
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 August 2009	04/09/2009

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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