Abstract: The invention relates to a Medium voltage switchgear with frame, wherein a three phase arrangement of pole parts with vacuum interrupters are fixed at one end on a support or a frame element, which is arranged in a switchgear panel, wherein the open ends of the pole parts, opposite to the fixed ends of the pole parts fixed on the support or frame, are among themselves mechanically joined or connected by an additional joining and/or overlapping element, and near to the aforesaid open ends of the pole parts, one electrical terminal per pole part is placed, according to the preamble of claim 1. In order to result in the function of mechanical reinforcement coupled with the enhancement of dielectric withstand, with easy structural features, the invention is, that the joining element (1) is made of insulating material and tightly fixed among the open ends of the pole parts (2) in such, that they mechanically interconnect the pole parts and additionally increases the dielectrical withstand between the terminals of the pole parts from each other.

Figure 1
Medium voltage switchgear with frame and/or support element

The invention relates to a medium voltage switchgear with frame, wherein a three phase arrangement of pole parts with vacuum interrupters inside circuit breakers are fixed at one end on a support or a frame element, which is arranged in a switchgear panel, wherein the open ends of the pole parts, opposite to the fixed ends of the pole parts fixed on the support or frame, are among themselves mechanically joined or connected by an additional joining element, and near to the aforesaid open ends of the pole parts, one electrical terminal per pole part is placed, according to the preamble of claim 1.

The invention is based on medium voltage vacuum circuit breakers for switchgears and vacuum circuit breaker "stand-alone". In general such medium voltage vacuum circuit breakers mainly consist of a drive mechanism and electric poles. Vacuum interrupters are installed within the poles or pole parts. The drive is connected to the vacuum interrupters via pushrods which drive the mechanical movement of the switching contacts inside the vacuum interrupters. The poles provide the mechanical support to the vacuum interrupters. The poles are fixed to the circuit breaker structure and therewith to the gas-insulated switchgear panel or inside air-insulated environment.

An assembled pole parts are disclosed in EP 2 720 245 A1. This document discloses a vacuum interrupter which is arranged or mounted between two halfshells made of insulating material. In three phase arrangements, three pole
parts are arranged in parallel. Short circuits cause a high mechanical impact to the positioned pole parts, so that joining elements are used to mechanically connect such pole parts in such arrangements.

Additionally to this mechanical requirement, the pole-design has to withstand also the dielectric and thermal stress during service and testing conditions. In respect of dielectric stress the insulation parts of electric poles must provide sufficient electric creepage distance on electrically stressed paths and sufficient high electric resistivity. Furthermore the design should avoid thin gas gaps between insulating and electrically stressed parts where an accumulation of the electric field appears.

In respect of thermal stress the insulating parts of electric poles must withstand the ambient temperature in the circuit breaker compartment and the temperature of conducting parts with which they are in contact. Mechanical and dielectric properties of the insulating parts of the poles must not change inappropriately.

In respect of mechanical stress the pole design and especially the mechanically supporting parts of the poles must withstand the mechanical stress during switching of the circuit breaker and the electromagnetic forces during short circuit current application like short time current or short circuit current interruption operation.

Mainly two different embodiments of electric poles for medium-voltage vacuum circuit breakers are known. I.e. embedded pole parts, the vacuum interrupter and connecting parts are embedded in insulating material like thermosets, bulk moulded compounds (BMC) and thermoplastic material, and discrete structures, assembled pole parts in which mechanically supporting elements, electrically connecting elements, insulating elements and the vacuum interrupter are glued, screwed or snapped together. In assembled poles the mechanical support for the vacuum interrupter is known to be made from insulating threaded rods,
insulating plates or insulating half-shells. In order to assure additional mechanical stability between the poles simple mechanical cross beams are known to be fixed across the poles.

As a result from well known pole designs, disadvantages for such known arrangements are at first the mechanical instability of electric poles during short circuit current, which can cause further damage to the switchgear.

Furthermore flashovers can occur between electric poles at narrow pole-distance.

Furthermore, known constructions for preventing the aforesaid negative consequences result in constructive big structures for high power ratings.

According to that, it is the object of the invention, to prevent the aforesaid functionally bad consequences with constructionally compact elements, in such, that the function of mechanical reinforcement is coupled with the enhancement of dielectric withstand, with easy structural features.

This is solved by the features of claim 1.

Further advantageous embodiments of the invention is mentioned in the depending claims.

The invention proposes, that the joining element is made of insulating material and tightly fixed among the open ends of the pole parts in such, that they mechanically interconnect the pole parts and additionally increases the dielectrical withstand between the terminals of the pole parts from each other. Thermal conductivity can be provided to enable the part as a heat sink.

So as a result, the joining element made of insulating material, which is fixed tightly over the open ends of the pole parts, reinforces the mechanical stiffness
of the pole part arrangement, and simultaneously results in an increase of the
dielectrical withstand between the electrical terminals of the pole parts in this
region.

So, by using this joining element, positioned at the defined place, mechanical
reinforcement as well as increase of dielectrical withstand is enhanced by only
one element.

In a special embodiment the joining element is at least partly covered by a
conductive surface deposition in order to compensate electrical surface
charging.

In a further advantageous embodiment, the joining element is a plate.

Alternatively and highly advantageous the joining element is reinforced at least at
one surface by a crossbeam structure.

In a further advantageous embodiment, the joining element is provided with
sealing strips or paths or regions between each pole part, at that side of the
joining element, which is directly fixed on the pole parts.

In a further advantageous embodiment, the joining element is fixed commonly
at the open ends of the pole parts via insulating screws, screwed into female
threads, which are integrated or implemented in the insulating half shells or
embedding cover of the pole parts.

In a further advantageous embodiment, the insulating half shells or the
insulating embedding cover of the vacuum interrupters are made of
thermoplastic, BMC or duroplastic material.

In a further advantageous embodiment, the joining element is fixed commonly
at the open ends of the pole parts via high strength insulating or metallic screws, at least at the resulting four corners of the joining element, screwed into female screw threads, which are integrated or implemented in the insulating half shells or resin of the pole parts.

In a further advantageous and final embodiment, the insulating half shells or the insulating material for embedding the vacuum interrupters are made of thermoplastic material.

The invention can be realized in an advantageous way in so called assembled pole parts, in which the insulation cover of the vacuum interrupters consists of assembled half shells, like is is shown in figure 1.

But this is not the only possible embodiment for the invention. It is also applicable for pole parts partly or fully embedded vacuum interrupters.

So an electrical and mechanical joining and therefore reinforcing element 1 is for the medium voltage switchgear the basical part of the invention. This joining element is in one embodiment designed as or provided with a cross beam structure 3 on the opposite surface of the plate fixed tightly among the electric poles or pole parts 2. It is fixed to the ends of the poles opposite to the drive.

It significantly decreases the mechanical and electrical stress on and between the poles.

The joining element 1 is provided with openings 3, in which counter- or fixation-discs or -plates 4 are introduced, in order to fix the joining element with each of the pole parts 2, like shown in figure 3.

The complete reinforcement element including the mechanically reinforcing cross beam structure is made from thermoplastic material and is produced in a
single injection molding process. The joining element is designed to be fixed on poles which mechanical support structure is realized by thermoplastic half-shells. The fixation of the joining element to the end of the pole half-shells is done by e.g. high-strength, insulating screws and/or some overlapping areas to fix or take the forces from the half shell to the support structure. The transition between the end-faces of the pole half-shells and the joining element is sealed by an elastic two compound sealing material. This sealing is already fixed to the joining element during its molding process. It is important, that the sealing is tight, in dielectric sense.

Above mentioned design of the reinforcement element prevents from flash-overs between conducting parts of the poles at high voltage levels and narrow pole distances.

Secondly it improves the mechanical stability during fault current by coupling the ends of the poles mechanically and reducing the risk of cracking of the pole supports or of the poles themselves.

A further alternative embodiment of the joining element may be provided with a low conductive surface finish in order to allow the equalization of accumulated electric charges between the insulating pole supports.

A further embodiment of the reinforcement element may be fixed to the pole half-shells by self-tapping screws.

Figure 2 shows the joining element 1 from the side, which comes into tight mechanical contact to the ends of the pole parts 2. The joining element is provided at that side with sealing strips 4, in order to result in good dielectric withstand. Therefore sealing elements were extruded on the joining elements surface. So far, also sealing elements can be used which
are positioned in grooves on the surface of the joining element. Furthermore glueing is possible.
Claims

1. Medium voltage switchgear with frame, wherein a three phase arrangement of pole parts with circuit breakers are fixed at one end on a support or a frame element, which is arranged in a switchgear panel, wherein the open ends of the pole parts, opposite to the fixed ends of the pole parts fixed on the support or frame, are among themselves mechanically joined or connected by an additional joining element, and near to the aforesaid open ends of the pole parts, one electrical terminal per pole part is placed, characterized in that the joining element (1) is made of insulating material and tightly fixed among the open ends of the pole parts (2) in such, that they mechanically interconnect the pole parts and additionally increases the dielectrical withstand between the terminals of the pole parts from each other.

2. Medium voltage switchgear according to claim 1, characterized in that the joining element (1) is made of electrically insulating material.

3. Medium voltage switchgear according to claim 1, characterized in that the joining element (1) is at least partly covered by conducting or semi-conducting surface.

4. Medium voltage switchgear according to claim 2 or 3, characterized in that the joining element (1) is a plate.

5. Medium voltage switchgear according to one of the aforesaid claims 1 to 4,
characterized in
that the joining element \((1)\) is provided with a cross beam structure \((3)\) on the opposite surface of the plate fixed tightly among the electric poles or pole parts \((2)\).

6. Medium voltage switchgear according to one of the aforesaid claims 1 to 5,
characterized in
that the joining element \((1)\) is provided with sealing strips \((4)\) or paths or regions between each pole part, at that side of the joining element, which is directly fixed on the pole parts.

7. Medium voltage switchgear according to one of the aforesaid claims,
characterized in
that the joining element is fixed commonly at the open ends of the pole parts via insulating screws, screwed into female screw threads, which are integrated or implemented in the insulating half shells or embedding cover of the pole parts.

8. Medium voltage switchgear according to one of the aforesaid claims,
characterized in
that the insulating half shells or the insulating embedding cover of the circuit breakers are made of thermoplastic, bulk moulding components \((BMC)\) or duroplastic material.

9. Medium voltage switchgear according to one of the aforesaid claims,
characterized in
that the joining element \((1)\) is made from thermal conductive material, in order to get heat dissipation by the function as a heat sink.
10. Medium voltage switchgear according to one of the aforesaid claims, characterized in that the joining element (1) is provided with openings, in which counter- or fixation-discs or -plates (4) are introduced, in order to fix the joining element with each of the pole parts (2).
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. H01H33/666 H01H33/66

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)

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 practicable, search terms used)

EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>EP 2 568 554 A1 (ABB TECHNOLOGY AG [CH]) 13 March 2013 (2013-03-13) abstract; figures 1-7</td>
<td>1-3, 5, 7-10</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>4, 6</td>
</tr>
<tr>
<td>X</td>
<td>JP 2000 357442 A (TOSHIBA CORP) 26 December 2000 (2000-12-26) abstract; figures 1-18</td>
<td>2, 3, 5-10</td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>2, 3, 5-10</td>
</tr>
<tr>
<td>A</td>
<td>JP 554 101476 U (UNKNOWN) 17 July 1979 (1979-07-17) abstract; figures 1-5</td>
<td>1-9</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

A: document defining the general state of the art which is not considered to be of particular relevance

E: earlier application or patent but published on or after the international filing date

L: document which may throw doubts on priority claim(s) on which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

* T: later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

A: document member of the same patent family

Date of the actual completion of the international search

10 October 2016

Date of mailing of the international search report

20/10/2016

Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer

Rucha, Johannes
<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP 2568554</td>
<td>13-03-2013</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>JP 2000357442</td>
<td>26-12-2000</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 2002043517</td>
<td>18-04-2002</td>
<td>DE 10128502 AI</td>
<td>02-05-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>FR 2815462 AI</td>
<td>19-04-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2002124159 A</td>
<td>26-04-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2002043517 AI</td>
<td>18-04-2002</td>
</tr>
<tr>
<td>JP S54101476</td>
<td>17-07-1979</td>
<td>NONE</td>
<td></td>
</tr>
</tbody>
</table>