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(54) **FIELD GRADING ELECTRODE**

(57) The invention relates to a field grading electrode for a low, medium or high voltage switchgear.  
The field grading electrode is configured to be assembled to a conductor of a low, medium or high voltage switchgear.

The field grading electrode comprises an elastomer or thermoplastic.  
The field grading electrode is conductive or semi-conductive.

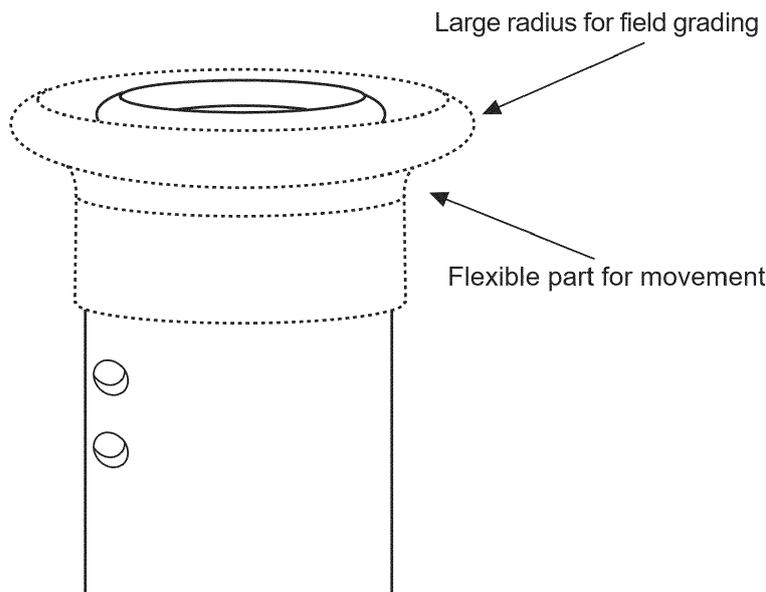


Fig. 1

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to a field grading electrode for a low, medium voltage or high switchgear, a conductor for a low, medium or voltage switchgear with field grading protection, and a method of field grading protecting a conductor for a low, medium or high voltage switchgear.

### BACKGROUND OF THE INVENTION

**[0002]** Field grading electrode in low voltage (LV), medium voltage (MV) and high voltage (HV) switchgears, that can be gas insulated switchgears, are used to homogenize the electrical field within the switchgear, such as across insulating gas distances.

**[0003]** The field grading electrodes reduce the maximum field strength in areas of sharp edges or tips, which could otherwise lead to a flashover under operation. By using such field grading electrodes it is possible to reduce insulations distances leading to a significant more compact design.

**[0004]** Field grading electrodes consists of electrically conductive materials to be able to influence the electrical field. Usually metallic materials such as Aluminum or Copper are used for this task.

**[0005]** However, such field grading electrodes are not optimum in all situations.

### SUMMARY OF THE INVENTION

**[0006]** Therefore, it would be advantageous to have an improved field grading electrode for low, medium or high voltage switchgears.

**[0007]** The object of the present invention is solved with the subject matter of the independent claims, wherein further embodiments are incorporated in the dependent claims.

**[0008]** In a first aspect, there is provided a field grading electrode for a low, medium or high voltage switchgear. The field grading electrode is configured to be assembled to a conductor of a low, medium or high voltage switchgear. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive or semiconductive.

**[0009]** In an example, at least one portion of the elastomer or thermoplastic is flexible.

**[0010]** In an example, at least one portion of the elastomer or thermoplastic is resilient.

**[0011]** In an example, the at least one portion of the elastomer or thermoplastic that is flexible is resilient.

**[0012]** In an example, a portion of the elastomer or thermoplastic comprises a large radius for field grading.

**[0013]** In an example, the portion of the elastomer or thermoplastic that comprises a large radius is different to the at least one portion that is flexible and/or is different

to the at least one portion that is resilient.

**[0014]** In an example, the field grading electrode comprises a single piece of elastomer or thermoplastic.

**[0015]** In an example, the elastomer or thermoplastic is a conductive elastomer or conductive thermoplastic.

**[0016]** In an example, the elastomer or thermoplastic comprises one or more conductive outer layers.

**[0017]** In an example, the field grading electrode is configured to be slid onto an end of the conductor.

**[0018]** In an example, the field grading electrode is configured to be inserted into an end of the conductor.

**[0019]** In an example, the field grading electrode comprises silicone.

**[0020]** In an example, the field grading electrode comprises ethylene-propylene-diene (EPDM) elastomer.

**[0021]** In an example, the field grading electrode once assembled to the conductor can move on the conductor.

**[0022]** In a second aspect, there is provided a switch system for a low, medium or high voltage switchgear, the switch system comprising:

- a moving contact; and
- a fixed contact;

wherein, a field grading electrode according to the first aspect is assembled to the moving contact and/or to the fixed contact.

**[0023]** In an example, at least a part of the field grading electrode is configured to deform elastically during switching operation.

**[0024]** In an example, the field grading electrode is configured to withstand piercing and/or sparking during switching operation.

**[0025]** In a third aspect, there is provided a conductor for a low, medium or high voltage switchgear with field grading protection.

A field grading electrode is assembled to the conductor. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive.

**[0026]** In a fourth aspect, there is provided a low, medium or high voltage switchgear, and wherein a field grading electrode according to the first aspect is assembled to a conductor of the switchgear, and wherein the conductor and field grading electrode are surrounded by one of: a vacuum, an insulating gas or an insulating fluid.

**[0027]** In a fifth aspect, there is provided a method of field grading protecting a conductor for a low, medium or high voltage switchgear. The method comprises assembling a field grading electrode to the conductor. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive or semiconductive.

**[0028]** The above aspects and examples will become apparent from and be elucidated with reference to the embodiments described hereinafter.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0029]** Exemplary embodiments will be described in the following with reference to the following drawing:

Fig. 1 shows an example of a field grading electrode on a round conductor, where the field grading electrode is shown in dotted lines; and

Fig. 2 shows a cross section through a tube shaped conductor with a plug-shaped field grading electrode.

## DETAILED DESCRIPTION OF EMBODIMENTS

**[0030]** Figs. 1-2 show examples of field grading electrodes that can be assembled to conductors of low, medium or high voltage switchgears to provide field grading protection.

**[0031]** In general, the field grading electrode is configured to be assembled to a conductor of a low, medium or high voltage switchgear. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive or semiconductive.

**[0032]** According to an example, at least one portion of the elastomer or thermoplastic is flexible.

**[0033]** According to an example, at least one portion of the elastomer or thermoplastic is resilient.

**[0034]** According to an example, the at least one portion of the elastomer or thermoplastic that is flexible is resilient.

**[0035]** According to an example, a portion of the elastomer or thermoplastic comprises a large radius for field grading.

**[0036]** According to an example, the portion of the elastomer or thermoplastic that comprises a large radius is different to the at least one portion that is flexible and/or is different to the at least one portion that is resilient.

**[0037]** According to an example, the field grading electrode comprises a single piece of elastomer or thermoplastic.

**[0038]** According to an example, the elastomer is a conductive elastomer or thermoplastic.

**[0039]** According to an example, the elastomer comprises one or more conductive or semiconductive outer layers.

**[0040]** According to an example, the field grading electrode in one form is configured to be slid onto an end of the conductor.

**[0041]** According to an example, the field grading electrode in another form is configured to be inserted into an end of the conductor.

**[0042]** According to an example, the field grading electrode comprises silicone.

**[0043]** According to an example, the field grading electrode comprises ethylene-propylene-diene (EPDM) elastomer.

**[0044]** According to an example, the field grading elec-

trode once assembled to the conductor can move on the conductor.

**[0045]** The field grading electrode can be utilized in a switch system for a low, medium or high voltage switchgear. The switch system comprises:

- a moving contact; and
- a fixed contact.

**[0046]** A field grading electrode as described above is assembled to the moving contact and/or to the fixed contact.

**[0046]** Thus, the field grading electrode provides an homogenization of the electric field around the moving or fixed or indeed both contacts.

**[0047]** In an example, at least a part of the field grading electrode is configured to deform elastically during switching operation.

**[0048]** In an example, the field grading electrode is configured to withstand piercing and/or sparking during switching operation.

**[0049]** Thus, Figs. 1-2 not only in general relate to a field grading electrode, but they also relate to a conductor for a low, medium or high voltage switchgear with field grading protection.

**[0050]** In general a field grading electrode is assembled to the conductor. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive or semiconductive. Thus, for example the field grading electrode can comprise a carbon black filled elastomer or thermoplastic.

**[0051]** In an example, at least one portion of the elastomer or thermoplastic is flexible.

**[0052]** In an example, at least one portion of the elastomer or thermoplastic is resilient.

**[0053]** In an example, the at least one portion of the elastomer or thermoplastic that is flexible is resilient.

**[0054]** In an example, a portion of the elastomer or thermoplastic comprises a large radius for field grading.

**[0055]** In an example, the portion of the elastomer or thermoplastic that comprises a large radius is different to the at least one portion that is flexible and/or is different to the at least one portion that is resilient.

**[0056]** In an example, the field grading electrode comprises a single piece of elastomer or thermoplastic.

**[0057]** In an example, the elastomer is a conductive or semiconductive elastomer or thermoplastic.

**[0058]** In an example, the elastomer comprises one or more conductive or semiconductive outer layers.

**[0059]** In an example, the field grading electrode in one form is assembled to the conductor by being slid onto an end of the conductor.

**[0060]** In an example, the field grading electrode in another form is assembled to the conductor by being inserted into an end of the conductor.

**[0061]** In an example, the field grading electrode comprises silicone.

**[0062]** In an example, the field grading electrode comprises ethylene-propylene-diene (EPDM).

**[0063]** In an example, a spring is located between the field grading electrode and the conductor.

**[0064]** A low, medium or high voltage switchgear can therefore make use of such a field grading electrode. Such a low, medium or high voltage switchgear has a field grading electrode, as described above, assembled to a conductor of the switchgear. The conductor and field grading electrode are then surrounded by one of: a vacuum, an insulating gas or an insulating fluid.

**[0065]** Thus, Figs. 1-2 not only in general relate to a field grading electrode and a conductor with field grading protection, but also relate to a method of field grading protecting a conductor for a low, medium or high voltage switchgear.

**[0066]** In general, the method comprises assembling a field grading electrode to the conductor. The field grading electrode comprises an elastomer or thermoplastic. The field grading electrode is conductive or semiconductive.

**[0067]** In an example, the field grading electrode comprises carbon black filled elastomer or thermoplastic.

**[0068]** In an example, at least one portion of the elastomer or thermoplastic is flexible.

**[0069]** In an example, at least one portion of the elastomer or thermoplastic is resilient.

**[0070]** In an example, the at least one portion of the elastomer or thermoplastic that is flexible is resilient.

**[0071]** In an example, a portion of the elastomer or thermoplastic comprises a large radius for field grading.

**[0072]** In an example, the portion of the elastomer or thermoplastic that comprises a large radius is different to the at least one portion that is flexible and/or is different to the at least one portion that is resilient.

**[0073]** In an example, the field grading electrode comprises a single piece of elastomer or thermoplastic.

**[0074]** In an example, the elastomer or thermoplastic is a conductive or semiconductive elastomer.

**[0075]** In an example, the elastomer or thermoplastic comprises one or more conductive or semiconductive outer layers.

**[0076]** In an example, the method comprises sliding the field grading electrode in one form onto an end of the conductor.

**[0077]** In an example, the method comprises inserting the field grading electrode in another form into an end of the conductor.

**[0078]** In an example, the field grading electrode comprises silicone.

**[0079]** In an example, the field grading electrode comprises ethylene-propylene-diene (EPDM).

**[0080]** In an example, the method comprises locating a spring between the field grading electrode and the conductor.

**[0081]** Thus, usually metallic materials are used as field grading electrodes on conductor parts. However, especially for conductors that are required to move, for example where metallic field grading electrodes are used on conductors for switches or disconnectors, the inflex-

ibility of such metallic field grading parts can be problematic. For the movement of such parts a springing functionality is needed. Usually metallic springs are used for this task. Also, the metallic field grading electrode must be joined to the conductor via screwing or clipping for example.

**[0082]** However, these issues are addressed in the new development where a conductive or semiconductive field grading electrode in the form of an elastomer or thermoplastic, that can be in the form of a single part based on conductive or semiconductive elastomers or a conductive or semiconductive coated elastomer or thermoplastic, is assembled to the conductor. Such material provides both a field grading function and can also provide the springing function. A further advantage is that less parts are needed leading to a reduction of assembling time and costs. Also, the elastomer or thermoplastic can be slid over or inserted into the conductor, and no specific further joining mechanism is required.

**[0083]** Thus, the new field grading electrode comes in the form of a flexible, conductive or semiconductive elastomer or thermoplastic that serves as field grading electrode and combines also a resilient function through the material itself.

**[0084]** Continuing with the figures, specific embodiments are now described in further detail. The new development utilizes elastomers or thermoplastic that are assembled on conductor parts for field grading purposes. Such elastomers or thermoplastics could consist of silicones or EPDM. Either conductive elastomers or thermoplastics are used or standard elastomers or thermoplastics that are coated by conductive or semiconductive layers can be used. If especially round conductors are used for the current path, elastic rings can serve as field grading. Elastomers or thermoplastics that are semiconductive, for example that comprise carbon black, can be utilized. In the following detailed discussion, reference to a field grading electrode being conductive means that it could be semiconductive.

**[0085]** An advantage of the new field grading electrode is that no further joining techniques are needed allowing for an easy and fast assembly. Especially if moving conductor parts are used (i.e. in disconnecter switch), there is a need for a resilient connection between elastomer or thermoplastic part and conductor. This resilient connection could consist of metal springs however can also make use of certain shapes of the elastomer or thermoplastic itself. Such a shape could consist of a round part with larger radius for field grading and a flexible part for springing (see for example Fig. 1). The flexible part can be designed in such a way that the field control can be actuated and rolled back by the contact system. The elastomer or thermoplastic can either be slid on the outer surface (Fig. 1) or for plug-shaped electrodes can be stuck inside tubular conductors (see Fig. 2).

**[0086]** While the invention has been illustrated and described in detail in the drawing and foregoing description, such illustration and description are to be considered il-

illustrative or exemplary and not restrictive. The invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing a claimed invention, from a study of the drawings, the disclosure, and the dependent claims.

### Claims

1. A field grading electrode for a low, medium or high voltage switchgear:
  - wherein the field grading electrode is configured to be assembled to a conductor of a low, medium or high voltage switchgear;
  - wherein the field grading electrode comprises an elastomer or a thermoplastic; and
  - wherein, the field grading electrode is conductive or semiconductive.
2. Field grading electrode according to claim 1, wherein at least one portion of the elastomer or thermoplastic is flexible.
3. Field grading electrode according to any of claims 1-2, wherein at least one portion of the elastomer or thermoplastic is resilient.
4. Field grading electrode according to claim 3 when dependent upon claim 2, wherein the at least one portion of the elastomer or thermoplastic that is flexible is resilient.
5. Field grading electrode according to any of claims 1-4, wherein a portion of the elastomer or thermoplastic comprises a large radius for field grading.
6. Field grading electrode according to claim 5 when dependent upon any of claims 2-4, wherein the portion of the elastomer or thermoplastic that comprises a large radius is different to the at least one portion that is flexible and/or is different to the at least one portion that is resilient.
7. Field grading electrode according to any of claims 1-6, wherein the field grading electrode comprises a single piece of elastomer or thermoplastic.
8. Field grading electrode according to any of claims 1-7, wherein the elastomer or thermoplastic is a conductive or semiconductive elastomer or thermoplastic.
9. Field grading electrode according to any of claims 1-8, wherein the elastomer or thermoplastic comprises one or more conductive or semiconductive outer layers.
10. Field grading electrode according to any of claims 1-9, wherein the field grading electrode is configured to be slid onto an end of the conductor.
11. Field grading electrode according to any of claims 1-9, wherein the field grading electrode is configured to be inserted into an end of the conductor.
12. Field grading electrode according to any of claims 1-11, wherein the field grading electrode comprises silicone.
13. Field grading electrode according to any of claims 1-11, wherein the field grading electrode comprises ethylene-propylene-diene (EPDM) elastomer.
14. Field grading electrode according to any of claims 1-13, wherein the field grading electrode once assembled to the conductor can move on the conductor.
15. A switch system for a low, medium or high voltage switchgear, the switch system comprising:
  - a moving contact; and
  - a fixed contact;
 wherein, a field grading electrode according any of claims 1-14 is assembled to the moving contact and/or to the fixed contact.
16. Switch system according to claim 15, wherein at least a part of the field grading electrode is configured to deform elastically during switching operation.
17. Switch system according to any of claims 15-16, wherein the field grading electrode is configured to withstand piercing and/or sparking during switching operation.
18. A conductor for a low, medium or high voltage switchgear with field grading protection:
  - wherein a field grading electrode is assembled to the conductor;
  - wherein the field grading electrode comprises an elastomer or thermoplastic; and
  - wherein, the field grading electrode is conductive.
19. A low, medium or high voltage switchgear, and wherein a field grading electrode according to any of claims 1-15 is assembled to a conductor of the switchgear, and wherein the conductor and the field grading electrode are surrounded by one of: a vacuum, an insulating gas or an insulating fluid.
20. A method of field grading protecting a conductor for

a low, medium or high voltage switchgear, wherein the method comprises:

assembling a field grading electrode to the conductor;  
wherein the field grading electrode comprises an elastomer or thermoplastic; and  
wherein, the field grading electrode is conductive.

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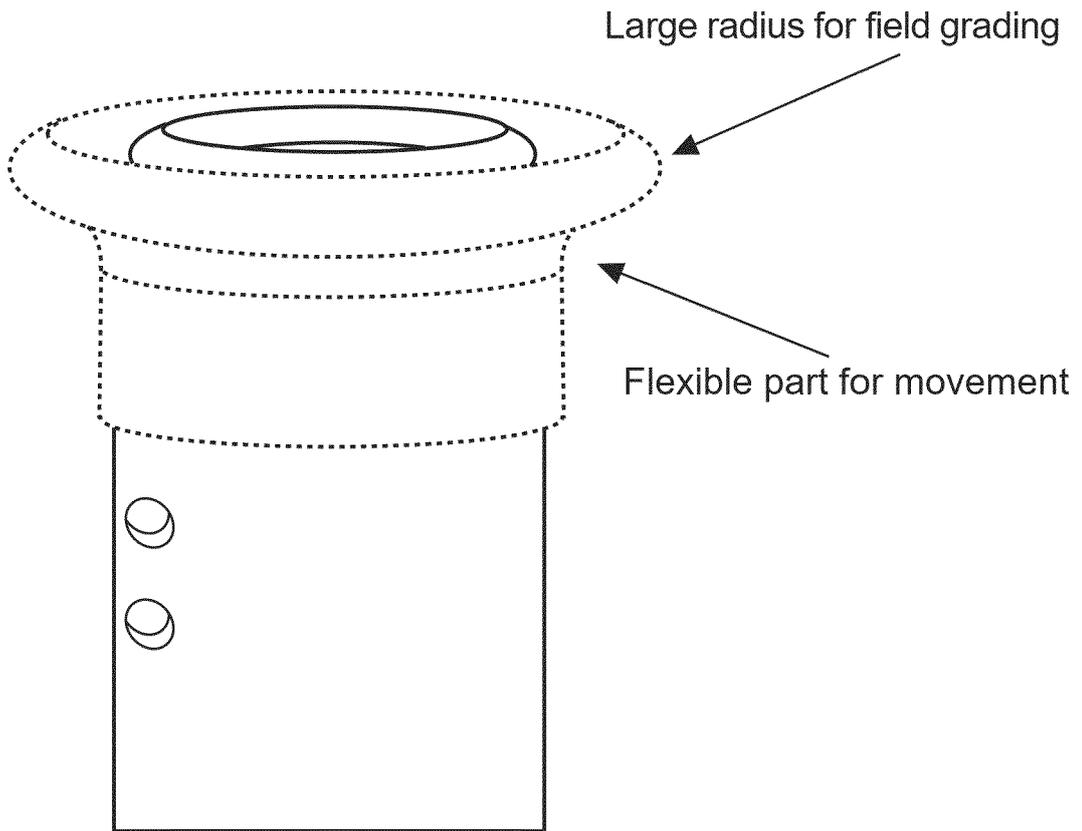


Fig. 1

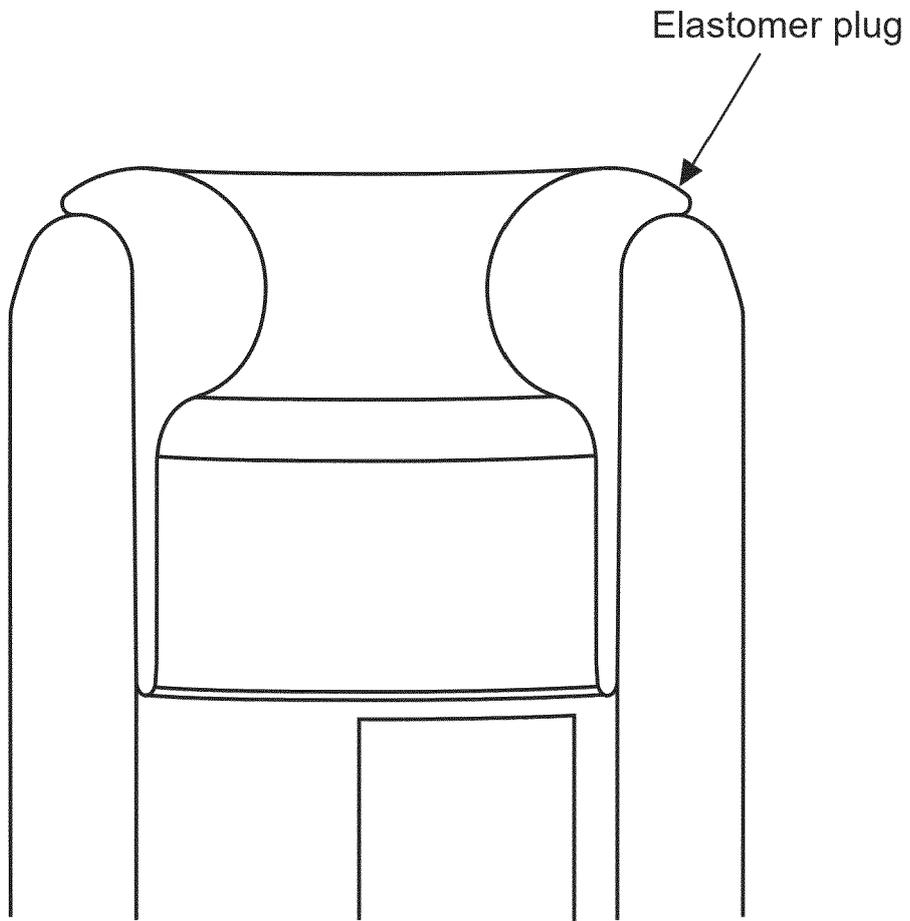


Fig. 2



EUROPEAN SEARCH REPORT

Application Number  
EP 20 18 9418

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 556 478 A1 (ASEA BROWN BOVERI [CH]) 25 August 1993 (1993-08-25) * column 2, line 19 - column 4, line 29; figure Figure *	1-20	INV. H01H1/64 H01H33/24
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 January 2021	Examiner Ernst, Uwe
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ANNEX TO THE EUROPEAN SEARCH REPORT  
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
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