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(54) **High voltage circuit breaker**

(57) A high voltage live tank circuit breaker comprises a support insulator (20), at least one elongated current interrupter (10) provided on said support insulator (20), terminals (30) connected to the ends of said current interrupter; and at least one corona ring (40) arranged to at least partly surround one of the terminals, wherein the corona ring (40) is provided with a hydrophobic surface layer (42).

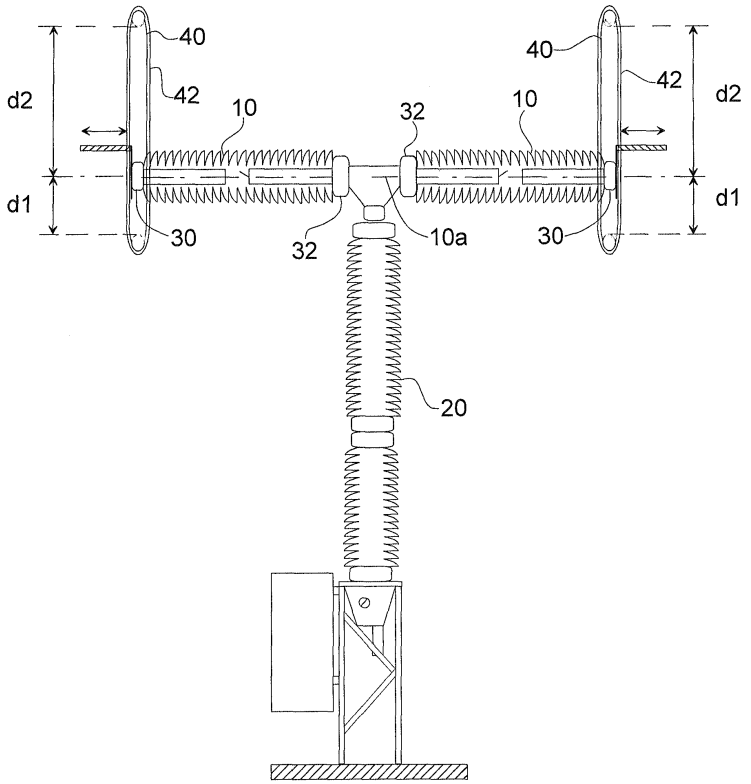

Fig. 1

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Description

FIELD OF INVENTION

[0001] The present invention relates to a high voltage live tank circuit breaker.

BACKGROUND OF THE INVENTION

[0002] Electrical power transmission networks are protected and controlled by high voltage circuit breakers. Such circuit breakers are divided in two classes: live tank circuit breakers (LTB) where the enclosure that contains the breaking mechanism is at line potential and the dead tank circuit breakers (DTB) where the enclosures are at earth potential.

[0003] The live tank circuit breakers at high voltage levels have to handle the high potential at the terminal electrodes where the tubes or cables are connected to pass the current through the circuit breaker. The high potential creates high electrical field stress at the terminal electrodes. Commonly the terminal electrodes are shielded with corona rings, which purpose is to reduce the local electrical field stress by their smooth shape and relatively large area compared to the terminals.

[0004] Two different corona ring designs are common. Either the corona rings are placed as close to the terminal electrode as possible. If capacitors or pre-insertion resistors are used the same philosophy is used. Alternatively, a circular corona ring is placed symmetrically around the circuit breaker center axis.

[0005] The live tank circuit breaker external isolation media is air. The external insulation is verified with dielectric tests following the requirements in applicable standards. These verifying tests for high voltage circuit breakers include both dry and wet tests since the high voltage circuit breaker is an out door equipment.

SUMMARY OF THE INVENTION

[0006] During such wet tests the rain is collected all over the surface of the circuit breaker and the corona rings. The water is pouring downwards on the surface and collected at the lowest position on each individual part of the circuit breaker and finally it is falling of the surface towards ground.

[0007] The water drops will be affected by the high voltage and change shape; they will be sharper then normal and increase the local electrical field stress.

[0008] The invention is based on the fact that during switching over voltages during wet conditions the local electrical field at the corona rings lower part will increase in comparison to dry conditions.

[0009] An object of the present invention is therefore to provide a high voltage live tank circuit breaker with an improved dielectric withstand capability, in particular during wet conditions.

[0010] A further object of the invention is to provide such a high voltage circuit breaker, which is robust, accurate, uncomplicated, space-saving, and inexpensive, and which has an optimum performance and which fulfills existing safety requirements.

[0011] A yet further object of the invention is to provide a method for preparing a high voltage circuit breaker which fulfills any of the above objects.

[0012] These objects are attained by high voltage circuit breakers and methods as claimed in the appended patent claims.

[0013] According to a first aspect of the invention there is provided a high voltage live tank circuit breaker comprising a support insulator, an elongated current interrupter provided on the support insulator, terminals connected to the ends of the current interrupter, and at least one corona ring arranged to at least partly surround at least one of the terminals.

[0014] The corona ring is provided with a hydrophobic surface layer to thereby obtain a high voltage live tank circuit breaker with improved dielectric withstand capability in wet conditions.

[0015] The wet conditions are the most severe and at the same time the hardest to theoretically calculate and dimension for each circuit breaker design. Different designs have therefore been experimentally tested in a high voltage laboratory and it has been found that the critical factor is the number and size of the water drops on the surface of the corona rings. A considerable improvement is obtained by the using the invention. The number and size of the water drops are considerably reduced.

[0016] In one embodiment the high voltage live tank circuit breaker comprises a horizontally arranged elongated current interrupter, and a horizontally arranged elongated capacitor and/or resistor connected between the terminals in parallel with the current interrupter, wherein the parts are so arranged that the vertical distance between the inner surface of the lower end of the corona ring and a center axis of the current interrupter, the capacitor, if present, or the resistor, if present, whichever being located lowest, is between about 1.5 and about 4 times shorter than the distance between the inner surface of the upper end of the corona ring and the center axis.

[0017] Hereby, a more evenly distributed electrical field around the corona ring is obtained in presence of water, and as a result, the dielectric withstand capability in wet conditions is further improved.

[0018] According to a second aspect of the invention there is provided a method for preparing a high voltage live tank circuit breaker comprising a support insulator, an elongated current interrupter provided on the support insulator, terminals connected to the ends of the current interrupter, and at least one corona ring arranged to at least partly surround at least one of the terminals. According to the method, the corona ring is provided with a hydrophobic surface layer.

[0019] Preferably, the hydrophobic surface layer is provided by means of spraying or coating the corona ring

with hydrophobic material such as silicone rubber or a resin such as a fluorine or silicone resin.

[0020] Further characteristics of the invention and advantages thereof, will be evident from the following detailed description of preferred embodiments of the present invention given hereinafter and the accompanying Figs. 1-2, which are given by way of illustration only and are thus not limitative of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 illustrates schematically in a side elevation view a high voltage circuit breaker according to an embodiment of the invention.

Fig. 2 illustrates schematically in an end view a current interrupter and a corona ring as being comprised in the high voltage circuit breaker of Fig. 1.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] In the following a detailed description of preferred embodiments of the present invention will be given. In this description, the term *high voltage* will be used for voltages of 1 kV and higher. It shall, however, be noted that the present invention is primarily intended for high voltage circuit breakers with much higher voltage ratings, such as 245 kV and above.

[0023] Fig. 1 illustrates schematically in a side elevation view a one-phase high voltage live tank circuit breaker, which comprises two horizontally arranged and serially connected elongated current interrupters 10 arranged on a support insulator 20. The current interrupters 10 may be referred to as breaker or extinguishing chambers and the assembly of two current interrupters 10 may be referred to as a breaking unit. Each of the current interrupters 10 is connected to a terminal 30 at its far end and to a connection flange 32 at its inner end.

[0024] Further, the circuit breaker comprises a respective corona ring 40 arranged to at least partly surround the terminal 30 connected to the far ends of the serially interconnected current interrupters 10, that is, typically no corona rings are arranged around the connection flanges 32, which interconnects the current interrupters 10.

[0025] Fig. 2 illustrates schematically in an end view one of the current interrupters 10 and one of the corona rings 40 of the high voltage circuit breaker of Fig. 1. The supports 41 holding the corona ring 40 are illustrated.

[0026] According to the invention one or preferably each of the corona rings 40 is provided with a hydrophobic surface layer 42.

[0027] Preferably, the hydrophobic surface layer 42 is applied by means of spraying or coating the corona ring (s) 42 with hydrophobic material such as a rubber or a resin material, e.g. a silicone rubber or a fluorine or silicone resin.

[0028] The hydrophobic surface layer 42 may cover essentially the entire surface of the corona ring(s) 40 or only portions of the surface of the corona ring(s) 40, preferably lower portions of the surface of the corona ring(s) 42.

[0029] For illustrative purposes the thickness of the layer 42 is highly exaggerated in Figs. 1-2.

[0030] It shall be appreciated that the corona rings 40 may be closed or open-ended and they can have different shapes, though the corona rings 40 in Figs. 1-2 are torus shaped.

[0031] Provided that the corona rings are arranged symmetrically around the current interrupters 10 in the lateral plane the sum of distances d1 and d2 corresponds to the inner diameter of the corona rings 40.

[0032] It shall further be appreciated that there can be arranged more corona rings around each terminal. Commonly, the corona rings are provided in pairs with a short fixed distance in between.

[0033] Further, in one version of the invention, one or each of the corona rings is located such that the vertical distance d1 between the inner surface of the lower end of the corona ring 40 and a center axis 10a of the current interrupter 10 is between about 1.5 and about 4 times shorter than the distance d2 between the inner surface of the upper end of the corona ring 40 and the center axis 10a.

[0034] If the circuit breaker, for each current interrupter, comprises a horizontally arranged elongated capacitor and/or resistor connected between the terminals in parallel with the current interrupter, each corona ring is preferably arranged such that the vertical distance between the inner surface of the lower end of the corona ring 40 and a center axis of the current interrupter 10, of the elongated capacitor, or of the resistor, whichever being located lowest, is between about 1.5 and about 4 times shorter than the distance between the inner surface of the upper end of the corona ring and that center axis.

[0035] By using the new design a higher dielectric withstand capability to withstand both the switching and lightning impulse voltage is obtained, especially during wet conditions.

[0036] A three-phase high voltage live tank circuit breaker comprises three of the circuit breaker as disclosed above.

Claims

1. A high voltage live tank circuit breaker comprising:

- a support insulator (20);
- at least one elongated current interrupter (10) provided on said support insulator (20);
- terminals (30) connected to the ends of said current interrupter; and
- at least one corona ring (40) arranged to at

least partly surround one of the terminals,

characterised in that

- said corona ring (40) is provided with a hydrophobic surface layer (42).

2. The circuit breaker of claim 1 wherein said hydrophobic surface layer (42) is made of any of a rubber or a resin material such as e.g. a silicone rubber or a fluorine or silicone resin.

3. The circuit breaker of claim 1 or 2 wherein said hydrophobic surface layer (42) covers essentially the entire surface of said corona ring.

4. The circuit breaker of claim 1 or 2 wherein said hydrophobic surface layer (42) covers only portions of the surface of said corona ring, preferably lower portions of the surface of said corona ring.

5. The circuit breaker of any of claims 1-4 wherein the corona ring is open-ended.

6. The circuit breaker of any of claims 1-5 comprising a further corona ring arranged to at least partly surround said one of the terminals, the corona rings being arranged concentrically with respect to one another.

7. The circuit breaker of any of claims 1-6 comprising a corona ring arranged to at least partly surround another one of the terminals, the corona rings being arranged concentrically with respect to one another.

8. The circuit breaker of any of claims 1-7 comprising a further elongated current interrupter (10) and terminals (30) connected to the ends of the current interrupter, the current interrupters being arranged concentrically with respect to one another and being serially connected, wherein said one of the terminals, which is at least partly surrounded by the corona ring (40), is an outer terminal of said serially connected current interrupters; and further comprising a corona ring (40) arranged to at least partly surround the other outer terminal of said serially connected current interrupters and being provided with a hydrophobic surface layer (42), the corona rings being arranged concentrically with respect to one another.

9. The circuit breaker of any of claims 1-7 wherein said elongated current interrupter is arranged essentially horizontally and said corona ring is arranged such that the vertical distance (d1) between the inner surface of the lower end of said corona ring and a center axis (10a) of said essentially horizontally arranged elongated current interrupter (10) is between about 1.5 and about 4 times shorter than the distance (d2) between the inner surface of the upper end of said corona ring and said center axis.

10. The circuit breaker of any of claims 1-7 comprising an essentially horizontally arranged elongated capacitor (50) and/or resistor (60) connected between the terminals in parallel with the current interrupter (10), which is essentially horizontally arranged, wherein said corona ring (40) is arranged such that the vertical distance (d1) between the inner surface of the lower end of said corona ring and a center axis (10a) of said essentially horizontally arranged elongated current interrupter (10), of said essentially horizontally arranged elongated capacitor (50), or of said essentially horizontally arranged elongated resistor (60), whichever being located lowest, is between about 1.5 and about 4 times shorter than the distance (d2) between the inner surface of the upper end of said corona ring and said center axis.

11. a three-phase high voltage live tank circuit breaker comprising three of the circuit breaker of any of claims 1-10, one for each phase.

12. A method for preparing a high voltage live tank circuit breaker comprising a support insulator (20); at least one elongated current interrupter (10) provided on said support insulator (20); terminals (30) connected to the ends of said current interrupter; and at least one corona ring (40) arranged to at least partly surround one of the terminals, said method being **characterised by** the step of

- providing said at least one corona ring (40) with a hydrophobic surface layer (42).

13. The method of claim 12 wherein the step of providing comprises spraying or coating said at least one corona ring with hydrophobic material.

14. The method of claim 12 or 13 wherein said hydrophobic surface layer (42) is made of any of a rubber or a resin material such as e.g. a silicone rubber or a fluorine or silicone resin.

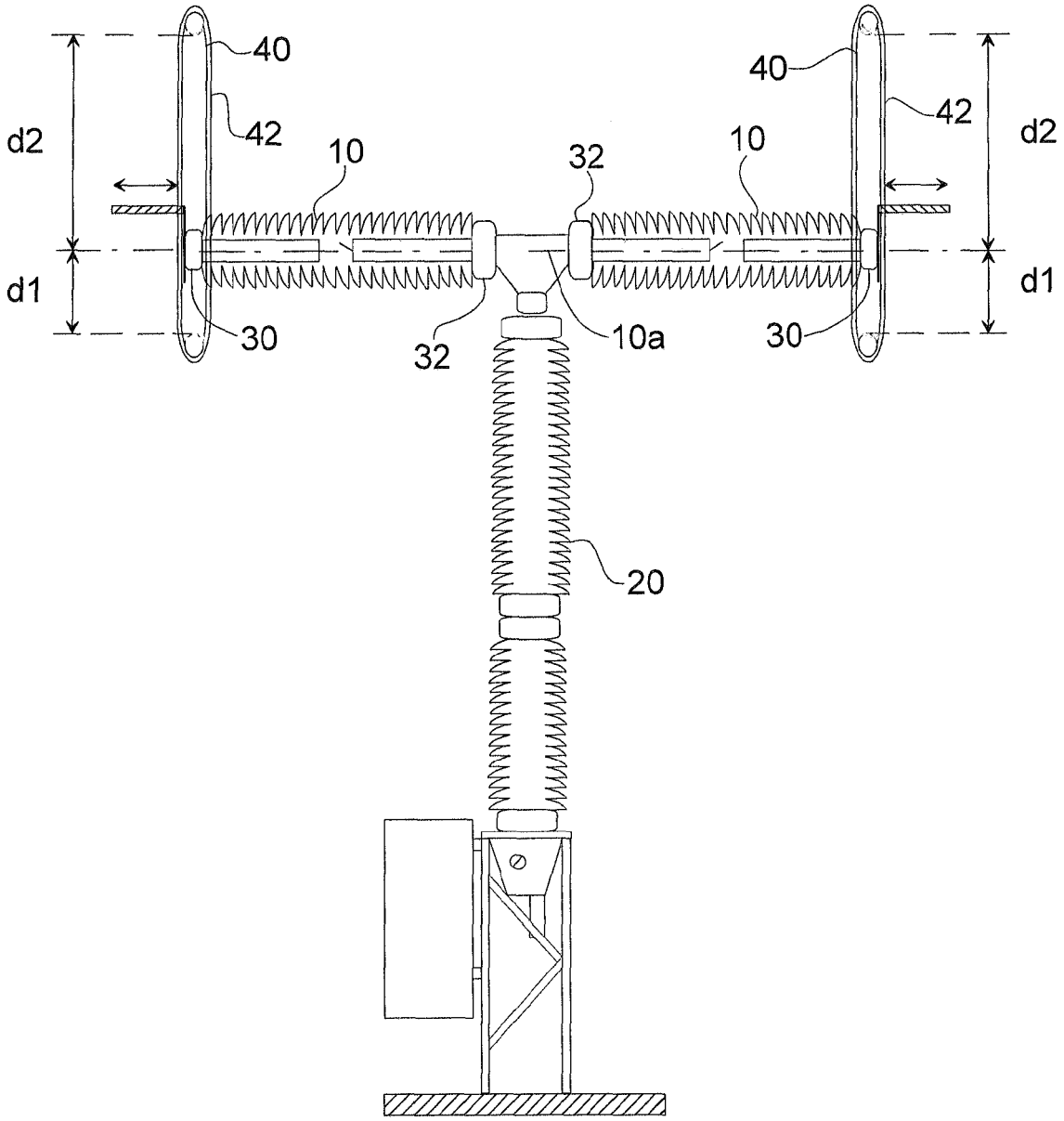

Fig. 1

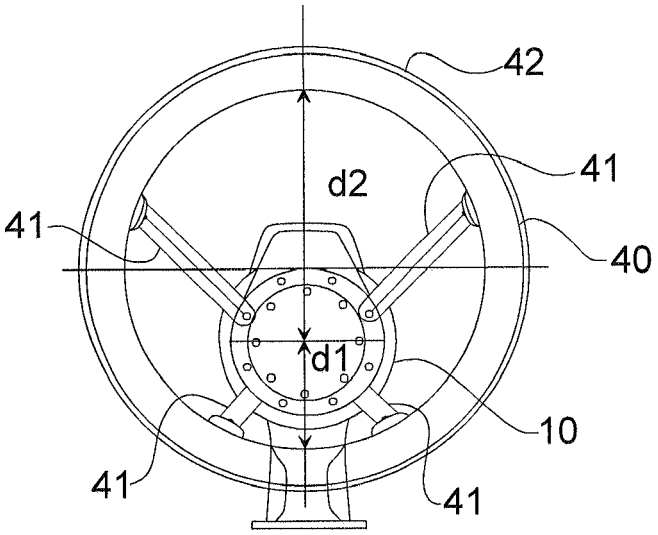

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 3376

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 504 142 A (MCKINNON JOHN P) 31 March 1970 (1970-03-31) * column 3, line 7 - column 6, line 4; figure 1 *	1	INV. H01H33/24
A	EP 0 077 516 A (TOKYO SHIBAURA ELECTRIC CO [JP]) 27 April 1983 (1983-04-27) * page 3, line 17 - page 5, line 22; figures 1-3 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

H01H
H01B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 February 2009	Nieto, José Miguel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 16 3376

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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25-02-2009

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