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Cable sealing end

Description



G00002

The invention relates to a cable sealing end, preferably an outdoor sealing end for high voltage, in accordance with the preamble to the main claim.

Different constructions of sealing ends are known. Previous designs have been
5 constructed with porcelain insulators and an oil or other chemical filling. The disadvantage of such sealing ends is that mechanically they are not very robust and no longer meet current environmental protection requirements with regard to potential substance leakage. A sealing end without an oil filling is described in EP 667 665 B1. The special feature of this sealing end is a rigid conducting
10 element, which is designed to accommodate transverse forces. Dissipation of force is effected from the overhead line tie-up point via the rigid conducting element, via a base member having a field-control and isolating device to the bearing structure. On the surface of the sealing end – especially in the region of the rigid conducting element – there is no field-controlling coating.

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The object of the invention is to propose a cable sealing end, preferably a high-voltage outdoor sealing end, which can be manufactured inexpensively, is mechanically stable and electrically reliably controlled.

20 That object is achieved by the features of the main claim. Further forms of embodiment are apparent from the subsidiary claims.

The sealing end is stayed at one end on a foot fitting, preferably for fastening to a cross-member. Means for fastening the cable are constructed on the foot fitting,
25 with an electrical bushing inside the sealing end. On a top fitting, there are disposed means for fastening an electrical conductor to the bushing; means for electrical

connection of the cable shield to earth potential and means for field control and insulation are present at the inhomogeneous potential junctions at the cable end.

The insulating body generally carries on its surface an elastomeric material
5 (preferably of silicone rubber) with a ribbed surface (shed plates). The length and especially the diameter of the insulating body are to be selected so that the demands for satisfactory insulation and avoidance of atmospheric arcing are met at full operating voltage. This requirement can be satisfied when the surface of the insulating body is covered by a voltage-dependent control layer. The diameter of
10 the insulating body can then also be kept especially small. The control layer is formed on the basis of microvaristors, preferably ZnO microvaristors (WO 9726693 A1). In the preferred construction, this involves ZnO-ceramic particles, which are embedded in a polymer matrix in a proportion of from 60 to 75 percent by weight. The ZnO particles are doped with mixed oxides in the order of magnitude of 10% on
15 the basis of the oxides of Bi, Cr, Sb, Co, Mn and other possible elements in smaller proportions. The polymer composition can be silicone rubber or polyethylene, depending on the base material of the carrier body. In the present case, the layer forming the control layer is formed inside the jacket constructed with shed plates of the insulating body. This layer in accordance with the invention enables the
20 potential profile to be changed in such a manner that the lines of force are displaced more to the upper end of the sealing end, so that, as a consequence of the changed electrical field distribution, voltage spikes or surges at the location of the cable conductor connection can be avoided. The effect of the field strength-dependent control layer is described in detail in the essay in Elektrizitätswirtschaft, vol. 99
25 (2000), pp 68-73.

The insulating body is fixed to the foot fitting. This kind of fixing is consistent with the prior art (EP 667 665 B1). The usual means for electrical connection of the cable shield to earth potential and means for field control (field-control body) and
30 insulation at the inhomogeneous potential junctions at the cable end are used. It is

important that when fixing to the foot fitting, voids existing between cable end and the field-control elements and insulating elements are closed by the mechanical clamping with the foot fitting.

- 5 The electrical bushing in the form of a tube or stud is connected with the cable conductor by way of contact elements, and the electrical bushing, the insulating body and the top fitting form one unit for assembly. The parts electrical bushing with contact elements, insulating body and top fitting are manufactured individually. The top fitting consists essentially of a conductive terminating plate and a conductor
- 10 connecting piece, in which there can be a thread for fixing a suspension eye. The electrical bushing is preferably fixed inside the terminating plate in a welding operation (or by another solid mechanical connection). The insulating body consisting of insulating material is adhesively secured in the top fitting. Using a crane, the resulting unit is lifted at a suspension eye into the installation position and
- 15 lowered from above over the prepared bottom part of the sealing end. The dimensions of the parts in the lower region of the arrangement, which forms a unit, are such that as they are joined together they slide in a self-locating manner into the base construction on the foot fitting.
- 20 Preferably, the contact holder on the cable conductor is secured with screws. The contact in the form of a plug-in connection to the electrical bushing is produced by means of contact laminations. This plug-in connection is not designed to accommodate the forces on the sealing end. In the present arrangement, the insulating body is therefore constructed and dimensioned so that it is able to
- 25 accommodate all mechanical forces, and the plug-in connection is then excluded from mechanical stress. 5 kN is reckoned to be a typical magnitude of transverse force, so that the mechanical design is to be dimensioned on the basis of this parameter.
- 30 The insulating body is manufactured from casting resin or another suitable material.

It can be materially reinforced, for example, with glass fibres. From the lower edge to the level of the contact elements the insulating body is fully filled with material. A cavity is preferably formed inside the insulating body. The cross-section of the cavity (the space factor) can be reduced linearly or in a curve in the form of a funnel towards the top fitting. The provision of the cavity enables the weight to be kept low; however, the extent of the reduction in wall thickness must only be such that the bending forces can be accommodated. In a preferred construction, the inner surface of the cavity is lined with a conductive coating.

- 10 The essential process steps during assembly are as follows:
- preparation of the cable end, cutting back and exposing the cable conductor
 - mounting the contact holder on the cable conductor
 - fixing the base structure to the foot fitting
 - lifting the assembled unit comprising insulating body, top fitting and electrical bushing by means of a crane
 - 15 - lowering the assembled unit onto the base structure secured to the foot fitting
 - the parts self-locate
 - fixing and clamping the assembled unit to the foot fitting
 - 20 - fixing the overhead conductor by way of a feeder clamp to the top fitting.

Embodiments of the outdoor sealing end are illustrated in the Figures, in which:

- Fig. 1 shows a first form of embodiment of constant outer diameter;
- 25 Fig. 2 shows another form of embodiment of stepped outer diameter;
- Fig. 3 shows a form of embodiment having different external contours in the right-hand and the left-hand half of the Figure, and
- Fig. 4 shows two embodiments of a flange.
- The sealing end according to the invention – for example, for a nominal voltage of
- 30 145 kV and having a conductor cross-section of 1200 mm² – consists of an

insulating body 50, preferably of casting resin, having inside it a cavity 56. As shown in the lower region of the Figure, at the end of the cable core (conductor 12 and conductor insulation 15) the arrangement of the field-control elements 36 and insulating elements 51 is of a construction known to the expert.

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A high-voltage cable 10 is introduced into the lower region of the outdoor sealing end 8. The shield wires 11 of the cable 10 are in electrical contact with the flange 20' of the foot part 20, which is stayed by way of insulators 21 on a cross-member of a mast.

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As shown in Fig. 1, the diameter of the insulating member 50 is kept to a minimum over its entire length, and particularly also in the lower region (see also reference numeral 53 in Fig. 3), using the voltage-dependent control layer 64. The control layer runs for the entire length of the insulating body from earth potential to high-voltage potential. To influence an optimum control effect, the layer thickness can be applied in different thicknesses. The external field strength in all operating states nevertheless lies below critical values.

As mentioned, the layer comprising ZnO microvaristors can be incorporated into a silicone embedding material, or into a substance (for example, polyethylene) compatible with the insulating body material. The control layer is located on the insulating body on the inside thereof, and the shed plates are located on the control layer.

25 The insulating body 50 can consist of two parts (51', 52'') adhesively secured to one another and having different material qualities, since the lower part 51' (fixing to the foot fitting as far as the level of the contact element on the cable conductor) – with no shed plate covering – is exposed to the surroundings and must be suitable for outdoor use. The upper part 51'' can consist of a simple material, since this region is in any case covered with shed plates 62. For an embodiment with shed plates 62.1

down as far as the foot fitting, there is likewise an outer protective covering, so that a simple grade of insulating body material can be used for this region as well.

5 The outer contour 59 of the insulating body is preferably cylindrical for the entire length. Depending on the design and quality of the outer field-control layer 64, the insulating body can be designed with different diameters (larger at the bottom and decreasing at the top with a conical transition therebetween) (see Figs 2 and 3).

10 The outer surface of the outdoor sealing end 8 is covered with sheds 62 of RTV-silicone rubber or of LSR-silicone rubber. The inner face 54 of the cavity 56 can be constructed to be conductive. It can be provided by conductive varnish, conductive plasma coating, metal foil (sheet metal), metallisation or by metal fabric embedded in resin. The face 54 is at high voltage potential. The advantage of this construction in that even if condensation water forms in the cavity, electrical safety is maintained since the electrical field conditions at the high voltage potential present are uniform.

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The contact holder embedded in the cast resin body 50 comprises the end contact 30 at the lower end of the current-carrying tube 32. The tube is taken as far as the top fitting 70 and is fixed there. A mechanically and electrically sealed end guard 71 is mounted in the upper region of the sealing end.

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The connection between cable conductor 12 and electrical bushing 32 is arranged at the transition from the solid-volume base body in the lower region 53 to the cavity.

25 The connector 30 clamps the exposed cable conductor in the lower part. The flow of current from the cable conductor 12 to the tube 32 is effected by way of the contact holder 17. Preferably, displaceable contact or clamping elements are provided for that purpose between cable conductor and electrical bushing. The transition between connector 30 and contact laminations 42 can be sealed by means of an O-ring.

30 The field control body 33 consists of silicone rubber and is located with its control element 36 on the transition region from conductor insulation 14 and the end of the

semi-conductive layer 15. The advantage of the invention lies in the construction of an insulating body 50 with a cylindrical outer profile 59. In its upper region, the insulating body has a constant outer diameter over its length. In the lower region (51), it accommodates the field-control body 33 and is screwed onto the foot part 20 (flange). In the upper region of the insulating body, a cavity 56 is formed inside it, the inner surface 54 of which is rendered electrically conductive. Air access to the cavity is possible.

In the foot part, the insulating body 50 is screwed together with a base plate or a flange 20 on a supporting frame 29 (for example, a cross-member across insulating posts 21). Alternatively, the lower region of the insulating body can be in the form of a cast member, which can be inserted into the flange to fit therein.

The right-hand half of Fig. 3 shows an embodiment of the insulating member with a cambered thickening in the lower region 53. The metal ring 26 used for the earth connection can continue in use in this construction with its diameter unchanged. Shed plates 62.1 (62.2) can be present in the cambered region 53.

The two Figs 4A and 4B show different forms of a flange. Fixing of the insulating body to the flange is effected by several screw connections 23 (Fig. 2 and Fig. 3). By tightening the screws, the said assembly unit is biased by the spring elements 44 (see Fig. 3), so that voids present in the region of the field-control body are completely closed. The reference numeral 24 (Fig. 3) denotes a conductive connection from the surface of the insulating body to the earth connection at the cross-member 29. A metal ring 26 (see Fig. 3) is mounted at the foot of the insulating body. The metal ring 26 is brought into contact with the earth connection 24 by a screw.

Reference numerals

8	Sealing end
10	High voltage cable
11	Shield wires of the cable
12	Cable conductor
14	Conductor insulation
15	Semi-conductive layer on the cable insulation
16	Cable core
17	Contact holder (clamping element on cable conductor)
18	Cable fixing to foot fitting
20, 20', 20"	Foot fitting (flange)
21	Insulator
23	Screw connection of insulating body
24	Earth connection
26	Metal ring (contact between outer semi-conductive layer and earth potential)
29	Cross-member
30	Connector (plug-in connector)
32	Conductive stud or tube
33	Field-control body
34	Electrode
36	Field-control funnel
42	Contact laminations
44	Spring elements
50	Insulating body
51', 51"	Top part/ bottom part
53	Lower region
54	Inner surface
56	Cavity
58	Conductive coating
59	Outer contour
62	Shed plates
62.1	Sheds in lower region (Fig. 3)
62.2	Sheds in middle part (Fig. 3)
64	Semi-conductive layer - external
65	Connection of semi-conductive layer to earth
70	Top fitting
71	End guard
72	Conductor fixing

Claims

1. Cable sealing end (8), especially an outdoor sealing end for an electrical cable (10) having a cable conductor (12), a cable insulator (14), a semi-conductive layer (15) and a cable shielding (11), wherein the sealing end (8) is stayed at one end on a foot fitting (20),
having means (18) on the foot fitting (20) for fixing the cable (10),
having an electrical bushing (32) inside the sealing end (8),
having a top fitting (70) for the fixing of an electrical conductor with the bushing (32),
having means (30) for electrical connection of the cable shielding (11) to earth potential,
having an insulating body (50) and
having means (23) for fixing the insulating body (50) to the foot fitting (20),
wherein the electrical bushing (32) is connected by way of contact elements (17, 30) to the cable conductor (12), characterised in that the insulating body (50) is filled with material between the region of the fixing means (23) at the foot fitting (20) to the level of the contact elements (17) and the filling is reduced towards the top fitting (70), whereby an inner cavity (56) is formed, and in that the surface of the insulating body (50) is covered with a voltage-dependent field-controlling layer (64).
2. Cable sealing end according to claim 1, characterised in that the field-controlling layer (64) is formed on the basis of microvaristors.
3. Cable sealing end according to claim 2, characterised in that ZnO microvaristors are used as microvaristors.
4. Cable sealing end according to any one of the preceding claims, characterised in that the field-controlling layer (64) extends over the entire length of the insulating body (50).

5. Cable sealing end according to any one of the preceding claims, characterised in that the insulating body (50) is constructed to accommodate mechanical forces on the sealing end (8).
6. Cable sealing end according to any one of the preceding claims, characterised in that the connection (17, 30) between cable conductor (12) and bushing (32) is in the form of a plug-in connection.
7. Cable sealing end according to claim 5, characterised in that the inner face (54) of the cavity (56) carries a conductive coating (58).
8. Cable sealing end according to any one of the preceding claims, characterised in that the insulating body (50) is manufactured from casting resin.
9. Cable sealing end according to any one of the preceding claims, characterised in that the electrical bushing (32) is in the form of a tube.
10. Cable sealing end according to any one of the preceding claims, characterised in that the contact elements (17) on the cable conductor (14) are contact laminations.