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(54) **Bushing insulator**

Isolatorbuchse

Manchon isolant

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(56) References cited:
US-A- 3 666 992
US-A- 3 678 432

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a bushing insulator or voltage transformer, comprising an end-to-end primary current conductor and a longitudinal frame cast of cast resin around the primary current conductor.

[0002] Bushing insulators are used e.g. in distribution transformers to connect a winding arranged within the transformer housing through the transformer housing to an external electric power system. Fuse protection is typically used in distribution transformers against damage to the transformer coils. Fuse protection prevents transformer malfunction from causing long voltage breaks in the distribution network or the bus-bar system of a switch gear, since the network can be kept live during the time required for finding the fault and preparing to replace the transformer.

[0003] In distribution transformers, a high voltage fuse can be placed within the transformer housing. The problem in this solution is the space required by the fuse, on account of which the dimensions of the transformer housing have to be changed in view of standard solutions.

[0004] A known solution to avoid the above problem related to increasing the size of the transformer housing is to use a porcelain bushing insulator and arrange an exchangeable fuse therein. Such a solution is known from US 3,666,992 A. In filling a transformer, an insulating liquid, which accordingly fills the transformer, also fills the free space left around the high voltage fuse within the bushing insulator. In order to lead the insulating liquid to said free space, the insulator has to comprise an arrangement for air removal, since the air remaining within the insulator will cause partial discharge to occur within the bushing insulator. The risk involved in this kind of porcelain bushing insulators, filled with insulating material and having an exchangeable fuse arranged therein, is that when they are broken, the liquid used as the insulating material leaks out causing environmental problems and fire risks, for example.

[0005] A separate fuse modul for an underground power cable system is known from US 3,678,432 A.

BRIEF DESCRIPTION OF THE INVENTION

[0006] The above problems can be solved by the bushing insulator or a voltage transformer as claimed in claim 1 and claim 3. The primary current conductor comprises a fuse which is not exchangeable and at least partly left within the cast resin when casting the frame, and that the part of the fuse remaining within the cast resin upon casting the frame is either encapsulated in a layer of rubber or other corresponding elastic material which in turn is encapsulated in a semiconducting layer, or encapsulated in a layer of semiconducting rubber or other corresponding semiconducting elastic material.

[0007] In order for the shrinkage of the cast resin in casting the frame not to cause the fuse such high tensions that would cause the fuse to be broken, the preferred embodiment of the bushing insulator or the voltage transformer of the invention is further characterized in that the part of the fuse remaining within the cast resin upon casting the housing is encapsulated in a layer of semiconducting rubber or other corresponding semiconducting elastic material. An alternative structure solution is to encapsulate the part of the fuse remaining within the cast resin upon casting the housing in a layer of rubber or other corresponding elastic material, which is encapsulated in a semiconducting layer. Because it is flexible, the rubber or other corresponding material is able to receive the tensions caused by the shrinkage of the cast resin, and consequently prevent the fuse itself from being broken because of said tensions. The semiconductivity of the material or the semiconducting layer serves, in turn, to keep the electric field in the insulation gap, i.e. within the cast resin, and thus prevent partial discharge from occurring either in the air possibly remaining within the closed-cell rubber cells or in the space possibly remaining between the fuse and the layer made of rubber or other corresponding elastic material.

BRIEF DESCRIPTION OF THE FIGURES

[0008] In the following the bushing insulator of the invention will be described in greater detail with reference to the attached drawing, in which the figure shows an exemplary embodiment of the bushing insulator of the invention in partial cross-section.

DETAILED DESCRIPTION OF THE INVENTION

[0009] The figure in the attached drawing shows an exemplary embodiment of the bushing insulator of the invention in partial cross-section. The insulator shown in the figure comprises a primary current conductor 1, extending throughout the insulator. An insulator frame 2 is cast of cast resin 3 around the primary current conductor 1. Since the exemplary embodiment shown in the figure is intended for outdoor use, the frame 2 is provided in a conventional manner with flanging which serves to prevent leakage currents along the insulator surface from the primary current conductor 1 to the supporting structure (not shown) of the insulator, such as a transformer housing. The insulator shown in the figure is intended to rest on the supporting structure from below a sturdy flange 7 at the vicinity of its one end.

[0010] In the bushing insulator of the figure, part of the primary current conductor 1 is composed of a fuse 4, for the most part cast within the cast resin 3. The fuse is connected to the rest of the primary current conductor by tinning at a metal cap at its upper end. Part of the fuse 4 projects outwardly from the lower end of the insulator frame 2. In order for the cast resin 3 cast around

the fuse 4 not to break the fuse 4 during post-cast shrinkage, the fuse typically having a ceramic frame, the fuse has been encapsulated in a layer 6 of rubber or other corresponding material before casting in the cast resin 3. This rubber layer 6 serves to receive the compressive stress exerted on the fuse upon shrinkage of the cast resin. During casting, an air layer may remain between the rubber layer 6 and the fuse 4 and could cause partial discharge to occur. By arranging a semiconducting layer, such as a paper 5, between the rubber layer 6 and the cast resin 3, partial discharge can be avoided since the electric field between the primary current conductor 1 and the supporting structure of the insulator keeps acting between said semiconducting layer 5 and the supporting structure, i.e. expressly over the cast resin 3. Although the semiconducting layer 5, when connecting in parallel with the fuse, partially short circuits the fuse, the short circuit is, however, so insignificant that the fuse still operates correctly, i.e. blows at fault currents caused e.g. by a fault in the coil of the distribution transformer.

[0011] The semiconducting layer 5, in parallel with the fuse, also causes the other end of the fuse to stay live, and a low leakage current still flows although the fuse is blown. However, in the case of a distribution transformer, for example, such a fault current is so low that it has no significance as regards the actual protective function, and perfect fault separation is thus not required.

[0012] An alternative solution to the above procedure for preventing partial discharge is to make the rubber or the other corresponding flexible material itself semiconducting, whereby it is unnecessary to use a separate semiconducting layer. In this case, too, the electric field is directed to the insulating gap, i.e. within the cast resin, and consequently no partial discharge occurs in the air possibly remaining within the rubber or other corresponding material or between said material and the fuse.

[0013] In addition to the above components, the high voltage bushing insulator shown in the figure comprises a field controller, in practice a metal cylinder, disposed within the cast resin 3, at the point where the bushing insulator is e.g. by the wall of the housing of the distribution transformer. In the figure this field controller is denoted by reference 8. The field controller 8 can be earthed by earth conductors which can be coupled to screw holes 9.

[0014] In the bushing insulator of the present invention, the fuse is not exchangeable. However, the fuse is dimensioned such that it blows only in case of transformer malfunction, so that the higher cost caused by exchanging the entire bushing insulator as compared with exchanging only the fuse is not significant when proportioned to the total cost caused by exchanging the entire transformer.

[0015] The need for fuse protection against transformer coil damage is also present in (single-phase) voltage transformers to be placed into switch gears. Owing to fuse protection, transformer malfunction does not cause a long voltage break, since the bus-bar can be kept live during the time taken by preparing to exchange transformers. Depending on the location of the damaged transformer and the structure of the bus-bar, it may be possible to exchange transformers without causing any power failure by changing the coupling of the bus-bar.

[0016] The arrangement of the invention for casting the fuse within cast resin by using a layer of rubber or corresponding material and a semiconducting layer, or alternatively, a layer of semiconducting rubber or other corresponding semiconducting material, to receive the compressive forces around the fuse is also very well suitable for use in association with this component. A voltage transformer fuse is typically so dimensioned that is blows only in transformer malfunction. However, since a transformer cast in resin cannot be repaired, the fuse can be cast fixedly within the transformer frame by the arrangement of the invention. This is a way of avoiding the solution used in conventional voltage transformers, in which the fuse is provided with a separate chamber comprising a fuse holder for connecting the fuse as a part of the primary current conductor. It is now possible to leave out the relatively expensive fuse holder. The joint which is susceptible to corrosion under unfavourable circumstances, but difficult to check, can also be left out.

[0017] The bushing insulator or other corresponding component according to the invention has been described above only by means of one exemplary embodiment and with reference to another preferred embodiment. It is obvious to those skilled in the art that the inventive method of casting a fuse within cast resin can also be applied to other similar electrotechnical switch gears and devices without, however, departing from the scope of the invention disclosed in the attached claims.

Claims

1. A bushing insulator or a voltage transformer, comprising an end-to-end primary current conductor (1) and an insulator frame (2) around the primary current conductor, the primary current conductor (1) comprising a fuse (4), **characterized in that** the frame is cast of cast resin (3), the fuse (4) is not exchangeable and at least partly left within the cast resin (3) when casting the frame (2), and the part of the fuse (4) remaining within the cast resin (3) upon casting the frame is encapsulated in a layer (6) of rubber or other corresponding elastic material which in turn is encapsulated in a semiconducting layer (5).

2. A bushing insulator or a voltage transformer as claimed in claim 1, **characterized in that** said rubber or other corresponding elastic material is sem-

iconducting.

3. A bushing insulator or a voltage transformer, comprising an end-to-end primary current conductor (1) and an insulator frame (2) around the primary current conductor, the primary current conductor (1) comprising a fuse (4), **characterized in that** the frame is cast of cast resin (3), the fuse (4) is not exchangeable and at least partly left within the cast resin (3) when casting the frame (2), and the part of the fuse (4) remaining within the cast resin (3) upon casting the frame is encapsulated in a layer of semiconducting rubber or other corresponding semiconducting elastic material.

Patentansprüche

1. Isolierbuchse oder Spannungstransformator, umfassend einen von einem Ende zum anderen Ende durchgehenden primären Stromleiter (1) sowie ein Isoliergehäuse (2) um den primären Stromleiter, wobei der primäre Stromleiter (1) eine Sicherung (4) aufweist, **dadurch gekennzeichnet, dass** das Gehäuse aus Gießharz (3) gegossen ist, die Sicherung (4) nicht auswechselbar ist und wenigstens teilweise beim Gießen des Gehäuses (2) in dem Gießharz (3) zurückbleibt und der innerhalb des Gießharzes (3) verbleibende Teil der Sicherung (4) nach dem Gießen des Gehäuses in einer Schicht (6) aus Gummi oder anderem entsprechenden elastischen Material gekapselt ist, die ihrerseits in einer halbleitenden Schicht (5) gekapselt ist.

2. Isolierbuchse oder Spannungstransformator nach Anspruch 1, **dadurch gekennzeichnet, dass** der Gummi oder das andere entsprechende elastische Material halbleitend ist.

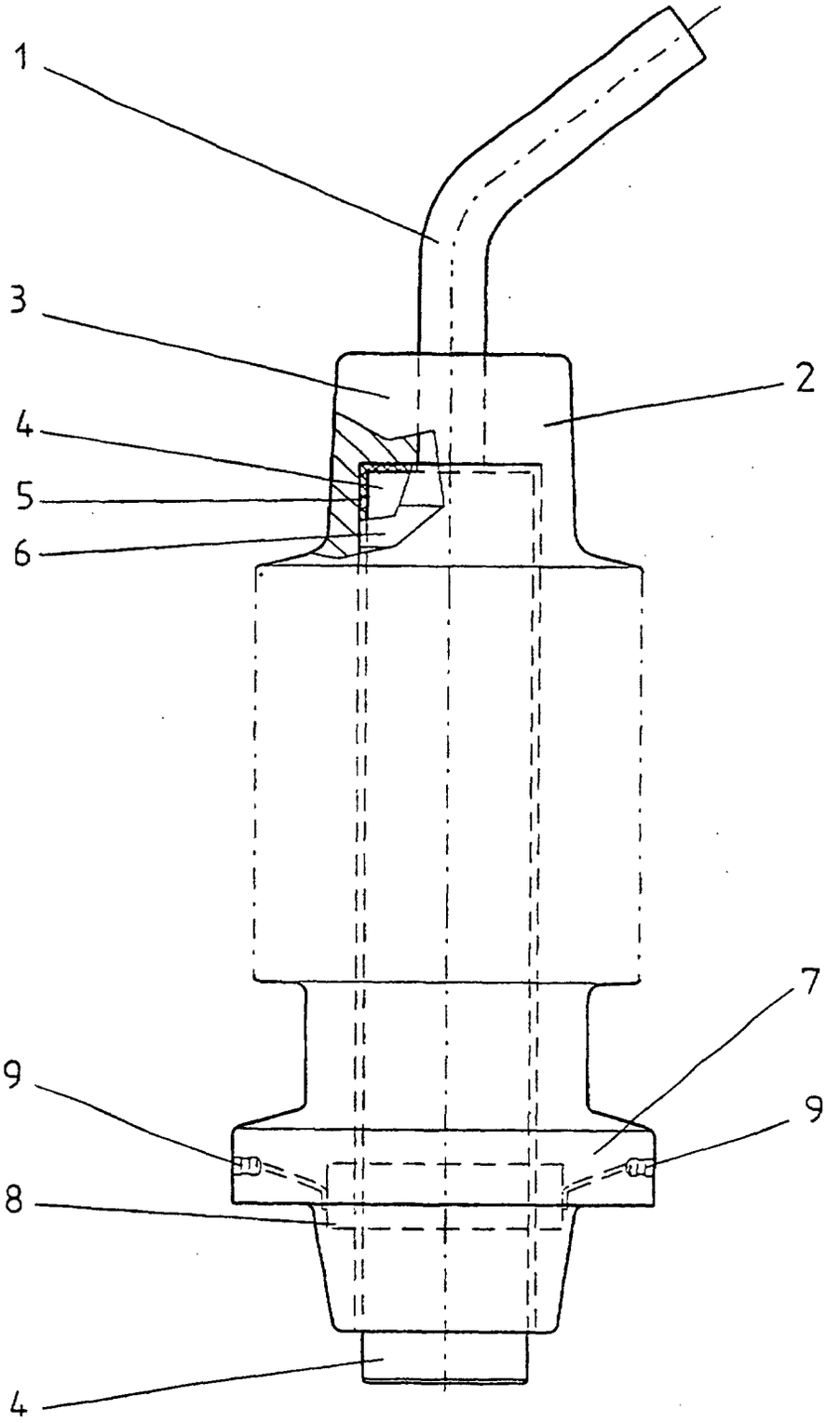
3. Isolierbuchse oder Spannungstransformator, umfassend einen von einem Ende zum anderen Ende durchgehenden primären Stromleiter (1) sowie ein Isoliergehäuse (2) um den primären Stromleiter, wobei der primäre Stromleiter (1) eine Sicherung (4) aufweist, **dadurch gekennzeichnet, dass** das Gehäuse aus Gießharz (3) gegossen ist, die Sicherung (4) nicht auswechselbar ist und beim Gießen des Gehäuses (2) wenigstens teilweise in dem Gießharz zurückbleibt und der in dem Gießharz (3) verbleibende Teil der Sicherung (4) nach dem Gießen des Gehäuses in einer Schicht aus halbleitendem Gummi oder anderem entsprechenden halbleitenden elastischen Material gekapselt ist.

Revendications

1. Isolateur de traversée ou transformateur de tension, comprenant un conducteur de courant primaire de bout en bout (1) et un cadre d'isolateur (2) autour du conducteur de courant primaire, le conducteur de courant primaire (1) comprenant un fusible (4), **caractérisé en ce que** le cadre est moulé en une résine de coulée (3), le fusible (4) n'est pas remplaçable et au moins partiellement laissé dans la résine de coulée (3) lors du moulage du cadre (2), et la partie du fusible (4) restant dans la résine de coulée (3) lors du moulage du cadre est encapsulée dans une couche (6) de caoutchouc ou d'un autre matériau élastique correspondant qui, à son tour, est encapsulée dans une couche semi-conductrice (5).

2. Isolateur de traversée ou transformateur de tension selon la revendication 1, **caractérisé en ce que** ledit caoutchouc ou autre matériau élastique correspondant est semi-conducteur.

3. Isolateur de traversée ou transformateur de tension, comprenant un conducteur de courant primaire de bout en bout (1) et un cadre d'isolateur (2) autour du conducteur de courant primaire, le conducteur de courant primaire (1) comprenant un fusible (4), **caractérisé en ce que** le cadre est moulé en une résine de coulée (3), le fusible (4) n'est pas remplaçable et au moins partiellement laissé dans la résine de coulée (3) lors du moulage du cadre (2), et la partie du fusible (4) restant dans la résine de coulée (3) lors du moulage du cadre est encapsulée dans une couche de caoutchouc semi-conducteur ou d'un autre matériau élastique semi-conducteur correspondant.


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