United States Patent

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[72] Inventor **Werner Berends**
Hamburg, Germany

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[73] Assignee **U. S. Philips Corporation**
New York, N.Y.
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[33] **Germany**
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[54] **HIGH VOLTAGE LINE**
8 Claims, 1 Drawing Fig.

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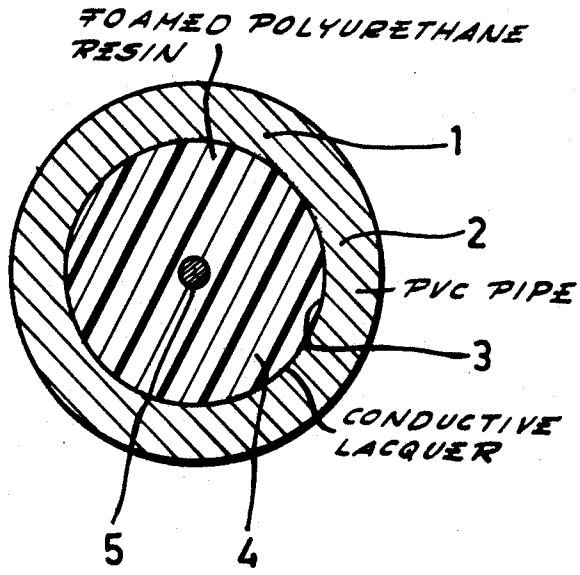
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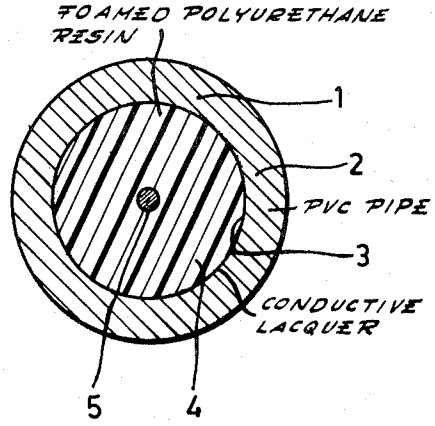
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Primary Examiner—E. A. Goldberg
Attorney—Frank R. Trifari

ABSTRACT: A high voltage cable comprising an insulating pipe coated on its inner surface with a conductive layer of lacquer. An inner conductor is coaxially mounted in the pipe and is supported within a core of nondeformable synthetic resin foam that fills the pipe. The inner conductor is conductively connected to the conductive layer of lacquer.





INVENTOR

WERNER BERENDS

BY Frank R. [illegible]

AGENT

HIGH VOLTAGE LINE

The present invention relates to a nondeformable high-voltage line possessing a stable form. Such lines are required, for example, for connecting individual high-voltage conducting components within a high-voltage apparatus. The lines must maintain their position and shape and not come into contact with components which have a different high-voltage potential. It is furthermore necessary that the high-voltage line be provided with a sufficiently large diameter so that, during operation of the apparatus, the electric field strength occurring therein will be smaller than the breakdown field strength of the insulating medium (usually oil).

It is known to use metal pipes for this purpose. Particularly in apparatus for high direct voltages, the pipe must be wrapped with cable paper which is subsequently impregnated. In this way, breakdowns are avoided even when fiber bridges are formed in the insulating oil (i.e. areas with comparatively high conductivity). For guiding several conductors insulated from each other and set up at approximately the same high-voltage potential, for example, for the connection of the cathode of an X-ray tube, it is already known to provide the conductors in a coiled unit with a sufficiently large cross section of the coil. The coiled unit is once again wrapped with cable paper and then impregnated. Both embodiments are comparatively expensive owing to the wrapping with cable paper and the subsequent impregnation of same.

It is an object of the invention to provide a cheaper construction.

According to the invention the above object is achieved in a high-voltage line of the type comprising at least one internal conductor surrounded by a conductive cylinder provided with an insulating material on its outside and which conductive cylinder during operation, has at least approximately the same potential as the internal wire, by providing an insulating pipe which is coated on its inside wall with a conductive layer of lacquer which encloses a foamed core in which at least one internal conductor is embedded.

In order that the invention may be readily carried into effect, one embodiment will now be described in greater detail, by way of example, with reference to the accompanying drawing, the sole figure of which shows a cross-sectional view of a high-voltage line according to the invention.

The line 1 includes a PVC pipe 2 which is coated on its inside surface with a conductive layer of lacquer 3. The polyvinyl chloride pipe is filled with a core 4 composed of a foamed material in which an internal conductor 5 is embedded.

The internal conductor 5 is conductively connected to the conductive layer of lacquer 3 (not shown). Since the conductivity of the thin conductive layer of lacquer is considerably smaller than that of the wire 5, substantially all of the current flows through the wire 5. The purpose of the conductive layer of lacquer is to increase the conductive surfaces which are operative towards the outside so that the occurring field strength is reduces. The internal diameter of the PVC pipe must therefore be large enough so that the electric field strength occurring during operation at the surface of the conductive layer 3 is smaller than the breakdown field strength of the PVC pipe and of the insulating medium which surrounds the high-voltage line. A particularly suitable material for the core 4 is foamed polyurethane resin.

It is also possible to embed two or more mutually insulated internal conductors in the core of foamed material. These conductors have approximately the same potential and one of them is conductively connected to the conductive layer of lacquer. Such high-voltage lines are utilized, for example, in the connection of the cathode of and X-ray tube for supplying the heating current. Only a comparatively small voltage difference exists between the two supply wires. However, relative to ground and the anode, respectively, the voltage difference is very great.

When the internal conductor is a high-ohmic resistance wire and when the inside of the PVC pipe is coated with a high-ohmic conductive lacquer, a damping resistance is obtained which may be connected in the high-voltage circuit of an X-ray tube to limit the current occurring upon breakdown of the tube.

For transferring very high voltage to a point outside of the apparatus, the high-voltage line 1 may be used as the internal wire of a high voltage pipe-type cable. The line 1 then lies within a further PVC pipe which is likewise filled with a core of foamed material and which is metallized on its outside.

For manufacturing a high-voltage line according to the invention, a silver suspension (for example, Leitsilber 202 N of Messrs. Degussa) is provided in a PVC pipe. The inside of the pipe is evenly wetted with the silver suspension by swirling the pipe. The silver suspension layer is then dried at 80° C for 2 hours. Inside the pipe the internal conductor 5 is then centered, for example, by means of a centrally perforated stopper, after which the pipe is filled with polyurethane hard foam which hardens after a few minutes.

It is very often not possible to lead the high-voltage line linearly through the high-voltage apparatus so that the PVC pipe first be bent to the required shape. It is known for this purpose to fill the PVC pipe with sand so that it can be bent after sufficient heating without its cross section varying. In manufacturing bent high-voltage lines according to the invention, the core of foamed material may take over the function of the sand filling. For this purpose, the PVC pipe is heated and bent after a hardening time of 10 minutes when the foam has not yet hardened entirely but is already rigid enough to prevent any variation of its cross section.

Alternative the pipe may be composed of other readily insulating synthetic resins which can be softened, for example, thermoplastic resins such as, polypropylene, polyethylene, polymethylmethacrylate, polycarbonate, and polysulphone resin.

After complete hardening, the core of foamed material gives the high-voltage core 1 a nondeformability which, particularly at high temperatures, cannot be achieved with pipes made of a synthetic resin alone.

The core of foamed material may likewise consist of polystyrene.

I claim:

1. A high-voltage cable comprising an inner electric conductor, a core composed of a substantially nondeformable synthetic resin foam surrounding said conductor in intimate contact therewith, and a pipe enclosing said core and composed of an electric insulator material having its inside surface coated with an electrically conductive layer of lacquer.

2. A high-voltage cable as claimed in claim 1 wherein the insulating pipe consists of a thermoplastic synthetic resin.

3. A high-voltage cable as claimed in claim 1 and adapted for use as a cathode connection line, said cable further comprising a second inner conductor enclosed within the insulating pipe and the foam core and insulated from the other inner conductor.

4. A high-voltage cable as claimed in claim 1 wherein the internal conductor is composed of an electric resistance wire and the conductive layer of lacquer is composed of a material that exhibits an electric resistance of finite magnitude.

5. A high-voltage cable as claimed in claim 1 wherein the synthetic resin of the core is selected from the group consisting of polyurethane and polystyrene.

6. A cable as claimed in claim 2 wherein the pipe is composed of an insulating synthetic resin selected from the group consisting of polypropylene, polyethylene, polymethylmethacrylate, polycarbonate and polysulphone resin.

7. A cable as claimed in claim 1 wherein said inner conductor and said conductive layer of lacquer are electrically connected and are dimensioned so that the electric conductivity of the layer is considerably lower than the electric conductivity of the inner conductor whereby substantially all of the current flow will be in the inner conductor.

8. A cable as claimed in claim 1 further comprising a second insulating pipe coaxially enclosing the first pipe, and a core of nondeformable synthetic resin foam within said second pipe and surrounding the first insulating pipe.