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ELECTRIC CABLE

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Fig. 1.

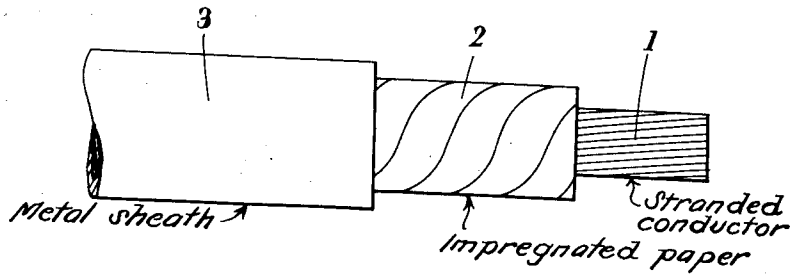
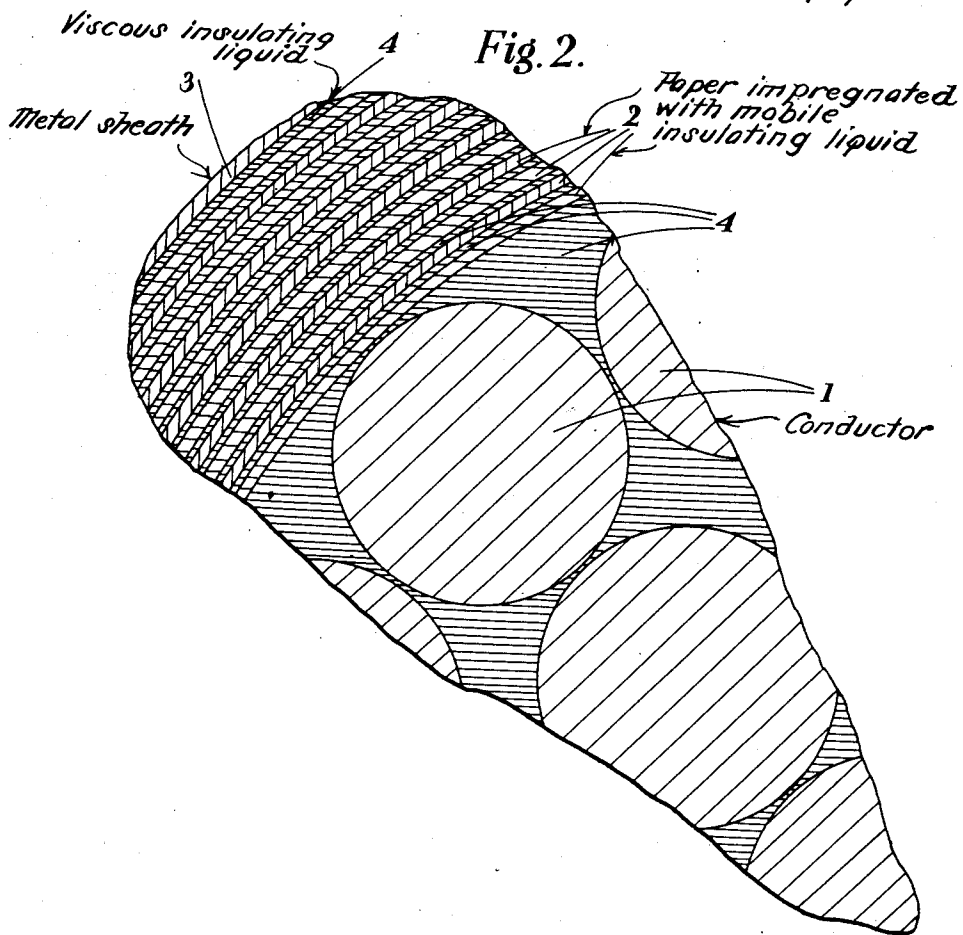


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRIC CABLE

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2 Claims. (Cl. 173—264)

This invention relates to the manufacture of high tension electric cables of the kind in which layers of paper are applied to the conductor by a wrapping process to form a laminated body of dielectric that is subsequently impregnated with a liquid or semi-liquid insulating material. The invention deals particularly with the method of impregnating the dielectric body surrounding the conductor.

In accordance with the invention the process of impregnating the dielectric is carried out in two stages. In the first stage of the process the previously dried laminated dielectric body of paper surrounding the conductor is impregnated with a mobile insulating oil. After this stage surplus insulating oil unabsorbed by the paper, that is to say, the oil that is present in the space between the paper lappings and in the interstices in the conductor, is removed from the insulated conductor under conditions that do not result in removal by evaporation of the oil absorbed by the paper. In the second stage, which follows this draining operation, the dielectric body of paper is impregnated with a relatively viscous insulating oil or compound. The first stage of impregnation may be carried out in the usual manner by first drying the dielectric with the assistance of heat and evacuation and then impregnating with a hot mobile oil under pressure. Heat and evacuation also precede the second stage of impregnation so as to insure complete removal of all free mobile oil and to facilitate the introduction of the hot impregnated compound in the second stage.

The oil for the first stage of impregnation has a sufficiently low viscosity and is sufficiently fluid at the temperature used during impregnation to impregnate the fibres of the paper, that is to say, to enter the cells and canals within the structure of these fibres as well as to occupy the smallest spaces between the fibres. The subsequent treatment of the insulated conductor does not remove the oil from the interior of the fibres or from the spaces between them. The temperature at which the first impregnation takes place will be determined partly by the degree of evacuation preferred. The temperature at which the draining operation is carried out will also depend to a certain extent upon the oil used in the first stage and will of course be well below the boiling point of that oil under conditions of pressure prevailing. The temperature at which the second impregnation takes place will be sufficiently high to reduce the viscosity of the compound selected to a sufficiently low value. This temperature must of course, be below the boiling point of the oil used

in the first stage. The impregnating temperatures suitable for any impregnating medium selected will either be apparent to the cable manufacturer or may be readily ascertained by him. As an example of suitable oil for use in the first stage of the process may be mentioned transformer oil, that is the oil generally employed in the tanks of static electric transformers.

The oil or compound used for the second impregnation is sufficiently stiff at normal temperatures to prevent running. It has been found preferable to employ an oil which though more viscous in character than the oil employed in the first stage, is an oil of the same base. This oil may, if desired, contain in admixture therewith rosin of a suitable grade.

The process may be carried out in the following manner. The paper insulated conductor is first dried by any of the known methods and inserted in a vacuum-tight impregnating vessel. The vessel is then evacuated and the first impregnating medium is then drawn in at a suitably high temperature. If transformer oil is used a suitable temperature is from 245° to 250° F. The impregnating fluid and the insulated conductor are maintained at this temperature until the fibres of the paper have become thoroughly impregnated with the fluid. The impregnation may be assisted by subjecting the fluid in the vessel to a suitable pressure and/or by evacuating the insulated conductor from the interior. After the impregnation of the fibres is complete, the surplus fluid which lies on the surfaces of the papers and, where the conductor is a stranded conductor, in the interstices of conductors, is removed, either by draining the mass of fluid from the vessel or by removing the insulated conductor from the vessel and allowing it to drain under atmospheric pressure. After the draining process has been carried out, the insulated conductor is again placed under vacuum in the impregnating vessel and the normally viscous fluid is drawn in at a temperature that is sufficiently high to render the fluid sufficiently mobile to enable it to fill the interstices in the body of insulation and in the conductor. Where transformer oil is used in the first stage and more viscous oil of the same base is used in the second stage, a suitable temperature for carrying out the second stage of impregnation is the temperature that was stated to be suitable for the first stage of impregnation, namely, a temperature of 245° to 250° F. As in the first stage, the impregnation in the second stage may be facilitated by subjecting the fluid to pressure and/or placing the interior of the insulated con-

ductor under vacuum. After cooling, the insulated conductor is withdrawn and furnished with an impervious sheath of lead or other material.

5 The accompanying drawing shows diagrammatically and by way of example only, a lead sheathed single core electric cable of which the laminated paper insulation thereof has been impregnated in accordance with the present invention. In this drawing,

10 Figure 1 is a side elevation of the cable from which portions have been removed to expose the construction of the interior of the cable and

15 Figure 2 is a fragmentary cross-section on an enlarged scale of the cable shown in Figure 1.

By referring to the drawing it will be seen that the cable conductor 1 consists of a plurality of wires stranded together and that the insulation consists of a plurality of layers 2 of paper, each
20 layer consisting of a helical lapping of paper tape. The insulated conductor is enclosed in a lead sheath 3. The fibres in the paper layers 2 are completely impregnated with a mobile insulating liquid and the spaces between the successive
25 lappings of paper and the interstices in the conductor are filled with insulating material 4 which is sufficiently viscous at normal temperatures to prevent it flowing along the cable. The outer surface of the insulation is also coated
30 with the viscous material. In this way the insulating fluid within the paper is sealed in place by the surrounding viscous material 4.

It will be understood that the illustration of the structure in Figure 2 is diagrammatic, since,
35 for clearness, it has been necessary to depart from the appropriate relation between the dimensions of the parts. Each paper layer 2 will have a thickness of a few thousandths of an inch while each layer 4 of impregnating material between the paper layers will have a thickness
40 of a fraction of a thousandth of an inch.

The result of the improved method of manufacture is an impregnated paper insulated conductor
45 or cable in which the interior structure of the paper remains substantially completely impreg-

nated with a mobile insulating oil and in which the production of a flowing oil or compound, by the dilution of the heavier oil or thick compound with light oil from the first stage of impregnation, is prevented. The oil retained after this first stage is substantially all bound to the internal parts of the paper structure.

It will be apparent that the mechanical construction of the cable need in no way be affected by the use of the improved impregnating process which may be employed in connection with the manufacture of single or multi-core type paper insulated cable.

I claim as my invention:—

1. The method of insulating the conductor of an electric cable, which comprises enveloping the conductor in a laminated body of paper, drying the said laminated body, impregnating the dried laminated body with an insulating liquid that is mobile at normal atmospheric temperatures, removing from the paper enveloped conductor with the assistance of heat and evacuation and under conditions that do not result in evaporation of the said mobile insulating liquid absorbed by the paper, surplus mobile insulating liquid unabsorbed by the paper, and subsequently impregnating the laminated body with a relatively viscous insulating liquid.

2. The method of insulating the conductor of an electric cable which comprises enveloping the conductor in a laminated body of paper, drying the said laminated body with the assistance of heat and evacuation, impregnating at an elevated temperature the said dried body with an insulating liquid that is mobile at normal atmospheric temperatures, removing in the liquid state from the paper enveloped conductor, with the assistance of heat and evacuation, surplus insulating liquid unabsorbed by the paper, and subsequently impregnating the laminated paper body, under conditions that do not result in evaporation of the mobile liquid absorbed by the paper, with a relatively viscous insulating liquid that at normal temperatures is highly viscous.

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