

[54] ELECTRIC CABLES

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[56] References Cited

UNITED STATES PATENTS

2,967,902 1/1961 Pasini 174/102 SC
2,112,322 3/1938 Wyatt 174/142,266,810 12/1941 Ruben 317/258
3,090,705 5/1963 Miksits 317/259 X
2,594,872 4/1952 Clark 317/259

FOREIGN PATENTS OR APPLICATIONS

874,981 8/1961 Great Britain 174/120 FP
744,481 2/1956 Great Britain 174/120 FP
463,893 3/1950 Canada 174/25 R
896,066 5/1962 Great Britain 174/25 R

Primary Examiner—Bernard A. Gileany

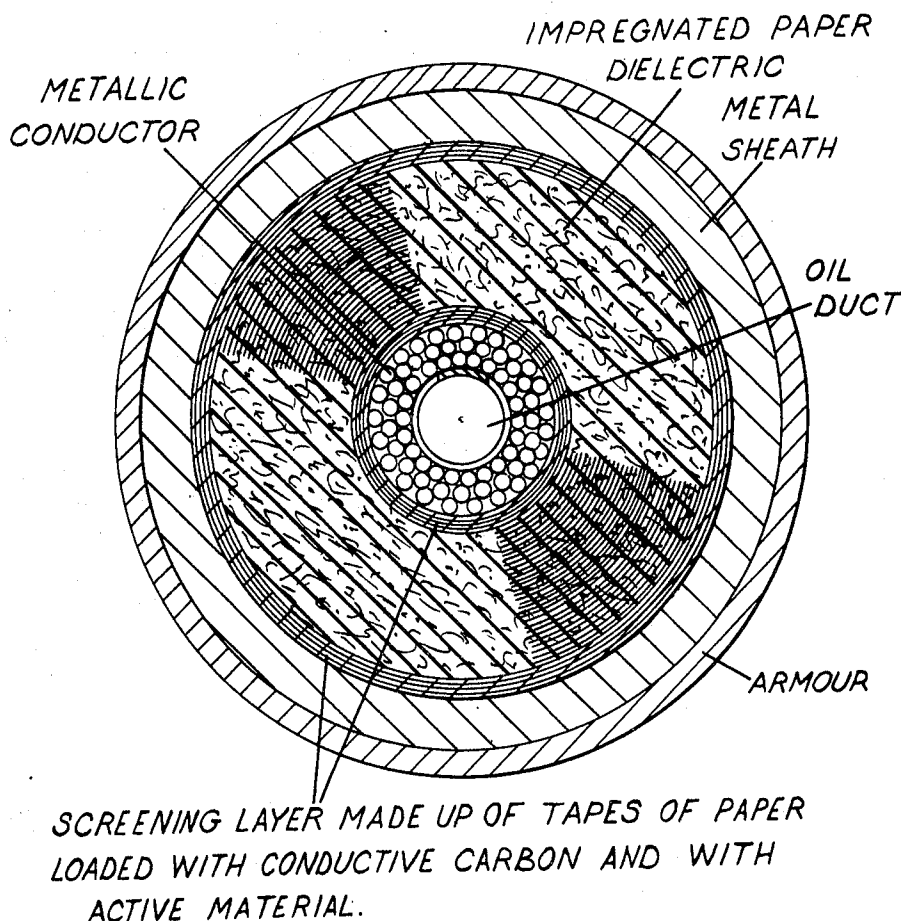
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[57] ABSTRACT

A conductive or semiconductive fibrous sheet material used as an electric screen in contact with the dielectric fluid of high voltage cables having a fluid impregnated dielectric is loaded both with conductive carbon and with at least one active, finely divided material selected from the group consisting of aluminium oxide and such other metallic oxides, hydrated metal oxides, metal hydroxides, metal carbonates and basic metal carbonates as have adsorptive powers comparable with that of active finely divided aluminum oxide. The dielectric is free of any adsorbent.

3 Claims, 3 Drawing Figures



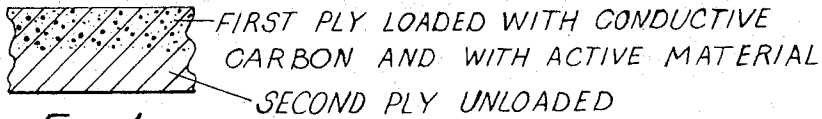


Fig. 1

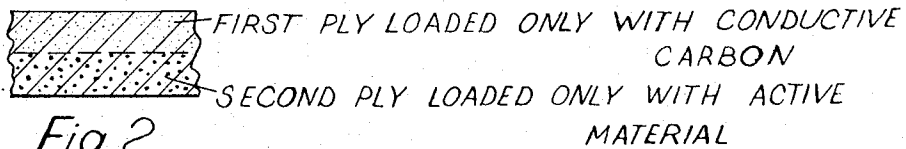


Fig. 2

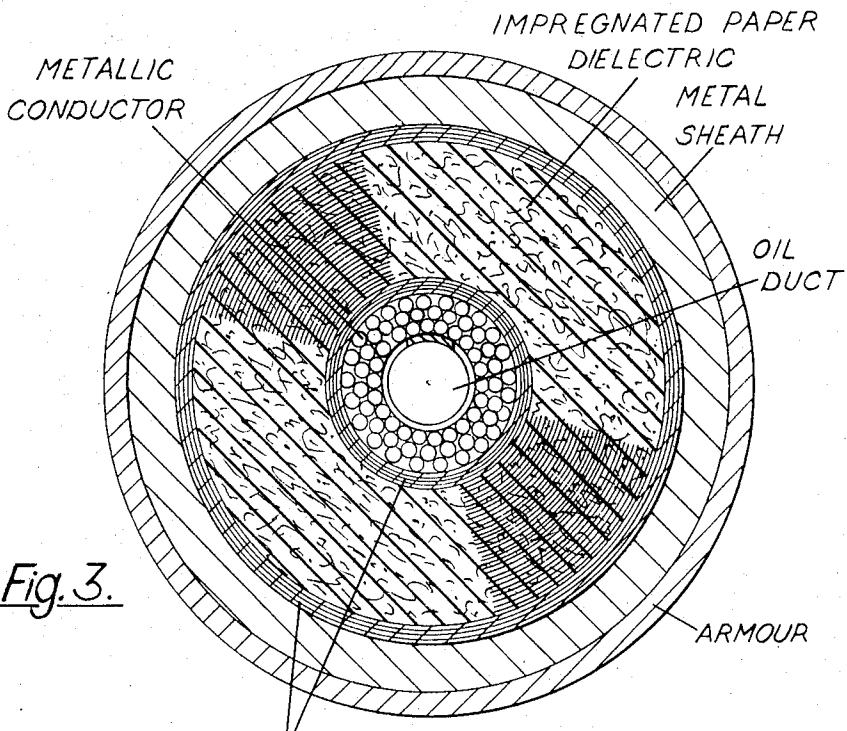


Fig. 3

SCREENING LAYER MADE UP OF TAPES OF PAPER
LOADED WITH CONDUCTIVE CARBON AND WITH
ACTIVE MATERIAL.

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ELECTRIC CABLES

This is a division of U.S. Pat. application Ser. No. 20,670, filed Mar. 18, 1970 now abandoned.

This invention relates to conductive or semiconductive fibrous material in sheet form suitable for use as an electric screen in contact with the dielectric fluid of high-voltage cables and other electrical apparatus having a fluid impregnated dielectric.

The invention is especially concerned with the dielectric and conductor screens of oil-filled electric cables which may be of the pipe type or of the self-contained type having one or more internal oil ducts. It has as its principal object the provision of a permeable material for this purpose that is capable of protecting the dielectric material against contamination and that is less liable to contaminate the dielectric and/or its impregnant than are permeable materials hitherto used.

The material in accordance with the invention is a conductive or semi-conductive fibrous material in the form of a flexible sheet loaded both with conductive carbon and with active finely divided material selected from the group consisting of aluminium oxide and such other metal oxides, hydrated metal oxides, metal hydroxides, metal carbonates and basic metal carbonates as have adsorptive powers comparable with that of active finely divided aluminium oxide. Of these materials aluminium oxide and titanium dioxide are preferred, in that order.

I prefer to use aluminium oxide or other active substances in the manner disclosed in U.K. Pat. No. 874,981 except that instead of incorporating these substances in a paper or other dielectric material suitable for use as a dielectric as claimed in that patent, they are incorporated in fibrous materials suitable for use as a conducting or semi-conducting screen.

The invention includes cables, especially cables having an impregnated dielectric such as oil-filled cables, in which the fibrous materials are used either as a conductor screen or as a dielectric screen or both. Normally, at least two layers of the loaded fibrous material will be used in each screen, the layers breaking joint.

The invention also includes multi-ply fibrous sheet materials in which at least one but not all plies is loaded with the active material and conductive carbon.

The invention also includes multi-ply fibrous sheet materials in which at least one but not all plies is loaded with conductive carbon but not with active alumina or other active material and at least one of the remaining plies is loaded with such active material but not with conductive carbon. In forming a conductor screen from such sheet material, such sheet material may be applied over an underlying layer of material loaded with conductive carbon, with the ply or plies that is or are loaded with active alumina or other active material on the outside (that is adjacent to the dielectric) but to avoid exposure of the conductive carbon loaded paper to the oil in the butt spaces between the turns of the multi-ply sheet material, it is preferable to apply a multi-ply sheet material over an underlying layer of material loaded with both active alumina and conductive carbon. A similar but inverted construction may be used in forming a dielectric screen.

The quantities and type of conductive carbon used will be substantially the same as in conventional carbon loaded paper used for this purpose.

The particle size of the alumina or other active substance must be such that it does not interfere with the paper making process; colloidal particles are preferably used. Although less than 2 percent of the active substance based on the weight of the paper can be used, since its effectiveness is a function of the quantity used larger quantities, e.g. 8-10 percent, are preferred. The active substance must be substantially free from ionic impurities that would deleteriously affect the electrical properties of the dielectric and before incorporation in the paper it is preferably subjected to the same tests as is paper for use as the dielectric of electric cables and other electrical apparatus, i.e., tests for conductivity and acidity/alkalinity of the aqueous extract. Also, as stated in the above mentioned British Patent Specification, the substance must not be overheated during the activation process to the extent that fusion of the particles occurs, since this would materially reduce the adsorptive power and by virtue of the increased crystallinity and abrasiveness interfere with the felting of the paper fibres.

The carbon and the alumina, or other active substance, can each be incorporated in the fibrous material either during manufacture, i.e., by addition to the pulp in the case of paper either at the hydro pulper or the beater, or after manufacture by impregnation of the fibrous material with a suspension of the material or materials.

Although the invention is mainly concerned with sheet material based on paper of the quality normally used as the dielectric in high voltage cables, other fibrous sheet materials, both natural and synthetic, that are compatible with the dielectric materials can alternatively be used.

The sheet material in accordance with the invention is intended primarily to act as a barrier inhibiting the migration into the dielectric of ionic impurities carried by the fluid impregnant, which impurities may for example be derived from metals with which the fluid comes into contact within the electrical apparatus or in ancillary apparatus through which the fluid is circulated, for example the metal of cable conductors, enclosing pipes or cable sheaths, binding tape applied to the dielectric, external heat exchangers, and circulating pumps. The alumina or other active substance may also inhibit migration of carbon or other semi-conducting particles derived from carbon black from the fibrous material into the adjacent dielectric or the impregnant therefor. In the accompanying drawings FIGS. 1 & 2 show two forms of fibrous sheet material in accordance with the invention; and FIG. 3 shows in cross-section a cable having a conductor screen and a dielectric screen of the material in accordance with the invention.

The presence of the alumina or other active substance will greatly increase the adsorptive power for contaminating ions of the paper or other fibrous material by virtue of the much higher adsorptive index of the alumina or other active substance as compared with the activated carbon. The presence of the alumina or other active substance will however not substantially affect the permeability of the loaded fibrous material and hence will not obstruct the passage of moisture from the dielectric during the drying of the dielectric prior to impregnation.

The sheet materials in accordance with the invention have the advantage over carbon loaded papers hitherto used that when used instead of such materials as the

conductor and/or the dielectric screen of a high voltage cable with an oil impregnated dielectric they reduce the rate at which the power factor of the cable increases over a long period of service.

They have the advantage over screens of solid metal foils (usually aluminium the alloy sold under the trademark Aluman, copper or bronze) and of metal foil laminated with fibrous material that they are permeable and that in comparison with the latter type of material the risk of contamination of the dielectric by the adhesive used to bond the metal foil to the fibrous material is avoided.

What I claim as my invention is:

1. An electric cable, comprising
 - a. at least one metallic conductor,
 - b. a fluid impregnated dielectric surrounding said conductor and bounded at each of its inner and outer circumferential surfaces by an electric screen in contact with said fluid and formed from a fibrous material in the form of a flexible sheet loaded with conductive carbon black and
 - c. an external fluid-tight sheath, said cable being characterized in that the said fibrous material of said electric screens comprises distinct plies loaded respectively with said conductive carbon black and with an active finely divided adsorbent material selected from the group consisting of aluminum oxide and such other active metallic oxides, hydrated metal oxides, metal hydroxides, metal carbonates and basic metal carbonates as have adsorptive powers comparable with that of active finely divided aluminum oxide and that the said dielectric is free of any adsorbent material.

2. An electric cable, comprising
 - a. at least one metallic conductor,
 - b. a fluid impregnated dielectric surrounding said conductor and bounded at each of its inner and outer circumferential surfaces by an electric screen in contact with said fluid and formed from a fibrous material in the form of a flexible sheet loaded with conductive carbon black and
 - c. an external fluid-tight sheath, the said cable being characterized in that the said electric screens each comprise a first layer of a multi-ply fibrous sheet material comprising one ply contiguous with the dielectric and loaded with an active finely divided adsorbent material selected from the group consisting of aluminum oxide and such other active metallic oxides, hydrated metal oxides, metal hydroxides, metal carbonates and basic metal carbonates as have adsorptive powers comparable with that of active finely divided aluminum oxide and another ply loaded with conductive carbon black and a second layer of material loaded with conductive carbon black and contiguous with said other ply and further characterized in that the said dielectric is free of any adsorbent material.
3. A cable as claimed in claim 2 in which said second layer is also loaded with an active finely divided material selected from the group consisting of aluminium oxide and such other metallic oxides, metal hydroxides, metal carbonates and basic metal carbonates as have adsorptive powers comparable with that of active finely divided aluminium oxide.

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