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HIGH VOLTAGE CABLE

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5 Claims

ABSTRACT OF THE DISCLOSURE

The central conductor is covered by an auxiliary shield, and between the latter and a surrounding outer shield assembly is a layer of primary insulation constituted by a laminated tape comprising a thin carrier layer of perforated resinous material and a substantially thicker layer of low density paper having plastic fibers, the paper having a density in the range of 0.4 to 0.8 gram per cubic centimeter and being bonded to and supported by the carrier layer.

The present invention relates to electrical power cable, and more particularly to an improved insulation for such cable.

The ever increasing need for larger blocks of electrical power in urban areas has focused renewed attention on the advantages of power transmission at extra high voltages. Overhead transmission lines are under construction or in operation in various areas of the U.S. designed to operate at 345 kv., 550 kv. and even 750 kv. However, such transmission systems must resort to underground cable in metropolitan areas, and hence new cable insulations for 550 kv. and 750 kv. systems must be developed in order to provide the underground EHV cable necessary to complete the transmission line routes within the suburbs and city proper.

In addition to adequate dielectric strength to ensure long service life at extra-high voltages, a fundamental and most essential requirement of an EHV insulation is low power (dissipation) factor. Low power factor is essential because otherwise the magnitude of the dielectric heating (due to the presence of the high voltage) would make it impossible for the cable to transmit any useful electric power, without jeopardizing the operating stability and useful life of the cable. For example, in a typical installation of 138 kv. cable having a dissipation factor of 0.25%, the reduction in power rating due to dielectric loss would amount to only a few percent. At 230 kv., the derating factor would be about 20%, and at 550 kv., the derating factor would be close to 100%, making it virtually impossible to transmit any useful power.

Even with the finest quality paper cable designs available today, auxiliary cooling of the cable system would be required for normal service at 500 kv. and above.

It is an object of the present invention to provide an insulating system affording a much lower dielectric loss (heating), making it practical to operate efficiently at EHV levels without auxiliary cooling, except possibly during emergency overload conditions.

In accordance with the present invention, the cable conductor of copper or aluminum is covered with an auxiliary shield either in extruded or tape form. This core is then lapped with a special tape whose windings form the primary insulation of the cable. The tape consists of a very thin layer of a polyester sheet, having bonded to it a thicker layer of low density paper made of plastic or of a combination of plastic and cellulose. The polyester tape serves as a carrier to support the low-loss, low density paper, which by itself would be too weak to wind satisfactorily on a cable core.

The power factor of the plastic paper, which is reflected in the increased efficiency of the cable, is much superior in this respect compared to other compatible paper insulating system for cable.

An over-all shield tape assembly, applied over the insulation, completes the electric cable design, which is then oil-impregnated and enclosed within an impervious oil-filled sheath or pipe.

The exceptional performance of impregnated paper insulation in high voltage cable service is due in large measure to the complete affinity (wetting) of the cellulose for the impregnant, the labyrinth path of the fiber structure, and the ebb and flow of liquid impregnant, all of which act to prevent the initiation of incipient failure and thus contribute to maintenance of a highly stable dielectric. By using low density paper of plastic or plastic and cellulose, not only is this excellent performance retained but an additional important advantage is provided, namely, that of lower power (dissipation) factor, for example, 0.02% instead of 0.2% typical of cellulose paper cable design.

Despite the advances over the years in the development of plastic or synthetic film materials for electrical insulation, a completely practical design has not been attained for a high-voltage cable having all-synthetic tape insulation. Among the reasons for this are the problems encountered in impregnation because the insulating film tape is impervious to oil, and the fact that the mechanics of manufacture are more difficult than with paper tape. Moreover, the synthetic film tape can impose limitations in cable-core flexibility during handling and reeling; and reserve electrical stability of such an oil-impregnated cable system, under loss of operating pressure, is markedly reduced as compared to cable insulated with paper tape.

Dielectric constant is the second equally important characteristic of a cable insulation which directly affects dielectric loss heating. Since the best EHV cables made with oil-impregnated paper exhibit a value of "k" no lower than about 3.4, there is definite need to reduce the value of this dielectric constant; and the present invention provides for a substantial reduction, for example, in the order of 20 to 30 percent.

The following is a detailed description of a preferred embodiment of the invention, with reference to the accompanying drawing, in which:

FIG. 1 is a plan view of the tape used as the primary insulation, with its various layers exposed, and

FIG. 2 is a plan view of the cable of the present invention with its layers cut back to illustrate the various materials of those layers.

The tape shown in FIG. 1 consists of a top layer 1 of plastic, low-density paper, a thin layer of polyester sheet 2, and a bottom layer 3 of plastic, low-density paper. Actually, only one layer of the plastic paper need be used, so that the tape may consist only of a relatively thick layer of plastic paper and a relatively thin layer of polyester film.

The low-density paper may be made from fibers of either plastic or a composite of plastic and cellulose. By "low-density" is meant a density in the range of 0.4 to 0.8 grams per cubic centimeter, but this is the preferred range and should not be considered restrictive. In contrast, ordinary cellulose papers used in cable insulation exhibit a density between 0.7 and 1.0.

Suitable plastics for such paper include polycarbonate, polyphenylene-oxide, polyesters, polyethers, and polyolefins such as polyethylene or polypropylene. Plastic papers made from these materials are porous, and are made from fibers formed on a foudrinier screen and then dried and calendered, as in the normal cellulose papermaking process. By "composite material" is meant a mixture of