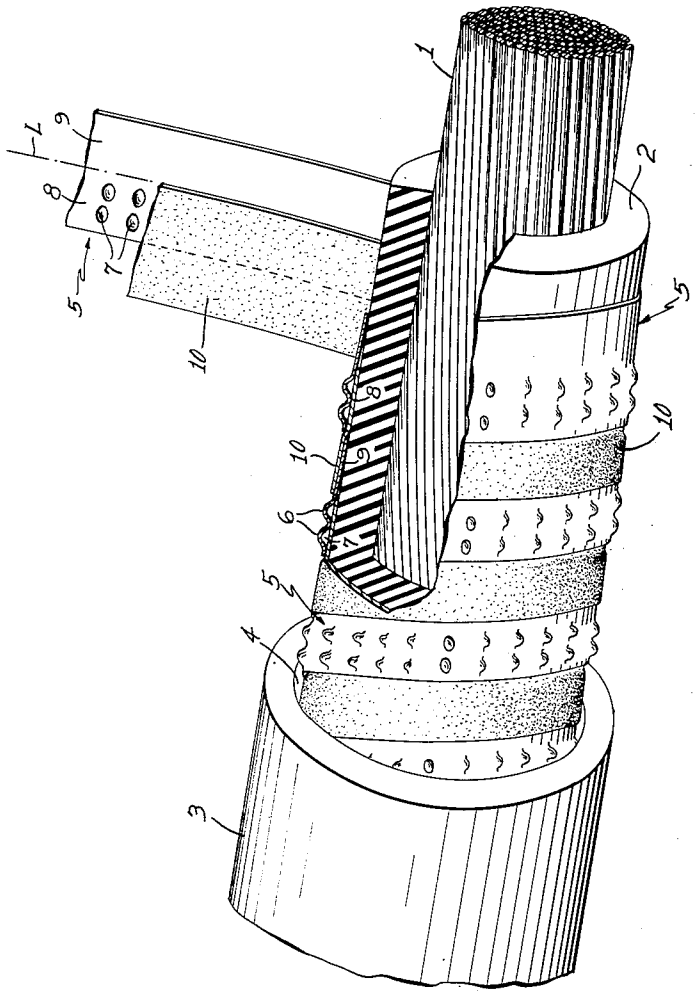
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GAS-FILLED POWER CABLE WITH EMBOSSED TAPE

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GAS-FILLED POWER CABLE WITH EMBOSSED TAPE

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This invention relates to power cables, and especially to power cables of the single-conductor fluid-filled type in which provision is made for a fluid passage extending lengthwise of the cable between the conductor insulation and the sheath. The principal object of the invention is to provide improved means for spacing the sheath from the insulation to provide such a passage, the spacing means serving at the same time to shield the insulation electrostatically.

It has been proposed heretofore to provide an annular fluid passage between the conductor insulation and the sheath of a single-conductor power cable by wrapping spacer wires, or transversely corrugated metallic tape, or tape having button-like projections stamped in it, helically about the insulation, so as to hold the insulated conductor centered in the sheath with the outer surface of the insulation spaced from the inner surface of the sheath. In all of these prior proposals, it has been necessary to shield the insulation electrostatically before applying the spacer wires or tapes, in order to avoid having a potential gradient develop between any point at the surface of the insulation and the sheath, or (in the case of spacer tapes formed with stamped projections) to avoid having such a potential gradient develop within the hollow space underneath the stamped projection. Such potential gradients are objectionable because they subject the spaces in which they occur to electrical stress and may result in incipient insulation breakdown at a point where the insulation is weak, and from where it can propagate into the main body of the insulation. Shielding entails wrapping a smooth layer of an electrically conducting tape tightly about the insulation before applying the spacer tape.

The invention provides a spacer tape of the stamped projection type which serves also as the electrostatic shielding for the cable insulation; and in accordance with the invention the hollow indentations resulting in the spacer tape from the stamping of the projections thereon are themselves electrostatically shielded so that no objectionable potential gradient can develop within them. In accordance with the invention, spacing of the cable insulation from the sheath is effected by a metallic tape wrapped helically about the insulation, the tape being provided on

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its outer face with projections extending substantially beyond the surface of the insulation and holding the sheath spaced therefrom, the inner face of said tape (the face adjacent the insulation) being formed with indentations corresponding to the projections on the outer face of the tape. The projections and corresponding indentations are formed only along one side portion of the tape (say between one side edge and the longitudinal center line of the tape), the other side portion of the tape being substantially plane. This metallic tape, when wound on the cable, is intercalated with a tape of fibrous electrically conducting material, such as paper impregnated with carbon black, which overlies the plane side portion of the metallic tape and underlies the indented side portion thereof. The fibrous tape extends completely across that portion of the spacer tape which is indented, and so serves to shield the indentations substantially completely from electrical stress.

The invention is described in greater detail below with reference to the accompanying drawing, which shows in cutaway perspective a single-conductor power cable having the new spacer and shielding tape applied over the insulation.

The cable shown in the drawings comprises a metallic conductor 1 surrounded by a layer of insulation 2 and enclosed in a sheath 3. For purposes of description, it is assumed that the cable insulation comprises multiple wrappings of oil-impregnated paper, and that in service the insulation is subjected to a moderate gas pressure, for which purpose an annular gas passage 4 must be provided between the sheath and the insulation. (Such cable is known as gas-filled cable. The invention, however, is not limited to this specific type of cable. It is applicable to any type of cable where a passage between the sheath and insulation is desired.)

The gas passage 4 is provided by spacing the outer surface of the insulation 2 from the inner surface of the sheath 3; and in accordance with the invention, this is accomplished by wrapping helically about the insulation a copper or other metallic tape 5 on which a large number of projections 6 are formed by stamping. These projections extend substantially above the general surface level of the tape and serve to support the insulated conductor centrally within and spaced

from the sheath. Stamping of the projections 6 on the outer surface of the tape results in forming corresponding indentations 7 on its undersurface (the surface adjacent the insulation 2). It is important to avoid having any potential gradient develop within these indentations, because it is impossible to keep them all completely filled with oil, and void spaces within them constitute focal points at which ionization can occur, leading ultimately to breakdown of the cable insulation. In accordance with the invention, therefore, the projections 6 and corresponding indentations 7 are formed only along one side portion 8 of the tape, i. e. to one side of a longitudinal center line L. (Although the line L is termed a "center line" for convenience, it is apparent that it need not lie in the geometrical center of the tape, but may instead be displaced considerably toward one side edge or the other). The other side portion 9 is left substantially plane. Then, in applying the spacer tape 5 to the cable, it is intercalated with a tape 10 of fibrous electrically conducting material, such as a tape of kraft paper impregnated with carbon black. The fibrous tape 10 overlies the plane side portion 9 and underlies the indented side portion 8 of the metallic spacer tape 5. The fibrous tape should be applied so as to extend completely across the indentations, thereby shielding the space within them from any potential gradient. The electrical resistivity of the fibrous tape 10 may be quite high, as it is in contact with the metallic spacer tape at numerous points and need serve only to carry charging currents from some point underlying an indentation to a nearby point of contact between the two tapes.

The spacer tape 5 is applied before the paper insulation 2 is impregnated with oil. If desired, to facilitate penetration of the oil into the insulation, the plane side portion 9 of the spacer tape may be perforated at frequent intervals with small holes. Such holes should then be completely covered by the fibrous tape 10 where it overlies this side portion of the spacer tape, to insure continuity of the shielding about the cable. While such holes are sometimes deemed advantageous, they are not necessary because the oil can penetrate into the paper insulation quite readily along the helical line where the fibrous tape 10 separates adjoining edges of the spacer tape 5.

It is apparent from the foregoing that the intercalated tapes 5 and 10 provide complete and effective electrostatic shielding for the cable insulation. The indentations 7 formed in the metallic spacer tape are at ground potential throughout their volume owing to the shielding effect of the fibrous conducting tape 10, and the gas passage 4 between the insulated conductor and the sheath is at ground potential in consequence of the shielding effect of the metallic spacer tape 5 and its contact with the sheath. Consequently these spaces of dielectric weakness are free from any electrical stress that might initiate breakdown of the insulation. At the same time, the metallic tape 5 effectively spaces the insulated conductor from the sheath in a way that maintains the gas passage 4 open uniformly about the periphery of the insulation.

Since the intercalated tapes 5 and 10 together serve the dual function of shielding the cable insulation and spacing it from the sheath, and since they are wrapped in place together, they economize both on materials and on the number of taping operations required in manufacturing the cable.

The invention, further, achieves the advantage of having intercalated metallic and fibrous shielding tapes. Such intercalation prevents damage to the cable insulation or to the shielding tapes due to any cutting action of the thin edges of the metallic tape 5 when the cable is bent rather sharply. Copper is the preferred metal for the spacer tape 5 because of its high electrical conductivity, easy workability, and good mechanical strength. However, other metals may be employed in its stead. Also, other fibrous conducting tapes than paper impregnated with carbon black may be used for intercalation with the spacer tape 5; but the use of carbon black impregnated paper is preferred because it serves the dual purpose of shielding the indentations 7 of the spacer tape and preventing deterioration under electrical stress of the dielectric properties of the oil with which the insulation 2 is impregnated.

I claim:

1. In a power cable having an insulated conductor surrounded by a sheath, means for spacing the outer surface of the insulation from the inner surface of the sheath to form a fluid passage therebetween comprising a metallic tape wrapped helically about the insulation, said tape being provided on its outer face with projections extending substantially beyond the surface of the insulation and holding the sheath spaced therefrom, the inner face of said tape which is adjacent the insulation being formed with indentations corresponding to the projections on the outer face thereof, said projections and corresponding indentations being formed only along one side portion of the tape, the other side portion thereof being substantially plane, said metallic tape being intercalated with a tape of fibrous electrically conducting material which overlies the plane side portion of the metallic tape and underlies the indented side portion thereof, the fibrous electrically conducting tape serving to shield substantially completely the indentations of the metallic tape where the latter overlies the former.

2. A power cable having an insulated conductor, a sheath spacer tape wrapped helically about the insulation, and a sheath surrounding the insulation and held spaced therefrom by the spacer tape, said spacer tape comprising a copper tape formed with projections extending above the general surface level of one face thereof and having indentations corresponding to said projections in the other face thereof, the projections and corresponding indentations being formed only along one side portion of the tape, the other side portion thereof being substantially plane, the spacer tape being applied to the cable insulation with the projections facing toward the sheath, and a tape of paper impregnated with carbon black intercalated with said spacer tape, said impregnated paper tape overlying the plane side portion of the copper tape and underlying and substantially completely shielding the indentations formed in the other side portion of the copper tape.

3. In a power cable having an insulated conductor surrounded by a sheath, means for spacing the outer surface of the insulation from the inner surface of the sheath to form a fluid passage therebetween comprising a metallic spacer tape wrapped helically about the insulation, said

tape being formed with projections extending above the general surface level of one face thereof and having indentations corresponding to said projections in the other face thereof, said projections and corresponding indentations being formed only along one side portion of the tape, the other side portion thereof being substantially plane, the metallic spacer tape being applied to the insulation with the projections facing toward the sheath, and metallic tape being intercalated with a fluid-pervious electrically conducting tape which overlies the plane side portion of the metallic tape and underlies the indented side portions thereof.

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