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F. W. WAKEFIELD

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SHIELDED RESIN INSULATED ELECTRIC CABLE

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FIG. 1.

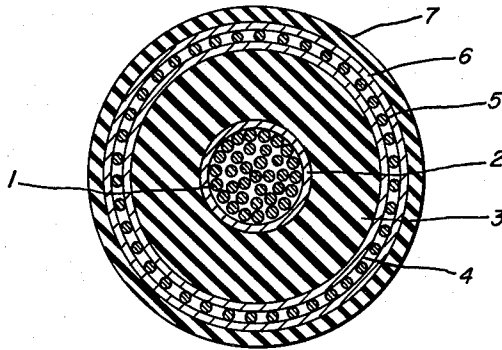
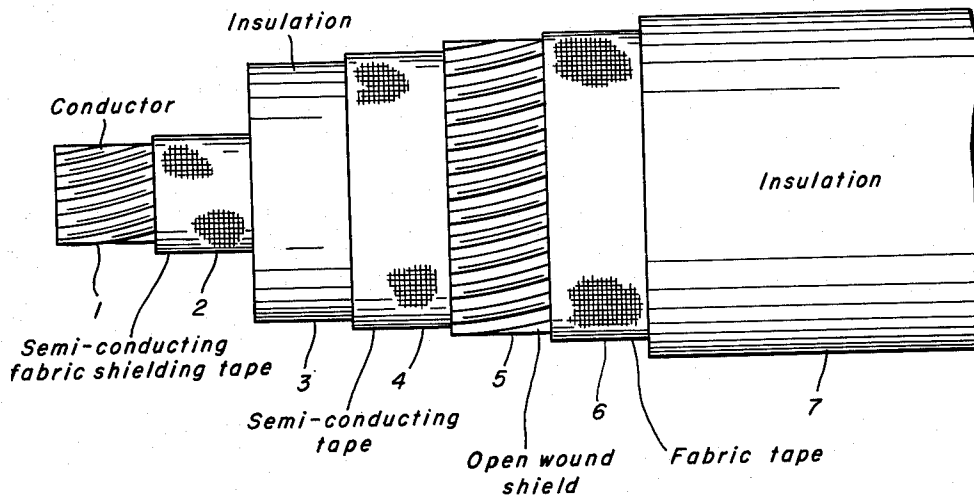


FIG. 2.



INVENTOR.
FREDERICK W. WAKEFIELD
By *Donald A. Dalton*
Attorney

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SHIELDED RESIN INSULATED ELECTRIC CABLE
Frederick W. Wakefield, Northboro, Mass., assignor to
United States Steel Corporation, a corporation of
Delaware

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8 Claims. (Cl. 174—36)

This application, which is a continuation-in-part of my co-pending application Serial No. 192,646, filed May 7, 1962, now abandoned, relates to an electric cable and more particularly to a high voltage shielded resin insulated electric cable. The usual high voltage single conductor shielded power cable consists of a metallic stranded conductor, semi-conducting tape strand shielding, insulation, semi-conducting tape over the insulation, metal tape and a jacket over the metal tape. For most insulating materials this cable construction is satisfactory, but when the insulation has a relatively high coefficient of expansion the construction is not suitable. For example, silicone rubber insulation, polyethylene and irradiated polyethylene have a linear thermal coefficient of expansion almost double that of rubber and other similar insulations. When using these insulations, which have an average linear thermal coefficient of expansion per degree centigrade greater than 1.7×10^{-4} , the insulation expands during heat cycles and causes permanent expansion of the metal shielding tape. Then when the cable cools to ambient temperature and the insulation contracts, voids and looseness occur between the metal tape and the semi-conducting tape or between the semi-conducting tape and the cable insulation. Separation between the metal tape and the semi-conducting tape may result in local heating by the charging current flowing from the semi-conducting tape to the metal tape. Voids between the semi-conducting tape and the cable insulation cause ionization which results in damage or deterioration of the insulation. Connell Patent No. 2,754,352 solves this problem by using a resilient semi-conducting tape over the cable insulation which due to elastic properties prevents void formation. However, this construction increases the cable diameter and the semi-conducting tape may not perform its intended function after sufficient heat aging in service.

It is therefore an object of my invention to provide a high voltage shielded resin insulated electric cable having insulation with a relatively high coefficient of expansion in which cable voids are eliminated without any substantial increase in the diameter of the cable.

This and other objects will be more apparent after referring to the following specification and attached drawing, in which:

FIGURE 1 is a transverse sectional view of the cable of my invention; and

FIGURE 2 is a longitudinal view of the cable of FIGURE 1 with parts broken away.

Referring more particularly to the drawing, reference numeral 1 indicates a stranded metallic conductor which is surrounded by a semi-conducting fabric shielding tape 2. Insulation 3 surrounds the tape 2 and is preferably polyethylene or irradiated polyethylene, but may be any suitable resin having an average linear thermal coefficient of expansion per degree centigrade greater than 1.7×10^{-4} . A semi-conducting tape 4 surrounds the insulation 3 and is preferably made of paper or fabric. A concentric open wound shield 5 surrounds the tape 4. The shield 5 must be a good electrical conductor and is preferably made of copper or aluminum. It will be seen that the shield 5 is made of a plurality of substantially round wires with a substantial distance between adjacent wires. The axes of the wires are all substantially the same

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distance from the center of the cable, this being what is meant by "concentric." While the cable of the drawing shows that the distance between wires is equal to the diameter of the wires, this distance may vary in accordance with the diameter of the cables. The lay of the wires in the shield should be as large as possible and the ratio between the length of lay of the wires and the diameter inside the wires of the open wound shield must be between 5 and 12. The ratio between the total cross sectional area of the wires in this shield in circular mils and the cable diameter under the wires in inches is between 5000 and 25000. The diameter of the wires in the shield may be as small as No. 22 AWG. A fabric tape 6 surrounds the open wound shield 5 and an insulating jacket 7 surrounds the tape 6. The jacket is made of a material either the same as the insulation 3 or of a material having substantially the same coefficient of expansion as the insulation 3.

Because of the concentric open wound shield and because the layers 3 and 7 have the same coefficient of expansion void formation in the cable is prevented. Since the metal shield is a concentric conductor little or no resistance is offered to the expansion of the cable insulation and since the jacket has the same coefficient of expansion as the cable insulation, expansion and contraction of the cable insulation due to heat can occur without void formation or looseness in the cable structure.

For the purpose of comparison, a cable was made as described above using polyethylene insulation, except that a flat tape with overlap was used in place of shielding layer 5 with the ratio between the lay thereof and the diameter inside the shielding layer 5 being less than 5. When this cable was heated to a temperature of 105° C., the metal shield burst due to internal pressure caused by expansion of the insulation 3. Even at lower temperatures, such as 95° C., permanent expansion of the tapes occurred, this causing looseness in the cable structure. With cables using silicone rubber insulation or similar material which can be operated at higher temperatures, the resulting damage would be greater and/or occur faster. A cable made according to the present invention with polyethylene insulation and open wound copper round wire shield was tested under the above stated conditions without any looseness developing in the cable structure and without bursting of the metal shield. No cables have been made with the ratio between lay of the shielding wires and diameter inside the shielding wires being greater than 12 because applicant knows from his many years of experience that manufacturing problems occur above this ratio. Probably the most difficult problem is to keep the shield wires close to the underlying structure of the cable. It is also very difficult to keep the spacing between the wires uniform.

The use of an open wound shield in place of closed or overlapping tape shields is important in that it enables larger diameter wires to be used in the shield while complying with trade specifications. This enables the cable to be made more cheaply and more easily because trade specifications require a minimum circular mil area for the cable metallic shield of 5,000 per inch of cable core diameter under the shield and it is easier and cheaper to apply a metallic shield consisting of large wires rather than small diameter wires or thin tape. The material cost is of course less and a smaller, faster and less expensive machine can be used to apply the shield wires to the cables because fewer wires are required.

Test results of applicant's cable disclose excellent electrical characteristics with no looseness developing in the cable structure under operation for long periods at high temperatures. For example, the corona extinction volt-

age of a life test was 16 k.v. which is well above the 9.5 k.v. required by I.P.C.E.A. specifications. Also, a sample cable made according to the present invention was heated in an oven at 105° C. for 7 hours without any looseness developing.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. An electric cable comprising a stranded metallic conductor, a semi-conducting shielding tape surrounding said conductor, insulation having an average linear thermal expansion coefficient per degree centigrade greater than 1.7×10^{-4} surrounding said shielding tape, a semi-conducting tape surrounding said insulation, a concentric open wound conducting metal shield surrounding said semi-conducting tape, the ratio between the length of lay of the open wound shield and the diameter inside the open wound shield being between 5 and 12, a fabric tape surrounding said open wound shield, and an insulating jacket having substantially the same coefficient of expansion as said first named insulation surrounding said last named tape.

2. An electric cable according to claim 1 in which the concentric open wound metal shield is a plurality of round wires with a substantial distance therebetween.

3. An electric cable according to claim 1 in which the ratio between the total cross-sectional area in circular mils of the wires in said open wound shield and the diameter inside the open wound shield in inches is between 5000 and 25000.

4. An electric cable according to claim 3 in which the concentric open wound metal shield is a plurality of round wires with a substantial distance therebetween.

5. An electric cable comprising a stranded metallic conductor, a semi-conducting fabric shielding tape surrounding said conductor, insulation of the class consisting of polyethylene and irradiated polyethylene surrounding said shielding tape, a semi-conducting tape surrounding said insulation, a concentric open wound shield

of a conducting material of the class consisting of copper and aluminum surrounding said semi-conducting tape, the ratio between the length of lay of the open wound shield and the diameter inside the open wound shield being between 5 and 12, a fabric tape surrounding said open wound shield, and an insulating jacket of the class consisting of polyethylene and irradiated polyethylene surrounding said last named tape, said first named insulation and said insulating jacket having substantially the same coefficient of expansion.

6. An electric cable according to claim 5 in which the concentric open wound metal shield is a plurality of round wires with a substantial distance therebetween.

7. An electric cable according to claim 5 in which the ratio between the total cross-sectional area in circular mils of the wires in said open wound shield and the diameter inside the open wound shield in inches is between 5000 and 25,000.

8. An electric cable according to claim 7 in which the concentric open wound metal shield is a plurality of round wires with a substantial distance therebetween.

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ROBERT K. SCHAEFER, *Primary Examiner.*

JOHN F. BURNS, *Examiner.*

D. A. KETTLESTRINGS, H. HUBERFELD,
Assistant Examiners.