Dec. 16, 1952 J. J. MORRISON 2,621,703

METHOD OF MAKING AN ELECTRICAL CABLE

Filed June 14, 1951

FIG. 1

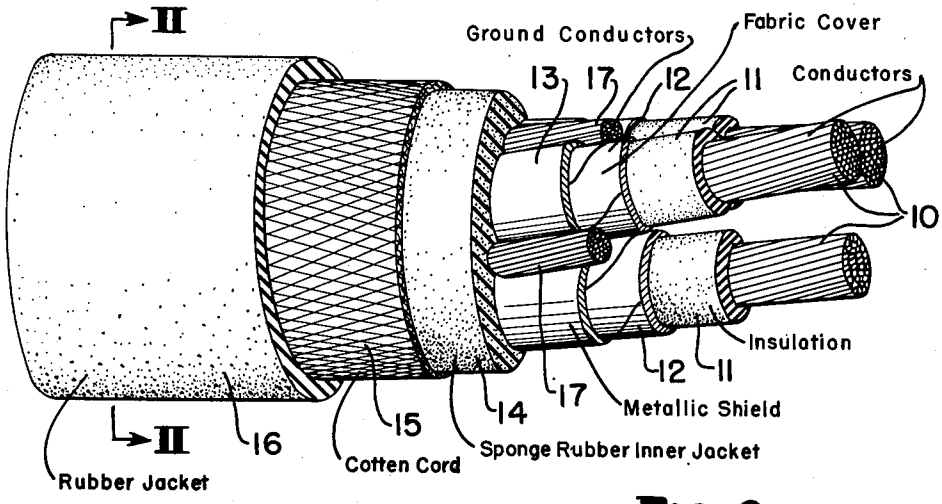


FIG. 2

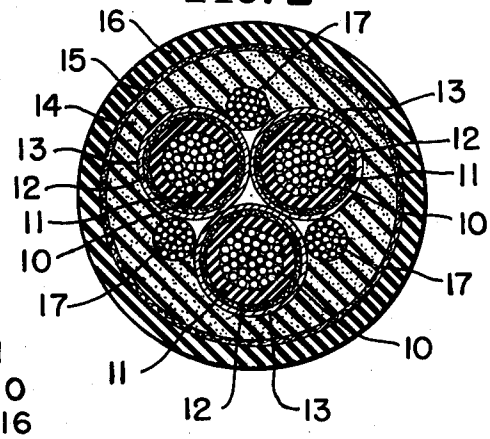
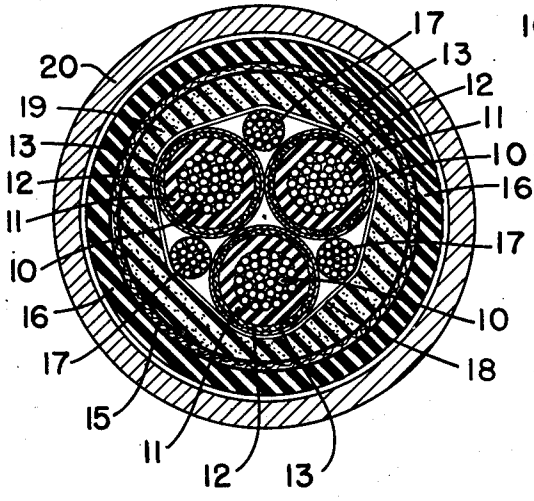


FIG. 3



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METHOD OF MAKING AN ELECTRICAL CABLE

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2 Claims. (Cl. 154—2.24)

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This invention relates to an improved method of making electrical cables and is a continuation-in-part of my copending application, Serial No. 72,574, filed January 25, 1949, which in turn was a division of my application, Serial No. 650,348, filed February 26, 1946, now abandoned. The invention has particular reference to a method of making portable cables that are subjected to rough handling and are exposed to mechanical shock in service.

Such cables, particularly of the rubber or rubber-like jacketed type, are subjected to extremely rough handling in normal service in mining operations, excavation work in general contracting, rock quarrying, dredging and the like. Shock from falling rock and construction materials, being run over by trucks and movable equipment, and other rough usage is common, and, unless sufficient protection is given by the jacket and fillers of the cable, the insulation on the individual electrical conductors may be damaged, with resulting failure of the cable.

It is common practice to use fillers of fibrous material, such as jute or cotton, to round up the cable core when the conductors are cabled into the required multiple conductor form; preformed rubber or rubber-like fillers may also be used for a like purpose. It is also common practice to fill the interstices between conductors with rubber or rubber-like compound by the extrusion process, the filler being bonded, if desired, with the later applied jacket by a final vulcanizing process. Such fillers, in addition to making the cable round, must also serve as a cushion base for the jacket for final absorption of the shock from blows received in service. Fillers of the fibrous type, as well as those of rubber or rubber-like material, however, often lack sufficient elasticity for such desired cushioning action. The fibrous fillers tend to pack and become hard, as well as being subject to freezing in cold weather from entrained moisture, while rubber or rubber-like fillers are stiff and also increase the weight of the completed cable.

An object of this invention is to provide a method of making a cable which will provide a uniform and increased cushioning action by the fillers while retaining the advantages of rubber or rubber-like material in the elimination of water absorption in such fillers.

This and other objects will be more apparent after referring to the following description and attached drawings in which:

Figure 1 is an elevation of a cable made in accordance with a preferred embodiment of this

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invention, portions of the cable being broken away to reveal the interior structure of the cable;

Figure 2 is a cross sectional view of the cable taken along line II—II of Figure 1; and

Figure 3 is a cross sectional view, similar to Figure 2, showing the cable in an intermediate stage of its construction.

Referring more particularly to the drawings, the reference numeral 10 indicates conductors which preferably are composed of stranded copper wires. The conductors 10 are provided with a layer of insulation 11 and are positioned adjacent to each other. The insulation 11 may be of rubber, rubber-like material, synthetic resin, varnished cambric, paper, fabric, or other suitable material as desired. Over the insulation 11 is provided a fibrous or fabric cover 12 so that the conductors 10 are furnished with additional protection. The color of the covers 12 may be varied so as to identify the various conductors. A further protection for the conductors may consist of a metallic shielding 13, in the form of a braid, tape, or wire wound thereabout, to reduce static stresses and provide a safe and continuous ground connection.

The individually insulated conductors, so constructed, are laid up together, as in the three conductor form of cable shown in the drawings. If required for additional ground capacity, grounded conductors 17 may be placed in the interstices formed by the cabled individually insulated conductors. Over the assembled conductors is placed a combined inner jacket and filler 14 and a dense, tough, outer jacket 16, such outer jacket being composed of rubber or rubber-like material. Between the outer jacket 16 and the inner jacket 14 may be placed a reinforcing wind or braid of cotton cord 15. The inner jacket 14 is composed of rubber or rubber-like material having therein a substantial quantity of a "blowing agent" which will form gas during vulcanization, thus producing a sponge-like condition in the filler and inner jacket.

The rubber or rubber-like material, generically termed an elastomer, of which inner jacket and filler 14 is made may be composed of a natural rubber alone, or of a tire stock, such as the so-called 60% tire stock, containing natural rubber and carbon black. It is also possible to use for such jacket and filler 14 any of the so-called synthetic rubbers which are vulcanizable, such as polymers of chloroprene, sold under the trade names Neoprene, Sovprene, and GR-M, copolymers of butadiene and styrene, sold under the trade names Buna S, Chemigum IV, Hycar OS,

and GR–S, polymers of butadiene, sold under the trade names Guna 85, Buna 115, SKA, and SKB, copolymers of butadiene and acrylonitrile, sold under the trade names Perbunan, Buna N, Perbunan Extra, Chemigum III, Hycar OR, and Thiokol RD, and copolymers of isobutylene and butadiene or isoprene, sold under the trade names Butyl or GR–I. It is to be understood that the above list is not exhaustive, and that various other vulcanizable elastomers, natural or synthetic, may be employed.

The "blowing agent" to be employed is thoroughly dispersed throughout the material of which jacket and filler 14 is to be formed before it is molded about the conductors. Such agent may be sodium bicarbonate, ammonium carbonate, or other similar materials or mixtures of materials well-known as sponging or blowing agents in the rubber working art.

An amount of blowing agent is used which is sufficient to cause the material forming inner jacket and filler 14 to expand in volume in amounts from 25 to 100% when such material is vulcanized in place in the cable. In one preferred embodiment such amount of expansion of volume after vulcanization is 40%. Such expansion of the inner jacket and filler is a direct measure of the volume of the voids in the sponge material as it occurs in the finished cable. Such volume of the voids thus may range from 25 to 100% of the volume of the elastomer per se in the sponge material. Such expansion is taken care of by a flow of the material 14 into the valleys between the insulated conductors 10 and between such conductors and grounded conductors 17, if such are employed, and by an expansion of the outer jacket 16, to some extent, due to the outwardly directed pressure exerted by the expanded, vulcanized, inner jacket and filler 14.

As a specific example of a composition suitable for use in the making of jacket and filler 14 there is given the following, which is illustrative only, all parts being given by weight:

	Parts
GR–S	100
Factice	200
ZnO	40
Litharge	3
Sulphur	2
Accelerator	2
Sodium bicarbonate	80
Stearic acid	40
Processing oil	12

The above composition is mixed in accordance with conventional rubber practice, as for example, in a Banbury mixer, and is then applied to the assembly of conductors and grounded cables. It will be understood that various ingredients in the above composition may be replaced by other known equivalents. For instance, in place of stearic acid any fatty acid may be employed. The processing oil may be a mineral oil such as paraffin oil or the well-known oil for such purpose marketed under the trade name "Circo Oil." Factice, which is an ingredient of the above composition, is a vulcanized vegetable oil customarily employed as a softener and filler for rubber and rubber-like materials.

The outer jacket 16 of the electrical cable may be made of natural rubber, natural rubber with a filler such as carbon black, or any one of the vulcanizable elastomers set out as useful in making the inner jacket and filler 14, the choice of such elastomer depending upon the particular properties desired in the finished outer jacket. The outer jacket may likewise be applied to the cable cover and intimate contact with the inner jacket and filler by an extrusion process.

Specifically my method is carried out as follows:

After the conductors 10 with the insulation and other individual coverings thereon have been assembled together either with or without the ground conductors 17, an extensible tape 18 such as crepe paper is wrapped around the outside of the assembled conductors as shown in Figure 3. The elastomer having a blowing agent therein is extruded around the extensible tape 18 to form a generally tubular member 19 completely surrounding the conductors and with a substantial thickness over the conductors. The outer jacket 16 is then extruded around the tubular member 19. If desired the braid 15 may be placed over member 19 before the extruding of the outer jacket. A lead sheath 20 is then extruded over the outer jacket 16. The inside diameter of the lead sheath 20 is made slightly greater (approximately 50 mils) than the outside diameter of the outer jacket 16. This is contrary to usual practice in which the inside diameter of the lead sheath is less than the uncompressed outside diameter of the outer jacket. The assembly is then vulcanized, the inward expansion of the member 19 being taken care of by a flow of the material under the sponging action into the spaces between the insulated conductors 10 and between such conductors and grounded conductors 17, if such are employed, and the outward expansion by expansion of the outer jacket 16 due to the outwardly directed pressure exerted by the expanded, vulcanized, inner jacket and filler 14 as stated hereinbefore. The clearance between the outer jacket 16 and lead sheath 20 permits the expansion of the outer jacket 16. The outer jacket 16 may be applied by strip insulating in tape form before the final application of the lead sheath. In place of using the lead sheath as a mold, the assembly may be vulcanized in a split metal mold having an inside diameter approximately 50 mils greater than the outside diameter of the outer jacket 16.

While I have shown and described a specific embodiment of this invention, it must be understood that I do not wish to be limited exactly thereto since various modifications may be made without departing from the scope of the invention as outlined by the appended claims.

I claim:

1. In the manufacture of cables for the transmission of electric current, the method which comprises assembling a plurality of insulated conductors so as to have valleys between them, extruding a generally tubular inner jacket and filler forming member of a vulcanizable elastomer completely around and into contact with the assembled conductors, such elastomer containing a sufficient quantity of a blowing agent to cause the elastomer to expand in volume from 25 to 100% when vulcanized in place around the cable, extruding an outer jacket forming body around the inner jacket and filler forming member, the outer jacket forming body being composed of a vulcanizable elastomer of such composition that when vulcanized it forms a dense, tough material, said outer jacket forming body having an inner diameter substantially greater than the outer diameter of said assembled conductors, extruding a lead sheath around the outer jacket, the inner diameter of said lead sheath being greater than the outer diameter of said outer jacket forming

body, and then subjecting the cable to heat to cause the first named elastomer to expand inwardly into said valleys and outwardly against said outer jacket to expand the latter and to vulcanize the inner jacket, filler and outer jacket.

2. In the manufacture of cables for the transmission of electric current, the method which comprises assembling a plurality of insulated conductors so as to have valleys between them, extruding a generally tubular inner jacket and filler forming member of a vulcanizable elastomer completely around and into contact with the assembled conductors, such elastomer containing a sufficient quantity of a blowing agent to cause the elastomer to expand in volume from 25 to 100% when vulcanized in place around the cable, forming an outer jacket forming body around the inner jacket and filler forming member, the outer jacket forming body being composed of a vulcanizable elastomer of such composition that when vulcanized it forms a dense, tough material, said outer jacket having an inner diameter substantially greater than the outer diameter of said assembled conductors, placing a mold around the outer jacket forming body, the inner diameter of said mold being greater than the outer diameter of said outer jacket forming body, and then subjecting the cable to heat to cause the first named elastomer to expand inwardly into said valleys and outwardly against said outer jacket to expand the latter and to vulcanize the inner jacket, filler and outer jacket.

JAMES J. MORRISON.

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