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 [73] Assignee **United States Steel Corporation**
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691,459, Dec. 18, 1967.

[56] **References Cited**
UNITED STATES PATENTS
 2,427,507 9/1947 Powell et al. 57/164
 2,927,954 3/1960 Ellsworth 174/108
 3,259,675 7/1966 Bowers 174/113 X

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[54] **SHIELDED ELECTRIC CABLE**
7 Claims, 2 Drawing Figs.
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 [51] Int. Cl. H01b 9/02
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 106.2, 108, 116, 113, 113.1, 120.2, 121, 121.3,
 121.4, 127, 128, 110.3, 110.4; 156/149, 153, 164

ABSTRACT: A shielded electric cable having a plurality of insulated electric conductors stranded together with a deformable semiconducting strand in each valley between the conductors and a shielding composition around and in intimate contact with the conductors and strands. Depending upon the type of service the shielding composition may be such as to remain plastic in the finished cable or may be such that it will be vulcanized. The conductors and strands are stranded together into a stranding die and the plastic shielding composition is forced around them while they are in the stranding die.

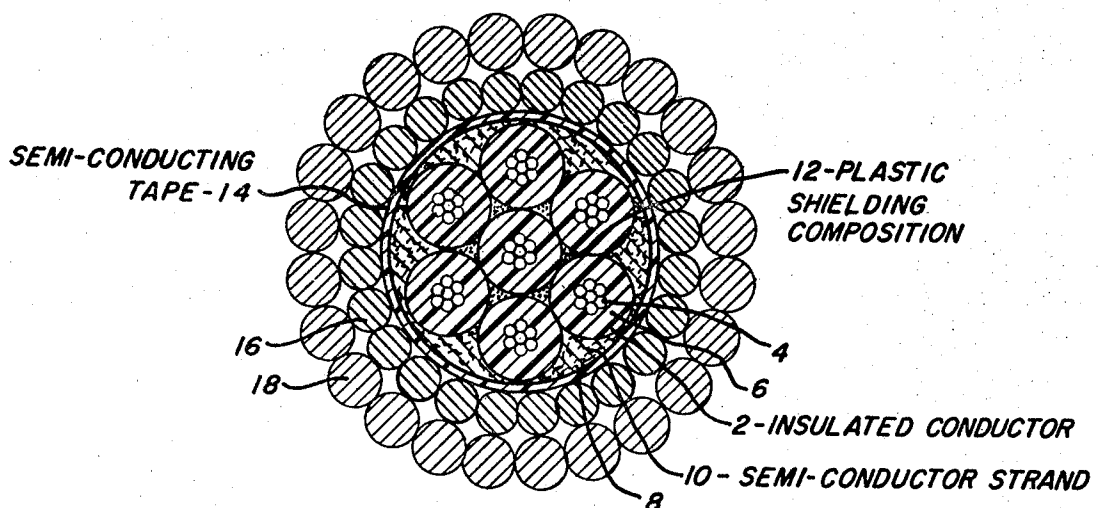


FIG. 1.

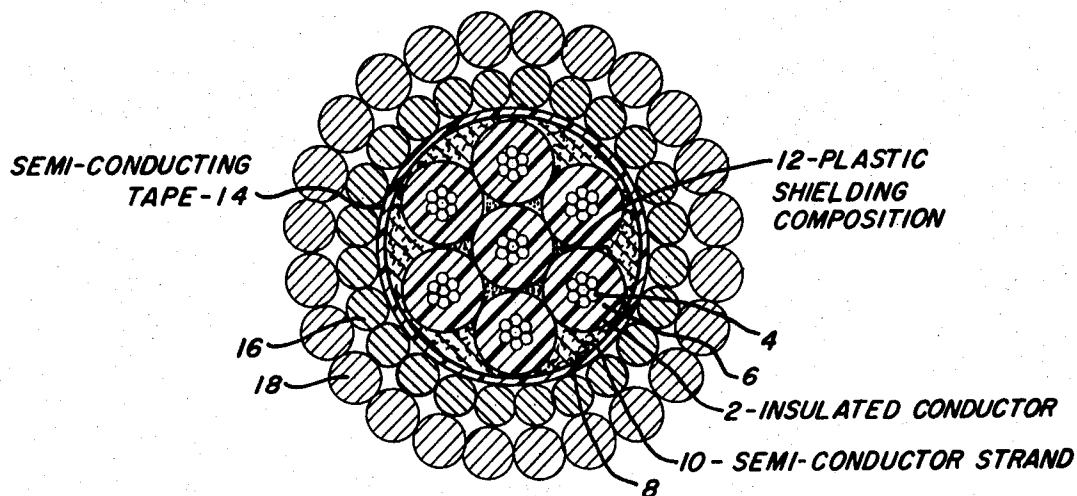
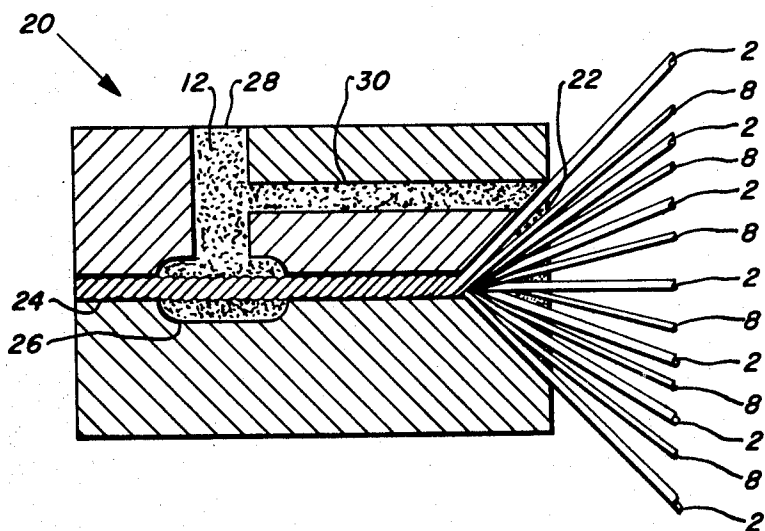


FIG. 2.



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SHIELDED ELECTRIC CABLE

This application, which is a continuation-in-part of my copending application, Ser. No. 691,459, filed Dec. 18, 1967, relates to a shielded electric cable and to a method of making the same.

The invention is particularly directed to oil well logging cables of the general type shown in Ellsworth Pat. No. 2,927,954 dated Mar. 8, 1960. These cables include a plurality of insulated electric conductors which are stranded together with valleys between the conductors. Shielding is applied around the stranded conductors and in the valleys. In many cables there is a tendency for the shielding to separate from the insulation during cable flexing in service, thus creating voids. These voids and voids resulting from improper application cause electrostatic interference which is detrimental to the efficiency of the cable.

It is therefore an object of my invention to provide a shielded electric cable having improved shielding around the conductors.

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

FIG. 1 is a transverse sectional view of oil well logging cable incorporating my invention; and

FIG. 2 is a schematic view of apparatus used in the practice of the method of my invention.

Referring more particularly to the drawings, reference numeral 2 indicates insulated electric conductors having a stranded copper conductor 4 surrounded by insulation 6. While any standard type of insulation may be used it is preferred to use either polypropylene or natural rubber for many types of service. For higher temperatures it is preferred to use chemically cross-linked polyethylene containing thermal carbon black which may be about 40 percent by volume of the entire mixture. While six conductors are shown stranded around a center core, it will be understood that the invention is equally applicable to any multiple number of conductors. It will be seen that a helical valley 8 is provided between each pair of outer conductors. Each valley is filled with a deformable semiconductor strand 10. This strand is preferably a cotton strand impregnated with a water emulsion of resin and carbon particles or with the resin and carbon particles suspended in a hydrocarbon solvent. The proportions of resin and carbon particles are not critical and may be varied depending upon the amount of conductivity desired. Two suitable mixtures include 20 percent by weight of acrylic resin, 30 percent by weight of carbon particles, and 50 percent by weight of either water or mineral spirits.

A shielding composition 12 fills voids around the conductors 2 and semiconducting strands 10 and is in intimate contact therewith. When it is desired that the shielding composition remain plastic in the finished cable the shielding composition consists of 30 percent to 70 percent by weight of depolymerized rubber or polybutene with the remainder being carbon particles and plasticizer. Rubber is preferred since it is compatible with any insulation 6 while polybutene is not compatible with polyolefins. The rubber may be either natural or synthetic. The percentages of carbon particles and plasticizer may vary within wide limits depending upon the amount of conductivity and viscosity desired. The viscosity may vary between 300,000 and 3,000,000 centipoises as measured on the Brookfield viscometer. One suitable composition consists of 50 percent depolymerized natural rubber, 40 percent conducting carbon black, and 10 percent coal tar plasticizer. This shielding compound remains plastic in the finished cable so that it will not crack and separate from the conductors, even under severe bending in use. For some methods of well-logging, length stability of the cable is very critical and for such uses it may be desirable to use a vulcanizable shielding composition. This may consist of 25 to 40 percent by weight of polysulfide rubber, 20 to 45 percent by weight of carbon black particles, 15 to 35 percent by weight of a plasticizer, and 1 to 3 percent by weight of a curing agent. One specific composition

which has been successfully used consists of 28 percent polysulfide rubber, 35 percent carbon black, 35 percent chlorinated hydrocarbon, and 2 percent lead peroxide. This composition will cure at 70° F. in 24 to 36 hours into a solid which forms with the conductors and fillers into a compact core. Because of the application of the shielding composition under pressure into and around the conductors and semiconducting strands as they are being stranded, there will be intimate contact of the composition around the conductors and strands. Surrounding this assembly is a semiconducting tape or tapes 14 of the type normally used for this purpose. One particular type which may be used is shown in the Ellsworth patent.

A first layer of steel armor wires 16 is helical around the semiconducting tape 14 with a second layer of armor wires 18 being wound about the first layer with its lay opposite to that of the first layer. If desired, a corrosion inhibitor, not shown, may be provided between the two armor layers and over the outer layer.

As shown in FIG. 2 seven insulated conductors 2 and six deformable strands 10 are stranded together into a stranding die 20. This die has a funnel shaped entry 22, and a cylinder opening 24 therethrough, and a chamber 26 is provided intermediate the ends of the opening 24.

The plastic shielding composition is introduced through a transverse opening 28 into the chamber 26 and through a branch opening 30 into the funnel shaped opening 22.

In operation, the insulated conductors 2 and the deformable strands 10 are brought together into the die entry 22 and the shielding composition is forced around and into the openings within these components both at the entry end and in the chamber 26. An air pressure of up to 7,000 lbs. per square inch is used to compress the semiconducting material into intimate contact around the conductors and the deformable strands. The deformable strands, which were originally circular in cross section, are deformed in the die so as to fill the majority of the valleys 8. The assembly leaving the die will be round with part of the semiconducting compound surrounding the outside thereof. In addition to making a better cable, the cost of making the cable is reduced because of the elimination of the separate step of applying the semiconductors around the conductors which were stranded previously around the core. The remaining operations are conventional and form no part of the present invention.

While several embodiments of my invention have 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. A shielded electric cable comprising a plurality of insulated electric conductors stranded together around a center core with helical valleys between the conductors; a single deformable compressed semiconducting strand substantially filling each valley; and a shielding composition around said conductors and semiconducting strands in intimate contact therewith; said shielding composition being of the class consisting of a mixture of 30 to 70 percent by weight of depolymerized rubber and the remainder carbon particles and plasticizer, and a mixture of 25 to 40 percent by weight of polysulfide rubber, 20 to 40 percent carbon particles, 15 to 35 percent plasticizer, and the remainder a curing agent.

2. An electric cable according to claim 1 including a semiconducting tape around the assembly of conductors, semiconducting strands and shielding composition, a first layer of armor wires helically wound about said semiconducting tape, and a second layer of armor wires helically wound about said first layer with a lay opposite to that of the first layer.

3. An electric cable according to claim 1 in which said shielding composition remains plastic and consists of 30 to 70 percent by weight of depolymerized rubber and the remainder carbon particles and plasticizer.

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4. An electric cable according to claim 3 in which said semiconducting strand is cotton impregnated with resin and carbon particles.

5. An electric cable according to claim 4 including a semiconducting tape around the assembly of conductors, semiconducting strands and shielding composition, a first layer of armor wires helically wound about said semiconducting tape, and a second layer of armor wires helically wound about said first layer with a lay opposite to that of the first layer.

6. An electric cable according to claim 1 in which said

shielding composition consists of 25 to 40 percent by weight of polysulfide rubber, 20 to 40 percent carbon particles, 15 to 35 percent plasticizer, and the remainder a curing agent.

7. An electric cable according to claim 6 including a semiconducting tape around the assembly of conductors, semiconducting strands and shielding composition, a first layer of armor wires helically wound about said semiconducting tape, and a second layer of armor wires helically wound about said first layer with a lay opposite to that of the first layer.

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