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R. D. GREEN

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INSULATED ELECTRIC CONDUCTOR

Filed March 13, 1934

FIG-1

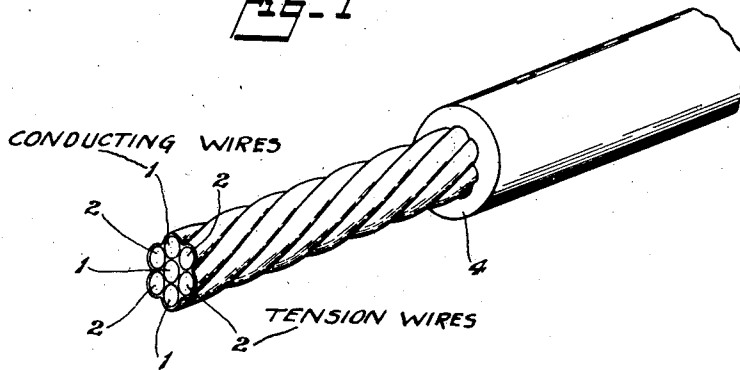


FIG-2

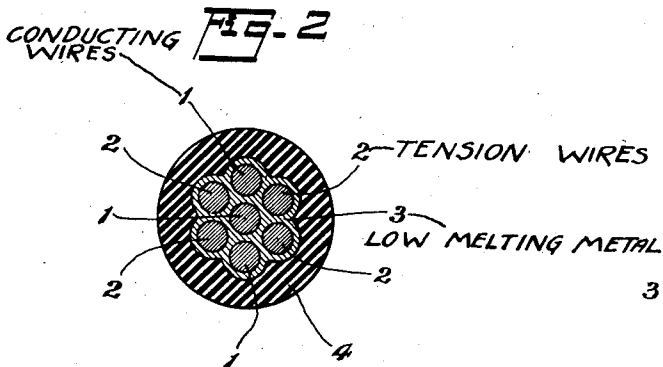
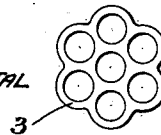


FIG-3



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INSULATED ELECTRIC CONDUCTOR

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2 Claims. (Cl. 173—264)

This invention relates to an insulated electric conductor.

It is common in the art to provide an insulated stranded conductor for field telegraph work, such as signal service work, where the conductor must be capable of withstanding considerable mechanical abuse when being handled, particularly when being laid on or taken up from the ground, and must be well insulated so that even if laid on damp or wet ground, it will perform satisfactorily as an electric conductive pair; also it must be flexible enough to be reeled up and unreeled repeatedly and so light in weight that long lengths may be carried readily from place to place, for example, by one man.

The insulated conductors of this kind are generally provided with at least two relatively small wires of good conductive non-ferrous metal, stranded with steel wires. However, it has been found that the insulated conductors hitherto known are not only difficult to manufacture but are not durable for the reason that, due to the frequent bending of the wires of the stranded conductors, as for example, in handling it in the field, the insulation is destroyed or seriously injured largely by the so-called "creeping" of some of the wires relative to the insulating coating, this "creeping" being a slight longitudinal shifting of a wire or wires in the strand, not necessarily throughout the entire length of the conductors, but only locally, involving sometimes a drawing or stretching of such creeping wire or wires and a consequent reduction in the cross-section of such wire or wires, which often results in a broken wire or wires and injures the insulation, so that the conductors are grounded or short circuited. As a result it has sometimes been considered advisable to employ wires of slightly larger gage than would be necessary otherwise for conduction of the telegraph currents, to allow for the slight drawing action due to creeping, and thereby give the conductor a longer useful life. The result of this use of a heavier gage size of wire, of course, increases the weight of the conductor and thereby reduces its convenient portability.

It is the object of the present invention to overcome the difficulties due to the said creeping action in conductors of this kind and to provide a more durable yet light, insulated stranded conductor, which will be sufficiently flexible to meet all requirements, but not so flexible as to kink easily.

With these general objects in view the inven-

tion consists in the hereinafter described and claimed conductor.

The invention will be described in detail in connection with the accompanying drawing, in which

Fig. 1 is a perspective view on a very large scale intended to illustrate a short length of conductor embodying the invention, with parts removed.

Fig. 2 is a cross-section on an enlarged scale, of the conductor illustrated in Fig. 1.

Fig. 3 is a diagrammatic view illustrating the principle of the invention, and shows how the integral series of metallic coatings for the wires, would appear at a particular cross-section, if the wires could be removed from the metal coatings.

In flexible insulated conductors used for field telegraph work it is important that the completed conductor be so well insulated that it may be laid along the ground, if necessary, and will not permit any appreciable leakage of current. Also, it must be so flexible that it may be reeled up readily and unreeled, and should be so durable that it will withstand many repetitions of such treatment without breaking. Furthermore, in order to meet the requirements of practice it must be relatively light for its conductivity so that considerable lengths may be transported readily.

In order to obtain this ready portability, the total cross-section of all the wires must be kept to a minimum for the requisite conductivity and strength. This results in the individual wires being quite small in diameter.

Since it is necessary to use vulcanized rubber for the insulating coating, the sulphur of the vulcanizing compound is likely to corrode the wires, particularly copper wires, and although in practice the depth of the outer layer of the wire corroded by the reaction of the vulcanizing material is extremely small, it is a material proportion of such a fine wire and the loss of conductivity and breaking of wires due to corrosion fatigue thereby resulting, is important. Hence, to protect the wires against this corrosion due to the reaction of the vulcanizing material it is necessary to give the wires a coating of some metal resistant to such corrosion. The recognized protective coating for this purpose is a tin coating, although other corrosion-resistant low-melting metals may be used, such metal being applied in a molten condition and then set by cooling. With a perfect tin or other metal coating the wire is fully protected.

However, it is extremely expensive and difficult to apply a perfectly uniform and adequate

coating to the wire at all points. This is particularly true with small wires. Hence, it has been the practice to run the wire very slowly through the molten metal bath in order to obtain the required thickness of coating. Owing to the fineness of the wires, the difficulties in handling the wires through the pickling and fluxing baths and particularly through the baths of molten metal are considerable, as is well known to those skilled in the art.

As the copper wires must be stranded with steel wires, in order to obtain the requisite strength in the final stranded composite conductor, it is important that the individual steel wires also be given a protective coating, particularly to protect them against rusting. With tinned copper, bronze or other non-ferrous or alloy wires, the steel wires also are tinned or coated with other protective metal, and it is necessary to run the wires very slowly through the molten metal bath for the same reason stated above with regard to the copper wires.

By the present invention all the difficulties of manufacture above referred to are avoided and a better conductor produced by stranding the bare wires, or at most merely applying one thin coating of tin, or other metal at very high speed, to each wire and then stranding them, and thereafter pickling and fluxing the stranded conductor and passing it through the bath of molten metal. Upon first consideration it might be thought that where the individual wires contact with each other in the completed strand they would not be coated, but I have discovered, where the wires are not too tightly stranded, that, due to the so-called wetting action of the tin, or other protective metal, on steel and copper, the great surface tension, and the resultant capillary action, the molten metal is drawn in, even between the contacting wires so as to coat all parts of the surface of the wires. Also the individual wires are locked together preventing any creeping of the individual wires in the strand and consequent injury to the insulating covering such as occurs in practice with the insulated conductors made by applying the usual coating of tin to each wire separately, then stranding the coated wires and applying the rubber coating and vulcanizing it.

Practice has shown that the molten tin is taken up with such avidity by the stranded conductor that even with only one pass through the molten bath, the stranded conductor takes up and holds several times the amount of tin, or other protective coating, carried by the old stranded conductor of the prior art where the individual wires have been passed through the bath of molten metal.

After the stranded conductor has been tinned, or coated with other metal, the vulcanizable rubber composition, or other insulating material, is applied in the usual manner and proportions and then vulcanized or treated by heat, or other medium.

A field telegraph conductor embodying one form of the invention is illustrated in Fig. 1, but on a greatly enlarged scale, this conductor consisting of three hard drawn copper wires, of high specific conductivity indicated at 1 and four steel wires 2 of metal having a high coefficient of elasticity and high tensile strength, these wires being all of approximately the same diameter and advantageously arranged as shown, that is, with the three copper wires in a line and the four steel wires in pairs, one pair at each side of the line or tier of copper wires. In practice, for field

telegraph work, each wire is about 0.0126 in diameter, that is, about #28 B. & S. gage. With the proper selection of materials, the copper wires will give about 90% of the electrical conductivity of the completed conductor and the four steel wires about 10%. The four steel wires will provide about 90% of the total tensile strength of the strand and the three copper wires about 10% of the said total tensile strength.

In the best embodiment of the invention the individual wires before being united into a strand may be given a single light coat of low-melting metal, such as tin, not for the purpose of protecting the wires, which is impossible with a light single coating, on account of its certain defectiveness, but as a means for slightly spacing the wires apart in the strand with a relatively easily fusible material which will become molten when the entire strand is passed into a molten bath of the same material, as more fully described hereinafter. However, I have discovered that this light spacing coating is not unconditionally necessary, particularly if the wires be not tensioned too much during the stranding operation, but are slightly loose in the strand.

After the light coating of the individual wires has been applied, and they are brought together in a strand, or after the clean bare wires are brought together somewhat loosely in a strand, the completed strand is then passed through suitable cleaning and fluxing baths, if necessary, and then is drawn through a bath of molten tin, or other protective metal, at such a rate that the strand will take up a heavy coat of the protective metal, the strand being in the molten metal long enough to melt the light spacing coating if that has been used, and long enough for the capillary action or surface tension of the molten metal to draw it down into the spaces between the individual wires as well as over all the surfaces of said wires, so that finally the molten metal when set forms a single integral body, about as shown on an exaggerated scale in Fig. 3, consisting of a plurality of coatings for the individual wires united to each other at the places of contact of such coatings, these places being the spaces between the wires. The conjoint integral coating system is indicated at 3 in the drawing.

It has been found that by this method of procedure about five or six times as much metal can be applied to the strand as will be the case if the individual wires are properly coated before stranding by the old and very expensive method.

Furthermore, as the strand formed of a plurality of wires is much stronger, of course, than any individual wire, there is no difficulty in pulling it through the bath of molten metal and because a strand is not so extremely flexible as a single wire, and particularly a copper wire, all the dangers of kinking and breaking which exist with the individual wires in individually applying a coat of metal on the wires separately, are avoided.

Of course, where the individual wires are given the light spacing coat of metal before stranding, some of the difficulty still exists, but as no reliance is placed on this light coating for the final protection of the wire and as the wire is not so heavily loaded with protective metal, it need not be strained to the same extent during coating, and in any event the difficulty encountered in applying the coating by the prior method is entirely avoided.

When the strand is passed once through the

bath of molten metal and has been cooled, it will be found that the wires are locked together, so that the individual copper wires are secured firmly to their adjacent steel wires and hence cannot creep at any part.

Upon this coated stranded plurality of wires there is applied a mass of rubber compound containing the materials for vulcanization, this coating being applied to the stranded wires in any of the known ways, as for example, by extruding the rubber compound around the strand in the usual machine or by passing strand through liquid rubber. The coating is shown at 4, Figs. 1 and 2.

Then the strand with its coating of insulating material is subjected to heat to vulcanize the insulating coating.

It will be noted that the tin, or other protective metal coating, on account of its increased amount somewhat reduces the flexibility of the conductor as compared with the flexibility of the conductor made by the prior methods, but that is an advantage, because it avoids the danger of small loops which result in kinks in the field, a danger which existed with the prior field telegraph conductors due to their unnecessarily great flexibility. At the same time, the conductor of the present invention has all the necessary flexibility for ease and convenience in reeling and unreeling, and in shifting its position on the ground when necessary. Furthermore, in view of the possibility of using wires of the smallest gage necessary to supply the requisite conductivity, the final weight per foot of the conductor of this invention is no greater than that of a conductor made by the old method using a slightly heavier gage for mechanical reasons in manufacture.

While in the present example, I have shown three copper wires and four steel wires in the conductor, the invention is not to be limited to this exact number of wires.

The legends on the drawing are added by way of illustration and not by way of limitation.

What is claimed is:

1. An insulated stranded conductor consisting of a plurality of wires some of which are copper of high conductivity and the remainder steel of high elastic limit and high tensile strength, each of said wires being coated with low-melting protective metal having the properties of metal set from a molten state, said protective coatings being integral with each other at their respective places of contact and firmly connected with each other by an integral mass of metal filling the interspaces between the inner portions of the respective surfaces of the wires, whereby creeping of the individual wires is prevented, the united stranded wires being embedded in vulcanized rubber which forms an insulating coating surrounding the stranded wires.

2. A field telegraph conductor consisting of a plurality of copper wires and a plurality of steel wires of high elastic limit and tensile strength, said wires being of small diameter and stranded together, each of said wires being completely tin coated, all of the tin coatings being integral with each other at their respective places of contact, whereby creeping of the individual wires is prevented, the united stranded wires being embedded in a sheath of vulcanized rubber which forms an insulating coating surrounding the stranded wires.

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