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METHOD OF MAKING GRADUATED CONNECTING LINKS
FOR DIVERSELY INSULATED ELECTRIC CABLES
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FIG. 1.

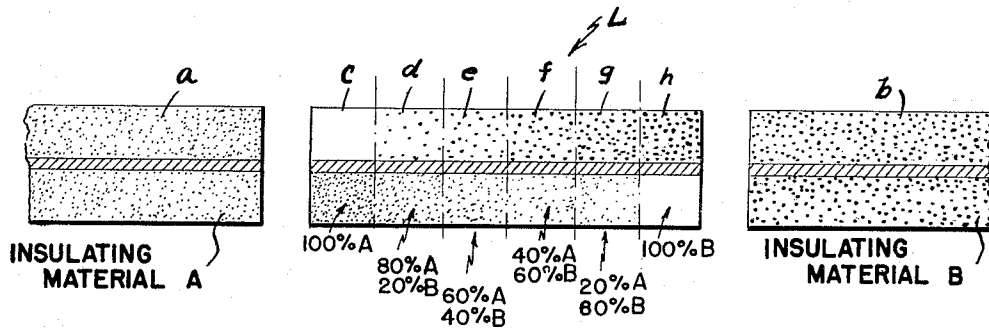


FIG. 2.

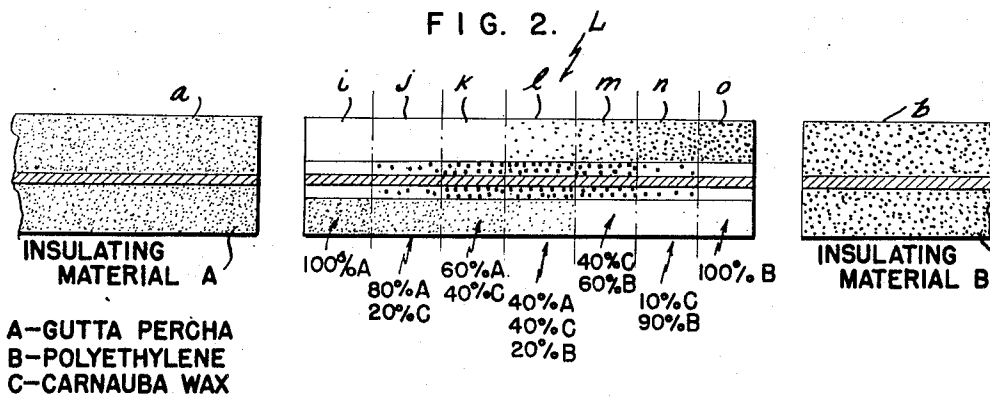
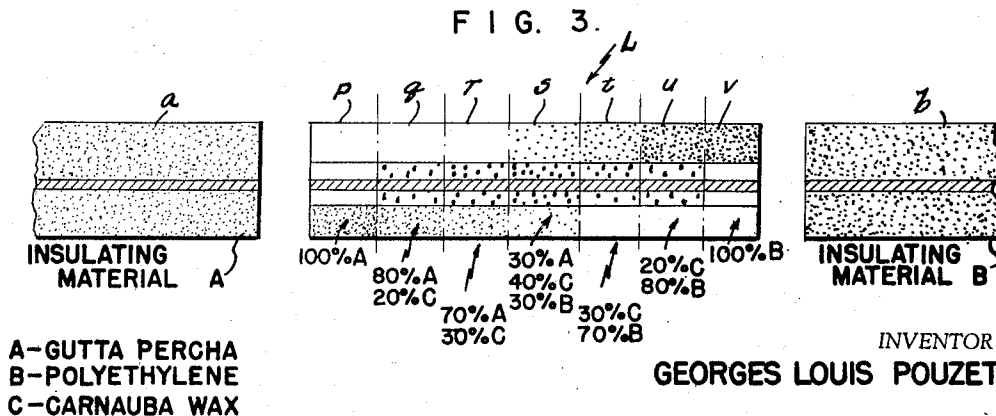


FIG. 3.



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METHOD OF MAKING GRADUATED CONNECTING LINKS FOR DIVERSELY INSULATED ELECTRIC CABLES

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6 Claims. (Cl. 18—59)

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The present invention relates to insulated electric cables and in particular to a novel manner of making a joint or connection between two different lengths of cable.

There are a number of different kinds of insulation materials which are applied to cables, many of which are thermoplastic, and the making of joints between different kinds of such insulation materials presents difficulties.

When the problem arises of making a joint between two different kinds of thermoplastic insulation materials which have been applied to the conductors of two different lengths of cable which are to be joined, it is usually found that the two different kinds of insulation materials are in general miscible with each other, but that their fusion points may be quite different.

This problem is particularly likely to arise in the case of submarine cables, the insulation of which in the past has generally been of gutta percha which is thermoplastic, but in recent years has been often constituted of synthetic resins, generally thermoplastic resins, such as polyethylene. Although gutta percha and polyethylene are miscible with one another in all proportions, it is very difficult to join or weld them together directly by usual known methods, because of the difference in their fusion points, which is 60° C. for gutta percha and 120° C. for polyethylene.

It is often necessary to be able to readily join a length of submarine cable covered with gutta percha, to another length of cable insulated with polyethylene. This is particularly likely to occur when a newly manufactured length of cable is being added, which is likely to be insulated with polyethylene.

A similar problem arises when it is desired for example to join cables insulated with gutta percha with cables insulated with polyisobutylene, or with cables insulated with polyisobutylene and polyethylene.

An object of the present invention is to provide for the making of such joints and to offer a simple solution for this problem.

The invention will be understood from the following specification and the accompanying drawings, wherein:

Figure 1 shows a connecting piece of cable constituted of coaxially aligned successive sections whose insulations are different but all of which consist of one or both of two different insulation materials, and the relative proportions of these two materials in successive sections vary from one end to the other.

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Figure 2 shows another kind of connecting piece of cable constituted of coaxially aligned successive sections whose insulations are different but all of which consist of one or more of three different kinds of insulation materials, and the relative proportions of these three materials in successive sections vary from one end to the other.

Figure 3 shows a still further kind of connecting piece of cable constituted of coaxially aligned successive sections whose insulations are different but all of which consist of one or more of three different kinds of insulating materials, the relative proportion of one of these materials being minimum near the two ends and a maximum near the longitudinal mid-point of said connecting piece of cable.

According to the present invention there is provided a method for making a joint between the insulations on two different lengths of cable which are covered with thermoplastic insulating materials of different natures and different fusion points, but which are miscible with each other at least when hot, this method being characterized by the insertion between the two lengths of cable of an intermediate connecting piece of cable the composition of whose insulation varies progressively longitudinally in successive component sections arranged along the length of the connecting piece from one of its ends to the other in such a manner that at each end the insulation of the connecting piece has substantially the same composition as the insulation of the length of cable with which this end is to be joined.

With such an intermediate piece of cable having longitudinally progressively varying composition of its insulation, the two ends of the insulation remain miscible at the operating temperatures of the cable with the insulations of the cable lengths to which they are to be joined.

To join two cable lengths covered with different kinds of insulations A and B, it will then be sufficient to insert such an intermediate connecting piece of cable between the two different lengths of cable, the ends covered with insulation of composition A being placed face to face, and the ends covered with insulation of composition B being placed face to face.

Hence, after the cable conductors have been joined together, the joining of the two adjacent insulations will simply require making a joint between the two pieces of insulation of the same nature and the same fusion point, which presents no difficulty.

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This special intermediate connecting piece of cable can be manufactured as follows. A series of different insulating compositions are prepared in individual containers, which compositions are respectively composed, a first one of insulating material A, another one of insulating material B, and others of one or more mixtures of insulating material A and insulating material B, these mixtures being in such proportions that the fusion points of these several insulating compositions so used while passing from 100% material A to 100% material B increase or decrease in a regular manner.

These several insulating compositions are then introduced successively into the insulating material hopper of a cable insulation machine, for example an extrusion machine, for instance of the type shown in the Ingmanson Patent No. 2,471,752. In such machines the conductor or wire is usually caused to travel longitudinally through a die during which operation a deformable and usually heated covering of plastic insulating material is extruded onto the traveling wire. The temperature at which the extrusion of such cable machine is operated is varied in a suitable manner so that this temperature variation corresponds to the law of the variation of the fusion points of the several insulating compositions which are successively fed into the machine.

The successive compositions fed into the cable machine may be:

- (a) 100% of insulating material A
- (b) 80% of insulating material A and 20% of insulating material B
- (c) 60% of insulating material A and 40% of insulating material B
- (d) 40% of insulating material A and 60% of insulating material B
- (e) 20% of insulating material A and 80% of insulating material B
- (f) 100% insulating material B

but the relative proportions of materials A and B may vary progressively in accordance with another kind of relation to conform to the particular law of the variation of the fusion points of the materials A and B and their various mixtures.

Figure 1 shows a connecting piece of cable of the kind just described.

The insulating material A may be gutta percha and the insulating material B may be polyethylene.

There is thus obtained a piece of cable whose insulation at one end is entirely of the composition of insulating material A, and at the other end is entirely of the different composition of insulating material B.

However, the case may occur for some given insulating materials A and B, that while insulating material A is miscible with insulating material B at some particular temperature, the material A and material B are no longer miscible at a lower temperature which is the actual operating temperature of the cable.

According to the present invention, to meet such a condition, provision is made at the time of manufacturing the intermediate length of cable to be introduced between the two lengths of cable to be connected, to introduce into the several intermediate insulating compositions which are fed successively to the cable insulating machine, besides composition A and composition B, one or several additional substances which prevent the separation or demixing of the compositions A and B, that is, their partial or

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complete separation upon cooling or solidification.

The case may also occur that it will become desirable in one or more of the intermediate compositions to entirely omit composition A itself or composition B itself, or both composition A and composition B. Then the intermediate compositions are constituted of only one substance, or of several substances which are miscible with both composition A and composition B, or with composition A or with composition B.

The duration of the interval during which each of these compositions is applied by the cable machine and the timing of the instant at which the application of each composition begins may be adjusted according to the law of the variation of the fusion temperature points of the several insulating compositions which are successively used, so that the fusion points of the several insulating compositions used increase or decrease in a regular manner.

Among the substances which may be thus introduced in the intermediate compositions, or which can constitute in whole or on part, these intermediate compositions, the following may be given:

Natural or synthetic waxes, petroleum pitches, paraffins, polyisobutylenes, polybutadienes, polystyrenes, butyl rubbers, and deproteinized rubbers.

Certain kinds of raw gutta percha and polyethylene are examples of substances which are not miscible in all proportions.

According to the present invention, the manufacture of the intermediate connecting cable pieces for insulating materials of these characteristics will be carried out according to a technique similar to that previously described, and operating according to one of the procedures hereinafter given, as examples, the proportions given being by weight.

Example No. 1

Introduce successively in the order stated into the cable insulation molding machine for making the intermediate connecting piece of cable:

- (a) raw gutta percha alone
- (b) a mixture of 80 parts of gutta percha and 20 parts of carnauba wax
- (c) a mixture of 60 parts of gutta percha and 40 parts of carnauba wax
- (d) a mixture of 40 parts of gutta percha 40 parts of carnauba wax, and 20 parts of polyethylene
- (e) a mixture of 40 parts of carnauba wax, and 60 parts of polyethylene
- (f) a mixture of 10 parts of carnauba wax and 90 parts of polyethylene
- (g) polyethylene alone.

A connecting piece of cable of this type is shown in Figure 2.

Example No. 2

Introduce successively in the order stated into the cable insulation molding machine for making the intermediate connecting piece of cable:

- (a) raw gutta percha alone
- (b) 50% of raw gutta percha plus 50% of polyisobutylene of molecular weight about 50,000
- (c) 100% of polyisobutylene of molecular weight about 100,000
- (d) 60% polyisobutylene, of molecular weight about 50,000, plus 40% polyethylene
- (e) polyethylene alone.

Example No. 3

Introduce successively in the order stated into the cable insulation molding machine for making the intermediate connecting piece of cable:

- (a) raw gutta percha alone
- (b) a mixture of 80 parts raw gutta percha and 20 parts carnauba wax
- (c) a mixture of 70 parts of gutta percha and 30 parts carnauba wax
- (d) a mixture of 30 parts gutta percha, 40 parts carnauba wax, 30 parts polyethylene
- (e) a mixture of 30 parts carnauba wax and 70 parts polyethylene
- (f) a mixture of 10 parts carnauba wax and 90 parts polyethylene
- (g) polyethylene alone.

A connecting piece of cable of this type is shown in Figure 3.

Cables and intermediate connecting cable pieces employing modifications of the arrangements and procedures which have been described are also within the scope of the present invention.

It will be apparent to those skilled in the art that my invention is susceptible of modifications to adapt the same to particular conditions, and all such modifications which are within the scope of the appended claims I consider to be comprehended within the scope of my invention.

Having thus described the invention, what I claim is:

1. The method of making by extrusion a connecting link to join two cable lengths having respectively two different kinds of miscible insulation, which consists in causing a wire to travel longitudinally, and extruding onto said traveling wire at the corresponding fusion temperature successively a first terminal plastic extrudable composition consisting entirely of the first of said two kinds of insulation, then extruding thereon at the corresponding fusion temperature a second plastic extrudable composition consisting of a relatively small proportion of the second of said two kinds of insulation and a relatively large proportion of the first of said kinds of insulation, then extruding thereon successively at the corresponding fusion temperatures a series of different plastic compositions consisting of both the first and the second of said two kinds of insulation wherein the proportion of the first of said kinds of insulation progressively decreases in said series and the proportion of the second of said kinds of insulation progressively increases in said series in the direction away from said first terminal, and finally extruding on to said wire at the corresponding fusion temperature a final terminal composition consisting entirely of the second of said two kinds of insulation, and continuously operating the extrusion and the variation of temperature of said extrusion according to the law of variation of the fusion points of said plastic compositions.

2. The method of making by extrusion a connecting link to join two cable lengths having respectively two different kinds of insulation which are miscible when hot and which remain miscible when cold in the presence of a selected separation preventing agent, which consists in causing a wire to travel longitudinally, and extruding on to said traveling wire at the corresponding fusion temperature a first terminal plastic extrudable composition consisting entirely of the first of said two kinds of insulation, then extruding thereon at the corresponding fusion temperatures suc-

sively a series of different plastic compositions, containing at least one of said two kinds of insulation and also containing said separation preventing agent, then extruding thereon at the corresponding fusion temperature a final terminal plastic extrudable composition consisting entirely of the second of said two kinds of insulation, the separating agent content of successive compositions in said series having a low value in the final composition of said series immediately following the composition consisting entirely of said first of said two kinds of insulation, and having a low value in the last composition of said series immediately preceding the composition consisting entirely of said second of said two kinds of insulation, and having higher values in the intermediate compositions of said series between said initial and last compositions of said series, and the proportion of the first of said kinds of insulation progressively decreasing in said series and the proportion of the second of said kinds of insulation progressively increasing in said series in the direction from the said first terminal composition to said second terminal composition, and continuously operating the extrusion and the variation of temperature of said extrusion according to the law of variation of the fusion points of said plastic compositions.

3. The method of preparing by extrusion a link for connecting two lengths of cable with different insulating materials, which consists in displacing longitudinally a conducting wire, extruding on to said wire at the corresponding fusion temperature a first plastic composition constituted entirely by the first of said two insulating materials, then extruding successively at the corresponding fusion temperatures a series of plastic compositions containing said first insulating material in progressively decreasing proportions up to proportions which can become zero and the second insulating material in progressively increasing proportions starting with proportions which can be zero in members of said series immediately succeeding said first composition, and finally extruding at the corresponding fusion temperature a final plastic composition constituted entirely by the second of said insulating materials, and continuously operating the extrusion and the variation of temperature of said extrusion according to the law of variation of the fusion points of said plastic compositions.

4. The method of making by extrusion a connecting link to join two cable lengths having, respectively, two different kinds of insulation, which are, respectively, gutta percha and polyethylene, which consists in causing a wire to travel longitudinally, and extruding onto said traveling wire successively a first plastic extrudable composition consisting entirely of gutta percha, then extruding thereon a second plastic extrudable composition consisting of a relatively small proportion of polyethylene and a relatively large proportion of gutta percha, and then extruding thereon successively a series of different plastic compositions consisting of both gutta percha and polyethylene, wherein the proportion of gutta percha progressively decreases in said series and the proportion of polyethylene progressively increases in said series in the direction away from said first terminal composition, and finally extruding onto said wire a final terminal composition consisting entirely of polyethylene.

5. The method of making by extrusion a connecting link to join two cable lengths having, respectively, two different kinds of insulation,

which are, respectively, gutta percha and polyethylene, which consists in causing a wire to travel longitudinally and extruding onto said traveling wire a first initial terminal plastic extrudable composition consisting entirely of gutta percha, then extruding thereon a series of different plastic compositions, containing at least one of said two kinds of insulation and also containing a separation preventing agent which contains a substantial amount of polyisobutylene, then extruding thereon a final last terminal plastic extrudable composition consisting entirely of polyethylene, the separation preventing agent content of successive compositions in said series having a low value in the final composition of said series immediately following the composition consisting entirely of gutta percha and having a low value in the last composition of said series immediately preceding the composition consisting entirely of polyethylene, and having higher values in the intermediate compositions of said series between said initial and last compositions of said series, and the proportion of gutta percha progressively decreasing in said series and the proportion of polyethylene progressively increasing in said series in the direction from said first terminal composition to said second terminal composition.

6. The method of making by extrusion a connecting link to join two cable lengths having, respectively, two different kinds of insulation, which are, respectively, gutta percha and polyethylene, which consists in causing a wire to travel longitudinally and extruding onto said traveling wire a first initial terminal plastic extrudable composition consisting entirely of gutta percha, then extruding thereon a series of different plas-

tic compositions, containing at least one of said two kinds of insulation and also containing a separation preventing agent which contains a substantial amount of carnauba wax, then extruding thereon a final last terminal plastic extrudable composition consisting entirely of polyethylene, the separation preventing agent content of successive compositions in said series having a low value in the final composition of said series immediately following the composition consisting entirely of gutta percha and having a low value in the last composition of said series immediately preceding the composition consisting entirely of polyethylene, and having higher values in the intermediate compositions of said series between said initial and last compositions of said series, and the proportion of gutta percha progressively decreasing in said series and the proportion of polyethylene progressively increasing in said series in the direction from said first terminal composition to said second terminal composition.

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