April 18, 1933. P. L. SHEE 1,904,887

ELECTRIC CABLE

Filed April 10, 1929

Fig. 1.

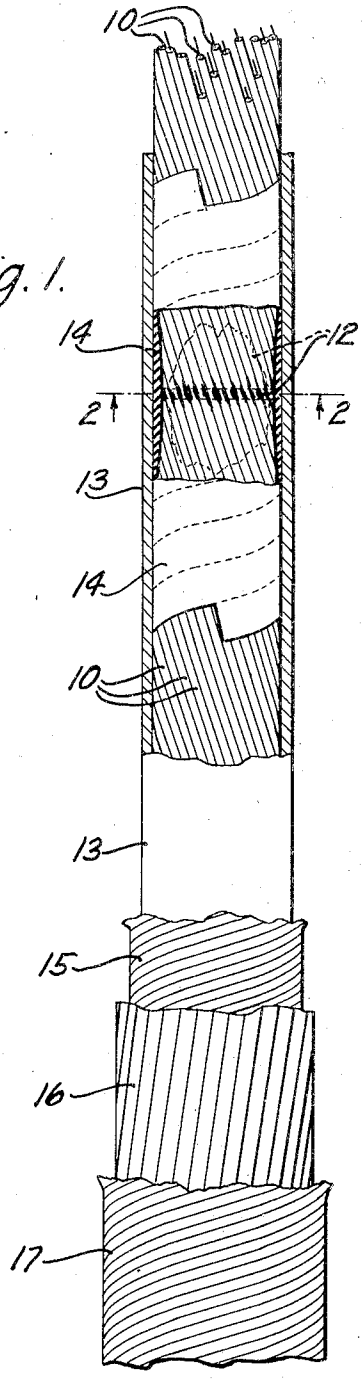
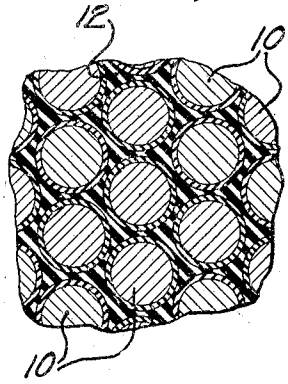


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRIC CABLE

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This invention relates to electric cables, and more particularly to improvements in submarine cables and methods of making them.

The usual practice in making submarine and land cables having paper or similar fibrous insulation is to provide a relatively large amount of insulation which is compressed as much as is mechanically possible without injuring the insulation during the stranding process. This compact form is used in order that as much resistance as possible may be offered to the flow of water in the event of a break in the sheathing and that the cable may be taken up and repaired before a substantial length thereof is impaired by the water.

It has been suggested that by inserting plugs at intervals in under-water and land cables, the same effect can be obtained. The value of a plug lies chiefly in the fact that with its use a much more efficient cable may be designed and constructed for, except at the actual plugging point, the cable may be made much less compact and therefore more efficient from a transmission standpoint than the type above mentioned. The cable can also be made with less insulating paper and of smaller diameter than is ordinarily possible.

The primary object of this invention is to provide an electric cable having an improved plug or seal which may be produced economically in a facile manner and is efficient in service.

In accordance with the general features of this invention as applied, for example, to submarine cables, the conductors along a comparatively short portion of the stranded cable core length are separated from each other to provide open convolutions. This portion of the core is then treated with a waterproofing compound of a consistency which will thoroughly impregnate and waterproof the paper insulating material. Thereafter the portion of the core having the treated and separated conductors is placed in a suitable cavity of a molding press and a composition, preferably containing an artificial resin such as a phenolic condensation product, is inserted in the mold cavity and around the conductors to fill all the spaces between the individual separated conductors. The press is then closed and simultaneously therewith the conductors are stretched taut by pulling upon the core at each side of the mold cavity and heat is applied to cure completely the phenolic plastic composition and to provide a moisture resistant wall or plug across the diameter of the core, which is of a width sufficiently narrow to permit the cable to be coiled in the usual manner without deleterious effect on the plug or the cable core. During the application of heat and pressure to form the plug the core for a comparatively short distance at each side of the plug is also subjected to pressure to compact the core, but to a less degree than that applied to form the plug. Upon removal of the core from the mold cavity of the press the cable core as a whole is inserted in a suitably heated baking oven for a suitable period to remove any moisture which may be contained in the insulation of the core. The portion of the core containing the plug is wrapped for a few inches at each side of the plug with a rubber compound adhesive tape, just previous to the core being inserted in an extrusion press for the application to the core of a lead sheath, for the purpose of providing a bond between the cured phenolic composition plug formed in the cable core and the lead sheath, the tape completely sealing and filling all spaces between the outside of the plug and the adjacent compressed portions of the core and the inside of the lead sheath.

Other objects and advantages of this invention will more fully appear from the following detailed description taken in connection with the accompanying drawing, wherein

Fig. 1 illustrates a length of submarine cable shown partly in section with a plug embodying the features of this invention formed therein, and

Fig. 2 is an enlarged fragmentary section taken on the line 2—2 of Fig. 1.

Referring now to the drawing in detail wherein like reference numerals indicate similar parts throughout the several views, conductors 10 are covered with paper insulating material and stranded into a cable core in the usual manner. A section of the

cable core length previous to the sheathing thereof, which is to be provided with a plug of the type hereinbefore referred to, is bunched or worked for a distance of approximately two feet to separate the insulated conductors 10 from each other to provide open convolutions. This section of the cable core having the open convolutions is then subjected in any suitable manner to a relatively thin waterproofing material which will completely impregnate the paper insulation of the individual conductors constituting the core. The waterproofing material may be of any suitable type, preferably such as that fully described in Patent 1,654,546, dated January 3, 1928, to F. S. Malm.

After impregnating the section of the core having the open conductor convolutions and in which the plug is to be formed with the waterproofing material previously referred to, this section of the core is placed in a suitable cavity of a molding press. Such a press may be of the usual hydraulic type provided with suitably shaped upper and lower mold or die sections. The spaces between the individually separatd conductors 10 after being positioned in the mold or die cavity of the press are completely packed or filled with a molding composition, preferably containing an artificial resin such as a phenolic condensation product. The total amount of the product within the mold cavity is only sufficient to insure after the subsequent curing of the product, to be presently described, that a unitary comparatively narrow mass of completely cured phenolic condensation product will extend across the diameter of the core with the insulated conductors extending therethrough. Any excess of the product inserted between the conductors will be forced along the conductors at each side of the point where the maximum pressure and heat is applied, thus providing sufficient resistance and friction, as the press closes, to maintain the central portion of the product in position and thus cause a perfect cure thereof. The excess product moving to each side of the central portion thereof will be more or less uncured and consequently will not be as rigid as the cured central portion. The press is then closed, and slowly and simultaneously therewith the conductors within the mold and cavity are stretched taut by suitable pulling means applied to the core at each side of the mold cavity and heat is applied to cure completely the phenolic plastic composition and to provide a moisture resistant wall or plug 12 across the diameter of the core. The width of the wall 12 should preferably be one-half inch so as to permit the cable to be coiled in the usual manner without deleterious effect on the plug or the cable core. In Fig. 1 of the drawing the width of the cured wall 12 is indicated by the broken lines extending across the diameter of the core. Although it is likely that the wall 12 will not be of a uniform width throughout its extent, but will be irregularly formed, there will be formed a wall or plug of an infusible and insoluble character with the conductors 10 substantially uniformly spaced extending therethrough, as clearly shown in Fig. 2.

The upper and lower mold sections of the press are designed in such a manner that during the application of heat and pressure the core for a comparatively short distance at each side of the wall is also subjected to pressure to compact the core therealong, but to a less degree than that applied to form the plug 12. Upon removal of the core from the mold cavity of the press, after the press is opened, any fins formed around the periphery of the core because of an excess phenolic condensation product extruded from between the mold sections are removed by filling or otherwise. This operation will not be necessary in all instances, but will depend on the design of the mold or die sections. Thereafter the core, as a whole, is inserted in a suitably heated baking oven for a suitable period to remove any moisture which may be contained in the insulation of the cable core.

Just previous to the cable core being inserted in an extrusion press of a usual type for the application to the core of a lead sheath 13, an adhesive filling material, preferably a wrapping of rubber compound adhesive tape 14, is applied to the core for a few inches at each side of the wall or plug 12 for the purpose of providing a bond between the cured phenolic composition plug formed in the cable core and the lead sheath and increase the diameter of the slightly compressed portions of the core at each side of the plug to the size of the uncompressed portion of the core. The rubber compound tape 14 may be of any suitable type which will be of a character to fill and seal the space between the outside of the plug 12 and the adjacent compressed portions of the core and the inside of the lead sheath 13 when the sheath is applied thereto. Preferably, for this purpose there is employed a tape formed from material of the type fully described in Patent 1,654,297, dated December 27, 1927, to F. S. Malm. A tape made up from the material described in the referred to patent is of such a character that the heat of the lead sheath 13 when applied is sufficient to cause the adhesive tape to fill completely all the spaces between the core plug 12 and the sheath 13 and to adhere to the adjacent surfaces thereof. When the sheath 13 is in place the usual hemp covering 15, the steel armour 16, and the outer jute covering 17 are applied in the usual manner. In the case of land or aerial cables the last mentioned coverings of hemp, steel armour and jute are omitted.

It will be apparent that a submarine cable plug embodying the features of this invention

offers a maximum resistance to the flow of water in the event of a break in the sheathing of the cable and that upon a leak developing, the portion of the cable affected will be confined to that portion thereof between successive plugs and the cable may be taken up and repaired or a new length of cable inserted by splicing.

While the invention has been disclosed and described as applied to a particular type of electric cable, it will be understood that the invention is capable of application to other types of cables and is only limited by the scope of the appended claims.

What is claimed is:

1. The method of forming a waterproof and electrical insulating baffle in an electric cable, which comprises separating the individual insulated conductors forming the cable along a portion of the core length, positioning around the separated condutors a charge of a moisture resistant and electrical insulating molding material capable of solidifying when subjected to heat and pressure, maintaining the separated portion of the conductors taut and simultaneously therewith subjecting the charge to heat and pressure.

2. The method of making an electric cable, which consists in assembling to form a cable core a plurality of insulated conductors, separating the individual conductors along a portion of the core length, positioning around the separated conductors a charge of phenolic condensation product, maintaining the separated conductors taut, and contemporaneously therewith subjecting the charge to heat and pressure to produce a unitary completely cured mass forming a plug in the core.

3. The method of making an electric cable, which consists in assembling to form a cable core a plurality of insulated conductors, separating the individual conductors along a portion of the core length, filling substantially all of the spaces between the separated conductors with a charge of phenolic condensation product, and subjecting the charge to heat and pressure to produce a unitary completely cured mass forming a plug in the core.

4. The method of making an electric cable, which includes the steps of assembling to form a cable core a plurality of insulated conductors, spreading the conductors along a portion of the core length, positioning the spread portions in a mold cavity, filling substantially all of the spaces between the conductors within the mold cavity with a charge of phenolic condensation product, molding the charge by subjecting it to heat and pressure to produce a unitary completely cured mass forming a plug in the core.

5. The method of making an electric cable, which consists in assembling to form a cable core a plurality of insulated conductors, separating the individual conductors along a portion of the core length, positioning around the separated conductors a charge of phenolic condensation product, maintaining the separated conductors taut and contemporaneously therewith subjecting the charge to heat and pressure and the core for a predetermined distance at each side thereof to pressure to produce a unitary completely cured mass forming a plug in the core, and building up the plug and the compressed portions of the core to the size of the uncompressed portion thereof.

6. The method of making a submarine cable, which consists in assembling to form a cable core a plurality of conductors having a fibrous insulation, separating the individual conductors along a portion of the core length, impregnating the separated conductors, positioning around the separated individual conductors a charge of phenolic condensation product, subjecting the charge to heat and pressure and the core for a predetermined distance at each side thereof to pressure to produce a unitary completely cured mass forming a plug in the core, subjecting the core thereafter to a drying medium to remove any moisture contained therein, building up the plug and the compressed portions of the core to the size of the uncompressed portion thereof, and applying a sheath to the core.

7. In an electric cable, a core comprising a plurality of insulated conductors, and a comparatively narrow rigid wall of moisture resistant material surrounding the individual conductors along a portion of the core length.

8. In an electric cable, a core comprising a plurality of insulated conductors, and a molded mass of artificial resin composition around the individual conductors along a portion of the core length providing a solid insulating impermeable plug in the core.

9. In an electric cable, a core comprising a plurality of insulated conductors, and a unitary molded mass of artificial resin composition filling substantially all of the spaces between the individual conductors along a comparatively short portion of the core length providing a solid insulating impermeable plug in the core.

10. In an electric cable, a core comprising a plurality of insulated conductors, and a cured mass of phenolic condensation product positioned around the individual conductors along a portion of the core length providing a solid insulating impermeable plug in the core substantially the diameter thereof.

11. In an electric cable, a core comprising a plurality of conductors covered individually with a fibrous insulating material, the insulating material along a portion of the core length being impregnated with a waterproofing material, and a unitary molded mass of artificial resin composition filling substantially all of the spaces between the individual conductors along a portion of the im-

pregnated core length providing a solid insulating impermeable plug in the core.

12. In an electric cable, a core comprising a plurality of conductors, each covered individually with a fibrous insulating material, the insulating material along a portion of the core length being impregnated with a waterproofing material, and a cured unitary mass of phenolic condensation product filling substantially all the spaces between the individual conductors along a comparatively short portion of the impregnated core length providing a solid insulating moisture resistant narrow wall across the diameter of the core.

13. In a submarine cable, a stranded core comprising a plurality of insulated conductors, each covered individually with a fibrous insulating material, the insulating material along a portion of the core length being impregnated with a waterproofing material, a cured unitary mass of phenolic condensation product filling substantially all the spaces between the individual conductors along a comparatively short portion of the impregnated core length providing a solid insulating moisture resistant narrow wall across the diameter of the core and a reduced diameter to the core for a predetermined distance at and at each side of the wall, a metallic sheath surrounding the core, and a bonding material filling the spaces between the reduced diameter portion of the core and the sheath.

14. The method of making an electric cable which consists in assembling to form a cable core a plurality of conductors, separating the individual conductors along a portion of the core length, positioning around the separated conductors a plastic moisture resistant material, and rendering the conductors taut to embed them entirely in the material.

15. The method of making an electric cable which consists in assembling to form a cable core a plurality of conductors, separating the individual conductors along a portion of the core length, positioning around the separated conductors a plastic moisture resistant material, rendering the conductors taut to embed them the more firmly in the material, and curing the material to produce a narrow rigid wall between the individual conductors.

16. The method of making an electric cable which includes the steps of assembling a plurality of insulated conductors to form a cable core, separating the conductors for a short distance, disposing a quantity of material containing uncured artificial resin among and around the separated conductors, compressing the separated conductors together with the material, and heating the material to cure the artificial resin.

In witness whereof, I hereunto subscribe my name this 30th day of March, A. D. 1929.

PARKE LAWTON SHEE.