

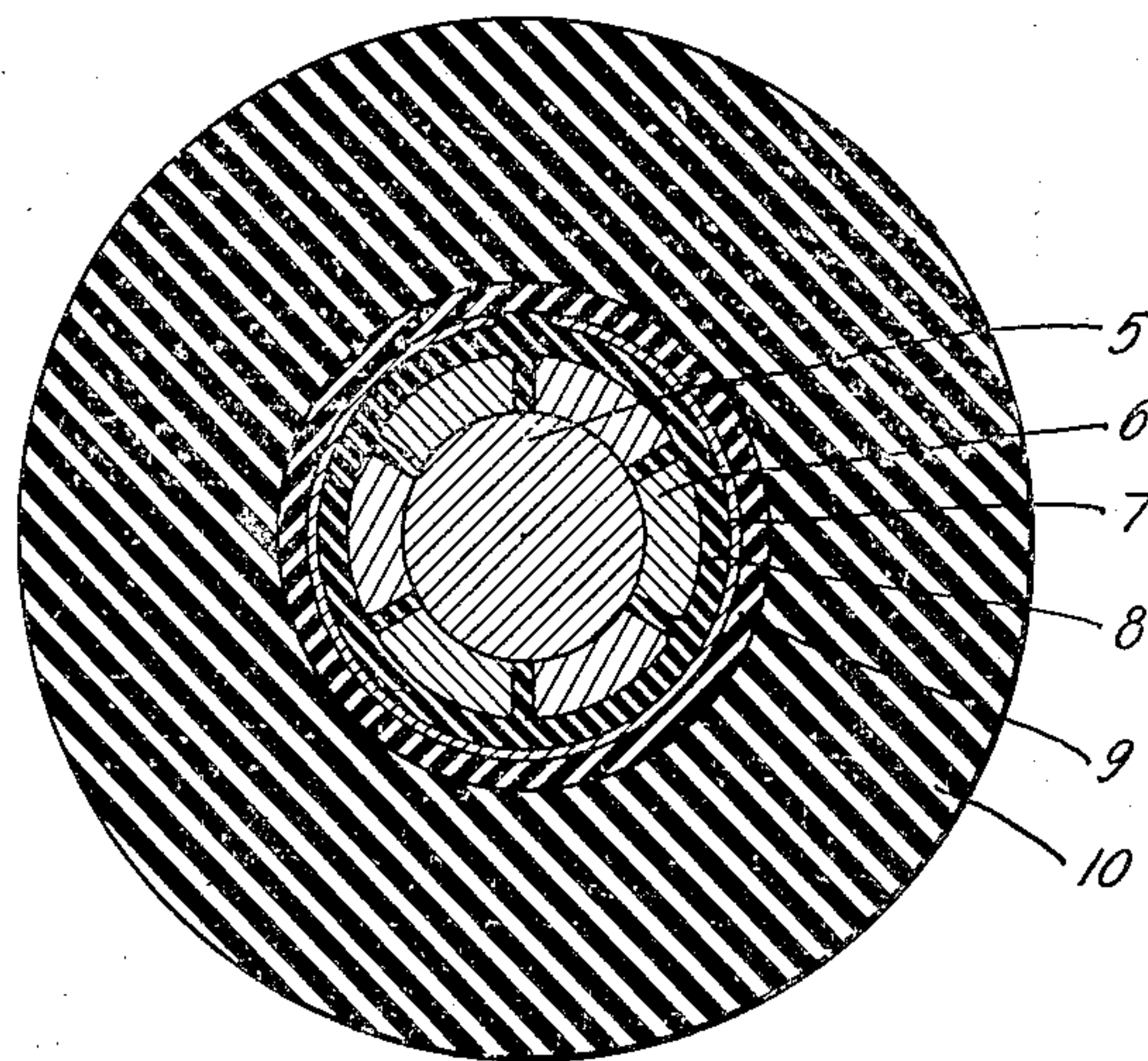
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CONTINUOUSLY LOADED TELEPHONE OR TELEGRAPH CABLE

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CONTINUOUSLY-LOADED TELEPHONE OR TELEGRAPH CABLE

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This invention relates to continuously loaded telephone or telegraph cables, and more particularly to cables of this type in which the loaded conductor is protected
5 against the effect of external forces, to which the cable may be subjected during manufacturing and installation, and against the effect of hydrostatic pressure, as in the case of deep sea submarine cables.

10 In cables of this type a conducting core is surrounded by a layer of magnetizable material, and, in turn, is enclosed by a heavy insulating sheath. There may be one or more such loaded and insulated conductors in a
15 cable.

With the object of preventing impairment of the characteristics of the cable when the cable is strained or subjected to high pressures, the present inventor has heretofore proposed to completely surround the loading material with a pressure equalizing material which is semi-fluid at the pressures and temperatures to which the cable may be temporarily or permanently subjected. A description of this prior method may be found
20 in United States Patent No. 1,700,766, Feb. 5, 1929, and in the corresponding British Patent No. 211,095 issued on August 7, 1924.

The specific pressure equalizing material disclosed in that application consists of liquid bitumen and is applied in a layer completely surrounding and covering the loading material. Although the layer placed on the outer surface of the loading material for this
30 purpose is very thin, it has been found that such a layer, when of bitumen, introduces an undesirably high leakance. There is thus considerable possibility for improvement of the conductor by reducing the leakance.
40 When the outer sheath of insulation is composed of rubber, which, due to recent technical developments has become possible even in submarine cables, it has also been found that certain of the more liquid constituents
45 of the bitumen are absorbed by the rubber sheath after a short time, perhaps even before the cable has been laid. The bitumen, consequently, loses its fluidity with the result that it becomes less effective in serving its intended
50 purpose of making uniform and preventing

a decrease of the inductance of the loaded conductor when subjected to the low temperature and high hydrostatic pressure at the sea bottom.

Melted or depolymerized rubber, as well as synthetic rubber when only partly polymerized, have also been suggested as pressure equalizing or floating materials for the loading. It has, however, been found difficult to maintain the melted rubber at a proper degree of fluidity to cause it to thoroughly fill the interstices between and under the windings of the loading tape or wire, especially when the conductor is stranded. Melted rubber also has the disadvantage of being subject to oxidation and tending to deteriorate when it is heated in open vessels for considerable periods.

The main objects of the present invention are: to provide an insulated continuously loaded conductor or cable which is efficient and is adapted for high frequency wave transmission, and in which the loaded conducting core is effectively protected against the influence of external mechanical forces, the protection being effective over an indefinite number of years; and to provide for a method of equalizing strains in the loaded conducting core caused by external forces or pressures, whereby manufacturing is simplified and cost reduced.

These objects may be attained in accordance with the present invention by first thoroughly impregnating the loaded conductor with a liquid substance, which should be so chosen that it will retain its liquid state at such temperatures as the conductor may be subjected to. Since it is placed inside the layer of loading material, it is not essential that this be a high grade insulating material. It must have such characteristics that it may be applied in commercial practice at a reasonable cost to impregnate the conductor and fill all interstices under the loading material. Certain liquid bitumens have been found to serve satisfactorily for this purpose, being comparatively cheap and being sufficiently liquid for the purpose even at temperatures close to the freezing point. These bitumens do not react chemically with the metals either of the

conductor or of the loading material. When such an impregnating material is used having comparatively poor insulating properties, it is important that the outer surface of the loading material be wiped clean after the
5 impregnating process.

The impregnated loaded conductor is next surrounded by a comparatively heavy layer of a liquid insulating material, which also
10 should be so constituted that it will retain its liquid state under the anticipated temperature conditions. Being located in the most intense portion of the electric field surrounding the conductor, it is extremely important,
15 especially in case of high frequency transmission, that this be a high grade insulating material and particularly one having a high leakage. A material should be selected for this purpose which will not react chemically with
20 either the loading material or the outer insulating sheath, and which will not have any of its constituents, that contribute to its fluidity, absorbed by that sheath. Melted rubber or various species of partly polymerized synthetic rubber have been found satisfactory
25 for this purpose and are particularly advantageous when the outer insulating sheath is of rubber.

The tendency towards reaction between the
30 two fluid substances located inside and outside the continuous layer of loading material may be effectively counter-acted by the presence of this layer. By properly reducing the spacing between strands or turns of the loading material, absorption of constituents from
35 one layer by the other may be indefinitely postponed.

After the outer fluid layer has been applied, the heavy sheathing of insulation is
40 pressed about the conductor. The dimension and material of this sheathing are determined by the requirements in each case.

It is, of course, possible to add other layers either to the outside of the insulated conductor here described in general terms or as
45 separators between the layers, and the various layers of material may be applied in a single application or as a number of successive layers, without departing from the scope of the
50 invention.

In its preferred form, the invention is applied to a continuously loaded submarine cable of the general structure shown in the attached drawing.

In accordance with this drawing, which is a sectional view of the cable and in which no attempt has been made to indicate dimensions of the parts to scale, the central conducting core, preferably of high grade copper, is
55 built up of a central strand 5 and a plurality of segmental strands 6, which are shaped to conform to the central strand and to present a smooth outer surface.

The magnetic loading 7 is in the form of a
65 thin narrow ribbon, which is wound helically,

with closely abutting turns, about the conducting core in such a manner, that a small annular space is provided between it and the surface of strands 6. The loading material may be a nickel-iron alloy, specially heat
70 treated, after being placed on the conductor, to have a permeability greatly in excess of that of iron. Alloys of this kind have been described in Patent No. 1,586,884 to G. W. Elmen, issued June 1, 1926. As is well
75 known, the magnetic properties of certain of these alloys and other magnetic materials suitable for loading purposes are deleteriously affected by strains in the material. Thus,
80 when an alloy of this kind is used for the loading of a submarine cable, and has been treated to have a high permeability, the effect thereon of the extremely high hydrostatic pressure existing at deep sea bottom, results in a greatly diminished inductance of
85 the cable as compared with that measured under atmospheric conditions, unless precautions, such as here described, have been taken to prevent an unequal distribution of the pressure within the cable, thereby eliminating
90 strains in the loading material.

The interstices within the loading are preferably filled, to the exclusion of all air, with a liquid bitumen 8, such as described in the application for patent already referred to. The
95 outside surface of the loading must be carefully wiped clean of all excess bitumen. To be satisfactory at the low temperatures at the sea bottom, the bitumen should have a fluidity which corresponds to a penetration of
100 at least 25 units, and preferably of 75 units or greater at 0° centigrade, as measured by a penetrometer of the New York Testing Laboratories' design, using a 100 gram load acting for 5 seconds on a standard needle.
105

The impregnation of the loaded conductor, including expulsion of air, may be accomplished in any desirable manner, but is preferably performed in a continuous process in
110 which the conductor is first passed through a highly evacuated space, then immediately passed into and through a container with bitumen which is maintained at a temperature at which the bitumen is highly liquid, and then forced through a wiper for removing the adhering bitumen from the outer surface of the loading.
115

The layer 9 on the outside of the loading 7 is preferably of melted rubber, that is, a high grade crude rubber, which has been first
120 softened by milling, then simultaneously masticated and heated to about 260° centigrade for from 15 minutes to one hour, and finally strained in its liquid form. The insulating properties of this material are substantially the same as those of the original
125 crude rubber, for which reason it would be permissible to make the layer 9 quite heavy. However, in view of difficulties in maintaining a uniform layer of this material during
130

the subsequent extrusion process, and due to the desirability of limiting decentralization of the loaded conductor within the insulating sheath, the thickness of layer 9 should not exceed .010" and should preferably be about .007". Since the melted rubber is sufficiently fluid at room temperature, it may be applied cold, so that the danger of oxidation during prolonged heating is obviated.

The outer layer 10 constitutes the main insulation of the conductor. The preferred cable structure being a submarine cable, the material in layer 10 must be a high grade insulator, with low dielectric losses, and must retain these characteristics for many years while under the influence of the sea water. Gutta percha may be used. However, a suitable material may be obtained from high grade crude rubber by heat treating the rubber in water under steam pressure for a number of hours depending upon the pressure, washing and drying it. It has been found that by so treating the rubber its water absorbent constituents are removed and it will be in condition to retain its original electrical characteristics under sea water for many years. It has also been found that the mechanical properties of the treated rubber are satisfactory for extrusion purposes. It may however be desirable to compound the treated rubber with gutta percha, balata or other plasticizing agents or fillers. A great advantage of using the heat-treated rubber resides in the fact that it need not be vulcanized, so that there is no danger of destroying the properties of the fluid pressure equalizing materials.

For a full description of the method of heat treating rubber referred to above and of the resulting product reference is made to my application for United States Patent, Serial No. 215,235, filed August 24, 1927.

The semi-fluid layer 9 on the outside of the loading 7 and the outer layer 10 of heavy rubber are preferably applied in a continuous process in immediate continuation of the impregnation process described above. Upon leaving the wiper for removing adhering bitumen from the outside of the loading the conductor enters and passes through a container holding the melted rubber, and then passes through an extrusion machine for the heavy rubber insulation. The melted rubber should be applied with a sufficient pressure to overcome the high pressure in the extrusion chamber to insure the formation of a layer of desired thickness between the loading and the outer insulating sheath.

For a description of a method and machine for this purpose reference may be had to my application for United States Patent, Serial No. 192,351, filed May 18, 1927.

The insulated core, described above, may be further insulated and may be protected

by wrappings and armoring in any desirable manner.

The preferred core structure thus provides for a continuous layer of loading material which is "afloat" between the conductor and the outer heavy insulation, due to the presence of fluid insulating materials which retain their fluidity at sea bottom temperatures, and one of which is a high grade insulating material providing for low capacity and low leakance and may be used in a rubber insulated cable, and the other of which is cheap and may be readily heated and forced into all interstices of the loaded conductor, thereby providing a backing against the high hydrostatic pressure and a cushion for the loading.

The invention lends itself to several modifications of the preferred structure here disclosed, such as use of a solid central conductor, wire instead of tape loading, and two or more layers of loading material. The scope of the invention is not limited to the prevention of reduction in the permeability of the loading material due to external forces but extends to use of the combinations and methods claimed for any useful purpose or to secure any desirable result.

What is claimed is:

1. A conductor having a continuous layer of magnetic material, and having a layer of pressure equalizing material and another layer of a different pressure equalizing material for said magnetic material, and having an outer sheath of heavy insulating material.

2. A conductor having a continuous layer of magnetic material imbedded in a pressure equalizing medium, said medium comprising at least two separate and different fluid materials, and having an outer sheath of insulation.

3. An insulated conductor having a continuous layer of magnetic material floated between two different fluid materials.

4. An insulated conductor having a continuous layer of magnetic material and having two different floating substances in a layer, said substances being separated by said magnetic material, whereby deleterious interaction between said substances is effectively prevented.

5. A continuously loaded submarine cable comprising a conducting core, an outer sheath of a heavy insulating material, and a layer of loading material suspended between said core and said sheath by an inner filling of a fluid impregnating material and an outer filling of a different fluid, highly insulating material.

6. A continuously loaded submarine cable comprising a stranded conducting core, a layer of magnetic material surrounding said core, a fluid bitumen filling the interstices under said layer, a thin coating of melted rubber surrounding said layer and a heavy coating

of rubber insulation surrounding said thin coating.

7. In a submarine cable, a continuously loaded conductor having a physical property
5 which may be influenced by an applied mechanical force and comprising a conducting core and a loading material of a magnetizable iron alloy loosely applied to said core, an impregnating material filling the interstices of
10 said loaded conductor, a different high grade insulating material surrounding said loaded conductor, and an outer insulating sheath, said impregnating material and said insulating material being semi-fluid at temperatures and pressures prevailing at deep sea
15 bottom, and serving to equalize said pressure on said loaded conductor.

8. A continuously loaded submarine cable comprising a conducting core, an application
20 on said core of a loading material of an iron alloy heat treated on the core to have a desirable magnetic property, said property being deleteriously affected by strain in the material, an outer sheath of a heavy rubber, a
25 filling of fluid bitumen under said loading material, and a filling of fluid rubber between said loading material and said sheath, said bitumen and said rubber being fluid at temperatures about 0° centigrade to relieve said
30 alloy of strain.

9. The method of floating a strand of a composite conductor within a heavy insulating sheath, which comprises impregnating the conductor with an insulating material
35 which is heated to be highly fluid, wiping off the excess material on the surface of said conductor, then applying a thin layer of fluid rubber at ordinary temperature, and then applying the heavy sheath by extrusion.

40 10. A method of floating a composite conductor within a heavy insulating sheath which comprises impregnating the conductor with an insulating material which is highly liquid when heated, surrounding the composite conductor with a layer of melted rubber at room temperature, and then applying
45 the heavy sheath, one of the component parts of said conductor being arranged to act as a separator to prevent deleterious interaction
50 between said material and said rubber.

11. A method of reducing strains in the loading material of a continuously loaded insulated conductor, which comprises impregnating the loaded conductor with an insulating material which is highly liquid when heated and which is viscous at sea bottom temperatures, wiping off the excess material on the surface of said loaded conductor, coating the loaded conductor with a thin layer of
55 another insulating material at ordinary temperature, said other insulating material being highly viscous at sea bottom temperatures and retaining its physical properties when a
60 sheath of rubber insulation is placed there-

about, and then applying a heavy sheath of rubber insulation about said thin layer.

In witness whereof, I hereunto subscribe my name this 28th day of February, 1928.

ARCHIE R. KEMP.