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SUBMARINE COMMUNICATION CABLE

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FIG. 1

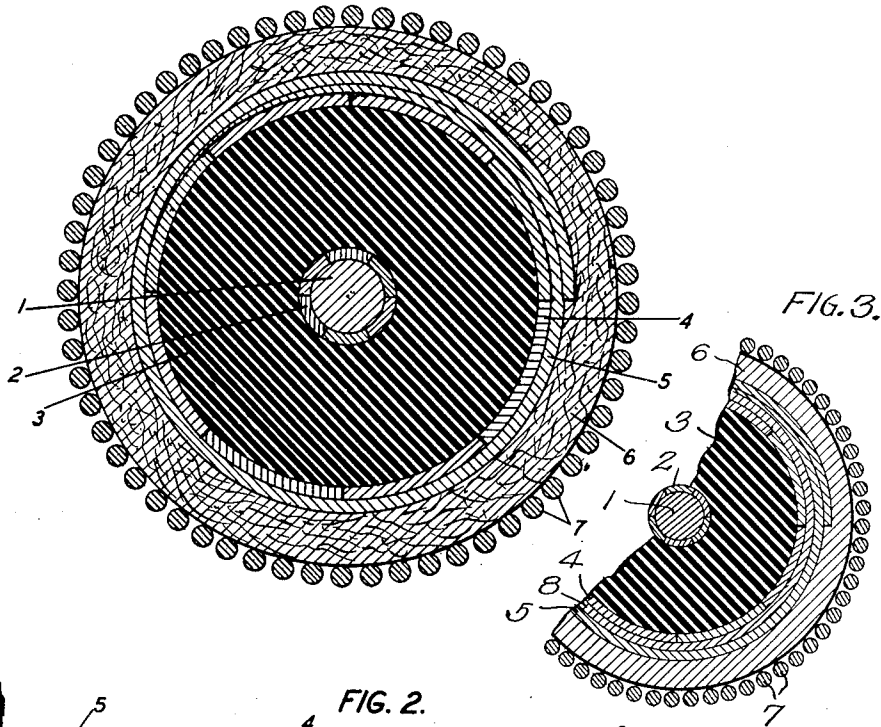
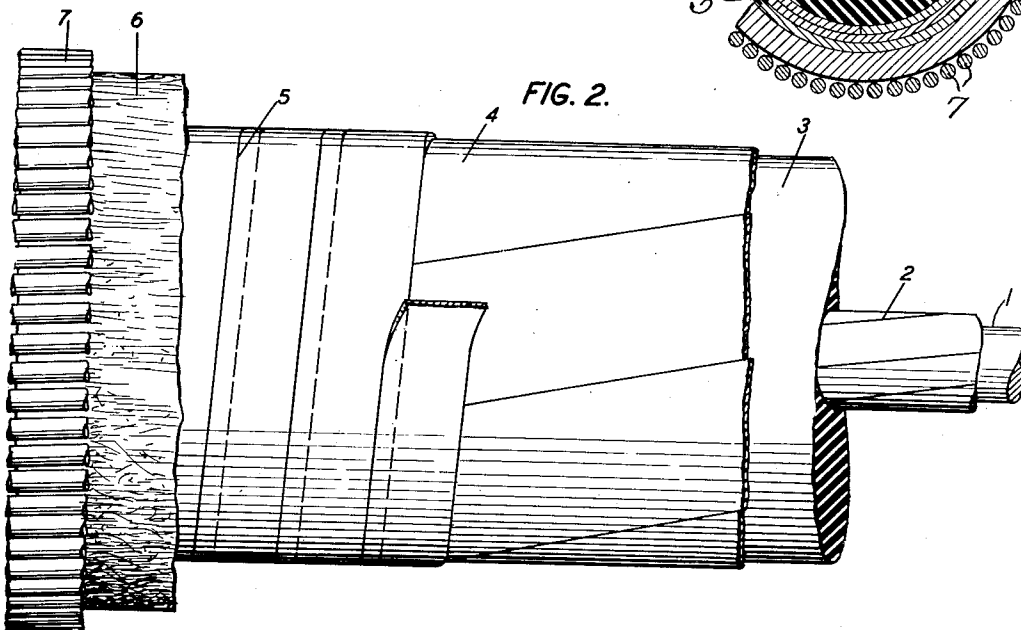


FIG. 2



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SUBMARINE COMMUNICATION CABLE

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and in Great Britain November 13, 1929

2 Claims. (Cl. 173—264)

This invention relates to submarine electrical communication cables.

In submarine cables utilized for the transmission of the higher frequencies, such as are found in speech, for example, it has been the practice to load the cable with magnetic material in order to increase the inductance per unit length of the cable and thus improve the transmission of alternating currents therethrough. As the frequency of alternating currents transmitted is increased, however, the improvement in the transmission characteristics of a cable due to the increased inductance produced by loading with magnetic material is more and more counteracted by the added resistance due to losses in the magnetic material until a point is reached at which the attenuation due to the cable is actually increased rather than decreased by the addition of magnetic loading material.

The present invention has for its object to provide a submarine electrical communication cable through which frequencies of the order of 10,000 or 20,000 cycles per second or even higher frequencies can be transmitted with sufficiently small attenuation to render practicable signaling through such a cable over distances of the order of 50 or 100 miles or greater.

A further object of the invention is to provide a cable upon which a plurality of signaling channels, each occupying a definite band of available frequencies, may be satisfactorily operated.

According to a feature of the present invention the submarine communication cable is provided with a return conductor incorporated therein in intimate contact with the insulating material about the conducting core. This return conductor may be made by serving, with as long a lay as possible, a plurality of copper tapes upon the core. A lay in which the edge of the tape makes an angle of more than 60° with a line tangent to the insulation of the core and perpendicular thereto is deemed to be a long lay. For the purposes of this specification, however, it is preferable if the angle be considerably greater and approach 90° . These tapes are preferably formed, before laying upon the core, to have such a section that they will lie in intimate contact with a circle of the same diameter as the diameter of the insulated core. These tapes may be preshaped and laid in intimate contact with the insulated core by a machine of the nature described in Trebes U. S. application 476,771, filed August 21, 1930. The skin effect which becomes prominent at high frequencies tends to confine the current to the inner side of the return conductor nearest to the

conducting core. Consequently the shaping of the tapes for the return conductor tends to promote more uniform distribution of the current over the section of the tapes and thus to promote a lower effective resistance of the return conductor.

In many cases it is necessary to protect the insulated coring against the attacks of marine life, such as teredos. To this end the cable may be served either within or without the return conductor with a material impenetrable or repulsive to such marine life. This material may be a conducting material, such as copper, or alternatively it may be an insulating material such as vulcanized rubber or other electrically non-conducting material repulsive to or impermeable by marine life.

When a metallic material is used this may be employed in the form of a copper tape about 0.1 mm. thick and about 3 cm. wide laid directly over the insulation of the conducting core or directly over the return conductor. The electrical resistance of this tape is rather high on account of the short lay with which it must be applied and unless it is properly disposed with respect to the return conductor considerable losses may result from its presence. If a cable is constructed with a concentric return conductor and a teredo tape spirally applied outside the return conductor, there will be two return circuit paths, one through the return conductor proper and the other through the teredo tape. It is known that the inductance per unit length of a circuit consisting of a central conductor and a concentric return conductor is larger, other things being equal, as the distance of the return conductor from the central conductor is greater. Since the return conductor has a very long lay and since the current in the teredo tape is likely to travel partly across the joints from turn to turn instead of following the spirals around the core the difference between the inductances added to each path due to spiraling may be neglected and the return conductor and teredo tape viewed as if they were laid longitudinally. Consequently, in such case, if the teredo tape lies inside the low resistance return conductor, the circuit through the return circuit proper will have greater inductance than the circuit through the teredo tape. Inasmuch as current tends to flow in the one of two paths having the least inductance there will be a tendency for the current to flow in the inner path, namely, through the teredo tape functioning as a return conductor. The teredo tape is a path of high resistance

and the long lay return conductor is a path of low resistance. Consequently, in such case, the current is forced from the low resistance return into the high resistance return path with a consequent increase in dissipation of the energy. The net effect of this is an increase in the effective resistance of the circuit. A space as small as ½ mm. between the teredo tape and the return conductor will result in an increase in resistance of the circuit of the order of 10%. In accordance with a feature of the present invention, this condition can be remedied either by having the teredo tape and the return conductor as close together as possible so as to reduce the inductance of the latter, or the teredo tape instead of being applied to the insulated core can be served on the outside of the return conductor. By applying the teredo tape on the outside of the return conductor and spacing it away from the return conductor the losses due to return current flowing in the teredo tape may be still further reduced.

At the lower frequencies of signaling a considerable part of the return current may be carried by the armour wires which are necessary to insure the mechanical strength of the protection for the cable. These wires are affected by the magnetic field due to the return current and if of magnetic material, as is usual, may cause modulation of the signaling currents which may result in mutual interference among the signaling channels.

In a submarine communication cable for transmitting signals of a frequency of the order of 10,000 to 20,000 cycles per second or higher it is usually advisable to increase the thickness of insulation beyond the normal thickness to such an extent that the natural inductance per unit length of the cable is increased and the capacity per unit length is decreased to such an extent that further increase of inductance, for example by magnetic loading of the cable, would have little or no advantage for said signaling frequency. Such a cable is capable of transmitting practically all the frequencies below said signaling frequency. Consequently the cable may be used for the direct transmission of speech and may also provide a plurality of channels for so-called carrier current signaling.

In order that the capacity per unit length of the cable may be kept low the insulating material with which the conducting core is surrounded should be a material of low dielectric constant, and in order to minimize attenuation of the transmitted signals the leakance of the material should also be low. A material of the nature described in British patent specification No. 307,966 is a suitable material. The central conductor of the cable is preferably of small diameter, of the order of 0.15 inch for example and it may be a solid wire or may be a wire of smaller diameter surrounded by a plurality of strands in known manner. If the latter, however, the strands are preferably laid in intimate contact with the central wire in order to minimize losses due to skin effect at the higher frequencies. For this purpose the strands may be preshaped and laid on by a machine of the nature described in U. S. application 476,771, filed

August 21, 1930. The thickness of insulation may be such that the overall diameter of the insulating core is about 0.7 inch.

A feature of the invention consists in the employment for the armouring of the cable of a material of high mechanical strength but low magnetic permeability, such for example, as one of the known non-magnetic steels or a steel containing 7% manganese, 5% nickel and 1% carbon.

Referring to the drawing, Fig. 1 shows in cross section a typical submarine communication cable designed in accordance with the principles underlying this invention;

Fig. 2 shows an end of the same cable with the successive layers partially removed; and

Fig. 3 shows a cross section of a modified form in which a small amount of spacing material such as jute is located between the return conductor and the teredo tape, the cable being otherwise in accordance with Fig. 1.

In Figs. 1 and 2 the central conductor 1, usually of copper, is shown surrounded by conducting strands 2. An insulating material 3, of gutta percha (or modern materials superior to gutta percha), covers the conducting strands. In intimate contact with 3 is a thin copper return conductor 4 which is wound upon the insulation with a long lay. The longer the lay the more effective is the return conductor. Consequently the lay should be as long as mechanical considerations will permit. Surrounding the return conductor 4 is a layer of metallic teredo tape 5. In order to protect the copper layers 4 and 5, a layer 6 of jute is served about the teredo tape. In order to protect the cable from injury due to the rubbing action of the waves and the like, a plurality of equally spaced steel armour wires 7 are served helically about the cable throughout its entire length.

Fig. 2 shows a section of the cable with various portions cut away. The same reference numerals which are employed in Fig. 1 are used in Fig. 2 and indicate the identical portions of the cable.

In Fig. 3 the teredo tape is separated from the return conductor by a thin layer of jute 8, the other parts being the same as and designated the same as in Fig. 1.

It will be appreciated that the above description is given by way of example only, and that many modifications may be made without departing from the scope of the invention.

What is claimed is:

1. A subaqueous single core signaling cable particularly adapted for the transmission of high frequencies having a return conductor of metal and a metallic tape of higher resistance measured longitudinally of the conductor for protection against teredos, characterized in this, that the return conductor is laid in intimate contact with the main insulated core and the teredo tape is laid externally with respect to the return conductor.

2. A cable construction in accordance with claim 1 in which the teredo tape is spaced away from the return conductor.

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