Oct. 4, 1932. O. E. BUCKLEY 1,880,764

SUBMARINE SIGNALING CABLE

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FIG. 1.

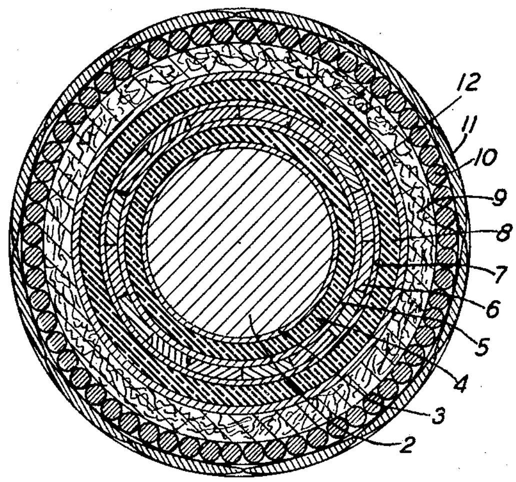

FIG. 2.

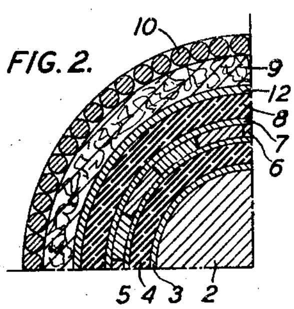

FIG. 3.

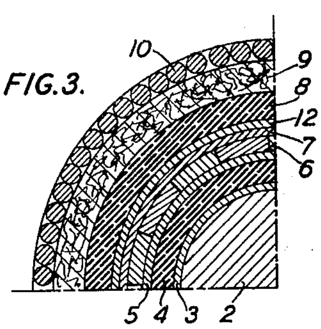

FIG. 4.

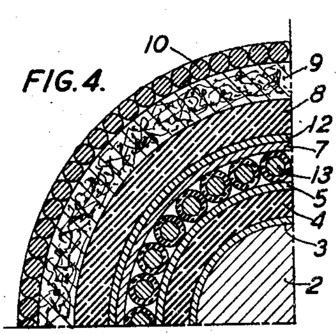

FIG. 5.

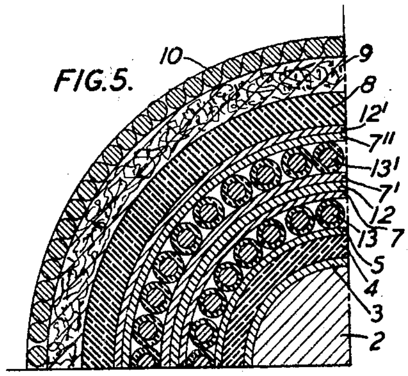

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FIG. 6

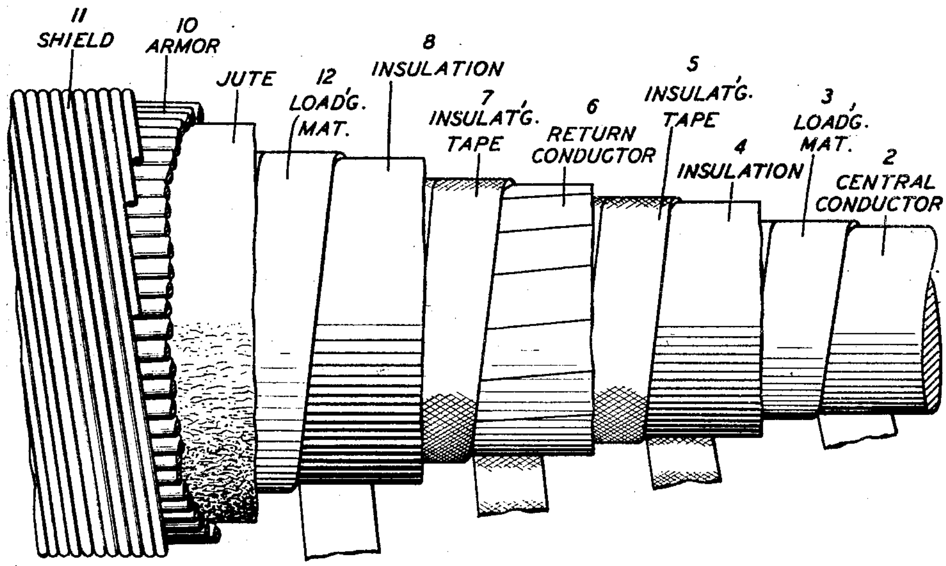
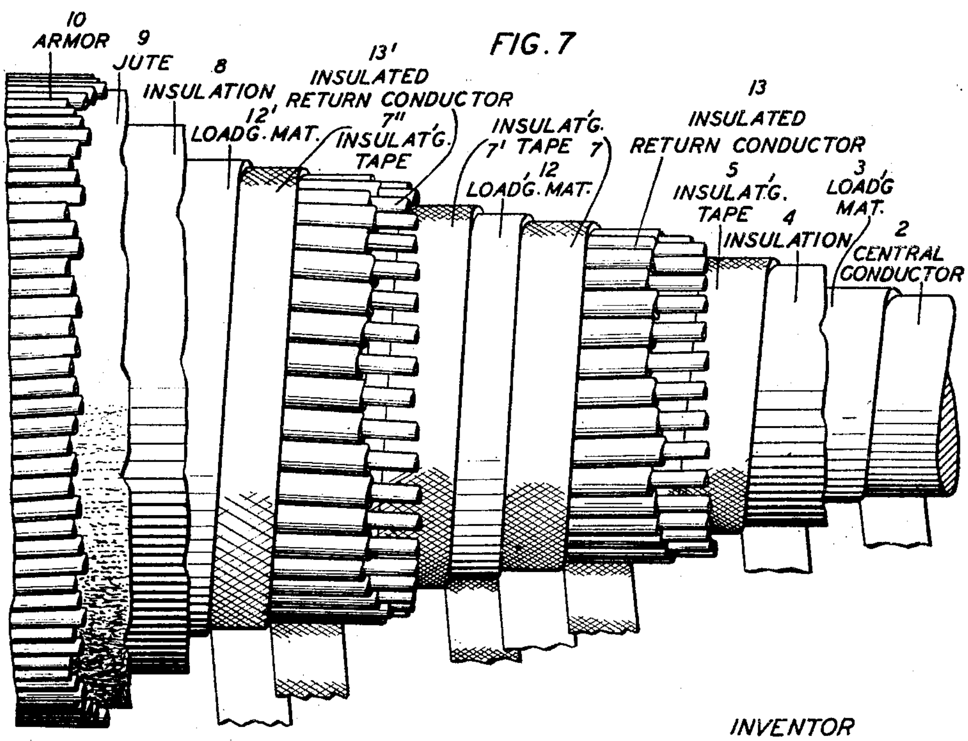


FIG. 7



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UNITED STATES PATENT OFFICE

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SUBMARINE SIGNALING CABLE

Application filed June 29, 1931, Serial No. 547,690, and in Great Britain August 13, 1930.

The present invention relates to signaling cables and more particularly to submarine signaling cables of the concentric return type.

An object of the invention is to prevent extraneous inductive and other disturbances of both high and low frequencies from interfering with the intelligibility of signals transmitted over long submarine cables.

A further object of the invention is to increase the signal to noise ratio of currents received from the terminals of long submarine signaling cables.

A further object of the invention is to reduce the power level at which intelligible signaling waves may be received at the receiving end of signaling cables having a high attenuation.

In applicant's application, Serial No. 392,351, filed September 13, 1929 there has been described a method of and means for reducing the effect of external disturbances upon a long deep sea signaling cable to a level below that of the resistance noise level of the cable conductors, without impairing the flexibility of the cable, by providing between the concentric return conductor and the armor wire a wrapping of tapes or wires constituting a sheath of magnetic material of high initial permeability forming a magnetic path around the inner conductors, and in cases where the external interference is more severe, by applying outside this shield a sheath of high electric conductivity forming a longitudinal conductor which is in turn surrounded by a magnetic sheath, or, in special cases, by providing a plurality of magnetic sheaths alternating with highly conductive sheaths.

This type of shielding may be looked upon as inductive loading of the current path through the armor wire and sea water since it raises the impedance for that part of the "return" circuit which is outside of the copper return conductors and this is the meaning of the term "loading" as applied herein to the result of the provision of a sheath or sheaths of magnetic material external to the concentric copper return conductor. This "loading" is obviously most effective (to cause the return current to flow in the copper return conductor rather than in the armor and/or sea water) at relatively high frequencies since the impedance added by a definite amount of inductive loading increases in proportion to the frequency. At very low frequencies such as in the range of low frequency telegraphy the effectiveness of this means of shielding is reduced.

The object of the present invention is to provide effective shielding for both high and low frequency electrical disturbances of terminal portions of long deep sea submarine telephone cables of the concentric return type.

To this end the invention contemplates a submarine cable, or section thereof, comprising a continuously loaded central conductor and a concentric return conductor continuously surrounded by magnetic material, wherein the return conductor or at least part thereof, in cases where the return conductor is partly formed by the metallic armoring of the cable, is insulated to shield the insulated part of the return conductor from low frequency electrical disturbances.

In the preferred embodiment the invention comprises a submarine cable terminal section comprising a continuously loaded central conductor and a concentric return conductor continuously surrounded by magnetic material, wherein the return conductor is insulated as well as being "loaded" so as to be shielded for both high and low frequency electrical disturbances.

According to one feature of the invention, the cable may comprise a central conductor surrounded by loading tape and insulation in the usual manner. This insulation may be provided with a wrapping of tough insulating material over which the return conductor, which may be in the form of copper strips or the like, is wound. This return conductor has a layer of insulating material extruded or otherwise applied thereto and a layer of magnetic tape is wound over this insulating material to shield the return conductor from high frequency electrical disturbances, the insulation over the return conductor forming a shield for low frequency electrical disturbances. The cable is completed by the application of a jute covering and the usual cable armoring.

In a modification, the "loading" tape or strip may be applied directly to the return conductor but insulated therefrom, the insulation surrounding the "loading" material as well as the return conductor in this case. This form of construction is advantageous in that it gives a higher "sea return inductance" and of course the insulation tends to prevent corrosion of the loading material.

In another embodiment of the invention submarine cable terminal section comprises a main central conductor loaded and insulated in the usual manner, but the return conductor in this case consists of separately insulated conductors preferably wound with a long lay over the insulation and "loading" material which is wound over these insulated conductors, a layer of insulating material being applied over the conductors and the "loading" material. Alternatively, the insulation may be applied to the insulated cable conductors and the loading material applied externally to the insulation. In a modification two or more layers of insulated return conductors may be used, each layer being loaded.

The invention will now be described with reference to the accompanying drawings which show embodiments thereof and in which similar reference numerals indicate similar parts.

Fig. 1 shows a cross-section of a terminal portion of a deep sea submarine cable wherein the armor forms part of the return conductor;

Fig. 2 shows a partial section of a cable wherein the return conductor is enclosed within "loading" material and insulating material;

Fig. 3 shows a modification of Fig. 2;

Fig. 4 shows a partial section of a cable wherein the return conductors consist of insulated wires;

Fig. 5 shows a modification of Fig. 4;

Fig. 6 shows a telescoped longitudinal view of the cable shown in Fig. 1; and

Fig. 7 shows a telescoped longitudinal view of the cable shown in Fig. 5.

In Figs. 1 and 6, reference numeral 2 indicates the main cable conductor, 3 the usual magnetic loading material (surrounded in practice by the usual pressure equalizing material, not shown), 4 the insulating material applied over the loading material, 5 a tough insulating tape applied over insulation 4, 6 the return conductor which may be in the form of copper wires, but which in Fig. 1 is shown as copper strips or tape and which is preferably wound with a long lay. A layer of insulating tape 7 may be applied over conductor 6 and a layer of insulating material 8 is extruded or otherwise applied over the insulated return conductor. The wrapping of "loading" material is shown at 12. A preferred composition of magnetic "loading" material comprises about 78½% nickel and the balance chiefly iron, heat treated to have an initial permeability of about 2000 or more. The usual jute cable covering is shown at 9 and the usual cable armor wires at 10.

In the construction shown in Fig. 1 the armor 10 forms part of the return conductor, since in the central sections the return conductor 6 is not usually "loaded" and insulated from the sea water and the armor; in this manner parallel return current paths are provided through return conductor 6 and the armor 10. In this case it is preferable to "load" the armor by surrounding it with a wrapping of magnetic material. To this end wires or strips 11 of iron or other magnetic material, such as an alloy of 78½% nickel and the balance chiefly iron, may be applied over the armor 10. These "loading" or "shielding" wires 11 are wound around the armor 10 with a short lay. By this construction the effective inductance of that part of the return current which flows through the sea water is increased and the return current is caused to flow chiefly through the metallic armor wires 10 and through the highly conductive concentric return path 6.

In the construction shown in Fig. 2 the return conductor is formed chiefly by copper wires or strips 6, and in this case the loading tape 12 may be applied over the insulating material 8.

Fig. 3 shows a modification of Fig. 2 in which the loading tape 12 is applied directly over the insulating tape 7 on the return conductor, and therefore is in close proximity to the copper return conductor, and this construction results in giving a higher "sea return inductance", and as the insulation 8 is applied over the "loading" material, this is effectively protected from corrosion.

In Fig. 4 the copper return conductor has the form of individually insulated copper wires 13 which are applied over insulation 4 and insulating tape 5 with a long lay. The wrapping of insulating tape 7 may be applied over these conductors and the "loading" material 12 and insulating material 8 may be applied thereover.

In Fig. 5 are shown two layers of individually insulated return conductors 13 and 13′, these being separated by insulating tapes 7 and 7′ and "loading" material 12. Wrappings of insulating tape are shown at 7, 7′ and 7″. "Loading" tapes 12′ are applied externally to the insulated conductors 13′.

In Figs. 6 and 7, those reference numerals which are identical with those of Figs. 1 and 5, respectively, indicate identical parts. It may be seen from these figures that the return conductors 6, (Fig. 6) 13 and 13′ (Fig. 7) are applied with a long lay and that the "loading" or shielding tapes 12 and 11 (Fig. 6) and 12 and 12′ (Fig. 7) are applied with a short lay.

The above described cable constructions are more particularly applicable as end portions of long deep sea cables, and the insulation of the return conductors is effective to shield the circuit comprising the central and/or outer or return conductors from very low frequency electrical disturbances, such as for example, currents of less than ten cycles per second, and the magnetic material wrapped around the outer conductors is effective for shielding the circuit from higher frequency interference.

This type of shielding has the advantage over the generally employed sea-earth in that a higher ratio of received signal to noise is obtained when the noise is that due to the thermal agitation of the electrons in the cable conductors.

What is claimed is:

1. A submarine cable comprising a continuously loaded central conductor and a return conductor continuously surrounded by magnetic material, wherein at least part of the return conductor is insulated to shield this part from low frequency electrical disturbances.

2. A cable according to claim 1, wherein the return conductor comprises in combination (a) a conductor surrounding the main cable conductor and (b) the metallic armor of the cable.

3. A cable according to claim 1, wherein a sheath of insulating material is applied over the concentric return conductor and a layer of magnetic material is applied over said insulation.

4. A cable according to claim 1, wherein a layer of magnetic material is applied externally to the return conductor and a sheath of insulating material is applied over the return conductor and the magnetic material.

5. An armored submarine cable comprising a continuously loaded central conductor and a concentric return conductor continuously surrounded by magnetic material, wherein a part of said return conductor is formed by said armor and another part of the return conductor consists of individually insulated conductors having a layer of magnetic material applied thereto.

6. A submarine signaling cable comprising a single insulated outgoing conductor, a concentric return conductor surrounding said outgoing conductor, means external to said conductors for shielding them from high frequency external disturbances, said means comprising a metallic sheath having a magnetic permeability at small magnetizing forces higher than about 400, and means for shielding said conductors from low frequency external disturbances, said means comprising a sheath of insulating material.

7. A cable as defined in claim 6 characterized in this, that the shield of magnetic material is provided underneath the sheath of insulating material.

8. In combination, in a medium conductive to parasitic currents of high and low frequency, an electrically insulated and continuously loaded central conductor, a second conductor surrounding said first mentioned conductor in the form of a substantially continuous and uniform sheath, a layer of magnetic material surrounding said sheath in a continuous and uniform manner for reducing the effect upon the conductors of said parasitic currents of high frequency, and shielding means for reducing the effect upon said conductors of said parasitic currents of low frequency, said means comprising a layer of insulating material surrounding said conductive sheath.

9. Combination as defined in claim 8 comprising an armor external to said conductive sheath, said armor forming a part of the return conductor and being surrounded by a wrapping of magnetic material.

In witness whereof, I hereunto subscribe my name this 26th day of June, 1931.

OLIVER E. BUCKLEY.