Dec. 8, 1931. J. J. GILBERT 1,835,771

SUBMARINE SIGNALING CABLE

Filed March 23, 1929

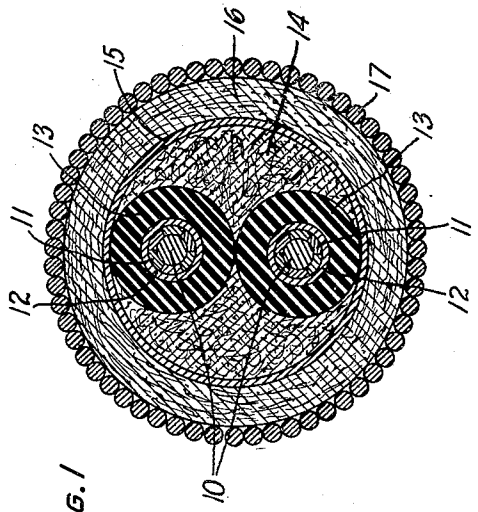

FIG. 1

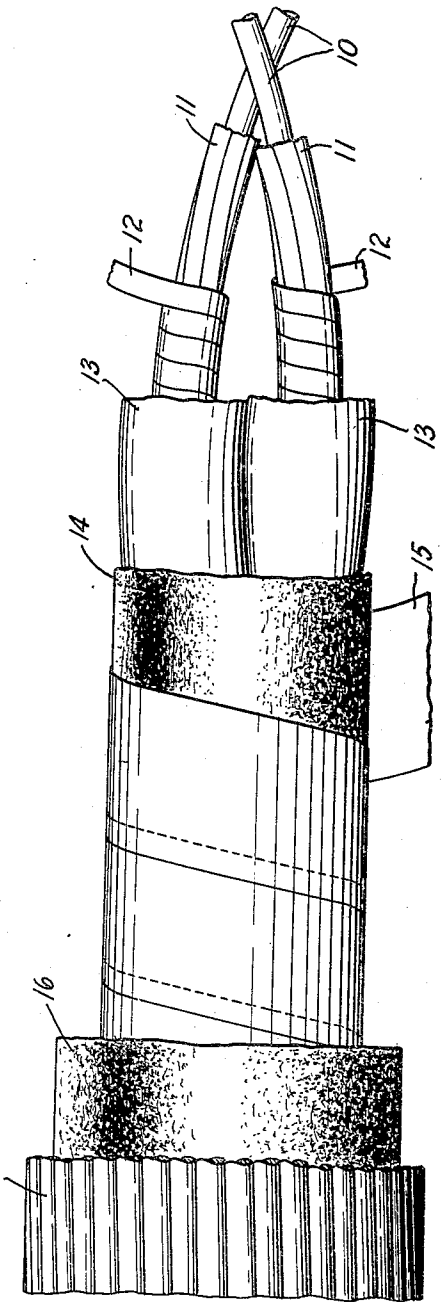

FIG. 2

INVENTOR
J. J. GILBERT
BY
J. W. Schmied
ATTORNEY

Patented Dec. 8, 1931 1,835,771

UNITED STATES PATENT OFFICE

JOHN J. GILBERT, OF DOUGLASTON, NEW YORK, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

SUBMARINE SIGNALING CABLE

Application filed March 23, 1929. Serial No. 349,317.

The present invention relates to submarine signaling, and particularly to the efficient transmission of voice frequency currents over long loaded submarine cables.

An object of the invention is to decrease the attenuation of voice frequency currents transmitted over a long loaded submarine signaling cable.

Another object of the invention is to reduce the effects of extraneous disturbances upon telephone currents transmitted over long loaded submarine cables.

Another object of the invention is to reduce the effects of extraneous interference upon the twin core termination of a single core submarine signaling cable.

A further object of the invention is to reduce reflection and modulation losses in the head end sections of a submarine signaling cable and consequently to increase the efficiency of transmission of the cable as a whole.

For long distance telephone or high frequency transmission a twin core cable structure possesses important advantages in the way of freedom from interference. The terminal sections of such a cable are the most critical portions both from the standpoint of losses due to the unsually great current at the transmitting end but also due to the fact that interference is likely to be most troublesome near the terminals. For practical reasons, a long deep sea signaling cable is usually manufactured in a number of sections of about one mile length which are joined during the laying operation. Owing to inherent manufacturing conditions the electrical properties of the individual sections will not be identical in all sections. There are particularly three electrical characteristics of primary importance, herein referred to as the parameters, which will be found to differ, namely, first, the initial inductance (i. e. the inductance at zero current density); second, the capacity; and third, the variation of hysteresis resistance with current.

The present invention makes use of these facts and applies them in the following manner: During manufacture, the parameters of the cores are measured and from the results of these measurements the cores are selected into groups so that the cores in any group have as nearly as possible identical initial inductance. Of the members of any group there are then selected pairs having as nearly as possible the same capacity. The conductors are then twisted or laid together spirally into pairs and the pairs arranged in order of decreasing hysteresis resistance. During the laying of the cable the pair having the lowest hysteresis resistance is placed near the cable terminal and those pairs having successively higher hysteresis resistance are placed in successive positions more remote from the terminal. For a two-way cable the other terminal will be treated in the same fashion.

In a cable in accordance with the present invention the separately measured impedances of the twinned cores measured from any two points on the cable and looking in the same direction will be as nearly equal as possible. This has the advantage that extraneous interfering electric and magnetic fields, such as those emanating from neighboring electric cables, from the effects of the earth's magnetic field and from static disturbances will be balanced out with respect to the twin core cable. Also in the terminal sections of the cable where the largest currents are encountered, the increase of attenuation due to hysteresis will be minimized.

The effect of extraneous interference is reduced by matching the cores as regards the inductance and capacity, and at the same time the increased attenuation due to hysteresis loss is minimized. The hysteresis resistance, upon which the increased attenuation depends, is, in a short length of conductor, proportional to the current in the conductor. The constant of proportionality varies from one conductor to another. An important feature of the invention, therefore, is to use in the head end sections of the cable, where the current is large, cores which have a small value for this constant of proportionality.

In the case of a twin core termination of a single core cable the method of selecting cores may be somewhat different from that employed in the manufacture of a twin core cable. The cable cores may first be grouped as regards hysteresis resistance, those having

low hysteresis resistance being selected for the terminal sections. These cores may then be paired so as to obtain the desired balance of inductance and capacity. It is however, possible to use this same method of selection also in the manufacture of a twin core cable.

In the accompanying drawings which show one embodiment of the invention:

The central copper conductors 10 are surrounded by a number of segments 11, say six, shaped to fit the central conductors 10. Upon the segments 11 is applied a helix of loading material 12. Suitable loading materials and suitable methods of applying loading materials are known and need not be discussed herein. The conductor is heat treated after the loading material is applied thereto. Suitable heat treating methods such as are well known may be employed. The loading material is surrounded by a pressure equalizing fluid, such as liquid bitumen or melted rubber. Surrounding the loading material is a sheath of insulating material 13 such as gutta percha or gutta percha substitute. The entire structure thus far described constitutes a unit hereinafter referred to as a core. Two such cores are twinned together in a twinning machine and given a spiral lay or pitch as indicated in Fig. 2. The pitch is preferably of the order of several feet. In order to give this twinned core the cylindrical shape required for armoring, the interiorly cusped crescent shaped spaces on both sides thereof are filled by a suitable filler 14, such as jute, which is molded around the twinned cores to produce a spherical cross-section. Teredo tape 15, jute 16 and armor wires 17 are provided to surround the cores in a suitable manner.

The invention has been described specifically as applied to a continuously loaded submarine signaling cable. It is, however, understood that the fundamental features of the invention are not limited in application to this specific embodiment, but apply equally well to twin core terminations of single core cables, to coil loaded cables and to cables intermittently loaded, i. e., cables in which loaded sections of say one mile length recurrently alternate with non-loaded sections of the same legnth.

What is claimed is:

1. The method of constructing a submarine cable which comprises selecting from a number of core lengths a group having, as nearly as possible, equality of inductances, selecting from a group thus formed pairs having, as nearly as possible, equality of capacity, to form a twin core section, and arranging the twin core sections thus formed in order of increasing hysteresis resistance losses as one proceeds from the terminal toward the center of the cable.

2. A submarine cable of twin core type in which the twin core lengths are matched, each to the other, as to one parameter and the twin cores are arranged progressively in the cable in accordance with a different parameter.

3. A submarine cable of the twin core type in which the twin core lengths of a section are matched each to the other as to their inductance characteristics and the twin core lengths are arranged progressively in the cable in accordance with increasing hysteresis resistance as one proceeds from a terminal toward the center of the cable.

4. In constructing a submarine signaling cable of great overall attenuation from sections of loaded cores the impedance of which varies, the method of reducing irregularities in the completed cable, which method comprises arranging the sections in pairs balanced with respect to their impedance values, and placing those pairs having the highest hysteresis resistance toward the mid-portion of the cable.

In witness whereof, I hereunto subscribe my name this 15th day of March, 1929.

JOHN J. GILBERT.