

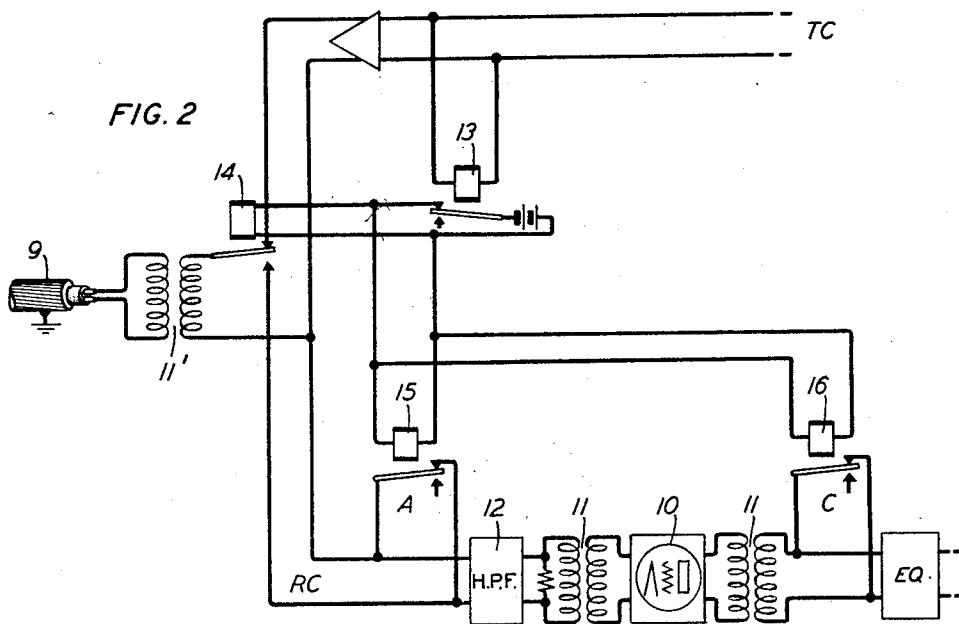
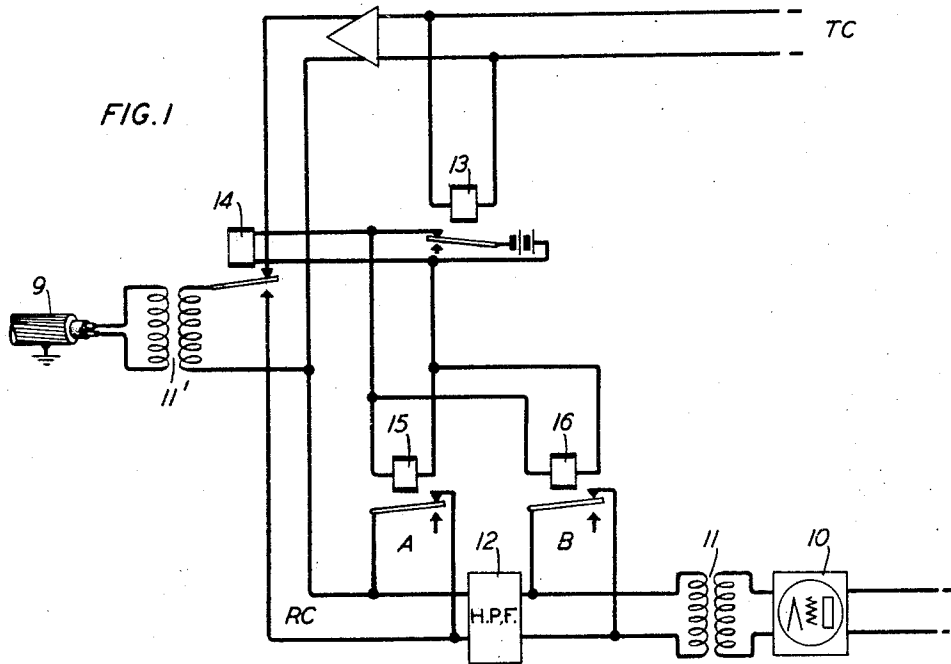
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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This invention relates to signaling systems and more particularly to submarine cable circuits adapted for transmission in only one direction at a time.

5 The general object of this invention is to protect the receiving apparatus in such a system from the excessive flow of current occurring just after the cable has been disconnected from the sending apparatus and is connected to the receiving apparatus. At the
10 end of the sending period and after the transmitter has been disconnected from the cable, there remains in the cable a residual charge which produces a slowly decaying current
15 from the cable to ground. This current is due chiefly to the combined action of the earth current flowing in the cable, caused by the different potentials of the earth at the respective terminals, and the flow of earth of
20 the electric charge absorbed by the cable dielectric during the sending period. That component of the current which is due to the charge previously impressed upon the cable by the transmitter and which consists chiefly
25 of low frequency currents will be referred to hereinafter as the "relaxation current".

The initial value of the relaxation current is about 30 to 40 decibels down from the level of the previously impressed signal, after
30 which it may take several times the transmission time of the cable to decay to a value 100 decibels further down. If, at any time within this interval, the receiving amplifier is connected to the cable and if an appreciable
35 current is flowing at the point of connection, the sudden change in terminal impedance will generate high frequency voltages which will cause an impulsive disturbing current to be transmitted through the receiving amplifier. Such an occurrence is frequent in the
40 case of a telephone circuit because it is necessary to connect the receiving amplifier to the cable very shortly after a speech impulse has been applied to the cable by the transmitting
45 amplifier.

A more specific object of the invention is to expedite the decay in a submarine cable of the relaxation current resulting from a previously transmitted signal. In pursuance of
50 this object, the receiving circuit is connected

to the cable while the input or cable side of the receiving circuit is short-circuited.

A feature of this invention is a special switching arrangement for avoiding the effect of the high frequencies generated by switching in the presence of the relaxation current and ground currents. 55

In accordance with this invention, the transmission of detrimental current impulses to a receiving circuit is avoided by short-circuiting the receiving path successively at two points, one adjacent to the cable and the other separated therefrom by a high-pass filter. The first short circuit causes the charge stored in the cable to disappear rapidly but due to the sudden change in impedance of the cable terminal, an impulse made up of high frequency currents is generated if an appreciable current is flowing at the point of such a change. The first short circuit may be opened after this impulse is passed. The impulse thus generated is transmitted partly into the cable and partly into the filter. That part of the impulse which travels into the cable is largely absorbed by the cable, the reflected components being at least thirty and possibly forty decibels down for a uniform and well assembled cable and in any case dying down much more rapidly than the relaxation current of the cable. That portion of the impulse which travels into the filter is partly dissipated therein and partly reflected by the second short circuit and the reflected part in turn passes into the cable and is absorbed. The second short circuit contact may then be opened for the reception of signals and as the high-pass filter has prevented the passage of the relaxation current (low frequency current) to this point, no further disturbing impulse of importance will be generated. 80

In an application for patent Serial No. 382,011, filed July 29, 1929 by A. M. Curtis, there is disclosed a method of and means for preventing earth currents, reflected energy, or other energy present in a cable circuit from sending an impulse into the receiving circuit, when the receiving circuit is being disconnected from the cable. This is accomplished by the provision of a plurality of short-cir- 95 100

cuiting shunts bridging the receiving circuit which are closed during the transmission of speech and which are successively removed when the near end talker stops speaking. The present application discloses improvements over the method of the former application chiefly in that the sequence of operation of the relay contacts which function to successively remove the short circuits from the receiving circuit when the near end subscriber stops talking is such as to allow time to the relaxation and other disturbing currents from the cable to be dissipated in means especially provided for this purpose, such as a high-pass filter.

The invention may be better understood from the following detailed description of its features and of its principles of operation when read in connection with the accompanying circuit drawing of embodiments thereof in which identical reference characters designate similar parts and in which:

Fig. 1 shows a diagrammatic representation of a receiving circuit which constitutes one embodiment of the invention; and

Fig. 2 shows a diagrammatic representation of another embodiment of the invention.

In Fig. 1 a receiving amplifier 10 is shown connected through transformers 11 and 11' and a high-pass filter 12 to a transmission line such as a submarine signaling cable 9. Contacts A and B across the signaling line are provided for the purpose of normally short-circuiting the line during transmission and just prior to reception of signals, so that no disturbing impulse is transmitted to the receiving circuit to the right of the amplifier 10. The high-pass filter 12 may have a cut-off frequency of about 200 to 300 cycles and it is so designed as to have an iterative impedance equal both to that of the cable proper and to that of the input impedance of the amplifier 10.

The operation of the system shown in Fig. 1 is as follows:

We assume the armatures of the relays 13, 14, 15 and 16 in the position shown, i. e., in the position corresponding to the transmission of speech by a subscriber over the transmitting circuit TC. Immediately after the near end talker stops speaking, the cable is disconnected from the transmitting circuit TC and is connected to the receiving circuit RC by virtue of the fact that the armature of relay 13 is released, which causes the release of the armature of relay 14. The relays 15 and 16 are of the slow-release type, relay 15 releasing its armature a brief time interval after the release of the armature of relay 14, and relay 16 releasing its armature a brief time interval after the release of the armature of relay 15, in that the resistances and capacities (not shown) which are permanently associated with these relays cause their windings to energize with a properly timed delay

in a manner well known in the art. If an appreciable current, such as the above-defined relaxation current, for instance, is flowing at the head end of the cable, an impulse will be generated by the sudden change in impedance at the cable terminal by the release of the armatures of relays 14 and 15. This impulse is transmitted partly into the cable and partly into the filter 12. That part of the impulse which travels into the cable is largely absorbed by the cable, the reflected parts having an intensity at least 30 and possibly 40 decibels less for a smoothly assembled cable. This part of the energy dies down much more rapidly than the relaxation current of the cable. That part of the impulse which travels into the filter and is not dissipated therein, that is, the higher frequency current, is reflected by the short circuit at point B back into the cable and is absorbed thereby. After this impulse has been reflected, the short-circuiting contact at point B is opened, by the delayed release of relay 16. The opening of contact B should follow the opening of contact A by a time interval just greater than the transmission time of the high-pass filter 12, and since the high-pass filter has prevented the passage of the relaxation current to this point, no serious impulse or click will be impressed upon the receiving amplifier 10. The high-pass filter 12 transmits signal frequencies but prevents transmission of low frequencies such as the principal components of the relaxation current in which the signal-to-noise ratio is low.

The embodiment of the invention described terminates the cable in an impedance equal to its own impedance. Such a construction may not be preferred, because there is a poorer ratio of signal to resistance noise in the circuit (the resistance noise is the noise which is caused by the thermal agitation of electricity in the cable conductors) than if the terminating impedance is made relatively high. From the standpoint of keeping the resistance noise contribution to the signal-to-noise ratio at a minimum, the embodiment of the invention described below and shown in Fig. 2 will be more desirable. In accordance with this modification of the invention, the input impedance of the high-pass filter 12 and the impedance of the amplifier 10 are given a definite value, for example, ten times the characteristic impedance of the cable, and the second or chief short-circuiting contact is placed at the point C which may be any point after the first amplifier 10. An impulse generated at the junction point of the cable with the receiving circuit, when the contact at point A is opened, is transmitted partly into the cable as in the embodiment described above and is similarly absorbed. That part of the impulse which passes into the filter 12 is also partly absorbed by the input impedance of the ampli-

fier. Thus after a time equal to or slightly greater than the time of transmission of an electrical impulse from point A to point C, the short-circuiting contact at point C may be safely opened without danger of a disturbing click. Since no component of the relaxation current in the cable reaches point C, no serious click will be generated by the operation of the contact located at this point.

What is claimed is:

1. In a signaling system, a transmission line, a receiving path connectible thereto, means for connecting the receiving path to the line, short-circuiting contacts bridging said receiving path at a plurality of points, means for successively removing said short circuits from said path, and means for suppressing the transmission between said points of currents of substantially all frequencies below the lowest signal frequency to be received by said receiving path.

2. System as defined in claim 1 characterized in this that said means for suppressing the transmission of low frequency currents includes a high-pass filter.

3. System as defined in claim 1 further characterized in this that the sequence of operation of the removal of said short circuits from said receiving path is such as to give time for the relaxation currents from the cable to be dissipated in said frequency current suppressing means.

4. System as defined in claim 1 further characterized in this that the opening of the second short circuit is delayed with respect to the opening of the first short circuit by a time interval just greater than the transmission time of the frequency current suppressing means.

5. A telephone system including a deep sea signaling cable, transmitting and receiving circuits at the terminals of said cable, a plurality of short-circuiting contacts bridging said receiving circuit when the transmitting circuit is in operation, and means for successively removing said short-circuiting contacts at a plurality of points, said points being separated by means in said receiving circuit for increasing the ratio of signaling energy to resistance noise energy, said means including at least one impedance element having an impedance which is a multiple of the characteristic impedance of said cable.

6. System as defined in claim 5 in which an amplifier is provided in said receiving circuit, said system being further characterized in that at least one of the short-circuiting means is located at a point on the side of the circuit connected to the output terminals of said amplifier.

In witness whereof, I hereunto subscribe my name this 15th day of December, 1931.

ROBERT C. MATHES.