

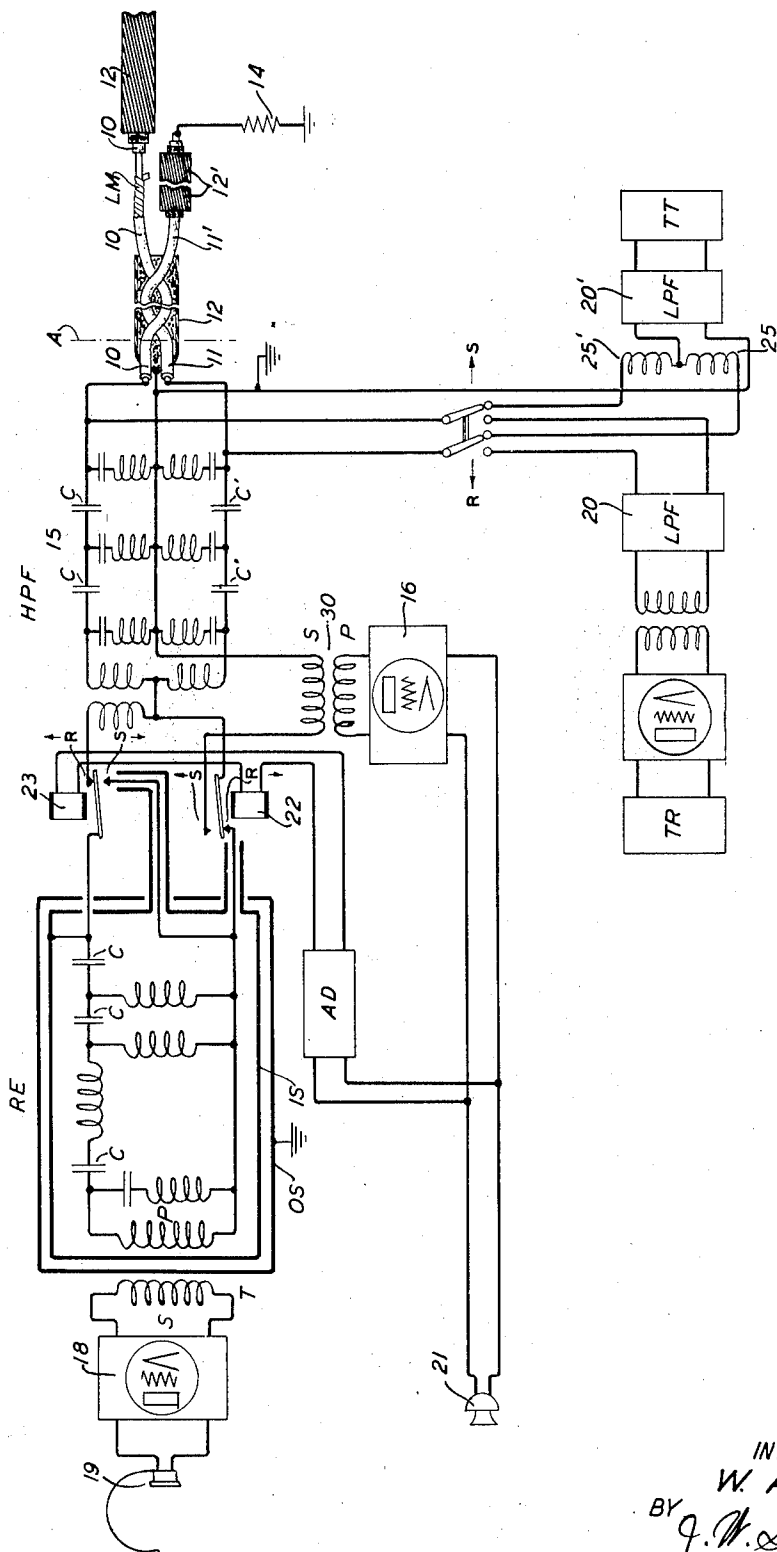
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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The present invention relates to submarine signaling systems, and more particularly to such systems which are adapted for the simultaneous transmission of telephone and telegraph currents over the same line conductor or conductors.

It has been found that when it is attempted to superpose telephone and telegraph currents on loaded deep sea signaling cables, the intelligibility of the messages transmitted suffers from at least two types of disturbances which are inherent in the nature of such a system and which interfere with its successful operation. First, there is a low frequency current which is produced by the interaction of two or more of the voice frequency currents. Second, certain harmonics of the telegraph frequency currents interfere with the voice frequency spectrum of the telephone currents. A further type of interference is caused by the presence of external disturbing currents of atmospheric and/or telluric origin, particularly at the cable terminals of such a system.

A general object of this invention is to improve the intelligibility of telephone and telegraph messages which are simultaneously transmitted over a long submarine signaling line.

Another object of the invention is to prevent modulation effects, which are produced in a loaded deep sea signaling cable by the interaction of the signaling currents with one another or with the characteristics of the loading material, from reaching the receiving apparatus.

A further object of this invention is to reduce or eliminate the effect of external electrical and magnetic disturbances upon the intelligibility of signaling messages transmitted through a deep sea signaling cable.

Still another object of this invention is to prevent the telephone receiving amplifier of a composited submarine signaling system from receiving large voice frequency currents from the telephone transmitting amplifier in case of a defective operation of the relays which are designed to automatically disconnect the receiving amplifier from the signaling line immediately after a subscriber starts speaking.

In pursuance of these objects, this invention contemplates suppressing or reducing the effects of undesired modulation effects by providing a balancing sea-earth cable extending seaward a distance sufficient for balancing out external disturbances, and an additional distance as a separate cable core, its termination being grounded in the usual manner through an im-

pedance element. The cable and sea-earth are connected, on the one hand, through a high pass filter and transmitting and receiving amplifiers to the telephone transmitter and receiver, respectively, and, on the other hand, through a low pass filter to the telegraph transmitter and receiver, respectively. Both telephone currents and telegraph currents are transmitted over the cable and sea-earth in parallel connection, and are received over them in series connection. In this manner the modulation products caused by the interaction of the transmitted voice frequency currents are balanced out and do not enter the telegraph receiver. Likewise, the harmonics caused by the transmitted telegraph signals are balanced out and do not enter the telephone circuit. Also, external interfering disturbances, which affect both the main cable and the balancing sea-earth in the same manner, are balanced out.

A feature of this invention is the provision of a double shield surrounding a part of the input receiving network. In conformity with this feature, if the voice operated switching relay which controls the transmission of voice frequency currents fails to immediately respond to the transmission of voice currents through the transmitting amplifier, the double shield of electrically highly conductive material such as copper (whose inner member would in this case remain connected to the transmitting amplifier) prevents the transmission of amplified voice frequency currents over the transformer to the receiving amplifier, by virtue of the fact that the double shield is interposed between the primary and the secondary of the transformer, whereby the induction of currents in the secondary, and their amplification by the receiving amplifier, and consequently the generation of a loud click or disturbance in the receiving circuit, is prevented.

A preferred embodiment of the present invention will now be described in more detail with reference to the accompanying drawing which shows a composite submarine telephone and telegraph system embodying the features of the invention.

The main cable conductor is shown at 10 and the sea-earth conductor at 11; the latter extends to a distance equal to that at which the depth of the sea is such that the sea water itself forms a shield sufficient to prevent external disturbances. The former may be loaded or non-loaded. It is shown loaded with tapes of loading material LM. The sea-earth conductor 11

is laid together with the main conductor 10 to form a twin core cable surrounded by a common armor 12. Preferably the sections of the insulated main conductor 10 and of the sea-earth conductor 11 are matched or balanced as evenly as possible with respect to their inductance, capacity and impedance characteristics. In this manner 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. At a distance such that the external interference is sufficiently low to permit to dispense with the twinning of the two conductors (this distance depends upon the configuration of the ocean bottom at the shore and may vary from several miles to about 50 miles or more) the sea-earth conductor 11 becomes a separate cable 11' having its own armor 12'. This separate cable may extend seaward a distance of about 100 to 150 miles and its termination is grounded in the usual manner through the impedance element 14. The main cable 10, the sea-earth conductor 11 and the grounded cable armor 12 are connected as shown: through a balanced 200-cycle high pass filter 15, and a transmitting telephone amplifier 16 to the telephone transmitter 21; through a receiving equalizer RE and the telephone receiving amplifier 18 to a telephone receiver 19; through low pass filters 20 and 20' (which have high impedance to telephone currents) to the telegraph transmitting and receiving circuits TT and TR respectively. Voice controlled relays 22 and 23 and amplifying detector AD are provided in the telephone circuit as shown.

The operation of the system is as follows:
When the armatures of both of the voice controlled telephone switching relays 22 and 23 are connected to their sending contacts S, voice frequency currents are transmitted from telephone transmitter 21 through the balanced high pass filter 15 to the cable 10 and sea-earth cable 11 in parallel. Since both the sending and receiving telegraph low pass filters 20 and 20' present a high impedance to the voice frequency currents, their effects are negligible in that range, and no disturbing current is received by the telegraph receiver TR and no such current interferes with the operation of the telegraph transmitter TT. The transmitted telephone currents, because of modulation effects, produce sum and difference tones in the cable 10 and sea-earth 11 in equal amplitudes and in the same phase so that the potentials of the head end of the cable at point A and the head end of the sea-earth at the same point both vary with respect to earth, but there is no potential difference between them, and consequently any modulation products generated in the signaling conductor are ineffective with respect to the receiving apparatus.

When telephone signals are received, i. e., when the armatures of relays 22 and 23 make contact with their contacts R the telephone receiving amplifier 18 is connected in series between the cable 10 and the sea-earth 11 through impedance elements C and C' which present a high impedance to the telegraph frequencies and a low impedance to the telephone frequencies. Choke coils 25 and 25' present a high impedance to the telephone frequencies but readily pass the telegraph frequencies.

External disturbances which are picked up by the shallow water sections of the cable affect both the main cable conductor 10 and the sea-earth conductor 11 in the same manner and consequently are balanced out and have no resultant effect upon the receiving circuits.

If the voice operated switching relay 22 which controls the transmission and reception of voice frequency current is operated to its sending contact S while the armature of relay 23 is still connected to its receiving contact R, in the absence of the inner shield IS high intensity voice frequency currents would be transmitted directly to the input of the receiving amplifier 18 since the circuit would be completed through the capacity to ground of the receiving equalizer network and the secondary winding S of the transmitting transformer 30 (which would be at ground potential, being connected to the grounded cable armor 12). This would produce a serious disturbance in the telephone receiver 19. In accordance with a feature of this invention, this detrimental transmission of amplified voice frequency current over the transformer T to the receiving amplifier 18 will be prevented by the provision of a double shield comprising both an inner member IS and an outer member OS which is interposed between the primary and the secondary of the transformer T. The inner shield IS is conductively connected as shown to the circuit of the receiving equalizer RE. Thus the electrostatic as well as the electromagnetic induction of currents in the secondary winding, and their amplification by the receiving amplifier 18 are prevented. In this manner the generation of a loud click or other disturbance in the telephone receiver 19 is avoided.

What is claimed is:

1. A deep sea signaling system for the simultaneous transmission of telephone and telegraph currents, comprising a main signaling cable, a source of telephone currents, a source of telegraph currents, transmitting devices for transmitting said currents over said cable and receiving devices for receiving said currents from said cable, means for preventing disturbing effects which are produced by the interaction of said telephone and telegraph currents and by external disturbances from reaching the receiving devices, said means including a balancing sea-earth cable, said transmitting devices and receiving devices comprising circuit instrumentalities for transmitting said telephone and said telegraph current over said main and said sea-earth cables in parallel and for receiving said telephone and said telegraph currents over said cables in series.

2. System as defined in claim 1, characterized in that said balancing sea-earth cable extends a distance along said main cable as a twin cable and an additional distance as a separate cable.

3. A system for the simultaneous transmission and reception of telephone and telegraph currents, comprising instrumentalities for transmitting and receiving telephone and telegraph currents, a main signaling conductor and a balancing sea-earth conductor, means for causing the signaling currents to traverse said conductor and sea-earth in series connection on reception of signals and in parallel connection on transmission of signals, and a filter adapted to pass voice frequency currents connected between the point of connection of the telegraph transmitting instrumentalities and the telephone receiving instrumentalities.

4. A composite signaling system comprising a transmitting circuit and a receiving circuit connected to a terminal of a signaling conductor, said receiving circuit comprising a receiving
5 equalizer connected to a receiving amplifier by a transformer, switching elements controlled by signaling currents for disconnecting the receiving circuit when the transmitting circuit is
10 active to transmit signaling currents, and a double shield of electrically conductive material surrounding at least a part of the receiving circuit located with respect to said switching elements remote from said terminal, a part of said
15 shield being interposed between the primary winding and the secondary winding of said transformer.

5. A system in accordance with claim 4 wherein said switching elements comprise a plurality of circuit changing devices and in which a failure
20 of one of said devices to operate causes the transmission of amplified voice frequency currents into the receiving amplifier, the inner member of said shield being conductively connected to the electrical circuit of said receiving
25 equalizer.

6. A composite telephone and impulse telegraphy cable system comprising telephone transmitting apparatus, telephone receiving apparatus, telegraph impulse transmitting apparatus, telegraph impulse receiving apparatus, a main
80 cable, a sea-earth cable and a ground connection, connections whereby said telephone transmitting apparatus is connected to transmit over a circuit comprising said ground connection and the parallel combination of said main cable and
85 sea-earth cable, and connections whereby said telegraph transmitting apparatus is connected to transmit over a circuit comprising said ground connection and the parallel combination of said main cable and said sea-earth cable.
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7. System as defined in claim 6 characterized in that it comprises connections whereby said telephone apparatus is connected to receive over a circuit comprising said main cable and sea-
95 earth cable in series combination, and connections whereby said telegraph impulse receiving apparatus is connected to receive over a circuit comprising said main cable and sea-earth cable in series combination.

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