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SIGNAL TRANSMISSION SYSTEM

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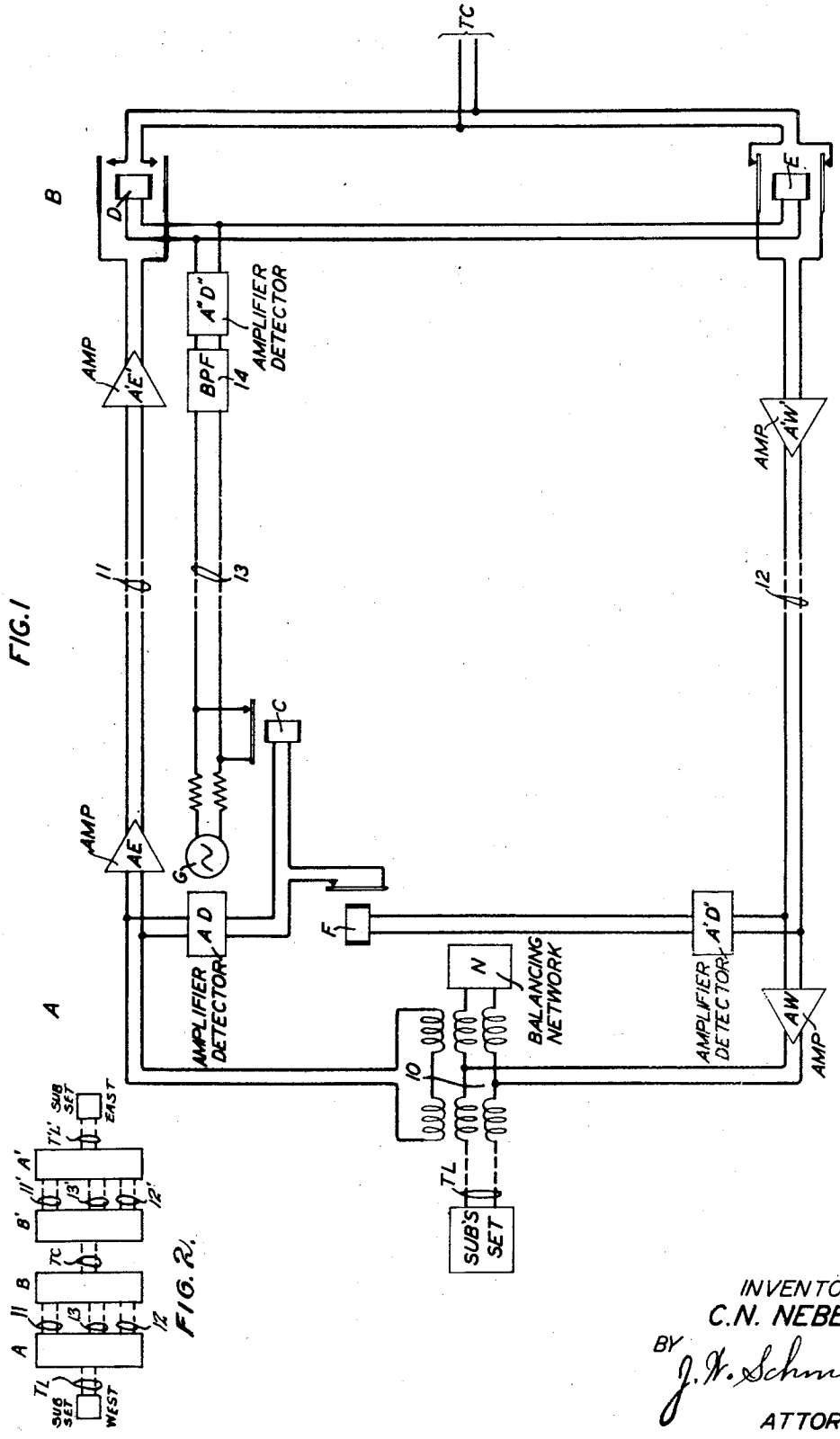

FIG. 1

FIG. 2.

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SIGNAL TRANSMISSION SYSTEM

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This invention relates to signal transmission systems and particularly to telephone cable systems which are electrically long.

An object of this invention is to minimize delays and hangover effects in electrically long telephone systems having large delays in transmission.

A further object of this invention is to make a cable system operate in a more efficacious manner and with less apparatus than heretofore used.

Electrically long transmission systems of great attenuation between repeaters are generally arranged to transmit signals in one direction at a time. Subscriber's voice currents entering the nearby terminal repeater actuate the control means to condition the repeater to transmit the voice currents to the line. Of the two persons conversing over the line the first to begin to talk controls the repeater at his terminal by circuits which introduce a portion of the voice energy into the controlling apparatus for connecting the repeater in the proper direction for transmission. In a certain type of system a so-called courier current is sent out in advance of the voice currents to condition the repeater at the distant terminal for reception of those voice currents. United States patents to H. A. Barton 1,574,781 issued March 2, 1926, R. C. Mathes 1,678,188 issued July 24, 1928 and H. D. Arnold 1,565,302 issued December 15, 1925 disclose several such arrangements. These circuits employ either the same or the same type of electrical transmission path for both the apparatus controlling current and for the speech current. Delay circuits are usually employed to delay the voice currents for an interval of time so that the courier current may proceed ahead of the voice currents to condition the distant repeater for transmitting the message waves in the proper direction.

Controlling currents have also been used in systems wherein the message waves are delayed for a definite interval of time sufficient to insure that the controlling current has already conditioned the distant terminal station for proper transmission of the message waves before the latter are released by the nearby terminal station. This method obviates the possibility of the terminal apparatus at both ends of a transmission line being conditioned at the same time. Such an event otherwise could occur when a controlling current has been sent out from the distant terminal station very shortly before the transmission of the controlling current from the nearby terminal station, but not sufficiently ahead in time to have prevented the transmission of the controlling current from the nearby station. The circuit for preventing such occurrence is termed an "anti-lockout" arrangement. The use of the courier in an "anti-lockout" system materially increases the time required for a party ceasing to talk to hear the first word in reply over the time required when such a system is not used.

In a system in accordance with the principles underlying this invention the controlling or courier current is transmitted over a separate circuit or a separate channel having a higher speed of transmission than that used for the message waves. This high velocity circuit for the courier current may be an open-wire circuit, non-loaded circuit, loaded open-wire circuit, phantom circuit, radio circuit, carrier circuit or any type of circuit having a shorter time of transmission than that used for the message waves. If the voice currents are transmitted over a loaded cable, then a non-loaded cable circuit having the same gauge conductor or a larger gauge conductor than the loaded circuit may be used for the controlling or courier current.

The time of transmission of any of the above mentioned control circuits should be shorter than for the loaded cable circuit for the message waves, the radio circuit having the shortest time of transmission.

This new method of control appreciably decreases the amount of artificial delay necessary at the terminal station nearest the talker and makes the overall transmission time less and, in some cases, eliminates the use of artificial delay circuits altogether.

An advantage of this method of control is that one circuit may be used for the transmission of a large number of couriers to control different paths of speech transmission. If considered desirable, there may be a number of control channels on the same high velocity circuit. In such case, a band-pass filter capable of passing a frequency range of approximately 100 cycles can be inserted in each control channel, thus eliminating from such frequency range other control frequencies and extraneous noises due to interference, static, etc.

This invention is particularly adapted to the shore end of a transatlantic cable system. As an illustration, the shore end in the United States of a New York-Newfoundland to Ireland-

London cable system would be about 1400 miles long. For a No. 19 gauge telephone cable, heavily loaded with an inductance of 44 millihenrys per loading section of 6000 feet, between New York and Newfoundland the time of transmission, including artificial delay, would be about .092 second. By using this invention the usual delay circuits at New York may be omitted from the voice circuit and the overall transmission time made less by .022 second which is the time of delay in the artificial circuit.

A feature of this invention is that the New York technical operator can change operating adjustments of the equipment at Newfoundland by changing the amplitude of the controlling or courier current. Such adjustments may be effected by providing a device in the high velocity channel at Newfoundland which is sensitive to a change in amplitude variation in the courier or controlling current. This device may be arranged to change the gain in an amplifier circuit if desired.

A system arranged in accordance with this invention will now be described with reference to the drawing in which:

Fig. 1 represents one half of this system showing in detail the arrangement of apparatus thereat; and

Fig. 2 represents schematically this system as a whole.

In Fig. 1, a long telephone submarine cable TC is illustrated as having a terminal station B and a repeater station A.

The repeater station A comprises essentially amplifiers AE and AW connected to a subscriber's line section TL through hybrid coil 10 and to land lines 11 and 12. The line section is shown balanced by network N. Bridged across the repeater path east in front of AE is amplifier detector unit AD. A similar unit A'D' is bridged across the path transmitting west in front of amplifier AW. These units are of a type well known in the art, the detailed arrangements being illustrated, for example, in United States Patent 1,560,543 to G. Crisson, November 10, 1925 and include suitable vacuum tube amplifying and rectifying apparatus for rectifying the voice currents to operate relays.

At terminal station B are amplifiers A'E' and A'W' and amplifier detector unit A''D'' which are similar to amplifiers AE and AW and amplifier detector units AD and A'D' respectively, which are located at station A.

When voice currents are transmitted from west to east the unit AD will actuate relay C to cause its normally closed contact to open. This contact normally short-circuits a source of oscillations G. When AD is actuated in response to voice currents transmitted from west to east the contact at relay C is opened and the generator G at once transmits oscillations of the frequency of the generator over high velocity channel 13 to terminal station B, where, after passing through band-pass filter 14 the oscillations actuate unit A''D'' which in turn causes the operation of relays D and E. Relay D, in operating, closes the west to east voice current path to permit the message waves to be sent out over cable TC. Relay E, in operating, opens the receiving or east to west path so that the voice currents transmitted from B cannot find their way back to the subscriber. Channels 11 and 12 are used for the transmission of the voice currents and are slower velocity channels than courier controlling channel 13.

Fig. 2 shows the system as a whole. It is to be understood that the terminal apparatus and associated equipment at the other end of TC is identical with that illustrated at the near end of cable TC. Consequently, the operation of the system as it affects only one set of repeater and terminal stations will be described.

When voice currents are transmitted from west to east they pass through hybrid coil 10 and are amplified by AE prior to passing over channel 11. Before reaching AE a portion of the voice currents enter amplifier detector unit AD which actuates relay C. Relay C in operating, opens the short circuit around high velocity channel 13 and permits oscillations from generator G to be sent out to station B. High velocity channel 13 may comprise any type of channel having better propagation characteristics than those of the voice channels, so that the courier from G will arrive at B and condition the terminal apparatus for transmitting over cable TC before the voice currents arrive. This channel may be an open-wire circuit, non-loaded cable circuit, loaded land circuit, phantom circuit, or any type of circuit having a shorter time of transmission than that used for the transmission of message waves. The courier oscillations transmitted by G pass through filter 14 and actuate amplifier detector A''D'', in turn, operating relays D and E. Relay D, as hereinbefore described, will close through the voice channel 11 to cable TC. Relay E will open the east to west path at its contacts to prevent the voice currents transmitted by B from reentering the system over voice channel 12.

When the west station is in its normal condition, current from the east station will follow the east to west path and will pass through the contacts of relay E and be amplified by amplifiers A'W' and AW. A portion of the voice currents arriving at the west repeater station will enter amplifier detector A'D' and cause the operation of relay F which will open the courier transmitting path. This will prevent the transmission of courier currents from generator G in the event that the subscriber at the west station desires to speak at this time.

It is to be understood, of course, that a single high velocity line comprising several channels may be used to condition several different circuits and that filter circuits may be used to separate courier currents of different frequencies. The amplifier detector units at the terminal stations may be designed, in a manner well known in the art, to be highly selective of any desired frequency. If considered desirable, channel 13 may also be used for other purposes such, as changing operating adjustments at the distant terminal station. This may be effected by changing the amplitude of the courier transmitted over 13 and inserting an amplifier detector at the distant terminal which is sensitive to changes in amplitude for accomplishing any desired purpose, such as affecting the gain in an amplifier.

It will be noted that the delay circuits usually employed in repeater stations, to delay the voice currents for an interval so that the controlling current may proceed ahead for conditioning the distant apparatus, are eliminated in this invention with a consequent decrease in the overall transmission time; advantage being taken of the gain in transmission time of the high velocity

channel over the message wave channels to condition the distant apparatus before the voice currents arrive at that distant station. Delay circuits having a very slight delay may be employed, if considered desirable, particularly in cases wherein the gain in transmission time of the high velocity channel over the voice channels may not be sufficient, in itself, to permit the distant station to be conditioned for a predetermined interval of time before the voice currents arrive at that station. In such cases, the artificial delay in the circuit is appreciably less than the delay necessary when a high velocity channel is not employed.

It is to be understood, of course, that this invention may be used, with slight modifications, in various other organizations without departing from the scope thereof, and that it is not limited to a courier current for conditioning the distant station but may employ a portion of the voice currents for that purpose.

What is claimed is:

1. A two-way communication system comprising in combination a first terminal station and a second terminal station between which alternate transmission in opposite directions is to be had, a submarine cable connecting the terminal stations for transmission of signal current, a repeater station connected to the first terminal station by a first land line for transmission of signal current, said first land line having—exclusive of any delay network anywhere in the communication system—a definite transmission time, apparatus effective upon and controlled by the beginning of transmission of signal current from the repeater station to the first terminal station to send courier current to condition apparatus at the first terminal station for transmission of the signal current over the submarine cable to the second terminal station, and instrumentalities for causing the courier current to arrive at the first terminal station before the arrival of the signal current transmitted from the repeater station, said instrumentalities including a second land line connecting the repeater station to the terminal station, said second land line having—exclusive of any delay network anywhere in the system—a transmission time shorter than said definite transmission time, and instrumentalities for causing the courier current to traverse the second land line.

2. A two-way communication system comprising in combination a first terminal station and a second terminal station between which alternate transmission in opposite directions is to be had, a transmission channel connecting the terminal stations for transmission of signal current, a repeater station connected to the first terminal station by a signal current channel for transmission of signal current, said signal current channel having—exclusive of any delay network anywhere in the communication system—a certain propagation characteristic, apparatus effective upon and controlled by the beginning of transmission of signal current from the repeater station to the first terminal station to send courier current to condition apparatus at the first terminal station for transmission of the signal current over the transmission channel to the second terminal station, and instrumentalities for causing the courier current to arrive at the first terminal station before the arrival of the signal current transmitted from the repeater station, said instrumentalities including a courier current channel connecting the repeater station to the terminal station, said courier current channel having—exclusive of any delay network anywhere in the communication system—a propagation characteristic of higher velocity than said certain propagation characteristic, and instrumentalities for causing the courier current to traverse the courier current channel.

3. A two-way communication system comprising in combination a first terminal station and a second terminal station between which alternate transmission in opposite directions is to be had, a transmission channel connecting the terminal stations for transmission of signal current, a repeater station connected to the first terminal station by a signal current channel, apparatus effective upon and controlled by the beginning of transmission of signal current from the repeater station to the first terminal station to send courier current to condition apparatus at the first terminal station for transmission of signal current over the transmission channel to the second terminal station, and instrumentalities for causing the courier current to arrive at the first terminal station before the arrival of the signal current transmitted from the repeater station, said instrumentalities including a courier current channel connecting the repeater station to the terminal station, and transmission apparatus for causing the courier current to traverse the courier current channel, said courier current channel comprising a medium which has—exclusive of any delay network anywhere in the communication system—a higher transmitting velocity than the signal current channel.

4. A two-way communication system comprising in combination a first terminal station and a second terminal station between which alternate transmission in opposite directions is to be had, a transmission channel connecting the terminal stations for transmission of signal current, a repeater station connected to the first terminal station by a signal current channel, normally operable circuit conditioning apparatus effective upon and controlled by the beginning of transmission of signal current from the repeater station to the first terminal station to send courier current to condition apparatus at the first terminal station for transmission of signal current over the transmission channel to the secord terminal station, and instrumentalities for causing the courier current to arrive at the first terminal station before the arrival of the signal current transmitted from the repeater station, said instrumentalities including a courier current channel connecting the repeater station to the terminal station, transmission apparatus for causing the courier current to traverse the courier current channel, said courier current channel comprising a medium which has—exclusive of any delay network anywhere in the communication system—a higher transmitting velocity than the signal current channel, and receiving apparatus responsive to the reception by the first terminal station of signal current transmitted by the second terminal station over the transmission channel for disabling said normally operable circuit conditioning apparatus.

5. A two-way communication system comprising in combination a first terminal station and a second terminal station between which alternate transmission in opposite directions is to be had, a transmission channel connecting the ter-

minal stations for transmission of signal current, a repeater station connected to the first terminal station by a signal current channel having—exclusive of any delay network anywhere in the communication system—a definite transmission time, normally disabled apparatus at the first terminal station for transmission of signal current over the transmission channel to the second terminal station, normally operable apparatus at the first terminal station for the reception of signal current transmitted by the second terminal station over the transmission channel, apparatus effective upon and controlled by the beginning of transmission of signal current from the repeater station to the first terminal station to send courier current to the first terminal station for rendering said normally disabled apparatus operable and for disabling said normally operable apparatus, and instrumentalities for causing the courier current to arrive at the first terminal station before the arrival of the signal current transmitted from the repeater station, said instrumentalities including a courier current channel connecting the repeater station to the terminal station, said courier current channel having—exclusive of any delay network anywhere in the communication system—a transmission time shorter than said definite transmission time, and transmission apparatus for causing the courier current to traverse the courier current channel.

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