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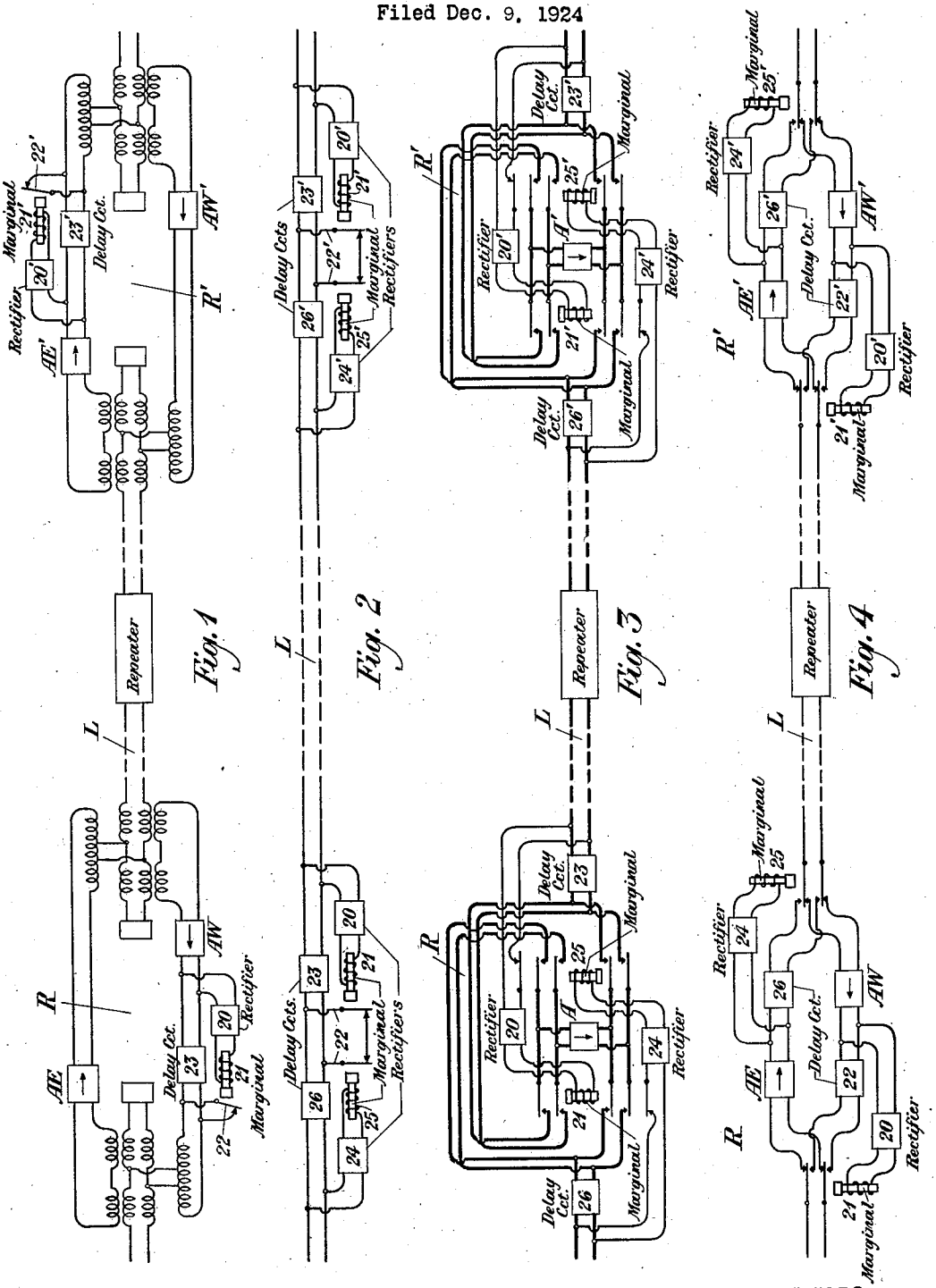


Fig. 1 Fig. 2 Fig. 3 Fig. 4

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MEANS TO CONTROL CROSS TALK.

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To all whom it may concern:

Be it known that we, ARTHUR G. CHAPMAN and RALPH G. McCURDY, residing at East Orange and Englewood, in the counties of Essex and Bergen and States of New Jersey and New Jersey, respectively, have invented certain Improvements in Means to Control Cross Talk, of which the following is a specification.

This invention relates to transmission circuits and more particularly to arrangements for reducing crosstalk or interference upon such circuits.

In designing telephone transmission circuits with respect to crosstalk limitations there are two factors to be taken into consideration, first, the effect of the crosstalk upon the intelligibility of the conversation while talking is taking place, and, second, the absence of secrecy during gaps in the conversation. The latter factor determines the limiting condition for the reason that the maximum crosstalk current which would be permissible without rendering the conversation unintelligible will be greater than the maximum crosstalk which may be permitted without rendering such crosstalk understandable during gaps in the conversation.

It will be evident that if it were possible to reduce or eliminate the crosstalk when conversation is not taking place over the circuit, lack of secrecy would not have to be taken into consideration in designing the circuits with respect to crosstalk and therefore a greater amount of crosstalk might be permitted without rendering the circuits uncommercial. In accordance with the present invention it is proposed to eliminate or reduce the crosstalk during such intervals as conversation is not taking place by providing arrangements for normally disabling the circuit for transmission purposes, such disabling means being removed, however, under the control of voice currents when conversation takes place.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, Figures 1, 2, 3 and 4 of which illustrate schematically four different forms of embodiment of the invention.

In general, the invention comtemplates the provision of a short circuit or other disabling means normally applied near each end of the transmission circuit to prevent crosstalk currents induced in the circuit along its length from being transmitted in either direction past the disabling point to a subscriber. Voice control apparatus is provided for removing the short circuit or otherwise rendering the circuit operative as soon as voice currents are applied from either subscriber's station. The voice responsive means for controlling the disabling apparatus should be marginal so that it will not respond to the maximum crosstalk currents which may be permitted, but will readily respond to even very weak voice currents transmitted from the subscriber.

Referring to Fig. 1, L designates a telephone transmission line of any well known type, provided, if desired, with repeaters at suitable points along its length. Near each terminal two-way repeaters R and R′ are provided. The repeater R comprises a channel for transmitting east, including an amplifier AE, and a channel for transmitting west, including an amplifier AW. The channel transmitting west includes voice operated apparatus, comprising a rectifier 20 of well known type for converting the voice currents into direct current components and a voice operated relay 21 responsive to the rectified currents. The relay 21 is arranged, when energized, to open a short circuit 22, bridged across the west transmission path of the repeater R. In order that the relay may remove the disabling means as quickly as possible it should be so designed as to attract its armature very quickly. Consequently, as soon as the armature begins to move the short circuit will be opened and it will not be necessary to take up the entire amount of time that would be necessary to move the armature from one limit to the other. In order to prevent the voice currents from being transmitted to the point at which the short circuit is applied until after the relay 21 has had time to open the short circuit, a delay circuit 23 may be included between the repeater AW and the short circuit 22. The relay 21 should be slow to release its armature so that at the end of a syllable the short circuit 22 will not be closed until

after the latter part of the syllable has been transmitted through the delay circuit.

The repeater R′ is similar to the repeater R, comprising an amplifier AE′ in the path transmitting east and an amplifier AW′ in the path transmitting west. Controlling apparatus is provided in connection with the path transmitting west, said controlling apparatus comprising rectifier 20′, quick-acting and slow-release relay 21′, a short circuit 22′ controlled by the relay, and a delay circuit 23′. These elements function in a manner similar to those already described in connection with the repeater R.

Both the relays 21 and 21′ are marginal in their action so that they will not respond to the maximum crosstalk currents which may be permitted without rendering conversation unintelligible, but will respond to the smallest voice currents transmitted over the circuit from the subscribers' stations. It will also be noted that the short circuit 22 normally disables the circuit for transmission from east to west, while the short circuit 22′ normally disables the circuit for transmission from west to east.

If the east subscriber should begin talking, the currents will be transmitted through the amplifier AW′ over line L and through the amplifier AW. The crest of the wave entering the circuit, including the rectifier 20, operates the marginal relay 21 to open the short circuit 22, the delay circuit 23 permitting this operation to take place before the crest of the wave reaches the point at which the short circuit 22 is applied. The voice currents then pass on to the west subscriber. If the west subscriber should begin talking the currents will be transmitted through the amplifier AE, over the line L, and through the amplifier AE′, thus actuating the relay 21′ to remove the short circuit 22′, permitting the currents to pass on to the east subscriber. During gaps in the conversation the circuit is disabled for transmission in either direction by means of the short circuit 22 near the west terminal of the line, which prevents transmission from east to west, and by means of the short circuit 22′ near the east terminal of the line, which prevents transmission in the opposite direction. Crosstalk currents arising along the line L between the terminals cannot be transmitted beyond the short circuited points and hence cannot be heard by the subscribers during the gaps in the conversation. Loss of secrecy will accordingly be prevented.

Where the circuit is not provided with repeaters the voice-operated controlling means may be applied near the terminals, as illustrated in Fig. 2, instead of being applied at terminal repeater points, as in Fig. 1. The disabling arrangement near the west terminal comprises a short circuit 22, controlled by either of two marginal relays 21 or 25. The relay 21 is controlled by rectified voice currents supplied by a rectifier 20, which is in turned bridged across the line L, with a delay circuit 23 between the points at which the rectifier is bridged across the line and the point at which the short circuit 22 is applied. Similarly, in response to voice currents transmitted from west to east, the short circuit 22 is controlled by the relay 25, which is connected with a rectifier 24 bridged across the west terminal of the line. A delay circuit 26 is interposed between the point at which the rectifier is applied to the line and the point at which the short circuit 22 occurs. A similar arrangement is provided at the east terminal of the line.

Under normal conditions when no conversation is taking place the line L is short circuited near each terminal by the short circuits 22 and 22′ respectively. If the east subscriber begins to talk to the west subscriber voice currents rectified by the rectifier 20′ operate the slow-release relay 21′ to open the short circuit 22′. The delay circuit 23′ prevents the crest of the voice wave from arriving at the short circuited point until this operation takes place. Upon opening the short circuit the voice currents pass through the delay circuit 26′ and on over the line L to the distant terminal. The voice currents arriving at the west terminal are rectified by the rectifier 20 and operate the relay 21 to open a short circuit 22. The delay circuit 23 permits this operation to take place before the voice currents arrive at the point at which the short circuit is applied. As soon as the short circuit is opened the voice currents pass on through the delay circuit 26 to the west subscriber. If the west subscriber talks to the east subscriber, the operation will be reversed, the relays 25 and 25′ being operated to open the short circuits 22 and 22′.

In this case, as in the case previously described, the relays 21, 21′, 25 and 25′ must be constructed to operate upon very narrow margins so that they will not respond to the maximum crosstalk currents but will respond to the weakest voice currents transmitted by the subscribers.

A modified arrangement is illustrated in Fig. 3, which enables the use of repeaters which are not provided with balancing arrangements at the terminal repeater points. A single amplifying element A is provided which may be switched to transmit either east or west in a manner to be described. A rectifier 20 is bridged across the line L near the point at which it enters the repeater R for the purpose of supplying rectified currents to the marginal relay 21. Similarly, a rectifier 24 is bridged across the west terminal for supplying rectified currents to the marginal relay 25.

Relay 21, when energized, performs three

functions: First, it connects the input side of the amplifer A to the west terminal of the line L; second, it connects the output side of the amplifier A to the subscriber's line going west, and, third, it opens the bridge circuit including the rectifier 24 and the relay 25. Similarly, the relay 25, when energized, connects the input circuit of the amplifier A to the subscriber's line west, connects the output circuit of the amplifier A to the west terminal of the line L, and disables the circuit including the rectifier 20 and the relay 21. The apparatus associated with the repeater R' is similar to that described in connection with the repeater R.

It will be obvious that during periods when no conversion is taking place on the line the circuit is disabled at both terminals, thereby preventing the transmission of crosstalk currents to either subscriber. If the west subscriber begins to talk, however, the relay 25 will be operated to switch the amplifier A into the circuit in a direction to transmit from west to east, at the same time disabling the rectifier 20. The delay circuit 26 permits the switching operation to take place before the crest of the voice wave is transmitted through the delay circuit and arrives at the switching point controlled by the relay 25. A similar operation takes place in connection with the relay 25' of the repeater R', thereby enabling the transmission to take place over the complete circuit from west to east.

If the east subscriber commences talking, the relay 21' of repeater R' and the relay 21 of the repeater R are energized to connect the amplifiers A' and A for transmission from east to west. In this case, as in those previously described, the various marginal relays must be designed so that they will not respond to the maximum crosstalk currents which are permissible without causing unintelligibility, at the same time being readily responsive to the weakest currents transmitted by subscribers conversing over the line.

Fig. 4 shows an arrangement similar to that of Fig. 3 except that the terminal repeaters are each provided with two amplifiers, one for transmitting east and one for transmitting west. For example, the repeater R is provided with an amplifier AE, the input of which is normally connected to the line leading to the west subscriber and the output of which is normally disconnected from the line L. The repeater is also provided with an amplifier AW, the input of which is normally connected to the line L, and the output of which is normally disconnected from the line leading to the west subscriber. A rectifier 20 and marginal relay 21 are bridged across the output side of the amplifier AW and when operated serve to disconnect the input of the repeater AE from the line leading to the west subscriber and to connect the output of the amplifier AW to the line leading to the west subscriber. A delay circuit 22 enables the switching operation to take place before the crest of the voice wave arrives at the switching point. Similarly, a rectifier 24 and marginal relay 25 are bridged across the output side of the amplifier AE, these elements, when operated, functioning to disconnect the input side of the amplifier AW from the line L and to connect the output side of the amplifier AE to said line. The delay circuit 26 permits this switching operation to take place before the voice currents arrive at the switching point. The apparatus at repeater R' is similar to that already described.

Normally, the circuit is disabled for transmission in either direction by reason of the fact that the output circuit of each of the amplifiers is open-circuited. Consequently, during periods when no conversation is taking place, crosstalk currents arising at any point along the line L between the repeater stations cannot be transmitted to the subscribers. If the west subscriber commences to talk, the marginal relay 25 will be operated to switch the line L to the output side of the amplifier AE. The voice currents may then pass through the amplifier AE and the delay circuit 26 to the line L. Upon arriving at the repeater R' the marginal relay 25' operates to connect the line going to the east subscriber with the output circuit of the amplifier AE'. Similarly, if the east subscriber commences to talk, relays 21' and 21 will operate to connect the output sides of amplifiers AW' and AW to the east terminal of the line L and to the line going to the west subscriber respectively, so that the voice currents may be transmitted from end to end in the direction from east to west. Here, again, the relays performing the switching operations must be marginal to prevent being responsive to crosstalk currents while readily responding to west signaling currents transmitted by the subscriber.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a transmission system, a telephone line interconnecting two subscribers' stations, means to normally prevent transmission from said line to either subscriber's station, and means responsive to voice currents originating at a subscriber's station for permitting transmission from said subscriber's station over the line to the other subscriber's station, said means being unresponsive to crosstalk currents induced in the line.

2. In a transmission system, a telephone

line interconnecting two subscribers' stations, means associated with said line near the station terminals thereof to normally prevent transmission from the line to the stations, and means responsive to voice currents originating at one of said stations to arrange the circuit so that currents may be transmitted from said station over said line to the other subscriber's station, said last mentioned means being unresponsive to crosstalk currents induced in the line.

3. In a transmission system, a telephone line interconnecting two subscribers' stations, switching means normally rendering said line inoperative for transmission to either station, and means responsive to voice currents for controlling said switching means, said means being unresponsive to crosstalk currents induced in the line.

4. In a transmission system, a telephone line interconnecting two subscribers' stations, switching means normally rendering said line inoperative for transmission to either station, and means responsive to voice currents transmitted from one of said stations to control said switching means so as to enable transmission from said station over said line to the other station, said last mentioned means being unresponsive to crosstalk currents induced in the line.

5. In a transmission system, a telephone line interconnecting two subscribers' stations, switching means near one station terminal of the line for disabling the line for transmission from the line to that station, means responsive to voice currents transmitted over the line in a direction towards said station for controlling said switching means to permit transmission in that direction, said means being unresponsive to crosstalk currents induced in the line, switching means near the other station terminal of said line for preventing transmission from said line to the other terminal station, and means responsive to voice currents transmitted over the line in a direction towards said other station for controlling said last mentioned switching means to permit transmission over the line to said other station, said means being unresponsive to crosstalk currents induced in the line.

6. In a transmission system, a telephone line interconnecting two subscribers' stations, two-way repeaters associated with said line near each station terminal thereof, means normally disabling one of said repeaters for transmission in one direction, means for normally disabling the other repeater for transmission in the opposite direction, and means responsive to voice currents originating at either station for controlling said disabling means to permit transmission between stations, said means being unresponsive to crosstalk currents induced in the line.

7. In a transmission system, a telephone line interconnecting two subscribers' stations, means normally disabling said line for transmission during intervals when voice currents are not present, and means responsive to voice currents transmitted from one of said stations to enable transmission to take place over said line, said last mentioned means being unresponsive to crosstalk currents induced in the line.

In testimony whereof, we have signed our names to this specification this 8th day of December 1924.

ARTHUR G. CHAPMAN.
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