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TWO-WAY RADIO TELEPHONE SYSTEM

Original Filed April 19, 1924

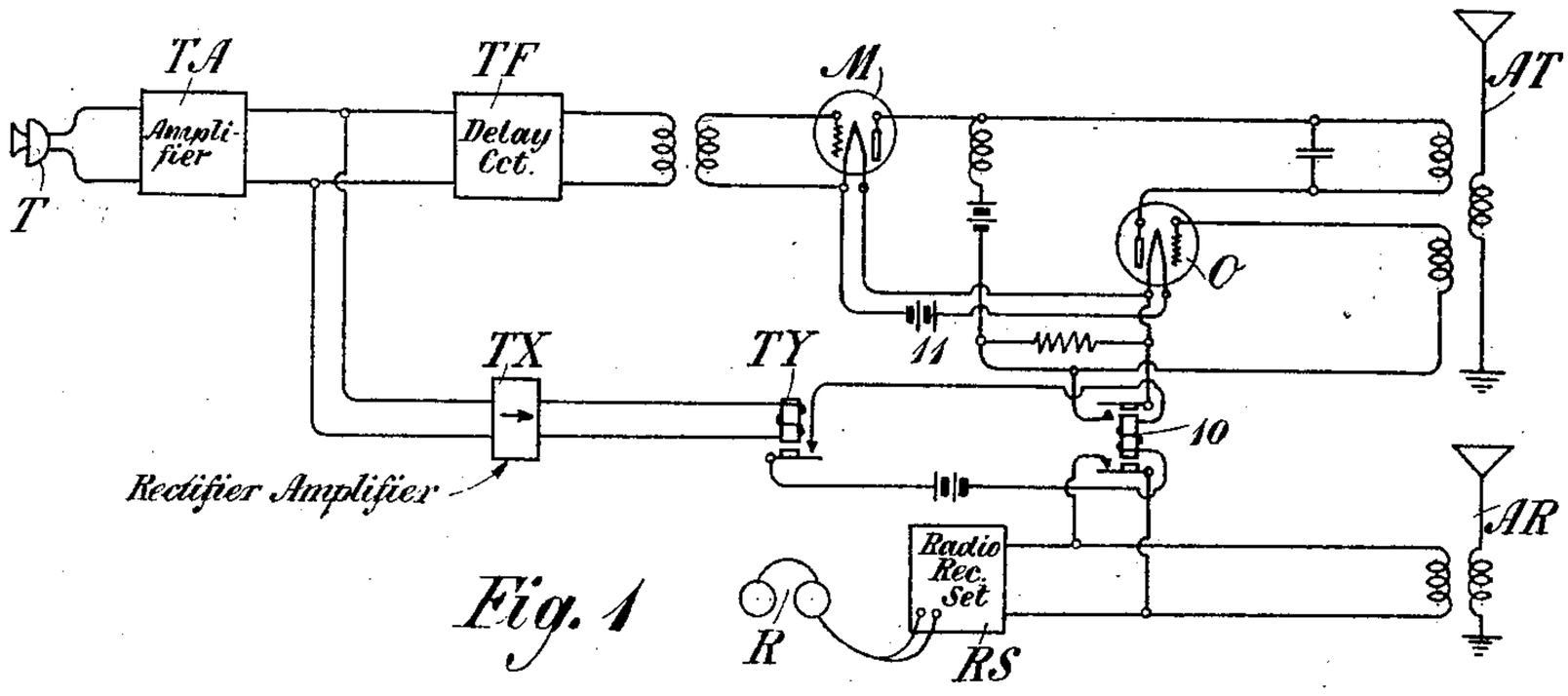

Fig. 1

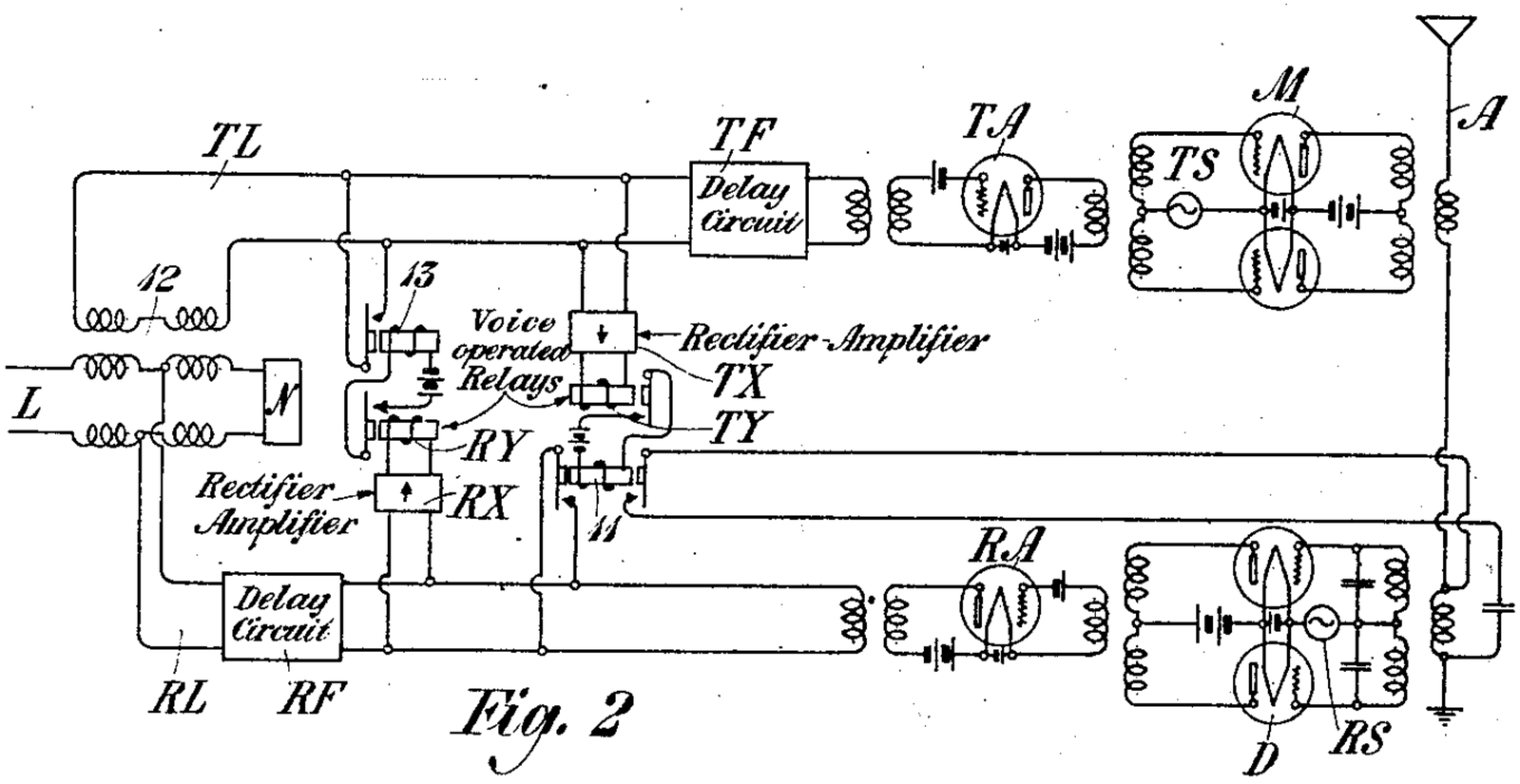

Fig. 2

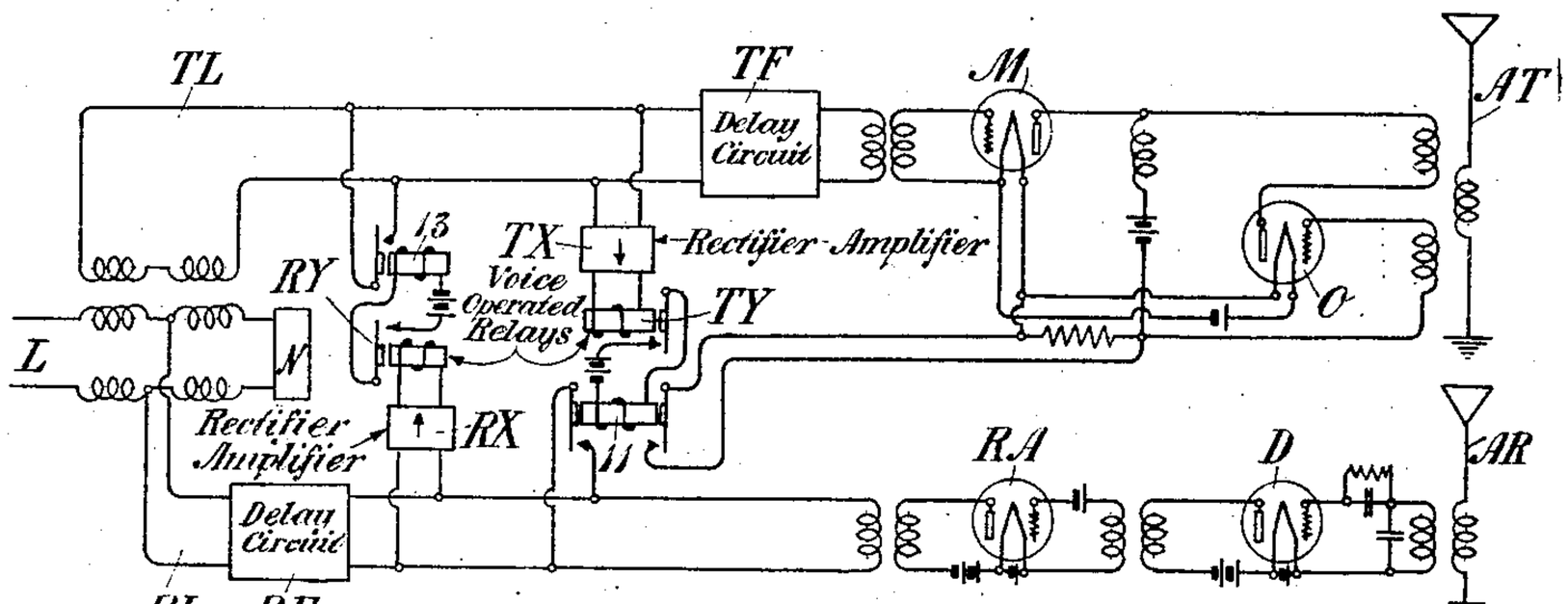

Fig. 3

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TWO-WAY RADIO TELEPHONE SYSTEM.

Application filed April 19, 1924, Serial No. 707,720. Renewed September 2, 1926.

This invention relates to radio transmission, and more particularly to arrangements for permitting the carrying on of a two-way conversation by radio.

Heretofore it has been quite difficult to carry on a two-way conversation by radio for a number of reasons. Where the same antenna is employed both for transmitting and receiving, it has been found impractical to balance the transmitting channel against the receiving channel sufficiently well to prevent overloading the receiver with transmitted energy. Where different antennæ are employed for transmitting and receiving and even where different wave lengths are employed, the amount of energy received by the radio receiver from the transmitting antenna has been too great for successful operation unless the transmitting and receiving antennæ are separated by prohibitive distances. Even where the transmitting channel is balanced against the receiving channel and different wave lengths are employed for transmission and reception, an undue amount of sending energy finds its way to the receiver. Another difficulty that has been encountered in all these cases is that energy received from a distant radio station, after detection finds its way back into the transmitting channel through the connection to a terminal line and is reradiated.

In accordance with the present invention these difficulties are overcome by associating voice operated equipment with both the transmitting and receiving channels. The voice operated equipment associated with the transmitting channel is arranged to disable the receiving circuit and, if the transmitter is normally inoperative, to render the transmitter operative in response to voice currents impressed upon the circuit. Preferably a delay circuit is interposed between the point at which the voice operated apparatus is associated with the channel and the transmitter so that the voice controlled means may perform its functions before the voice current reaches the transmitter thus avoiding any hiatus or clipping off of the first part of the speech signal. The voice operated apparatus associated with the receiver is likewise arranged so that it responds to received radio signals to disable the transmitting circuit and prevent the received voice currents from entering the transmitting circuit to be retransmitted. Preferably a delay circuit will be employed in the receiver circuit at a point beyond the voice responsive apparatus so that the latter may perform its function before the received voice currents will have had an opportunity to enter the transmitting channel.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which illustrate three different embodiments of the invention.

Referring to Fig. 1, a simple form of the invention is illustrated. In this figure, T designates an ordinary telephone transmitter connected to an amplifier TA, conventionally represented. This amplifier may be of any type well known in the art. O designates a vacuum tube oscillator for supplying the carrier frequency to the antenna AT, and M is a vacuum tube modulator having its input associated with the voice frequency amplifier TA and having its output associated with the oscillator O in such a manner that the oscillations produced by the oscillator will be modulated in accordance with speech. A delay circuit TF is interposed between the amplifier TA and the modulator M. This delay circuit may be any type of transmission element which will cause a desired time interval to elapse during the transmission of a wave from its input terminals to its output terminals. For example, the delay circuit may be one of the well known types of Campbell filters so designed as to transmit the desired voice band.

AR designates the receiving antenna which is coupled with a radio receiving set RS of any well known type, the receiver R being associated with the receiving set in the usual manner. Voice operated equipment is associated with the transmitting circuit between the amplifier TA and the delay circuit TF, said equipment comprising a rectifier-amplifier combination, conventionally indicated at TX, and a voice operated relay TY. The rectifier-amplifier combination may be of any well known type, such as a vacuum tube amplifier associated with a vacuum tube rectifier, these devices operating one to amplify the voice currents and

the other to rectify them and produce therefrom a direct current component which will operate the voice relay TY. A relay 10 is controlled by the voice operated relay TY and has its contacts so arranged that when energized in response to transmitted voice signals it will short-circuit the receiving set RS and change the grid potential of the oscillator O so that the grid of the oscillator, which is normally excessively negative, will have such a negative potential applied thereto as to permit it to generate oscillation.

The operation is as follows: When the transmitter T is spoken into, voice currents are generated and amplified by the amplifier TA and then impressed upon the rectifier-amplifier combination TX so that a direct current component is produced which operated the voice relay TY. The circuit of the relay 10 is accordingly closed, and at its lower contact said relay short-circuits the radio receiver RS. At the same time the upper contact of the relay 10 short-circuits the resistance 11 thereby changing the negative potential on the grid of the oscillator O so that the oscillator, which is normally unable to function, will now begin to generate oscillations of the carrier frequency to be transmitted to the antenna AT. In the meantime the voice currents are transmitted from the amplifier TA through the relay circuit TF and arrive at the modulator M after the relay 10 has had an opportunity to function. The voice currents therefore operate through the modulator M to modulate the oscillations generated by the oscillator O, and the modulated oscillations are transmitted by the antenna AT without any hiatus or clipping off of the first part of the voice signal. The energy radiated from the transmitting antenna AT to the receiving antenna AR is ineffective to produce any action upon the receiving set RS because said set is short-circuited before any radiation takes place. In receiving signals from a distant station, the relay 10 being normally deenergized, the received signals are impressed directly from the antenna AR upon the radio receiving set, and after being detected the voice currents may be heard in the receiver R. As the receiver R of the transmitter T has no electrical connection with the transmitter in the case illustrated, no difficulty will arise because of the received signals being retransmitted by the transmitting channel.

In case, however, the **transmitting** and receiving channels are both associated with a common telephone line, a certain amount of received energy may be passed into the transmitting channel and reradiated. In order to overcome this difficulty, the circuit may be arranged as shown in Fig. 2 in which L designates an ordinary voice frequency transmission line which is connected through a hybrid coil 12 with the transmitting channel TL and the receiving channel RL, the line being balanced by a suitable network N so that a condition approaching conjugacy will exist between the transmitting channel and the receiving channel. The transmitting channel includes a delay circuit TF, an amplifier TA and a modulator M. The latter is of the well known balanced type arranged so that the carrier will be suppressed.

The receiving channel includes a balanced detector D, the receiving amplifier RA and the delay circuit RF. The balanced detector is supplied with a local source of carrier current RS so that it operates on the well known homodyne principle. The delay circuits RF and TF may be filters of the Campbell type designed to transmit the desired range of voice frequencies. On the input side of the delay circuit TF is bridged a rectifier-amplifier combination TX for operating the voice relay TY. The latter controls a relay 11 which short-circuits the receiving channel at some suitable point, for example, between the detector D and the delay circuit RF. The relay 11 may also change the tuning of the antenna A where a different frequency is employed for transmission and reception and the same antenna is used for both purposes. A similar rectifier-amplifier combination RX controlling the voice relay RY is bridged across the receiving channel upon the input side of the delay circuit RF to control a relay 13, which, in response to a received signal, short-circuits the transmitting channel TL.

The operation is as follows: Voice currents incoming from the line L are transmitted through the hybrid coil 12 and are impressed upon the rectifier-amplifier TX to energize the voice operated relay TY. This relay completes the circuit of relay 11, which, at its left-hand front contact, closes a short-circuit for the receiving channel RL between the amplifier RA and the delay circuit RF. Relay 11 at its right-hand front contact closes a circuit including a tuning condenser for changing the tuning of the antenna A so that it will be resonant at the transmitting frequency rather than at the receiving frequency. While these operations are taking place, the voice currents are transmitted through the delay circuit TF and after being amplified by the amplifier TA are impressed upon the modulator M. A sufficient delay occurs in transmission through the circuit TF so that the voice currents are not impressed upon the modulator M until after the relay 11 has performed its functions. Any transmitted energy which passes by way of the antenna into the receiving detector D is prevented from being transmitted through the receiving channel

of the line L to the transmitting channel TL by reason of the short-circuit across the channel RL previously described.

The antenna A is normally tuned to the receiving frequency, and when signals are received from a distant transmitting station the received radio frequency is impressed upon the detector D so that the voice currents are detected in its output circuit and impressed upon the amplifier RA. After being amplified by the latter, the voice currents pass into the circuit of the rectifier-amplifier RX and operate the voice relay RY which closes the circuit of the relay 13. The relay 13 in turn closes a short-circuit for the transmitting channel TL. In the meantime the voice waves pass through the delay circuit RF and into the line L. Any component of the voice wave which enters the transmitting channel TL by reason of unbalance is ineffective to operate the radio transmitter because of the short-circuit closed by the relay 13.

It will be observed that in the circuit above described both the transmitting channel and the receiving channel are normally operative. As soon as transmission takes place over one of these channels, however, the channel transmitting in the other direction is disabled so that no transmitting energy can affect the receiving circuit and no receiving energy can affect the radio transmitter. By means of the delay circuits TF and RF the voice operated relays are given time to operate and perform their functions before the voice waves pass into the circuits beyond the delay circuits.

The use of a modulator and detector of the balanced type, such as is illustrated in Fig. 2, is not essential to the proper operation of the circuit. For example, in Fig. 3 the modulator M and oscillator O are of the type shown in Fig. 1, and separate antennæ AT and AR are used for transmitting and receiving respectively. The radio receiving apparatus may comprise the detector D of the ordinary unbalanced type and an amplifier RA for amplifying the detected signals. The voice operated relay TY is arranged to short-circuit the receiving channel RL, and the voice operated relay RY is arranged to short-circuit the transmitting channel TL and to render the oscillator O operative.

The operation is as follows: Voice currents received from the line L pass into the channel TL and operate the rectifier-amplifier combination TX to energize the voice relay TY. The latter closes the circuit of the relay 11 which completes the short-circuit for the receiving channel RL between the delay circuit RF and the detector D. The relay 11 also changes the potential of the oscillator O in the manner shown in Fig. 1 so that the oscillator O generates oscillations. In the meantime the voice currents are passed through the delay circuit TF and arrive at the modulator M after a sufficient delay to permit the relay 11 to perform its functions. Any energy radiated from the transmitting antenna AT to the receiving antenna AR is without effect upon the receiving channel because the latter is short-circuited by relay 11.

When signals are being transmitted from the distant communicating system, they are impressed by the antenna AR upon the detector D which detects the voice frequency component, and this component is amplified by the amplifier RA. The voice currents are then passed into the rectifier-amplifier RX to operate the voice relay RY, which, in turn, closes the circuit of the relay 13. Relay 13 completes a short-circuit across the transmitting channel TL. In the meantime the voice currents are transmitted through the delay circuit RF to the line L, and any received voice currents passing into the transmitting channel TL by reason of unbalance will be without effect because the relay 13 will have short-circuited the transmitting channel before such currents can be impressed upon the channel. The operation of the relay 13 in both Fig. 2 and Fig. 3 also prevents received voice currents which are transmitted to the line L and reflected back by reason of some impedance irregularity from producing any effect in the transmitting channel TL.

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 radio system, a radio transmitting channel and a radio receiving channel, radio transmitting apparatus in said transmitting channel and radio receiving apparatus in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have signal modulated energy applied thereto by said transmitting channel, a voice responsive relay associated with said transmitting channel and responsive to voice currents to disable said receiving channel, and a delay circuit interposed between said voice responsive relay and said radio transmitting apparatus to enable said relay to perform its function before the voice currents are impressed upon said transmitting apparatus.

2. In a radio system, a radio transmitting channel and a radio receiving channel, radio transmitting apparatus in said transmitting channel and radio receiving apparatus in said receiving channel, said receiving channel being normally operatively conditioned

to function for receiving purposes, a transmitting antenna normally conditioned to have signal modulated energy applied thereto by said transmitting channel, a voice responsive relay associated with said transmitting channel and responsive to voice currents to disable said receiving channel and render said transmitting apparatus operative, and a delay circuit interposed between said voice responsive relay and said radio transmitting apparatus to enable said relay to perform its function before the voice currents are impressed upon said transmitting apparatus.

3. In a radio system, a radio transmitting channel and a radio receiving channel, radio transmitting apparatus in said transmitting channel and radio receiving apparatus in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, a voice responsive relay associated with said transmitting channel and responsive to voice currents to disable said receiving channel, a delay circuit interposed between said voice responsive relay and said radio transmitting apparatus to enable said relay to perform its function before the voice currents are impressed upon said transmitting apparatus, and a voice responsive relay associated with said receiving channel and responsive to detected voice currents for disabling said transmitting channel.

4. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated with said telephone line, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, and both of said channels being normally operative, the one to receive and the other to transmit, means responsive to the transmission of currents into said transmitting channel to disable the receiving channel, and means responsive to the transmission of currents into said receiving channel to disable said transmitting channel.

5. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated with said telephone line, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, and both of said channels being normally operative, the one to receive and the other to transmit, means responsive to voice currents entering said transmitting channel for disabling said receiving channel, and means responsive to detected voice currents in said receiving channel for disabling said transmitting channel.

6. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated with said telephone line, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel and both of said channels being normally operative, the one to receive and the other to transmit, means responsive to voice currents entering said transmitting channel for disabling said receiving channel, and means to delay the transmission of said voice currents to said transmitting apparatus until said receiving channel has been disabled, means responsive to detected voice currents in the receiving channel for disabling the transmitting channel, and means to delay the transmission of voice currents to said telephone line until the transmitting channel has been disabled.

7. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to currents entering said transmitting channel to disable said receiving channel and render said radio transmitting apparatus operative, and means responsive to currents entering said receiving channel for disabling said transmitting channel.

8. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to voice currents entering said transmitting channel for disabling said receiving channel and for rendering said radio transmitting apparatus operative, and means responsive to detected voice currents in said receiving channel for disabling said transmitting channel.

9. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said

transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to voice currents entering said transmitting channel for disabling said receiving channel and rendering said radio transmitting apparatus operative, means to delay the transmission of voice currents to said radio transmitting apparatus until said last mentioned means has functioned, means responsive to voice currents detected in the receiving channel for disabling said transmitting channel, and means to delay the transmission of voice currents to said telephone line until said last mentioned means has functioned.

10. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to currents entering said transmitting channel to disable said receiving channel, and means responsive to currents entering said receiving channel for disabling said transmitting channel.

11. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to voice currents entering said transmitting channel to disable said receiving channel, and means responsive to the voice currents detected in said receiving channel for disabling said transmitting channel.

12. In a radio system, a telephone line, a radio transmitting channel and a radio receiving channel associated therewith, radio transmitting apparatus included in said transmitting channel and radio receiving apparatus included in said receiving channel, said receiving channel being normally operatively conditioned to function for receiving purposes, a transmitting antenna normally conditioned to have energy applied thereto by said transmitting channel, means responsive to voice currents entering said transmitting channel to disable said receiving channel, means to delay the transmission of said voice currents to said radio transmitting apparatus until said receiving channel has been disabled, means responsive to voice currents detected in the receiving channel for disabling said transmitting channel, and means to delay the transmission of voice currents to said telephone line until said transmitting channel has been disabled.

13. A two-way signaling system comprising two paths adapted for transmission in opposite directions between two stations, means connecting said paths in energy flow relation at each station, means in one path to render it normally inoperative for transmission, means in the other path for rendering it normally operative for transmission, means whereby signal conveying energy impressed on one of said paths renders the normally inoperative path operative for transmission and the normally operative path inoperative for transmission, and a delay circuit adapted to delay the round-trip transmission of echo currents until said operative path has been made inoperative.

14. In combination, a loop transmission path, means for transmitting signal waves of one signal characteristic over a portion of said loop, means for transmitting signal waves having a different signal characteristic over the remaining portion of said loop, biased circuit closers normally respectively rendering one portion operative and the other portion inoperative, signal control means whereby transmission over the normally inoperative portion actuates said circuit closers to their respectively alternate positions, and a delay circuit in said normally inoperative portion for preventing echo and singing effects while both of said portions are momentarily in operative condition.

15. A four-wire radio signaling system comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, and signal responsive means for substantially simultaneously rendering said normally operative branch inoperative and said normally inoperative branch operative for transmission.

16. A four-wire radio signaling system comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the

ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, and means responsive to signal conveying currents transmitted over the normally inoperative branch for substantially simultaneously rendering said normally operative branch inoperative and said normally inoperative branch operative for transmission.

17. A four-wire radio signaling system comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, signal responsive means for substantially simultaneously rendering said normally operative path inoperative and said normally inoperative path operative for transmission, and means for preventing the round-trip transmission of echo currents over the loop constituted by said four-wire circuit during the operation of said signal operated means.

18. A four-wire radio signaling system, comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, means responsive to signal conveying currents transmitted over the normally inoperative branch for substantially simultaneously rendering said normally operative branch inoperative, and said normally inoperative branch operative for transmission, and means for preventing the round-trip transmission of echo currents over the loop constituted by said four-wire circuit during the operation of said signal operated means.

19. A four-wire radio signaling system comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, signal responsive means for substantially simultaneously rendering said normally operative path inoperative and said normally inoperative path operative for transmission, and delay circuit means for preventing round-trip transmission of echo currents over the loop constituted by said four-wire circuit during the operation of said signal operated means.

20. A four-wire radio signaling system comprising a two-wire branch having radio transmitting apparatus associated therewith, a second two-wire branch having radio receiving apparatus associated therewith, means to interconnect said branches at the ends remote from said radio apparatus, means normally rendering one branch operative for transmission, means normally rendering the other branch inoperative for transmission, means responsive to signal conveying currents transmitted over the normally inoperative branch for substantially simultaneously rendering said normally operative branch inoperative, and said normally inoperative branch operative for transmission, and delay circuit means for preventing round-trip transmission of echo currents over the loop constituted by said four-wire circuit during the operation of said signal operated means.

In testimony whereof, we have signed our names to this specification this 17th day of April, 1924.

LLOYD ESPENSCHIED.
HERMAN A. AFFEL.
CLIFFORD N. ANDERSON.