April 16, 1935. E. R. TAYLOR 1,997,706

MULTIPLE RADIOTELEPHONE AND TELEGRAPH CIRCUIT

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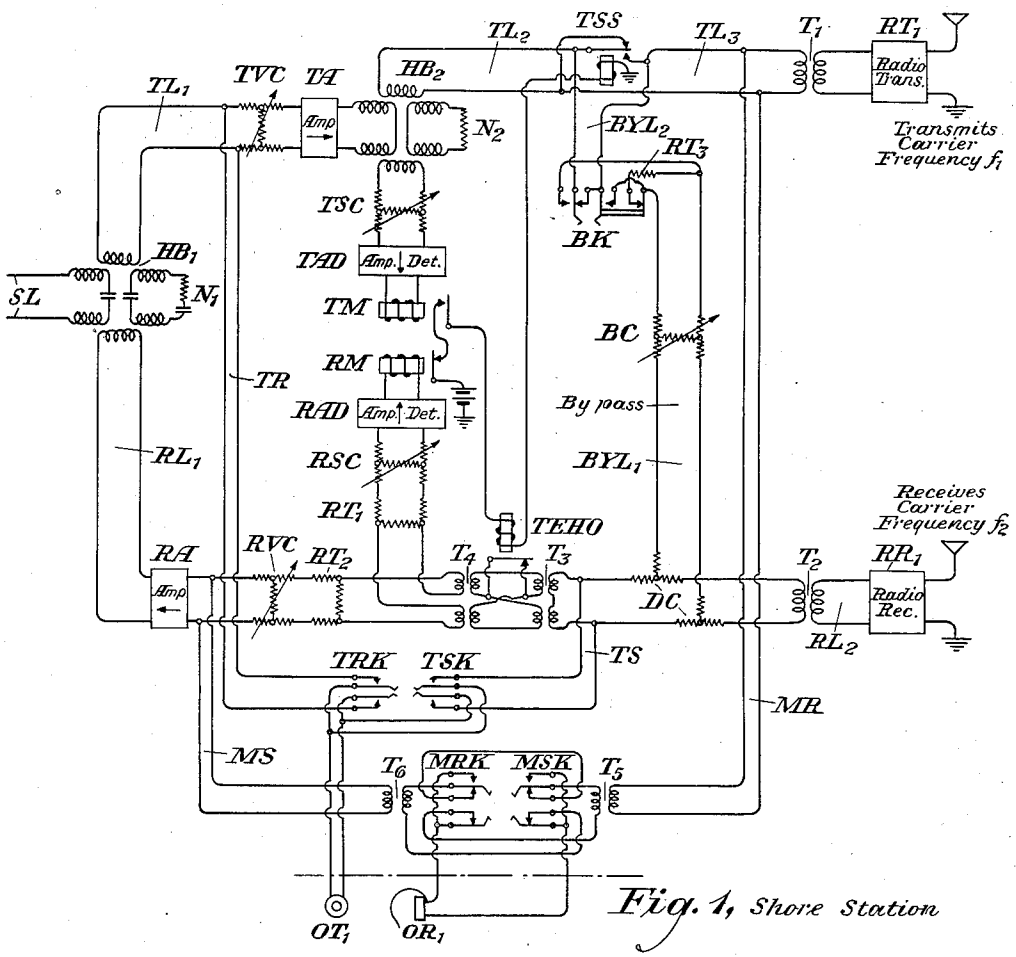

Fig. 1, Shore Station

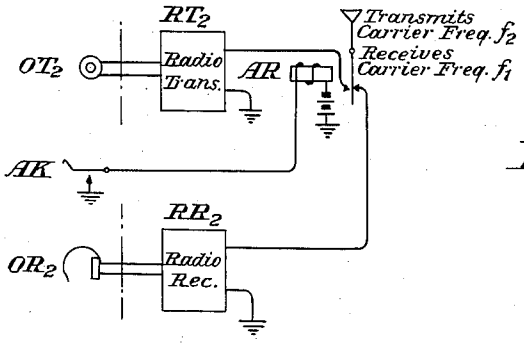

Fig. 2, Ship Station

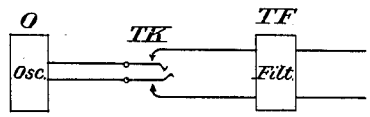

Fig. 3, Telegraph Transmitter

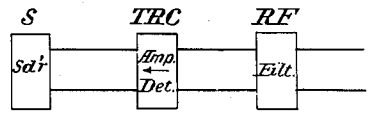

Fig. 4, Telegraph Receiver

INVENTOR
E. R. Taylor
BY
ATTORNEY

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MULTIPLE RADIOTELEPHONE AND TELEGRAPH CIRCUIT

Edmund R. Taylor, Mount Vernon, N. Y., assignor to American Telephone and Telegraph Company, a corporation of New York

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19 Claims. (Cl. 250—9)

This invention relates to radiotelephone systems, and more particularly to arrangements for sending telephone or telegraph messages over radiotelephone channels between a multiplicity of radio stations.

In operating a radiotelephone circuit such, for example, as may be used in a ship harbor, it is desirable to transmit information not only between a ship and the shore but also between ships or between several ships and the shore. It is also desirable in the interest of economy, ease of operation, and simplicity of maintenance to operate all ship radio transmitters at the same carrier frequency and all ship radio receivers at a common carrier frequency which is different from the one transmitted from the ships. In accordance with this invention, circuit arrangements are provided whereby telephone or telegraph messages may be transmitted between any two or more of the radio stations without readjustment of the carrier frequencies or causing objectionable singing or echoes.

As is well known, a radio transmitter and radio receiver may be connected by means of a combination of four-wire and two-wire circuits to a two-wire terminal at a switching point where connections may be established between the radio channel and various telephone or telegraph circuits. It is also well known that terminal amplifiers, voice-operated devices and other apparatus under the control of a technical operator may be associated with the four-wire circuit in such a manner that echoes and singing, which might be caused by radio or wire line unbalances, are effectively eliminated, and radiation by the radio transmitter of signals received by the radio receiver is prevented. In accordance with the invention, interconnections between the radio transmitter, the radio receiver and the voice-operated devices of such a station are provided, so that the radio transmitter and the radio receiver may be used as a frequency changer and radio repeater in communications between two or more of the other radio stations without interfering with the normal operation of the interconnected units in communications between the circuits connected at the switching point and the distant radio stations.

Arrangements are included whereby the amount of energy delivered by the radio receiver to the radio transmitter when they are acting as a radio repeater may be adjusted by the technical operator when necessary, in order to obtain the desired percentage of modulation and so that the radio repeater action may be disabled when its use is undesirable on account of abnormal radio conditions or because the additional publicity of re-radiation is not desired. Other arrangements are provided whereby the technical operator may monitor transmission in both or either direction and may control the amounts of amplification and the sensitivities of the voice-operated devices, and may communicate in either or both directions as desired.

Whereas static and other interference which is received by the radio receiver along with the desired signals is re-radiated by the radio transmitter when the system is acting as a radio repeater, such static and interference is not re-radiated when signals from the two-wire line are being transmitted.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, Figure 1 of which shows the circuit arrangement for one terminal of a radio system embodying the invention which acts as the radio repeater, and Fig. 2 of which shows a circuit arrangement which may be used for one or more of the other radio stations. Figs. 3 and 4 show respectively a telegraph transmitter and a telegraph receiver which may be substituted for the telephone transmitters and telephone receivers, in Figs. 1 and 2 when telegraph operation is desired.

Referring to the drawing, Fig. 1 shows the circuit arrangement of one end of the radiotelephone system which will be called the "shore station" for descriptive purposes. Fig. 2 shows the circuit arrangement of one of the radio stations to be communicated with, which is called a "ship station" for descriptive purposes. It will be understood, of course, that the invention is not to be limited to a ship-to-shore radiotelephone system.

Referring to Fig. 1, SL designates the two-wire line connecting the shore station to the switchboard. The two-wire line SL is connected through a hybrid coil HB_1 to a transmitting path, TL_1 and a receiving path RL_1, being balanced by a suitable network N_1. The path TL_1 and the following parts of the transmitting circuit include the transmitting volume control variable attenuator TVC, amplifier TA, hybrid coil HB_2, transmitting path TL_2, the normally open contacts of relay TSS, transmitting path TL_3, transformer T_1 and radio transmitter RT_1. The receiving path includes radio receiver RR_1, receiving path RL_2, transformers T_2, T_3 and T_4, resistance termination RT_2, receiving volume control attenu-

ator RVC, amplifier RA and receiving path RL_1.

In order that when transmission is taking place over either the transmitting or receiving path the other path will be disabled, echo suppressor devices are associated with each path. The echo suppressor associated with the transmitting path TL_1 comprises an amplifier-detector unit TAD, of well-known type, with its input connected through variable attenuator TSC to hybrid coil HB_2 in conjugate relationship with transmitting path TL_2, the output of amplifier TA being balanced by a suitable network N_2. The output of the amplifier-detector unit TAD controls through master relay TM the relays TSS and TEHO for performing operations incident to the blocking or disabling operations whereby transmission is permitted in only one of the paths TL_2 and RL_1 at a time. Normally, transmission path TL_2 is disabled by the back contacts of relay TSS, which short-circuits the conductors, and transmission from transmitting line TL_1 to the radio transmitter cannot take place. Blocking means comprising transformer arrangements T_3 and T_4 are associated between receiving lines RL_1 and RL_2. These disabling means comprise transformer arrangements which are so connected as to be balanced when the contacts of relay TEHO are opened, thereby preventing transmission through the transformer arrangements. When the contacts of relay TEHO are closed, however, the transformer circuits instead of being balanced are, in effect, connected so as to be parallel-aiding, thereby permitting transmission to take place readily. Normally, relay TEHO (which is controlled by the amplifier-detector TAD) is de-energized so that the receiving path is unblocked to permit transmission to take place from the radio receiver RR_1 to the two-wire line SL. The input of an amplifier-detector arrangement RAD is connected through receiving sensitivity control RSC and resistance termination RT_1 to the secondary windings of transformer T_4, so as to be effectively in series with the resistance termination RT_2 in the receiving path RL_1, and has in its output a relay RM, which when operated opens the control circuit from the amplifier-detector TAD to switching relays TSS and TEHO, thereby maintaining the transmitting path TL_2 blocked and receiving path RL_1 unblocked when signal currents are being received from the radio receiver RR_1.

The operation of the apparatus so far described for signal transmission is as follows: Signal currents incoming over the two-wire circuit SL pass through the hybrid coil HB_1 and through the amplifier TA. Some of the energy enters the amplifier-detector unit TAD and causes relays TM, TSS and TEHO to be energized. Relay TSS removes the short circuit from transmitting line TL_2, while relay TEHO, by opening its contact, causes the transformer arrangement T_3 and T_4 to block the receiving path. In the meantime a part of the energy passes from hybrid coil HB_2 through transmitting paths TL_2 and TL_3 to radio transmitter RT_1 and is transmitted on carrier frequency F_1. The receiving amplifier-detector RAD associated with the receiving path cannot be actuated to disturb the circuit condition now existing because the receiving path is disabled in the manner already described.

If in the normal condition of the circuit, signals are received over line section RL_2 from the radio receiver RR_1 which is tuned to carrier frequency F_2, they pass through line RL_2 and the transformer arrangements T_3 and T_4. A part of the energy passes through receiving amplifier RA and hybrid coil HB_1 to the two-wire line SL. The remaining received energy passes through receiving sensitivity control RSC to the amplifier-detector RAD, to cause the operation of relay RM which opens the circuit controlled by the amplifier-detector unit TAD, thereby preventing energization of relays TSS and TEHO, so that the transmitting path is disabled and the receiving path remains unblocked so long as the signaling currents are being received.

The apparatus so far described relates to communication between the two-wire line SL and a ship station. The additional equipment and the circuits which are associated with the shore station in order to afford radio repeater action in communication between ship stations will not be described. Referring to Fig. 1, it will be seen that a by-pass is connected between the receiving and transmitting legs of the four-wire circuit, in order to by-pass the voice operated equipment and the two-wire line and convey energy from the radio receiver to the radio transmitter, effectively connecting them in cascade and establishing a radio repeater. The by-pass includes energy dividing circuit DC in the receiving path between transformers T_2 and T_3, by-pass line BYL_1 volume control attenuator BC, the normally open contacts of key BK, by-pass line BYL_2, and the normally closed contacts of relay TSS. Key BK is so arranged that when radio repeater action is not desired it may be left in the unoperated position shown and transmission path BYL_1 is terminated in resistance termination RT_3, and transmission path BYL_2 is short-circuited, permitting normal operation in communication between radio stations and the two-wire terminal.

Radio repeater action may now be described: if key BK is operated and the voice-operated relays are in their normal positions, signals from the radio receiver RR_1 pass through transmission path RL_2 and transformer T_2 to dividing circuit DC, where a part of the energy passes to transformer arrangements T_3 and T_4 and the remainder passes through transmission path BYL_1. The latter is attenuated to the desired value by attenuator BC and passes through contacts of key BK and relay TSS, transmission path TL_3 and transformer T_1 to the radio transmitter RT_1, where they are re-radiated on the desired radio frequency. A part of the energy which passes into transformer arrangements T_3 and T_4 causes the operation of relay RM in a manner similar to that described above for communication between the two-wire line and a ship station, and the remainder passes to the two-wire line SL. The operation of relay RM prevents echoes or other signals transmitted by the two-wire line from causing operation of relay TSS and consequent mutilation of the repeated signals. When the echoes of the received signals have ceased, relay RM releases and normal conditions obtain.

If signals from the two-wire line are to be transmitted while key BK is in the operated positions and signals are not being received by the radio receiver, the apparatus and circuits function in the normal manner for such transmission as described above. The by-pass is disabled in this case by the operation of relay TSS which short-circuits transmission path BYL_2 shortly after it removes the short circuit from transmission path TL_2. During the travel time of the armature of relay TSS (the time after the

short circuit has been removed from transmission path TL_2 and before it is applied to transmission path BYL_2) transmission paths TL_2, TL_3 and BYL_2 are effectively connected in series but false operation of relay RM by energy passing from transmission path TL_2 through transmission path BYL_2, is prevented by the disabling action of transformer arrangements T_3 and T_4 since relay TEHO opens its contact at the same time that relay TSS removes its short circuit from transmission path TL_2.

Apparatus and circuits are included in the shore station whereby the technical operator may communicate with the ship stations or over the two-wire line and may monitor transmission in either direction. The facilities whereby the technical operator at the shore station signals to the ships include operator's transmitter OT_1, key TRK, and transmission path TR, which is connected in multiple with transmitting volume control attenuator TVC. The facilities whereby he transmits over the two-wire line include operator's transmitter OT_1, key TSK and transmission path TS, which is connected in multiple with the primary of transformer T_3. Keys TRK and TSK in their normal positions are arranged to hold open the paths from the operator's transmitter OT_1. Signals received over the radio and the two-wire line may be monitored by the technical operator with apparatus and circuits which include transmission paths MR and MS, transformers T_5 and T_6, keys MRK and MSK, and operator's receiver OR_1. When key MRK is operated, monitoring is limited to signals transmitted over the radio, and when key MSK is operated, to signals transmitted into the two-wire line. When keys MRK and MSK are not operated, operator's receiver OR_1 is effectively in series with transmission paths MR and MS, but the transmission loss through transformers T_5 and T_6 is sufficiently large to prevent objectionable echoes being transmitted from one side of the four-wire circuit to the other through the monitoring circuit.

The apparatus and circuits employed at the ship station may be of several well-known types, as, for example, those shown in Fig. 2 which shows an antenna normally connected to radio receiver RR_2 which is arranged to receive carrier frequency F_1, and the radio transmitter RT_2, arranged to transmit carrier frequency F_2. The antenna may be switched from the radio receiver RR_2 to radio transmitter RT_2 in a well-known manner by relay AR which is controlled by key AK. The output of radio receiver RR_2 is connected to operator's receiver OR_2 and the input of radio transmitter RT_2 is connected to operator's transmitter OT_2. Accordingly, the operator at the ship station may normally receive signals transmitted on carrier frequency F_1 and may transmit signals on carrier frequency F_2 by operating key AK which enables radio transmitter RT_2 and disables radio receiver RR_2. The operation of the ship station is the same for ship-to-shore and ship-to-ship communications.

The apparatus and the circuits described heretofore are designed primarily for telephone communication but may be readily adapted to telegraph communication by the substitution of well-known voice-frequency telegraph equipment for the operator's transmitter and receiver. For example, operator's transmitters OT_1 and OT_2 may be replaced by the arrangement shown in Fig. 3 and operator's receiver OR_1 or OR_2 by the arrangement shown in Fig. 4. The operation of the apparatus shown in Fig. 3 is as follows: signaling energy produced by oscillator O is keyed by key TK to produce voice-frequency telegraph impulses which are transmitted through transmitting filter TF. The operation of the apparatus shown in Fig. 4 is as follows: voice-frequency telegraph impulses pass through receiving filter RF and are detected by amplifier-detector TRC, the resultant current being used to control telegraph sounder S. Key TK and sounder S could be replaced by the transmitting contacts and the receiving magnet, respectively, of a printer if printing telegraph operation were desired.

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. The method of two-way signaling between a plurality of stations which consists of generating signals in a certain frequency band at one station, transmitting the signals through a transmission medium to a repeater point, converting them into a second frequency band at said repeater point, transmitting the converted signals through a transmission medium and detecting them at a second station, in signaling in one direction between stations in one group; generating signals in the first frequency band at said second station, transmitting them through a transmission medium to said repeater point, converting them into the second frequency band at said repeater point, transmitting the converted signals through a transmission medium and detecting them at said first station, in signaling in the other direction between stations of that group; generating signals in the first frequency band at a station of said group, transmitting them through a transmission medium to said repeater point, detecting them at said repeater point, and transmitting them without conversion over a second transmission medium to a distant station in another group, in signaling in one direction between a station in the group first mentioned and another station outside said group; and in transmitting signals without conversion over said second medium in the opposite direction from the station outside said group to said repeater point, converting the signals into the second frequency band at said repeater point, transmitting them from said repeater point through a transmission medium and detecting them, in signaling in the other direction between a station in the first group and said station outside said group.

2. The method of two-way signaling between a plurality of stations which consists of generating signals in a certain frequency band at one station, transmitting the signals through a transmission medium to a second station, detecting them at said second station and transmitting them without conversion over a second transmission medium to a third station, in signaling in one direction to said third station; converting signals in said first frequency band to signals in a second frequency band at said second station, transmitting the converted signals through a transmission medium and detecting them in signaling to a fourth station; and transmitting signals without conversion from said third station over said second transmission medium to said second station, translating said signals to said second frequency band at said second sta-

tion, transmitting them through said first transmission medium and detecting them at said first station, in signaling in the other direction from said third station to said first station.

3. The method of two-way signaling between a plurality of stations which consists of generating signals in a frequency band at one station, transmitting the signals through a certain transmission medium to a second station, detecting them at said second station and transmitting them without conversion through a second medium to a third station, in signaling in one direction to said third station; simultaneously repeating said signals translated into a second frequency band into a third transmission medium at said second station, transmitting the translated signals through said third transmission medium and detecting them, in signaling to a fourth station; and transmitting signals without conversion from said third station over said second transmission medium to said second station, translating said signals to said second frequency band at said second station, transmitting them through said first transmission medium and detecting them at said first station, in signaling in the other direction from said third station to said first station.

4. The method of two-way signaling between a plurality of stations which consists of generating signals in a certain frequency band at one station, transmitting the signals through a transmission medium to a repeater point, converting them into a second frequency band at said repeater point, transmitting the converted signals through a transmission medium and detecting them at a second station, in signaling in one direction between stations in one group; generating signals in the first frequency band at said second station, transmitting them through a transmission medium to said repeater point, converting them into said second frequency band at said repeater point, transmitting the converted signals through a transmission medium and detecting them at said first station, in signaling in the other direction between stations of that group; generating signals in the first frequency band at a station of said group, transmitting them through a transmission medium to said repeater point, detecting them at said repeater point, and transmitting them without conversion over a second transmission medium to a distant station in another group, in signaling in one direction between stations of the first mentioned group and another station outside said group; and in transmitting signals without conversion over said second transmitting medium in the opposite direction from the station outside said first mentioned group to said repeater point, converting said signals into said second frequency band at said repeater point, transmitting them from said repeater point through a transmission medium and detecting them, in signaling in the other direction between a station in the first group and said other station; and suppressing reaction between transmissions in the two directions between a station in said first group and said other station.

5. The method of two-way signaling between a plurality of stations which consists of generating signals in a certain frequency band at one station, transmitting the signals through a transmission medium to a second station, detecting them at said second station, and transmitting them without conversion over a second transmission medium to a third station, in signaling in one direction to said third station; converting signals in said first frequency band to signals in a second frequency band at said second station, transmitting the converted signals through a transmission medium and detecting them, in signaling to a fourth station; transmitting signals without conversion from said third station over said second transmission medium to said second station, translating said signals to said second frequency band at said second station, transmitting them through said first transmission medium and detecting them at said first station, in signaling in the other direction from said third station to said first station; and suppressing reaction between the transmissions in the two directions between said first and third stations.

6. The method of two-way signaling between a plurality of stations which consists of generating signals in a frequency band at one station, transmitting the signals through a certain transmission medium to a second station, detecting them at said second station, and transmitting them without conversion over a second transmission medium to a third station, in signaling in one direction to said third station; simultaneously repeatng the signals translated into a second frequency band into a third transmission medium at said second station, transmitting the translated signals through said third transmission medium and detecting them, in signaling to a fourth station; transmitting signals without conversion from said third station over said second transmission medium to said second station, translating said signals to said second frequency band at said second station, transmitting them through said first transmission medium and detecting them at said first station, in signaling in the other direction from said third station to said first station; and suppressing reaction between transmission in the two directions between said first and third stations.

7. In a radio communicating system, a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal for the transmission of a signal band, and means for by-passing the two-wire terminal so that a part of the energy of full signal band width from the output of the radio receiver is fed into the radio transmitter without passing through the two-wire terminal.

8. In a radio communicating system; a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal for the transmission of a signal band, means for by-passing the two-wire terminal so that a part of the energy of full signal band width from the output of the receiver is fed into the radio transmitter without passing through the two-wire terminal, and means for preventing echoes of received energy which arise in the two-wire line from being transmitted by the radio transmitter.

9. In a radio communicating system, a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal for the transmission of a single band, means for by-passing the two-wire terminal so that a part of the energy of full signal band width from the output of the radio receiver is fed into the radio transmitter without passing through the two-wire terminal, and means for preventing energy from the output of the radio

receiver from being fed into the radio transmitter while energy from the two-wire terminal is being transmitted.

10. In a radio communicating system, a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal, means for by-passing the two-wire terminal so that a part of the energy from the output of the radio receiver is fed into the radio transmitter without passing through the two-wire terminal, means for preventing echoes of received energy which arise in the two-wire line from being transmitted by the radio transmitter, and means for preventing energy from the output of the radio receiver being fed into the radio transmitter while energy from the two-wire terminal is being transmitted.

11. In a radio communicating system, a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal for the transmission of a signal band, means for by-passing the two-wire terminal so that a part of the energy of full signal band width from the output of the radio receiver is fed into the radio transmitter without passing through the two-wire terminal, and means for preventing echoes of energy which is fed from the two-wire terminal to the radio transmitter from being received by the radio receiver and re-transmitted by the radio transmitter.

12. In a radio communicating system, a four-wire circuit comprising a transmitting path and a receiving path for connecting a radio transmitter and a radio receiver, respectively, to a two-wire terminal for the transmission of a signal band, means for by-passing the two-wire terminal so that a part of the energy of full signal band width from the output of the radio receiver is fed into the radio transmitter without passing through the two-wire terminal, and means whereby the amount of energy fed into the radio transmitter may be varied at will.

13. In a radio communicating system, a two-wire terminal, a radio transmitter, a radio receiver and means whereby the radio receiver may be connected to the two-wire terminal, an independent connection from the radio receiver to the radio transmitter, together with switching devices under the control of energy to be transmitted from the two-wire terminal for disabling the independent connection from the radio receiver to the radio transmitter and for establishing a connection between the two-wire terminal and the radio transmitter.

14. In a radio communicating system, a two-wire terminal, a radio transmitter, a radio receiver and means whereby the radio receiver may be connected to both the two-wire terminal and the radio transmitter, together with switching devices under the control of energy to be transmitted from the two-wire terminal for disabling the above connections to the radio receiver and for establishing a connection between the two-wire terminal and the radio transmitter, together with other switching devices under the control of energy received through the radio receiver for preventing the operation of the first mentioned switching devices under the control of energy to be transmitted from the two-wire terminal while energy is being received from the radio receiver.

15. In a radio communication system, a plurality of outlying radio stations each transmitting on the same wave length and each receiving on a different common wave length, a central radio station having transmitting equipment to transmit on the wave length at which the outlying stations receive and receiving equipment to receive on the wave length at which the outlying stations transmit, means to connect said central radio station with any one of a plurality of communication stations for two-way communication with any of said outlying radio stations, said connecting means being arranged to prevent signals transmitted from said receiving equipment to a communication station from reacting on said transmitting equipment, and means at said central station to translate the wave length at which it receives to the wave length at which it transmits to enable any outlying station to carry on two-way communication through the central station as a repeater with any other outlying station.

16. In a radio communication system, a plurality of outlying radio stations each transmitting on the same wave length and each receiving on a different common wave length, a central radio station having a transmitting channel including a radio transmitter to transmit on the wave length at which the outlying radio stations receive and a receiving channel including a radio receiver receiving on the wave length at which the outlying radio stations transmit, means to connect said channels to a switching point to enable two-way communication to take place between any one of a plurality of communication stations and any of said outlying stations, said connecting means being arranged to prevent signals transmitted from said receiving equipment to a communication station from reacting on said transmitting equipment, and means to connect said receiving channel in tandem with said transmitting channel independently of the connection of said channels to said switching point, whereby the wave length received by said radio receiver will be translated to the wave length transmitted by said radio transmitter to enable any outlying station to carry on two-way communication through the central station as a repeater with any other outlying station.

17. In a radio communication system, a plurality of outlying radio stations each transmitting on the same wave length and each receiving on a different common wave length, a central radio station having a transmitting channel including a radio transmitter to transmit on the wave length at which the outlying radio stations receive and a receiving channel including a radio receiver receiving on the wave length at which the outlying radio stations transmit, a hybrid coil arrangement to connect said channels to a switching point to enable two-way communication to take place between any one of a plurality of communication stations and any of said outlying stations, and means to connect said radio receiving channel in tandem with said radio transmitting channel independently of said hybrid coil whereby the wave length received by said radio receiver will be translated to the wave length transmitted by said radio transmitter to enable any outlying station to communicate through the central station as a repeater with any other outlying station.

18. In a radio communication system, a plurality of outlying radio stations comprising transmitting apparatus and receiving apparatus, a central radio station having a one-way transmitting channel and a one-way receiving chan-

nel, means to interconnect said channels with a transmission medium forming a two-way communication path to a communication station, the connection being such that one channel is used solely for transmission in one direction over said path and the other channel is used solely for transmission in the opposite direction over said path, whereby said channels will operate on a four-wire basis to permit two-way signaling between a communication station associated with said central radio station and any of said outlying radio stations, additional means to so interconnect said channels that they will also operate in tandem so that the outlying radio stations can carry on two-way communication with each other through said central radio station acting as a repeater, the receiving apparatus of each outlying station being normally conditioned to receive and the frequencies being so assigned that when a communication station associated with the central station transmits, all outlying radio stations may receive signals and any outlying radio station may signal in the reverse direction to reply to the received signal.

19. In a radio communication system, a plurality of outlying radio stations comprising transmitting apparatus and receiving apparatus, a central radio station having a one-way transmitting channel and a one-way receiving channel, means to so interconnect said channels with a transmission medium forming a two-way communication path to a communication station, the connection being such that one channel is used solely for transmission in one direction over said path and the other channel is used solely for transmission in the opposite direction over said path, whereby said channels will operate on a four-wire basis to permit two-way signaling between a communication station associated with said central radio station and any of said outlying radio stations, additional means to so interconnect said channels that they will also operate in tandem so that said outlying radio stations can carry on two-way communication with each other through said central radio station acting as a repeater, the receiving apparatus of each outlying station being normally conditioned to receive, communication stations associated with the central office being also normally conditioned to receive, and the frequencies of the outlying radio stations and the central radio station being so assigned that when any station of the system transmits, regardless of whether the transmitting station is an outlying radio station or a communication station associated with said central radio station, all other stations of the system may receive the signals and any other station of the system may signal in the reverse direction to reply to the received signal.

EDMUND R. TAYLOR.