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RADIO TELEPHONE AND TELEGRAPH SYSTEM

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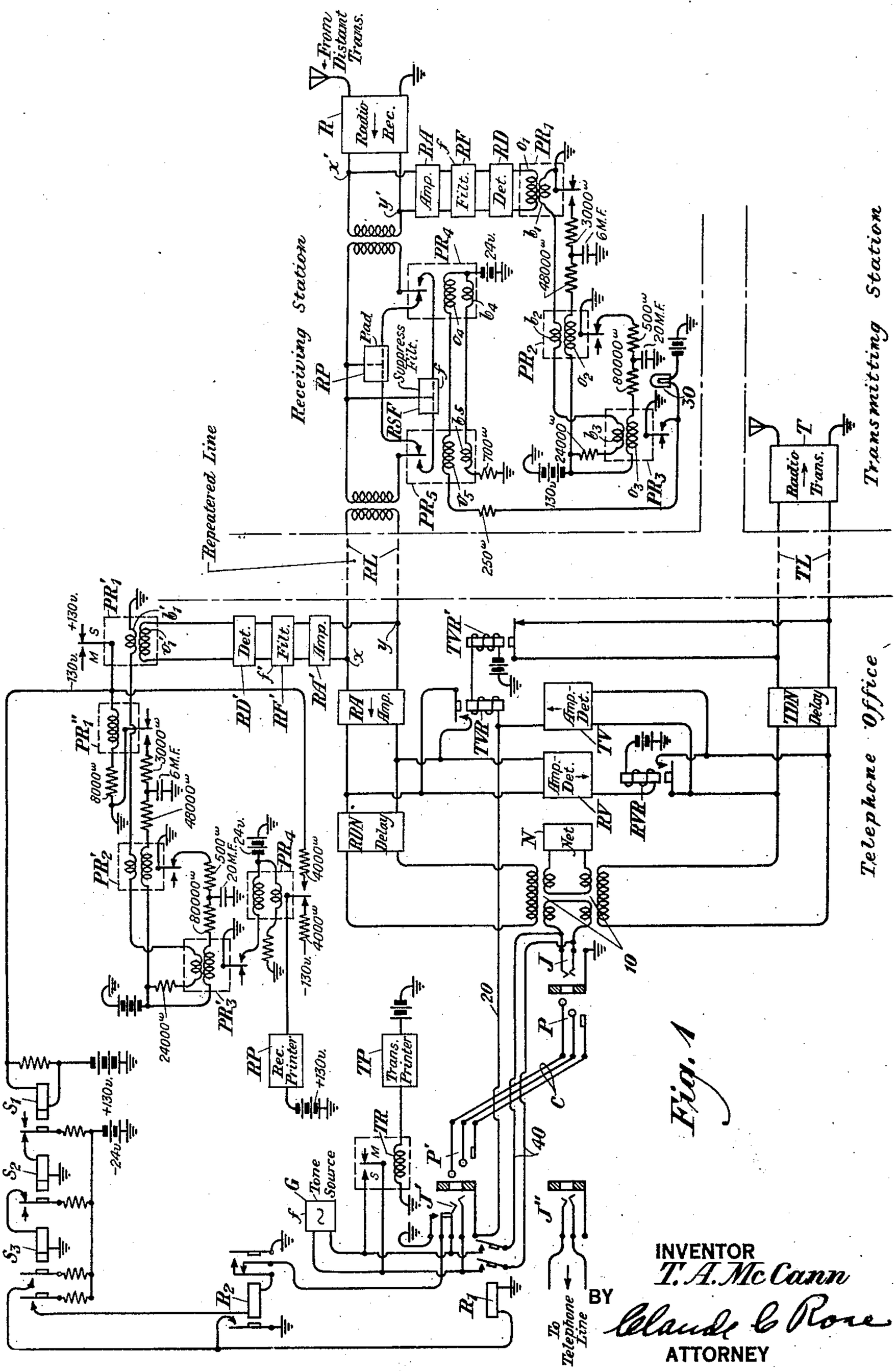

Fig. 1

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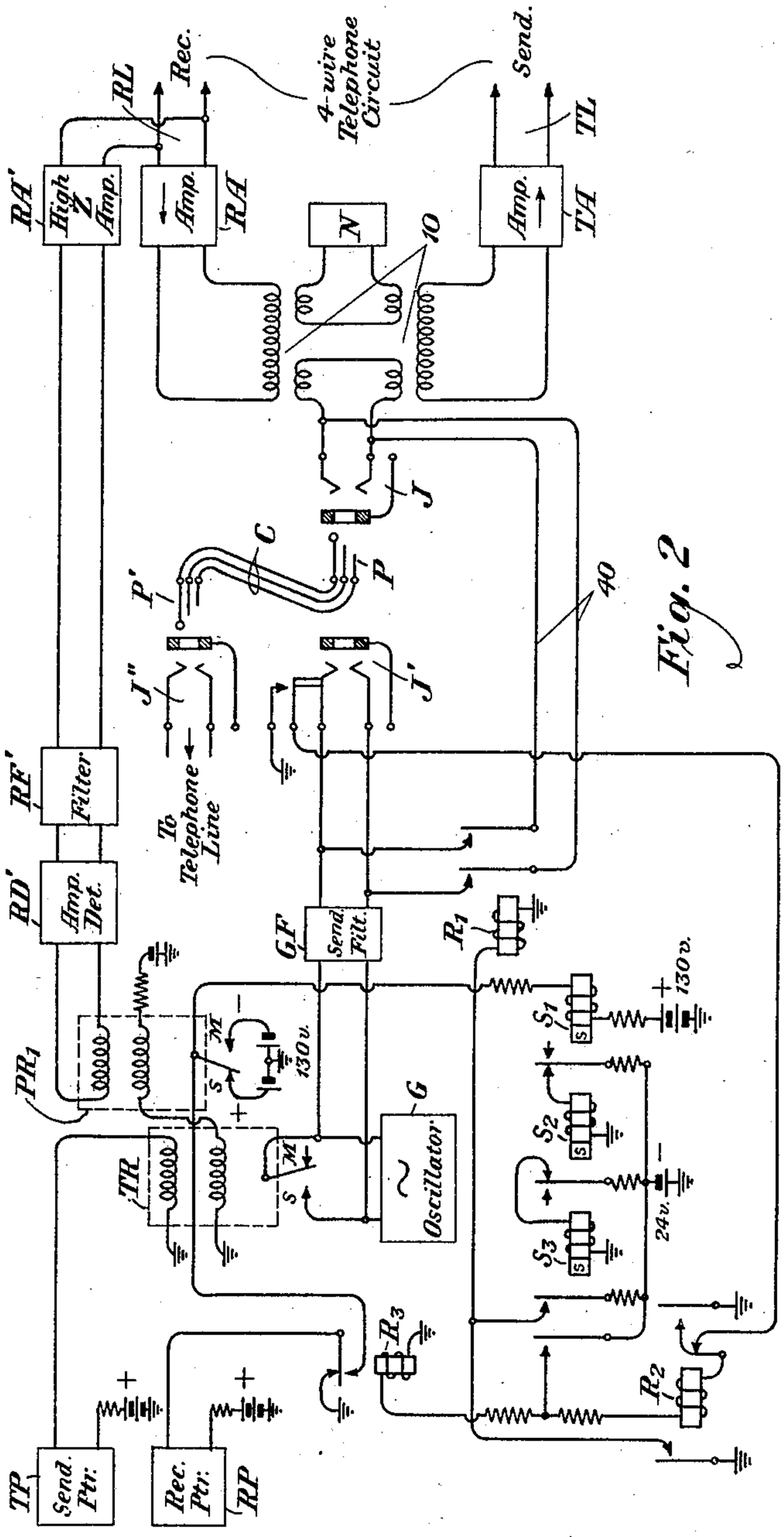

Fig. 2

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UNITED STATES PATENT OFFICE

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RADIO TELEPHONE AND TELEGRAPH SYSTEM

Application filed July 19, 1929. Serial No. 379,491.

This invention relates to the transmission of signals and more particularly to arrangements for utilizing the radio apparatus of a radio telephone system for the transmission of telegraph signals.

Where a radio link is used for establishing telephone connections between two distant points, such, for example, as New York and London, it is desirable to utilize the radio apparatus which is normally employed for telephone transmission, for the transmission of telegraph messages when the apparatus is not employed for telephone purposes. It is particularly desirable to use the radio telephone apparatus for the transmission of telegraphic messages between operators in connection with the establishment of telephone connections. Arrangements have been provided, therefore, for enabling such use of the radio telephone channel for telegraph purposes during idle periods.

In such arrangements of the prior art, certain difficulties have been encountered when the telegraph part of the system is operated on a full duplex basis. In full duplex operation the system is so set up that telegraph messages may be sent simultaneously in both directions. With the system as heretofore operated, the telegraph signals were transmitted as an interrupted tone. While tones of different frequencies were employed for sending and receiving, the tone used for sending was sometimes received by the local radio receiver as interference of such magnitude as to overload the repeaters in the receiving line extending from the radio receiver to the local telegraph receiving apparatus. This resulted in mutilation and sometimes loss of signals, and it was therefore necessary to provide a relay train responsive to the sending tone for automatically cutting a suppression filter in at the radio receiver to prevent the sending tone from being transmitted through the repeaters of the receiving line.

Since it was undesirable that this relay train operate in response to static or unbalance to received telephone signals, it was necessary to so design it that it would not operate in response to the sending tone unless the tone had been applied continuously for an interval longer than any corresponding tone frequency would persist in the case of telephone or static signals. As the relay train only operates to cut in the filter when the local telegraph transmitter is applied to the circuit, received signals would be lost if the distant telegraph operator should apply her sending telegraph apparatus to the radio channel and start sending before the local operator applies her telegraph transmitter to the circuit. This arises from the fact that a tone from the local transmitter would be received as interference at the local radio receiver and thereby cause mutilation of received signals until the relay train has had time to operate and cut in the suppression filter.

In order to obviate this difficulty it is proposed in accordance with the present invention to so arrange the telegraph circuits that when the operator at one end of the system applies the telegraph transmitter to the radio chanuel the received tone will operate automatic switching means for switching the tone from the local telegraph sender to the radio transmitting channel, thereby causing the relay train associated with the local receiver to operate and cut in the suppression filter. The local operator may then plug up the telegraph sender to the radio circuit in the usual manner independently of the automatic tone connection previously established whenever it is desired to send messages in the opposite direction. This plugging up operation, with the ensuing transmission of telegraph signals, will not cause any intereference with received signals because the suppression filter will have already been connected in circuit at the local radio receiver. Preferably the circuit is so arranged that when the local operator takes down the connection to the telegraph sender the tone will be removed from the circuit.

The invention will now be more fully understood from the following detailed description thereof when read in connection with the accompanying drawings, Figure 1

of which illustrates a circuit arrangement embodying the principles of the invention applied to a radio telephone system, and Fig. 2 of which illustrates the invention applied to a wire transmission system. In the drawings, the circuit arrangement and apparatus at one terminal only of the radio link is shown, it being understood that the apparatus at the other terminal will be similar to that illustrated.

Referring to the drawings, a radio transmitter is conventionally indicated at T, and similarly a radio receiver is conventionally indicated at R. The receiver and transmitter are located some distance apart in order to reduce interference in the receiver from the local transmitter. The radio receiver and radio transmitter are connected by means of a four-wire circuit to a telephone office at which switching connections are established to any desired telephone circuit by means of a cord C, which may connect the terminal jack J of the four-wire circuit with a jack J'' of a desired telephone line by means of the plugs P and P'. The four-wire circuit comprises one-way lines TL and RL connected together at the telephone office through a hybrid coil 10 and balancing network N, in a well-known manner. The lines TL and RL are one-way lines, the line TL being arranged to transmit from the terminal jack J to the radio transmitter T and the line RL being arranged to transmit from the radio receiver R to the jack J. Either or both of these lines may include a number of repeaters (not shown) for amplifying the telephone currents transmitted thereover.

In order to prevent singing over the overall four-wire circuit including the radio paths to the distant terminal, and also to prevent singing over the local circuit from the transmitter T to the receiver R, over the line RL, through the hybrid coil 10, and over the line TL to the radio transmitter, the line TL is normally disabled. Voice-operated devices are provided whereby when transmission takes place from the jack J over the line TL to the transmitter T, the line TL is put in operative condition and the line RL is disabled. When, however, transmission takes place from the receiver R over the line RL to the jack J the line TL is maintained disabled. This is accomplished by associating with each one-way line a voice-operated device for controlling a short-circuit across the other line. In the case of the line TL this apparatus comprises an amplifier-detector unit of well-known type TV associated with the line TL, said unit controlling relays TVR and TVR'. When voice currents enter the amplifier-detector TV the relays TVR and TVR' are energized, the latter opening the normal short-circuit across the line TL and permitting transmission to take place from jack J to the transmitter T, and the former closing a short-circuit across the line RL and the input terminals of an amplifier-detector unit RV associated with the line RL.

The amplifier-detector unit RV is associated with the line RL and responds to voice currents received from the radio receiver R and transmitted over the line RL to energize a relay RVR in a well-known manner, so that the latter short-circuits the line TL independently of the normal short-circuit controlled by the relay TVR'. The short-circuit thus applied to the line TL also serves to short-circuit the amplifier detector TV to prevent false operation. Delay networks TDN and RDN are associated with the lines TL and RL, respectively, to enable the voice-controlled switching devices to perform their offices before the voice currents arrive at the points in the circuits which are affected by the switching operations. For example, when voice currents are transmitted from the jack J over the line TL the voice currents are sufficiently delayed in passing through the network TDN to enable the amplifier-detector unit TV to remove the short-circuit from the line TL before the voice currents arrive at the point at which it is applied. Similarly, when voice currents are transmitted from the receiver R over the line RL the voice currents are sufficiently delayed by the network RDN to enable the amplifier-detector RV to short-circuit the line TL before the voice currents have an opportunity to pass through the hybrid coil 10 (due to unbalance) and enter the line TL.

During periods when the circuit above described is not being used for telephone operation, it is desirable to use the radio facilities for the transmission of telegraph messages, and more particularly it is desirable to transmit printer messages between operators to give directions necessary to the establishment of telephone connections over the radio link. In order to transmit such telegraph messages from the telephone office shown to a distant telephone office associated with the distant terminal of the radio link, the cord C, which is used for setting up telephone connections, may have its plug P' inserted in a jack J' which is connected to a telegraph transmitter. This transmitter may comprise a transmitting printer unit conventionally indicated at TP which, by means of marking and spacing signals, controls a relay TR. The contact of this relay is arranged to open and close a short-circuit across the terminals of a tone source G connected to the tip and ring conductor of the jack J'. For reasons that will more fully appear hereinafter the relay TR has its contact so arranged as to open the

short-circuit across the tone source G during marking impulses and to close the short-circuit during spacing impulses. Consequently, an audible tone will be applied to the terminals of the jack J and transmitted over the line TL to the radio transmitter during the marking intervals, while spacing signals will be represented by a no-tone condition of the circuit. The tone employed is preferably an audible frequency so that it may be transmitted over the circuit TL in the same manner as voice currents are transmitted.

Since, as has already been described, the line TL is normally disabled by means of the short-circuit applied by the relay TVR′, it is necessary to render the connection over the line TL operative in order that the printer signals may be transmitted. This result is accomplished by a ground connection established over the sleeve conductors of the jack J, plug P, sleeve conductor of the cord C, sleeve conductors of the plug P′, and the telegraph jack J′ and thence over a conductor 20, through the windings of relays TVR and TVR′ to the plate battery. This causes the energization of relays TVR and TVR′ independently of the plate circuit of the amplifier-detector unit TV and maintains these relays operated as long as the telegraph connection is established. The short-circuit is, therefore, removed from the line TL so that the tone corresponding to the marking signals may be transmitted over the line TL to the radio transmitter T, where it is modulated upon the radio carrier in the same way as ordinary telephone currents, and transmitted to the radio receiver at the distant radio terminal. The energization of the relay TVR, however, short-circuits the line RL between the amplifier RA and the delay network RDN so that transmission cannot take place from the radio receiver R over the line RL to the jack J. It is, therefore, necessary that the telegraph receiving apparatus be associated with the line RL for reception of telegraph signals from the distant station in such manner as not to be affected by the short-circuit controlled by the relay TVR. Accordingly, such telegraph receiving apparatus is bridged across the line RL at *x*—*y* between the point at which the short-circuit is applied and the radio receiver R. The one-way amplifier RA is then connected between the terminals *x*—*y* of the telegraph receiving apparatus and the point at which the short-circuit is applied by the relay TVR, so that the short-circuit does not have any effect upon the telegraph receiving apparatus and transmission may take place from the radio receiver R over the line RL to the terminals *x*—*y* and thence into the telegraph receiving apparatus.

The telegraph signals received from the distant radio transmitter are applied to such radio transmitter as an interrupted tone in a manner similar to that already described with respect to the station shown, but in this instance the tone will have a different frequency from that generated by the tone source G. The tone employed at the distant station is modulated upon the carrier and transmitted to the receiver R where it is demodulated and transmitted over the line RL to the telegraph receiving apparatus connected at *x*—*y*. In order that the telegraph receiving apparatus may distinguish between this tone and the tone corresponding to the source G, which may appear in the output circuit of the radio receiver R due to interference from the local transmitter T, such telegraph receiving apparatus includes a filter RF′ for selecting the desired tone. An amplifier RA′ may also be provided for amplifying the received current, and a detector RD′ of well-known type is provided for rectifying the tone to produce direct current signals corresponding to the telegraph impulses. The direct current impulses actuate the polar relay PR'_1, as will be described in more detail later, and by means of this relay are transmitted to the receiving printer conventionally indicated at RP, as will also be made clear later.

In operating the circuit on a full duplex basis so that transmission of telegraph messages takes place in both directions at the same time, difficulty may be encountered where interference from the local transmitter T is very heavy, due to the fact that the signals from the local transmitter T, when transmitted over the line RL at the same time as the desired signals from the distant transmitting station, will tend to overload the repeaters (not shown) in the line RL, and thereby cause distortion of the signals actually received by the telegraph receiving apparatus. It therefore becomes necessary to suppress from the line RL the tone frequency corresponding to the tone source G. This is accomplished by switching into the line RL on the output side of the radio receiver R a suppression filter RSF, of any well-known type, so designed as to suppress from the line RL the tone frequency corresponding to the source G, while freely passing other frequencies within the voice range. As the inclusion of such a filter in the telephone circuit during telephone transmission would tend to suppress from the telephone band frequencies in the neighborhood of the tone from the source G, thereby causing telephonic distortion, the arrangement should be such that the suppression filter RSF is only cut into the circuit when the system is being used for telegraph reception, a pad RP, having an impedance equal to the impedance of the filter

in the frequency range outside the band which the latter suppresses, being substituted therefor during telephone reception.

This switching operation is accomplished by selecting some of the energy of the undesired tone from the local transmitter T on the output side of the radio receiver R, and by rectifying the energy, operating a relay train to switch the filter in and out of the circuit. Accordingly, a circuit is bridged across the terminals x'—y' which comprises an amplifier RA for amplifying the unwanted tone frequency, a selecting filter RF for selecting such an unwanted tone frequency, and a detector RD for rectifying the selected current to operate a polar relay PR_1. The polar relay PR_1 controls the circuit of a relay PR_2, which in turn opens a circuit of a polar relay PR_3. The latter relay controls the switching relays PR_4 and PR_5 for switching the filter RSF in and out of circuit.

Each of the polar relays PR_1, PR_2 and PR_3 includes an operating winding and a biasing winding, the biasing windings b_1, b_2 and b_3 being connected in series and through a resistance (which may be 24,000 ohms) to battery. The current flowing through these biasing windings normally holds their armatures against their back contacts, but when a current flows through the corresponding operating windings of sufficient strength, a pull is provided upon the armature in the opposite direction, and the armatures of the relays are shifted to their front contacts. When a tone is received the detector RD produces a rectified current through the operating winding o_1 which shifts the armature of the relay PR_1 to its front or left-hand contact, thereby causing current to flow from ground through the operating winding o_2 to battery. The current through the operating winding of the polar relay PR_2 in turn shifts its armature from its right-hand or back contact to its front contact, thereby opening the circuit normally existing from ground through the operating winding o_3 of the relay PR_3 to battery. The relay PR_3 thereupon shifts its armature from its front contact to its right-hand or back contact, thereby completing a circuit from ground through the operating windings o_5 and o_4 of the relays PR_5 and PR_4. The relays PR_4 and PR_5 thereupon shift their armatures in such direction as to disconnect the pad RP and substitute therefor the suppression filter RSF. The armature of the relay PR_3 at the same time closes the circuit of a signal lamp 30 to indicate that the suppression filter is in circuit.

The relay train above described should be so designed as to prevent false operation due to relatively short telephone and static signals involving frequencies corresponding to the selected tone frequency. Accordingly, the operating and releasing times of the various relays are so set as to take into account the time intervals involved in the transmission of printer signals. Assuming that the printer is operated at a speed of 60 words per minute (about 23 dots per second) the shortest undistorted marking or tone transmitting impulse due to the printer operation will be about .022 second. Allowing for a little over twenty-five per cent. distortion, this figure becomes .015 second. The longest spacing or no-tone impulse which would occur will be six units long, or about .13 second. Under these conditions the relay train should be designed to be unresponsive to impulses or tone groups shorter than about .015 second. For impulses longer than .015 second the relay PR_2 of the train is operated and remains operated for at least .13 second after the impulse ends, thus providing a hang-over period sufficient to prevent release during the longest no-tone interval which may occur during the transmission of signals. The operation of the relay PR_2 in response to an impulse longer than .015 second does not, however, necessarily switch the suppression filter in the circuit as the train should be so designed that this switching operation will not take place in response to an initial operation of the relay PR_1 by reason of a fairly sustained telephonic frequency corresponding to the tone frequency. To prevent such false operation in response to telephone currents, the switching operation to cut in the filter is arranged to take place only if the relay PR_1 remains operated continuously for some arbitrary period such as, say, 1.5 seconds. When, therefore, a steady tone is received, such as occurs whenever the local printer is first connected to the circuit, or if interrupted tone is received such as occurs whenever the local printer is connected to the circuit while already sending a message, this switching operation will be performed in 1.5 seconds. In order to insure that a steady tone will be received in the majority of cases, the code is so arranged that the tone is transmitted during the marking interval and not during the spacing interval. Consequently, the mere fact of connecting the printer to the circuit at the local transmitter results in the transmission of a steady tone until the sending of signals commence, which causes the complete operation of the relay train.

In order that the relay train may have the timing above described, the relays PR_2 and PR_3 have associated with their operating windings resistances and condensers for obtaining slow operation or slow release. In the case of the relay PR_2 this relay operates as soon as the 6 M. F. condenser is discharged upon the shifting of the armature

of PR_1 to its front contact. A suitable resistance of, say, 3,000 ohms, is included in the discharge circuit so that the impulses shorter than .015 will not cause sufficient discharge to operate the relay PR_2. When the armature of the relay PR_2 is shifted to its back contact, a charging current flows through the operating winding o_2 of the relay PR_2 to charge the 6 M. F. condenser, and a resistance of, say, 48,000 ohms, is connected in this charging circuit so that the charging current will maintain the relay PR_2 operated for .13 second after the relay PR_1 has been released. The relay PR_3 is normally operated, and its circuit constants are such that it will not be released until the relay PR_2 has been operated for about 1.5 second. This is due to the charging current for the 20 M. F. condenser which flows through its operating winding o_3 and through an 80,000-ohm resistance. The operating circuit of the relay PR_3, in response to the release of the relay PR_2, is made very quick-acting due to the fact that the charging of the 20 M. F. condenser, which must take place before the winding o_3 gets a sufficient operating current, occurs very quickly in series with the small 500-ohm resistance. Relays PR_4 and PR_5 are very fast operating and very fast to release, and their operation is controlled by the relay PR_3. It will be understood, of course, that the values of the resistances and condensers as above given and as indicated upon the drawings are given only for purposes of illustration, and these values may be widely varied and their proportions with respect to each other may be changed without defeating the result above described. Furthermore, the timing of the relay train as above given is merely illustrative and may be varied through a considerable range depending upon the nature of the telegraph signals transmitted, the speed of transmission and the margin of insurance against false operation deemed necessary in a particular design.

As has been previously stated, the receiving telegraph instrument, such as the receiving printer RP, is operated by the shifting of the armature of the relay PR'_1 in the output circuit of the detector RD', the armature of the relay PR'_1 sending negative or positive impulses to the receiving printer RP for marking and spacing signals, respectively. With the code arrangement previously described, in which the tone is transmitted during marking intervals and no tone during the spacing interval, it will be evident that whenever the telegraph sender at the distant end is disconnected from the jack corresponding to J, the marking tone, which is normally sent when no signals are transmitted and which normally functions to hold the armature of the relay PR'_1 against its negative contact to send a marking signal to the receiving printer RP, will no longer be received. The result is that the armature of the relay PR'_1 will be shifted to its positive contact due to the action of the biasing winding b'_1 and the receiver will then receive a continuous spacing signal so that it will continue to operate unless some means is provided to prevent this action. Accordingly, a relay train comprising relays PR''_1, PR'_2 and PR'_3 is provided, the last relay (PR'_3) of the train operating to control a relay PR'_4 whose armature serves to switch the receiving printer RP from a normal marking battery to a contact which completes the connection from the printer to the armature of the relay PR'_1. This relay train will preferably have the same timing and hang-over features as the relay train previously described for controlling the switching of the suppression filter RSF. The initial relay PR''_1 of the train is a simple polar relay whose winding is in circuit with the armature of the receiving polar relay PR'_1, and therefore the armature of the relay PR''_1 moves in unison with the armature of the receiving polar relay. The armature of the polar relay PR''_1 controls the circuit of the relay PR'_2 in the same way that the relay PR_2 of the previous train is controlled by the relay PR_1. In short, the relay PR''_1 is merely provided because the usual polar relay of the type of the relay PR'_1 has only one set of contacts. If such relay had two sets of contacts, one of the sets of contacts would be used to control the relay PR'_2 and the other relays of the train in exactly the same way as the relay PR_1 controls its train.

The result is that when the printer is not connected at the distant sending station, relays PR''_1 and PR'_2 will be released, the latter maintaining the relay PR'_3 operated so that the operating circuit of the switching relay PR'_4 is open and the armature of said relay PR'_4 is held against its left-hand or back contact to connect the receiving printer RP to a negative marking source. This prevents the receiving printer from receiving a continuous positive spacing current over the armature of the relay PR'_1. As soon as the printer is connected to the circuit at the distant sending station, a tone will be received and rectified by the detector RD'. This tone must continue for a period of, say, .015 second in order to enable the relay PR''_1 to actuate the relay PR'_2, and when the latter relay is actuated, it will not be released for a period of, say, .13 second, or long enough to hold over the longest no-tone interval which may occur during the sending of signals. The relay PR'_3, however, will not release in response to the operation of relay PR'_2, unless the latter relay remains operated continuously for some interval such as, for example, 1.5 seconds. When, however, the re-

lay remains operated for this length of time, as it will when the sending printer is normally connected to the circuit at the distant station with the consequent transmission of a marking tone or when the printer sender is actually operating and sending signals, the relay PR'_3 releases, thereby operating the relay PR'_4 which is quick to operate and quick to release, so that the receiving printer RP is disconnected from the normal marking source and is connected to the armature of the relay PR'_1 to receive signals. When the distant printer is disconnected so that the tone ceases, the relay PR'_2 releases as soon as the tone has ceased for a period of, say, .13 second, thereby causing the relay PR'_3 to operate quickly and through relay PR'_4 shift the connection of the receiving printer RP to the normal marking source.

In the operation of the system as above described it will be noted that the relay train which cuts in the suppression filter RSF at the radio receiver is responsive only to the tone frequency from the local transmitting source G. Inasmuch as the relay train for cutting in the filter requires about 1.5 seconds for its operation, difficulty will be encountered if the distant operator should apply her telegraph transmitter to the circuit and start sending before the local operator should plug up her telegraph transmitter TP to the circuit by means of the cord circuit C. Obviously, if the local operator plugs up her telegraph transmitter to the radio channel after the distant operator has started sending, the tone from the source G will be received and transmitted over the line RL during the period of a second and a half required for the relay train under the control of the relay PR_1 to operate and connect in the suppression filter. This may result in mutilation of the received signal during the period required for the relay train to cut in the suppression filter RSF. The circuit is therefore arranged in accordance with the present invention so that, when the operator at one end of the system connects the telegraph transmitter to the radio channel the received tone operates a relay train for automatically connecting the transmitting tone to the radio chanel at the other end.

In order to accomplish this result, a relay S_1 is connected to the armature of the polar relay PR'_1 of the telegraph receiving apparatus so that the relay S_1 will be operated whenever the telegraph receiver responds to a sending tone applied at the distant station. The relay S_1 which is slow to release has its armature arranged to close the circuit of a slow release relay S_2 when the armature is retracted. The slow relay S_2 in turn, when operated, maintains closed the circuit of a slow release relay S_3. The relay S_3 controls the circuits of a switching relay R_1 and a locking relay R_2 to automatically connect the tone from the source G to the radio channel independently of the cord circuit C, in a manner to be described presently, whenever the telegraph tone is transmitted from the distant transmitter.

The train of relays S_1, S_2 and S_3 which controls the automatic connection of the local tone in response to the distant tone, should be so timed as not to operate the switching relay R_1 in response to voice currents or static signals. As the voice current peaks or static signals will usually be very short the relay S_1 may be timed to release in about .25 second and the relays S_2 and S_3 may each be arranged to release in about .4 second. The relay S_1 being quick to pull up its armature in response to a received tone, it follows that it will require about .8 second for relays S_2 and S_3 to successively release and thereby close the circuit of the switching relay R_1 so that the relay R_1 will not be operated in response to momentary signals such as voice current peaks and static. The slow release of relay S_1 is so timed that when operated said relay will hold up its armature over the interruptions in the received tone due to the sending of spacing signals.

The operation of the circuit is as follows: Assume that the telegraph transmitters are idle at both ends of the radio telephone circuit so that no telegraph carrier is being received from the distant station and the local operator has her plugs P and P′ removed from the jacks J and J′. Under these conditions the slow release relay S_1 will be de-energized. As its circuit is connected to the armature of the polar relay PR'_1 which will be resting upon its spacing contact (no tone being received), positive 130-volt battery is therefore connected to both terminals of the relay S_1 and no current flows in the relay circuit. The relay S_2 is held operated and relay S_3 in turn is held operated so that the circuits of the relays R_1 and R_2 are open.

If, now, the operator at the distant terminal connects her telegraph transmitter to the circuit by the use of a cord and plug arrangement similar to the cord circuit C, a tone will be received by the telegraph receiving apparatus RA′—RF′—RD′ which causes the polar relay PR'_1 to shift its armature to the marking position, thereby connecting negative battery to the circuit of the relay S_1 and also to the circuit of the relay PR''_1. The train of relays controlled by the latter operates as already described to connect the receiving printer RP to the armature of the polar relay PR'_1. In the meantime the relay S_1 is energized and immediately pulls up its armature to open the circuit of the relay S_2. After an interval of about .4 second the relay S_2 releases and in turn opens the circuit of the relay S_3. The latter after an additional interval of about

.4 second releases its armature, thereby connecting battery to the windings of the relays R_1 and R_2. Relay R_1 operates and at its armatures connects the source G over the conductors 40 to the two-wire terminal of the hybrid coil 10 so that the tone is now transmitted over the transmitting line TL to the radio transmitter T. This tone upon being received as interference by the local radio receiver R causes the operation of the relay train under the control of the polar relay PR'_1 to connect the suppression filter RSF in circuit after an interval of about 1.5 seconds, as already described. The distant operator now transmits signals and these signals will not be mutilated or lost if, while they are being received, the local operator uses the cord C to plug from the jack J through the jack J′ to the transmitting printer TP, because the local transmitting tone is already on the circuit.

It will be noted that when the relay S_3 released, the relay R_2 was not operated because its circuit is controlled by the springs of the jack J′. Therefore, if the local operator desires to connect up her printer after signaling has started from the distant station, she may insert the plug P in the jack J and the plug P′ in the jack J′. The circuit of the relay R_2 is now completed over the contact of the jack J′ so that said relay R_2 operates and locks up over its right-hand armature independently of the springs of the jack J′. At its left armature relay R_2 short-circuits the winding of relay R_1 which releases, with the result that the tone from the source G no longer is applied to the radio telephone circuit over the conductors 40 but is now applied to the radio telephone circuit over the cord circuit C. The printer or telegraph sender may now be operated in the usual manner without causing any interference with the received telegraph signals.

If the operator no longer has any messages to be transmitted, she may disconnect the local telegraph tone from the radio telephone circuit by removing plugs P and P′ while the distant telegraph sender is connected to the circuit. Under these conditions the relay S_1 remains operated, relays S_2 and S_3 remain released, and the relay R_2 remains operated since, as already described, it was locked up independently of the contacts of the jack J′. The relay R_1 was, of course, previously released and consequently, the local tone from the source G will not be applied to the radio telephone circuit unless the operator again plugs up over the cord C. When the distant telegraph transmitter is disconnected, the relay S_1 will be released, whereupon relays S_2 and S_3 are energized, the latter opening the circuit of the locked up relay R_2 which now releases so that the circuit is restored to normal. Should the distant operator again connect the transmitter to the circuit, the tone circuit source G will again be automatically applied to the radio telephone circuit in the manner already described.

Coming again to the condition where both telegraph transmitters are connected to the circuit so that the local tone is being transmitted and the distant tone is being received, under these conditions the relay R_1 is released and the relay R_2 locked up as already described and the tone from the source G is applied over the cord circuit C. If, now, the distant operator should disconnect her transmitter first, relay S_1 will release, so that relays S_2 and S_3 will be operated and relay R_2 will be released (relay R_1 having already been released as previously described). The tone from the source G will still be applied to the circuit over the cord circuit C so that the filter RSF will still be connected in circuit at the radio receiver R. Under these conditions the local telegraph transmitter may be operated to send signals in the normal manner over the cord circuit C just as though the relay train S_1—S_2—S_3 were not provided.

It will be understood, of course, that the relay trains S_1—S_2—S_3, together with the switching relay R_1 and locking relay R_2 and their associated circuits, will also be provided at the distant terminal, so that when either operator comes in on the circuit with the telegraph transmitter the sending tone will be applied to the circuit at the other terminal.

While the invention as above outlined is primarily applicable to radio circuits, the principle thereof may be applied to ordinary wire transmission circuits particularly where it is desired to use telegraph printers to pass information relating to calls over toll telephone circuits during idle periods of the circuit. This application of the principle is illustrated in Fig. 2 which shows the invention applied to a four-wire telephone circuit, although it will be obvious that it may be applied to the terminal two-way repeater of a two-wire telephone line since the two-way repeater is in effect a short four-wire circuit.

Referring to Fig. 2, the terminal of a four-wire telephone circuit here shown, the circuit comprising a transmitting line TL and a receiving line RL, including one-way terminal amplifiers TA and RA respectively. The lines TL and RL of the four-wire circuit are associated by means of a hybrid coil 10 and balancing network N with the usual terminal jack J. Tone telegraph receiving apparatus similar to that described in connection with Fig. 1 is bridged across the receiving line RL by means of a high impedance amplifier RA′. The printer apparatus and associated circuits are similar to those described in connection with Fig. 1,

except that a relay R_3 is provided for switching the receiving printer RP to the contact of the receiving relay PR'_1. This relay R_3 performs the function of the train of relays PR'_1, PR'_2 and PR'_3 of Fig. 1. There is no necessity for a train of relays in the case of Fig. 2 because no suppression filter corresponding to RSF is connected in to the receiving line in the case of the wire telephone circuit since the two lines of the four-wire circuit are sufficiently isolated electrically from each other so that undue interference from the transmitting line to the receiving line does not take place.

Further details of the apparatus will be clear from a description of the operation which is as follows:

Assuming that the cord C has been used to connect the four-wire telephone circuit to a terminal telephone line by inserting the plugs P and P′ in the jacks J and J″ respectively, speech currents will pass over the lines of the four-wire circuit in the usual manner. The high impedance amplifier RA′ which connects the receiving side of the printer telegraph system to the four-wire circuit does not materially affect the electrical transmission characteristics from a telephone standpoint. A part of the voice currents may tend to pass through the high impedance amplifier, but the narrow band-pass filter RF′ passes only a narrow band of telephone frequencies to the amplifier detector RD′. The resultant rectified peak currents may intermittently operate the receiving relay PR'_1, but these currents have no effect on the receiving printer RP because it is connected in a local circuit which is normally closed by the back contact of the relay R_3. This relay is not disturbed by the intermittent operation of the receiving relay PR'_1, because of the protection afforded by the release relay train S_1, S_2 and S_3, this train operating in the same manner as the similar train described in connection with Fig. 1. During the telephone connection the sending printer TP maintains its circuit closed in the idle condition, thus holding the sending relay TR on its marking contact.

Let us now assume that the telephone connection is taken down and that the distant operator connects a sending printer to the circuit at the distant terminal. It will be understood that the apparatus at the distant terminal will be identical with that shown in Fig. 2. The operator at the distant terminal inserts the plug corresponding to P in the jack corresponding to J thereat, and inserts the plug corresponding to P′ in the jack corresponding to J′ at the distant terminal. Tone will now be transmitted from the oscillator corresponding to G at the distant terminal, through the sending filter corresponding to GF, and over the jacks corresponding to J′ and J, via the cord corresponding to C, and over the sending side of the four-wire telephone circuit at the distant terminal. Since the transmitting line at the distant terminal corresponds to the receiving line RL at the terminal illustrated in Fig. 2, the station shown in Fig 2 will receive this tone over the circuit RL. The tone will now pass through the high impedance amplifier RA′, and through the filter RF′ to the amplifier detector RD′ to operate the receiving relay PR'_1 on its marking contact. When the receiving relay closes on its marking contact, the slow-release relay S_1 will be immediately energized, and the slow-release relays S_2 and S_3 will release in turn after a short interval. Upon the releasing of relay S_3 relays R_1 and R_3 will be operated. Relay R_3 transfers the receiving printer RP from its local circuit to the armature of the receiving relay PR'_1. At the same time relay R_1 connects the tone from the oscillator to the transmitting line TL by way of the auxiliary circuit 40 and the hybrid coil 10.

It will be clear from the operation above described, that the connection of the transmitting printer to the telephone line at the distant terminal results in automatically connecting the transmitting printer TP of Fig. 2, to the telephone line. The time of the complete action, from the connection of the printer at the distant station when the operator puts up the cord, to the automatic connection of the local printer, is determined by the releasing time of the slow-release relays S_2 and S_3.

The local operator at the station of Fig. 2, may at any time obtain control of the connection by inserting the plug P of the cord C in the jack J, and by inserting the plug P′ of the cord C in the jack J′. As a result of this action the auxiliary contacts of the jack J connect ground to the relay R_2 which was not operated as a result of the automatic action previously described. Since relay S_3 is released the relay R_2 is now operated, and is locked up independently of the jack J′, at its right-hand contact. At its left-hand contact it short-circuits the winding of the relay R_1 thereby disabling the auxiliary circuit 40 so that the tone is now applied to the telephone line over the cord circuit C. The sending printer apparatus may, of course, be disconnected from the line, under these conditions, at any time, by merely pulling down the cord C.

If the operator at the terminal shown in Fig. 2 should initiate the setting up of a printer connection by connecting jack J to jack J′ through the cord C thereby connecting the oscillator G to the transmitting line TL, the auxiliary contacts of the jack J′ will be operated. Momentarily no effect is produced upon the relay R_2 however. At

the distant terminal the tone is applied to the line RL by an automatic operation similar to that already described and as soon as this tone is received the receiving relay PR'_1 operates the train of relays S_1, S_2 and S_3 as before. As soon as relay S_3 is released relays R_2 and R_3 will be operated from the left-hand contact of the relay S_3. With the operation of the relay R_2 the winding of the relay R_1 is at once short-circuited which prevents it from being energized, and consequently the auxiliary circuit 40 does not come into play. Relay R_2 locks up to ground through its own armature and contact, as before. The local transmitting tone from the source G is transmitted over the cord circuit C, and the operator may remove the tone at will, by pulling down the cord.

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 appended claims.

What is claimed is:

1. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a signal transmitter for each terminal normally disconnected from the radio receiver, and means responsive to the switching of the signal transmitter into connection with the radio transmitter at one terminal to switch the signal transmitter at the other terminal into connection with the corresponding radio transmitter.

2. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a signal transmitter for each terminal normally disconnected from the radio receiver, a signal receiver for each terminal normally associated with the corresponding radio receiver, and means responsive to signals received by the signal receiver at one terminal from the other terminal to switch the transmitter at said first terminal into connection with the corresponding radio transmitter.

3. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal to the corresponding radio transmitter, and means responsive to such connections by an operator at one terminal to automatically associate the signal transmitter with the radio transmitter at the other station independently of the link circuit at the latter terminal.

4. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal to the corresponding radio transmitter, means responsive to such connection by an operator at one terminal to automatically associate the signal transmitter with the radio transmitter at the other station independently of the link circuit at the latter terminal, and means whereby the operator at said latter terminal may establish connection between the signal transmitter and radio transmitter by means of the link circuit while such automatic connection is established.

5. In a radio signaling system, a radio transmitter and radio received at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal to the corresponding radio transmitter, means responsive to such connection by an operator at one terminal to automatically associate the signal transmitter with the radio transmitter at the other station independently of the link circuit at the latter terminal, and means whereby the operator at said latter terminal may disconnect the signal transmitter from the radio transmitter at will.

6. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a telegraph transmitter for transmitting signals by an interrupted tone at each terminal, and means responsive to the connection of the telegraph transmitter with the radio transmitter at one terminal to apply the tone from the telegraph transmitter at the other terminal to the radio transmitter thereat.

7. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a telegraph transmitter for transmitting signals by an interrupted tone at each terminal, a telegraph receiver at each terminal responsive to the tone transmitted at the other terminal, and means responsive to the tone received by the telegraph receiver at one terminal from the transmitter at the other terminal to connect the tone from the telegraph transmitter at said first terminal to the corresponding radio transmitter.

8. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a telegraph transmitter for transmitting signals by an interrupted tone at each terminal, a link circuit at each terminal whereby an operator may connect the telegraph transmitter at the terminal to the corresponding radio transmitter, and means responsive to such connection by an operator at one terminal to automatically apply the tone from the telegraph transmitter at the other terminal to the radio transmitter thereat independently of the link circuit at that terminal.

9. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a telegraph transmitter for transmit-

ting signals by an interrupted tone at each terminal, a link circuit at each terminal whereby an operator may connect the telegraph transmitter at the terminal to the corresponding radio transmitter, means responsive to such connection by an operator at one terminal to automatically apply the tone from the telegraph transmitter at the other terminal to the radio transmitter thereat independently of the link circuit at that terminal, and means whereby the operator at said latter terminal may establish connection between the signal transmitter and radio transmitter by means of the link circuit while such automatic connection is established.

10. In a radio signaling system, a radio transmitter and radio receiver at each terminal, a telegraph transmitter for transmitting signals by an interrupted tone at each terminal, a link circuit at each terminal whereby an operator may connect the telegraph transmitter at the terminal to the corresponding radio transmitter, means responsive to such connection by an operator at one terminal to automatically apply the tone from the telegraph transmitter at the other terminal to the radio transmitter thereat independently of the link circuit at that terminal, and means whereby the operator at said latter terminal may disconnect the tone from the radio transmitter at said terminal at will.

11. In a signaling system, a transmitting path and a receiving path at each terminal, a signal transmitter for each terminal normally disconnected from the transmitting path, and means responsive to the switching of the signal transmitter into connection with the transmitting path at one terminal to switch the signal transmitter at the other terminal into connection with the corresponding transmitting path.

12. In a signaling system, a transmitting path and a receiving path at each terminal, a signal transmitter for each terminal normally disconnected from the transmitting path, a signal receiver for each terminal normally associated with the corresponding receiving path, and means responsive to signals received by the signal receiver at one terminal from the other terminal to switch the signal transmitter at said first terminal into connection with the corresponding transmitting path.

13. In a signaling system, a transmitting path and a receiving path at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal for transmission over the link circuit to the corresponding transmitting path, and means responsive to such connection by an operator at either terminal to automatically associate the signal transmitter with the transmitting path at the other station independently of the link circuit at the latter terminal.

14. In a signaling system, a transmitting path and a receiving path at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal to the corresponding transmitting path, means responsive to such connection by an operator at one terminal to automatically associate the signal transmitter with the transmitting path at the other station independently of the link circuit at the latter terminal, and means whereby an operator at said latter terminal may establish connections between the signal transmitter and transmitting path by means of the link circuit while such automatic connection is established.

15. In a signaling system, a transmitting path and a receiving path at each terminal, a signal transmitter for each terminal, a link circuit at each terminal whereby an operator may connect the signal transmitter at the terminal to the corresponding transmitting path, means responsive to such connection by an operator at one terminal to automatically associate the signal transmitter with the transmitting path at the other station independently of the link circuit at the latter terminal, and means whereby an operator at said latter terminal may disconnect the signal transmitter from the transmitting path at will.

In testimony whereof, I have signed my name to this specification this 17th day of July, 1929.

THOMAS A. McCANN.