

UNITED STATES PATENT OFFICE

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RADIO TELEPHONE AND TELEGRAPH SYSTEM

Application filed December 13, 1928. Serial No. 325,331.

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 as, for example, 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.

Heretofore such telegraph operation has been carried out upon a half-duplex basis; that is, while messages could be transmitted over the radio links in either direction they were actually transmitted in only one direction at a time. This was accomplished as follows: The radio transmitter and radio receiver at one end of the radio link were located some distance apart and connected by separate one-way lines to a common switching point at which connections could be established to any desired telephone line. Each one-way line was provided with voice-controlled apparatus whereby when telephone currents were transmitted over the line leading to the radio transmitter, the one-way line leading from the radio receiver was disabled, and vice versa. This was necessary in order to obtain proper telephone operation. Telegraphic messages were transmitted by impressing an audible tone, interrupted in accordance with the message, upon the telephone terminal at the telephone switching point. The connection of the telegraph transmitter at this point automatically operated the voice-controlled devices to render the one-way line connected to the radio transmitter operative and to disable the line leading from the radio receiver. The audible tone was then modulated upon the carrier wave of the radio transmitter in the same manner as telephone currents. In order to

receive telegraph messages the telegraph receiver was associated with the one-way line leading from the radio receiver at a point between the radio receiver and the point at which the disabling means was applied to the one-way line, so that the fact that the line as a whole was disabled, so far as transmission from the radio receiver to the telephone switching point was concerned, did not prevent reception of telegraph messages over the non-disabled portion of the one-way line. An audible tone of a different frequency was used to modulate the carrier and was then transmitted from the distant terminal of the radio link. This tone was then detected and reproduced by the radio receiver in a manner similar to the reproduction of ordinary telephone currents, and upon being selectively transmitted from the one-way receiving line to the telegraph receiver was caused to operate the telegraph receiver in a well-known manner.

While the foregoing arrangement permitted the transmission of telegraph messages one way at a time, it is highly desirable to be able to transmit the telegraph messages on a full-duplex basis so that telegraph transmission may take place in both directions simultaneously. It might be supposed that this would be entirely possible where audible tones of different frequencies are employed for transmitting the telegraph messages to the radio transmitter and for receiving the telegraph messages from the radio receiver, but experience shows that such is not the case. Due to the fact that the radio receiver is nearer to the local radio transmitter than it is to the distant radio transmitter, it frequently receives more energy from the local transmitter than from the distant transmitter, even when slightly different radio wave lengths are employed for transmission in the two directions and the receiving system is made highly selective to the wave length employed by the distant transmitter by employing directional antenna systems. Under these conditions the telegraph message being sent over the one-way line leading to the radio transmitter is received on the one-way line leading from the radio receiver simultaneous-

ly with the telegraph message from the distant station. While the telegraph receiving apparatus associated with the receiving line is able to discriminate by frequency selection between the two tones corresponding to the sending and received telegraph signals, it has been found that when the energy of the undesired signal exceeds certain limits the one-way amplifiers included in the one-way receiving line between the radio receiver and the telegraph receiver are overloaded, thereby causing distortion of the desired signals. This distortion is so great as to cause false signals, particularly when printing telegraph messages are transmitted.

In order to overcome this difficulty it has been proposed to prevent the tone corresponding to the telegraph signals from the local transmitter from being transmitted over the one-way receiving line by associating therewith, at or near the radio receiver, a filtering arrangement for suppressing the tone corresponding to the unwanted telegraph signals. As such suppressing arrangement would suppress the corresponding frequency in ordinary telephone transmission and thereby cause distortion of the telephone message, it has been proposed to automatically cut in the suppression device when interfering telegraph signals are being received from the local transmitter and to again cut the suppression device out when such telegraph signals cease or fall below a harmful value. This is accomplished by selecting from the radio receiver some of the energy of the tone corresponding to the signals from the local transmitter, rectifying the energy and causing it to operate a relay arrangement for cutting the filter in and out. As this arrangement should not be responsive to telephone currents or static signals of the same frequency as the tone employed for telegraph transmission, the relay arrangement for switching the filter in and out is designed to operate only when the tone frequency is received over an interval of time longer than that during which a telephone signal or a static signal would persist, and the arrangement has a sufficient hang-over so that when it is once operated to cut in the filter it will be maintained operated during interruptions of the tone such as would occur in connection with the transmission of the signals of a telegraph message.

Now in any telegraph system employing two current values for transmission, the code may be considered as being made up of marks and spaces. In ordinary land wire Morse or printer operation, the circuit in its idle condition transmits a continuous marking signal. In radio telegraphy the circuit when in idle condition transmits a continuous spacing signal. If any ordinary Morse or printer transmitter is used in connection with the arrangement above described so that tone is trans-

mitted for each spacing signal of the telegraph transmitter and no tone is transmitted during marking intervals, it will be necessary to precede each telegraph message by a tone sustained long enough to cause the operation of the switching arrangement controlling the filter. In order to overcome this difficulty, it is proposed, in accordance with the present invention, to reverse the arrangement now used for half-duplex operation and transmit the tone during marking intervals, the spacing signals being represented by no-tone intervals. Accordingly, when the telegraph transmitter (such as a printer) is connected to the circuit and no message is at the moment being transmitted, the printer sending circuit will be closed and a marking tone will be applied automatically and without any thought on the part of the operator. The rectifier and relay arrangement are accordingly arranged to respond to this tone and cut in the filter. The relay arrangement is also provided with a hang-over such as to maintain the filter cut in during the longest marking interval that would occur during the transmission of a message. The filter will, therefore, remain in the circuit so long as the telegraph transmitter is applied to the circuit for transmission from the local radio transmitter, and will be cut out after the telegraph transmitter has been disconnected, thus leaving the circuit in condition for telephone transmission.

Since the telegraph receiving apparatus is permanently associated with the receiving line, the fact that a continuous tone is received during marking and no tone during spacing would result in causing the local receiving printer to operate continuously whenever the distant transmitter is disconnected, resulting in objectionable noise and the printing of false characters during telephone operation. This is because the disconnection of the distant telegraph transmitter causes the tone to cease, and as the absence of any tone corresponds to the spacing condition so far as the receiving printer is concerned, it will receive a continuous spacing signal when the distant transmitter is disconnected. In order to prevent this false operation of the receiving printer, it is proposed, in accordance with the present invention, to associate with the tone receiving apparatus which controls the local telegraph receiver a relay train similar to that employed for cutting the filter in and out of the one-way receiving line. The local printer or telegraph receiver is normally disconnected from the tone receiving apparatus and is connected to a circuit which maintains it in marking condition. When the distant transmitter is applied to the circuit so that a sustained marking tone is received, the relay train operates to connect the receiving printer or the telegraph receiver to the tone receiver so that it will respond to the received

telegraph signals and will be maintained connected to the tone receiver during tone interruptions corresponding to the spacing signals of a message. When, however, the distant transmitter is disconnected so that the tone ceases to be received for a time longer than the normal interruptions occurring during message transmission, the relay train will permit the receiving printer to be disconnected from the tone receiver and again connected to a local circuit, which maintains it in marking condition.

The invention will now be more fully understood from the following detailed description thereof when read in connection with the accompanying drawing, the figure of which illustrates a preferred circuit arrangement embodying the principles of the invention. In the drawing, 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 drawing, 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 latter 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, these conditions being reversed with respect to the present method of printer transmission over such circuits. 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 an 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 PR₁', 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.

The arrangement so far described will operate satisfactorily for half-duplex operation where the circuit is only used for the transmission of telegraph messages in one direction at any one time. In attempting to operate the circuit on a full-duplex basis so that transmission of telegraph messages takes place in both directions at the same time, however, 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 the 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 PR₁. The polar relay PR₁ controls the circuit of a relay PR₂, which in turn opens a circuit of a polar relay PR₃. The latter relay controls the switching relays PR₄ and PR₅ for switching the filter RSF in and out of circuit.

Each of the polar relays PR₁, PR₂ and PR₃ 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 produced 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 PR₁ 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 PR₂ 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 PR₃ to battery. The relay PR₃ 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 PR₅ and PR₄.

The relays PR₄ and PR₅ 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 PR₃ 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 PR₂ 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 PR₂ 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 PR₁ 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 PR₂ 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 arranged, as has already been described, so that the tone is transmitted during the marking interval and not during the spacing interval, as was heretofore the case. 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 commences, 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 seconds. 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 drawing 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 de-

scribed, 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 positive 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_1' . 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 relay 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.

It will be observed that the relay train for connecting the receiving printer RP in circuit responds only to the tone frequency originating at the distant transmitter. The relay train for switching the suppression filter RSF into and out of circuit, on the other hand, responds only to the tone frequency transmitted from the local transmitter T. Consequently the receiving printer may be cut in and out of circuit and may receive its signals without material distortion regardless of whether or not the local printer TP is connected to the circuit over the cord C. Whenever such local transmitting printer TP is connected in circuit, however, the suppression filter will be cut in quite independently of whether signals are being received from the distant transmitter.

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 signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extending from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting

apparatus producing a tone interrupted in accordance with a code so that the tone is transmitted during marking signals and no tone is transmitted during spacing signals, whereby a sustained marking tone preceding the transmission of code signals is transmitted when said telegraph transmitting apparatus is connected to said four-wire junction, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, means connecting said telegraph receiving apparatus with said receiving line between the point at which it is disabled and said radio receiver, a suppression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used for telegraph transmission from the distant terminal, and means responsive to the sustained marking tone, transmitted by radio from the local radio transmitter to the local radio receiver upon connection of the telegraph transmitting apparatus to connect said suppression device in said receiving line.

2. In a radio signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extending from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting apparatus producing a tone interrupted in accordance with a code so that the tone is transmitted during marking signals and no tone is transmitted during spacing signals, whereby a sustained marking tone preceding the transmission of code signals is transmitted when said telegraph transmitting apparatus is connected to said four-wire junction, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, means connecting said telegraph receiving apparatus with said receiving line between the point at which it is disabled and said radio receiver, a sup-

pression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used for telegraph transmission from the distant terminal, and means to connect said suppression device in said receiving line, said means operating in response to a sustained tone of the frequency supplied by said telegraph transmitting apparatus upon being connected to the four-wire junction.

3. In a radio signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extending from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting apparatus producing a tone interrupted in accordance with a code so that the tone is transmitted during marking signals and no tone is transmitted during spacing signals, whereby a sustained marking tone preceding the transmission of code signals is transmitted when said telegraph transmitting apparatus is connected to said four-wire junction, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, means connecting said telegraph receiving apparatus with said receiving line between the point at which it is disabled and said radio receiver, a suppression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used for telegraph transmission from the distant terminal, and means to connect said suppression device in said receiving line, said means operating in response to a sustained tone of the frequency supplied by said telegraph transmitting apparatus upon being connected to the four-wire junction, said means also operating to maintain said suppression device connected during interruptions of said tone due to spacing signals.

4. In a radio signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extend-

ing from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting apparatus producing a tone interrupted in accordance with a code, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, a suppression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used for telegraph transmission from the distant terminal, means responsive to the tone transmitted by radio from the local radio transmitter to the local radio receiver to connect said suppression device in said receiving line, said telegraph receiving apparatus being associated with said receiving line between the point at which it is disabled and the radio receiver and said direct current signal responsive means being normally dissociated from said translating means and connected to a marking circuit, and means responsive to the tone transmitted by radio from the distant radio terminal for connecting said signal responsive means to said translating means.

5. In a radio signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extending from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting apparatus producing a tone interrupted in accordance with a code, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, a suppression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used

for telegraph transmission from the distant terminal, means to connect said suppression device in said receiving line, said means operating in responsive to tone impulses of predetermined character and of the frequency supplied by said telegraph transmitting apparatus, said telegraph receiving apparatus being associated with said receiving line between the point at which it is disabled and the radio receiver and said direct current signal responsive means being normally dissociated from said translating means and connected to a marking circuit, and means responsive to the tone transmitted by radio from the distant radio terminal for connecting said signal responsive means to said translating means.

6. In a radio signaling system including a radio transmission link, a radio transmitter and a radio receiver at one terminal of said radio link, a four-wire junction, a normally disabled one-way transmitting line extending from said four-wire junction to said radio transmitter, a one-way receiving line extending from said radio receiver to said junction, means associated with each of said lines and responsive to telephone signals transmitted thereover to disable the other line, telegraph transmitting apparatus and telegraph receiving apparatus, said telegraph transmitting apparatus producing a tone interrupted in accordance with a code, said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into direct current marking and spacing signals and means responsive to said direct current signals, means operating when the telegraph transmitting apparatus is associated with said four-wire junction to render said transmitting line operative and to disable said receiving line, a suppression device for suppressing the tone frequency supplied by said telegraph transmitting apparatus while passing the tone frequency used for telegraph transmission from the distant terminal, means to connect said suppression device in said receiving line, said means operating in response to tone impulses of predetermined character and of the frequency supplied by said telegraph transmitting apparatus, said means also operating to maintain said suppression device connected during interruptions of said tone due to spacing signals, said telegraph receiving apparatus being associated with said receiving line between the point at which it is disabled and the radio receiver and said direct current signal responsive means being normally dissociated from said translating means and connected to a marking circuit, and means responsive to the tone transmitted by radio from the distant radio terminal for connecting said signal responsive means to said translating means.

7. In a signaling system, a circuit over which signaling impulses of various kinds, including printing telegraph signals, are transmitted at different times, means controlled by printing telegraph signals regardless of the character whose code is transmitted for determining when the signaling impulses on the circuit are printing telegraph signals, and switching arrangements controlled by said determining means for connecting a receiving printing telegraph device to the circuit.

8. In a signaling system, a circuit over which signaling impulses of various kinds, including code signal impulses, are transmitted at different times, means responsive to code signal impulses regardless of the character represented by the code for determining when the signaling impulses on the circuit are code signal impulses, and switching arrangements controlled by said determining means for connecting a code receiver to the circuit.

In testimony whereof, I have signed my name to this specification this 12th day of December, 1928.

JOSEPH HERMAN.

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