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RADIO TELEPHONE AND TELEGRAPH SYSTEM

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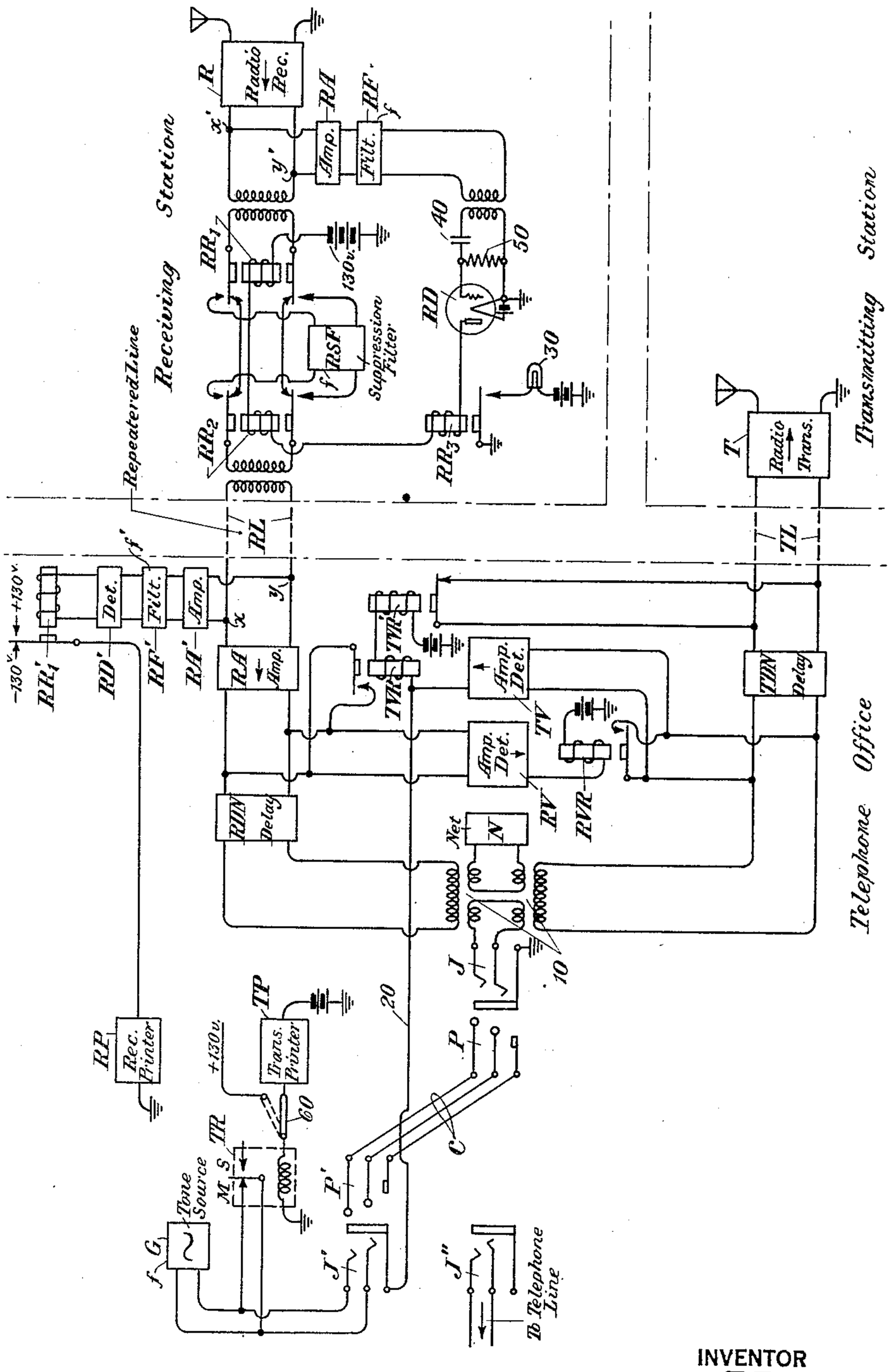

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RADIO TELEPHONE AND TELEGRAPH SYSTEM

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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. Telegraph 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 transmiting 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 simulta-

neously 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 is proposed, in accordance with the present invention, 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 to the telephone message, it is further proposed to automatically cut in the suppression device when the 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 frequencies 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 currents differing in frequency or intensity, 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 the idle condition customarily transmits a spacing signal. If any ordinary Morse or printer transmitter is used in connection with the arrangement above described so that no tone is transmitted during its marking interval, the idle periods will nevertheless be considered as marking periods. This explanation is necessary to understand more completely the detailed description of this invention to follow:

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 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′. The relay TR has its contact so arranged as to close the short-circuit across the tone source G during marking impulses, and to open 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 spacing intervals, while marking signals will be represented by a no-tone condition of the circuit. The tone employed is preferably an audio 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 conductor 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 the 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 spacing 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 a telegraph receiving apparatus is bridged across the line RL at x—y between the point at which the short circuit is applied and the 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 Accordingly, such a telegraph receiving apparatus and transmission may take place from the radio receiver R over the line RL to the termials 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 receiving relay RR'_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.

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 desired 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.

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 applying the selected energy to a detector which operates switching relays 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 unwanted tone frequency and a vacuum tube detector RD in whose plate circuit are connected relays RR_1, RR_2 and RR_3. These relays are normally energized by the plate current flowing through the tube RD, and the relays RR_1 and RR_2 normally connect the receiver R through to the line RL independently of the suppression filter RSF. When the selected tone is applied to the grid of the tube RD, however, the plate current is reduced so that the relays are de-energized, relays RR_1 and RR_2 interpolating the suppression filter RSF between the receiver R and the line RL, while the relay RR_3 closes the circuit of a signal lamp 30, which indicates that the suppression filter is in circuit.

The relay arrangement above described should be so designed as to prevent false operation due to relatively short telephone and static signals involving frequencies corresponding to the tone frequency selected by the filter RSF. In order to accomplish this result, the condenser 40 and grid leak resistance 50, which are connected to the grid circuit of the tube RD, are so proportioned that the negative potential built up on the grid in response to the alternating current tone frequency is built up so gradually that the relays, such as RR_1 and RR_2, do not release to cut in the filter RSF until a period has elapsed longer than an ordinary telephone or static signal would persist. The elements 40 and 50 also serve to prevent the negative charge built up on the grid from leaking off and thereby increasing the plate current sufficiently to again energize the relays RR_1, RR_2 and RR_3 until a time has elapsed after the cessation of the tone which is slightly greater than the longest tone interruption which would occur during the transmission of telegraph signals.

As this hang-over period, which prevents the relays from cutting out the suppression filter during tone interruptions due to marking signals, must be longer than any normal spacing signal, the detector RD and the relays controlled thereby will not in general be operated to switch in the suppression filter in response to the first spacing signal transmitted after the printing telegraph transmitter is applied at the jack J. Also, when

the transmitter is applied to the jack J without sending any signals, no tone will be applied since the marking condition is a no-tone condition. Accordingly, some provision must be made for applying a tone to the circuit after the telegraph transmitter has been connected and just before the transmission of telegraph signals begins, this tone being sustained long enough to build up a negative potential on the grid of the detector tube RD to release the relays RR_1 and RR_2 and connect the filter RSF in circuit. For this purpose a switch 60 may be provided for connecting the transmitting printer TP to the transmitting relay TR. By throwing the switch 60 to its dotted line position after the telegraph transmitter has been plugged up to the jack J and just before the transmitter starts to send signals, a spacing current will be applied to the transmitting relay TR, thereby removing the short-circuit from the tone source G long enough to transmit the tone frequency to cut in the suppression filter RSF. As soon as the transmitting printer is ready to transmit signals, the switch 60 is thrown to its lower position, and the ensuing transmission of interrupted spacing signals serves to maintain the suppression filter in circuit. When the transmitting printer TP is not operated for an appreciable length of time or when it is disconnected by withdrawing the plug P from the jack J, the transmission of the tone frequency ceases, and after the hang-over period has elapsed, the relays RR_1, RR_2 and RR_3 are again energized and the suppression filter is cut out of circuit.

Whenever the telegraph transmitter at the distant station is applied to the circuit, the transmission of messages will be preceded by the transmission of a sustained tone to operate the local arrangement at the distant receiving station for cutting in the suppression filter. This tone will then be followed by an interrupted tone corresponding to the message. The tone frequency employed at the distant station will be different from that generated by the source G and will be applied to the distant radio transmitter to modulate the carrier in the same manner as a telephone signal. The carrier is received by the radio receiver R, which detects therefrom the tone frequency and transmits it over the line RL to the telegraph receiving apparatus connected at the point *x*—*y*. This receiving apparatus comprises an amplifier RA′ for amplifying the desired tone, a filter RF′ for selecting the tone corresponding to the distant transmitter and a detector RD′ for rectifying the tone to operate the receiving relay RR'_1. The initial sustained tone for operating the suppression filter causes the relay RR'_1 to transmit to the receiving printer RP a spacing signal, which may cause one or more false characters to be printed before the message actually starts. As soon as the message begins, however, the relay RR'_1 will relay to the printer RP marking and spacing signals corresponding to the message, and the message will be printed in the usual manner.

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, means responsive to the application of telegraph signals from said telegraph transmitting apparatus to 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 associated with said radio receiver for suppressing telegraph signals received from the local radio transmitter while passing telegraph signals received from the radio transmitter at the distant end of the radio link, and means responsive to telegraph signals received by said radio receiver from the local radio transmitter 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, means responsive to the application of telegraph signals from said telegraph transmitting apparatus to 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 associated with said radio receiver for suppressing telegraph signals received from the local radio trans-

mitter while passing telegraph signals received from the radio transmitter at the distant end of the radio link, and means to connect said suppression device in said receiving line, said means operating in response to a sustained signal of predetermined length received by the local radio receiver from the local radio transmitter and maintaining said suppression device connected during code interruptions.

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, means responsive to the application of telegraph signals from said telegraph transmitting apparatus to 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 associated with said radio receiver for suppressing telegraph signals received from the local radio transmitter while passing telegraph signals received from the radio transmitter at the distant end of the radio link, and means to connect said suppression device in said receiving line, said means operating in response to a sustained signal of predetermined length received by the local radio receiver from the local radio transmitter, said means operating to maintain said suppression device connected during code interruptions.

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 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, and said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into telegraph 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 tone transmitted by radio from the local radio transmitter to the local radio receiver to connect said suppression device in said receiving line.

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, and said telegraph receiving apparatus including means to translate an interrupted tone of different frequency received from the distant terminal into telegraph 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 predetermined duration and of the frequency supplied by said telegraph transmitting apparatus.

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, and said telegraph receiving apparatus including means to translate an interrupted tone of

different frequency received from the distant terminal into telegraph 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 predetermined duration and of the frequency supplied by said telegraph transmitting apparatus, said means also operating to maintain said suppression device connected during code interruptions of said tone.

7. In a signaling system a transmission circuit, a suppression filter for suppressing undesired frequencies, and means associated with said transmission circuit and responsive to undesired frequencies for connecting said suppression filter in said transmission circuit, said filter when so connected permitting desired frequencies to pass through it while suppressing undesired frequencies.

8. In a signaling system a transmission circuit capable of transmitting a band of voice frequencies, a suppression filter for suppressing interfering frequencies within the voice range, and means associated with the transmission circuit and responsive to said interfering frequencies but unresponsive to voice currents for connecting said suppression filter in said transmission circuit, said filter when so connected permitting desired frequencies to pass through it while suppressing undesired frequencies.

In testimony whereof, I have signed my name to this specification this 10th day of December, 1928.

AUSTIN BAILEY.