May 23, 1933. A. BAILEY ET AL 1,910,458

PRINTING TELEGRAPH ARRANGEMENT FOR RADIO TELEPHONE SYSTEMS

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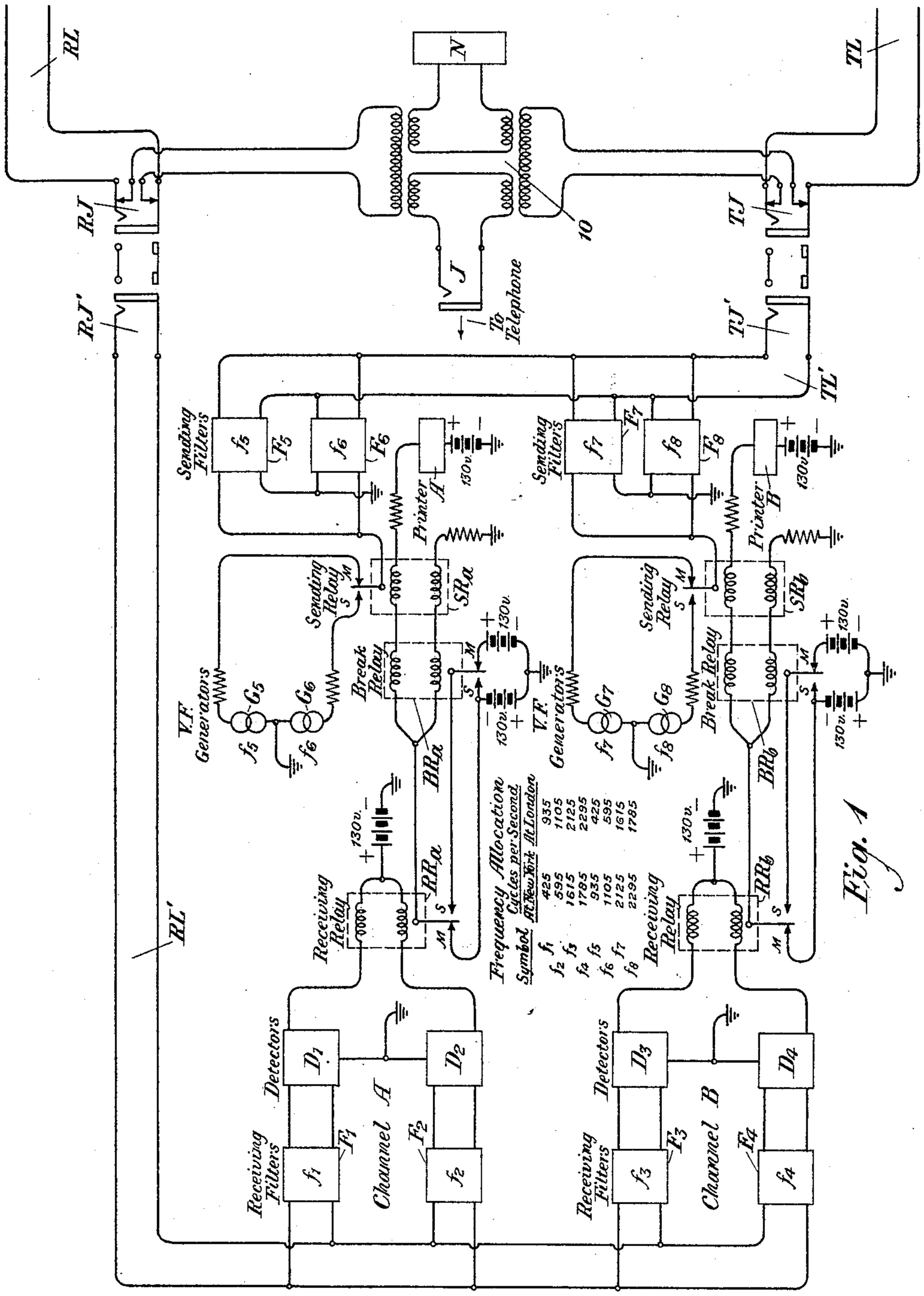

Fig. 1

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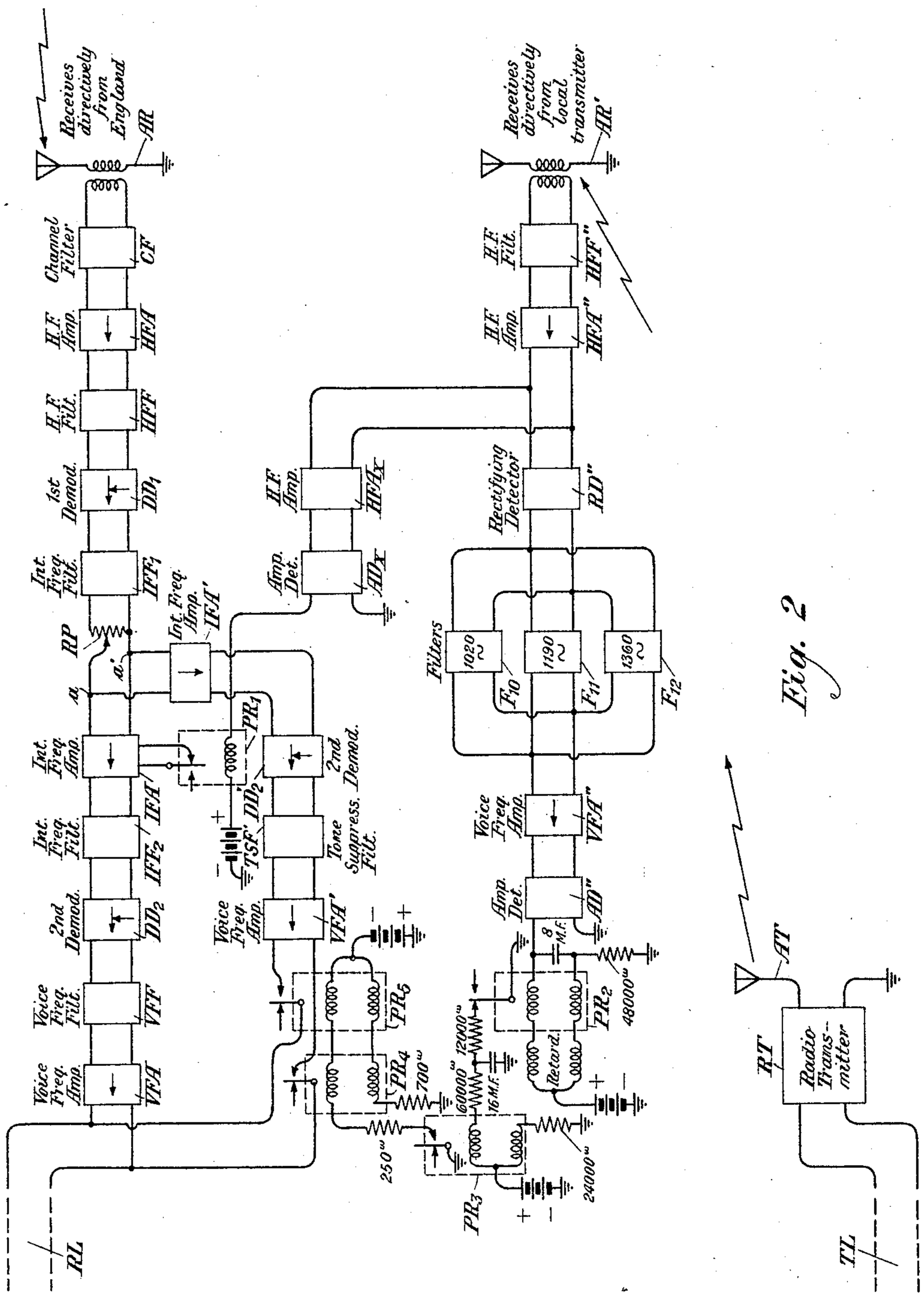

Fig. 2

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UNITED STATES PATENT OFFICE

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PRINTING TELEGRAPH ARRANGEMENT FOR RADIO TELEPHONE SYSTEMS

Application filed October 15, 1929. Serial No. 399,803.

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 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.

Where a number of telephone channels are provided, whether the channels be long wave or short wave channels, it is desirable to have at least two associated printing telegraph channels available for the purposes above mentioned. Preferably, such a telegraph system should be arranged so that it may be patched to any one of the telephone channels which happens to be idle.

The method of transmission which it is proposed to use in such a two-channel telegraph system, in accordance with the present invention involves transmitting currents of different tone frequencies for marking and spacing instead of interrupting a single frequency. By this method, the bias of the telegraph signals will not vary substantially with changes in the transmission equivalent of the circuit since both the marking and the spacing currents will be affected to the same extent.

Furthermore, the load on the radio transmitter will be kept practically constant thereby avoiding so-called "current strength effects" analogous to "crowding". These effects manifest themselves as variations in the amplitude of a tone frequency of a given channel when the tone frequency of an adjacent channel is interrupted.

It is proposed to utilize the radio receiver which is normally employed for telephone reception for receiving printing signals from the distant terminal when no telegraph signals are being transmitted from the local radio transmitter. When, however, the local transmitter is sending telegraph signals, a part of the radio receiver would be overloaded due to the proximity of the local transmitter, and repeaters in the line leading from the radio receiver to the telephone switching terminal would also be overloaded. This makes it desirable to disable such part of the normal receiver as would be overloaded and by-pass the disabled part with suitable supplement receiving apparatus. In order that the system may function properly for telephone transmission, a portion of the radio receiver is disabled when the radio transmitter is being actuated. This may be accomplished by means of an auxiliary receiver which is highly responsive to the local transmitter but is substantially non-responsive to the distant transmitter. It is proposed to utilize this same auxiliary receiver for switching the bypass connection around the disabled part of the radio receiver whenever telegraph signals are transmitted from the local transmitter, the bypass including suitable means for suppressing the tones corresponding to the locally transmitted signals while freely passing the signals corresponding to those from the distant terminal.

The bypass circuit must not be brought into play when the local radio transmitter is sending out telephone signals. To prevent such false operation, the auxiliary radio receiver utilizes a simple detector without any local beating tone being supplied. Since the carrier wave is suppressed and only the side band transmitted, such a detector does not reproduce any tone corresponding to any particular voice frequency but merely produces a rectified direct but pulsating current. Whenever telegraph signals are being transmitted, however, since a tone of one or the other of two frequencies will at all times be present for each channel of the telegraph system, the radio waves corresponding to these tones will beat with each other to produce difference frequency tones. By selecting these difference frequency tones and rectifying them, the switching apparatus for

connecting in the bypass circuit may be operated. Such switching apparatus will not respond, however, to voice frequency transmission due to the fact that no continuous tone will be produced and the rectified current cannot pass through the selecting means.

The invention will be more fully understood from the following description, when read in connection with the accompanying drawings. Figures 1 and 2, when placed end to end, show the invention as applied to the radio apparatus at one terminal of a transoceanic radio telephone system, it being understood that the equipment at the distant terminal will be similar to that shown or at least will be capable of operation with such a terminal. For example, if the radio telephone system has its terminals at New York and London, the apparatus shown may be assumed to be that associated with the New York terminal.

The radio telephone system upon which the telegraph system, in accordance with the present invention, is superposed, comprises a radio transmitter RT associated with a transmitting antenna AT, and a corresponding radio receiver associated with a receiving antenna AR, the radio transmitter and receiver being connected to a telephone terminal by means of a four-wire circuit comprising lines TL and RL. The lines TL and RL are connected through the usual hybrid coil arrangement 10 to a jack J for establishing connections to terminal lines, said terminal lines being balanced by a network N in order to render the transmitting path TL and the receiving path RL conjugate.

For the purpose of illustration, the telephone system is assumed to be one in which the carrier wave is suppressed and only the side band transmitted. The radio receiver is preferably arranged so that the demodulating operation may take place in two steps. The radio receiver elements employed for telephone reception involve a channel filter CF for selecting the particular radio telephone signal which is assigned to the station illustrated, a high frequency amplifier HFA and a high frequency filter HFF for further filtering the high frequency side band received from the antenna AR. The high frequency selected wave is then impressed upon the first demodulator DD_1 which is supplied with a beating frequency bearing such relation to the carrier used for modulation that the side band will be stepped down to an intermediate frequency, as is well understood in the art. An intermediate frequency filter IFF_1 is provided for selecting the stepped-down side band from the other frequencies resulting from the demodulating operation. The intermediate frequency is then applied to an intermediate frequency amplifier IFA and the amplified current is then passed through a second intermediate frequency filter IFF_2, after which it is applied to the second demodulator DD_2. This demodulator is provided with a carrier frequency which beats the side band down to its normal position in the voice range and the resultant voice components passing through the voice frequency filter VFF are then applied to the voice frequency amplifier VFA and transmitted over the line RL to the switching terminal.

Since the same carrier frequency may be used for both transmitting and receiving, the receiver must be disabled when the local transmitter is operated, and for this purpose an auxiliary receiver involving an antenna AR′ and associated apparatus is provided. This antenna is made directive in such manner that its greatest response is from the direction of the local transmitter AT while it discriminates against waves coming from the direction of the transmitter at the distant terminal. Consequently, when telephone waves pass over the transmitting line TL to the radio transmitter and are sent out into the ether by the antenna AT, such waves are picked up by the auxiliary antenna AR′ and selected by the filter HFF′ and amplified by the high frequency amplifier HFA′. Part of the energy then passes through a further high frequency amplifier HFA_x and is then applied to an amplifier detector AD_x to produce a rectified current which operates a switching relay PR_1 to disable the intermediate frequency amplifier IFA of the radio telephone receiver. This arrangement prevents overloading of repeaters (not shown) in the receiving line RL, due to the waves received by the antenna AR from the local transmitter AT. Although the antenna AR is directively receptive to signals from the distant transmitter and tends to discriminate against signals from the local transmitter, due to the fact that the same carrier wave is employed for both sending and receiving, and due to the further fact that the local receiver and transmitter are in close proximity, the waves from the latter may be received in a radio receiver with greater amplitude than the desired waves from the distant station, and hence the necessity for disabling the radio receiver when the transmitter is acting.

The telegraph apparatus may be connected to the transmitting line TL and the receiving line RL in any suitable manner as, for example, by means of jacks TJ and RJ, respectively. Two telegraph channels A and B are shown, each channel employing two tone frequencies, one for marking and one for spacing. Four different tone frequencies will also be employed for transmitting from the distant terminal so that

the frequency assignment may be as follows:

Frequency assignment for telegraph operation

Channel	Transmit to England		Receive from England	
	Marks	Spaces	Marks	Spaces
A	935	1105	425	595
B	2125	2295	1615	1785

The apparatus for the two channels will be similar except for the filters and frequencies of the current supplied by the tone generators. Referring to channel A, two receiving filters F_1 and F_2 are connected in parallel across the receiving leg RL′ which terminates in a jack RJ′ so that it may be patched to the receiving line RL of the four-wire circuit by means of any suitable patching cord. The filter F_1 passes the tone frequency corresponding to marking signals from the corresponding channel at the distant terminal while filter F_2 passes the tone frequency corresponding to the spacing signals. The current passing through either filter is applied to the input of a separate detector, the detectors D_1 and D_2 being associated with the filters F_1 and F_2 for this purpose. The output circuits of the two detectors pass through separate windings of a polar receiving relay RR_a. The windings of this relay are so connected that current from the detector D_1 moves the relay armature to its marking (M) contact, while from the detector D_2 moves the armature to its spacing (S) contact. The operation of the armature of receiving relay RR_a transmits direct current signals into a differential loop circuit and causes the operation of the receiving unit of the printer A. While this loop circuit equipment is shown as being arranged for half duplex operations, the loop circuits may be arranged for full duplex operations in a manner well known in the art, without in any way changing the operation of the alternating current features of the circuit. Windings of a break relay BR_a and the sending relay SR_a are included in the differential loop circuit. But, as the windings of these two relays are connected differentially in the loop circuit, the relays are not affected by current changes controlled by the armature of the receiving relay RR_a.

When the system is operated on a half-duplex basis so that signals are only sent in one direction at a time, the receiving relay RR_a will be held on its marking contact by the tone from the distant station during such time as the printer A is used for transmitting. In order to send signals, the sending mechanism of the printer A then opens and closes the loop circuit in accordance with the spacing and marking signals, respectively, and operates the sending relay SR_a and break relay BR_a. The operation of the break relay is ineffective so long as marking tone is received from the distant station as the circuit controlled by its contact is open at the spacing contact of the receiving relay RR_a. In transmitting a marking signal, the sending relay SR_a connects the voice frequency generator G_5 to the sending filters F_5 and F_6 and current of the frequency f_5 passes through the sending filter F_5 to the sending leg TL′ which terminates in a jack TJ′ so it may be patched by a patching cord to the jack TJ associated with the transmitting line TL of the four-wire circuit. In the case of a spacing signal, the sending relay SR_a connects the generator G_6 to the sending filters, thereby transmitting current of the frequency f_6 through the sending filter F_6 over the transmitting line TL to the radio transmitter RT. The radio transmitter is merely indicated symbolically and may be any known type of apparatus for modulating a radio frequency in accordance with the marking and spacing tones. Preferably, in order that the switching apparatus associated with the radio receiver distinguishes between telephone and telegraph signals, as will be described later, the radio transmitter should be of the type in which the carrier component itself is suppressed and only one side band resulting from modulation transmitted.

The apparatus associated with the channel B, as already stated, is similar to that of channel A and need not be further described. It will be evident that at all times tones of two frequencies will be applied to the transmitting leg TL′ regardless of whether the channels A and B are sending marking or spacing signals and, consequently, when the transmitting leg TL′ is patched to the transmitting line TL leading to the radio transmitter, radio frequencies corresponding to two tones will be radiated. It will also be noted that when the transmitting and receiving legs TL′ and RL′ are patched to the transmitting line TL and the receiving line RL, respectively, the switching jacks TJ and RJ disconnect the sending and receiving lines from the hybrid coil 10 and the telephone jack J, it being understood that the telegraph apparatus is only to be used when the system is not employed for telephone transmission.

As has already been described, the auxiliary radio receiver associated with the antenna AR′ is arranged to disable the main radio receiver by means of the relay PR_1 whenever signals are transmitted by the radio transmitter RT. In the case of telegraph transmission, the system must be able to both transmit and receive simultaneously.

Therefore, some provision must be made for applying to the receiving line RL telegraph signals received from the distant terminal regardless of whether telegraph signals are transmitted from the local transmitter. This necessarily involves some provision of means for suppressing from the line RL telegraph signals received from the local transmitter as such signals will, in general, be of greater amplitude than the desired signals from the distant terminal. When telegraph signals are radiated from the antenna AT, they will be picked up by the auxiliary antenna AR′ and the amplifier-detector AD_x will actuate the relay PR_1 to disable the intermediate frequency amplifier IFA of the radio telephone receiver just as in the case of the transmission of telephone signals from the antenna AT. When no telegraph signals are being transmitted over the line TL, however, the telegraph signals from the distant terminal (which, in the case assumed, is located in England) may be received by the radio telephone receiver, already described, in the same manner as radio telephone signals, as the intermediate frequency amplifier IFA will be operative. When telegraph signals are transmitted from the local transmitter, the part of the radio telephone receiver including the intermediate frequency amplifier and the apparatus beyond it cannot be used for telegraph reception and it will be necessary either to provide a complete auxiliary receiver or to use a part of the radio telephone receiver with certain supplemental receiving elements included in a bypass about the disabled part of the radio telephone receiver. The latter alternative is to be preferred and accordingly a bypass circuit is provided including an intermediate frequency amplifier IFA′, a second demodulator DD_2', a tone suppressing filter TSF′ and a voice frequency amplifier VFA′.

This bypass circuit is connected to the radio receiver at points *a*—*a′* just beyond the potentiometer on the input side of the intermediate frequency amplifier FFA. There are several reasons for connecting it at this point. Obviously, it must be connected ahead of the intermediate frequency amplifier IFA which will be disabled. Even if the intermediate frequency amplifier IFA were not disabled, however, there would be some point in the radio telephone receiver at which the telegraph signals from the local transmitter AT would be amplified by the successive stages of apparatus to such volume as to overload the receiving apparatus beyond. This consideration would make necessary a circuit of lower gain for such interfering signals, even though the intermediate frequency amplifier IFA were not disabled. Where transmission and reception take place on the same carrier wave with the radio transmitter and receiver in the same general locality but reasonably well separated, and the radio antenna AR arranged to discriminate directively against the local transmitter, the signals from the local transmitter can pass through the radio telephone receiver apparatus to the output side of the intermediate frequency filter IFF_1 without overloading vacuum tubes or other apparatus in the receiver. Accordingly, the bypass circuit is bridged across the normal radio receiver just beyond the potentiometer RP as this potentiometer can always be adjusted to keep the volume at the bridge points *a*—*a′* at the desired level. The disabling of the intermediate frequency amplifier IFA breaks the radio telephone receiving apparatus beyond this point.

It will be noted that the second demodulator DD'_2 in the bypass circuit will reproduce not only tones from the distant terminal but also those from the local radio transmitter RT. The latter tones are undesirable and, consequently, the tone suppression filter TSF′ is arranged to pass the wanted tones from the distant transmitter while suppressing those from the local transmitter to such a low level that they will not produce undue interference in the receiving line RL. The tone frequencies employed should be so chosen that harmonics of the lower tone frequencies from the transmitter will not fall within the passed band of the tone suppressing filter TSF′.

Normally, the bypass circuit above described is disconnected from the line RL and, consequently, some switching arrangement must be employed for connecting it to the receiving line when necessary. Such switching arrangement might be controlled either by the signal from the distant station or by the signals from the local radio transmitter. The latter arrangement is preferable, because the transmission received from the local transmitter is more stable than that from the distant transmitter. Accordingly, the auxiliary receiving antenna AR′ and the associated high frequency filter HFF″ together with the high frequency amplifier HFA″ are used to control the switching arrangement for the bypass circuit, a rectifying detector RD″ being connected to the output side of high frequency amplifier HFA″ for this purpose.

The currents present in the output circuit of the rectifying detector RD″, whenever the telegraph apparatus is connected to the local transmitter RT, have frequencies corresponding to the difference between any two of the four frequencies used for marking and spacing tones in the two telegraph channels. By reference to the table of frequencies herein given, it will be seen that these difference frequencies may be 1020, 1190 or 1360 cycles, depending upon the marking or spacing conditions in the two channels.

While these difference frequencies are in the telephone range, it should be noted that they can only appear in the output of the detector RD'' when two tone frequencies are applied to the telegraph sender. Similar frequencies will not be produced in the output circuit of the detector RD'' in response to telephone signals. This is because the radio carrier is suppressed and only the side band transmitted. If we should have a telephone signal which consisted of a single tone and use such a signal to modulate the carrier, then, when the carrier and one side band is suppressed, only a single radio frequency will be transmitted and such frequency when received by the detector RD'' will produce, when rectified, a continuous current but no tone corresponding to the original modulating tone.

When two tones are applied to the transmitter, one corresponding to each telegraph channel, these tones are used to modulate the carrier wave to the transmitter. The side band finally transmitted will include two waves differing in frequency from each other by the difference between the frequencies of the two original tones. When two such waves are impressed upon the rectifying detector, a difference in frequency will be produced and, in the case of the tone frequencies assumed, this difference in frequency will be one of the three above mentioned. Therefore, if means be provided in the output circuit of the rectifying detector RD'' to pass the three difference frequencies referred to and suppress other frequencies, the switching apparatus which is now about to be described cannot be actuated by speech and will only be actuated by telegraph signals.

In order to carry out this principle, three filters F_{10}, F_{11} and F_{12} are arranged in multiple in the ouput circuit of the rectifying detector RD'', these filters passing the frequencies 1020, 1190 and 1360. A voice frequency amplifier VFA'' and an amplifier-detector AD'' are provided on the output side of the filter arrangement so that any difference tone which passes thorugh will be rectified by the amplifier-detector AD'' and caused to actuate the polar relay PR_2. The polar relay PR_2 has its operating winding connected in the plate circuit of the amplifier-detector AD'' and a similar winding in the biasing circuit so that whenever the plate current is sufficient to overcome the effect of the biasing winding, the polar relay PR_2 will be actuated. A retard coil is differentially connected into the two branches of the relay circuit, as shown, and a condenser is connected across the two branches. The purpose of the condenser and retard coil is to partially balance out the rapid variations in the rectified current thereby minimizing the effect of current impulses due to speech and static which might tend to operate the relay.

The operation of the relay PR_2 by telegraph currents causes its armature to remove ground from its left hand contact thereby initiating the release of the relay PR_3. The latter relay is connected in a slow electrical circuit consisting of a condenser and a 60,000 ohm resistance. By making the biasing current of the relay fairly small, the relay may be prevented from releasing for a period of one or more seconds after the relay PR_2 has been operated. This gives further protection against false operation of the final switching relays PR_4 and PR_5 which are controlled by the relay PR_3 and which connect the telegraph bypass circuit, previously described, to the wire line.

From the above description of the switching arrangement, it will be evident that the chances of false operation due to speech and static are quite small. The protection against false release during telegraph operation is practically the same except that relay PR_3 will respond sooner to the releasing of relay PR_2 than it did to the operation of the latter relay. This is due to the fact that the discharge circuit for the condenser is only 12,000 ohms instead of 60,000 ohms and also because the condenser need be discharged only a small amount to cause the operation of relay PR_3 and consequently the releasing of relays PR_4 and PR_5.

It will be understood that the various frequencies referred to and the various values of electrical constants given in the foregoing description are purely illustrative and that other frequency assignments and other values of electrical constants may be used where desired.

It will be seen from the above 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 telegraph system, a radio transmitter, a radio receiver, a terminal station, a transmitting line extending from said terminal station to said radio transmitter, a receiving line extending from said radio receiver to said terminal station, telegraph apparatus adapted to be associated with said lines at said terminal station, said telegraph apparatus comprising a plurality of two-way channels, each channel comprising transmitting and receiving apparatus and a loop circuit having a telegraph transmitter and receiver therein, said telegraph transmitting apparatus including means to transmit a tone of one frequency in response to a marking signal in such loop and a tone of different frequency in response to spacing

signals in said loop, means to transmit the marking and spacing tones responsive to both channels over said transmitting line to said radio transmitter, means to transmit over said receiving line corresponding tones received from the distant terminal by said radio receiver, said telegraph receiving apparatus corresponding to each channel, including means responsive to one tone received from the receiving line to produce a marking signal in the loop, and means responsive to a different tone from the receiving line to produce a spacing signal in the loop, and switching means at the terminal station for connecting and disconnecting said telegraph apparatus to said lines at the will of the terminal operator.

2. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at the terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, means to switch a bypass circuit about a portion of said radio receiver in response to the transmission of signals from said radio transmitter, said last mentioned means being responsive to telegraph signals but non-responsive to telephone signals transmitted from said radio transmitter, and said bypass including means to suppress tones corresponding to telegraph signals from said local radio transmitter but freely passing tones corresponding to signals from a distant terminal, and switching means at the terminal station for connecting and disconnecting both the sending and reproducing means of said telegraph apparatus to said lines at the will of the operator.

3. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at the terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, means to switch a bypass circuit about a portion of said radio receiver in response to the transmission of signals from said radio transmitter, said last mentioned means being responsive to telegraph signals but non-responsive to telephone signals transmitted from said radio transmitter, said bypass including means to suppress tones corresponding to telegraph signals from said local radio transmitter but freely passing tones corresponding to signals from a distant terminal, and means responsive to signals from said local radio transmitter to disable the bypassed portion of said radio receiver.

4. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at a terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, a bypass adapted to be switched about a portion of said radio receiver, an auxiliary radio receiver, switching means controlled thereby for switching said bypass into the circuit, said auxiliary receiver responding to telegraph signals transmitted from said local radio transmitter to operate said switching means but non-responsive to radio telephone signals, and means in said bypass to suppress tones corresponding to telegraph signals from said local radio transmitter while passing tones corresponding to telegraph signals from a distant terminal.

5. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at a terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, a bypass adapted to be switched about a portion of said radio receiver, an auxiliary radio receiver, switching means controlled thereby for switching said bypass into the circuit, said auxiliary receiver responding to telegraph signals transmitted from said local radio transmitter to operate said switching means but non-responsive to radio telephone signals, means in said bypass to suppress tones corresponding to telegraph signals from said local radio transmitter while passing tones corresponding to telegraph signals from a distant terminal, and means associated with said auxiliary radio receiver for disabling the bypassed portion of the main radio receiver in response to signals from said radio transmitter.

6. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal

station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at a terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, a bypass adapted to be connected around a portion of said radio receiver, auxiliary receiving means including a detector, said detector responding to telegraph signals from said local transmitter to produce tone frequencies corresponding to the differences between the several marking and spacing tones transmitted from said terminal station, said detector producing no continuous tone in response to radio telephone signals from the local transmitter, and switching means associated with said detector and controlled by said difference frequencies to switch said bypass, said bypass including means to suppress tones corresponding to signals from said local radio transmitter while freely passing tones corresponding to signals from a distant terminal.

7. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at a terminal station comprising a plurality of two-way channels, each having means for sending different tones for marking and spacing and for reproducing received marking and spacing signals in response to different tones, a bypass adapted to be connected around a portion of said radio receiver, auxiliary receiving means including a detector, said detector responding to telegraph signals from said local transmitter to produce tone frequencies corresponding to the differences between the several marking and spacing tones transmitted from said terminal station, said detector producing no continuous tone in response to radio telephone signals from the local transmitter, and switching means associated with said detector and controlled by said difference frequencies to switch said bypass, said bypass including means to suppress tones corresponding to signals from said local radio transmitter while freely passing tones corresponding to signals from a distant terminal, and means for disabling the bypassed portion of said main radio receiver in response to signals from said local radio transmitter.

8. In a radio telegraph system, a plurality of radio links each including a radio transmitter and a radio receiver, a terminal station, each radio link also including a transmitting line extending from said terminal station to the radio transmitter of the link and a receiving line extending from the corresponding radio receiver of the link to said terminal station, a telegraph apparatus comprising a telegraph transmitter adapted to be associated with the transmitting line of any radio link and a telegraph receiver adapted to be associated with the corresponding line of the radio link, and means whereby the telegraph transmitter may be selectively connected to the transmitting line of any idle radio link and the telegraph receiver connected to the corresponding receiving line of such idle radio link.

9. In a combined radio telephone and telegraph system, a radio transmitter and a radio receiver, a terminal station, a transmitting line extending from said terminal station to the radio transmitter, a receiving line extending from the radio receiver to the terminal station, telegraph apparatus at the terminal station adapted to be associated with said transmitting and receiving lines, means to substitute for a portion of said radio receiver an auxiliary receiving apparatus in response to the transmission of signals from said radio transmitter, said last mentioned means being responsive to telegraph signals but non-responsive to telephone signals transmitted from said radio transmitter, said auxiliary receiving apparatus including means to suppress tones corresponding to telegraph signals transmitted from said local radio transmitter but freely passing tones corresponding to signals from a distant terminal.

10. In a combined radio telephone and telegraph system, a control station, a radio station comprising a radio transmitter, a radio telephone receiving apparatus and an auxiliary radio telegraph receiving apparatus, a four-wire circuit comprising a one-way transmitting path and a one-way receiving path connecting said radio transmitter and said radio telephone receiving apparatus respectively to said control station, means responsive to the connection of a telegraph cord circuit to said four-wire circuit for causing an alternating control current to be transmitted over said four-wire circuit to said radio station, and means at said radio station responsive to the transmission of control current for connecting said radio telegraph receiving apparatus to said receiving path of said four-wire circuit in place of said radio telephone receiving apparatus, in condition to receive incoming telegraph signals.

11. In a combined radio telephone and telegraph system, a control station, a radio station comprising a radio transmitter, a radio telephone receiving apparatus and an auxiliary radio telegraph receiving apparatus, a four-wire circuit comprising a one-way transmitting path and a one-way receiving

path connecting said radio transmitter and said radio telephone receiving apparatus respectively to said control station, means responsive to the connection of a telegraph cord circuit to said four-wire circuit for causing an alternating control current to be transmitted over said four-wire circuit to said radio station, means at said radio station responsive to the transmission of control current for connecting said radio telegraph receiving apparatus to said receiving path of said four-wire circuit in place of said radio telephone receiving apparatus, in condition to receive incoming telegraph signals, and means to maintain continuous transmission of a control current from said control station to hold said receiving apparatus connected to said receiving path during the period in which said telegraph cord circuit is connected to said four-wire circuit regardless of whether or not telegraph signals are being transmitted to said radio station.

In testimony whereof, we have signed our names to this specification this 14th day of October 1929.

AUSTIN BAILEY.
JOSEPH HERMAN.
WILLIAM T. WINTRINGHAM.