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METHOD AND APPARATUS FOR BALANCING OUT RADIOINTERFERENCE ON WIRE LINES

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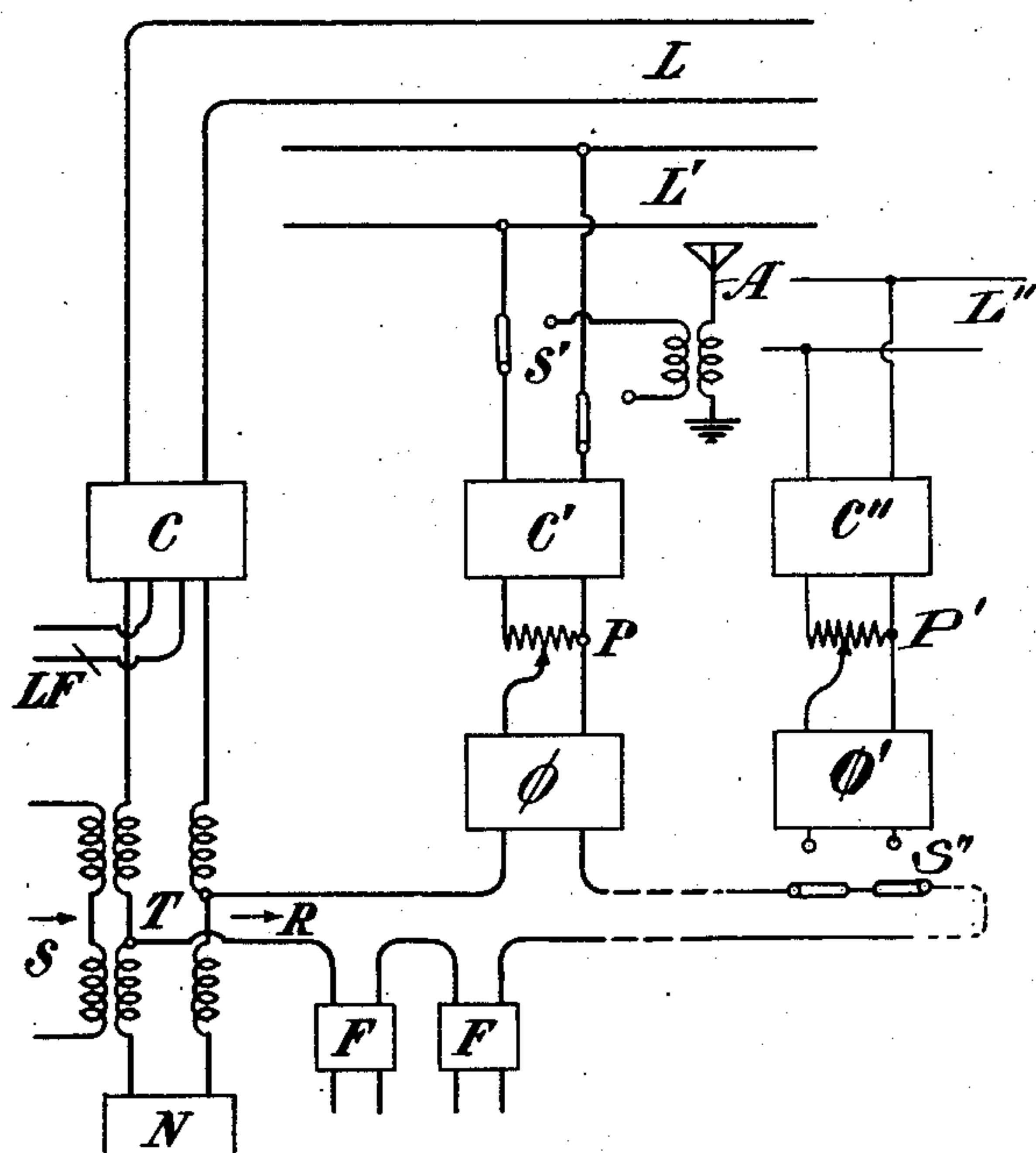


Fig. 1

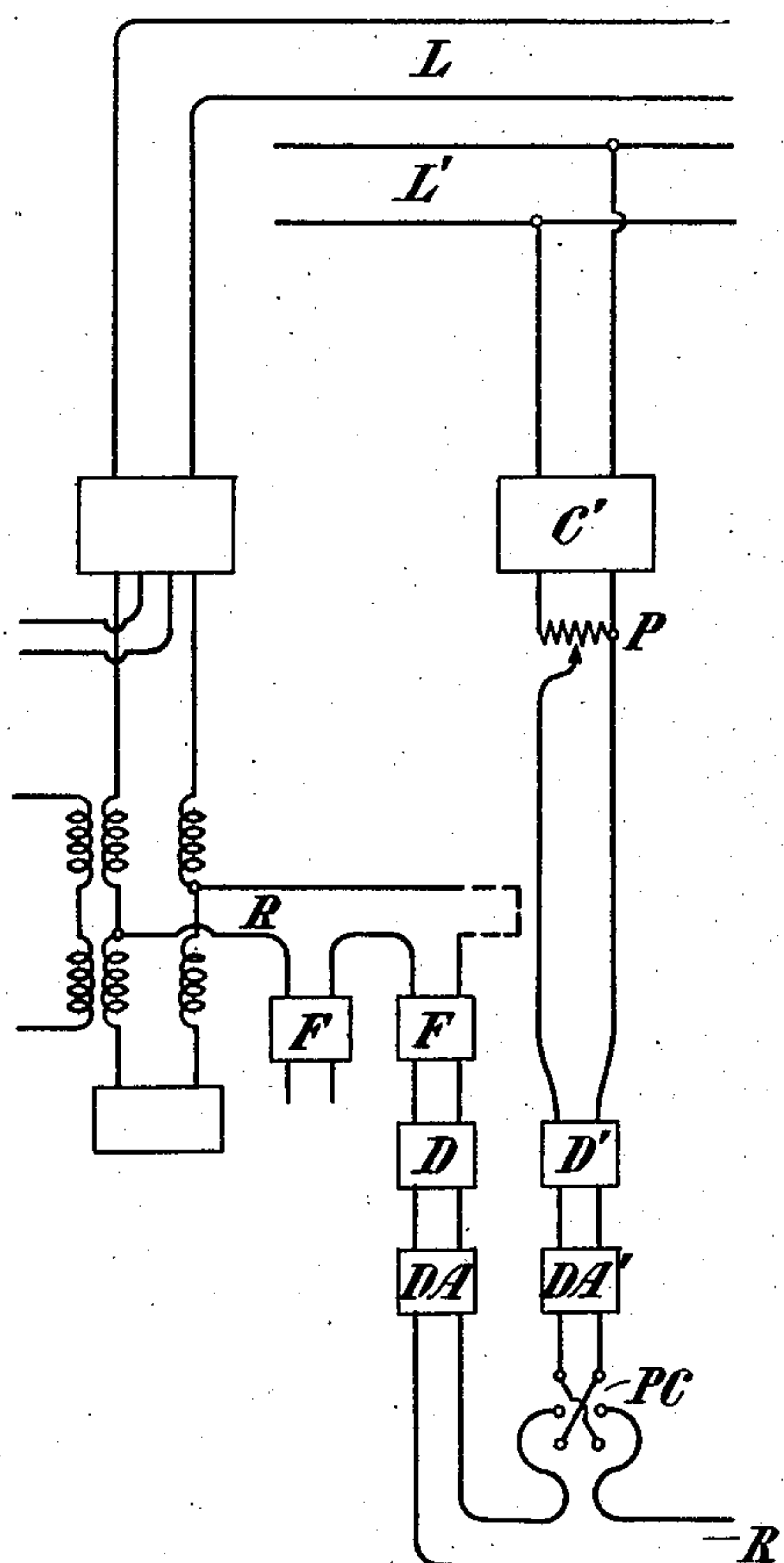


Fig. 2

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METHOD AND APPARATUS FOR BALANCING OUT RADIOINTERFERENCE ON WIRE LINES.

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The principal object of my invention is to provide a new and improved system to overcome the interference on signaling conductors due to radio transmission. In another aspect, my invention relates to balancing out the interference in a carrier current channel caused by radio signaling with a frequency lying within the range of that channel. These and other objects of my invention will be made apparent upon consideration of a few specific examples of practice in accordance therewith. In the accompanying drawings, the apparatus for these examples is shown in diagram and I will now proceed to a specific description with the understanding that the invention is defined in the appended claims.

In the drawings, Figure 1 is a diagram for a case in which a balance is effected in a high frequency receiving circuit, and Fig. 2 is a diagram for a case in which a balance is effected in a low frequency receiving circuit.

Referring to Fig. 1, carrier currents of high frequency and lying in a plurality of carrier current channel ranges of frequency are transmitted both ways on the line L. At the station shown in the diagram, this line L passes through the composite set C to the hybrid coil transformer T with the balancing network N. From the composite set C the low frequency conductors LF are led away and only the high frequencies go into the transformer T.

The high frequency sending currents are impressed upon the line L at the station shown in Fig. 1 through the conductors S at the transformer T. The arrangement is such that the sending currents are balanced in their effect on the receiving conductors R and these last mentioned conductors receive only the high frequency currents that come into the station over the line L.

These received high frequency currents lie in a number of frequency ranges corresponding to different channels of transmission, for example, one channel may comprise frequencies from 7000 to 10000 cycles per second, another from 17000 to 20000 cycles per second, etc.

It may happen that in the geographical region through which the line L extends,

there are radio waves due to some long distance radio transmitting station and having a frequency within one of these ranges, say a frequency of 18,200 cycles per second. Since the radio wave trains of this frequency lie within the carrier current band from 17000 to 20000 cycles per second, they may produce objectionable interference in a telephone conversation employing that channel.

To balance out such interference, I select some other line L' in the same general locality as the line L and therefore subject to the same radio transmission waves. This line L' may advantageously be one which does not carry carrier currents, but on which the E. M. F. induced by the radio waves is at least as great as that causing interference on line L. From this line L' I take branch conductors through a composite set C' which matches the set C, and also insures that the low frequency transmission on the line L' shall not be affected.

From the composite set C', conductors go through a potentiometer P and phase shifter ϕ , whose output is connected in series in the circuit of the high frequency receiving conductors R.

This circuit R passes in series through the inputs of the several band filters F, each corresponding to a frequency range channel, and in particular, one of these filters passes the frequencies from 17000 to 20000 cycles per second, received from the transformer T, and this same band filter F excludes frequencies lying outside that range.

The interfering frequency E. M. F., which in the example is assumed to be of a frequency 18,200 cycles per second, is superposed in the line L and thus enters the receiving circuit R through transformer T. By proper adjustment of the potentiometer P and phase shifter ϕ , this same frequency E. M. F., which is of course received in the line L', is introduced in the receiving circuit R so as to be equal in magnitude and opposite in phase to the superposed E. M. F. of that frequency received from the line L, and hence to neutralize it. This allows the transmitted frequencies within the range 17000 to 20000 cycles per second that are received over the line L to enter the receiving circuit

R and pass to the output of the band filter F without the presence of superposed currents due to the radio frequency of 18,200.

In the manner indicated in the foregoing description a troublesome interfering radio frequency can be neutralized in a wire signaling system. For this purpose, any one of a large number of overhead transmission lines such as L' can be utilized, selecting the
 10 line L' from among those in which the radio frequency is not objectionable so far as the normal use of that line is concerned. Indeed, it is simply desirable to obtain the radio frequency from any source different
 15 from the line L and by throwing the switches S', the neutralizing radio frequency currents may be drawn from the antenna A if desired.

In Fig. 2, I have shown a modification in
 20 which the high frequency currents are first demodulated, both as received over the wire line and as received for the purpose of balancing, and are then combined to produce a null effect. The wire signaling system is the
 25 same as in Fig. 1 to the receiving circuit R, from which the band filters F for the respective frequency ranges lead to the branch receiving circuits as shown. One of these band filters passes the frequency range which in-
 30 cludes the interfering radio frequency which, for example, we have mentioned as 18,200. In the usual manner for carrier current reception, the received currents of this frequency range pass through the detector D
 35 and detecting amplifier DA to the low frequency receiving circuit R'.

The high frequency currents tapped from the line L' go through a composite set C' and a potentiometer P, as in Fig. 1, but the
 40 phase shifter ϕ of Fig. 1 is omitted, and the radio frequency currents of Fig. 2 pass through a detector D' and detecting amplifier DA', whose output is connected in series in the receiving circuit R'.

45 The interference in the receiving circuit R', due to the radio currents received in the line L, is superposed on the currents that are properly and desirably received in the circuit R'. This superposed electromotive
 50 force is matched oppositely by an electromotive force in the output of the detecting amplifier DA', determined by the radio reception in the line L'. A pole changer PC is provided to insure that the output shall be
 55 series opposing instead of series aiding, and a phase shifter may be interposed here if needed.

Some radio telegraph systems employ the method of sending which involves short-
 60 circuiting a part of the inductance of the antenna circuit with the sending key. Thus, when the key is in spacing position, the part of the inductance is short-circuited and the frequency is say 18,800 cycles per second, but when the key is pressed to marking position,

the short-circuit around the part of the inductance is opened and the frequency falls to 18,200 cycles per second.

In such a case it may happen that only one of these two frequencies produces serious
 70 interference in the carrier current wire line and the system which I have described can be adjusted to balance out that frequency. Again, it may happen that both frequencies
 75 will be equally within a single carrier current range and equally troublesome, in which case the system that I have proposed will balance out both of them, provided the line L' picks up both frequencies in the same
 80 ratio as the line L.

If there is more than one interfering frequency to be balanced out which cannot satisfactorily be cared for by one equipment
 85 such as I have shown as associated with the line L', then two or more lines L' may each be tapped to obtain balancing electromotive forces for the several interfering frequencies; and these may be applied through suitable phase shifters and amplifiers or potentiometers in series in the receiving circuit R
 90 of Fig. 1 or R' of Fig. 2.

By throwing the switches S'' in Fig. 1 it will be seen that the line L'' will be tapped in the same way as the line L', thus illustrating the foregoing statement about how
 95 to proceed to balance out more than one interfering frequency.

What is claimed is:

1. In the operation of a high frequency wire signaling system, the method of over-
 100 coming interference at a receiving station of said system due to radio signaling, which consists in intercepting some of the radio wave power at said receiving station and
 105 applying the electromotive forces obtained thereby at said receiving station to oppose the interfering electromotive forces in a receiving circuit of the said system.

2. In the operation of a carrier current wire signaling system, the method of over-
 110 coming interference at a receiving station of said system due to radio signaling at a frequency within one of the carrier current channels, which consists in obtaining electromotive forces of that frequency and ap-
 115 plying them at the said receiving station to oppose the interfering electromotive forces in a receiving circuit of the said system.

3. In the operation of a high frequency wire signaling system, the method of over-
 120 coming interference at a receiving station of said system due to radio signaling, which consists in obtaining electromotive forces from radiation of the interfering frequency in the neighborhood of the receiving station, deriving therefrom electromotive forces of
 125 proper amplitude and phase relation and applying them at the receiving station in opposition to the interfering electromotive forces in a receiving circuit at said station. 130

4. A high frequency wire signaling system subject to radio interference, a conductor that is exposed to the same radiation as said system, receiving branch circuits connected to said system and said conductor and means to apply electromotive forces in opposition corresponding to the radio reception in the said system and the said overhead conductor.

5. In the operation of a high frequency wire signaling system, the method of overcoming interference at a receiving station of that system due to radio signaling, which consists in obtaining electromotive forces of the interfering frequency from radiation near the said receiving station and applying such electromotive forces to oppose the interfering electromotive forces in a receiving circuit at the said station.

6. In the operation of a high frequency carrier current wire signaling system which is subject to interference by radio of the same frequency, the method of overcoming such interference at a receiving station of said system which consists in gathering radiated energy from the same interfering source, adjusting the amplitude and phase of this energy and applying the modified energy to the said wire system at said receiving station to neutralize the interference therein.

7. In combination, a high frequency wire signaling system subject to radio interference from a certain source, said system comprising a receiving station, a conductor exposed to radiation from said source, and

means at said station connecting from said conductor to said station to apply electromotive forces from said exposed conductor so as to neutralize the interference in said system.

8. In combination, a high frequency transmission line, a three-winding transformer associated therewith for simultaneous transmitting and receiving, receiving conductors connected with said transformer, a plurality of filters having their input terminals connected in series with said receiving conductor, a conductor exposed to interfering radiation, and a connection from said conductor interposed in series with the inputs of said filters, said connection comprising an amplifier and a phase shifter.

9. In combination, a plurality of wire transmission lines all subject to the same radio interference, a receiving station for carrier currents of the same frequency as said radio interference said station being connected with one of said lines, branch circuits connected with at least one of the other lines to draw off therefrom energy of frequency determined by said radio interference, an amplifier and a phase shifter to modify the energy drawn off in this way, the output from the amplifier and phase shifter being connected with the receiving system for the other conductor to neutralize the interference therein.

In testimony whereof, I have signed my name to this specification this 14th day of February, 1922.

RALPH W. DEARDORFF.