

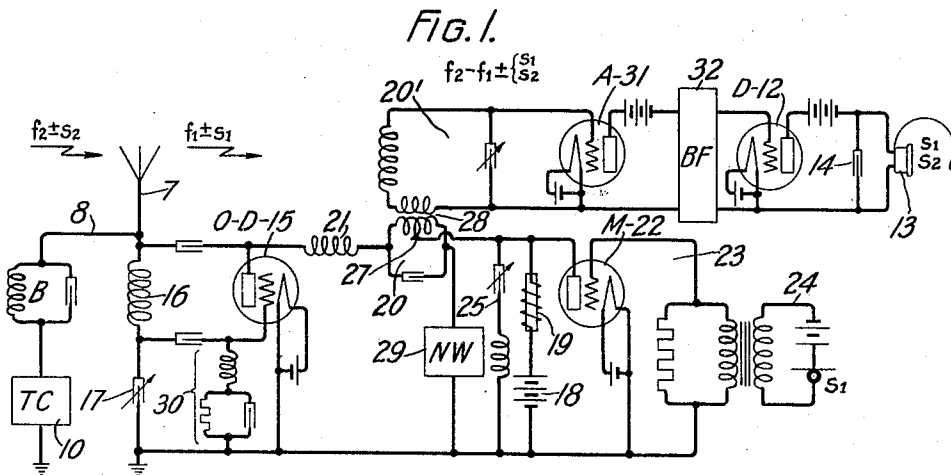
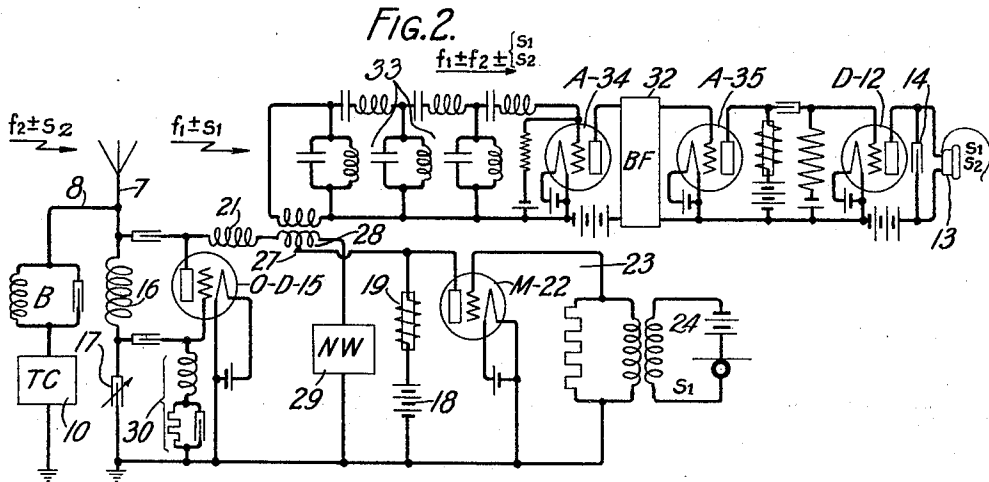
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SIGNALING SYSTEM

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SIGNALING SYSTEM

Original application filed July 31, 1923, Serial No. 654,823. Patent No. 1,724,917, dated August 20, 1929.

Divided and this application filed June 13, 1927. Serial No. 193,443.

The present invention relates to signaling systems and particularly to two-way signaling systems employing successive detection of carrier waves, as for example, duplex radio telephone systems using double detection receiving circuits.

The principal object of the invention is to prevent the transmitter at one end of such systems from causing disturbances in the receiver at that end.

This application is a division of application Serial No. 654,823, filed July 31, 1923, Patent No. 1,724,917, granted August 20, 1929.

A portion of the subject matter described and claimed herein is disclosed in my copending application Serial No. 326,986, filed September 27, 1919, Patent No. 1,738,235, granted December 3, 1929.

In the illustrative embodiments of the invention shown and described in detail hereinafter, an oscillator connected to a transmitting and receiving antenna generates an outgoing carrier wave and serves also in receiving, as a heterodyne oscillator and high frequency detector. Means are provided for connecting to it, in conjugate relation to each other, a receiving path and a sending path, the receiving path including an intermediate frequency detector and a telephone receiver, and the transmitting path including a microphone and means for causing signal modulation of the outgoing carrier wave. This conjugate relation prevents the modulating current from causing disturbances in the receiver, although proper side tone effect is provided by detection of the modulated intermediate frequency carrier wave resulting from the beating action between the unmodulated carrier wave collected by the antenna and the outgoing modulated carrier wave.

Figs. 1 and 2 are circuit diagrams of two forms of the invention.

Description of Fig. 1.—The transmitting system in Fig. 1 comprises an antenna 7 to which is connected a vacuum tube O—D—15 in a well-known manner as illustrated, whereby oscillations are produced in the antenna at a frequency approximately equal to the natural frequency determined by the series ar-

range ment comprising the capacity of the radiating member 7, the inductance of the coil 16 and the capacity of the condenser 17. The frequency of these oscillations may be designated f_1 . The value of f_1 may be 500,000 cycles/sec., for example. Space current for the tube O—D—15 is provided by the source 18, through the speech frequency choke coil 19, the circuit 20, and the high frequency choke coil 21. The choke coil 21 offers high impedance to both the incoming and outgoing high frequency waves. Shunted around the source 18 and the coil 19 is the anode-cathode path of a vacuum tube M—22. The input circuit 23 of the tube M—22 is coupled to a microphone circuit 24 which represents any suitable source of speech or other signaling frequency electrical waves or variations. The frequency of these variations may be designated s_1 . The production of speech waves in the circuit 24 will cause a corresponding variation in the impedance of the tube M—22, which will in turn cause a corresponding variation in the current supplied to the tube O—D—15 owing to the choking action of the coil 19. This will cause the high frequency waves generated in the antenna by the oscillating tube O—D—15 to be varied or modulated in amplitude in accordance with the waves produced in the circuit 24. The frequency of the resulting modulated current is herein designated by the expression $f_1 \pm s_1$. This symbolic manner of designating a modulated wave will be used throughout this specification. A modulated wave so designated may or may not contain an unmodulated carrier component. In the operation of the systems of Figs. 1 and 2, the transmitted modulated wave does include such unmodulated carrier component.

Incoming signal waves will be impressed upon the antenna 7. Owing to the detecting action of the tube O—D—15 upon both incoming and outgoing high frequency waves, a variation of potential difference will be produced across the anode and the cathode of the tube O—D—15, having frequencies equal to the differences between the incoming and outgoing frequencies. The tuned circuit 20 will be adjusted to be resonant to these differ-

ence frequencies. Thus, if the incoming wave is a carrier wave of frequency f_2 , modulated at times by speech waves s_2 , and if frequency f_1 equals 500,000 cycles and f_2 equals 530,000 cycles, then circuit 20 will be adjusted to be resonant at 30,000 cycles; and owing to the detecting or demodulating action of the oscillating tube O—D—15 which has its anode-cathode circuit connected to circuit 20 there will occur, in circuit 20, oscillations having a component with a frequency of 30,000 cycles and a wave of this auxiliary carrier frequency modulated in accordance with the speech signal s_1 or the signal s_2 or by both of them in case both are being simultaneously transmitted. This is represented by the legend

$$f_2 - f_1 \pm \left\{ \frac{s_1}{s_2} \right\}$$

adjacent a circuit 20', which is coupled to the circuit 20 and which is tuned to and selects the auxiliary or intermediate carrier frequency. The currents of the intermediate carrier frequency in the circuit 20' are amplified by means of a suitable amplifying device A—31 and then passed through any suitable filter 32 to the detector D—12, the output circuit of which includes a suitable indicating device such as a telephone receiver 13, shunted by a condenser 14. The filter 32 is designed to pass only modulated auxiliary carrier frequencies.

$$f_2 - f_1 \pm \left\{ \frac{s_1}{s_2} \right\}$$

A circuit 25 comprising a variable condenser and a variable inductance may, if desired, be connected in parallel to the circuit containing the source 18 and the coil 19. The circuit 25 may be most advantageously tuned to be resonant at the auxiliary carrier frequency. This prevents a loss of energy of the auxiliary carrier frequency due to the voltage drop across the tube M—22.

The branch circuit 8 which is connected to the antenna, is intended to give the antenna one natural period equal to the mean period of the incoming waves from the distant station which are represented by the legend $f_2 \pm s_2$. An anti-resonant circuit B is serially included in the branch 8 and turned to the transmitting carrier frequency f_1 in order to prevent current of that frequency, or of the frequencies of the outgoing waves which are impressed on antenna 7, from passing through the branch 8. Any suitable tuning circuit or tuning means 10 is also provided in the branch 8 whereby the said branch may be given any desired reactance which is necessary to tune the antenna for the incoming waves.

An important feature of this arrangement is that the frequency of the waves being transmitted is determined by and can be varied by the adjustment of the coil 16 and the

condenser 17. After establishing the outgoing carrier at the desired frequency and adjusting circuit B to this frequency, the tuning reactance means 10 may be varied within considerable limits without producing a material variation of the waves being generated by the tube O—D—15 in the antenna.

If desired, the circuit 8 may be omitted; but with the antenna tuned for the outgoing carrier wave frequency incoming signals will then be received less efficiently.

If the space current path of tube M—22, instead of being connected to circuit 20 and oscillator O—D—15 as shown in the drawing, for supplying speech frequency voltage to the oscillating tube O—D—15, be connected in the place of balancing network 29, and the balancing network be then omitted, the voltage of speech frequency which is supplied to the oscillating tube from the tube M—22 is impressed serially across the circuit 20. In some cases, this results in objectionable transients being set up in circuit 20 which cause interference with the operation of the system. In order to avoid this, the circuit 20 is balanced for speech frequencies. The lead from the plate of the tube M—22 is connected to an intermediate point 27 of the coil 28 and a balancing impedance network 29 is provided. This impedance network is so adjusted that the time constant

$$\frac{L}{R}$$

of the circuit from the point 27 through the oscillator O—D—15 to ground is equal to the time constant

$$\frac{L}{R}$$

of the circuit from point 27 through the network 29 to ground. The network 29, therefore, constitutes an impedance which simulates the impedance of the plate-filament path of the oscillating tube O—D—15 during its oscillating condition.

The elements 30 constitute a grid leak path for the oscillating tube O—D—15 and comprise an inductance in series with a parallel combination of a resistance and a condenser.

Operation of Fig. 1.—When signals are being transmitted from the local station there is radiated from the antenna 7, a modulated carrier wave $f_1 \pm s_1$, which is available for combination with the incoming signaling wave $f_2 \pm s_2$ to cause the transmission through circuits 20 and 20' of the wave

$$f_2 - f_1 \pm \left\{ \frac{s_1}{s_2} \right\}$$

This produces in the receiver 13 at any instant either or both of the signals s_1 and s_2 , as indicated by the legend

$$\left\{ \frac{s_1}{s_2} \right\}$$

adjacent the receiver, depending upon whether one or both are being transmitted at that instant. When no transmission of the signaling frequency is going on, of course, only the unmodulated component of the outgoing carrier combines with the incoming wave, to produce the auxiliary carrier wave. The auxiliary carrier frequency may be equal either to the sum or the difference of the principal carrier frequencies, but since many practical advantages are attached to using the difference frequency rather than the sum frequency, this is the one which it has been assumed above is utilized. The amplitude of the intermediate or auxiliary carrier frequency wave impressed on the detector D—12 is proportional to the product of the amplitudes of the principal carrier waves generated at the local and the distant stations, respectively. Thus, assuming the same percentage of modulation at each station, the signal heard in the local receiver is of approximately the same intensity whether the local or distant station is signaling. In order to obtain a maximum indication from the distant station, it is consequently desirable to allow sufficient energy of the local carrier wave frequency to enter the receiving circuit to load the detector or the rectifying device such as D—12 with approximately the maximum energy input which it is capable of handling without material signal distortion. The local energy is thus utilized as a desirable agent during the non-transmitting periods. The effects of interfering waves on the radio system are thereby, to a considerable extent, overcome.

The transmitting operator will at once become cognizant of an inoperative condition of his transmitting or receiving system or that of the distant transmitter, since the absence of side tone effect will warn the operator that the apparatus is not working properly.

Balancing the circuit 20 for speech frequencies reduces the number and amplitude of disturbing transients introduced in the receiving circuit and reduces the amplitude of speech frequency side tone directly introduced into the receiving circuit.

Description of Fig. 2.—Fig. 2 is similar to Fig. 1 but includes additional means to increase the selectivity and to reduce the side tone. Corresponding elements in the two figures are identified by similar reference characters, and the letters *f* and *s* with appropriate subscripts are applied in Fig. 2 with meanings similar to those in connection with Fig. 1. The selecting function of the tuned circuits 20 and 20', of Fig. 1 is here performed by a band pass filter 33 of a well-known type. The filter 33 selects a band of frequencies equal in width to the modulated wave resulting from the combina-

tion of the incoming and outgoing waves and substantially suppresses waves of other frequencies. The band pass filter 33 is connected to the input circuit of an amplifier A—34. To the output circuit of the amplifier is connected a band pass filter 32 similar to filter 33 or otherwise constructed as may be desired.

The filter 32 supplies the input circuit of an amplifier A—35 which in turn feeds the detector D—12. It will thus be seen that the intermediate frequency which may be equal either to the sum or the difference of the outgoing and incoming carrier waves is first selected by the band filter 33, amplified by the amplifier A—34, again selected by the filter 32 and again amplified by the amplifier A—35. Such an arrangement is highly efficient in selection and amplification. Additional stages of amplification or additional selective means may be inserted in the circuit at any point.

By a tap 27 upon the coil 28 a balance of speech frequencies is obtained whereby the amount of speech frequency voltage introduced into the filter 33 is reduced. The operation of the circuit of Fig. 2 will be apparent from the description above of the operation of Fig. 1, without further explanation.

What is claimed is:

1. A station for two-way communication systems comprising in combination, a transmitting circuit including, a source of signaling waves, a high frequency carrier wave source, and means for modulating said carrier waves in accordance with the signaling waves, means including a portion of said transmitting circuit for combining the energies of said carrier waves, modulated at times, with an incoming carrier wave, modulated at times, to produce a similarly modulated intermediate frequency carrier wave, a receiving circuit for said intermediate frequency carrier wave, and means conjugately relating portions of said transmitting and said receiving circuits.

2. A carrier wave transmission system comprising a transmitting circuit, means connected in said circuit for translating the transmitted wave and for combining the transmitted wave with an incoming modulated carrier wave to produce a modulated intermediate frequency carrier wave, a circuit for transmitting modulating waves to and said modulated intermediate frequency carrier wave from said means, a source of modulating current in energy transfer relation to said last mentioned circuit, a modulated intermediate frequency carrier wave transfer circuit also in energy transfer relation with said last mentioned circuit, and balancing means for preventing the modulating waves from affecting said transfer circuit.

3. A carrier wave transmission system comprising a transmitting circuit, means connected in said circuit for translating the transmitted wave and for combining the transmitted wave with an incoming modulated carrier wave to produce a modulated intermediate frequency carrier wave, a circuit for transmitting modulating waves to and said modulated intermediate frequency carrier wave from said means, a source of modulating current in energy transfer relation to said last mentioned circuit, a modulated intermediate frequency carrier wave transfer circuit also in energy transfer relation with said last mentioned circuit, and balancing means for preventing the modulating waves from affecting said transfer circuit, said balancing means comprising an impedance which simulates the impedance, during its transmitting condition, of the path, including the transmitting circuit, from one terminal of the impedance to the other.

4. A transmitting and successive detection signaling system comprising a two-way communication channel, a signal current channel and a receiving channel connected in substantially conjugate relationship to each other, and means comprising an oscillator-detector circuit to connect said conjugate channels in energy transfer relation to said two-way channel.

5. A signaling system comprising a two-way communication channel, a detector included in said channel, a receiving channel, means included in said receiving channel for producing a second detection of the detected wave from said first mentioned detector, a sending channel, and means connecting said sending channel and said receiving channel to said two-way channel in substantially conjugate relation to each other.

6. A signaling system comprising two stations each of which includes a source of signal waves, a high frequency carrier wave source, means for modulating the carrier wave generated by said source in accordance with the corresponding signal wave, means at least partially common to said high frequency carrier wave source for combining the energy of said carrier waves, each modulated at times, to produce a similarly modulated intermediate frequency carrier wave, means for deriving the signal waves from said intermediate frequency carrier wave, and means substantially conjugately relating said modulating means and said means for deriving the signal waves from said intermediate frequency carrier wave.

7. A station for two-way communication systems comprising in combination a transmitting circuit and a receiving circuit, including a transmitting and receiving conductor, common means associated in energy transfer relation with said conductor for generat-

ing the outgoing high frequency carrier wave and for producing from the incoming modulated high frequency carrier wave a similarly modulated intermediate frequency carrier wave, a modulating circuit associated with said means for modulating said outgoing high frequency wave, a device for detecting said intermediate frequency wave, and means substantially conjugately relating portions of said transmitting and receiving circuits.

8. A carrier wave transmission system comprising a transmission circuit, means connected to said circuit in energy transfer relation for generating a high frequency carrier wave and for producing from an incoming modulated high frequency carrier wave a similarly modulated intermediate frequency carrier wave, a circuit for transmitting modulating currents to and intermediate frequency modulated current from said means, a modulating source in energy transfer relation to said last mentioned circuit, a detecting device, a tuned circuit connecting said detecting device in energy transfer relation to said last mentioned circuit, and balancing means for preventing the modulating current from affecting said detecting device.

9. A carrier wave transmission system comprising in combination, a transmitting and receiving conductor, common means associated with said conductor for generating a high frequency carrier wave and for producing from the modulated carrier wave received over said conductor a similarly modulated carrier wave of different frequency, a band pass filter associated with said means for selecting the modulated carrier wave of said different frequency, an amplifier for amplifying said selected wave, a band pass filter connected to said amplifier for selectively transmitting said amplified wave, an amplifier for amplifying the latter wave, a detector connected to said latter amplifier, modulating means associated with said conductor and said first mentioned filter, and means substantially conjugately relating said modulating means and said first mentioned filter.

10. A combination for two-way signaling comprising a transmission means, an oscillator-modulator circuit, a source of signal currents and a receiver circuit both of which are associated with said transmission means through said oscillator-modulator circuit; and balancing means for preventing said signal currents from affecting said receiver circuit.

In witness whereof I hereunto subscribe my name this 8th day of June, A. D., 1927.

JOHN F. FARRINGTON.