

Oct. 6, 1925.

1,556,320

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HIGH FREQUENCY MULTIPLEX SIGNALING SYSTEM

Filed April 9, 1921

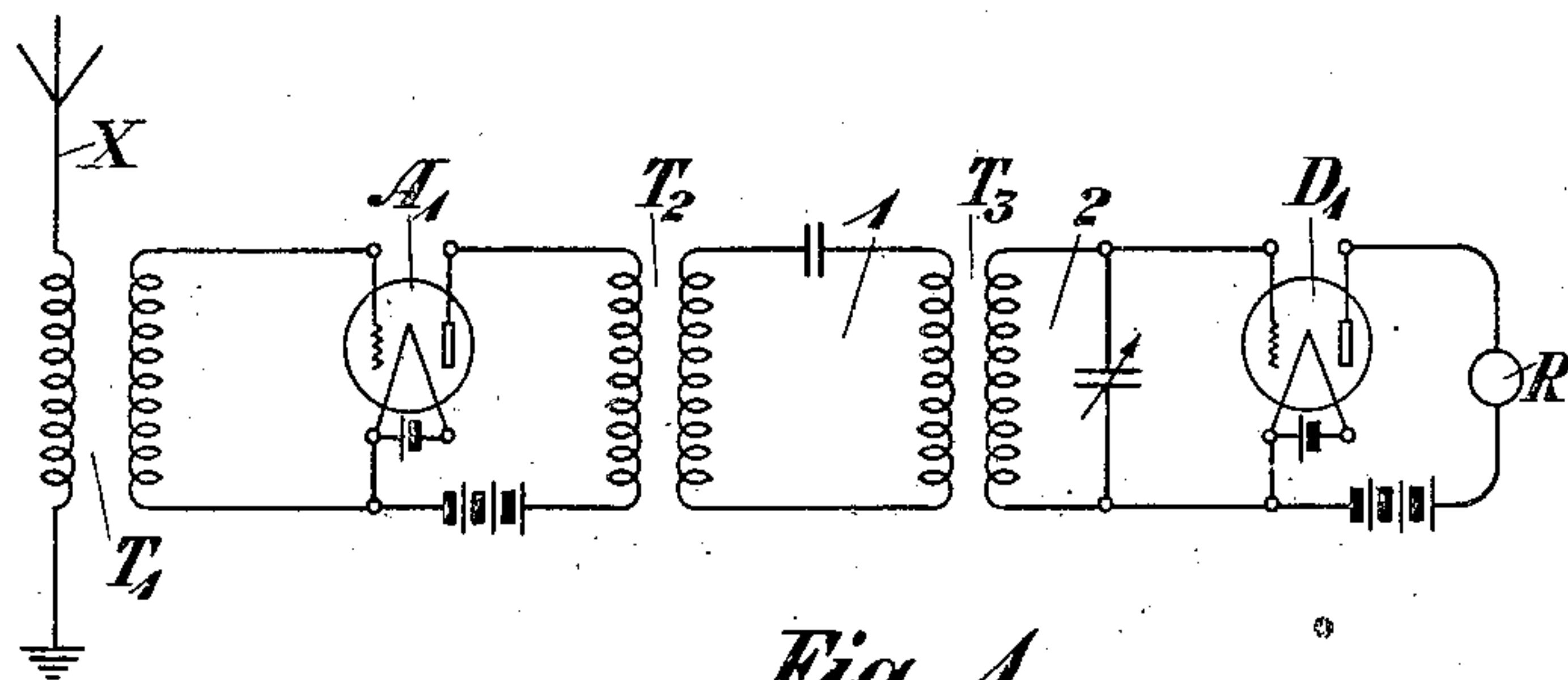


Fig. 1

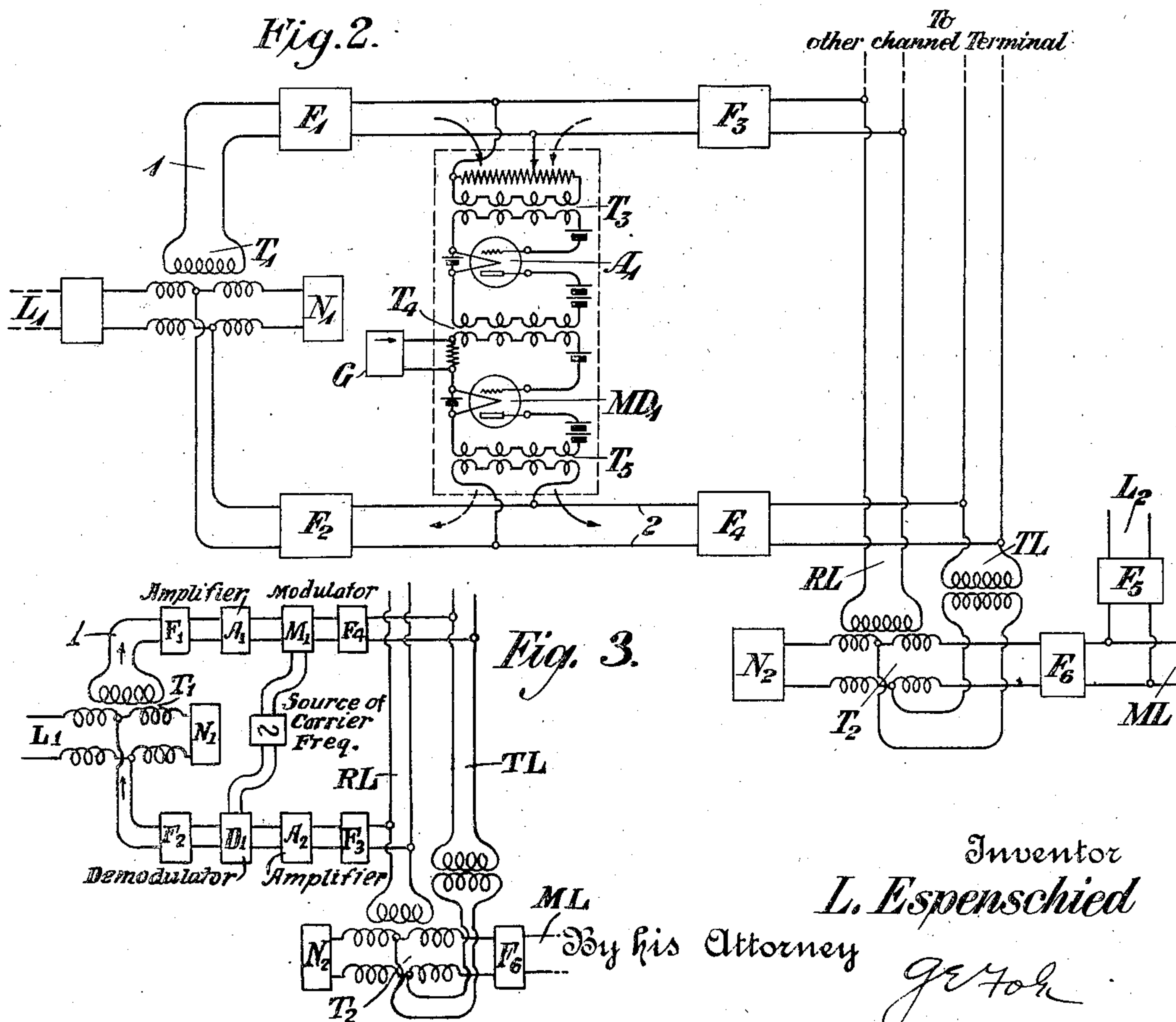


Fig. 3.

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Patented Oct. 6, 1925.

1,556,320

UNITED STATES PATENT OFFICE.

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HIGH-FREQUENCY MULTIPLEX SIGNALING SYSTEM.

Application filed April 9, 1921. Serial No. 459,834.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Queens, in the county of Queens and State of New York, have invented certain Improvements in High-Frequency Multiplex Signaling Systems, of which the following is a specification.

This invention relates to high frequency multiplex signaling system and more particularly to a terminal circuit arrangement embodying the use of amplifiers adapted to amplify the side band and the carrier frequency oscillations received by the said terminal circuit.

This application is a continuation in part of my copending application, Serial No. 327,501 filed September 30, 1919, entitled High frequency multiplex signaling system.

The broad object of the invention is to improve the transmission efficiency and the transmission quality of carrier current circuits. One feature is the provision of a carrier current amplifier for improving the transmission efficiency of the carrier circuit. A further object of the invention is to provide means whereby the ratio of the unmodulated carrier current transmitted over the system to the modulated or side band component may be controlled for the purpose of insuring good quality in the carrier transmission circuit.

A comprehensive understanding of the invention will be facilitated by recognizing that in the ordinary form of carrier current transmission represented by radio, there are involved really two channels, one the unmodulated carrier current which is transmitted over the system at the original carrier frequency and the other the modulated or side band component which is transmitted at a frequency differing from the original carrier frequency by an amount corresponding to the signaling frequency. These two channels are commonly treated in radio, for example, as a single channel, and at the receiving end are fed unseparated into the detector. The detecting action obtains, however, only by virtue of modulation between, that is, the beating together of, the currents of the two channels, the carrier and one or both side bands. The present invention is concerned with that type of carrier current system, either wire or wireless, wherein the carrier is transmitted with the side bands as

in ordinary radio practice, as distinguished from the type of carrier system first employed for multiplex service over wires wherein the carrier frequency was suppressed at the sending end and resupplied at the receiving end by a control system.

One feature of the invention resides in the use of an amplifier in the high frequency part of the circuit which amplifies simultaneously both the carrier and the side band currents. A given amplification inserted in this manner in the high frequency circuit results in a twofold amplification of the detected current by virtue of the fact that the amplitude of the detected current is a function of the product of the amplitudes of the carrier and the side band currents.

This invention will be better understood from the following description when read in connection with the attached drawing, of which Figure 1 shows an arrangement for amplifying to the same degree both the carrier frequency and the side band frequency oscillations, Figure 2 shows an arrangement using a common translating circuit adapted to amplify the low frequency signals and the side band oscillations before impressing them upon a modulating and demodulating device having a local source of carrier oscillations associated therewith, and Fig. 3 shows an arrangement having separate translating circuits individual to the transmitting and receiving paths respectively whereby the processes of amplifying, modulating and demodulating are carried out.

The circuit arrangement shown in Figure 1 discloses a means whereby the received oscillations of carrier frequency and the modulated oscillations, that is the side band component, the frequency of which differs from the original carrier frequency by an amount corresponding to the signal frequency may be amplified simultaneously and the amplified oscillations impressed upon a detecting device. In the figure, X represents an antenna which is tuned for the reception of oscillations of carrier frequency, and also for oscillations of frequencies represented by the side band. The antenna X is connected with the input side of the amplifying circuit by means of a transformer T_1 which preferably is of the tight-coupling step-up type. This transformer is adapted to relate more efficiently the low re-

5 resistance antenna circuit with the high re-
 sistance of the gap between the grid and
 the filament. The amplifier A_1 , which is
 adapted to amplify the impressed oscilla-
 10 tions is shown in the figure as being of the
 well known vacuum tube type, but it is to
 be understood that any type of non-distort-
 ing amplifier may be used instead. The
 transformer T_2 which is a tight-coupling
 15 step-down transformer, is adapted to asso-
 ciate the high resistance output circuit of
 the amplifier A_1 with the high frequency
 tuning circuit 1. The transformer T_3 is of
 the loose-coupling type for impressing the
 20 oscillations of the tuning circuit 1 upon the
 closed tuning circuit 2 in the input side of
 the detector D_1 , in the output side of which
 is the receiver R . In the operation of this
 circuit the oscillations of the frequencies re-
 ceived by the antenna X are impressed by
 the transformer T_1 upon the input side of
 the circuit containing the amplifier A_1 .
 The amplifier A_1 is adapted to amplify the
 25 carrier frequency and also the frequencies
 represented by the side band component.
 These frequencies are impressed upon the
 circuit 1 and in turn upon the input side of
 the detector D_1 . The amplification of the
 30 carrier frequency, together with the fre-
 quencies of the side band results in a two-
 fold amplification of the detected current in
 the output side of the device D_1 by virtue
 of the fact that the amplitude of the detect-
 ed current is a function of the product of
 35 the amplitudes of the carrier and the side
 band currents.

In Figure 2, L_1 shows a source of low
 frequency signaling currents which is con-
 40 nected with the terminal circuit by means
 of a transformer T_1 having a network N_1
 associated therewith adapted to balance the
 line L_1 . This terminal circuit, which is of
 the four-wire type, has associated with it
 45 low frequency filters F_1 and F_2 and the high
 frequency filters F_3 and F_4 . The transmit-
 ting path of this circuit is connected with
 the branch transmission circuit TL , which
 is in turn connected with the main transmis-
 sion line ML by means of transformer T_2 .
 50 A network N_2 associated with transformer
 T_2 is adapted to balance the line ML . An-
 other circuit L_2 is connected with the main
 transmission line ML through the low fre-
 quency filter F_5 , the function of the said line
 55 being to transmit low frequency voice cur-
 rents over the line ML simultaneously with
 the transmission of the high frequency sig-
 naling currents from the terminal circuits.
 High frequency oscillations received over
 60 the line ML pass through the high frequency
 filter F_6 and are impressed on the branch
 receiving circuit RL by the transformer T_2 .
 Connected between the two sides of the four
 wire circuit is a translating circuit which
 65 forms a common path for the outgoing and

incoming currents of the terminal circuit.
 The input side of this translating circuit is
 connected with one side of the terminal cir-
 cuit by means of the transformer T_3 which
 is of a type designed for the efficient trans- 70
 fer of both low frequency and high fre-
 quency currents from the terminal circuit to
 the translating circuit. Connected with the
 translating circuit is an amplifier A_1 adapt- 75
 ed to amplify the currents impressed upon
 the translating circuit by the transformer
 T_3 and the currents thus amplified are im-
 pressed upon a modulating and demodulat-
 ing device MD_1 by means of a transformer
 80 T_4 . The modulating and demodulating de-
 vice has associated with it a source of high
 frequency carrier supply current G . The
 currents resulting from modulation and de-
 modulation are impressed upon the output
 side of the terminal circuit by means of the 85
 transformer T_5 .

In the operation of this circuit low fre-
 quency signaling currents arising in the cir-
 cuit L_1 are impressed by the transformer T_1
 upon the low frequency circuit 1 and passing 90
 through the filter F_1 are impressed upon the
 translating circuit by the transformer T_3 .
 These low frequency currents are amplified
 by the amplifier A_1 , and by means of the de-
 vice MD_1 , serve to modulate the carrier cur- 95
 rent. The modulated high frequency oscil-
 lations are impressed upon the high fre-
 quency output circuit from whence they pass
 through the high frequency filter F_4 to the
 transmission lines TL and ML . Simulta- 100
 neously with the transmission of the modu-
 lated high frequency oscillations unmodu-
 lated carrier oscillations produced by the
 source G are transmitted through device
 105 MD_1 , and over the lines TL and ML to the
 corresponding terminal circuit at the oppo-
 site end of the said line.

The modulated high frequency oscillations
 received from the terminal circuit at the
 said other end of the line ML are impressed 110
 upon the branch receiving line RL and pass
 through the filter F_3 into the translating cir-
 cuit. Simultaneously with the reception of
 these modulated oscillations unmodulated
 oscillations of the same frequency are re- 115
 ceived by the line RL and are impressed
 upon the translating circuit passing through
 the filter F_3 which is adapted to transmit the
 carrier frequency and the band of frequen- 120
 cies based thereon. The received band of
 oscillations and the carrier oscillations are
 amplified together by the amplifier A_1 and
 are impressed by means of the transformer
 125 T_4 upon the device MD_1 in which they are
 modulated. The low frequency signaling
 current resulting therefrom passes through
 the filter F_2 to the line L_1 and actuates the
 low frequency signaling apparatus associ-
 ated therewith. The amplification of the 130
 oscillations of the side band frequencies and

of the carrier frequency itself results in a two-fold amplification of the detected current by virtue of the fact that the amplitude of detected current is a function of the product of the amplitude of the carrier oscillations and the amplitude of the side band oscillations. Thus an amplification which doubles the received high frequency currents of both the side band and of the carrier simply results in quadrupling the detected current as a result of this product relationship. It is therefore apparent that the arrangement shown in Figure 2 results in a substantial gain in the transmission of signals by a system employing high frequency carrier currents. As has been stated, the modulated high frequency oscillations transmitted over the lines TL and ML from the terminal circuit shown in Figure 2 will be received at the other end in a terminal circuit preferably similar to that shown in Figure 2 and the modulated high frequency oscillations and the unmodulated carrier oscillations will pass through a filter similar to F_3 and will be impressed upon a translating circuit similar to that shown in Figure 2.

Although the high frequency amplifier is illustrated in Figure 2 applied in a type of circuit wherein one amplifier is common to both sending and receiving it will be understood that the amplifier may be employed in a circuit of any type such as the 22 type circuit wherein separate high frequency amplifiers are employed for sending and receiving. Such modification is shown in Fig. 3 in which the same reference characters have been used to represent parts which perform the same function as in Fig. 2. Low frequency variations from the line L_1 will be impressed by the line transformer upon the circuit 1 and after passing through the low-pass filter F_1 will be amplified to the desired degree by the amplifier A_1 and then will be impressed upon the modulator M_1 which has a source of unmodulated high frequency oscillations connected therewith. The resultant modulated oscillations will be transmitted through the high-pass filter F_4 to the line TL, from which they will be transmitted to the main transmission line ML in the same manner as described in connection with Fig. 2. The modulated high frequency oscillations and unmodulated carrier oscillations which are transmitted from the distant end of the line ML will be impressed upon the receiving line RL and will pass through the high-pass filter F_3 , assuming that the frequencies are within the range of transmission of this filter. These oscillations will be amplified by the amplifier A_2 and the resultant amplified oscillations will be impressed upon the demodulating device D_1 wherein the signal component will be detected and will be transmitted through the low-pass filter F_2 to the line L_1 . The trans-

lating circuits in the transmitting and receiving paths of Fig. 3, represented by the rectangles designated amplifier, modulator or demodulator, should preferably be of the form represented in Fig. 2 within the dotted rectangle.

It will be seen that this invention provides means whereby the received carrier frequency and also the frequencies represented by the received side band or bands may be amplified simultaneously. It is also apparent that the arrangement shown in Figure 2 is adapted to amplify simultaneously received oscillations of the carrier frequency and also the low frequency signals originating upon the line L_1 which pass through the filter F_1 and are impressed upon the translating circuit by the transformer T_3 .

Since the filters F_1 and F_2 are adapted to transmit the same band of low frequency currents, and F_3 and F_4 are adapted to transmit the same band of high frequency currents, singing around the circuit over either the low frequency path or the high frequency path is prevented by the use of the conjugate transformers T_1 and T_2 and the networks N_1 and N_2 adapted to balance their respective line circuits L_1 and ML.

Although Figure 1 shows the invention embodied in a radio circuit and Figure 2 shows it in a wire signaling circuit it is to be understood that the invention is not limited to such specific forms but that it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a signaling system adapted for the transmission and reception of high frequency signals and characterized by a translating circuit common to the transmitting and receiving paths of the said system, the method which consists in simultaneously amplifying in a common circuit low frequency signals and modulated high frequency signals, modulating an unmodulated high frequency carrier current in accordance with the said low frequency signals, demodulating the modulated high frequency oscillations by means of the said carrier current, and transmitting the currents resulting from such modulation and demodulation.

2. In a signaling system, the combination with a low frequency signaling circuit of a high frequency transmission circuit, a connecting circuit providing paths for the oppositely traveling currents from the said signaling circuit and the said transmission circuit, the said connecting circuit having a translating circuit common to the said paths, the said translating circuit having means for amplifying the currents impressed upon the said connecting circuit by the said low

frequency and the said high frequency circuit, and means for modulating and demodulating the said amplified currents.

3. In a signaling system, the combination
5 with a low frequency signaling circuit of a high frequency transmission circuit, a four-wire connecting circuit between the said low frequency circuit and said high frequency circuit having frequency selecting means in
10 each of the two-wire branches to provide paths for the oppositely traveling currents, and a translating circuit common to the said paths of the said connecting circuit, the said translating circuit having means to amplify
15 the transmitted and received currents impressed upon said translating circuit.

4. In a signaling system, the combination
20 with a low frequency signaling circuit of a high frequency transmission circuit, a four-wire connecting circuit between the said low frequency circuit and the said high frequency circuit, providing two-wire paths for the oppositely traveling currents, each path
25 having associated therewith a low-pass filter and a band filter, and a translating circuit common to both of said paths containing means to amplify the currents impressed on the said translating circuit, and means to
30 modulate and demodulate the said amplified currents.

5. In a signaling system, the combination
35 with a low frequency signaling circuit, of a high frequency transmission circuit, and a four-wire connecting circuit characterized by filters in the two-wire branches to establish definite paths for the transmitted and received currents and also characterized by

means to amplify transmitted and received currents before modulation or demodulation.

6. In a signaling system, the combination
40 with a low frequency circuit, of a high frequency circuit, a four-wire connecting circuit comprising two two-wire branches each having a low pass filter and a band filter therein and a translating circuit bridged
45 across said branches and comprising an amplifier, a modulating and demodulating device whereby currents from the said low frequency circuit and from the said high frequency circuit may be amplified before mod-
50 ulation or demodulation and means for impressing upon the translating circuit the low frequency and high frequency currents from one of said two-wire branches.

7. In a signaling system the combination
55 with two line circuits, of networks to balance the said line circuits, a four-wire connecting circuit interposed between the said line circuits and electrically related thereto
60 by means of conjugate transformers, the said four-wire circuit having a translating circuit connected between the two-wire branches of the four-wire circuit containing means to amplify all currents impressed on
65 the said translating circuit and selecting means inserted in each of the said two-wire branches to establish proper channels for the passage through the said four-wire circuit of
70 the currents flowing over the said line circuits.

In testimony whereof, I have signed my name to this specification this 7th day of April 1921.

LLOYD ESPENSCHIED.