May 2, 1939. W. P. PLACE 2,156,702

RECEIVING APPARATUS FOR COMMUNICATION SYSTEMS

Filed April 1, 1937 2 Sheets-Sheet 1

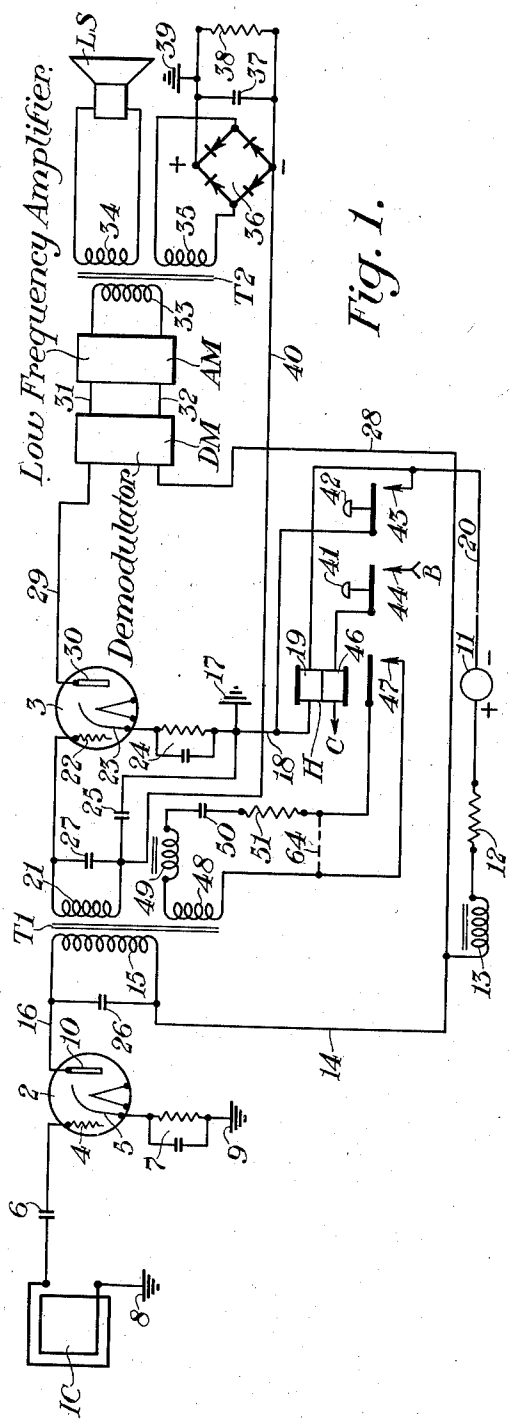


Fig. 1.

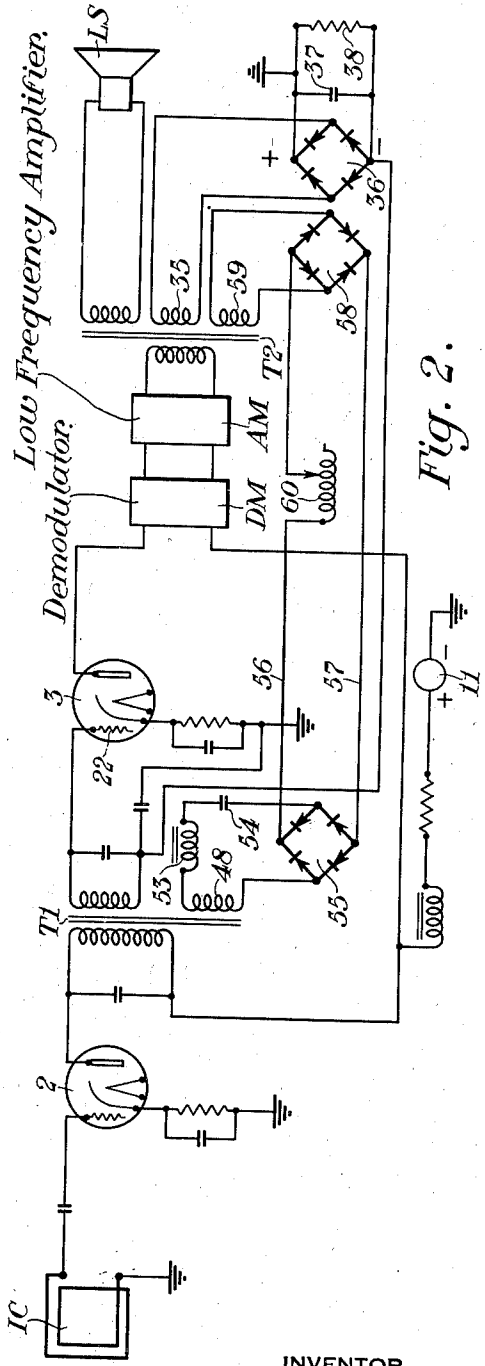


Fig. 2.

INVENTOR
Willard P. Place.
BY
HIS ATTORNEY

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RECEIVING APPARATUS FOR COMMUNICATION SYSTEMS

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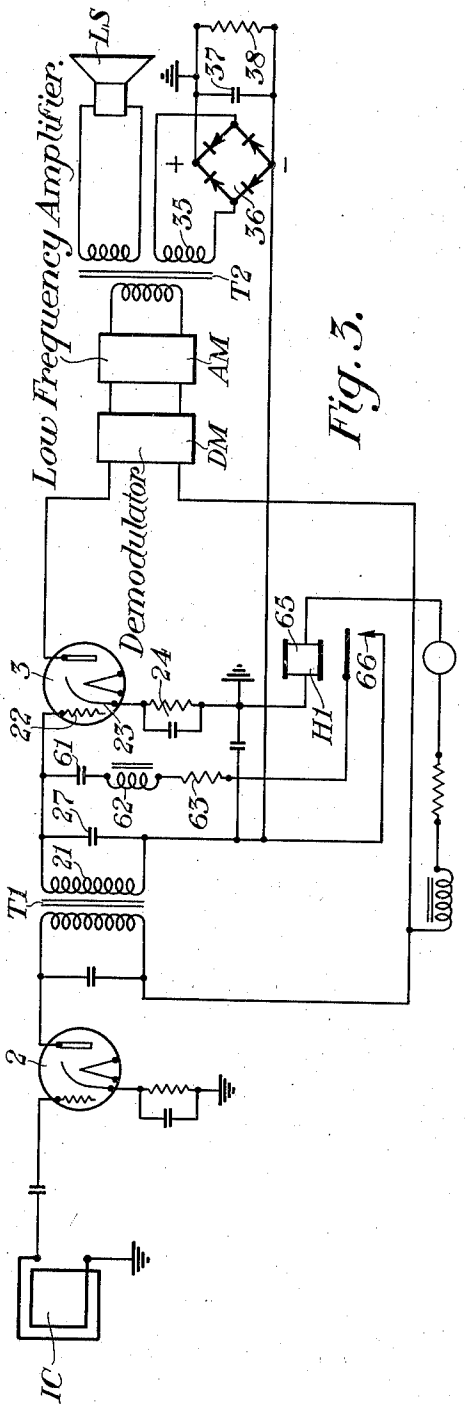


Fig. 3.

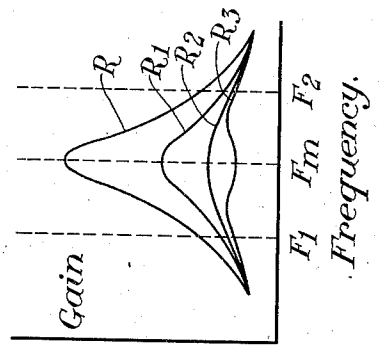


Fig. 5.

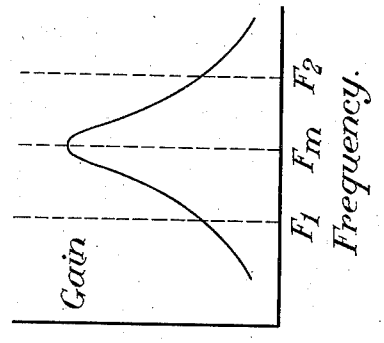


Fig. 4.

INVENTOR
Willard P. Place.
BY
HIS ATTORNEY

Patented May 2, 1939 2,156,702

UNITED STATES PATENT OFFICE

2,156,702

RECEIVING APPARATUS FOR COMMUNICATION SYSTEMS

Willard P. Place, Wilkinsburg, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application April 1, 1937, Serial No. 134,357

9 Claims. (Cl. 250—20)

My invention relates to receiving apparatus for communication systems, and particularly to receiving apparatus for communication systems employing a modulated carrier current.

I shall describe several forms of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

A feature of my invention is the provision of novel and improved receiving apparatus for communication systems which is highly selective to a narrow band of frequencies and is adjustable for effective reception of a relatively wide band of frequencies. Another feature of the invention is the provision of apparatus of the type here involved which is operative to effect an automatic volume control and also to provide substantially the same order of amplification for all frequencies of a given band of frequencies. Still another feature of the invention is the provision of such receiving apparatus normally conditioned for reception and wherewith noise energy during non-communication periods is largely suppressed. Other features and advantages of my invention will appear as the specification progresses.

In the accompanying drawings, Fig. 1 is a diagrammatic view of one form of apparatus embody the invention. Figs. 2 and 3 are diagrammatic views of two other forms of apparatus each of which embodies the invention, and Figs. 4 and 5 are diagrams illustrating operating characteristics of the apparatus. In each of the several views, similar reference characters designate similar parts.

Apparatus embodying my invention is peculiarly suitable for use in railway train communication systems in which a carrier current modulated with voice frequencies is employed for telephone communication, and a current equivalent to such carrier modulated by a single voice frequency is employed for calling and code signaling. In such communication systems for railway trains it has been proposed to transmit the upper side band of a carrier of, say, 7000 cycles per second modulated with voice frequencies for telephone purposes, and to transmit a current equivalent to such carrier modulated with a predetermined voice frequency for calling and code signaling. Taking the voice frequencies to extend from 500 to 2500 cycles per second, the telephone current in the case here cited has a range extending from 7500 to 9500 cycles, and the calling current is of, say, 8500 cycles per second. It has been found in such railway train communication systems that communication may be effected by use of the calling current when telephone communication is unsatisfactory because of adverse transmitting conditions and due to the fact a higher amplification of the calling current can be tolerated. In other words, there is a fixed energy level for the incoming current below which communication by means of the calling current is more satisfactory and above which level communication may be effected by either the calling current or the telephone current. In such communication systems for railway trains, the earth currents and stray magnetic fields may produce noise of a volume that is very annoying during non-communication periods, since the receiving apparatus is normally conditioned for reception and includes a high gain amplifier. As set forth hereinbefore, apparatus embodying my invention is effective to suppress most of such noise energy. It will be understood, of course, that my invention is not limited in its use to communication systems for railway trains, and furthermore it is not limited to the specific frequencies cited above.

Referring to Fig. 1, the receiving apparatus includes two stages of high frequency amplification, a demodulator and a low frequency amplifier, as well as a receiver and a loud speaker. The reference character IC indicates a receiver for receiving energy from a transmitting circuit not shown. When the apparatus is applied to a railway train, the receiver IC would be preferably a coil or inductor mounted on a vehicle of the train in inductive relation with the track rails, the rails being included in the transmitting circuit.

The first and second stages of high frequency amplification include electron tubes **2** and **3**, respectively. As here shown, these tubes **2** and **3** are of the indirectly heated cathode type, the filaments of which are constantly heated in the usual way. The receiver IC is connected across the control grid **4** and cathode **5** of the tube **2**, a condenser **6** being interposed between the grid **4** and the top terminal of the receiver IC, and the cathode **5** being connected with the lower terminal of the receiver IC over a biasing unit **7** and the ground electrodes **8** and **9**. Plate voltage is supplied to the plate **10** of tube **2** from a genator **11**, the plate circuit extending from the positive terminal of generator **11** over a resistor **12**, a reactor **13**, wire **14**, primary winding **15** of a coupling transformer T1, wire **16**, plate **10**, intervening tube space to cathode **5**, biasing unit **7**, ground electrodes **9** and **17**, wire **18**, winding **19** of a relay H to be referred to later, and wire **20** to the negative terminal of generator **11**.

The secondary winding 21 of the coupling transformer T1 is connected across the control grid 22 and cathode 23 of the second stage tube 3, a biasing unit 24 and a condenser 25 being interposed in the connection. Condensers 26 and 27 are connected across a primary winding 15 and the secondary winding 21, respectively, of transformer T1 for effectively tuning the coupled circuits in a manner to be described later. The plate circuit for the tube 3 may be traced from the positive terminal of generator 11 over resistor 12, reactor 13, wire 28, input side of a demodulator DM, wire 29, plate 30, intervening tube space to cathode 23, biasing unit 24, wire 18, winding 19 of relay H and wire 20 to the negative terminal of the generator. It follows that electromotive forces induced in the receiver IC are amplified at each of the two stages of amplification and are applied to the input side of the demodulator DM. It will be understood, of course, that additional stages of amplification may be employed if desired.

The demodulator DM may take any one of several well-known types, and is shown conventionally only for the sake of simplicity. It is deemed sufficient to point out that when either the calling or the telephone current is applied to the demodulator it is mixed with a local carrier current and the voice frequencies are supplied to the output of the demodulator, the local carrier and the other products of demodulation being suppressed and filtered out.

The output side of the demodulator DM is connected over wires 31 and 32 to the input side of a low frequency amplifier AM, which may consist of one or more stages of amplification. The amplifier AM would be of the usual type and is illustrated conventionally in order to simplify the drawings as much as possible. The output side of the amplifier AM includes the primary winding 33 of an output transformer T2. One secondary winding 34 of the transformer T2 is connected with the operating winding of a loud speaker LS. Another secondary winding 35 of the transformer T2 is connected with the input terminals of a full wave rectifier 36, the output terminals of which are connected with a circuit including a condenser 37 and a resistor 38 in parallel. The arrangement is such that the polarity of the rectifier 36 and the circuit including condenser 37 and resistor 38 is that indicated by the plus and minus signs. The positive terminal of this circuit including condenser 37 and resistor 38 is connected to a ground electrode 39, and the negative terminal is connected over wire 40 with the grid circuit of the tube 3, as will be readily understood by an inspection of Fig. 1. It is clear that the elements consisting of secondary winding 35, rectifier 36, condenser 37 and resistor 38 constitute an automatic volume control device for controlling the biasing voltage of the tube 3.

The relay H is a two-winding direct current relay, the winding 19 of which is interposed in the plate circuits of the tubes 2 and 3, as pointed out hereinbefore. The parts are so proportioned that the normal plate current energizes the relay H sufficiently to pick up the relay and open its back contact 47. Two push buttons 41 and 42 are associated with relay H. When the push button 42 is depressed to close its contact 43, the winding 19 of relay H is shunted and the relay releases closing back contact 47. When the push button 41 is depressed to close its contact 44, current is supplied from the B terminal of any convenient source of current such as a battery not shown over contact 44 of push button 41, winding 46 of relay H and to the C terminal of the current source, and the relay H is energized and picks up opening its back contact 47.

The coupling transformer T1 is provided with a tertiary winding 48, which is connected with an auxiliary circuit including an inductor 49, a condenser 50, a resistor 51 and the back contact 47 of relay H. The function of this auxiliary circuit will appear when the operation of the apparatus is described.

As set forth earlier in the specification, the apparatus is normally conditioned for reception, and to that end the filaments of the tubes 2 and 3, as well as the filaments of the tubes included in the demodulator DM and amplifier AM, are heated, and the generator 11 is operated to supply plate voltage to the several tubes. Under such normal condition, and during the time no communication energy is induced in the receiver IC, the negative bias voltages applied to the grids of the tubes 2 and 3 are low and the plate current of each tube is high. This high plate current flowing in the winding 19 of relay H energizes the relay sufficiently to pick up the relay and open back contact 47. With the back contact 47 open, the auxiliary circuit including the tertiary winding 48 of transformer T1 is open and the auxiliary circuit is of substantially infinite resistance. The transformer T1 and the associated condensers 25, 26 and 27 are proportioned and adjusted so that the circuits coupling the tubes 2 and 3 are adjusted for resonance at the frequency of the calling current. In the case cited hereinbefore for illustration, the parts are tuned to resonance at 8500 cycles per second. The curve of Fig. 4 illustrates the gain effected by the two stages of amplification under such normal condition, the frequency F_m of Fig. 4 representing the mid frequency of 8500 cycles. That is, the parts are so proportioned that the apparatus operates under normal conditions in accordance with the well-known resonant curve. It is to be noted that the amplification of frequencies to each side of the mid frequency F_m falls off rapidly, and consequently the apparatus at its normal setting is highly selective at the mid frequency and only a few cycles of noise energy to each side of such mid frequency are passed at high gain. Hence, the normal setting of the apparatus is that required for reception of the calling current at high gain and for suppression of noise energy.

Looking at Fig. 4, if F_1 and F_2 represent the frequency range of the telephone current, namely, 7500 to 9500 cycles, it is clear that voice reception might not be satisfactory owing to the relatively high gain at the mid frequency and the relatively low gain at the band edges.

When an electromotive force is induced in the receiver IC in response to the calling current flowing in the transmitting circuit, such electromotive force is passed at high gain to the demodulator and is demodulated. The resulting voice frequency is further amplified at the amplifier AM and appears in the current flowing in the primary winding 33 of transformer T2 to induce an electromotive force of corresponding frequency in each of the secondary windings 34 and 35 of that transformer. The electromotive force induced in the secondary winding 34 causes a note of corresponding pitch to be sounded by the loud speaker LS. The electromotive force induced in the secondary winding 35 is rectified and is utilized to charge the condenser 37. This charge

on the condenser 37 is in turn employed to govern the bias voltage applied to the grid of the tube 3. The parts are so proportioned that when the incoming calling current is below the energy level that indicates transmission conditions good enough for satisfactory reception of telephone current, the electromotive force induced in the secondary winding 35 of transformer T2 is sufficient to exert little automatic volume control. When the incoming calling current is relatively strong, that is, above the energy level required to assure satisfactory reception of a telephone current, the negative voltage applied to the tube 3 as a result of the electromotive force induced in the secondary winding 35 causes a decrease in the direct current component of the plate current for the tube 3 of such an extent that the energization of relay H is reduced to a point where the relay is released and its back contact 47 is closed.

With the back contacts 47 of relay H closed, the auxiliary circuit including the tertiary winding 48 of transformer T1 is completed and made active to influence the coupling between the electron tubes 2 and 3. The inductor 49 and condenser 50 of the auxiliary circuit are adjusted for series resonance at the frequency of the calling current, that is, at the frequency F_m, when considering the curve of Fig. 4. Such tuning of the auxiliary circuit causes more current to flow in the auxiliary circuit at the resonant frequency than at other frequencies, and there is a greater voltage drop across the resistor 51 at the resonant frequency than at the band edge frequencies corresponding to F_1 and F_2 of Fig. 4. This larger loss in the auxiliary circuit at the frequency F_m is reflected in the tuning between the tubes 2 and 3, and the influence is a reduction in the amplification at the frequency F_m in relation to the amplification at the frequencies F_1 and F_2. This operating characteristic is illustrated in Fig. 5, the curves R_1, R_2 and R_3 indicating different values for resistor 51, and the curve R illustrating the condition when the auxiliary circuit is open-circuited. It follows that normally the apparatus of Fig. 1 is highly selective and is operative to effect a high amplification of the calling current. Reception of calling current below a fixed energy level causes a note to be sounded at the loud speaker, but effects no change in the adjustment of the apparatus. When the calling current is above such energy level, the auxiliary circuit is made active, as well as a note being sounded at the loud speaker, and the apparatus is automatically adjusted for reception of the telephone current through the action of the auxiliary circuit.

The condenser 37 and resistor 38 of the automatic volume control device are proportioned so that the charge built up on the condenser 37 maintains the negative bias voltage of the tube 3 for a substantial delay period subsequent to the termination of the calling current. Hence, a telephone current received immediately following the termination of the calling current is amplified at a substantially uniform rate of amplification, is demodulated and is reproduced at the loud speaker. The electromotive force induced in the secondary winding 35 of the transformer T2 as the result of reception of telephone current under the favorable transmitting conditions maintains the automatic volume control active, with the result that the apparatus is maintained in the condition for reception of the full range of voice frequencies.

As shown in Fig. 1, the adjustment of the apparatus for reception of a relatively wide band can be effected manually by depressing the push button 42 to shunt the winding 19 of relay H and cause the relay to be released closing the auxiliary circuit. Again, the apparatus may be held in the highly selective condition for reception of the calling or code signaling current by manually depressing the push button 41 to energize the winding 46 of relay H and retain the auxiliary circuit in an open-circuited condition.

In Fig. 2, the apparatus includes a receiver IC, two high frequency stages of amplification, a demodulator, a low frequency amplifier and a loud speaker, the same as in Fig. 1. Furthermore, the generator 11 supplies plate voltage to the several tubes and an automatic volume control device governs the biasing voltage of the tube 3, the same as in Fig. 1. In Fig. 2, the tertiary winding 48 of transformer T1 is connected with an auxiliary circuit that includes an inductor 53, a condenser 54 and a full wave or bridge-type copper oxide rectifier 55. The output terminals of the rectifier 55 are connected over wires 56 and 57 with the output terminals of another full wave rectifier 58, the input terminals of which latter rectifier are connected across a third secondary winding 59 of the output transformer T2. An inductor 60 is preferably interposed in wire 56.

It is well-known that a copper oxide rectifier has a relatively high resistance in the forward direction for low voltages. That is, the resistance of a copper oxide rectifier in its forward direction is relatively high for voltages so low as to cause little or no current to flow therethrough, and the resistance of the rectifier in the forward direction rapidly decreases with increase of current flow. In Fig. 2, the parts are so proportioned that the voltage of the electromotive force induced in the winding 48 of transformer T1 is relatively low and when applied to the rectifier 55 causes little current to pass therethrough, with the result that the rectifier 55 provides a relatively high resistance for the auxiliary circuit. Consequently, the auxiliary circuit normally possesses high resistance and the coupling between the tubes 2 and 3 is that required for high selectivity and high amplification at the frequency of the calling current. The voltage of the electromotive force induced in the secondary winding 59 of transformer T2 as the result of reception of a relatively strong calling current is such as to cause current to pass through the rectifier 58 and, in turn, to flow from the lower terminal of rectifier 58 over wire 57 to the lower terminal of the rectifier 55, thence through the two arms of that rectifier to the upper terminal thereof and back over wire 56 and inductor 60 to the opposite terminal of the rectifier 58. This current flowing in the rectifier 55 materially reduces its resistance in the forward direction, with the result that the auxiliary circuit is adjusted for relatively low resistance and is effective to modify the coupling between the tubes 2 and 3, as required for satisfactory reception of the voice band of frequencies. It is clear, therefore, that the apparatus of Fig. 2 operates in a manner similar to the apparatus of Fig. 1, being normally conditioned for satisfactory reception of the calling current and being automatically adjusted in response to reception of a relatively strong calling current for satisfactory reception of the telephone current. It is clear that the apparatus is automatically restored to its normal condition subsequent to termination of reception of the telephone current.

In Fig. 3, the apparatus is similar to that of Fig. 1, except for the auxiliary circuit. In this form of the invention, a single winding relay H1 is provided in place of the two-winding relay H of Fig. 1, the operating winding 65 of relay H1 being interposed in the plate circuits for the associated tubes 2 and 3, the same as the winding 19 of relay H is interposed in the plate circuits of the tubes 2 and 3 of Fig. 1. The auxiliary circuit consists of a condenser 61, an inductor 62, a resistor 63 and the back contact 66 of relay H1, and is connected across the secondary winding 21 of the coupling transformer T1, whereas in Fig. 1 the auxiliary circuit is connected with the tertiary winding 48 of the transformer T1. The condenser 61 and inductor 62 are tuned to series resonance at the frequency of the calling current, and the resistor 63 is proportioned to reduce the amplification of the mid frequency in relation to the amplification of the band edge frequencies. While the arrangement of Fig. 3 is less flexible than the previous arrangements, the tertiary winding for the coupling transformer T1 is avoided. It is apparent that the apparatus of Fig. 3 will operate in a manner similar to that described for the apparatus of Fig. 1, except for the fact no manual control over the auxiliary circuit is provided.

Another possible arrangement is indicated in Fig. 1. The auxiliary circuit may be completed as indicated by the dotted line 64 instead of being controlled over the back contact 47 of the relay H. With the apparatus of Fig. 1 thus modified, and the auxiliary circuit comprising tertiary winding 48 of transformer T1, inductor 49, condenser 50, resistor 51 and connection 64 proportioned for series resonance at the mid frequency F_m, it is clear that automatic adjustment of the apparatus without the use of relay H and its manually operable push buttons 41 and 42 is accomplished so that the mid frequencies of the voice band are amplified at a reduction in relation with the amplification of the band edge frequencies, the amplification of the calling current being, of course, somewhat reduced in relation to that effected when relay H is used.

Although I have herein shown and described only a few forms of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at a predetermined frequency for reception of a first signaling current equivalent to the carrier modulated by a particular frequency within a given band of frequencies; an auxiliary circuit including a condenser, an inductor and a resistor and effectively coupled with said second circuit means for modifying the tuning of said second circuit means for reception of a second signaling current equal to said carrier modulated by said band of frequencies; said auxiliary circuit normally conditioned to be in effect an open circuit so as to be normally ineffective, and means including a winding coupled with the output circuit of the demodulator and an electroresponsive device operatively connected with said auxiliary circuit to condition the auxiliary circuit to be in effect a closed circuit.

2. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at a predetermined frequency for reception of a first current equivalent to the carrier modulated by a particular frequency within a given band of frequencies; an auxiliary circuit including a condenser, an inductor and a resistor and effectively coupled with said second circuit means for modifying the tuning of said second circuit means for reception of a second current equal to said carrier modulated by said band of frequencies; said auxiliary circuit normally conditioned to function as an open circuit so as to be normally ineffective, and means including a winding coupled with the output circuit of the demodulator and an electroresponsive device operatively associated with said auxiliary circuit to condition the auxiliary circuit for functioning as a closed circuit in response to current above a given energy level flowing in said output circuit.

3. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at a predetermined frequency for reception of a first current equivalent to the carrier modulated by a particular frequency within a given band of frequencies; and auxiliary circuit including a condenser, an inductor and a resistor and effectively coupled with said second circuit means for modifying the tuning of said second circuit means for reception of a second current equal to said carrier modulated by said band of frequencies; a relay having a back contact interposed in said auxiliary circuit and a winding interposed in the plate circuit of the tube to normally energize the relay for retaining the auxiliary circuit normally open, and means including an automatic volume control device coupled with the output circuit of the demodulator and having connection with the grid of said tube to control the plate circuit current of the tube for causing the relay to be deenergized and its back contact closed to close said auxiliary circuit in response to current corresponding in fre-

quency to that of said first current and exceeding a predetermined value flowing in the output circuit of the demodulator.

4. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at a predetermined frequency for reception of a first current equivalent to the carrier modulated by a particular frequency within a given band of frequencies; an auxiliary circuit including a condenser, an inductor and a resistor and effectively coupled with said second circuit means for modifying the tuning of said second circuit means for reception of a second current equal to said carrier modulated by said band of frequencies; a relay having a back contact interposed in said auxiliary circuit and a winding interposed in the plate circuit of the tube to normally energize the relay for retaining the auxiliary circuit open, means including an automatic volume control device coupled with the output circuit of the demodulator and having connection with the grid of said tube to control the plate circuit current of the tube for causing the relay to be deenergized and its back contact closed to complete the auxiliary circuit in response to current corresponding in frequency to that of said first current and above a predetermined value flowing in the output circuit of the demodulator, and manually operable means for controlling the relay.

5. Receivig apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at a predetermined frequency for reception of a first signaling current equivalent to the carrier modulated by a particular frequency within a given band of frequencies; an auxiliary circuit including a tertiary winding of said transformer and capacitance, a first full wave copper oxide rectifier serially interposed in said auxiliary circuit to provide the circuit with relatively high resistance to permit high gain reception of said first signaling current, a winding coupled with the output circuit of the demodulator, and a second full wave copper oxide rectifier having its input terminals connected across said winding and its output terminals connected across the output terminals of said first rectifier to reduce the resistance of said auxiliary circuit for effective reception of a second signaling current equal to the carrier modulated by said band of frequencies.

6. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at substantially the mid frequency of a carrier current modulated by a selected band of frequencies; an auxiliary circuit including capacitance, inductance and resistance coupled with said second circuit means and proportioned for series resonance at said mid frequency to provide a substantially uniform amplification throughout said frequency band; said auxiliary circuit normally conditioned to be in effect an open circuit, an electroresponsive device operatively associated with said auxiliary circuit to condition the circuit to be in effect a closed circuit, and circuit means including a winding coupled with the output circuit of the demodulator for operating said electroresponsive device when the current flowing in said output circuit exceeds a predetermined energy level.

7. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at the frequency of a calling current which is equivalent to a carrier modulated by the mid frequency of a given band of voice frequencies; an auxiliary circuit including a tertiary winding of said transformer, capacitance and an asymmetric unit having a non-linear resistance in its conducting direction; said auxiliary circuit tuned to resonance at the frequency of the calling current, an output winding coupled with the output circuit of the demodulator, and circuit means including a rectifier and an inductor to connect said output winding across said unit to cause rectified current derived from the output of the demodulator to flow in said unit to reduce its resistance for reception of a telephone current corresponding to the carrier modulated by said voice frequency band.

8. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at the frequency of a calling current which is equivalent to a carrier modulated by the mid frequency of a given band of voice frequencies; an auxiliary circuit including a tertiary winding of said transformer, capacitance and a resistor; said auxiliary circuit tuned to resonance at the frequency of the calling

current, a relay having a back contact interposed in said auxiliary circuit, a first winding of the relay interposed in the plate circuit of the tube to normally energize the relay to open said auxiliary circuit, means including a push button to shunt said first relay winding to at times close the auxiliary circuit, other means including a second winding of the relay and another push button to at times energize the relay independently of the first relay winding, and means including an automatic volume control device coupled with the output circuit of the demodulator and having connection with the grid of the tube for automatically controlling the grid bias and causing the relay to be deenergized to close the auxiliary circuit for reception of a telephone current corresponding to the carrier modulated by said voice frequency band when the current in said output circuit exceeds a predetermined energy level.

9. Receiving apparatus for communication systems employing a modulated carrier current comprising, a receiver responsive to such current, a stage of amplification including an electron tube, a demodulator provided with an input side and an output circuit, means to couple the input side of the demodulator with the plate circuit of said tube, a coupling transformer, a first circuit means to couple a primary winding of said transformer with said receiver, a second circuit means to connect a secondary winding of said transformer across a control grid and cathode of said tube, said first and second circuit means proportioned for resonance at the frequency of a calling current which is equivalent to a carrier modulated by the mid frequency of a given band of voice frequencies; an auxiliary circuit including inductance, capacitance and resistance connected across the control grid and cathode of said tube, said auxiliary circuit tuned to resonance at the frequency of the calling current, a relay having a back contact interposed in said auxiliary circuit, a winding of the relay interposed in the plate circuit of the tube to normally energize the relay to open said auxiliary circuit, and means including an automatic volume control device coupled with the output circuit of the demodulator and having connection with the grid of the tube for automatically controlling the grid bias and causing the relay to be deenergized to close the auxiliary circuit for reception of a telephone current corresponding to the carrier modulated by said voice frequency band when the current in said output circuit exceeds a predetermined energy level.

WILLARD P. PLACE.