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CARRIER CURRENT TELEPHONE APPARATUS

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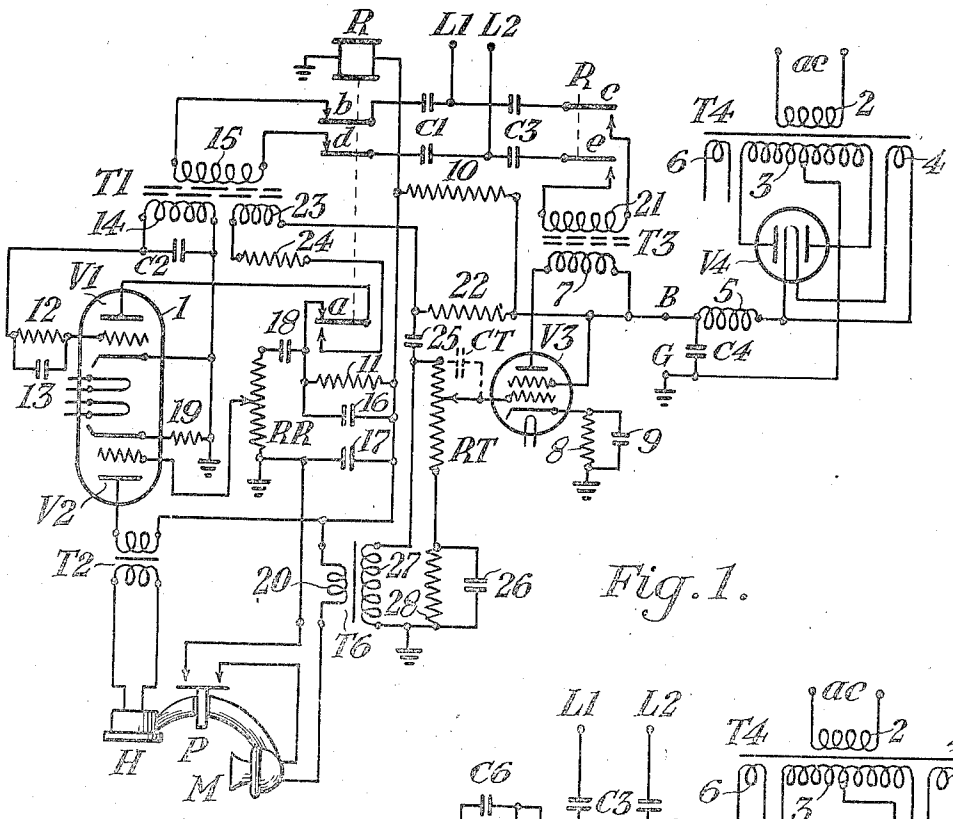


Fig. 1.

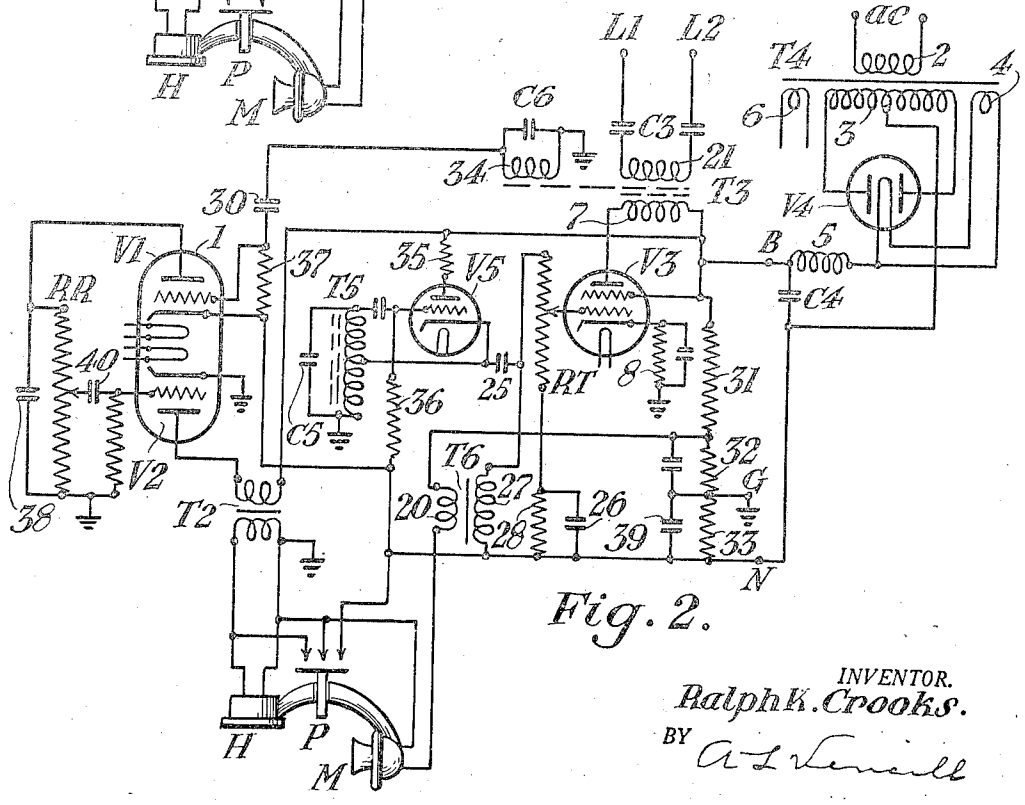


Fig. 2.

INVENTOR.
Ralph K. Crooks.
BY A. L. Merrill
HIS ATTORNEY.

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CARRIER CURRENT TELEPHONE APPARATUS

Ralph K. Crooks, O'Hara Township, Allegheny County, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

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13 Claims. (Cl. 179—2.5)

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My invention relates to communication apparatus, and more particularly, to portable carrier current telephone apparatus.

The principal object of my invention is the provision of apparatus suitable for use on railroads or elsewhere for emergency communication between two local stations or between such stations and a central office over existing telephone, telegraph or signal line circuits without interference with the services normally using such circuits, or under conditions involving the failure of the usual communication circuits.

In its preferred form my invention is embodied in a set of electron tubes and associated apparatus mounted in a readily portable unit to which a telephone hand set is attached. Power may be supplied to the unit by connecting it to an alternating current lighting circuit, and the unit has two line terminals by which it may be connected between a pair of wires on a pole line, or between a line wire and ground, to provide voice communication between the set and one or more similarly connected units at distant points to which the line wires extend.

The units are adapted to transmit and receive amplitude modulated carrier currents of a suitable frequency such as 35 kilocycles per second. All units employ the same carrier frequency, and each hand set is provided with a "push-to-talk" button to change the unit from the receiving to the transmitting condition. No calling device is needed, as the apparatus is intended principally for use under conditions where an operator will be listening for calls.

One object of my invention is the provision of modulated carrier current transmitting and receiving apparatus which has a minimum number of parts, and which can be quickly adjusted to function efficiently either as a receiver or as a transmitter under widely different line conditions.

A feature of my invention is the provision of novel means for controlling the unit by a push button so as to enable the button to be located in the hand set but without requiring additional wires leading thereto. In accordance with this feature of my invention, a voltage divider is provided in the unit by which the potentials applied to the electron tubes are controlled, which is so arranged that the unit may be changed from the receiving to the transmitting condition by closing a circuit over a push button contact which shunts a portion of the voltage divider.

Another feature of my invention resides in improved means for regulating the output of

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the transmitting tube to provide a substantially uniform degree of modulation for all settings.

Other objects, features and purposes of my invention will be pointed out as the description proceeds.

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

Referring to the accompanying drawings, Fig. 1 illustrates one form of apparatus embodying my invention in which the switching from the receiving to the transmitting condition is accomplished, in part, by the provision of a relay R in the unit, while Fig. 2 illustrates another form in which the switching is accomplished wholly by changing the potentials applied to the tubes.

Similar reference characters refer to similar parts in both views.

Referring to Fig. 1, the reference character 1 designates a twin tube containing in a single bulb two voltage amplifier triodes V1 and V2, while tube V3 is a power amplifier tetrode. Direct current is supplied to the positive terminal B of the unit, and to the negative or ground terminal G, connected to the frame of the unit, by a power supply unit of conventional form comprising a transformer T4, having its primary winding 2 arranged for connection to the local alternating current lighting circuit as indicated by the legend "A. C." on its terminals. The end terminals of the secondary winding 3 are connected to the plates of a full wave rectifier tube V4, and the middle terminal of secondary winding 3 is connected to ground. The filament of tube V4 is energized from a secondary winding 4 of transformer T4, and is connected through a filter coil 5 to terminal B, with a filter condenser C4 connected across terminals B and G.

The heaters of tubes V1, V2 and V3 are energized from another secondary winding 6 of transformer T4, the heater circuits being omitted to simplify the drawing.

Terminal B supplies high voltage to the screen grid of the tetrode V3, and through coil 7 of a transmitting filter or coupling coil T3 to the plate of tube V3, the cathode of which is connected to ground through a biasing resistor 8 and a bypass condenser 9.

The resistor 10 and the winding of relay R are connected in series across the supply terminals B and G and constitute a voltage divider for providing a reduced voltage for energizing the tubes V1 and V2, relay R being normally energized, as shown, in parallel with tubes V1 and V2.

The output or plate to cathode circuit of tube

V1 extends from terminal B over resistors 10 and 11, front contact *a* of relay R to the plate of tube V1, the cathode of which is connected directly to ground. The input or grid to cathode circuit of tube V1 includes resistor 12 and condenser 13 and the winding 14 of a receiving filter or coupling coil T1. The winding 14 is tuned to resonance by a condenser C2, and is coupled inductively to the line winding 15 which is tuned to resonance by the condensers C1 and connected over front contacts *b* and *d* of relay R and condensers C1 to the line terminals L1 and L2.

The coupling coil T1 serves as a filter to selectively pass modulated carrier current, and tube V1 is connected to function as a detector of the voice frequency components of the carrier current as will be readily apparent. The carrier frequency component of the current in the output circuit for tube V1 is by-passed through condensers 16 and 17 to ground, while the voice frequency components pass through condenser 18 and a gain control resistor RR to ground, resistor RR having an adjustable connection to the grid, or input circuit of tube V2.

The output circuit of tube V2 extends from terminal B over resistor 10, and the primary winding of transformer T2 to the plate of tube V2, the cathode of which is connected through a biasing resistor 19 to ground, so that tube V2 amplifies the voice frequency currents and supplies them to the telephone receiver H connected to the secondary winding of transformer T2.

The receiving system of Fig. 1 thus comprises the selective filter T1, the detector V1, audio amplifier V2, transformer T2 and the telephone receiver H.

To establish the transmitting condition, the operator presses the button P on the hand set which shunts relay R by a low resistance circuit portion comprising primary winding 20 of transformer T6 and the microphone M of the hand set, through which sufficient current flows to render the microphone active, but reducing the voltage across relay R to such a low value that tubes V1 and V2 are disabled, and relay R releases.

When relay R releases, its back contacts *c* and *e* connect the line winding 21 of the transmitting filter T3 through the condensers C3 across the line terminals L1 and L2, in place of the receiving filter T1, and the output circuit of tube V1 is supplied with current from terminal B over resistor 22, winding 23 of the receiving filter T1, resistor 24 and back contact *a* of relay R. The winding 14 of filter T1 which is tuned by condenser C2 to the carrier current frequency and is connected to the input circuit of tube V1, is thereby set into oscillation, and serves as a tank circuit to cause tube V1 to supply current to winding 23 of filter T1 to maintain the oscillations. In the transmitting condition, tube V1 thus serves as an oscillator to generate carrier current, but inasmuch as the circuit for winding 15 of filter T1 is now open, the current in coil 14 and condenser C3 will tend to oscillate at a slightly different frequency from that to which they are resonant in the receiving condition. It is desirable that the received and transmitted frequencies should be substantially the same, and to this end compensation is provided by including the resistor 24 in the circuit of winding 23 to shift the phase of the voltage fed back to the tank circuit of the oscillator by the required amount.

The carrier frequency voltage from the left-hand terminal of resistor 22 to ground, due to the oscillations generated by tube V1, is impressed upon the gain control resistor RT through condensers 25 and 26, which are of relatively small capacity. Resistor RT has an adjustable connection for applying a portion of this voltage to the input circuit of tube V3, the output of which is supplied through the coupling coil T3 and condensers C3 to the line terminals L1 and L2. The secondary winding 27 of transformer T6 is connected across resistors RT and 28, in series, and it will be seen that as the sound waves to which microphone M responds cause current variations in winding 20, a voice frequency voltage is generated in winding 27 which varies the bias of the grid of tube V3 to correspondingly modulate the carrier current supplied by tube V3 to the line circuit.

The resistor 28, by-passed by condenser 26, is included in the secondary circuit of transformer T5 in order to permit the gain control resistor RT to be set at any position without altering the degree of modulation of the carrier frequency delivered by tube V3. To make this clear I have shown a condenser CT in the drawing, representing the stray capacity of the grid of tube V3, which it will be seen shunts the upper portion of resistor RT, and so tends to cause the change in the carrier voltage applied to the input circuit of tube V3 in response to a given change in adjustment of resistor RT to be less than the change in voice frequency voltage, since the latter is not affected materially by the presence of the small capacity CT. On the other hand, the presence of resistor 28 in the circuit has but slight effect upon the carrier voltage due to the provision of the by-pass condenser 26. Resistor 28 reduces the effect of a change in adjustment of resistor RT with respect to the voice frequency voltage, to correspond with the reduced change in carrier voltage due to the effect of the stray capacity CT. That is to say, for any setting of resistor RT the ratio of the modulation voltage to the carrier voltage is substantially constant.

The transmitting system of Fig. 1 thus comprises a source of carrier current comprising the oscillator tube V1, the tank circuit 14—C2, and the coupling coil 23; a source of voice frequency current comprising the microphone M and transformer T6; a grid-modulated transmitting amplifier V3, and a transmitting filter T3.

It has been stated that the units are intended for use over existing communication circuits without interference with the services normally using such circuits. This is accomplished by the use of filters such as T1 and T3 which are designed to present a high impedance to all frequencies outside the band of frequencies employed by the units. The tuned impedance presented to the line by the receiving filter T1 to currents within that band is also made relatively high in order to permit several units to be bridged across the line without causing serious attenuation of the transmitted signals.

Referring now to Fig. 2, this form of my invention differs principally from Fig. 1 in that the change from the receiving to the transmitting condition in response to the operation of the "push-to-talk" button P is obtained wholly by the resulting changes in the potentials applied to the tubes without the use of a relay R as in Fig. 1.

In Fig. 2, the power supply unit comprising transformer T4 and tube V4, etc., is the same as in Fig. 1 except that its output terminals are designated B and N, the lower terminal N being

made negative with respect to ground by connecting resistors 31, 32 and 33 across the terminals B and N and grounding the junction of resistors 32 and 33 as shown. Tubes V1 and V2 function as a detector and audio amplifier in the receiving condition, and tube V3 as a grid modulated amplifier in the transmitting condition, as in Fig. 1, and since Fig. 2 lacks means for changing the connections of tube V1 provided in Fig. 1 by relay R, a separate oscillator tube V5 is provided having a tank circuit comprising the coil T5 and condenser C5, similar to the winding 14 of filter T1 and condenser C1, and the transmitting filter T3 is arranged to serve as a receiving filter as well, by the provision of a winding 34 tuned by a condenser C6 and loosely coupled to the line winding 21.

The output circuit of tube V3 in Fig. 2 extends from terminal B through winding 7 to the plate of tube V3, and from its cathode through resistor 8 to ground, and thence through resistor 33 to terminal N, and the grid of tube V3 is connected through resistors RT and 28 to terminal N, which maintains a negative biasing potential on the grid of tube V3 sufficient to cut off the plate current and render tube V3 inactive so long as the unit is in the receiving condition.

The output circuit for tube V5 extends from terminal B through resistor 35 to the plate of tube V5, and from its cathode through the lower portion of coil T5 to ground and thence through resistor 33 to terminal N. The grid of tube V5 is connected through resistor 36 to terminal N so that tube V5 is also biased negatively to a point which renders it inactive when the unit is in the receiving condition.

In Fig. 2, the potential difference across resistor 33 is applied to the detector tube V1, the plate to cathode circuit of which extends from terminal B over resistors 31 and 32 to ground, and thence in parallel with resistor 33, from ground through the gain control resistor RR to the plate of tube V1, and from its cathode to terminal N. When modulated carrier current is received from the line by the filter T3, the resonant voltage induced in its winding 34 is supplied through a small condenser 38 to the grid of tube V1, which is also connected through a high resistance 37 to terminal N, tube V1 serving as a detector, as in Fig. 1. The carrier frequency components of the output of tube V1 are by-passed to terminal N through condensers 38 and 39, and the voice frequency components are impressed on the gain control resistor RR and adjustably applied through condenser 40 to the input circuit of tube V2. The output circuit of tube V2 in Fig. 2 extends from terminal B through transformer T2 to the plate of tube V2 and from its cathode to ground, and thence through resistor 33 to terminal N, and the voice frequency components of the output of tube V2 are supplied through transformer T2 to the telephone receiver H.

In Fig. 2 the microphone M and winding 20 of transformed T6 are connected across resistor 32 and are supplied with a low value of current in the receiving condition through resistors 31 and 33.

When button P is pressed to establish the transmitting condition, its contacts connect terminals N and G together, short circuiting resistor 33. This disables the detector tube V1, the plate to cathode circuit of which is connected across resistor 33, and the current through the microphone M is increased to a suitable operating value, while the negative bias on the grids of tubes V5 and V3 is decreased to a value proper for their operation. The tank circuit comprising coil T5 and condenser C5 is set into oscillation at the carrier frequency to energize the input circuit for tube V5, the output of which is supplied to the lower half of coil T5 to maintain the oscillations and is impressed on the transmitter gain control resistor RT through condensers 25 and 26. The voice frequency voltage developed by microphone M is impressed by transformer T6 on resistors RT and 28 so that tube V3 functions as a grid modulated transmitting amplifier as in Fig. 1, to supply its output through the filter T3 to the line terminals L1 and L2.

It will be seen that the filter T3 continues to supply voltage to the grid of the detector tube V1, when button P is pressed, but the plate, grid and cathode of tube V1 are then grounded, and tube V1 is thereby disabled and rendered incapable of energizing the input circuit of tube V2. The plate circuit of tube V2 is constantly energized in Fig. 2, and it would be capable of energizing the telephone H if tube V1 were not fully suppressed or if voltage were supplied to the grid-cathode circuit of tube V2 by a stray field, and to prevent the response of the receiver H under such conditions, button P is provided with an additional contact in Fig. 2, by which transformer T2 is short circuited when button P is pressed.

In Fig. 2, the tuned impedance which the apparatus presents to the line is made relatively high, as in Fig. 1, but since in Fig. 2 the same coupling coil is used for transmitting, its impedance will generally be higher than the optimum value at which tube V3 delivers its maximum output, in which case the apparatus of Fig. 2 would not be capable of transmitting as much power as that of Fig. 1. For this reason the amplifier tube V2 is arranged to be supplied with a higher plate voltage in Fig. 2 to increase the power supplied to the receiver H thereby compensating for the decreased power of the received signals.

Although I have herein shown only two forms of apparatus embodying my invention, it is to be 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. Carrier current communication apparatus comprising a telephone receiver and a microphone, an electron tube detector, an electrical filter including resonant circuit elements tuned to a carrier current frequency having input terminals for connection to a line circuit and output terminals connected to the input circuit of said detector tube, means for energizing said telephone receiver in response to the voice frequency components of the output of said detector tube, a normally inactive transmitter tube having an output circuit energized from a direct current source, said circuit including elements tuned to a carrier frequency and adapted to deliver the output of said transmitter tube to said line circuit, an input circuit for said transmitter tube connected to a normally inactive source of carrier frequency current and also to a source of voice frequency current derived from said microphone, a voltage divider connected across the terminals of said direct current source for supplying a reduced voltage to said detector tube and said microphone, manually operable contact means for

shunting a portion of said voltage divider to disable said detector tube and to render the microphone effective to impress voice frequency variations on the input circuit of said transmitter tube, and means responsive to the shunting of said voltage divider by said push button circuit for rendering said source of carrier current effective to energize the input circuit of said transmitter tube and to render said transmitter tube effective to deliver its output to said line circuit.

2. Carrier current communication apparatus comprising a telephone receiver and a microphone, an electron tube detector, an electrical filter including resonant circuit elements tuned to a carrier current frequency having input terminals for connection to a line circuit and output terminals connected to the input circuit of said detector tube, means for energizing said telephone receiver in response to the voice frequency components of the output of said detector tube, a normally inactive transmitter tube having an output circuit energized from a direct current source, said circuit including elements tuned to a carrier frequency and adapted to deliver the output of said transmitter tube to said line circuit, an input circuit for said transmitter tube connected to a normally inactive source of carrier frequency current and also to a source of voice frequency current derived from said microphone, a voltage divider connected across the terminals of said direct current source for supplying a reduced voltage to said detector tube, comprising a resistor and the winding of a relay in series, manually operable contact means for shunting the winding of said relay to effect its release and to disable said detector tube, and means controlled by said relay when released for rendering said source of carrier current effective to energize the input circuit of said transmitter tube and to render said transmitter tube effective to deliver its output to said line circuit.

3. Carrier current communication apparatus comprising a telephone receiver and a microphone, an electron tube detector, an electrical filter including resonant circuit elements tuned to a carrier current frequency having input terminals for connection to a line circuit and output terminals connected to the input circuit of said detector tubes, means for energizing said telephone receiver in response to the voice frequency components of the output of said detector tube, a normally inactive transmitter tube having an output circuit energized from a direct current source, said circuit including elements tuned to a carrier frequency and adapted to deliver the output of said transmitter tube to said line circuit, an input circuit for said transmitter tube connected to a normally inactive source of carrier frequency current and also to a source of voice frequency current derived from said microphone, a voltage divider connected across the terminals of said direct current source for supplying a reduced voltage to said detector tube, means responsive to the operation of said push button for shunting a portion of said voltage divider to disable said detector tube, and means including said voltage divider when shunted for rendering said source of carrier current and said microphone effective to energize the input circuit of said transmitter tube and to render said transmitter tube effective to supply modulated carrier current to said line circuit.

4. In combination with a telephone hand set comprising a receiver, a microphone, and a push button; a detector tube having an input circuit coupled to a line circuit and an output circuit coupled to said telephone receiver, a normally inactive source of carrier current, a normally inactive transmitter tube for supplying modulated carrier current to said line circuit having an input circuit coupled to said source of carrier current and to said microphone, a source of direct current for energizing said transmitter tube, a voltage divider connected across the terminals of said direct current source for supplying a reduced voltage to said detector tube, a circuit controlled by said push button for shunting the portion of said voltage divider across which said detector tube is connected to disable said tube, and means responsive to the shunting of said portion for rendering said carrier current source effective to energize the input circuit of said transmitter tube and for causing said transmitter tube to supply modulated carrier current to said line circuit.

5. Carrier current communication apparatus comprising a telephone receiver and a microphone, a detector tube, a transmitter tube, a source of direct current for energizing said tubes, a relay normally energized from said source in series with a resistor, an input circuit for the detector tube including resonant circuit elements tuned to a carrier frequency and coupled to a line circuit over front contacts of said relay, a first output circuit for said detector tube connected across the winding of said relay over a front contact thereof and arranged to supply voice frequency components of its output to said telephone receiver, a second output circuit for said tube connected to said source over back contacts of said relay and arranged to supply carrier frequency output of said tube to its input circuit to cause oscillations of a frequency determined by said resonant circuit elements, means for supplying oscillations from said second output circuit to the input circuit of said transmitter tube and for modulating said oscillations in accordance with current supplied by said microphone, an output circuit for said transmitter tube connected to a tuned circuit connected across said line circuit over back contacts of said relay, and means including a normally open manually operable contact in series with said microphone for shunting said relay to effect its release and to render said microphone effective to modulate the oscillations supplied to said transmitter tube.

6. Carrier current communication apparatus comprising a telephone receiver, a microphone and a push button, a relay controlled by said push button, a detector tube having an input circuit coupled to a line circuit over front contacts of said relay and an output circuit coupled to said telephone receiver over a front contact of said relay, a source of carrier current controlled over a back contact of said relay, a transmitter tube having an input circuit coupled to said source of carrier current and to said microphone, and an output circuit coupled to said line circuit over back contacts of said relay, a source of direct current for energizing said tubes across which the winding of said relay is connected in series with a resistor, a circuit controlled by said push button including said microphone for shunting said relay to effect its release and at the same time energizing the microphone to render it effective to modulate the carrier current supplied to said transmitter tube.

7. Carrier current communication apparatus comprising a telephone receiver and a microphone, a detector tube having an input circuit

coupled to a line circuit and an output circuit coupled to said telephone receiver, a transmitter tube having an output circuit coupled to said line circuit, an oscillator tube for supplying carrier frequency current to the input circuit of said transmitter tube, means controlled by said microphone for modulating the current supplied to the input circuit of said transmitter tube, a source of direct current for energizing said tubes and said microphone, a voltage divider connected across the terminals of said source which normally provides a reduced voltage for energizing said detector tube and applies a biasing voltage to the input circuit of said transmitter tube sufficient to render such tube inactive when the detector tube is energized, and manually operable means for shunting a portion of said voltage divider to disable said detector tube and to remove said bias to render said transmitter tube effective to supply modulated carrier current to said line circuit.

8. Carrier current communication apparatus comprising a telephone receiver, a microphone, a detector tube having an input circuit coupled to a line circuit and an output circuit coupled to said telephone receiver, a normally inactive transmitter tube having an output circuit for supplying modulated carrier current to said line circuit, means for supplying carrier current to the input circuit of said transmitter tube and for modulating said current by said microphone, a source of direct current for energizing said tubes and said microphone, a voltage divider connected across the terminals of said source which normally provides a reduced voltage for energizing said detector tube, means including said voltage divider for preventing said transmitter tube from supplying current to said line circuit when said detector tube is energized, and manually operable means for shunting a portion of said voltage divider to disable said detector tube and at the same time render the transmitter tube effective to supply current to said line circuit.

9. Carrier current communication apparatus comprising a telephone receiver and a microphone, a detector tube having an input circuit coupled to a line circuit and an output circuit coupled to said telephone receiver, a normally inactive transmitter tube having an output circuit for delivering modulated carrier current to said line circuit, a gain control resistor associated with the input circuit of said transmitter tube for regulating the current delivered by said tube, a source of carrier current, means for supplying carrier current to said gain control resistor from said source and for also supplying voice frequency current thereto derived from said microphone to modulate said carrier current, manually operable contact means for disabling said detector tube and at the same time rendering said transmitter tube active, and means including a fixed resistor in the circuit by which voice frequency current is supplied to said gain control resistor to reduce the effect of a change in adjustment thereof to compensate for the reduced effect of said change in adjustment upon the carrier current supplied to the input circuit of said transmitter tube due to the shunting of said gain control resistor by stray capacity.

10. Carrier current communication apparatus comprising a telephone receiver and a microphone, a detector tube having an input circuit coupled to a line circuit and an output circuit coupled to said telephone receiver, a normally

inactive transmitter tube having an output circuit for delivering modulated carrier current to said line circuit, a gain control resistor having an adjustable connection to the input circuit of said transmitter tube for regulating the current delivered by said tube, a source of carrier current having a connection to the input circuit of said transmitter tube through stray capacity, means for supplying carrier current to said gain control resistor from said source and for also supplying voice frequency current thereto derived from said microphone to modulate said carrier current, means including a fixed resistor in the circuit by which voice frequency current is supplied to said gain control resistor to compensate for said stray capacity, and manually operable means for rendering said transmitter tube active to deliver its output current to said line circuit and at the same time disabling said detector tube to render said telephone receiver nonresponsive thereto.

11. Carrier current communication apparatus comprising a telephone receiver and a microphone, a detector tube having an input circuit coupled to a line circuit and an output circuit coupled to said telephone receiver, a normally inactive transmitter tube having an output circuit for delivering modulated carrier current to said line circuit, means for supplying carrier current to the input circuit of said transmitter tube and for also supplying voice frequency current thereto derived from said microphone to modulate said carrier current, and manually operable means for shunting said detector tube by a relatively low resistance circuit portion including said microphone to render the microphone effective to supply voice frequency current to the input circuit of said transmitter tube and to render said tube effective to deliver its output current to said line circuit and at the same time disabling said detector tube to render said telephone receiver nonresponsive thereto.

12. In combination with a telephone hand set comprising a receiver and a microphone, a source of direct current, a voltage divider connected across the terminals of said source, a detector tube having an input circuit coupled to a line circuit and a plate to cathode circuit connected between a point on said voltage divider and the negative terminal of said source and coupled to said telephone receiver, an oscillator tube for generating carrier current and a transmitter tube for delivering said current to said line circuit, each of which has its plate connected to the positive terminal and its grid connected to the negative terminal of said source with its cathode connected to a point on said voltage divider to bias the tube to cut off and render it inactive, a gain control resistor for regulating the input circuit for said transmitter tube which is supplied with carrier current by said oscillator tube when active and by voice frequency current by the microphone for modulating said carrier current, and manually operable means for connecting a point on said voltage divider to said negative terminal to decrease the bias on the oscillator and transmitter tubes to render said tubes active and to short circuit said detector tube to prevent the response of said receiver to the current supplied to the line circuit by said transmitter tube.

13. In combination with a telephone hand set comprising a receiver and a microphone, a source of direct current, a voltage divider connected across the terminals of said source, a detector tube having an input circuit coupled to a line

circuit and a plate to cathode circuit connected to a point on said voltage divider and the negative terminal of said source, an amplifier tube having its input circuit arranged to be supplied with voice frequency current by said detector tube and its output circuit coupled to said receiver and connected to the terminals of said source, an oscillator tube for generating carrier current and a transmitter tube for delivering said current to said line circuit, each of which has its plate connected to the positive terminal and its grid connected to the negative terminal of said source, with its cathode connected to a point on said voltage divider to bias the tube to cut off and render it inactive, means for supplying carrier current from the output of said oscillator tube when active to the input circuit of said transmitter tube, and for modulating said current by voice frequency current derived from said microphone, manually operable means for connecting a point on said voltage divider to said negative terminal to decrease the bias on said oscillator and transmitter tubes to render said tubes active, and means for short circuiting said receiver to prevent its response when current is being supplied to the line circuit by said transmitter tube.

RALPH K. CROOKS.

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