

April 29, 1941.

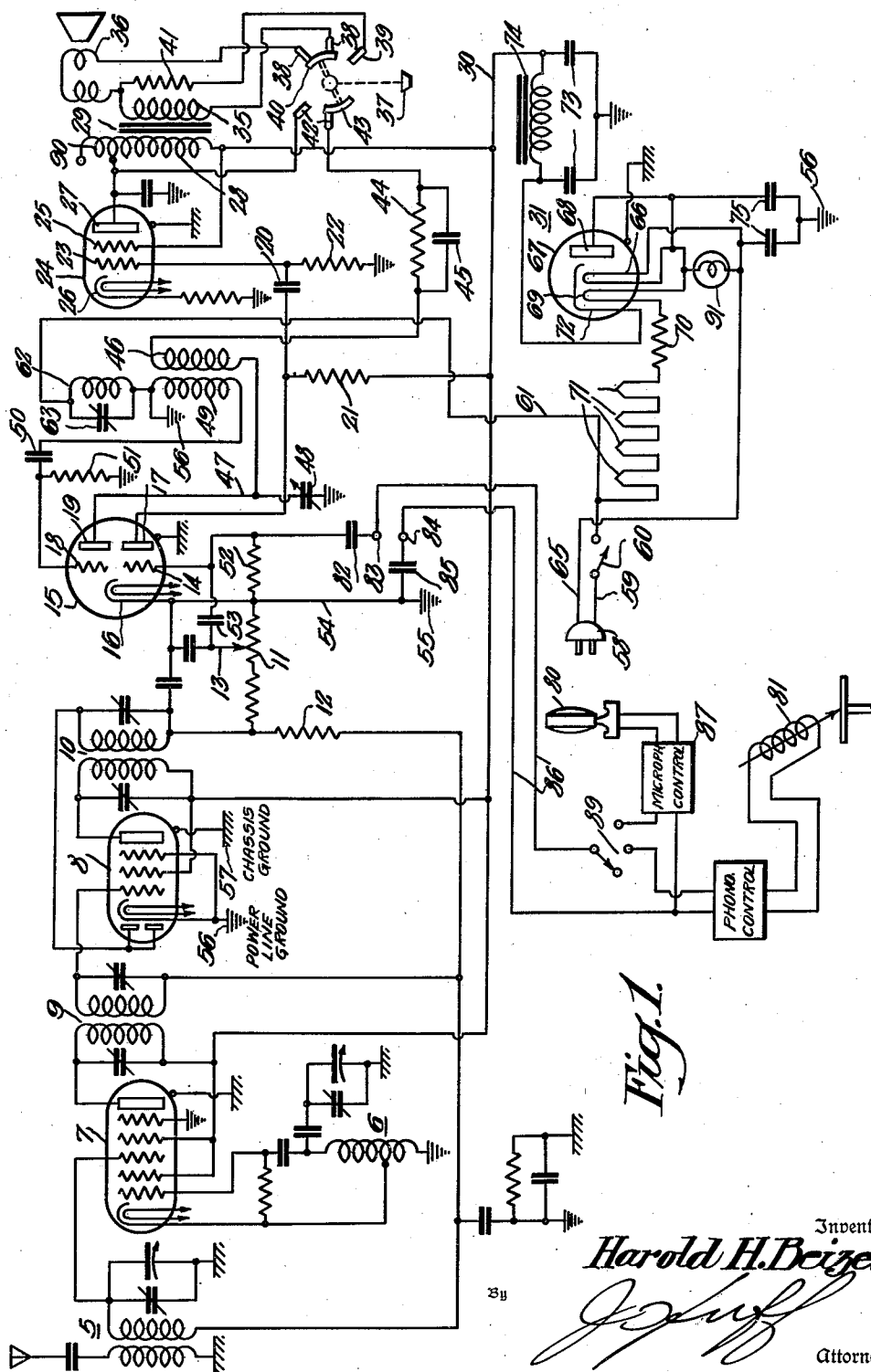
H. H. BEIZER

2,239,772

RADIO RECEIVER

Filed May 31, 1939

2 Sheets-Sheet 1



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RADIO RECEIVER

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2 Sheets-Sheet 2

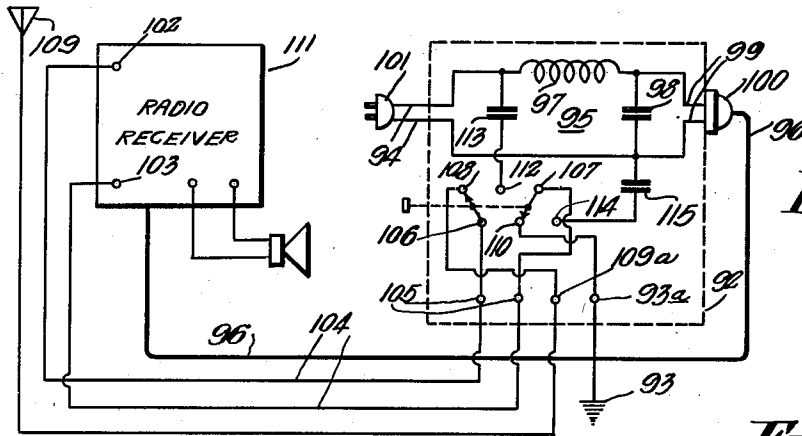


Fig. 2.

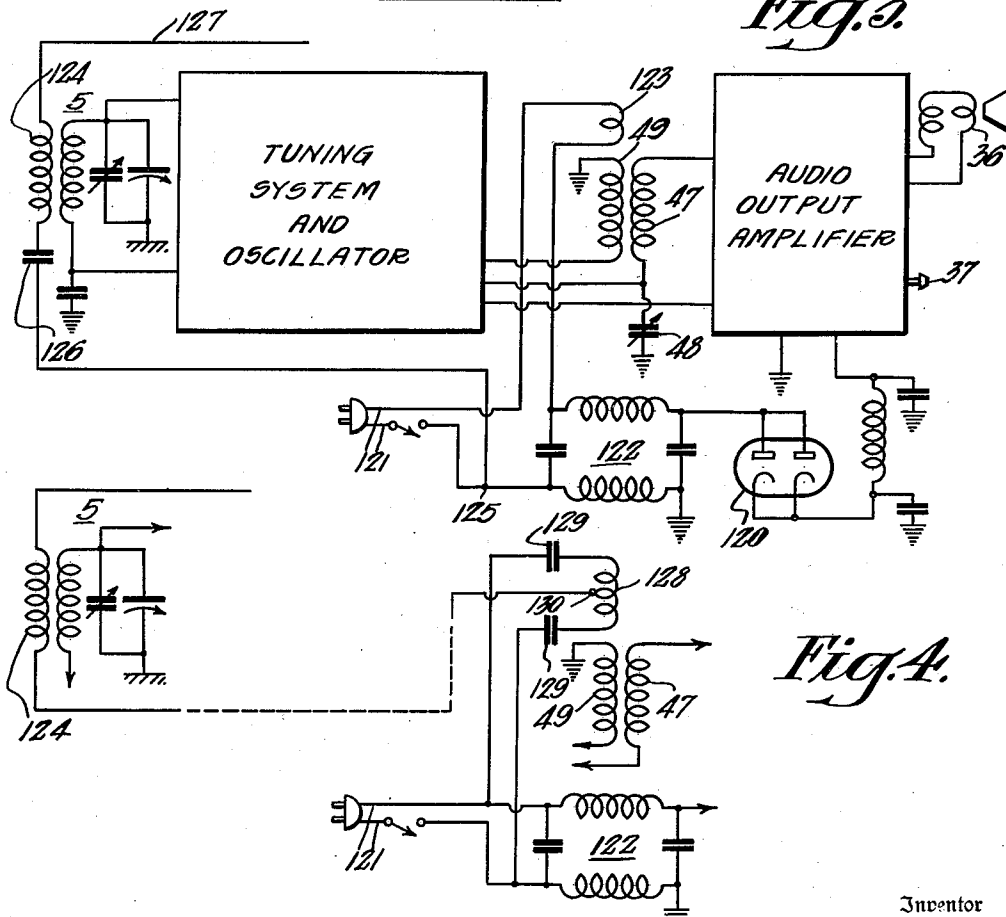


Fig. 3.

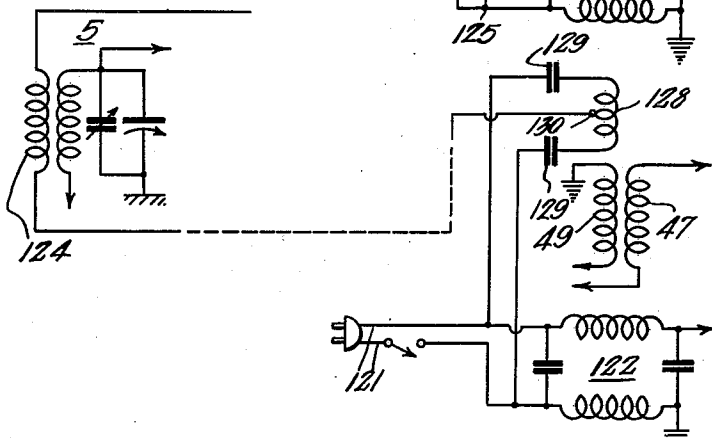


Fig. 4.

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By

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UNITED STATES PATENT OFFICE

2,239,772

RADIO RECEIVER

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Application May 31, 1939, Serial No. 276,582

6 Claims. (Cl. 250-20)

The present invention relates to radio receivers, and more particularly it relates to a radio receiver provided with means for radiating signals at a predetermined frequency and modulating said signals with the modulation envelope of a signal selected by the receiver within its tuning range, the percentage modulation applied to the signal output being controlled by a volume control means in the receiver as shown, described and claimed in my copending application with Rudolph H. Siemens for Radio receivers, Serial No. 276,583, filed May 31, 1939, concurrently herewith and assigned to the same assignee as this application.

In the application referred to, an audiofrequency output tube or amplifier is arranged through simplified circuit connections to function selectively as an audio frequency output amplifier means for the radio receiver to actuate a sound output device, such as a loudspeaker, in the normal operation of the receiver, and to operate as an oscillator for the generation of signals at a predetermined output frequency and to modulate such signals in accordance with the audio frequency signals applied to the output tube from the receiving system.

In this manner, the receiver may function as a remote control unit for a second receiver tuned to the predetermined frequency and controlled by the tuning and volume control means of the first receiver as to signal selection and volume of signal output.

It is an object of the present invention to provide a radio receiver having an improved circuit arrangement whereby the audio frequency output amplifier may function in a normal manner to operate an output device such as a loudspeaker, and alternatively may be caused to operate as a modulator in response to received audio frequency signals to modulate a separate oscillator for the production of modulated output signals in a remote control system of the type hereinbefore referred to, the dual functioning of the output stage being effected with minimum switching operations and in conjunction with a simplified modulator-oscillator circuit.

It is also an object of the present invention to provide an oscillator in conjunction or in the same envelope with one of the tubes of the receiver, whereby the modulator-oscillator system may be included in an existing or designed receiver without the addition of a tube. The remote control of a second receiver by the application thereto of a modulated wave at a fixed frequency has been found to be improved by

utilizing the output stage as a modulator for an additional oscillator, in that the quality of the radiated signal is improved, while the circuit arrangement is maintained substantially in the same simplified form as in the system above referred to.

It is also a further object of the present invention to provide an improved radio receiver, which may be utilized as a remote control unit for a second receiver, having an input antenna circuit and an output circuit for modulated oscillations, either or both of which may be connected or coupled with an alternating or direct current power supply line for the receiver without introducing hum modulation into the transmitted signal by reason of the rectifier action in the controlling receiver or in the remotely controlled receiver.

In accordance with the present invention, in practice a relatively small size or midget type of radio receiver is contemplated as a combined control unit and radio receiver, the signal selecting and volume control means serving to select and control the volume of received signals in a normal manner or alternatively to provide signal selection and volume control of a second remotely located receiver when the latter is adjusted to the predetermined frequency of the oscillations or output wave. The output wave is provided by an oscillator modulated by the output tube or stage, the latter being modified by suitable simplified circuit and selector means to act as a modulator for the oscillator.

A further and important object of the invention is to provide an improved filter arrangement in the controlling receiver whereby the oscillator output circuit and the antenna input circuit may be coupled with a power supply line without introducing hum modulation of the radiated modulated signal and whereby at the remotely located receiver, the modulated signal may be received through said power line without being subjected to hum modulation created by the rectifier in the remotely controlled receiver.

Although remote control may be effected through radiation from the power line being picked up by the standard antenna of the remotely controlled second receiver, it has been found that best operation is obtained if the input circuit of the said second receiver is coupled to the power line thereby to receive with greater intensity the modulated signal from the remote control unit.

Accordingly, it is a still further object of the present invention to provide an improved control

unit for the second or remotely controlled receiver for switching the antenna and ground connections from a normal antenna and ground means to the power line through capacity coupling, and to provide switching means for that purpose in a filter unit insertable between the receiver and the power line connection, the filter being adapted to prevent introducing hum modulation on the received modulated wave resulting from the short-circuit action of the rectifier in the second or remotely controlled receiver.

While the receiver constituting the combined receiver and remote control unit may operate from a normal antenna and ground connection, its installation in any one location and its removal and installation in another location, to provide operation as a remote control unit, is greatly facilitated by eliminating the antenna and ground external connection, and to this end it is a further object of the invention to provide an improved circuit arrangement for coupling the antenna or input winding of the remote control unit or receiver without interfering with the use of the power line to convey the output modulated oscillations, thereby eliminating external antenna and ground connections for the said receiver.

It is customary in certain types of radio receivers to provide auxiliary signal input terminals through which externally generated audio frequency signals may be applied to the audio frequency amplifier of the receiver and reproduced through the loudspeaker or output device, a well known example being that in which the audio frequency amplifier and loudspeaker are utilized to amplify and reproduce signals generated in an electric pickup device for phonograph records.

In a system of the type herein considered for the remote control of radio receivers and the like utilizing apparatus for modulated carrier waves, it is a further object of the present invention to provide means for applying to the audio frequency output amplifier, audio frequency signals derived from a phonograph pickup device or a microphone for reproducing signals through the remotely controlled receiver, as well as for reproducing the modulations from received carrier waves. Since the volume control means of the receiver serves to control the percentage modulation of the modulated carrier wave for the remotely controlled receiver, the volume control means ordinarily provided in conjunction with phonograph pickup devices, microphones and the like may serve the same purpose when transmitting signals therefrom to the remotely controlled receiver.

In any case, it will be observed that since the remote control unit serves to transmit a modulated carrier wave through a power line, the signal may serve to actuate more than one remotely controlled receiver or other utilization device.

The invention will, however, be better understood from the following description when considered in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

In the drawings,

Figure 1 is a schematic circuit diagram of a radio receiver provided with an audio frequency output amplifier and modulated oscillator together with a suitably filtered power supply circuit and signal input means, embodying the invention;

Figure 2 is a schematic circuit diagram of a

remotely controlled radio receiver and power line filter providing an antenna input circuit in accordance with the invention; and

Figures 3 and 4 are similar schematic circuit diagrams showing modifications of a portion of the circuit of Fig. 1 in accordance with the invention, to provide a self-contained signal input circuit for the remote control unit.

Referring to Fig. 1, the circuit is that of a superheterodyne receiver having suitably tuned signal input and oscillator circuits 5 and 6, respectively, coupled to a combined detector oscillator tube 7 which supplies an intermediate frequency output signal to a combined intermediate frequency amplifier and second detector tube 8 through suitable coupling transformers 9 and 10 in the intermediate frequency amplifier portion of the receiver. The second detector is of the diode type having a diode output resistor 11 from which automatic volume control potentials are derived through an output resistor 12, and from which audio frequency signals are derived through a variable output contact 13 for the application to the amplifier control grid 14 of a combined audio frequency amplifier and oscillator tube 15.

The tube 15 includes a cathode 16, which is common to the amplifier and oscillator portions thereof, an amplifier output plate 17, an oscillator grid 18 and an oscillator plate 19. The amplifier anode 17 is coupled through a coupling capacity 20 and suitable coupling resistors 21 and 22 to a control grid 23 in an output amplifier tube 24 constituting the audio frequency output stage of the receiver.

The tube 24 is of the screen grid type having a screen grid 25, a cathode 26 and an output anode 27. The anode 27 is connected through the primary winding 28 of an audio frequency output transformer 29 to the positive anode supply lead 30 of a power supply system indicated at 31. The screen grid 25 is also connected to the same positive source of potential 30.

The secondary 35 of the output transformer 29 is connected to a loudspeaker device indicated at 36 to which, in the normal operation of the receiving system, the received signals are applied through the receiving channel above described.

The connections for the loudspeaker with the secondary 35 of the output transformer are controlled by switch 37 which operates through contacts 38 and 39 in connection with a movable contact element 40 to provide, in the position shown, a normal operating connection for the loudspeaker 36 with the secondary and alternatively to disconnect or reduce the output to the loudspeaker and provide a connection for a shunt resistor 41 across the secondary 35, when the element 40 is moved to connect the contact 39 with the lower contact 38. This provides a substitute load for the loudspeaker on the output amplifier tube 24 when the loudspeaker is put out of operation for the transmission of modulated signals.

The switch 37 includes two additional contacts 42 which are bridged by a movable contact element 43 when the loudspeaker output is reduced or cut off, to complete a circuit from the anode 27 of the output tube 24, through a resistor 44 shunted by capacitor 45, an oscillator anode inductance 46 and an anode lead 47, to the anode 19 of the oscillator portion of the tube 15. The anode inductance 46 together with a shunt variable capacitor indicated at 48, provides a tuned oscillator circuit which is coupled to feed back oscillations to the control grid 18 of the oscillator

through a grid winding 49 inductively coupled to the winding 46 and a coupling capacitor 50. The usual oscillator grid leak is provided at 51. The first audio frequency control grid 14 in the same envelope, is connected to cathode through a relatively high value grid leak 52 which may be of the order of 10 megohms and is also coupled to the volume control contact 13 through a coupling capacitor 53. The grid 14 derives biasing potential from the grid current through the resistor 52.

It will be noted that one end of the diode output resistor for the second detector and one end of the resistor 52 are connected to the cathode lead 54 of the A. F. amplifier-oscillator tube 15 and that this lead is connected to a ground indicated at 55. This ground is not at chassis potential but is at the potential of one side of the power line as are other similar points in the receiving system indicated by similar ground symbols, for example, as indicated at 56 in connection with the cathode of the tube 8. The chassis grounds throughout the receiver are indicated by symbols as shown at 57. This distinction between chassis and power line ground in the receiver is caused principally by the fact that the receiver shown is adapted for use in connection with either A. C. or D. C. power supply circuits, and does not include a transformer since the rectifier is connected directly with the line.

In the present example, the power supply plug indicated at 58 is provided with one lead 59 which is connected through a power switch 60 with the power line ground 56 of the receiving system, the connection being completed through a lead 61 and an output coupling coil 62 inductively coupled with the oscillator grid and plate inductances 49 and 46, respectively. The low potential end of the inductance 49 is also grounded to the power line ground as indicated. It will be noted that the output coupling coil 62 is tuned by a shunt capacitor 63 preferably to the same frequency as the oscillator frequency. The high potential lead 65 of the power supply line is connected through one of the heater sections 66 of the power rectifier tube 67 to the anode 68 of the rectifier. The cathode heater circuit may further be traced through a second section 69 of the rectifier cathode heater element, a series controlling resistor 70 and the cathode heaters 71 of the tubes 23, 7, 8 and 15 in the order named, to the opposite side 59 of the power supply circuit.

The cathode of the power rectifier device 67, indicated at 72, is connected with the high potential positive anode supply lead 30 of the receiver through the usual filter comprising two shunt filter capacitors 73 and a series choke coil 74.

Between the power supply line 59—65 and the rectifier 67, the resistance of the first section 66 of the cathode heater is made sufficiently high to be utilized as a filter impedance for the anode supply current. The filter is completed by the addition of two shunt capacitors 75, connected to the power line ground 56, on either side of the heater section 66. The R. F. filter provided between the rectifier and one side of the line prevents the rectifier 67 from short circuiting the line on alternate half waves and modulating the output from the oscillator. The filter provided by the filament arrangement of the rectifier also serves to prevent coupling between the rectifier circuit and the output coil 62.

The operation of the system thus far described is as follows: When the switch 37 is adjusted to

the position shown, the receiving system operates in the normal manner hereinbefore referred to, to select any one of a plurality of broadcasting stations or signals and to control the volume of output through volume control means 13. The audio frequency signals amplified in the amplifier portion of the tube 15 are transmitted through the amplifier tube 24 and output transformer 29 to the loudspeaker 36. The oscillator plate circuit 47—46—44 is open at the contacts 42 of the switch 37. Therefore, the oscillator is disconnected from the primary or modulator inductance 23 and is inoperative.

It should be noted before continuing with a further description of the operation, that signals from an external source such as a microphone indicated at 80 or a phonograph pickup indicated at 81 may be reproduced through the audio frequency amplifier and the loudspeaker 36 by suitable connections with the grid 14 of the first audio frequency amplifier. In the present example these connections are provided by a coupling capacitor 82 between the grid 14 and an input terminal 83, and a second input terminal 84 connected to the power line ground and cathode through a relatively large by-pass capacitor 85.

The input leads 86 for any external signal source are connected with the terminals 83 and 84 and may be made selectively connectable, for example, with a microphone control means 87 or a phonograph control means 88 through a selector switch 89. The microphone control is connected with the microphone 80 while the phonograph control is connected with the pickup 81 to provide suitable operation of said devices and may also provide volume control in any suitable and well known manner. It will be seen that signals selected from either the microphone or the pickup device are applied between the terminals 83 and 84 and between the control grid and cathode of the first audio frequency amplifier tube. The signals are thus amplified and reproduced through the loudspeaker device or are applied to the oscillator, through the output transformer 29 in either case, and in the latter case are reproduced at the remotely controlled receiver, as will appear from the following further description of the operation.

When the switch 37 is adjusted for remote control operation, the contact element 40 is moved to connect with the terminal 39 and to place the auxiliary load resistor 41 across the secondary as hereinbefore described, and the contact element 43 closes the contacts 42 permitting plate current to flow to the oscillator plate or anode 19 from the positive supply lead 30 through the primary 23 of the output transformer 29, as the modulator choke, thence through the resistor 44, the tuned plate circuit inductance 46 and the plate lead 47 to the anode 19. The circuit is completed through the power line ground 55 from the cathode 16 and is connected to the opposite side of the power line through the power line ground 56, the oscillator output coupling winding 62 and the lead 61.

Audio frequency signals resulting from demodulation of a received signal are controlled in amplitude by the volume control means 13 and applied to the control grid 23 of the output amplifier tube 24. The amplified signals modulate the oscillator anode current through the primary winding 23 of the output transformer as the modulator choke coil.

The tuned oscillator circuit 46—43 provides oscillations of a predetermined frequency, pref-

erably in the low frequency end of the broadcast band in the case of a broadcast receiver, for modulation by the output amplifier 24, and the modulated oscillations or signal thus provided is transmitted to the power line through the coupling winding 62 which is substantially in series with one side of said line. Adjustment of the volume control contact 13 may provide any degree of modulation or percentage modulation and hence of volume at a remote receiver.

Thus it will be seen that signals derived from external sources such as a microphone 80 or a phonograph pickup 81 may also serve to modulate the oscillator and to cause the remotely controlled receiving device to operate in response to the modulations. With this arrangement, speech or music may be transmitted from the control unit to a remotely located receiving instrument, and the level of the speech may be controlled at the control unit.

It has been found that in order to reduce or prevent distortion in the modulation system shown, the oscillator plate voltage is reduced, preferably substantially two-thirds of its normal value for 100 percent modulation, and this is provided in the circuit shown by the series resistor 44 in the plate lead of the oscillator, the resistor being provided by suitable R. F. by-pass capacitor 45.

A substantially distortionless modulation characteristic may be obtained also if the output transformer 29 is provided with a primary winding having an additional section indicated at 90, to which the plate circuit of the oscillator may be connected to provide a step-up ratio between the modulator anode and the oscillator anode. If this arrangement is used, the resistor 44 may be omitted.

When the power switch 60 is closed, the resistance of the heater sections 66 and 69 is relatively low. Therefore, the pilot light for the receiver, indicated at 91, may be connected in parallel with the section 66 so that it is protected from burn-out during the time when the receiver is heating up. It will also be noted that the current to the power rectifier anode 68 is caused to flow through the heater section 66 and the pilot lamp 91, thereby providing sufficient current for both the heater and the pilot lamp.

Referring now to Fig. 2, a radio receiver to be controlled remotely is indicated at 111. This may be of any radio receiver or signal receiving and demodulating apparatus adapted to be tuned to the predetermined output frequency of the remote control unit receiver.

While the remote control system will operate satisfactorily in many installations merely by the radiation from the power line being picked up by the normal antenna 109 of the remotely controlled receiver, it has been found that best operation may be obtained if the input circuit of the remotely controlled receiver is coupled to the power line.

For this reason an antenna selecting and filter device 92 is provided for the remotely controlled receiver 111 which enables the user to switch from the standard antenna 109 and the ground connection 93 to the power line 94, to pick up directly the radiated modulated carrier wave from the remote control unit.

The problem of preventing hum modulation at the controlled receiver because of the short-circuiting action of the power rectifier device on the R. F. currents is the same as at the remote control unit. Accordingly, a filter 95 is included in

the device 92, interposed between the power line 94 and the receiver power supply connection or cord 96, to isolate the line from the receiver.

The filter 95 includes a filter choke 97 in one lead of the power supply circuit and a bypass capacitor 98 across the output end of the filter. The terminal leads 99 of the filter are arranged to receive a plug-in connection 100 for the power cord 96 of the receiver. The leads 94 are provided with a plug 101 for the usual power outlet or baseboard power supply connection. The antenna and ground connections on the receiver 111, indicated respectively at 102 and 103, are connected through leads 104 with terminals 105 on the filter unit 92 which in turn are connected with the switch arms 106 and 107 of a suitable antenna selector switch. In the position shown the contact arm 106 for the antenna connection engages a contact 108 connected with a terminal 109a for the antenna 109, while the arm 107 is connected with a contact 110 having a terminal connection 93a for the ground 93. This provides the normal antenna and ground connections for the receiver 111.

When the arm 106 is moved to a contact 112, the antenna is coupled through a capacitor 113 with one side of the power line on the power line side of the filter choke 97. The switch arm 107 is connected to move jointly with the arm 106 to engage a contact 114 through which the ground connection of the receiver is completed with the opposite side of the power line through a coupling capacitor 115. This selective switching arrangement permits the radio receiver 111 to be coupled with the power line to receive the modulated oscillations therefrom directly, while the rectifier system is isolated from the power supply line and the modulated oscillations by the filter 95. In practice, the unit 92 is supplied with the remote control receiver for use in connection with any radio receiver for which the receiver of Fig. 1 may act as a remote control unit.

In the circuit of Fig. 1 a filter comprising a portion of the tapped heater element of the power rectifier is utilized in conjunction with suitable filter capacitors to provide a filter in the power supply circuit between that circuit and the power supply rectifier, to prevent the rectifier from short-circuiting the power line with respect to radio frequency signals or the modulated signals whenever the rectifier conducts currents. The oscillator coupling coil for the power line is connected to the line side of the filter means thus provided.

Referring to Figures 3 and 4 along with Fig. 1, the same reference numerals as used in Fig. 1 are applied to like parts, and certain portions of the system of Fig. 1 are shown in simplified block diagram form in Fig. 3.

In the circuit of Fig. 3, a different type of rectifier 120 is provided in the power supply means for the receiver and is separated from the power supply leads 121 by a separate filter 122. The oscillator coupling coil is indicated at 123 and is included serially in the power supply circuit as in the circuit of Fig. 1 except that it is in the high side of the power supply line. Essentially, however, the circuit is the same as that of Fig. 1 in that a filter device is interposed in the power line between the oscillator coupling coil and the rectifier for the receiver power supply means to prevent hum modulation of the output modulated wave by the rectifier action.

To provide a suitable antenna for a remote control type of receiver as shown in Fig. 1, where-

by external antenna and ground connections may be eliminated, to contribute to the portability and ease of installation of the remote control unit, it has been found that in conjunction with a filter element in the power supply circuit as shown in Figs. 1 and 3, the antenna or input winding indicated at 124 may be connected with one side of the power line as indicated at 125 through a suitable coupling capacitor 126 thereby eliminating one external connection for the signal input winding. To reduce the external connections further, the antenna circuit may include a signal pickup wire 127 located above and included with the receiver as diagrammatically indicated. In this case the power line operates as an antenna while the short wire 127 operates as a counterpoise.

When the transmitted signal from the remote control unit is sufficiently strong to cause the receiver to oscillate if fed back into the antenna, the oscillator coil may be tapped as indicated at 128 in Fig. 4, the oscillator coil being connected across the power supply line through coupling capacitors indicated at 129, and the antenna connection for the signal input coil 124 being made to a center tap 130 on the output coil.

When so connected, the signal received through the counterpoise and power supply line as an antenna system is balanced through the oscillator output coil 128 and accordingly no energy is introduced from the output of the receiver into the input circuit. However, in this case the impedance of the coupling coil 128 must be relatively low within the broadcast band or other band of frequencies through which the receiver is tunable.

From the foregoing consideration of the invention, it will be seen that a separate oscillator may be provided by an additional tube which constitutes the transmitting oscillator, and this may be included in the same envelope as a tube normally in the receiver, while the audio frequency output system of the receiver may be used as a modulator for the oscillator, to improve the quality of the signal developed for use in the remotely controlled receiver or utilization device, and that the power line may be utilized as the transmission medium provided that hum modulation is prevented at both the remote control unit and the remotely controlled receiver or utilization device by filter means between the line and the power rectifier device in both cases. Furthermore it will be seen that the power rectifier, if of the tapped heater type, may be utilized to form its own R. F. filter by the addition of simple filter capacitors to one section of the heater for the cathode of the rectifier.

The oscillator circuit is simplified and is readily controlled by a simple switching connection directly with the primary winding of the audio frequency output transformer whereby the latter may be utilized both as a modulator choke for the oscillator plate circuit and as a coupling or primary winding for a loudspeaker or load device, without requiring switching in the audio frequency output anode circuit.

I claim as my invention:

1. In a radio receiver having a power input supply circuit, the combination with signal selecting and volume control means, of an audio frequency sound output system variably controllable in signal output level by said volume control means, a signal generator, means providing connections between said output system and the signal generator for suppressing the second output and utilizing said output system as

a controllable modulator for said signal generator, means for deriving variably controllable modulated oscillations from said generator in response to received signals, means for applying said derived modulated oscillations to said power supply circuit, a power rectifier device for said receiver connected with said power supply circuit, and a high frequency filter circuit connected between said supply circuit and said power rectifier device for preventing the reentry of said oscillations into said receiver through said power supply circuit, said rectifier having a cathode heater connected in said filter circuit as a filter element thereof.

2. In a remote control system, the combination of a radio receiver having a signal input circuit, means providing a power line high frequency filter for said receiver having an input circuit and an output circuit, means for coupling the signal input circuit of said receiver to the input circuit of said filter, a second radio receiver having power supply leads, an oscillator in said second receiver, means for deriving through said power supply leads from said oscillator a signal wave for said first receiver at a predetermined frequency and modulation depth, a sound output device an audio frequency output tube therefor and volume control means preceding said output tube in the amplifying channel of said second receiver, and means providing connections between said output tube, sound output device and said oscillator for suppressing the sound output and utilizing said output tube as a modulator for said oscillator under control of said volume control means.

3. In a radio remote control system, a radio receiver having a power supply input lead and comprising signal selecting, volume control and sound producing means, and an audio frequency amplifier including a power output tube, means for coupling said output tube to said sound producing means, means providing a tunable low power signal generator in said receiver, means for coupling said generator to said output tube through said output coupling means, means selectively operable to provide connections for said output tube as an amplifier for said sound producing means and as a modulator for said oscillation generator under control of said signal selecting and volume control means, and means for suppressing the output to said sound-producing device when said selector means is operated to connect said output tube as a modulator for said oscillation generator.

4. The combination with a portable radio receiver having signal-selecting and volume-control means, a loudspeaker device and a plurality of amplifier tubes including an audio frequency power amplifier tube for said loudspeaker device, of means for adapting said receiver for effecting both remote tuning and remote volume control for an additional radio receiver or receivers, said means comprising a tunable oscillator including one of said first-named tubes, and circuit elements therefor including an oscillator anode circuit, an output anode circuit for said audio frequency power amplifier tube, means for connecting said last-named output anode circuit selectively with said loudspeaker device for the reproduction of received signals and with the oscillator anode circuit to the exclusion of said loudspeaker device for applying a modulating audio frequency signal to said oscillator in response to selected signals under control of said volume control means, whereby the percentage

modulation in said oscillator may be varied, and thereby to effect remote tuning and signal output volume control at a remotely located radio receiver responsive to the frequency of the tunable oscillator.

5. The combination as defined in claim 4 further including a power rectifier device connected with said power supply leads, said rectifier having a heater element, and means for decoupling said leads and said rectifier comprising a high 10

frequency filter, the series filter element of which is provided by a portion of said heater element.

6. The combination as defined in claim 4 further including means in the oscillator anode circuit for adjusting the ratio of oscillator anode voltage to the modulation output received from said output tube to permit modulation of the oscillator over a linear portion of the modulation characteristic thereof.

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