June 17, 1941. S. W. SEELEY 2,245,829

REMOTE CONTROL SYSTEM

Filed Oct. 9, 1937 2 Sheets-Sheet 1

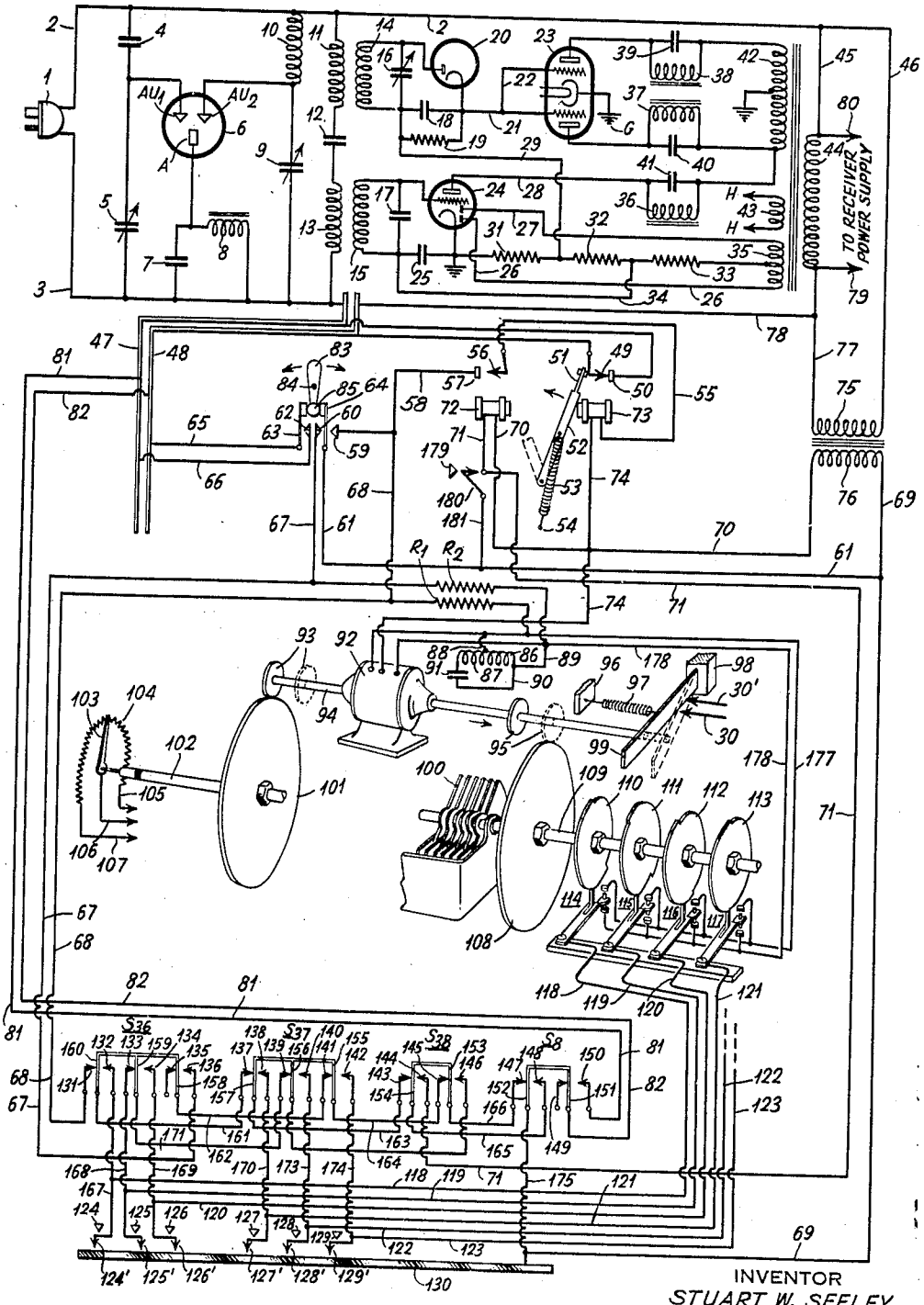


Fig. 1

INVENTOR
STUART W. SEELEY
BY H. S. Sewell
ATTORNEY

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Fig. 2

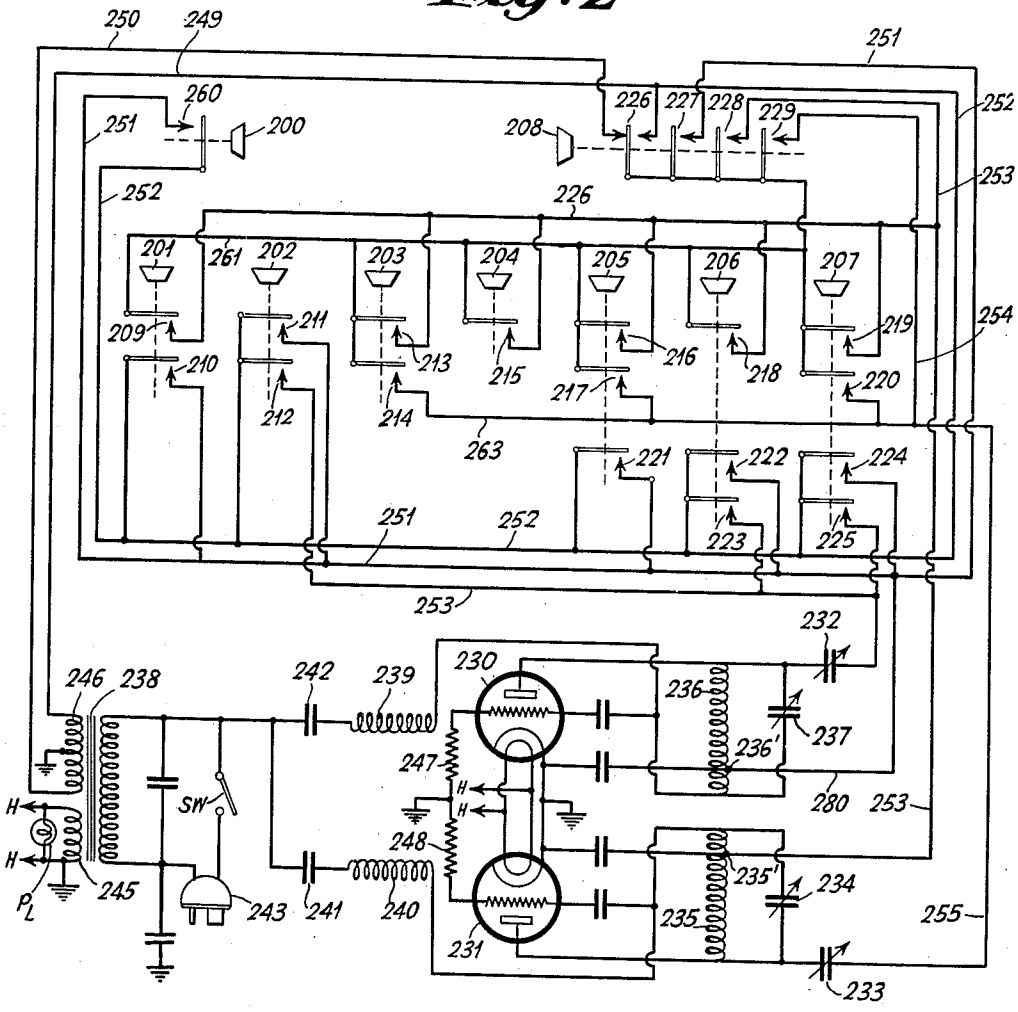
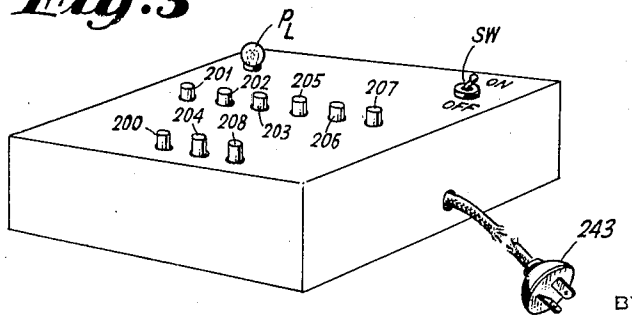


Fig. 3



INVENTOR
STUART W. SEELEY
BY H. S. Grover
ATTORNEY

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REMOTE CONTROL SYSTEM

Stuart W. Seeley, Bayside, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application October 9, 1937, Serial No. 168,180

3 Claims. (Cl. 177—380)

The present invention relates, in a broad sense, to control systems, for operating controllable elements of electrical and other similar apparatus whereby their various functions may be controlled both at the apparatus and from points remote therefrom. More particularly, the invention is applied to a system for operating the tuning means, volume control means, "on" and "off" controls and other major control elements of radio apparatus.

An important feature of the invention is that its objects are obtained without expenditure of power during non-operating or standby periods and without the necessity of any wiring outside of that already existing in buildings provided with a commercial power supply network such as is found in all buildings provided with the usual house lighting system or the like.

Briefly, the arrangement which is described herein for the purpose of illustrating the features of the invention, makes use of a single motor at the receiver for operating both the tuning instrumentality of a radio receiver, as, for instance, a multiple unit condenser arrangement, and the volume control device which may be a potentiometer. At the receiver there are provided a series of selector buttons and related circuits for conditioning the motor circuit. A plurality of settable cam devices arranged to rotate in unison with the tuning shaft of the receiver, provide a control for the motor circuit to determine its direction of rotation and the extent of its operation. The receiver is turned "on" by means of an electrical switch which also is used to control the motor for the purpose of operating the volume control device.

In addition to the above, the invention provides a remote control arrangement through the operation of which all of the functions necessary to operate a receiver may be performed by plugging in a control device in one of the network light sockets located in any room of the house within which it is desired to have the system operate.

The invention will be more fully described by reference to the drawings, wherein

Figure 1 illustrates the invention as applied to a radio receiver. In this figure, only those parts of a radio receiver are shown which are necessary to a clear understanding of the invention;

Figure 2 illustrates diagrammatically the wiring diagram of one of the remote control boxes; and,

Figure 3 is a front view of the panel of a remote control box.

The nature of the method of remote control utilized in the arrangement described herein is such that by means of frequency and phase selective circuits and relays in the receiver unit, all the necessary functions for operating the receiver may be performed electrically from a remote point by means of push-buttons or switches located at the remote point. An important feature of the invention is that various carrier frequencies and arrangements of their 60 cycle modulating envelopes (if the network supplies 60 cycle current) are transmitted through the power line to act on relays which are used to make or break connections between a motor which may be geared to the condenser shaft or to the volume control shaft and the A. C. network.

In an embodiment of the invention, the remote control unit contains two oscillators, the frequency of each being made, for instance, either 200 or 300 k. c. Means are provided for reversing the phase of the 60 cycle line voltage which acts as the plate supply for the oscillator tubes so that the system is capable of feeding into the power line either or both of two frequencies with two possible phase relations of the 60 cycle modulating envelope. The result is an intermittent series of pulses of carrier frequency modulated at 60 cycles with the interval of each pulse not greater than $\frac{1}{120}$ of a second. This follows from the fact that each tube will oscillate only when the A. C. plate voltage applied to it is positive with respect to the tube's cathode. Two carrier frequencies and two phases of the modulating voltage result in 10 possible combinations of frequency and phase and the selective circuits in the receiver unit operate to energize any one or pair of four low current relays which in turn cause 60 cycle power to be supplied to the motor to thereby cause it to operate either the multiple unit condenser or the volume control potentiometer.

Figure 2 of the drawings shows the oscillator connections. The tubes **230** and **231** together with their associated circuits form the two oscillators. Tubes **230** and **231** derive their necessary energizing potentials from the available A. C. network by connection of polarized plug **243** to a suitable outlet of the network. Actually plug **243** is plugged into the outlet and the turning "on" and "off" of the power supply is accomplished by means of switch S_W located on the control box. When switch S_W is in the "on"

position the line voltage is applied across the primary of transformer 238. Transformer 238 is provided with two secondaries. One of these comprises a heater winding 245 which furnishes current of proper voltage to the heater connections H, H of the two tubes. The other secondary comprising a winding 246 supplies the two tubes 230 and 231 with plate voltage through the circuits including switches operated by push buttons 200–208 inclusive. The midpoint of winding 246 is grounded to give the effect of a push-pull circuit for reasons which will appear hereinafter.

The upper portion of Figure 1 of the drawings shows the selective circuits in the receiver unit. A cold cathode gas tube 6 the operation of which is explained in my United States Patent No. 2,177,843 issued October 31, 1939, is coupled to the power line through conductors 2, 3 and polarized plug-in device 1. Tube 24 which may be of the 6R7 type, plays a double role in the arrangement shown in that its diodes produce non-filtered full wave rectification of a small 60 cycle voltage which, as will be described hereinafter, is used as a bias to maintain tubes 24 and 23 at cut-off in the absence of carrier current signals. The triode plate circuit of tube 24 contains a relay 36. This relay closes switch S_{36} when sufficient carrier voltage appears across the circuit 15, 17 which is tuned to 300 k. c. Resonant circuit 15, 17 is connected between the control grid of tube 24 and ground. It should be noted that the peak value of the incoming 60 cycle modulated carrier must coincide in time with the positive peak of the 60 cycle plate voltage supplied to tube 24 in order for current to pass through the relay 36.

Tube 23 which is shown as a 6N7 type tube is connected as a push-pull phase detector with the rectified envelope of the modulated 200 k. c. carrier applied to its grids in parallel. The insertion of tube 20 which may be a 6H6 type rectifier tube is for the purpose of deriving sufficient grid excitation for tube 23. It should be understood that if a double triode tube with lower amplification factor were available in place of a 6N7 it would obviate the necessity of tube 20 and the modulated carrier frequency could be applied directly as is done to tube 24. Carrier energy of 200 k. c. applied to the line with a given polarity of 60 cycle modulating voltage energizes and closes one of the relays 37, 38 in the plate circuit of tube 23. Reversal of the line voltage applied to the oscillator plates causes the other relay of tube 23 to close.

A survey of the combined operation of the control and receiver units will show that 300 k. c. modulated by 60 cycles in, let us say, for convenience, phase A, causes the gas tube 6 to conduct which energizes relay 8, thus throwing S8 to the right. A change of oscillator frequency to 200 k. c. with no change in the phase of the modulating line voltage causes plate current to flow in the upper half of tube 23 and as a consequence relay 38 is energized which throws switch S38 to the right. Reversal of the phase of the A. C. plate voltage applied to the oscillator causes plate current to flow in the lower half of tube 23 and relay 37 becomes energized throwing switch S_{37} to the right. If the frequency is then changed back to 300 k. c. relay 36 is energized throwing S_{36} to the right. It is to be understood that the function of the push-button switches on the control unit is to apply the line voltage to or to shunt condensers across, either or both of the oscillators which results in optional frequency and modulating phase relations in the carrier voltage emanating from the control oscillator as will be described hereinafter. The necessity for two oscillators in the control unit is apparent when it is realized that it is often necessary to close more than one relay at a time. Relays 8 and 36, for instance, are energized when both oscillators are operating at 300 k. c. with opposite polarities of A. C. line voltage. Relays 8 and 37 become energized when one oscillator is at 300 k. c. and the other at 200 k. c. with opposite line voltage polarities for plate supply.

The motor unit energized by the energization of the contacts of any of the four relays 8, 36, 37 and 38 in the receiver may, for example, consist of a 23 volt capacitor type A. C. motor 92 which may be geared to the condenser shaft 109 or to the shaft of the volume control potentiometer 102 through suitable gear trains 95, 108 and 93, 101 respectively. The motor circuit is provided with an arrangement comprising a tapped reactor 87 and condenser 91 for changing the phase angle of the current supplied to the motor so that the motor is capable of running in either direction. Operation of the motor 92 at 18 volts as when it is energized through resistors R1 or R2, causes the motor to run in a position where gears 93 and 101 are engaged, thereby operating the volume control shaft. Increasing the voltage to 23 volts, causes the motor to speed up and its armature is thereby thrust axially in the direction indicated by the arrow so as to disengage pinion 93 from the volume control gear 101 and engage the pinion gear 95, condenser shaft gear 108. A more detailed explanation of the manner in which the motor shaft operates may be found in U. S. patent to Hopkins 1,999,359, issued April 30, 1937.

A series of cams and contactors control the proper direction of rotation and also the stopping and starting of the motor for the selection of a desired station. In the drawings, for convenience only four cams, 110 through 113 have been shown, however, it should be understood that any number of cams may be utilized depending upon the number of stations desired to be tuned to automatically. The cams may be preadjusted on the shaft 109 to positions which correspond to the stations desired for each of the cams. The manner in which the cams control the operation of the motor and their adjustment is fully described in U. S. patent to Garrett 1,956,419, issued April 24, 1934.

Turning the receiver "on" and "off" is effected by means of the relays but it is not necessary to maintain the supply of carrier current continuously in order to have the receiver operate continuously once it is turned "on." This follows from the fact that when relay 8 closes it causes a small locking relay to close the line circui. to the primary of the receiver power transformer connected across terminals 79 and 80.

It is thought that the invention will be best understood by taking up at this time the operation of the push-button tuning arrangement, the "on" and "off" mechanism and the volume control mechanism as operated by means of switches, etc., at the receiver without regard to the remote control feature of the invention. To turn the receiver "on" it is first necessary to insert polarized plug 1 into a suitable outlet of the power supply network. After this is done switch 83 is turned counter-clockwise thus causing contactor 64 to come in contact with contact point 59 and

also switch 63, 62 to close. Closure of switch 63, 62 connects the two contact strips 47 and 48 together, electrically, through wires 65 and 66 with the result that voltage is put on transformer windings 44 and 75, and across terminals 79, 80. The latter energizes the receiver through the usual power transformer. Magnet 73 is also energized by connection of its winding across secondary 76. The circuit may be traced as follows:

From the left hand side of transformer secondary winding 76 through wire 70, wire 74, relay winding 73, wire 55, switch 56, 57 which is normally closed when the receiver is not in operation, switch 59 (now closed due to the counterclockwise operation of lever 83), conductor 61, conductor 69, back to the right hand side of winding 76. When the relay winding 73 becomes energized, it pulls arm 52 to the right as shown in full lines in the drawings thus closing switch 49, 50 which acts to connect electrically the contact bars 47 and 48. When this happens switch 56, 57 is opened due to the fact that the arm 52 is flipped over to the right with the result that the relay winding 73 becomes de-energized. However, spring 53 keeps the arm 52 in the position shown in spite of the de-energization of the magnet 73. It should be understood that elements 63 and 64 are spring contact members which act to maintain switch arm 83 in a neutral position in the absence of force tending to rotate it either clockwise or counter-clockwise. To tune in a station after the set is "on" and the tubes properly operating, one of the buttons 125 through 129 depending upon which of the stations represented is desired, is pressed down and held down. For example, if it is desired to receive the station corresponding to push-button 126, that button is pressed down and held down, thus, causing the contactor 126' to come in contact with the conductor bar 130. This completes the circuit of motor 92 across winding 76, thereby causing current to flow through the following circuit:

From the right hand side of transformer secondary winding 76, wire 69 to ground strip 130, contactor 126', conductor 120, switch 116 which happens to be contacting its lower terminal due to the fact that the cam follower is riding on the high portion of cam 112, conductor 178, motor 92, conductor 74, conductor 70 to the left hand side of the transformer winding 76. In this way the full voltage across the transformer winding 76 is applied to the motor 92, thereby causing its armature to be thrust in the direction indicated by the arrow which results in pinion gear 95, meshing with gear wheel 108. The motor thereby rotates shaft 109 and, hence, the rotors of the multiple-unit, condenser 100 as well as the cam shaft 109. Due to the fact that the motor shaft 94 was thrust in the direction indicated by the arrow the right hand end of the shaft forces the contactor arm to the right against the action of spring 97, thereby short circuiting contactors 30 and 30'. The contactors 30 and 30' are suitably connected to the receiver and act to remove the output from the loudspeaker so that the receiving set is "quieted" during the tuning operation. It can be seen from the above that the motor 92 is caused to rotate in one direction carrying with it the rotors of the multi-unit condenser 100 as well as the set of cams represented by cams 110 through 113. When cam 112 which corresponds to the push-button 126 is rotated to a position which causes the switch 116 to open, that is, to a position where both the upper terminal and the lower terminal thereof are open (see position of switch 117) the motor circuit is broken stopping motor 92 and hence rotation of shaft 109. When this happens it is no longer necessary to hold down push button 126 so that the button may now be released. If instead of the station tuned to another station had been desired, let us say the station corresponding to push button 125, then 125 would be depressed and held down, thus causing the motor circuit to become energized through the following electrical path:

From right hand side of transformer winding 76, conductor 69, bar 130, contact device 125' (now in contact with 130 due to depression of button 125), conductor 119, switch 115 which, as shown, contacts its upper terminal owing to the fact that the cam follower is riding on the lower portion of the cam 111, conductor 177, through motor 92, conductor 74, conductor 70, to the left hand side of the transformer winding 76. This rotates the motor 92 in the opposite direction from that previously described in connection with the depressions of push button 126. The circuit is broken and the motor stops when cam 111 breaks contact at switch 115.

After a station is tuned to and signals are received, it may be necessary or desirable to vary the volume either up or down for proper enjoyment of the signals. For this purpose, the switch 83 is used. Operation of this switch counterclockwise causes the motor 92 to increase the volume and clockwise to decrease the volume. To turn the volume "up" switch 83 as previously stated is turned counter-clockwise, thereby closing switch 59, 64. This energizes the motor 92 through the following circuit:

Left hand side of the transformer winding 76, conductor 70, conductor 74, motor 92, conductor 177, resistor R_1, conductor 68, switch 59, 64 (now closed), conductor 61 and conductor 69 to the right hand side of transformer winding 76. Resistance R_1 acts to reduce the voltage applied to the motor 92 with the result that gear 93 stays in engagement with gear 101 as shown. This is for the reason that the thrust on the motor armature due to the reduced voltage is not sufficient to shift the motor shaft 94 as described in connection with the tuning operation.

Rotation of the motor will adjust movable arm 103 of the volume control potentiometer 103, 104, through shaft 102, so as to increase the volume. As soon as the desired volume is reached the switch 83 is allowed to return to its normal middle position which is the position shown in the drawings, thus breaking the contact 59, 64 which stops the motor 92. If it is desired to reduce the volume the switch 83 is turned clockwise, thus permitting spring contact 64 to come in contact with connector 60. The motor is energized and rotates in the opposite direction than in the previous example. The motor is energized through the following path:

From left hand side of transformer winding 76, conductor 70, conductor 74, motor 92, conductor 178, resistor R_2, conductor 67, switch 60, 64 (now closed), conductor 61, and conductor 69 to the right hand side of transformer winding 76. As in the case of resistor R_1, resistor R_2 also reduces the voltage applied to the motor with the result that the gear 93 stays in mesh with gear wheel 101. However, the motor 92 will rotate in the opposite direction and rotate the movable arm 103 oppositely to the previously described volume control operation, thereby re-

ducing the volume. When the desired volume is reached switch 83 is allowed to return to its normal released position, thus breaking the motor circuit. To turn the receiver "off," button 179 is depressed which closes switch 180. This energizes the winding of electromagnet 72 through the following circuit:

From the left hand side of transformer winding 76, wire 70, relay winding 72, wire 71, switch 180, wire 181, wire 61 and wire 69, back to the right hand side of transformer winding 76. Energization of relay 72, flips the arm 52 counter-clockwise, thus opening switch 49, 50 and thereby disconnecting contact bars 47 and 48 which de-energizes the receiver. At the same time, the switch 56 and 57 is closed.

The remote control box shown in Figure 2 energizes circuits and tubes capable of generating oscillations of two predetermined frequencies with 60 cycle A. C. voltage employed directly as plate supply through transformer 238. The function of the switches operated by push-buttons 200—208 is to connect circuits to the oscillator tubes 230 and 231 which apply plate potential to either or both tubes to energize the same and to shunt condensers across either or both of the oscillators to thereby alter the oscillating frequency and also to alter the phase of the 60 cycle A. C. plate voltage to give various combinations of output frequency and modulating phase to the controlling energy fed into the power line.

To operate the receiver from a remote point, the polarized plug 243 is plugged into a suitable outlet of the A. C. network and the switch S_W closed. This immediately applies the line voltage across the primary of the transformer 238 thus energizing the heater circuits of tubes 230 and 231 through heater winding 245 and placing a voltage across secondary 246. It should be noted that the mid-point of secondary 246 is tied to the common cathode connection between tubes 230, 231. In Fig. 2 push-button 200 which closes switch 260 is both the "on" button and the "volume up" button. Push button 208 which when depressed closes switches 227, 228 and 229 and switches 226 from its upper contact position to its lower contact position is the "off" button. The "volume down" push button 204 closes switch 215. The six station selector push buttons 201, 202, 203, 205, 206 and 207 are arranged to close various switches which will be described below in greater detail.

The operation of the device is as follows:

To turn the set "on" push button 200 is depressed closing switch 260 thereby connecting the top side of secondary winding 246 to the tap 236' on coil 236. By this means a 60 cycle A. C. voltage is applied as plate supply for tube 230. This will cause the tube to oscillate at a frequency determined by the resonant circuit 236, 237 which in this case is 300 k. c. Application of the 60 cycle voltage permits tube 230 to oscillate only during that portion of a 60 cycle period during which the plate of the tube is positive with respect to its cathode. The output of tube 230 is coupled into the A. C. power line through the connection including coil 239 and condenser 242. The energy thus fed into the line consists of a voltage at 300 k. c. modulated at 60 cycles, thus it appears as a series of pulses each of which is not more than $\frac{1}{120}$ of a second in duration. This energy is transmitted to the receiver Fig. 1 through the A. C. power line and enters the control circuits in the receiver through polarized plug 1. Tube 6 is arranged by means of its connection to the polarizing potential divider 4, 5 and by proper connections through polarized plug 1 to the A. C. line, so that an incremental voltage developed across coil 10 by resonant rise in series resonant circuit 9, 10 tuned to 300 k. c. is all that is required to initiate a discharge between the auxiliary electrodes AU_1 and AU_2. As a result of this discharge the gap between AU_2 and A is ionized and relay 8 is energized. For this to happen it must be understood that the peak of the modulating envelope of the voltage across 10 must coincide substantially in time relation with the peak 60 cycle present across the condenser so that the net difference of potential between AU_1 and AU_2 is increased (see my copending application previously referred to). Energization of relay 8 causes switch S_8 to be thrown to the right thereby breaking contacts 147, 152 and making contacts 152, 148 and 150, 151. Connection of 150 to 151 connects together contact bars 47 and 48 by means of wires 81, 82. When this happens A. C. voltage is applied to the primary of the receiver power supply transformer through terminals 79 and 80 as well as the winding 75, the latter being through conductors 77 and 46. Voltage is thus developed across secondary winding 76 and causes relay winding 73 to be energized thereby pulling arm 51 over to the right as shown closing switch 49, 50 which shorts the bars 47 and 48. At the same time switch 56, 57 is opened to thereby remove voltage from coil 73 and prevent its becoming over heated, while the receiver is on. Relay 73 is energized through the following circuit:

Left side of 76, wire 70, wire 74, coil 73, wire 55, switch 56, 57, wire 58, wire 68, contacts 131, 160 of S_{36}, wire 161, contacts 137, 157 of S_{37}, wire 163, contacts 143, 154 of S_{38}, wire 165, contacts 148, 152 of S_8 (bearing in mind that S_8 is over to the right), wire 175, wire 69 to right side of 76 which completes the circuit.

Now that the receiver is "on" it will be shown how to select a particular station: To tune to a station as, for instance, to the station corresponding to button 201 (Fig. 2) this button is pressed down, thus closing switches 209 and 210. Closure of 210 connects the plate supply voltage to tube 230 as follows:

Upper terminal of 246 through wire 249, wire 252, switch 210, wire 251, wire 280 to the tap on coil 236. That causes tube 230 to oscillate at a frequency determined by 236, 237 (say 300 k. c.) with a certain phase of the 60 cycle modulating envelope. Since 209 is also closed by depressing button 201, oscillator tube 231 is also supplied with A. C. plate voltage by a connection from the bottom half of winding 246, conductor 250 closed switch 226 conductor 261 switch 289 (which is closed due to the depression of button 201), conductor 226, conductor 253 to tap 235' on coil 235 and oscillates at a frequency determined by 235 and 234 (300 k. c.). The oscillations in tube 231 appear only during those portions of the A. C. 60 cycle current when the plate of either tube 230 or 231 is positive with respect to its cathode.

Since plate voltage available for application to tube 230 is out of phase with that available to tube 231 because of 180° phase relation between opposite ends of transformer secondary 246, it follows that the envelope of the output voltage which appears in the output of tube 230 is out

of phase with the envelope of the output of tube 231. These two oscillations are fed into the power line or network and taken out at the receiver where they appear across line 2, 3. This will cause tube 6 to pass current as previously described, thus energizing relay 8 (due to the output of oscillator 230) and throwing switch S_8 to the right. At the same time switch S_{36} is thrown to the right due to energization of relay 36 which is caused by the energy from the output of tube 231 acting on tube 24. This action results from the following:

60 cycle voltage is applied between the plate of tube 24 and its cathode from the lower side of transformer secondary 42, the primary 44 of which is connected across the line 2, 3. The phase arrangement is such that modulated (300 k. c.) carrier which appears across coil 15 due to resonant rise in circuit 15, 17 and coupled to coil 13 causes tube 24 to pass current in its plate circuit when the peak value of the modulation envelope impressed on the grid of tube 24 coincides in time with the peak value of the 60 cycle A. C. voltage applied to the plate thereof. The diode portion of tube 24 acts merely to produce an unfiltered full wave rectified 60 cycle voltage derived from secondary 35.

A portion of this, namely, the drop across resistors 31 and 32 is applied between the grid and cathode of tube 24 to maintain the tube in a cut-off condition until a modulated voltage, whose envelope is in the proper phase relation to the A. C. plate voltage, appears across the tuned circuit 15, 17. Voltage of this required phase will appear due to the output of oscillator tube 231. It can be seen that output voltage which energizes tube 6 will not cause the passage of plate current through tube 24. Throwing of S_{36} and S_8 to the right by the action described previously, will cause the receiver to be tuned to a predetermined station which is the same as the station corresponding to button 124 when the receiver is operated locally. The circuit which energizes the motor in this instance may be traced as follows:

From the right side of secondary winding 76 through wire 69, wire 175, through contacts 152, 148 of switch S_8, wire 165, contacts 154, 143 of S_{38}, wire 163, through contacts 157, 137 of S_{37}, wire 161, contacts 160, 132 of S_{36}, wire 167, wire 118, cam switch 114, lower contact of switch 114, wire 178, motor 92, wire 74 and wire 70 to the left side of winding 76.

The full voltage across 76 is thus placed across the motor which causes motor shaft 94 to be thrust axially in the direction indicated by the arrow thus causing the engagement of gears 95 and 100 thereby rotating the rotor of multiple unit condenser 100 and also cam shaft 109. The motor, continues to rotate until its circuit is broken due to the fact that it comes to a position where switch 114 is not in contact with either its upper or lower terminals.

It should be noted that the axial thrust of the motor shaft when running on full voltage causes spring contactor 99 to engage or short contacts 30 and 30' to thereby remove the output voltage from the loudspeaker or otherwise quiet the receiver. As soon as the circuit is broken by switch 114 the motor stops and the armature slides back to its original position as shown in the drawing, thereby allowing spring 97 to draw back spring contact 99 and thereby remove the short-circuit from terminals 30, 30'.

Referring again to Figure 2, if a station corresponding to push-button 205 had been desired, then this push-button is depressed closing switches 216, 217 and 221.

Closure of switch 221 has exactly the same action on oscillator tube 230 as switch 210 had in the previous description. This means that the output of oscillator 230 is composed of a modulated series of pulses with a carrier frequency of 300 k. c. Oscillator tube 231 now has its output frequency changed from the 300 k. c. emitted when switch 209 was closed in the previous illustration to 200 k. c. This is caused by the connection of condenser 233 across a portion of tank circuit 234, 235. This connection is brought about by means of switch 217 in the following manner.

Starting at the cathode terminal on coil 235, through wire 253, wire 226, switch 216, switch 217, wire 263, wire 255, through condenser 233 to plate of 231.

As the result of pressing down push button 205 there are two voltages impressed upon the A. C. power line. One, has a frequency of 300 k. c. and is modulated in, say, phase A, which will cause tube 6 to pass current thus energizing relay 8 and causing switch S_8 to be thrown over to the right. The other 200 k. c. modulated in phase B will be shown to cause plate current to flow in one of the plate circuits of tube 23 thereby energizing relay 37 causing S_{37} to be thrown to the right.

The circuit comprising tube 23 and its associated elements acts in the same manner essentially as tube 24 in that it operates as a selective phase detector. The section of the tube in which plate current flows is determined by the phase of the modulated 200 k. c. impressed upon the parallel grids of the double triode tube 23 with respect to the phase of the A. C. plate voltage obtained from the push-pull transformer secondary 42.

Unfiltered full wave rectified bias voltage is applied to the grids of tube 23. This bias voltage is developed across the resistor 31 and acts to maintain tube 23 inoperative in the absence of A. C. grid voltage. It may be noted that tube 20 is not inherently a part of the system. It acts merely to increase effectively the sensitivity of tube 23 in the following manner.

The modulated 200 k. c. voltage impressed across the plate cathode terminals of diode detector 20 is rectified and appears across resistor 19 as a low frequency product of demodulation whose wave shape is the same as the modulation envelope of the incoming 200 k. c. This expedient was found necessary in an actual embodiment of the invention because the amplification factor of tube 23 was not sufficiently low to permit obtaining the desired sensitivity. A tube such as 23 but with the lower amplification factor would eliminate the necessity of tube 20.

The phase of the envelope which appears between the grids of tube 23 and the cathode as the result of depressing button 205 on the remote control unit (Fig. 2) causes plate current to flow in the lower half of tube 23 due to the fact that the potential on the lower half of transformer secondary 42 is arranged to be positive when the grids are positive.

Relays 37 and 8 having been energized and subsequently having thrown to the right their associated switches S_{37} and S_8, cause a new station to be tuned. The motor 92 is energized through the following circuit:

Right hand side of winding 76, wire 69, wire 175, contacts 152 and 148 of S_8, wire 165, contacts 154, 143 of S_{38}, wire 163, contacts 157, 138 of S_{37}, wire 170, wire 121 to cam switch 117.

It will be noted that both the upper and lower contacts of switch 137 are open. This signifies that the tuning condensers when last operated were set to the same station as is now desired. Consequently, the motor will not operate.

Actually, however, under these conditions signals from the desired station would have come in upon depression of the "on" button 200 after the usual time required to heat the tube cathodes of the receiver.

If instead button 202 is depressed, switches 211 and 212 are closed. They cause oscillator 230 to be energized and to feed into the power line carrier frequency of 200 k. c. modulated at 60 cycles in a phase which would cause tube 6 to operate if the frequency had not been changed from 300 k. c. to 200 k. c. This energy will be stepped up by resonant circuit 14, 16 (Fig. 1) and will cause the modulation envelope to appear on the grids of tube 23. The phase of the plate voltage on the top section of tube 23 is so arranged that current passes through relay 38 energizing it, causing S_{38} to be thrown to the right. The action which takes place is the same as though button 125 had been pressed locally and the receiver will tune to a station corresponding to the setting of cam 111 on shaft 109.

It should now be apparent that the function of the push buttons 201, 202, 203, 205, 206 and 207 is to alter the output frequency and the modulating phase of the voltage developed in the oscillation generating circuits comprising tubes 230, 231 and their associated circuits.

The resultant voltages act upon different combinations of tubes shown in Figure 1 and cause energization of several possible combinations of relays which in turn cause to be connected electrically from a remote point, the same contacts which would be made by local operation of the receiver through the push-buttons 124 through 129 inclusive of Figure 1.

Assuming that the receiver has been turned "on" and is tuned to a desired station, the operation which enables one to vary the volume from a remote point will now be taken up.

If it is desired to increase the volume, button 200 is depressed. This performs the same function electrically as when the receiver is turned on by means of depressing button 200, in other words, switch 260 is closed supplying oscillator tube 230 with plate potential. This generates carrier frequency of 300 k. c. modulated with 60 cycle plate voltage as previously described. The generated energy is transmitted over the A. C. power lines and is picked up in the receiver circuits of Figure 1, causing tube 6 to be ignited and relay 8 to be energized thus throwing switch S_8 to the right. The motor circuit is thereby energized causing the motor 92 to run at reduced speed whereby the setting of the volume control potentiometer is effected in the following manner:

Current flows from the right side of 76, wire 69, wire 175, contacts 152, 148 of S_8, wire 165, contacts 154, 143 of S_{38}, wire 163, contacts 157, 137 of S_{37}, wire 161, contacts 160, 131 of S_{36}, wire 68, resistor R_1, wire 177, motor 92, wire 74, wire 70 to left side of 76.

The voltage drop across resistor R_1 causes the motor to run at reduced speed (below the speed at which it runs to effect tuning). Consequently, there is insufficient axial thrust of shaft 94 to cause axial differences and the motor gear 93 remains engaged to volume control gear 101. Rotation of the motor causes shaft 102 to rotate thereby moving the movable arm 103 of the potentiometer along resistance 104. Wires 105, 106, 107 may be connected to the audio system in the receiver in such a way that variations of the position of arm 103 on element 104 cause variations in the volume output of the receiver.

It should be noted that current cannot flow through relay 73 because switch 56, 57 is open due to the fact that arm 52 was previously flipped over to the right when the set was turned on by depressing button 200 the first time.

If it is desired to run the volume "down" then button 204 is depressed, closing switch 215 and thereby energizing oscillator 231 which emits a frequency of 300 k. c. modulated by a 60 cycle voltage in the opposite phase to that used to modulate 230 in the preceding illustration of increasing the volume.

The 300 k. c. energy is transmitted over the power lines and is picked up by the receiving units. Due to the phase relation of the 60 cycle voltage on the plate of tube 24 (Fig. 1) tube 24 is caused to pass current in its plate circuit energizing relay 36. It is to be noted that tube 6 does not operate because the phase of the modulation envelope is not correct to initiate a discharge in this tube. Relay 36 being energized, switch S_{36} is thrown to the right. Motor 92 now runs at reduced speed in a direction opposite to that in which it runs to increase the volume. The electrical circuit which controls this operation of the motor 92 is as follows:

Right side of winding 76, wire 69, wire 175, contacts 152, 147 of S_8, wire 166, contacts 153, 145 of S_{38}, wire 164, contacts 155, 141 of S_{37}, wire 162, contacts 158, 136 of S_{36}, wire 67, resistor R_2, wire 178, motor 92, wire 74, wire 70 to left side of winding 76.

The action is the same as that which causes the volume to be increased except that the motor now runs in reverse direction, thus causing arm 103 to decrease the volume.

To turn the set "off" from the remote point, button 208 is depressed, thereby moving switch 226 from its left hand position shown to its right hand position and at the same time closing switches 227, 228 and 229. When this happens the electrical action is such as to cause oscillator 230 to operate at 300 k. c. with the normal phase of A. C. voltage supplied as plate supply. Oscillator 230 is now made to run at 300 k. c. due to the energization thereof thru the following circuit:

From top of winding 246 conductor 249 closed switch 226 (switch in its right-hand position), closed switch 227 conductor 251, conductor 280 to tap 236' on the coil 236. The circuit is completed thru ground since the center tap of secondary 246 is connected to ground and the cathode of the tube 230 is connected to ground. The depression of button 208 causes oscillator tube 231 to operate at 200 k. c. and also causes the plate supply voltage to be in phase with the plate supply voltage on the oscillator 230. This is obtained thru the following circuit:

Starting at the top of winding 246 conductor 249 closed switch 226, closed switch 228 wire 253 tap 235' on the coil 235 back thru ground between the cathode of the tube 231 and the grounded center point of winding 246. To change the frequency the condenser 233 is

shunted across part of the coil **235** thru the following circuit:

From the plate of tube **231** to the tap **235'** on coil **235** wire **253** closed switch **228** closed switch **229** conductor **254** conductor **255** to the right-hand side of the condenser **233**, it being noted that the left-hand side of the condenser **233** is connected to the plate of the tube **231**. Hence the condenser **233** is shunted across that part of the coil **235** which is between the plate of the tube **231** and the point **235'**. Oscillator **231** runs at 200 k. c. but the phase of its modulating plate supply voltage is reversed from that of any previous condition explained and is now in phase with the A. C. voltage applied to oscillator **230**. In other words, the A. C. voltage used as power supply for both tubes is now taken off the top half of transformer secondary **246** through the medium of the switches which are closed when button **208** is depressed.

Accordingly, there is impressed on the A. C. power line as a transmitting medium two frequencies, 200 k. c. and 300 k. c., both effectively contained in the same envelope. These frequencies are picked up by the receiver selective circuits as previously described and they act on tube **6** and tube **23**. Tube **6** is ignited and causes relay **8** to be energized in the manner disclosed in the discussion pertaining to turning the receiver "on" and increasing the volume level. The upper half of tube **23** has the proper polarity of A. C. voltage applied to its plate to cause plate current to pass throug relay **38** when 200 k. c. modulated in the phase resulting from the action of pressing **208** in Fig re 2 is applied. Consequently, relays **8** and **3** are energized throwing switches S_8 and S_{38} to the right. This causes magnet coil **72** to be energized, throwing switch **51** to the left, breaking contact **49**, **50** which removes the A. C. supply from the primary winding of the receiver power supply transformer shutting the receiver "off." It is to be noted that when the arm of switch **51** is thrown to the left, switch **57**, **56** closes, thereby making the device ready for the next "turn on" operation. The circuit which performs this function is as follows:

From the right side of **76**, wire **69**, wire **175**, contacts **152**, **148** of S_8, wire **165**, contacts **154**, **144** of S_{38}, wire **71**, coil **72**, wire **70** to left side of winding **76**.

If the station corresponding to button **206** is desired, this button is depressed, closing switches **218**, **222** and **223**. This will cause oscillator **230** to operate at 200 k. c. and oscillator **231** to operate at 300 k. c. with A, C. modulating voltages which are mutually out of phase. The resultant output energy transmitted through the power line acts upon the following circuits in the receiver:

The 200 k. c. energy is picked up by coil **14** and is ultimately placed upon the grid of tube **23**. This in conjunction with the fact that the plate voltage on the top section of **23** presents its peak value when the envelope of the carrier on the grid of **23** becomes positive, causes plate current to flow through the relay winding **38** causing S_{38} to be thrown to the right. At the same time the 300 k. c. component of energy acts on the grid of tube **24** whose plate voltage is properly phased to cause current to flow through relay winding **36** energizing it and throwing S_{36} to the right. The closure of these switches causes voltage to be applied to the motor **92** through the medium of a cam switch (not shown) which acts in a similar manner as cam switches **114** through **117**, causing the motor to rotate until the cam comes in the position to break the cam switch, as described hereinbefore.

To tune to a station corresponding to button **207**, this button is depressed, closing switches **219**, **220**, **224**, **225**. That causes both **230** and **231** to operate at 200 k. c. with the phase of the modulating voltage mutually opposite. The resultant energy acts on the grid of tube **23**, both halves of which now pass plate current energizing relays **37** and **38**, throwing switches S_{37} and S_{38} to the right. This brings about a rotation of motor **92** through the medium of still another cam switch, not shown in the diagram, but similar in action of those shown. The operation is as previously described.

In the description of the various operations of the invention given above, it should be borne in mind that when tuning to a station by depressing any one of the station selector buttons **124** through **129** of Figure 1, or any one of the station selector buttons **201**, **202**, **203**, **205**, **206** and **207** of Figure 2, the selected button must be kept depressed until its corresponding cam controlled switch breaks the motor circuit at which time the push button may be released so as to allow it to return to its normal position. The same is true of the volume control buttons **200** and **204**, so that if it is desired to change the volume either button **200** or button **204** is depressed and kept depressed until the motor **92** has operated the potentiometer sufficiently to give the desired volume at which time the depressed button is released. To control the volume locally the lever **85** of Figure 1 is turned clockwise or counter-clockwise depending upon which direction the change is desired and maintained in the new position until the desired volume is reached. When the desired volume is reached the lever **83** is released, thereby allowing it to return to its normal position through the action of the spring contacts **63** and **64**. On the other hand, for turning the receiver "on" locally it is only necessary to rotate the lever **83** counter-clockwise and immediately releasing the same. At the remote point, all that is necessary to turn the receiver "on" is to momentarily depress push button **200** while turning it "off" which required only the momentary depressing of the push button **208**.

It will be evident to those skilled in the art that in some instances as in some apartment houses conditions might prevail where the control energy impressed upon the network of one apartment would find its way to the network of another thereby controlling a radio receiver in the second apartment. To prevent this, it is only necessary to isolate the controlling energy in any particular apartment by connecting to the line at the meter board a series choke coil of suitable dimensions for the frequencies in question. Such an arrangement would prevent the control energy from being transmitted beyond the meter to another apartment network. It would also tend to act the other way, that is, it would prevent control frequencies from some other network entering the first network.

It should be understood that while the invention has been described in connection with a radio receiver, it is not limited thereto since it is quite obvious that it may be applied to other apparatus having one or more control shafts adapted to be remotely controlled.

I claim:

1. In a remote control system, a transformer

having a primary winding adapted to be connected to an alternating current distribution network and a secondary winding, a first electronic tube oscillator including an anode, a cathode and a grid, a tank circuit for said tube connected between the anode and cathode of the tube, a second electronic tube oscillator having an anode, a cathode and a grid, a tank circuit for said second tube connected between the anode and cathode of said second tube, a connection between the grid electrode of the first tube and a point of the first named tank circuit, means for connecting the grid electrode of the second tube to a point of the second named tank circuit, means connecting an intermediate point of said secondary winding to both of said cathodes, means adapted to be connected to said first named tank circuit for altering the frequency characteristics thereof, means adapted to be connected to said second named tank circuit for altering the frequency characteristics of the second tank circuit, a plurality of selectively operable means, one of said means acting upon operation to connect a point of said first named tank circuit to one end of said secondary winding, another of said operable means acting upon operation to connect said first named tank circuit to said first named end of the secondary winding and simultaneously to connect a point of the second named tank circuit to the other end of said secondary winding, a third one of said operable devices acting upon operation to connect a point of said first named tank circuit to said first named end of the secondary winding and simultaneously to connect the first named frequency changing means to the first named tank circuit, a fourth one of said operable means acting upon operation to connect a point of the second named tank circuit to said second named end of the secondary winding and simultaneously to connect the second named frequency changing device to said second named tank circuit, a fifth one of said operable means acting upon operation to connect a point of the second named tank circuit to said second named end of the secondary winding, a sixth one of said operable means acting upon operation to connect a point of the second named tank circuit to the second named end of said secondary winding and simultaneously to connect the second named frequency changing means to said second named tank circuit, and the point of the first named tank circuit to the first named end of said secondary winding, a seventh one of said operable means acting upon operation to connect a point of the second named tank circuit to the second named end of said secondary winding and simultaneously to connect a point of said first named tank circuit to the first named frequency changing means to the first named tank circuit, an eighth one of said operable means acting upon operation to connect a point of the second named tank circuit to said second named end of the secondary winding, said second named frequency changing means to the second named tank circuit, a point of the first named tank circuit to the first named end of said secondary winding and the first named frequency changing means to the first named tank circuit all simultaneously, a ninth one of said operable means acting upon operation to connect the first named tank circuit to the first named end of the secondary winding, the second named frequency changing means to the second named tank circuit, and a point of the second named tank circuit to the first named end of said secondary winding.

2. In a remote control system, an alternating current distribution network, means for generating control oscillations comprising an electronic tube having an anode, a cathode and a grid electrode, a tank circuit comprising an inductance coil and a condenser for determining the frequency of the generated oscillations, a transformer having a primary winding adapted to be connected to said distribution network and a secondary winding, means for connecting the cathode of said tube to an intermediate point of said secondary winding, means including an operable switching device and at least a portion of said tank circuit for connecting said anode to one end of said secondary winding, means for electrically connecting said tank circuit across said primary winding, operable means for changing the frequency to which the tank circuit is tuned, and means including a second operable switching device acting upon operation to connect the anode of said tube to one end of said secondary winding and simultaneously therewith operate said frequency changing means.

3. In a signalling system, a transformer having a primary winding adapted to be connected to an alternating current distribution network, and a secondary winding, an electronic tube oscillator including an anode, a cathode and a grid, a tank circuit for said tube, means for connecting the anode to a point of said tank circuit, the cathode to another point of the tank circuit and the grid to still another point of the tank circuit, a connection between an intermediate point of said secondary winding and the cathode, signal transmission means, means for coupling said tank circuit to said signal transmission means, a plurality of selectively operable means, one of said selectively operable means acting upon operation thereof to connect the anode of said tube to one end of said secondary winding, a second of said operable means acting upon operation thereof to connect the anode of said tube to the other end of the secondary winding, means connectible to said tank circuit for changing the frequency characteristics thereof, and a third operable means acting upon operation to connect the anode of said tube to one end of the secondary winding of said transformer and said connectible means to the tank circuit simultaneously.

STUART W. SEELEY.