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SENSITIVITY CONTROL SYSTEM FOR AUTOMOBILE RADIO RECEIVERS

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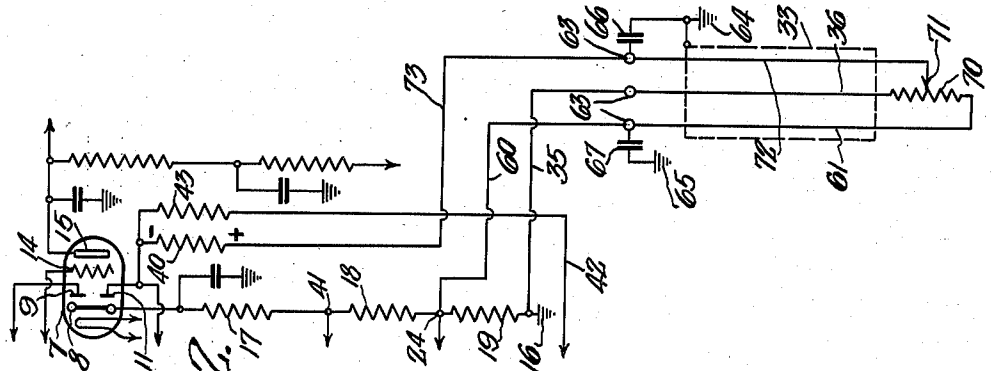


Fig. 2.

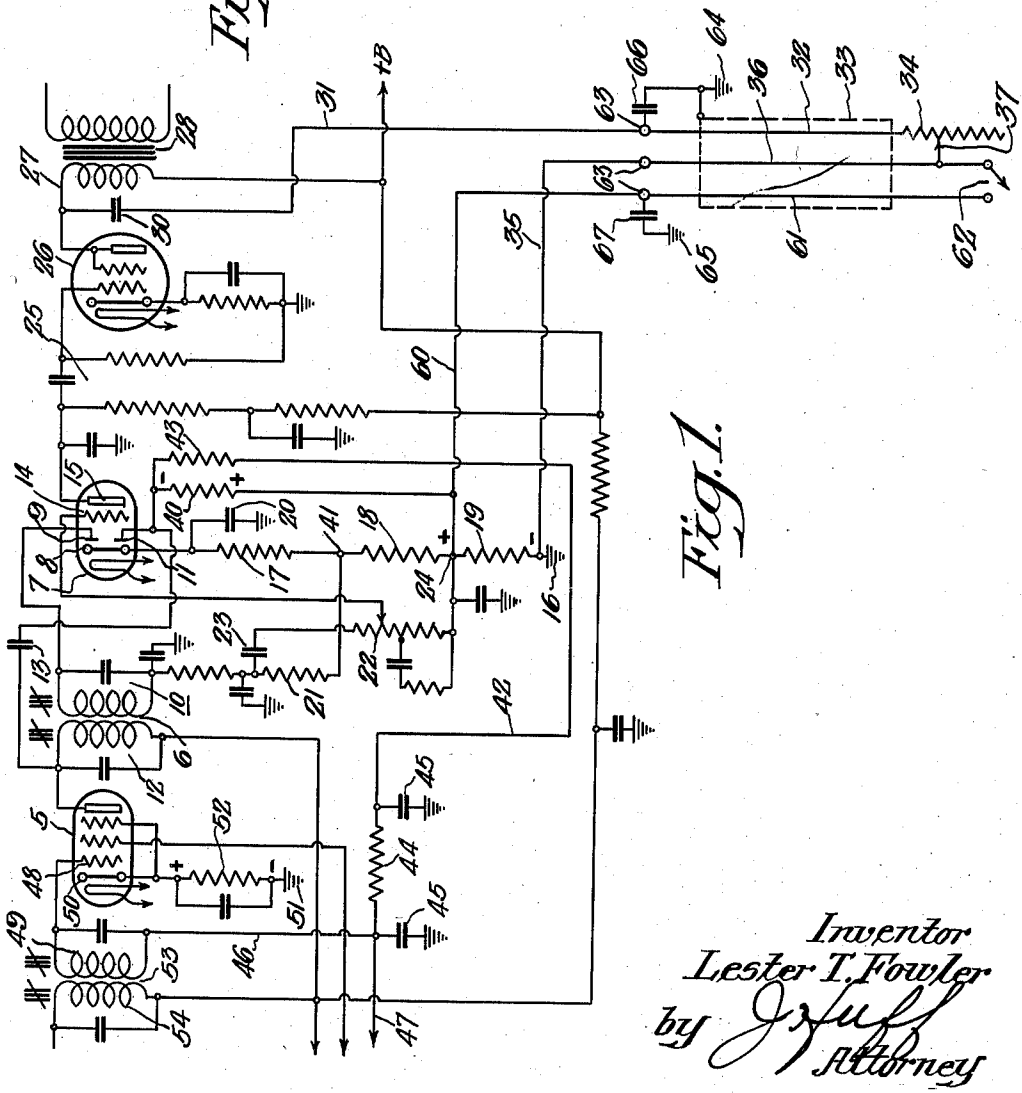


Fig. 1.

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SENSITIVITY CONTROL SYSTEM FOR AUTOMOBILE RADIO RECEIVERS

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10 Claims. (Cl. 250—20)

The present invention relates to a sensitivity control system for automobile radio receivers and the like, which are normally subjected to ignition and other interference, and has for its object to provide an improved sensitivity control system of the character referred to which permits of an extended control circuit from the receiving apparatus and which does not introduce interference signals into the receiving apparatus.

Since the sensitivity control for automobile receivers and the like must be extended to the instrument panel of the automobile, the control circuit is external to the receiver and is connected thereto by a cable. The usual method of providing a sensitivity control for such receivers includes the use of a variable resistor in the cathode circuit of one or more of the radio or intermediate frequency amplifier tubes, as well as the first detector tube. Such tubes are essentially sensitive to ignition interference and the extension of such circuits involves additional filters and shielding to prevent picking up ignition and other interference.

Cathode resistor control of the intermediate frequency amplifier tubes alone is unsatisfactory, although less sensitive to interference. Control of the intermediate frequency amplifier tube or tubes requires biasing to such a wide degree that the tubes lose sufficient power to drive the diode rectifier or second detector. Also, with this method of control, the distortion increases and additional second harmonic signals are generated in the plate circuit of the intermediate frequency amplifier tube or tubes. This causes the beat note condition to be worse than normal, so that additional filtering is necessary to suppress the beat notes.

It is, therefore, a further object of the present invention to provide a sensitivity control system for automobile radio receivers and the like which effectively overcomes substantially all of the above disadvantages and which is at the same time easily provided at low cost.

In a radio receiving system, the automatic volume control circuit is provided with suitable filters comprising series resistors and by-pass capacitors for decoupling the controlled grids from the automatic volume control bias source. It is, therefore, a further object of the present invention to provide a sensitivity control system for automobile radio receivers and the like having a filtered automatic volume control circuit which is applied to the return circuit of the automatic control means to take advantage of the inherent filtering and without resulting in any control connection with the cathode circuits of any of the amplifier tubes, whereby interference pick-up is reduced to a minimum.

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 drawing, Figure 1 is a schematic circuit diagram of a portion of a radio receiver for automobiles and the like provided with a sensitivity control system embodying the invention, and

Figure 2 is a similar schematic circuit diagram, being a portion of the circuit of Fig. 1, showing a modification of the sensitivity control circuit.

Referring to Fig. 1, 5 is an intermediate frequency amplifier tube which is coupled through an intermediate frequency coupling transformer 6 with a second detector and amplifier tube 7. The latter is of the double-diode, triode type, having a cathode 8, a detector diode anode 9 connected with the tuned secondary circuit 10 of the transformer 6, an automatic volume control diode anode 11 connected with the tuned primary circuit 12 of the transformer 6 through a coupling capacitor 13, and having a control grid 14 and an output anode 15 for the triode amplifier portion thereof. The cathode 8 is connected to chassis or ground 16, which is also the automatic volume control return circuit, through a self bias or cathode resistor comprising three sections 17, 18 and 19 provided with a by-pass capacitor 20.

The control grid 14 is arranged to receive audio frequency signals from the detector diode 9, through a diode output resistor 21 and a shunt volume control resistor 22, conneced therewith through a coupling capacitor 23. The grid 14 receives a biasing potential from a tap 24 between the resistor sections 18 and 19, to which tap point the volume control resistor 22 is connected at its low potential end, as shown.

The output anode 15 of the triode section is coupled through suitable resistance coupling means 25 with a first audio frequency amplifier tube 26, in the output anode circuit 27 of which an output coupling device 28 is provided for connection with additional amplifier stages or other output devices (not shown). The amplifier stage 26 is provided with a tone control means comprising a capacitor 30 connected to the output circuit 27 and having a control lead 31 connected through a lead 32 in an extension cable 33, with a tone control resistor 34 adapted for mounting on the instrument panel of the automobile. A ground lead 35 connected with the chassis 16 is

extended through a lead 36 in the cable 33 to a manually adjustable tone control contact 37 in connection with the resistor 34, whereby the tone is controllable in a well known manner, the resistance in circuit with the capacitor 30 being reduced to reduce the high frequency response of the amplifier by the increased shunting action of the capacitor across the signal circuit.

The automatic volume control circuit is connected with the diode anode 11, which receives signals from the primary of the transformer 6 and is thereby more broadly responsive than the secondary. The diode circuit is provided by a diode output resistor 40 connected between the diode anode 11 and the terminal 24 or other suitable tap along the cathode resistor. This places a delay potential on the diode anode 11 provided by the drop through the resistors 17 and 18. It will be noted that a lesser delay potential is placed on the diode anode 9 for the detector through the connection of the detector output resistor 21 with a tap point 41 between the resistor sections 17 and 18.

The automatic volume control potentials developed across the resistor 40 are applied to an automatic volume control lead 42 for the preceding amplifier tubes, through a series filter resistor 43 and a second filter resistor 44, for which by-pass capacitors 45—45 are provided.

The controlled amplifier tubes, represented by the intermediate frequency amplifier tube 5, are connected with the automatic volume control lead 42 through suitable leads indicated at 46 and 47. In the present example, the control grid 48 of the amplifier 5 is connected through the input circuit 49 with the lead 46, while the cathode 50 is connected to chassis or ground 51 through a self bias resistor 52. Other amplifier tubes (not shown) are connected in a similar manner to the chassis and automatic volume control lead 47, whereby the chassis provides the automatic volume control return circuit connection.

Intermediate frequency signals are applied to the second detector and automatic volume control means included in the tube 7 and associated circuits, through the amplifier 5 from an intermediate frequency input transformer 53, the secondary of which is included in the input circuit 49 and the primary 54 of which may be included in the anode output circuit of either the first detector or a preceding intermediate frequency amplifier tube (not shown), as is well understood.

The automatic volume control lead 47 may be connected with any of the preceding gain control tubes as normally used in a receiver such as the usual radio frequency amplifier, first detector, and other intermediate frequency amplifier tubes, the connections being as shown for the tube 5. In this circuit, the biasing potential between grid and cathode is provided by the automatic volume control diode output resistor 40 and the cathode resistor 19 as two potential sources, together with the potential source provided by the self bias resistor 52 at the amplifier tube. The polarity of these sources is indicated adjacent thereto.

The bias circuit arrangement is such that the automatic volume control diode resistor 40, instead of being returned directly to ground or chassis 16, is returned thereto through the potential source 19 which is positive at the terminal 24 with respect to ground or chassis by an amount determined by the degree of sensitivity control which is desired. The self bias resistors, such as the resistor 52, are of a higher than normal resistance for such self bias use by an amount such that the cathodes of the controlled tubes, such as the cathode 50, may have a positive potential with respect to ground or chassis sufficient to provide the grids, such as the grid 48, with a normal negative bias in the absence of signals, whereby maximum sensitivity is obtained. The drop in potential through the self bias or cathode resistor 52 is therefore greater than the drop in potential through the fixed potential source in the automatic volume control return circuit at 19, whereby the predominating bias potential on the grid is negative by the desired amount over the positive bias set up in the potential source 19.

If, now, the automatic volume control return terminal 24 is connected to chassis or ground 16, it will be seen that the grids of the controlled tubes will become more negative with respect to their cathodes by the amount of the potential provided by the resistor 19 and the over-all sensitivity of the receiver will be reduced accordingly, to some desired lower value, suitable, for example, for receiving local signals without interference. This control may be effected by extending a lead 60 from the terminal 24, through a cable lead 61 in the cable 33 to a switch 62 representing any suitable control device for grounding the lead 61. In the present case, the switch serves to connect the lead 61 to ground through the leads 36 and 35.

Because of the connection provided with the ground return circuit of the automatic volume control system as shown, interference from ignition or other sources introduced into the extension leads 36 and 61 have no effect upon the receiving circuits because of the filtering in the automatic volume control circuit, and the fact that the controlled potential source is connected adjacent to ground.

The extensible control circuit shown may be connected with the receiver through terminals indicated at 63 and the control leads may in certain cases be grounded at R. F. and I. F. potentials to the cable shield 33 and ground or chassis 64 and 65 through suitable high frequency by-pass capacitors 66 and 67 at the receiver terminals. The by-pass connections at this point are effective in removing ultra high frequency disturbances from the internal circuits of the receiver and in further isolating the same electrically from the external circuits connected therewith.

The circuit shown has been found to be satisfactory in connection with automobile receivers operating in the presence of heavy ignition and other interference potentials. Furthermore, the two-point sensitivity control is effective to provide what may be termed local and distance receiving conditions, depending upon the particular tubes used, and the amount of potential change required for reducing the sensitivity for local receiving conditions.

The range of control is determined by the potential established across the auxiliary or sensitivity control resistor 19 provided as the fixed potential source in the automatic volume control circuit return lead to ground or chassis.

In case, as is desirable, the fixed potential source for the sensitivity control is provided as a part of the cathode resistor of the combined second detector and amplifier tube, the resistance of the resistor section 19 should be relatively low with respect to the resistance of the remainder of the resistor comprising sections 17 and 18, in order that as the sensitivity control section is short-circuited the change in the bias on the

triode section of the detector amplifier and automatic volume control tube 7 may not be too great for its proper operation. However, any suitable fixed source of biasing potential may be utilized in place of the cathode resistor section 19 in a receiver.

If variable control of the sensitivity is desired, the automatic volume control lead to the source at the terminal 24 may be made variable, or the section 19 may be extended externally of the receiver and a variable return connection may be made therewith as shown in Fig. 2, to which attention is now directed, and in which like circuits and circuit elements as in Fig. 1 are designated by the same reference numerals.

In this case, the terminal 24 and the ground 16 are connected through the leads 60 and 35 with the cable leads 61 and 36, respectively, as before, which terminate in a potentiometer resistor 70 having a movable contact 71 connected through a cable lead 72 with a lead 73 in the receiver for the automatic volume control ground return from the automatic volume control diode output resistor 40, whereby the said lead is variably connected with the potential source 19. It will be seen that movement of the potentiometer contact 71 permits a varying potential to be applied to the automatic volume control circuit in opposition to the higher than normal biasing potential provided in connection with each amplifier tube by the self bias grounded cathode resistors, thereby permitting the sensitivity to be reduced gradually from a maximum to a minimum determined by the range of potential variation available across the source 19. In certain cases, where interference is less severe, the resistor 19 may be omitted and the resistor 70 may provide the potential drop required for the range of sensitivity control.

In the present case, the tone control connection is omitted, although it may be applied through the cable connection in the same manner as shown in the circuit of Fig. 1. The present circuit, however, reduces the number of leads required in the cable which is extended to any suitable location for the sensitivity control device.

In either of the embodiments shown in Figs. 1 and 2, the operation of the automatic volume control means is not impaired, since the potentials set up across the diode output resistor 40, in the presence of signals, serve further to increase the negative bias of the controlled tubes, and therefore reduce the gain whether the sensitivity is set for maximum or minimum or any intermediate position by either of the means shown in Figs. 1 and 2.

In either circuit, the sensitivity control is applied in the ground return connection for the automatic volume control circuit, the latter being provided with sufficient fixed negative biasing potential on the controlled tubes to overcome a series fixed opposing positive biasing potential of a value representing the range of biasing control desired for changing the receiving system from a condition of maximum sensitivity to a condition of reduced sensitivity for the reception of local signals.

With this arrangement, the series automatic volume control source of variable potential may operate effectively to control the gain locally under any condition of sensitivity and the external circuits from the receiver are effectively isolated from the receiving circuits through the normal filter provided in the automatic volume control circuit.

I claim as my invention:

1. The combination with an automobile radio receiving system having automatic volume control means, of an extensible sensitivity control circuit for said system comprising a chassis ground lead and a ground return lead for said automatic volume control means, means providing a controllable connection between said leads at a point remote from said receiving system to control the sensitivity between predetermined limits, and means providing a source of potential between said leads in circuit with said automatic volume control means and in opposition to the biasing potential provided by said automatic volume control means in response to signals, the potential of said source being of a predetermined value determining the range of sensitivity control effective at said remote control point.

2. The combination with an automobile radio receiving system having automatic volume control means, of a remote control system having an extensible control circuit comprising a chassis ground lead, a tone control circuit including said lead, and a ground return lead for the automatic volume control system, means for connecting said leads at a point remote from said receiving system to control the sensitivity and tone between predetermined limits, and means providing a source of potential between said ground and ground return leads in opposition to a normal biasing potential provided by said automatic volume control means and of a predetermined value determining the range of sensitivity control effective at said remote control point.

3. The combination with an automobile radio receiving system having automatic volume control means, of an extensible sensitivity control circuit for said system comprising a chassis ground lead and a ground return lead for said automatic volume control means, means providing a controllable connection between said leads at a point remote from said receiving system to control the sensitivity between predetermined limits, means providing a source of potential between said leads in circuit with said automatic volume control means and in opposition to biasing potential provided by said automatic volume control means in response to signals, the potential of said source being of a predetermined value determining the range of sensitivity control effective at said remote control point, said automatic volume control means including a diode signal rectifier having an output resistor and a plurality of signal amplifier tubes in said receiving system, each of said tubes having a control grid connected with the negative end of said output resistor, a filter in said connection, and said ground return lead for the automatic volume control system being connected with the opposite end of said output resistor.

4. The combination with an automobile radio receiving system having automatic volume control means, of a sensitivity control system having an extensible control circuit comprising a chassis ground lead and a ground return lead for the automatic volume control system, means for connecting said leads at a point remote from said receiving system to control the sensitivity between predetermined limits, means providing a source of potential between said leads in opposition to biasing potential provided by said automatic volume control means in response to signals and of a predetermined value determining the range of sensitivity control effective at said remote control point, said automatic volume

control means including a diode signal rectifier having an output resistor and a plurality of signal amplifier tubes in said receiving system, each of said tubes having a self bias resistor connected with said chassis ground providing a potential in excess of the potential of said source by an amount to provide maximum sensitivity in the absence of received signals, each of said tubes having a control grid connected with the negative end of said output resistor, a filter in said connection, and said ground return lead for the automatic volume control system being connected with the opposite end of said output resistor.

5. The combination with a radio receiver having an automatic volume control circuit provided with a grounded chassis return connection, of means providing a fixed source of positive biasing potential for said circuit in said ground return connection of a potential value corresponding to a desired change in sensitivity between a condition of maximum and minimum sensitivity, means in said automatic volume control circuit providing a negative biasing potential in excess of and in opposition to said first named potential by an amount sufficient to provide a predetermined maximum sensitivity, and means connected with said first named potential source for reducing said first named potential thereby to decrease the sensitivity of the receiving system from maximum, an extensible control circuit for said last named means connected with the automatic volume control circuit, and filter means in said automatic volume control circuit for isolating said extensible circuit from the receiving system.

6. In a radio receiving system, the combination with automatic volume control means and a plurality of amplifier tubes controllable thereby, of an automatic volume control circuit comprising means providing a control potential responsive to variations in received signal strength, means providing a return lead to a chassis ground for said circuit, means in said lead providing a fixed source of biasing potential for said tubes, means providing a second fixed source of biasing potential for said tubes, the magnitude of which potential is in excess of the potential provided by said first named source and in opposition thereto by an amount to provide a condition of maximum sensitivity for said receiving system, sensitivity control leads extending from said first named source of biasing potential, and means connected with said leads for connecting said automatic volume control return lead to said chassis ground.

7. In a radio receiving system, the combination with automatic volume control means and a plurality of amplifier tubes controllable thereby, of an automatic volume control circuit comprising means providing a controlling potential responsive to variations in received signal strength, a chassis ground connection therefor, means in said connection providing a fixed source of biasing potential, means providing a second fixed source of biasing potential for said controlled amplifier tubes, the magnitude of which last named potential is in excess of the potential provided by said first named source and in opposition thereto by an amount to provide a condition of maximum sensitivity for said receiving system, sensitivity control leads extending from said first named source of fixed biasing potential, and means connected with said leads for variably connecting said automatic volume control circuit to ground.

8. In a radio receiving system, the combination with automatic volume control means including a diode signal rectifier adapted to provide automatic volume control potentials, of an output resistor for said rectifier having a negative terminal, an automatic volume control circuit connected therewith, filter means in said connection including a series high resistance element and by-pass capacitor, means providing a fixed biasing potential in said last named circuit in series with said output resistor connected between the opposite end thereof and ground in said system, a plurality of amplifier tubes controlled by said automatic volume control means, each of said control tubes having a self bias resistor means providing a biasing potential greater than said first named potential by a predetermined amount and in opposition thereto, and remote control means for reducing the effect of said first named potential in said automatic volume control circuit comprising a circuit control device and circuit leads connected therewith and with said first named potential source.

9. In a radio receiving system, the combination of an interstage amplifier coupling transformer having a primary winding and a secondary winding, a signal rectifier device including a cathode and an anode, means for connecting said anode with the primary winding to receive signal energy therefrom, an output resistor for said signal rectifier, means providing a common chassis ground connection for said receiving system, a cathode circuit resistor connected between said cathode and said common chassis ground and having a connection at the cathode end thereof with the positive terminal of said output resistor, an automatic volume control circuit having a negative biasing supply lead connected with the negative terminal of said output resistor, filter means in said connection comprising a series resistor and a by-pass capacitor to the chassis ground from said lead, means for applying direct current to said cathode circuit resistor to cause a predetermined potential drop therethrough to effect a predetermined change in sensitivity of said receiving system, a pair of shielded control leads connected with said cathode circuit resistor, and remote control means connected with said leads and operative to connect the positive end of the signal rectifier output resistor to chassis ground to the exclusion of said cathode circuit resistor, thereby to change the sensitivity of said receiving system through a predetermined range dependent upon said potential.

10. In a radio receiving system, the combination with automatic volume control means including a diode signal rectifier adapted to provide automatic volume control potentials, of an output resistor for said rectifier having a negative terminal, an automatic volume control circuit connected therewith, filter means in said connection, an amplifier having a cathode circuit including a resistor providing a fixed biasing potential in series with said output resistor and connected with the opposite positive terminal of said output resistor at a point on said cathode circuit resistor which is positive with respect to ground, said ground providing a common return connection for said automatic volume control circuit, a plurality of amplifier tubes connected with said automatic volume control circuit to receive biasing potential therefrom in response to signals and from said fixed biasing potential, each of said control tubes having a self bias resistor means connected between cathode and ground and providing a biasing potential greater than said first fixed biasing potential in opposition

thereto and by a predetermined amount sufficient to effect substantially maximum sensitivity, means for reducing the effect of said fixed biasing potential on said automatic volume control circuit comprising a circuit control device and extended circuit leads connected therewith and with said first named potential source, and means for shielding said leads including by-pass paths of low alternating current impedance at the terminal of said leads at said receiving system.

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