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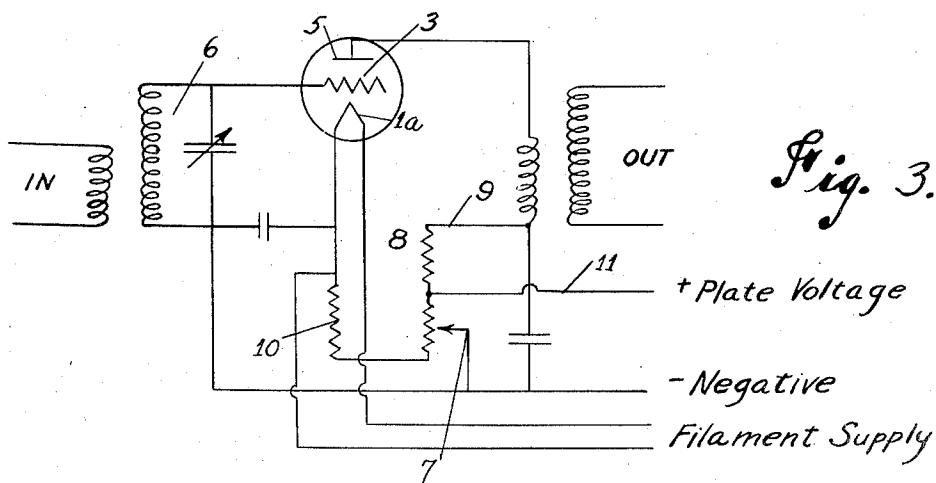
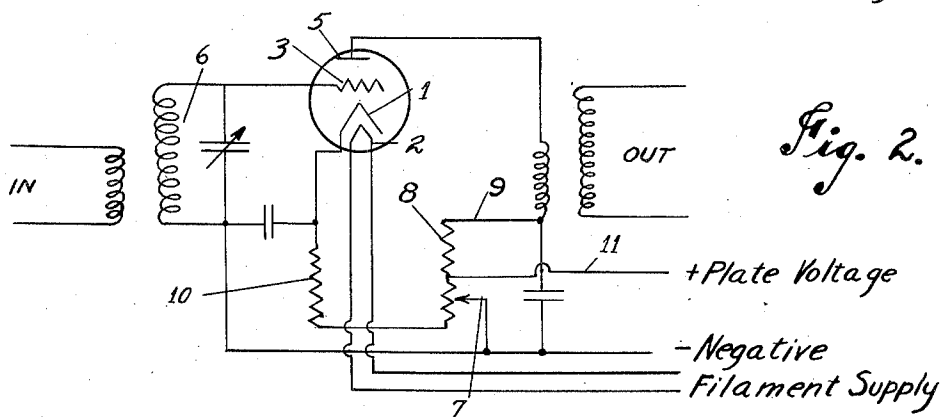
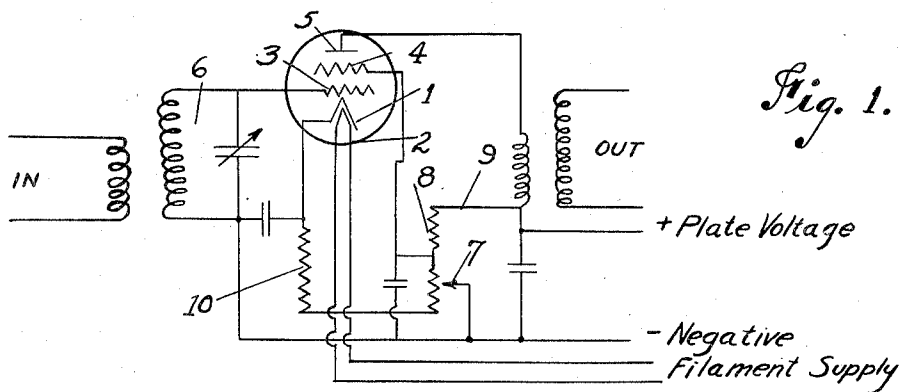
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1,978,008

VOLUME CONTROL METHOD FOR RADIORECEIVERS

Filed Oct. 26, 1929

3 Sheets-Sheet 1



INVENTOR.

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BY

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Oct. 23, 1934.

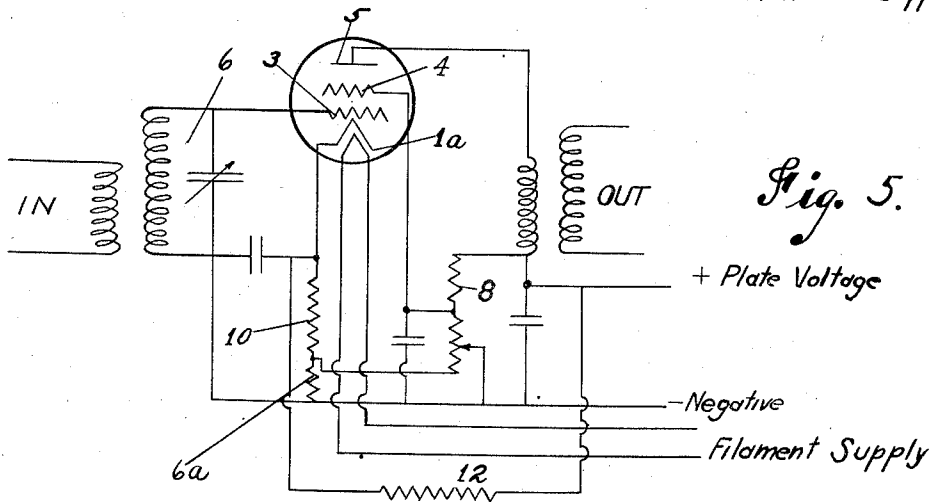
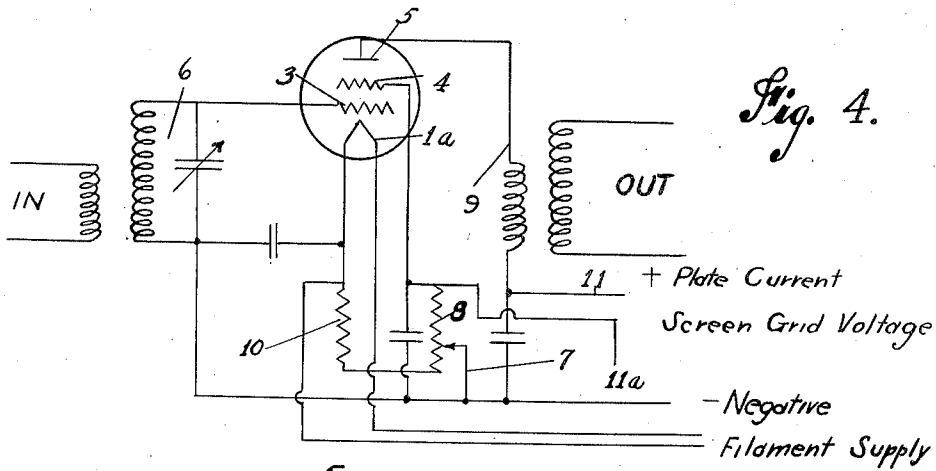
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VOLUME CONTROL METHOD FOR RADIORECEIVERS

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3 Sheets-Sheet 2



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VOLUME CONTROL METHOD FOR RADIORECEIVERS

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3 Sheets-Sheet 3

Fig. 6.

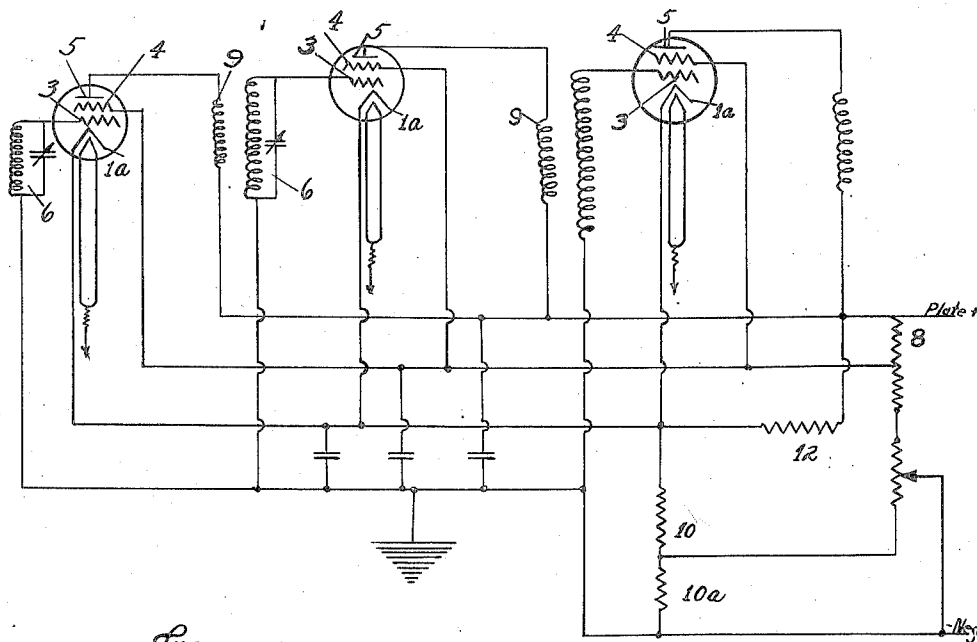
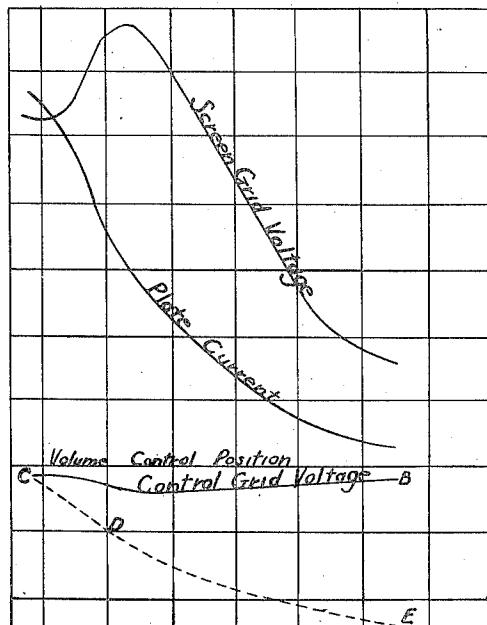


Fig. 7.

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UNITED STATES PATENT OFFICE

1,978,008

VOLUME CONTROL METHOD FOR
RADIORECEIVERSEmmery J. H. Bussard, Cincinnati, Ohio, assignor
to The Crosley Radio Corporation, Cincinnati,
Ohio, a corporation of Ohio

Application October 26, 1929, Serial No. 402,771

14 Claims. (Cl. 179—171)

My invention relates to means for controlling the volume of output of a radio receiver, and is perhaps chiefly applicable to multiple grid amplifier receivers, although it may also be used advantageously on single grid amplifiers. My volume control is applicable to radio tubes in which the filament supply is an unrectified or only partially rectified alternating current applied directly to the filaments, but is primarily intended for use with amplifier tubes in which the applied current is used to heat the emitting element or cathode and does not pass there-through, or to direct current energized tubes.

With the filament type of A. C. radio tubes it is usually impractical to adjust the output volume or amplification factor of the tubes by a method which changes the tube characteristics, due to the tendency of the tube to transmit the A. C. pulsations. It is possible, however, with the "heater" type of tubes to adjust the negative bias of the grid, so as to control amplification. Thus an increase from normal, negative bias will reduce the amplification.

With tubes having two grids commonly known as screen grid tubes, it is not practical in some of the most desirable types of circuit to alter the bias of either of the grids without at the same time affecting the bias of the other. The one grid, as a matter of fact, will so react to a change of bias of the other grid, as to partly compensate for the variation in amplification which would otherwise result, or the control grid bias may drop sufficiently low to allow the tube to draw grid current. This results in loss of selectivity and objectionable cross talk, a feature which has been known to be serious enough to make receivers impractical.

If it were not for this compensating reaction of the tube net work, the ideal amplification control system for screen grid tubes would be to alter the normal potential of the screen grid with relation to the filament or emitter.

In heater type, or D. C. screen grid tubes, it will accordingly be desirable, in controlling the volume of output (by means that cut down amplification), to adjust the bias of both grids. My invention relates to a mode of accomplishing such a double adjustment by a single control element. In the illustrated embodiment the control grid-filament return and plate-filament return are applied to the screen grid-filament return in an adjustable manner, the result being that as the screen grid plus bias is decreased the control grid minus bias is not decreased or made positive which would otherwise occur.

Indeed, the effect of the structure will be to impart a greater negative value to the control grid bias over the entire range than is usually desirable, so that while the use of my device is valuable for use as above noted, I ordinarily employ a suitable by-pass, so that the control grid minus bias may be maintained constant over all or a desired portion of the range. It may be so arranged as to give gradually increasing control grid bias to some predetermined value which will not result in complete plate current cut off and rectification or detection in these tubes, as this will give a very mushy and unpleasant reproduction, and is the maximum attenuation possible by means of increased grid bias. Usually the control grid bias is not increased to more than about half this value as a maximum, and the remaining attenuation possible in the tube is accomplished by decreasing the screen grid voltage as far as possible without causing mushy or garbled reproduction.

I accomplish my object in its preferred and simplest form by that control system to be hereinafter specifically described and the novelty therein duly claimed.

In the drawings:—

Figure 1 is a diagram of a heater type, screen grid tube net work illustrating my invention.

Figure 2 is a diagram of a heater type tube net work, in which no screen grid is employed.

Figure 3 is a diagram of a tube net work of filament emitter type without screen grid.

Figure 4 is a diagram of a tube net work in which the tube is of filament emitter type, with both control and screen grids.

Figure 5 is a diagram similar to Figure 1 but in which a shunting resistance is employed.

Figure 6 is a chart showing the plate current and the control and screen grid voltages plotted against volume control as same is applied according to my invention, with a dotted line showing the normal drop of control grid voltage which would follow if resistance 10a were omitted.

Figure 7 shows my circuit in connection with a plurality of tubes.

Referring first to the arrangement shown in Figure 1—the emitter 1 of the tube is energized by a heater indicated at 2. The control grid is indicated at 3, screen grid at 4, and plate at 5. The tuned circuit 6 for the control grid is connected at its ground side to a slider indicated at 7, this slider also carrying the negative return to the emitter of the D. C. plate supply.

The screen grid is connected to a selected point of a resistance 8, one end of which is connected

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to the plate circuit 9 and the other end of which is connected to the emitter through the usual biasing resistance 10.

By connecting the control grid circuit or the ground potential (negative) by means of the slider to some point between the screen grid connection and the emitter connection on the resistance 8, the negative bias of the control grid will be correct for the maximum amplification of the tube. As the slider is moved toward the screen grid connection this negative bias will be increased. At the same time, however, the positive bias between the screen grid and the emitter will be decreased and brought near to the ground potential (negative) since with my arrangement the center arm of the potentiometer is at ground potential.

Referring next to the other views in which a like end result is obtained—in Figure 2 the indicating numbers are the same as in Figure 1 for the several elements of the net work. The screen grid is, however, omitted, and the selected point on the resistance 8 is connected to the direct current source of plate voltage, as by lead 11. In this arrangement as the negative potential or ground is moved further from the emitter along the resistance 8, thus increasing the grid bias, the negative plate return is brought nearer to the positive point, thus cutting down the potential difference between the emitter and the plate.

In Figure 3 the filament 1a is the emitter. The arrangement is otherwise like that of Figure 2, with the same results.

In Figure 4 there is shown a case in which there is a screen grid, but the filament 1a is the emitter. As will be noted, the arrangement in this instance is a combination of the arrangement in Figures 1 and 3. In this view the resistance 8 is connected at one end to the screen grid lead, and the screen grid potential is supplied from the voltage supply of the receiver, rather than from the plate voltage supply as in the other views, said supply in the other views being passed through part of the resistance 8 before reaching the screen grid. This variation in Figure 4 is merely another way of wiring the receiver, and is the full equivalent to the arrangement in the other diagrams.

In Figure 5 the arrangement is similar to Figure 1 in which the positive plate circuit lead is connected to the resistance 8. In addition, a resistance 12 is shunted across the biasing resistances, so as to provide a leakage path for the direct current, that prevents cutting down the difference of plate potential with relation to the filament, beyond a certain amount.

In Figure 5 another variation over the other views that is of importance, is the use of the resistance 10a. The fixed biasing resistance 10 plus the variable biasing resistance at 8, cannot, in the arrangement of Figure 5, be effective beyond a certain point, because the resistance 10a is inserted so as to by-pass the variable resistance.

In Figure 5 is the most complete and preferred arrangement of the net work required for the best operating condition of my invention with screen grid tubes. To the basic arrangement as shown in Figure 1 are added the by-pass resistance 10a, and stabilizing resistance 12 shunted from the plate circuit to the emitter providing a definite or floating leakage depending on voltage which tends to maintain a fairly constant current through resistance 10. There is a tendency for the plate voltage to increase to dangerous values as the plate current is cut by action of the volume control on the two grids in the tube. Resistance

12 serves to reduce this floating tendency to a minimum and permits the tube to be operated nearer its maximum plate voltage with resulting maximum amplification.

Referring finally to the chart illustrative of the screen and control grid voltage changes, I have indicated the plate current screen grid voltage and control grid voltage plotted against volume control position. Point C is the point of greatest volume, and point B is the point of greatest attenuation without signal distortion. At point D on curve E, the control grid bias will begin to be so great that the plate circuit will exhibit rectifying action. Curve E is the control grid bias in a structure which omits the resistances 10a and 12 or their equivalents.

While I have described my arrangement as applied to a single tube, it will be apparent that it can be used as a common element in a series of coupled circuits. Figure 7 illustrates the device in connection with a series of tubes.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. A volume control method for application to screen and control grid radio tubes having a control grid to screen grid circuit and control grid to emitter circuit, which consists in changing the bias of the screen grid while maintaining, substantially at full value, the minus bias of the control grid, by substantially inversely varying the resistances in a circuit including the control grid and the screen grid, and in a circuit including the control grid and the emitter.

2. A volume control method for application to plural grid tubes, which consists in changing the bias potential of one of the grids to control the volume output, and simultaneously changing the impressed bias potential of the other grid to offset a compensation change in the bias of said grid.

3. A volume control method for application to plural grid tubes which consists in varying the normal potential of the screen grid with relation to the emitter and simultaneously compensating for the reaction in the control grid circuit by changing the resistance in the control grid circuit return, to compensate for the plate current change.

4. A volume control method for application to plural grid tubes which consists in varying the normal potential of the screen grid with relation to the emitter and simultaneously compensating for the reaction in the control grid circuit by changing the resistance in the control grid circuit return, to compensate for the plate current change.

5. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the high voltage supply of one of the other elements of the tube and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along said resistance.

6. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the high voltage supply of one of the other elements of the tube and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along the said resistance, and a second resistance element connected from the cathode to the high voltage supply of one of the other elements.

7. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the screen grid of the tubes, and a connection from said resistance element to the common return of the control grid and plate circuits, said connection to the resistance being adjustably variable along said resistance. 80
8. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the screen grid of the tubes, and a connection from said resistance element to the common return of the control grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a second resistance element connected from the cathode to the high voltage supply of one of the other elements. 85
9. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the high voltage supply of one of the other elements of the tube, and a common return of the grid and plate circuits having a connection to said resistance, said connection being adjustably variable along said resistance, and a fixed resistance in series with the adjustably variable connection and the said grid. 90
10. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the plate of the tubes and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a resistance by-passing the said variable resistance. 95
11. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the screen grid of the tubes, and a connection from said resistance element to the common return of the control grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a resistance by-pass to the control grid from said common return. 100
12. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the screen grid of the tubes, and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a resistance by-pass to the control grid from said common return. 105
13. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the plate of the tubes and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a resistance by-passing the said adjustably variable connection. 110
14. A volume control for radio circuits employing vacuum tubes, which consists of a resistance element connected from the cathode to the plate of the tubes and a connection from said resistance element to the common return of the grid and plate circuits, said connection to the resistance being adjustably variable along said resistance, and a resistance by-passing the said adjustably variable connection. 115

EMMERY J. H. BUSSARD.

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