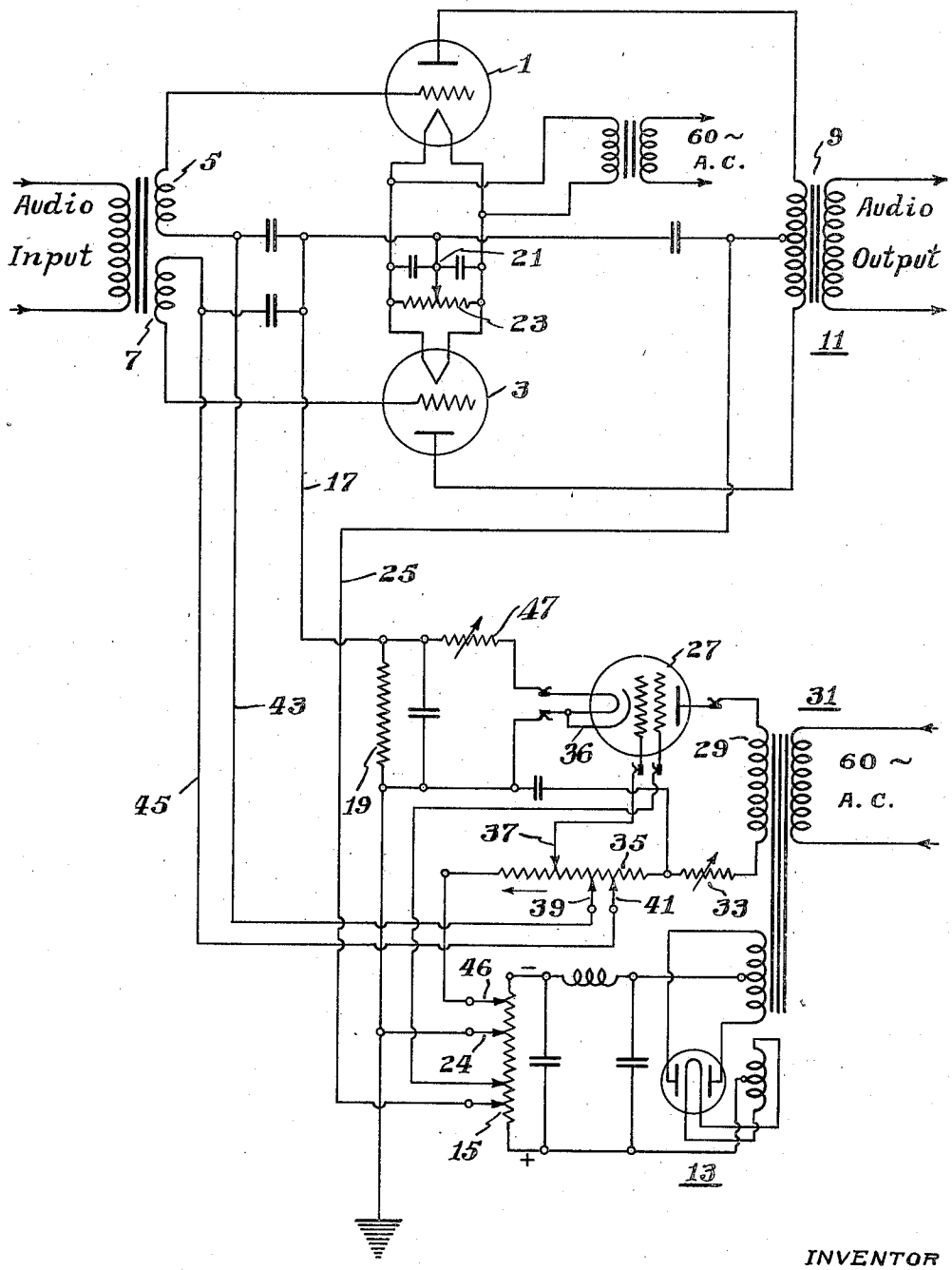
Dec. 21, 1937. G. L. BEERS 2,102,779

THERMIONIC AMPLIFIER

Filed Feb. 28, 1934



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Patented Dec. 21, 1937 2,102,779

UNITED STATES PATENT OFFICE

2,102,779

THERMIONIC AMPLIFIER

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Application February 28, 1934, Serial No. 713,261

10 Claims. (Cl. 179—171)

My invention relates to thermionic amplifiers and it has particular relation to amplifiers of the power type such as those utilized in the output stages of radio receivers and the like.

Since the output tubes in a broadcast receiver constitute the most important factor to be considered in determining the current which the anode potential supply system must provide, it is impractical to obtain a fixed bias for these tubes from such supply system if the average current of the tubes is to vary with applied signal voltage. For example, if tubes of the type commercially known as Radiotron 2A3 are used in push pull in the output stage they will give an output of 15 watts, with total distortion of not over 2.5% in the event that an appropriate fixed bias of 60 volts is applied to their grids. On the other hand, if the same tubes are used with a self-bias resistor, their rated output is only 10 watts with a distortion of 5.0%, thus stressing the advisability of utilizing a fixed bias.

In view of the foregoing, it has been proposed to use an additional rectifier solely for the purpose of providing the necessary fixed bias. Conventional systems of the type using an additional rectifier tube are satisfactory just so long as the rectifier filament is intact but if the filament burns out or if the tube is removed from its socket while the amplifier is in use the bias is removed from the output tubes and serious damage to these tubes and to other parts of the receiver may result.

It is, accordingly, an object of my invention to provide a fixed bias supply system that shall obviate the disadvantages mentioned.

When thermionic amplifiers are operated to give high output currents the phenomenon of grid-emission causes grid-currents to flow in such direction that, if a self bias resistor or the like is included in the grid-return circuit, the grids are biased in the positive direction. Under such circumstances the tubes may draw excessive anode current and be ruined.

Another object of my invention, therefore, is to provide a fixed bias supply system that shall be self-regulating to the extent that the effect of grid-emission in the biased tubes shall be compensated.

A still further and more specific object of my invention is to provide a fixed bias supply system that shall be self regulating to the extent that fluctuations in the primary power supply thereto shall be compensated.

The foregoing objects and other objects ancillary thereto I prefer to accomplish through the combination of a self-bias resistor, a bias-potential supply system, including a grid-controlled thermionic rectifier of the high vacuum type, and means for rendering the self-bias resistor inoperative when the rectifier is operative and vice versa. More specifically, I connect the thermionic rectifier in shunt relation to the self-bias resistor and return the grids of the amplifier tubes to a point on the main potential-supply resistor over a circuit including part or all of an output resistor connected between the anode and the cathode of the said rectifier.

For the purpose of regulating the rectifier, I also utilize the potential drop along the output resistor or a portion thereof to control the impedance of the rectifier by applying it to the grid therein.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing.

The single figure of the drawing is a diagrammatic view of an output stage including a preferred embodiment of my invention.

Referring to the drawing, I have chosen to illustrate the application of my invention to the output stage of a radio receiver constituted by two thermionic tubes 1 and 3 connected in push-pull relation through a split input inductor 5—7 and a common output inductor 9 which may be the primary winding of an output transformer 11. The specific thermionic tubes adopted by way of example are those known commercially as Radiotron 2A3; obviously, my invention is not limited thereto.

Anode potential for the tubes is provided by a rectifier 13 having an output resistor 15. A connection 17 including a self-bias resistor 19 extends between a movable element 21 in contact with a potentiometer resistor 23 connected in shunt relation to the cathodes of the tubes and a grounded movable connector 24 normally in contact with the output resistor 15 adjacent to the negative end thereof. Plate potential for the tubes is supplied over a connection 25 extending between a point on the output resistor 15 adjacent to the positive end thereof and an intermediate tap on the output inductor 9.

A biasing potential of 60 volts is desirable for tubes of the type referred to. Since these tubes

each draw 40 milliamperes of plate current, such potential is provided if the self-bias resistor 19 has a magnitude of the order of 750 ohms.

The amplifier stage thus far described is conventional and, as hereinbefore stated, when bias for the tubes is supplied by the self-bias resistor it is capable of but 10 watts output at 5% distortion. Therefore, in accordance with my invention, I provide an additional source of biasing potential and means for automatically substituting it for the self-bias resistor. Specifically, the additional source is constituted by a thermionic bias-supply tube 27 which may be of the screen-grid type the filament of which is connected in shunt to the self-bias resistor 19 and the anode of which is connected back to the filament over a circuit including the secondary winding 29 of a power transformer 31, a variable regulating resistor 33, a bias-supply resistor 35 and a portion of the rectifier output resistor 15.

It is desirable that the bias-supply tube shall function immediately upon application of cathode energizing potential thereto. I have illustrated it at 36, as being of the equipotential cathode type, which if quick-heating, may be used. Otherwise an ordinary cathode or filament is preferable.

A movable contact 37 associated with the bias-supply resistor is conductively connected to the grid of the bias-supply tube 27, whereby its potential may be determined with respect to the filament. By means of additional second movable contacts 39 and 41, also associated with the bias-supply resistor 35 more or less of the said resistor may be included in connections 43 and 45 extending respectively, from the grids of the amplifier tubes 1 and 3 ultimately to the movable connector 46 normally contacting the rectifier output resistor 15 adjacent to the negative terminal thereof.

Preferably, in order to insure against overheating and to provide longer life, the filament of the bias-supply tube normally draws slightly less current than is available from the space current in the amplifier tubes. In the example given the bias supply tube filament draws 60 milliamperes at two volts and a filament rheostat 47 may be included in the filament circuit to regulate the filament current.

In the operation of my improved system the potential applied to the anode of the bias supply tube 27, the potential applied to the filament thereof, and the bias potential applied to the grid from the bias supply resistor are so adjusted that, under normal conditions, the total potential developed across the bias-supply resistor 35 is in excess of the biasing potential required for the grids of the amplifier tubes. If the bias-supply resistor has a magnitude of 120,000 ohms, such excess potential may be obtained by a flow of one milliampere therein and the movable contacts 39 and 41 connected to the grids of the amplifier tubes may be adjusted therealong to give a biasing potential of 60 volts for the said amplifier tubes.

Additional control of the bias potential applied to the amplifier tube grids may be obtained through adjustment of either contactor 24 or contactor 46, or through adjustment of both of them.

If, during the operation of the system, grid-emission occurs grid-current tends to flow in the bias supply resistor 35 in the direction of the arrow; that is, in a direction counter to the rectified current from the bias-supply tube. Such counter-flow of current would render the amplifier tube grids less negative were it not for the fact that the grid of the bias-supply tube is so connected to the bias-supply resistor 35 as to also become less negative with respect to the filament of the bias-supply tube when such grid-current flows. The impedance of the bias supply tube, therefore, is reduced and additional rectified current is delivered to the bias-supply resistor to counteract the effect of the grid-current, thus maintaining the bias on the amplifier tube grids substantially constant.

Furthermore, by reason of the connection between the grid of the bias-supply tube and the bias-supply resistor, any change in plate potential from the transformer 31 is counteracted and the bias supply, therefore, is self regulating.

In the event that the filament of the bias-supply tube burns out or if it is removed from its socket, bias will be supplied to the amplifier tubes from the self bias resistor 19. Under certain conditions it may be desirable that the amplifier tubes shall become inoperative upon failure of the fixed bias-supply. In that case, the self-bias resistor 19 should have a much higher resistance than 750 ohms, a value of approximately 100,000 ohms being sufficient to supply substantially cut-off potential to the amplifier tubes.

From a consideration of the foregoing it will be apparent that I have provided a bias-supply system that is distinctly novel and one that has numerous advantages. Among such advantages may be reiterated the fact that the system is self regulating, it counteracts the effect of grid-emission on the biasing potential applied to the grids of the amplifier tubes and it provides a reserve bias-source operative upon failure of the bias-rectifier.

Although I have chosen a particular embodiment of my invention for purposes of explanation many modifications may, obviously, be made. My invention, therefore, is not to be limited except by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination, an amplifier tube having an input circuit and an output circuit, a self-bias resistor common to both of said circuits, a thermionic rectifier having a cathode, means for utilizing the normal potential drop across the self bias resistor for energizing the cathode of the rectifier, a resistor in the output circuit of the rectifier and means for including at least a portion of said resistor in the input circuit of the amplifier tube.

2. In combination, a plurality of thermionic amplifying devices, means for supplying anode current and cathode heating current to one of said devices, means including a thermionic rectifier device for supplying grid biasing potential to said device, and means for supplying a portion of said anode current as cathode heating current to the rectifier device from the first mentioned device.

3. The invention set forth in claim 2 additionally characterized in that means are provided for maintaining the output current from the rectifier substantially constant irrespective of variations in potentials supplied thereto.

4. In combination, a thermionic tube, means whereby space current in said tube furnishes a grid-biasing potential thereto, supplemental means for furnishing grid-biasing potential to the tube, and means providing connections between said first mentioned and supplemental means whereby, when the last supplemental

means is active the first mentioned means is automatically rendered inactive, said supplemental means including a rectifier tube having a cathode energized by said space current of the first named tube.

5. The invention set forth in claim 4 characterized in that the first mentioned means is a resistor and the connection means includes a circuit whereby the rectifier is supplied with cathode heating current from the resistor.

6. The invention set forth in claim 4 characterized in that the rectifier tube is provided with an output resistor and with a grid and further characterized in that the last named grid is connected to a point on the output resistor to render the impedance of the rectifier dependent on changes in the grid current in the thermionic tube to which bias is supplied, and in opposition to such changes in affecting the biasing potential of the first named tube.

7. The invention set forth in claim 1 further characterized in that the rectifier is provided with a control grid which is connected to a point on the output resistor to receive a biasing potential therefrom, whereby the impedance of the rectifier is automatically caused to compensate the effect of grid-current in the amplifier tube.

8. In combination, an amplifier tube, an input circuit and an output circuit therefor, a self-bias resistor common to both of said circuits and additional biasing means included in said input circuit, said biasing means including a bias supply resistor included in said input circuit, a rectifier connected in circuit with said last named resistor to supply current thereto, and having a cathode connected with said self bias resistor to be energized therefrom and a control grid connected with said bias supply resistor to receive a controlling potential therefrom.

9. In combination, an amplifier tube having an input circuit and an output circuit, a self-bias resistor common to both of said circuits, a thermionic rectifier having a cathode, a grid and an anode, means for utilizing the potential drop across the self-bias resistor, when the amplifier tube is in operation, for energizing the cathode of the rectifier, a resistor in the output circuit of the rectifier, means for applying potential between the cathode and the anode of the rectifier, means providing a connection from the grid of the rectifier to the output resistor and means providing a connection from the input circuit of the amplifier tube to the output resistor, whereby a portion of the output resistor is common to the rectifier and amplifier grid circuits and whereby, if grid emission occurs in the amplifier tube the impedance of the rectifier is lowered.

10. The combination with an amplifier including an amplifier tube having an input grid circuit, an output anode circuit, and a cathode connection common to said circuits, of an anode potential supply means therefor including an output resistor having positive and negative terminals, an anode potential supply connection for the anode circuit connected to said resistor adjacent to the positive terminal thereof, said cathode connection including a bias resistor and a tap on said anode potential supply resistor adjacent to the negative terminal thereof, a bias supply tube having a cathode connected to receive energy from said self bias resistor, a control grid, a screen grid and an output anode, means providing an anode circuit for said bias supply tube including an alternating current supply connection and a bias supply resistor connected between the last named anode and the anode potential supply resistor adjacent to the negative terminal thereof, means providing connections for the first named input grid circuit and said last named control grid with the bias supply resistor, and means providing a connection for said screen grid with the anode potential supply resistor adjacent to the positive terminal thereof.

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