Nov. 18, 1941. H. BOUCKE 2,262,916

ELECTRIC AMPLIFYING SYSTEM

Filed April 26, 1939 3 Sheets-Sheet 1

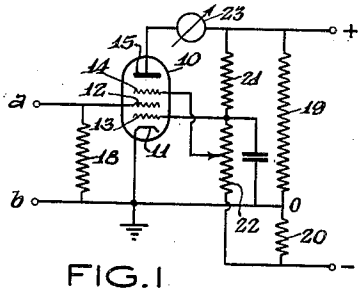


FIG. 1

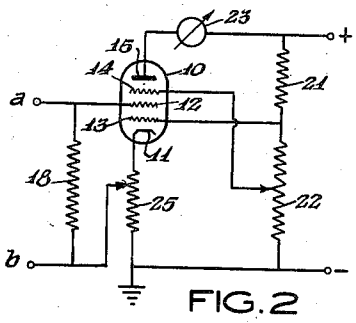


FIG. 2

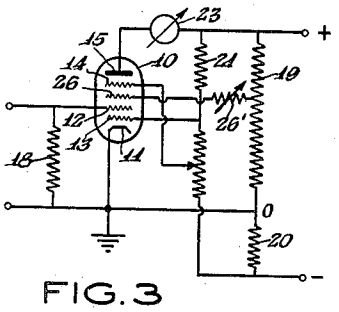


FIG. 3

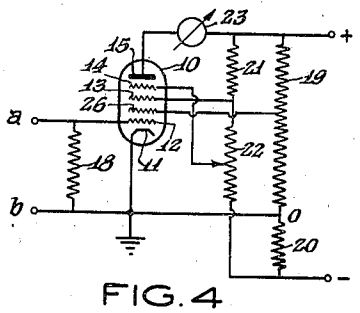


FIG. 4

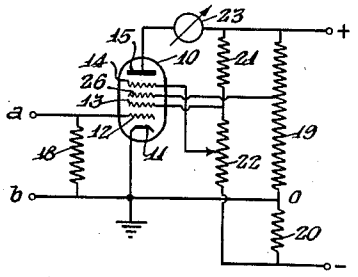


FIG. 5

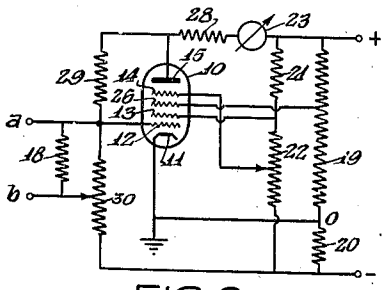


FIG. 6

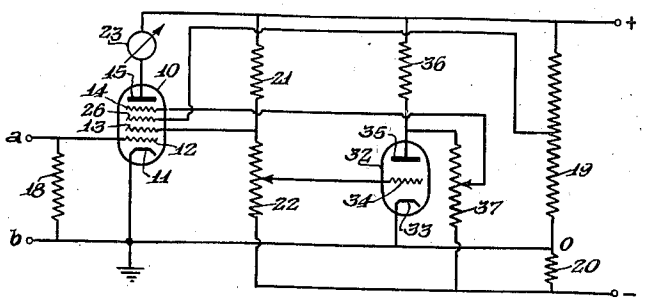


FIG. 7

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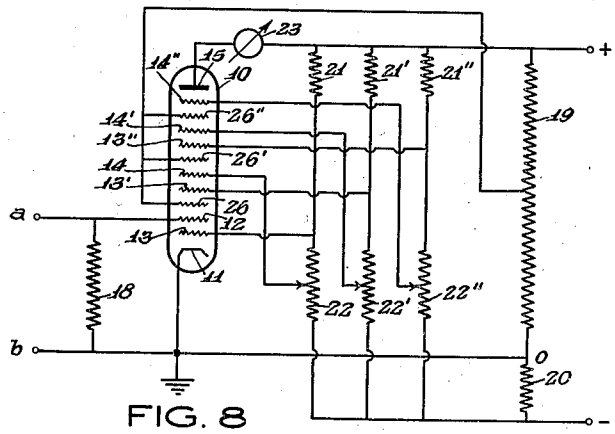


FIG. 8

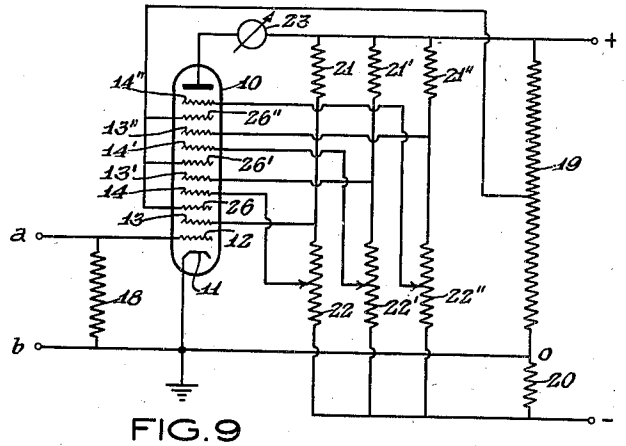


FIG. 9

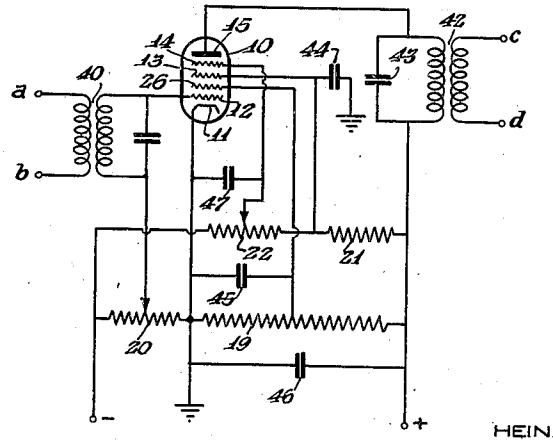


FIG. 10

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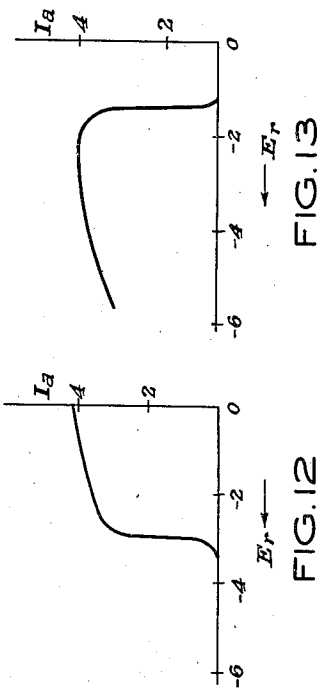


FIG. 13

FIG. 12

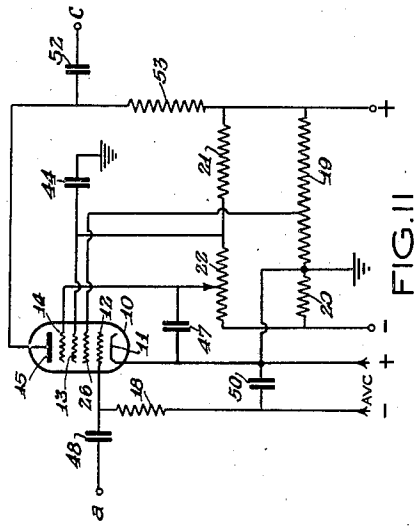


FIG. 11

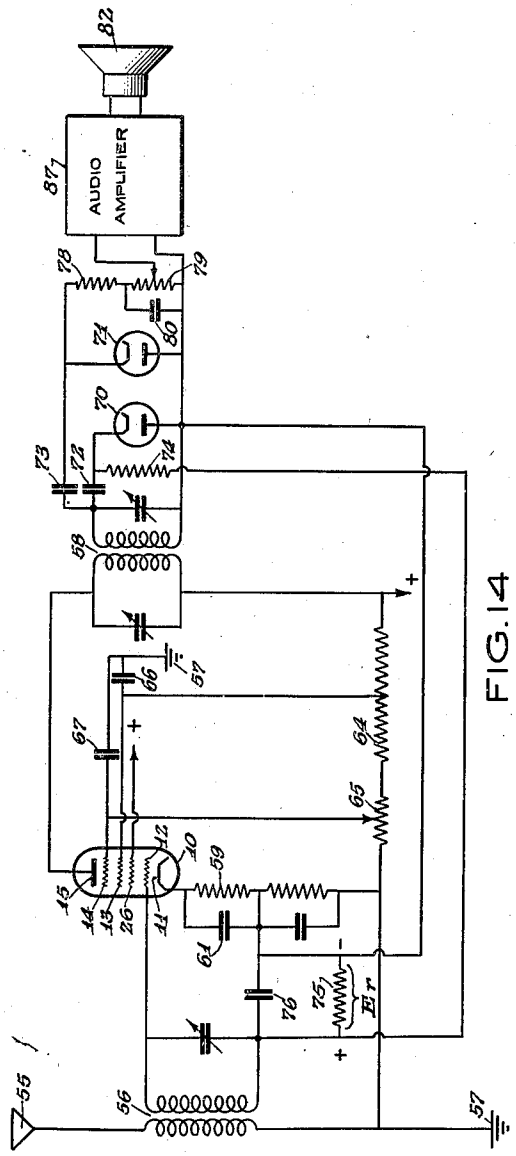


FIG. 14

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UNITED STATES PATENT OFFICE

2,262,916

ELECTRIC AMPLIFYING SYSTEM

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Application April 26, 1939, Serial No. 270,053
In Germany May 30, 1938

16 Claims. (Cl. 179—171)

The present invention relates to electron valve amplifiers and a method of operating the same, more particularly to aperiodic or direct coupled multi-stage amplifiers for translating or amplifying signals comprising a substantial frequency band or for amplifying relatively slow periodic or aperiodic variations of electric current or potential. There are numerous applications for amplifiers of this type such as in industrial control equipment, telegraphic signalling, measuring systems, in radio receivers and various other uses.

An object of the invention is the provision of a direct coupled electron valve amplifier comprising two or more amplifying stages embodied in a single amplifying valve.

Another object is the provision of a novel automatic volume control (A. V. C.) arrangement for use in radio receivers or the like characterized by substantially increased sensitivity and efficiency compared with A. V. C. systems at present known in the art.

A more specific object is to provide a self-regulating amplifier or volume limiting device adapted to automatically maintain a desired output level in a radio receiver or any other amplifying system.

Another object is to provide a multi-grid electron valve amplifier capable of simultaneously amplifying both direct and alternating currents.

With the above objects in view, the invention contemplates the use of a multi-grid electron valve amplifier having an input control grid upon which are impressed the potential variations to be amplified to cause corresponding fluctuations of the electron stream passing through the valve. Amplified potential variations are derived from the first positive or anode grid and impressed through a direct current coupling arrangement upon a second control grid arranged to control the same electron stream. Suitable compensating means are provided to suppress the effect of the positive operating potential at the anode grid upon the second control grid and to maintain the latter at a suitable preferably negatively biased operating point to ensure efficient and faithful amplification and translation of the input potential variations within a desired operating range. Further direct coupled stages may be included in the same valve for additionally controlling the common electron stream. The final amplified potential or current is derived from an anode and/or one of the positive grid electrodes.

The above and further objects and aspects of the invention will become more apparent from the following detailed description taken with reference to the accompanying drawings illustrating several practical embodiments of the invention and wherein:

Figures 1 to 7 represent simple direct coupled two-stage amplifier circuits embodying a multi-grid electron valve in accordance with the invention,

Figures 8 and 9 illustrate circuits embodying a multi-grid valve providing more than two amplifying stages,

Figure 10 illustrates an amplifier stage of a radio receiver or the like embodying the improvements of the invention for automatically controlling the output volume of the receiver,

Figure 11 shows an amplifier stage in a radio receiver or the like embodying the improvements of the invention for suppressing inter-carrier noises during the tuning of the receiver,

Figures 12 and 13 are graphs illustrative of the function and novel effect obtained by the invention,

Figure 14 illustrates the invention as embodied in a radio receiver for obtaining improved automatic volume control.

Similar reference numerals identify similar parts throughout the different views of the drawings.

Referring to the drawings, Figure 1 shows a simple direct coupled amplifier constructed in accordance with the invention and comprising a multi-grid valve 10 having a cathode 11 which may be of either the directly or indirectly heated type, an input control grid 12, a first positively biased or anode grid 13, in the example shown having the form of a space charge grid located near the cathode, a second preferably negatively biased control grid 14 and an anode 15. The input voltage to be amplified is impressed between the cathode 11 and input grid 12 through terminals *a*, *b* the latter being shunted by an input impedance such as an ohmic resistance 18. The positive or anode grid 13 is connected to the positive terminal of a high tension supply source represented by the potentiometer resistance 19 through a load impedance 21 whereby amplified potential variations will be developed at the grid 13 corresponding to the variations of the applied input potential. These potential variations are impressed directly and conductively upon the control grid 14 through a potential divider resistance 22 connected between the grid 13 and the negative terminal of a compensating battery or potential source represented by the potentiometer resistance 20. The positive

end of the potentiometer resistance 20 is connected to the negative end of the resistance 19, with the junction point between the resistances forming the negative or ground terminal of the circuit in such a manner that the effect of the positive potential on the grid 13 due to its connection to the positive side of the high tension source or potentiometer resistance 19 is compensated. In this manner the bias of the grid 14 may be adjusted to a suitable preferably negative operating point to ensure most favorable operating conditions and efficient amplification of the electron current variations. The amplified current variations may serve to operate a measuring instrument 23 if the system serves for measuring purposes, or alternatively, the instrument 23 may be replaced by a suitable coupling impedance or network for applying the amplified current or potential variations to a suitable translating device or to a further amplifying stage.

In the afore-described arrangement the electron discharge current passing through the valve from the cathode to the anode is subjected to the simultaneous control by the two grids 13 and 14.

Figure 2 shows a two-stage direct coupled amplifier similar to Figure 1 wherein a special compensating source is dispensed with by the provision of a resistance 25 in series with the cathode lead or ground of the valve. The effect of this resistance is to render the control grid 14 negative relative to the cathode thereby compensating the effect of the positive or anode potential as a result of the conductive connection between the grids 13 and 14. This kind of compensation of the steady positive potential is possible due to the fact that the total anode current passing through the resistance 25 within the operating range of high mutual conductance of the valve varies only slightly, and that the control of the currents flowing to the positive grid 13 and to the anode is effected by a varying relative distribution of the total discharge current in accordance with the applied control potential.

In the circuit arrangement according to Figures 1 and 2, a direct current feedback exists due to the fact that the potential variations of the second control grid 14 react upon the space charge or anode grid 13. This reaction is minimized according to Figure 3 by the provision of a screen grid 26 arranged between the input grid 12 and the second control grid 14 and connected to a suitable positive point of the high potential source such as a tap point of the potentiometer resistance 19 as shown. By controlling the potential of the screen grid 26 such as by varying the voltage drop or bleeder resistance 26' placed in the screen grid lead it is possible to adjust the direct current reaction to suit any existing requirements.

According to a modification an increased controlling action of the input grid is obtained by employing an input grid located near the cathode and by deriving amplified potential from a positively biased or anode grid spaced therefrom in the direction of the anode. A circuit arrangement of this type is shown in Figure 4. In the latter the input grid 12 is located near the cathode and the positive grid 13 placed next to the second control grid 14. The screen grid in this modification is arranged between the input grid 12 and the positive grid 13. Alternatively, the screen grid may be placed between the positive grid 13 and the second control grid 14 such as shown in the embodiment Figure 5 being otherwise similar to Figure 4. Alternatively, the screen grid may be omitted or separate screens arranged at opposite sides of the positive or anode grid 13. In an arrangement of this type the grids 12 and 14 are controlled in anti-phase relation due to the fact that a phase reversal takes place between the first and second control in a manner similar to that of an ordinary triode amplifier. Since, however, the second control potential on the grid 14 is substantially amplified, the control by the second grid may be caused to predominate over the control by the first grid by proper design of the circuit elements, resulting in a considerable increase of amplification. In the arrangements according to Figures 1–3 on the other hand, the grids 12 and 14 are excited in like phase since the current to the positive grid 13 varies oppositely to the current in Figure 4 in view of the location of grid 13 on the opposite side of the input grid 12.

In a circuit according to Figure 5 wherein the screen grid 26 is placed between the positive grid 13 and the second control grid 14, the direct current reaction between these grids is substantially reduced. If nevertheless in an arrangement of this type a certain amount of reaction is desired a separate exterior feedback circuit may be provided such as shown in Figure 6. In the latter, the anode 15 is directly connected to the input grid 12 through a resistance 29. The effect of the anode potential on the input grid is compensated by a suitable counter potential derived in the example shown from the potentiometer resistance 20 which also serves for compensating the positive potential on the second control grid 14. In order to adjust the compensating potential, there is provided a voltage divider 30 connected between the input grid 12 and the negative terminal of the compensating potential source, the input impedance 18 being connected to the grid 12 on the one hand and to a variable tap point of the potential divider 30. In order to develop feedback potentials at the anode 15 there is provided a suitable load resistance 28 in the anode circuit.

In a similar manner as it may be advisable for certain uses to employ direct current reaction, it may be desired in other cases to completely eliminate any possibility of reaction, especially if a highly stable operation is desired such as for indicating and measuring purposes. In this case, it would not suffice to provide one or more screen grids to eliminate reaction and according to a further feature of the invention a special phase inverting valve is used between the output of the positive grid 13 and the second control grid 14.

A circuit arrangement of this type is shown in Figure 7. In the latter, the amplified potential variations derived from the tap point of the potential divider 22 are impressed upon the input grid 34 of a triode valve 32 comprising a cathode 33 and an anode 35. While a triode has been shown for illustration, it is understood that any other type of valve or equivalent device adapted to effect a phase reversal may be provided for the purpose of the invention. The anode of valve 32 is connected to the positive pole of the high tension source through a load resistance 36 to produce amplified potential variations to be impressed upon the second control grid 14 of the amplifier 10 being of similar design to that in the preceding embodiments. For this purpose the anode of the valve 32 is further connected to

the negative pole of the compensating potential source 20 through a potentiometer resistance 37 and a variable tap of the latter is connected to the second control grid 14 of valve 10. By this connection, the effect of the high potential on the anode 35 of valve 32 upon the grid 14 of valve 10 is compensated in a manner readily understood from the above.

According to a further modification, the number of amplifying stages may be increased or the electron discharge current controlled at more than two points by the same potential such as shown in the exemplifications according to Figures 8 and 9. In Figure 8, the cathode 11, input grid 12, positive grid 13 and second control grid together with load resistance 21 and compensating potentiometer 22 constitute a two-stage direct coupled amplifier substantially similar as shown in Figures 1 and 3. In order to obtain additional amplification in the same valve, there is provided a further positive grid 13' having connected thereto a load resistance 21' and compensating resistance 22' in a manner substantially similar as the first positive grid 13. The compensating resistance 22' has a variable tap connected to a further control grid 14'. Any desired number of additional amplifying stages may be provided in this manner as will be readily understood. In the example illustrated a four-stage amplifier is shown, the corresponding elements of the separate stages being identified by similar but primed reference numerals as used for the first two amplifying stages.

Referring to Figure 9, there is shown a multi-stage amplifier similar to the preceding embodiment wherein the grid electrodes for the several amplifying stages are arranged relatively as shown in Figures 4 and 5. In the latter arrangement, a phase reversal by 180° takes place between successive amplifying stages while in case of Figure 8 all the controls of the common electron stream by the grids 12, 14, 14', 14'', etc., act in the same sense as will be readily understood from the above. The function of the screen grids and other elements is substantially similar as described in connection with the two-stage amplifier shown in the preceding diagrams.

The arrangements described hereinbefore are specially suited for the amplification of variable direct potentials or currents. Thus, the amplifiers may be used in the measuring art or for amplifying control potentials such as AVC (automatic volume control), AFC (automatic frequency control) potentials, volume expanding potentials in radio receivers or the like. In many cases an existing multi-grid valve for low frequency or high frequency amplification may be used additionally as a multi-stage direct coupled amplifier for amplifying a potential serving to control the operation of the amplifier. In this manner it is possible to effect substantial variations of the alternating current amplification with a comparatively weak control potential with a minimum of valves and circuit elements.

In Figure 12 there is shown a graph illustrating the variation of the anode current in an amplifier of the aforedescribed type in dependence upon the direct potential applied to the input of the valve such as in a circuit of the type according to Figures 1, 2 and 3. As is seen, a variation of the direct grid potential by about .5 volt is sufficient to change the amplification from zero to its maximum value. The amplification of an alternating potential which may be additionally applied to the input grid is determined by the known operating characteristic of the valve. The auxiliary grids 13 and 14 in this case employed for the additional direct current amplification should be by-passed or grounded for the alternating potential by means of condensers.

If in the arrangements according to Figures 1 to 8 suitable alternating current circuits are connected to the input grid and to the anode such as is customary in low frequency or high frequency amplifiers, and if a direct control potential is simultaneously impressed upon the input grid there is obtained in this manner a low frequency or high frequency amplifying stage particularly well adapted for automatic volume control and/or volume expansion. The degree of the direct current amplification may be varied by suitably adjusting the values of the resistances 21 and 22 between substantial limits.

The high sensitivity of the adjustment of the amplification by small variations of direct potential makes it possible further to obtain an automatic volume control without requiring an additional AVC or outside control potential or in other words to provide a self-regulating or limiting amplifier. For this purpose it is only necessary to adjust the operating point upon the curved part of the characteristic for the input grid 12 in such a manner as to cause a partial rectification of the applied alternating potential resulting in direct potential variations on the positive grid electrode 13. These potential variations, depending on the location of the electrode, may serve to effect an amplitude limitation or increase of the alternating potentials derived from the anode.

An exemplification of a circuit of this type is shown in Figure 10. In the latter, if the valve used has a curved mutual characteristic representing current in the circuit of the positive grid 13 as a function of the potential on the grid 12, a partial rectification of the alternating potential impressed across the transformer 40 will take place resulting in corresponding variation of the steady potential on the grid 13. As the amplitude of the impressed alternating potential increases, the direct potential on the grid 13 becomes less positive in such a manner that the amplified direct potential on the grid 14 will become more negative, resulting in a decrease of the electron discharge current flowing to the anode 15. In this manner, the amplified alternating output current translated through the tuned transformer 42 to the output terminals *c, d* is automatically maintained at a predetermined level in a manner similar to the operation of known automatic volume control systems but without requiring a separate external control potential produced by a separate rectifier in a manner well known. The partial rectification of the input alternating potential may also be effected in a different way such as by rectification in the grid circuit or in any other suitable manner. In an arrangement of this type the control potential applied from the grid 13 to the grid 14 should be sufficiently filtered such as by the provision of ground by-pass condensers 44 and 47 if the control is to be dependent upon the average amplitude of the alternating potential rather than upon its fluctuations or modulation. Condensers 45 and 46 are the usual grounding or by-pass condensers for the screen grid 26 and the high tension supply source, respectively.

The fact that by an arrangement according to the invention, provided the resistances 21 and 22 are properly designed, it is possible to secure a

sudden increase in amplification by means of a small variation of a control potential while with further increase of the control potential in the same sense the amplification is only slightly affected, renders the circuits especially suited for obtaining inter-carrier noise suppression in broadcast receivers. For this purpose, the automatic volume control (AVC) potential is impressed upon the grid of the first audio tube, which additionally serves as a multi-stage direct coupled amplifier in such a manner that the tube is blocked for small control potentials and suddenly assumes its full amplification at a determined potential which may be adjusted to suit any existing requirements. An example of an arrangement of this type is illustrated in Figure 11. In the latter, the low frequency potential to be amplified is applied through coupling condenser **48** to the input grid **12** and the amplified output potential derived by means of coupling condenser **52** and coupling resistance **53** in a manner well understood. The output potential may be applied to a succeeding stage of amplification or to a suitable translating device. The direct current amplifier is of the type to effect a phase reversal between successive amplifying stages whereby with the AVC potential E_r impressed to normally render the grid **12** negative as shown in the drawings, the tube will be blocked for small values of the negative grid potential and become conductive with increasing control potential. If the control potential is further increased, the amplification again begins to decrease provided a valve is used having a regulating or variable mu characteristic for the first or input grid. This decrease in amplification enables an efficient volume control by reason of the fact that the decrease is inversely proportional to the output potential of the preceding high frequency amplifier. In Figure 13 is shown a graph further explaining the operation of Figure 11 representing anode current as a function of input grid potential in a two-stage direct coupled amplifier of the type provided in Figure 11 and generally illustrated in Figures 4, 5, 6. This graph differs from Figure 12 corresponding to circuits of the type of Figures 1–3 by a reversal of the output phase as explained hereinbefore.

It is evident from the above that the arrangements according to the invention are susceptible of numerous modifications and variations coming within the broader scope and spirit of the invention. Thus, it is possible to provide further grids or auxiliary anodes within a valve serving to produce additional effects or to construct the electrodes in any desired form. Furthermore, the circuits shown may be embodied in a reflex amplifier using the same valve for radio, audio and direct current amplification. When simultaneously using a valve for amplification of a direct potential and alternating potential as described herein, it is also possible to apply the input potential to separate grids; that is, to apply the alternating potential to one grid and the direct potential to another input grid. It is also possible to derive the amplified alternating potential from one of the positive grids **13**, **13'**, **13''**, etc., instead of from the anode circuit or simultaneously from both or one or more of the positive grids. In the latter case the positive grid used for deriving alternating potential should not be by-passed or grounded for the potentials to be derived and in addition a suitable filter should be provided to prevent the alternating potential from being impressed upon the succeeding control grid.

The arrangements described for direct current amplification, especially those embodying positive reaction are also suited for generation of oscillations, both sinusoidal oscillations by the provision of suitable capacities and self-induction coils and for the generation of relaxation oscillations as used in television.

In order to avoid in the arrangements shown excessive control swings of the grid **13** beyond the negative region and to prevent appreciable grid currents, the control potential may be impressed upon this grid through a high ohmic resistance in which case the grid is preferably grounded or by-passed for high or low frequency.

Referring to Figure 14, there is shown a receiving circuit for broadcast signals embodying an improved automatic volume control arrangement according to the invention. The signals absorbed by an antenna **55** are impressed through a tuned coupling transformer **56** upon the grid-cathode path of a multi-grid amplifying valve **10** of the type described hereinbefore. The amplified high frequency signals are segregated by means of a tuned transformer **58** in the anode circuit of the valve and impressed upon a pair of diode rectifiers **70** and **71** in parallel through coupling condensers **72** and **73**, respectively. The output of the rectifier **71** is fed through a network comprising a smoothing resistance **78**, smoothing condenser **80** and volume control potentiometer **79** to an audio amplifier **81** having its output connected to a suitable translating device such as a loud speaker **82**. The rectifier **70** serves to produce AVC potential applied through resistances **74** and **75** to the grid **12** of the valve **10** in such a manner as to normally maintain the grid positive relative to the cathode. This AVC potential which may be of relatively small value compared with AVC potentials required in the known AVC arrangement in use today is amplified by the tube **10** acting simultaneously as a direct coupled multi-stage amplifier in accordance with the invention, as described in detail hereinbefore. For this purpose the positive grid **13** is connected to a suitable tap point of the potentiometer resistance **64** while the second control grid **14** is connected to a tap point of a further potentiometer resistance **65** in series with the first resistance **64** and connected to the positive pole of the high potential or anode current supply source on the one hand and the negative potential or ground on the other hand. Item **59** represents a compensating resistance in the cathode lead by-passed for high frequency by a condenser **61** and serving to eliminate the effect of the high potential on the control grid **14**. Both the positive grid **13** and the second control grid **14** are by-passed to ground for high frequency by by-pass condensers **66** and **67**, respectively.

In the afore-described arrangement, variations of the AVC potential E_r supplied by the rectifier **70** will cause similar variations of the potentials on the grids **13** and **14** in such a manner that by a slight decrease of the negative bias of the input grid **12** (slight increase of the AVC potential), the negative potential of the grid **14** increases to such an extent as to substantially decrease the anode current due to the current distribution control. By suitable design of the circuit elements and operating potentials it is possible to effect a change of the degree of amplification between a minimum and maximum by

varying the control potential E_r from .5 to 1.5 volts.

As will be evident from the foregoing the novel circuit according to the invention is susceptible of various other modifications and applications coming within the broad scope and spirit of the invention as defined in the appended claims. The specification and drawings are accordingly to be regarded in an illustrative rather than a limiting sense. Thus, the cathode heating and plate potential supply sources, by-pass condensers or choke coils to prevent direct or alternating currents from entering certain circuit portions but to enable them to readily pass through other circuits of the system, and other conventional elements and details have not been shown as being immaterial to the understanding of the invention and for clarity of disclosure and simplification of the drawings.

I claim:

1. In a combined alternating current-direct current amplifier, an electron valve having a cathode, an anode and a plurality of grids located at different points in the electron stream passing from said cathode to said anode, alternating current input and output circuits operatively connected to an input grid and to said anode, respectively, for amplifying an alternating current signal, further means for impressing direct potential variations upon a first grid of said valve, means comprising a load resistance and a source of positive potential connected to a second grid to produce amplified direct potential variations at said second grid, a conductive coupling connection from said second grid to a third grid of said valve, means to compensate the effect upon said third grid of the positive potential at said second grid, and further means to prevent alternating potential from affecting said third grid.

2. In a combined alternating current-direct current amplifier, an electron valve having a cathode, an anode and a plurality of grids located at different points in the electron stream passing from said cathode to said anode, alternating current input and output circuits connected to a first grid and to said anode, respectively, for amplifying an alternating current signal, further means for impressing direct potential variations upon said first grid, means comprising a load resistance and a source of positive potential connected to a second grid to produce amplified direct potentials at said second grid, a conductive coupling connection from said second grid to a third grid adapted to control the operation of said valve, means to compensate the effect upon said third grid of the positive potential at said second grid, and further means for preventing alteranting potential from affecting said third grid.

3. In a combined alternating current-direct current amplifier, an electron valve having a cathode, an anode and a plurality of grids located at different points in the electron stream passing from said cathode to said anode, alternating current input and output circuits connected to a first grid and to said anode, respectively, for amplifying an alternating current signal, means for producing a direct potential varying according to the average amplitude of the alternating current being amplified, means for impressing said direct potential upon said first grid, further means comprising a load resistance and a source of positive potential connected to a second grid to produce amplified direct potential at said second grid, a conductive coupling connection from said second grid to a third grid adapted to control the amplifying characteristics of said valve, means for compensating the effect upon said third grid of the positive potential at said second grid, and means to prevent alternating potential from affecing said third grid.

4. In a combined alternating current-direct current amplifier, an electron valve comprising a cathode, an anode, a first grid located near said cathode, alternating current input and output circuits connected to said grid and anode, respectively, for amplifying an alternating current signal, means for producing a direct potential varying in accordance with the average amplitude of the alternating current being amplified, means for impressing said direct potential upon said first grid in negative polarity relation to said cathode, further means comprising a load resistance and a source of positive potential connected to a second grid spaced from said first grid in a direction towards the anode to produce amplified direct potential variations at said second grid, a conductive coupling connection from said second grid to a third grid adapted to control the amplifying gain of said valve, means to compensate the effect upon said third grid of the positive potential at said second grid, and means to prevent alternating potential from affecting said second and third grid.

5. In a combined alternating current-direct current amplifier, an electron valve having a cathode and an anode, a first grid located near said cathode, input and output circuits connected to said grid and said anode, respectively, for amplifying a modulated carrier signal by said valve, means for producing a direct control potential varying in accordance with the carrier amplitude of said signal, means for impressing said control potential upon said grid in positive polarity relation to said cathode, further means comprising a load resistance and a source of positive potential connected to a second grid spaced from said first grid in a direction towards said anode to produce amplified direct potential at said second grid, a conductive coupling connection from said second grid to a third grid near said anode adapted to control the amplifying gain of said valve, means to compensate the effect upon said third grid of the positive potential upon said second grid, and means to prevent carrier potential from affecting said second and third grids.

6. In a combined alternating current-direct current amplifier, an electron valve having a cathode and an anode, a first grid located near said cathode, input and output circuits connected to said grid and said anode, respectively, for amplifying a modulated carrier signal by said valve, means for producing a direct control potential varying in accordance with the carrier amplitude of said signal, means for impressing said control potential upon said first grid in positive polarity relation to said cathode, further means comprising a load resistance and a source of positive potential connected to a second grid spaced from said first grid in a direction toward said anode to produce amplified direct potential at said second grid, a conductive coupling connection from said second grid to a third grid, means for compensating the effect upon said third grid by the positive potential at said second grid, and means to prevent carrier potential from affecting said second and third grids.

7. A self-regulating amplifying stage comprising an electron valve having a cathode, an anode and a plurality of grids located at different points

in the electron steam passing from said cathode to said anode, alternating current input and output circuits connected to a first grid and to said anode, respectively, for amplifying an alternating current signal, load resistance means and a source of positive potential connected to a second grid spaced from said first grid in a direction towards the anode, the mutual operating characteristic for said second grid in relation to said first grid being such as to produce a rectified negative potential at said second grid varying in proportion to the average amplitude of the alternating potential to be amplified impressed upon said first grid, a direct current coupling connection from said second grid to a third grid spaced therefrom in a direction towards the anode and adapted to control the amplifying gain of said valve, means to compensate the effect upon said third grid of the positive potential at said second grid, and further means to prevent alternating potential from affecting said third grid.

8. A self-regulating amplifying stage comprising a multi-grid electron valve having input and output circuits operatively connected thereto for amplifying oscillatory signal energy, means operatively connected with one of the grid electrodes of said valve other than the input grid for producing thereon a rectified negative potential varying in proportion to the average amplitude of the energy to be amplified, a conductive coupling connection from said last grid to a further grid electrode adapted to control the amplifying gain of said valve, and means to prevent oscillatory potential from affecting said grid electrodes.

9. An electrical system comprising an electron discharge tube having a cathode, an anode and at least three grids located in the path of the electron current passing from said cathode to said anode, space current supply means for maintaining a first of said grids at a positive potential with respect to the cathode, a source of modulated carrier signals coupled to a second grid and the cathode, a signal output circuit coupled to said anode and said cathode, means including load impedance means connected to said first grid to develop a potential at said first grid varying in proportion to fluctuations of the carrier component of said signals, a direct conductive coupling connection from said first grid to the third grid, and means to compensate the effect of the positive potential of said first grid upon said third grid.

10. An electrical system comprising an electron discharge tube having a cathode, an anode and at least three grids located in the path of the electron current passing from said cathode to said anode, space current supply means for maintaining a first of said grids at a positive potential with respect to the cathode, a source of modulated carrier signals coupled to a second grid and the cathode, a signal output circuit coupled to said anode and said cathode, means including load impedance means connected to said first grid to develop a potential at said first grid varying in proportion to fluctuations of the carrier component of said signals, a direct conductive coupling connection from said first grid to the third grid, means to compensate the effect of the positive potential of said first grid upon said third grid, and a screening electrode intervening between said first and third grids.

11. An electrical amplifier comprising an electron discharge tube having a cathode, an anode grid, a first control grid, a second control grid and an anode, all arranged in spaced relation in the order named with respect to said cathode, space current supply means for maintaining said anode and said anode grid at positive direct current potentials with respect to said cathode, a source of signal energy, means for coupling said source to said first control grid and cathode, load impedance means connected to said anode grid to develop signal potential variations on said anode grid, means for applying the signal potential on said anode grid to said second control grid, and a signal output circuit connected to said anode and cathode.

12. A direct current amplifier comprising an electron discharge tube having a cathode, an anode grid, a first control grid, a second control grid and an anode, all arranged in spaced rela tion in the order named with respect to said cathode, space current supply means for maintaining said anode grid and said anode at positive direct current potentials with respect to said cathode, means for impressing a varying direct current potential between said first control grid and said cathode, direct current load impedance means in the output circuit of said anode grid to develop potential variations proportional to said impressed potential on said anode grid, a conductive coupling connection from said anode grid to said second control grid, means to compensate the effect upon said second control grid of the steady potential on said anode grid, and a signal output circuit connected to said anode and cathode.

13. A direct current amplifier comprising an electron discharge tube having a cathode, an anode grid, a first control grid, a second control grid and an anode, all arranged in spaced relation in the order named with respect to said cathode, a source of space current connected across said anode and cathode, a resistive impedance inserted between said cathode and said source, means for impressing positive bias potential from said source upon said anode grid, means for impressing varying direct current potential between said first control grid and a point of said impedance close to said cathode, direct current load impedance means connected to said anode grid to develop potential variations proportional to said impressed potential on said anode grid, a conductive coupling connection from said anode grid to said second control grid, and a signal translating device inserted in the anode circuit of said tube.

14. A direct currnet amplifier comprising an electron discharge tube having a cathode, an anode grid, a first control grid, a second control grid and an anode, a source of space current connected across said anode and cathode, a resistive impedance inserted between said cathode and said source, means for impressing positive biasing potential from said source upon said anode grid, means for applying varying direct current potential between said control grid and a point of said impedance close to said cathode, direct current load impedance means connected to said anode grid to develop potential variations proportional to said impressed potential on said anode grid, a conductive coupling connection from said anode grid to said second control grid, and a signal translating device inserted in the anode circuit of said tube.

15. A combined alternating current direct current amplifier comprising an electron discharge tube having a cathode, an anode and a plurality

of grids located at different points in the electron stream passing from said cathode to said anode, alternating current input and output circuits operatively connected to an input grid and said anode, respectively, for amplifying an alternating current signal, means for impressing direct current potential variations upon a first grid of said tube, means comprising a load resistance and a source of positive potential connected to a second grid to produce amplified direct current potential at said second grid, a conductive coupling connection from said second grid to a third grid of said tube, and means to compensate the effect upon said third grid of the steady potential on said second grid.

16. A direct current amplifier comprising an electron discharge tube having a cathode, an anode grid, a first control grid, a second control grid and an anode, space current supply means for maintaining said anode grid and said anode at positive direct current potentials with respect to said cathode, means for impressing a direct current input potential between said first control grid and said cathode, direct current load impedance means connected to said anode grid to develop potential variations proportional to said impressed potential on said anode grid, a conductive coupling connection from said anode grid to said second control grid, means to compensate the effect upon said second control grid of the steady potential on said anode grid, said control grids and said anode grid being relatively arranged so that potential variations on said second control grid are substantially in phase with the input potential variations on said first control grid, and a signal output circuit connected to said anode and cathode.

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