Please note that the links in the PEARL logotype above are "live" and can be used to direct your web browser to our site or to open an e-mail message window addressed to ourselves.

To view our item listings on eBay, click here.

To see the feedback we have left for our customers, click here.

PATENT SPECIFICATION

Application Date: June 5, 1937. No. 15620/37.

Complete Specification Left: March 4, 1938.

Complete Specification Accepted: Dec. 5, 1938.

496,883

PROVISIONAL SPECIFICATION

Improvements in or relating to Thermionic Valve Amplifying Circuits

I, ALAN DOWER BLUMLEIN, of 37, The Ridings, Ealing, London, W.5, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to thermionic valve amplifying circuits, and is particularly concerned with power amplifying circuits.

It is usual in such circuits to employ as the last valve of the stage a pentode valve or a power tetrode. These valves are provided with screening grids which are usually maintained at a constant positive potential with respect to the cathode. Valves of this kind give a greater output for a given anode potential than triodes, but they suffer from the disadvantage that their characteristic impedance to the anode is very much greater than the ratio of the steady D.C. voltage to the steady D.C. current. Consequently, in order to obtain a good power output the impedance of the load must be very much less than the characteristic impedance of the valve. Furthermore, particularly in the case of either a pentode or a power tetrode valve, which is coupled to its load through a transformer, it is known that if the load is removed then for relatively moderate variations in potential of the input grid, excessively high output voltages will be produced which may be sufficient to cause disruption of the valve or of the output transformer.

It is the chief object of the present invention to provide an improved circuit in which the characteristic impedance of valves of the kind referred to can be more nearly matched to their optimum loads and in which the danger of an excessive increase of voltage on removal of the load may be substantially avoided.

According to the invention a thermionic valve amplifying circuit is provided employing a pentrode or tetrode valve in which the screening grid of the valve is so connected that the potential thereof varies in proportion to the A.C. potential variations of the anode of the valve. This result may be achieved by connecting the screening grid to a tapping point on the primary winding of an output transformer, or alternatively, the screening grid may be connected to a source of potential through a resistance and connected through a decoupling condenser to a tapping point on the primary winding of the output transformer. Other alternative connections for causing the potential of the screening grid to vary in proportion to the potential of the anode may be employed. For example, the screening grid may be connected to a tapping point in a choke connecting the anode of the valve to the source of anode current.

The effect of causing the screen to vary in potential proportional to the variations in anode potential is to cause the valve to function somewhat after the manner of a triode. It is known that in a triode the anode impedance is less than the ratio of the steady D.C. anode voltage to the steady D.C. anode current. Hence, by choosing a suitable tapping point for the screening grid the characteristic impedance of the anode and screen effectively combined can be given any desired value between the impedance of a pentode or tetrode and the impedance of a triode. A suitable tapping point, in practice, may be found to be such that the voltage swing on the screen is between about a quarter and a half the voltage swing on the anode.

For the purpose of describing the invention more in detail reference will be made to the accompanying diagrammatic drawings in which:

Fig. 1 illustrates the application of the invention to a circuit embodying a pentode valve, and

Fig. 2 illustrates the application of the invention to a tetrode valve.

As shown in Fig. 1, signals to be amplified are applied between the control grid 3 and cathode 4 of a pentode valve through a coupling condenser 5 and leak resistance 6, the cathode of the valve being biassed by a dropper resistance 7 shunted by a by-pass condenser 8. The suppressor grid 9 is connected to the cathode in the usual manner. The anode 10 is connected through the primary winding 11 of an output transformer to the positive terminal of a suitable source of

high tension current the secondary winding 12 of the transformer being connected to a load not shown. The screening grid 13 is connected as shown to a tapping point on the primary winding 11 so that the screening grid 13 varies in potential in proportion to the potential variations on the anode 10. As stated above, the tapping point may be arranged so that the voltage swing on the screen grid 13 is between about a quarter and a half the voltage swing on the anode 10.

The arrangement shown in Fig. 2 of the drawings illustrates the invention as applied to a tetrode valve and, in this case, signals to be amplified are applied between the control grid 14 and cathode 15 through an input transformer 16 the cathode 15 being biassed by a dropper resistance 17 shunted by a by-pass condenser 18. The anode 19 is connected to the positive terminal of a source of anode current through the choke 20 and is connected through a by-pass condenser 21 to the primary winding 22 of an output transformer the secondary winding 23 of which is connected to a load, not shown. In this example of the invention the screening grid 24 is connected through a resistance 25 to the source of high tension current and is also connected in the manner shown through a decoupling condenser 26 to a tapping point on the primary winding 22 of the output transformer. If desired, in Fig. 2, instead of connecting the screen grid 24 to a tapping point on the primary winding 22, it may be connected to a suitable tapping point on the choke 20. Many other alternative connections are possible.

The circuits described also have the advantage that if the loads are removed the output voltage obtained for relatively small potential variations of the control grids is not as great as with the arrangements usually employed, since the screening grid which is partially effective in controlling the cathode current will swing in opposite phase to the grid and so prevent or reduce an excessive output voltage.

In some cases the decoupling condensers 8 and 18 of Figs. 1 and 2 respectively may not be employed, in which cases negative feedback will occur tending to reduce the second harmonic output. The effect of such feedback will, however, be to increase the impedance of the valves so that in cases where it is desired to reduce the second harmonic output it should be arranged that the potential variations of the screen should be greater compared with the cases in which the decoupling condensers are employed in order to maintain the anode impedance at the required value. In each example described it will also be appreciated that the current which flows in the screening grid also contributes to the useful output of the circuit.

Dated this 4th day of June, 1937.
F. W. CACKETT,
Chartered Patent Agent.

COMPLETE SPECIFICATION

Improvements in or relating to Thermionic Valve Amplifying Circuits

I, ALAN DOWER BLUMLEIN, of 37, The Ridings, Ealing, London, W.5, a British Subject, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to thermionic valve amplifying circuits, and is particularly concerned with power amplifying circuits.

It is usual in such circuits to employ as the last valve of the stage a pentode valve or a power tetrode. These valves are provided with screening electrodes or grids which are usually maintained at a constant positive potential with respect to the cathode. Valves of this kind give a greater output for a given anode potential than triodes, but they suffer from the disadvantage that their internal impedance is very much greater than the ratio of the steady D.C. voltage to the steady D.C. current. Consequently, in order to obtain a good power output the impedance of the load must be very much less than the internal impedance of the valve. Furthermore, particularly in the case of either a pentode or a power tetrode valve, which is coupled to its load through a transformer, it is known that if the load is removed then for relatively moderate variations in potential of the input grid, excessively high output voltages will be produced which may be sufficient to cause disruption of the valve or of the output transformer.

It is the object of the present invention to provide an improved circuit in which the internal impedance of valves of the kind referred to can be more nearly matched to their optimum loads and in which the danger of an excessive increase of voltage on removal of the load may be

substantially avoided.

According to one feature of the invention a thermionic valve amplifying circuit is provided comprising a valve having at least a cathode, control electrode, an anode and a screening electrode adapted to form an electrostatic screen between the control electrode and anode, and a relatively low impedance load connected to said valve, wherein instead of maintaining said screening electrode at the usual constant positive potential less than the anode potential which would cause said valve to have a high impedance, it is so connected to the anode circuit of said valve that in operation the potential of said screening electrode will vary in phase, but at a lower amplitude with respect to the potential variations of said anode so as to reduce the impedance of the valve whereby it is more nearly matched to its low impedance load.

According to another feature of the invention a thermionic valve amplifying circuit is provided comprising a valve having at least a cathode, control electrode, an anode and a screening electrode adapted to form an electrostatic screen between the control electrode and anode, and a relatively low impedance load connected to said valve, wherein instead of maintaining said screening electrode at the usual constant positive potential less than the anode potential which would cause said valve to have a high impedance, it is so connected with the output circuit of said valve that in operation the potential of said screening electrode will vary in phase, but at a lower amplitude with respect to the potential variations of said anode so as to reduce the impedance of the valve whereby it is more nearly matched to its low impedance load. The desired result may be achieved by connecting the screening electrode to a tapping point on the primary winding of an output transformer, or alternatively, the screening electrode may be connected to a source of potential through a resistance and connected through a by-pass condenser to a tapping point on the primary winding of the output transformer. Other alternative connections for causing the potential of the screening electrode to vary in proportion to the potential of the anode may be employed. For example, the screening electrode may be connected to a tapping point in a choke connecting the anode of the valve to the source of anode current.

The effect of causing the screening electrode to vary in potential proportional to the variations in anode potential is to cause the valve to function somewhat after the manner of a triode. It is known that in a triode the anode impedance is less than the ratio of the steady D.C. anode voltage to the steady D.C. anode current. Hence, by choosing a suitable tapping point for the screening electrode the internal impedance of the anode and screening electrode effectively combined can be given any desired value between the impedance of a pentode or a tetrode and the impedance of a triode. A suitable tapping point, in practice, may be found to be such that the voltage swing on the screening electrode is between about a quarter and a half the voltage swing on the anode.

In order that the invention may be clearly understood and readily carried into effect it will now be more fully described with reference to the drawings accompanying the Provisional Specification in which:—

Fig. 1 illustrates the application of the invention to a circuit embodying a pentode valve, and

Fig. 2 illustrates the application of the invention to a tetrode valve.

As shown in Fig. 1, signals to be amplified are applied between the control grid 3 and cathode 4 of a pentode valve through a coupling condenser 5 and leak resistance 6, the cathode of the valve being biassed by a dropper resistance 7 shunted by a decoupling condenser 8. The suppressor grid 9 is connected to the cathode in the usual manner. The anode 10 is connected through the primary winding 11 of an output transformer to the positive terminal of a suitable source of high tension current the secondary winding 12 of the transformer being connected to a load not shown. The screening grid 13 is connected as shown to a tapping point on the primary winding 11 so that the screening grid 13 varies in potential in direct proportion to or in phase with the potential variations on the anode 10. As stated above, the tapping point may be arranged so that the voltage swing on the screen grid 13 is between about a quarter and a half the voltage swing on the anode 10.

The arrangement shown in Fig. 2 of the drawings illustrates the invention as applied to a tetrode valve and, in this case, signals to be amplified are applied between the control grid 14 and cathode 15 through an input transformer 16 the cathode 15 being biassed by a dropper resistance 17 shunted by a decoupling condenser 18. The anode 19 is connected to the positive terminal of a source of anode current through a choke 20 and is connected through a by-pass condenser 21 to the primary winding 22 of an output transformer the secondary winding 23 of

which is connected to a load, not shown. In this example of the invention the screening grid 24 is connected through a resistance 25 to the source of high tension current and is also connected in the manner shown through a by-pass condenser 26 to a tapping point on the primary winding 22 of the output transformer. If desired, in Fig. 2, instead of connecting the screen grid 24 to a tapping point on the primary winding 22, it may be connected to a suitable tapping point on the choke 20. Many other alternative connections are possible.

The circuits described also have the advantage that if the loads are removed the output voltage obtained for relatively small potential variations of the control grids is not as great as with the arrangements usually employed, since the screening grid which is partially effective in controlling the cathode current will swing in opposite phase to the grid and so prevent or reduce an excessive output voltage.

In some cases the decoupling condensers 8 and 18 of Figs. 1 and 2 respectively may not be employed, in which cases negative feedback will occur tending to reduce the second harmonic output. The effect of such feedback will, however, be to increase the impedance of the valves so that in cases where it is desired to reduce the second harmonic output it should be arranged that the potential variations of the screen should be greater compared with the cases in which the decoupling condensers are employed in order to maintain the anode impedance at the required value. In each example described it will also be appreciated that the current which flows in the screening grid also contributes to the useful output of the circuit.

With the arrangements described the internal impedance of the valves is reduced thus enabling the valves to be matched more nearly to their low impedance loads such as are normally employed with power output valves. The effect of causing the screening electrode 13 (Fig. 1) or 24 (Fig. 2) to vary in phase with the potential variations of the anodes of their respective valves sacrifices however some of the screening properties of the electrodes 13 and 24 compared with the case where these electrodes are maintained at constant potentials. Screening action does however to some extent occur since the potential differences between the screening electrode and the control electrode are less than the potential differences between the anode and control electrode. By causing the potential of the screening electrode to vary as above described the impedance of the valve is reduced for the purpose above-mentioned and the fact that the screening properties of the screening electrode are reduced is relatively immaterial particularly in low frequency amplifiers.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A thermionic valve amplifying circuit comprising a valve having at least a cathode, control electrode, an anode and a screening electrode adapted to form an electrostatic screen between the control electrode and anode, and a relatively low impedance load connected to said valve, wherein instead of maintaining said screening electrode at the usual constant positive potential less than the anode potential which would cause said valve to have a high impedance, it is so connected to the anode circuit of said valve that in operation the potential of said screening electrode will vary in phase, but at a lower amplitude with respect to the potential variations of said anode so as to reduce the impedance of the valve whereby it is more nearly matched to its low impedance load.

2. A thermionic valve amplifying circuit comprising a valve having at least a cathode, control electrode, an anode and a screening electrode adapted to form an electrostatic screen between the control electrode and anode, and a relatively low impedance load connected to said valve, wherein instead of maintaining said screening electrode at the usual constant positive potential less than the anode potential which would cause said valve to have a high impedance, it is so connected with the output circuit of said valve that in operation the potential of said screening electrode will vary in phase, but at a lower amplitude with respect to the potential variations of said anode so as to reduce the impedance of the valve whereby it is more nearly matched to its low impedance load.

3. A thermionic valve amplifying circuit according to claim 1 or 2, wherein the screening electrode is connected to a tapping point on an impedance connected between the anode of the valve and the source of anode current.

4. A thermionic valve amplifying circuit according to claim 1 or 2, wherein the screening electrode is connected through a resistance to a source of potential and through a by-pass condenser to a tapping point on an impedance, across which the voltage variations occurring at the anode of the valve are set up.

5. A thermionic valve amplifying circuit substantially as described herein with

reference to Figure 1 or 2 of the drawings accompanying the Provisional Specification.

Dated this 3rd day of March, 1938.
F. W. CACKETT,
Chartered Patent Agent.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1939.

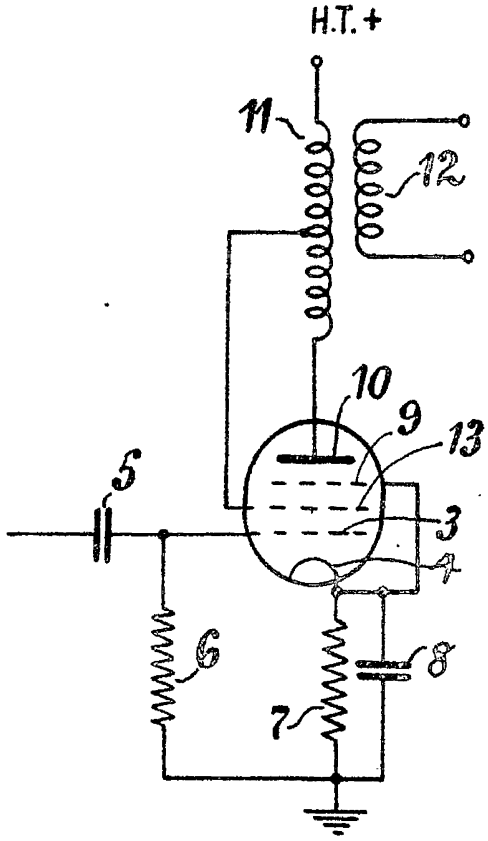


Fig. 1.

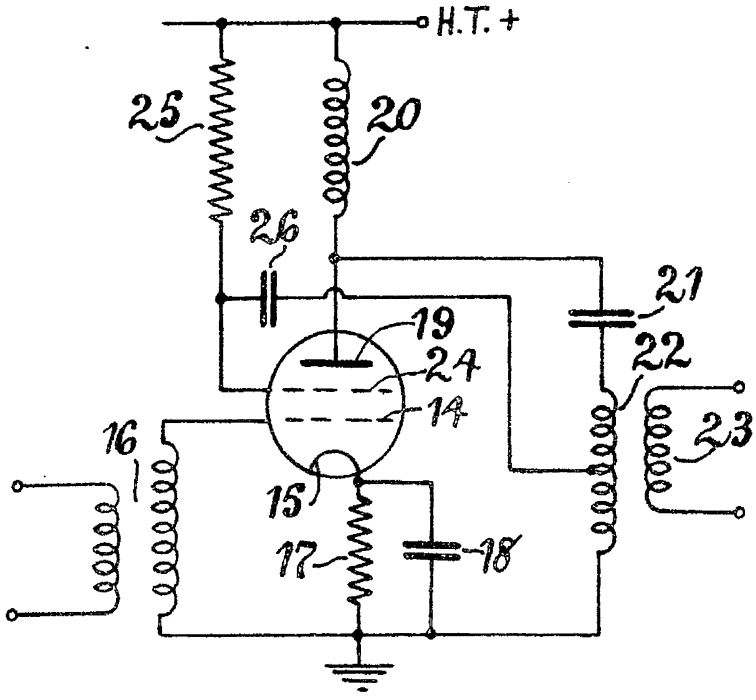


Fig. 2.

Malby & Sons, Photo-Litho

UNITED STATES PATENT OFFICE

2,218,902

THERMIONIC VALVE AMPLIFYING CIRCUITS

Alan Dower Blumlein, London, England, assignor to Electric & Musical Industries Limited, Hayes, Middlesex, England, a corporation of Great Britain

2,218,902

Patented Oct. 22, 1940

Application May 18, 1938, Serial No. 208,619
In Great Britain June 5, 1937

4 Claims. (Cl. 179—171)

This invention relates to thermionic valve amplifying circuits and is particularly concerned with power amplifying circuits.

It is usual in such circuits to employ as the last valve of the stage a pentode valve or a power tetrode. These valves are provided with screening grids which are usually maintained at a constant positive potential with respect to the cathode. Valves of this kind give a greater output for a given anode potential than triodes, but they suffer from the disadvantage that their characteristic impedance to the anode is very much greater than the ratio of the steady D. C. voltage to the steady D. C. current. Consequently, in order to obtain a good power output the impedance of the load must be very much less than the characteristic impedance of the valve. Furthermore, particularly in the case of either a pentode or a power tetrode valve, which is coupled to its load through a transformer, it is known that if the load is removed, then for relatively moderate variations in potential of the input grid, excessively high output voltages will be produced which may be sufficient to cause disruption of the valve or of the output transformer.

It is the chief object of the present invention to provide an improved circuit in which the characteristic impedance of valves of the kind referred to can be more nearly matched to their optimum loads and in which the danger of an excessive increase of voltage on removal of the load may be substantially avoided.

According to the invention a thermionic valve amplifying circuit is provided employing a pentode or tetrode valve in which the screening grid of the valve is so connected that the potential thereof varies in proportion to the A. C. potential variations of the anode of the valve. This result may be achieved by connecting the screening grid to a tapping point on the primary winding, of an output transformer, or alternatively, the screening grid may be connected to a source of potential through a resistance and connected through a by-pass condenser to a tapping point on the primary winding of the output transformer. Other alternative connections for causing the potential of the screening grid to vary in proportion to the potential of the anode may be employed. For example, the screening grid may be connected to a tapping point in a choke connecting the anode of the valve to the source of anode current.

The effect of causing the screen to vary in potential proportional to the variations in anode potential is to cause the valve to function somewhat after the manner of a triode. It is known that in a triode the anode impedance is less than the ratio of the steady D. C. anode voltage to the steady D. C. anode current. Hence, by choosing a suitable tapping point for the screening grid the characteristic impedance of the anode and screen effectively combined can be given any desired value between the impedance of a pentode or tetrode and the impedance of a triode. A suitable tapping point, in practice, may be found to be such that the voltage swing on the screen is between about a quarter and a half the voltage swing on the anode.

In order that the invention may be clearly understood and readily carried into effect it will now be more fully described with reference to the accompanying drawing in which:

Fig. 1 illustrates the application of the invention to a circuit embodying a pentode valve; and,

Fig. 2 illustrates the application of the invention to a tetrode valve.

As shown in Fig. 1, signals to be amplified are applied between the control grid **3** and cathode **4** of a pentode valve through a coupling condenser **5** and leak resistance **6**, the cathode of the valve being biased by a dropper resistance **7** shunted by a decoupling condenser **8**. The suppressor grid **9** is connected to the cathode in the usual manner. The anode **10** is connected through the primary winding **11** of an output transformer to the positive terminal of a suitable source of high tension current the secondary winding **12** of the transformer being connected to a load not shown. The screening grid **13** is connected as shown to a tapping point on the primary winding **11** so that the screening grid **13** varies in potential in proportion to the potential variations on the anode **10**. As stated above, the tapping point may be arranged so that the voltage swing on the screen grid **13** is between about a quarter and a half the voltage swing on the anode **10**.

The arrangement shown in Fig. 2 of the drawing illustrates the invention as applied to a tetrode valve and, in this case, signals to be amplified are applied between the control grid **14** and cathode **15** through an input transformer **16** the cathode **15** being biased by a dropper resistance **17** shunted by a decoupling condenser **18**. The anode **19** is connected to the positive terminal of a source of anode current through a choke **20** and is connected through a by-pass condenser **21** to the primary winding **22** of an output transformer the secondary winding **23** of which is connected to a load, not shown.

In this example of the invention the screening grid **24** is connected through a resistance **25** to

the source of high tension current and is also connected in the manner shown through a by-pass condenser **26** to a tapping point on the primary winding **22** of the output transformer. If desired, in Fig. 2, instead of connecting the screen grid **24** to a tapping point on the primary winding **22**, it may be connected to a suitable tapping point on the choke **20**. Many other alternative connections are possible.

The circuits described also have the advantage that if the loads are removed the output voltage obtained for relatively small potential variations of the control grids is not as great as with the arrangements usually employed, since the screening grid which is partially effective in controlling the cathode current will swing in opposite phase to the grid and so prevent or reduce an excessive output voltage.

In some cases the decoupling condensers **8** and **18** of Figs. 1 and 2 respectively may not be employed, in which cases negative feedback will occur tending to reduce the second harmonic output. The effect of such feedback will, however, be to increase the impedance of the valves so that in cases where it is desired to reduce the second harmonic output it should be arranged that the potential variations of the screen should be greater compared with the cases in which the decoupling condensers are employed in order to maintain the anode impedance at the required value. In each example described it will also be appreciated that the current which flows in the screening grid also contributes to the useful output of the circuit.

I claim:

1. In an amplifying circuit, a thermionic valve having an anode, a cathode, a grid electrode and a screening electrode, an input circuit for said valve connected between the cathode and grid electrode thereof, said input circuit including means for connecting to a source of signal voltage, an output circuit for the valve including a load impedance across which is developed the output voltage, and means for connecting the screening electrode to an intermediate point of said load impedance device to thereby produce a voltage swing on the screening electrode which is an amplitude reduced image of the voltage swing produced on the anode due to signal energy impressed upon the input circuit, the point of connection of the screening electrode to the load impedance being so chosen that the voltage swing on the screen is of the order of ⅓ the voltage swing on the anode.

2. In an amplifying circuit, a thermionic valve having an anode, a cathode, a grid electrode and a screening electrode, an input circuit for said valve connected between the cathode and grid electrode thereof, said input circuit including means for connecting to a source of signal voltage, an output circuit for the valve including a load impedance across which is developed the output voltage, and means for connecting the screening electrode to an intermediate point of said load impedance device to thereby produce a voltage swing on the screening electrode which is an amplitude reduced image of the voltage swing produced on the anode due to signal energy impressed upon the input circuit, the load impedance comprising a transformer having a primary winding connected in the output circuit of the valve and a secondary winding adapted to be connected to a utilizing device, said screening electrode being connected to a point of said primary winding.

3. In an amplifying circuit a thermionic tube having an anode, a cathode, a grid electrode and an auxiliary electrode, an input circuit for said tube connected between the grid electrode and the cathode thereof and including means for connection to a source of signal voltage, a source of anode potential for said tube including a high tension terminal, a connection including a choke coil between the anode of the tube and said high tension terminal, an output circuit for said tube including a load impedance connected between the anode and cathode of the tube, means including an impedance device for connecting the auxiliary electrode to said high tension terminal and a by-pass condenser connected between said auxiliary electrode and an intermediate point of said load impedance whereby there is impressed upon the auxiliary electrode an amplitude reduced image of the voltage swing produced on the anode due to signal energy impressed upon the input circuit.

4. An arrangement as described in the next preceding claim characterized by that the output impedance comprises a transformer having a primary winding connected in the output circuit of the tube and a secondary winding provided with means for connection to a utilizing device, said auxiliary electrode being connected through the by-pass condenser to an intermediate point of said primary winding.

ALAN DOWER BLUMLEIN.

Oct. 22, 1940. A. D. BLUMLEIN 2,218,902

THERMIONIC VALVE AMPLIFYING CIRCUITS

Filed May 18, 1938

Fig. 1

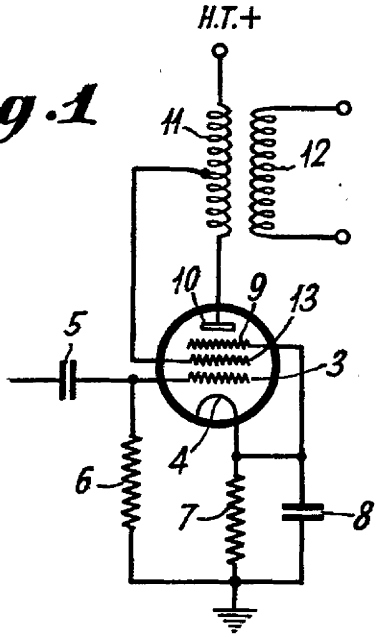
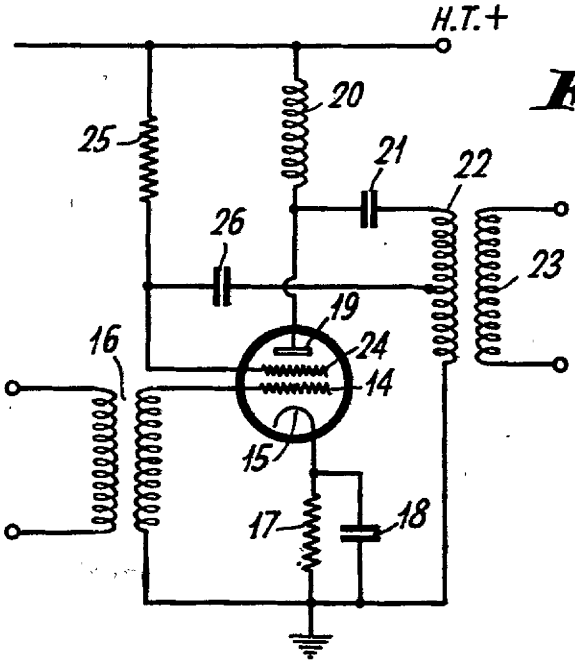


Fig. 2



INVENTOR
ALAN DOWER BLUMLEIN
BY
H. S. Brower
ATTORNEY