Nov. 23, 1943. G. W. FYLER 2,335,050

ELECTRON DISCHARGE AMPLIFIER

Filed June 22, 1942

Fig. 1.

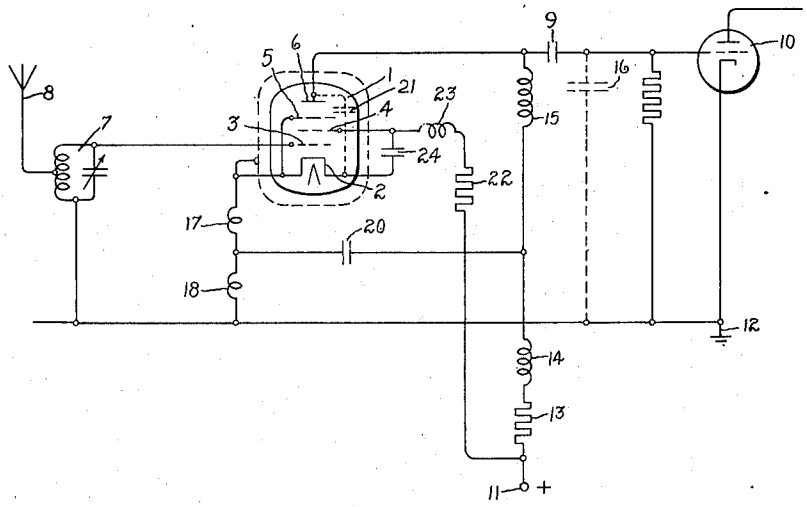
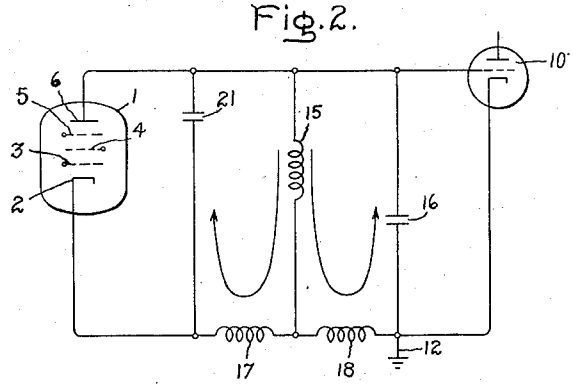


Fig. 2.



Inventor:
George W. Fyler;
by Harry E. Dunham
His Attorney.

Patented Nov. 23, 1943 2,335,050

UNITED STATES PATENT OFFICE

2,335,050

ELECTRON DISCHARGE AMPLIFIER

George W. Fyler, Stratford, Conn., assignor to General Electric Company, a corporation of New York

Application June 22, 1942, Serial No. 447,939

6 Claims. (Cl. 179—171)

My invention relates to electron discharge amplifiers and particularly to such amplifiers operating at frequencies at which difficulties are encountered due to low input resistance of the discharge device.

In amplifiers operating at very high frequencies undesirably low resistance between the control eelctrode and cathode may result by reason of degeneration produced by the oscillatory currents in the output of the discharge device flowing through the unavoidable inductance of the conductor which extends between the cathode of the discharge device and ground. This conductor may be made as short as it is practical to make it but still has some unavoidable length, and therefore some inductance, which is common to the output and input circuits of the discharge device. The voltage on this inductance is present between the control electrode and cathode of the discharge device and operates to reduce the resistance between the control electrode and cathode. This reduction in resistance may occur to such an extent as to damp to a very objectionable degree the input tuned circuit and thus reduce the sensitivity of the amplifier.

An object of my invention is to reduce the degeneration produced by oscillatory currents of the output circuit of the amplifier flowing in this common lead to the cathode.

A further object of my invention is to provide means to maintain the cathode of an electron discharge device operating at such frequencies at ground potential.

Another object of my invention is to provide means to produce neutralization of the voltage on this cathode lead.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents an embodiment of my invention and Fig. 2 represents schematically a portion of the circuits of Fig. 1.

Referring to Fig. 1 of the drawing I have shown therein an amplifier 1 having a cathode 2, a control electrode 3, a screen electrode 4, a suppressor electrode 5 and an anode 6. Between the control electrode 3 and cathode 2 is connected a tuned circuit 7, which I have indicated as being coupled to a receiving antenna 8, although, of course, any desired means may be employed for exciting in this circuit 7 oscillatory electromotive forces to be amplified by amplifier 1. These oscillatory electromotive forces are amplified by the discharge device 1 and may be supplied through a coupling condenser 9 to the control grid of a subsequent amplifier 10, if desired. The anode 6 of the discharge device is supplied with operating potential from a source of anode voltage the positive terminal of which is indicated at 11 and the negative terminal of which may be grounded as at 12. This circuit may include a suitable resistance 13, high frequency choke coil 14 and tuning inductance 15. The inductance 15 may be proportioned to resonate with such capacity as exists between the anode and cathode of the discharge device 1 plus the capacity across the input of discharge device 10. This latter capacity is indicated in dotted lines at 16.

The cathode of the discharge device 1 is connected to ground through a lead conductor having unavoidable inductance, although this conductor may be made as short as conditions of practice permit. This inductance is represented at 17 and 18. A substantial portion of this inductance may be that comprised by the lead extending within the discharge device. Oscillatory electromotive force produced on these inductances 17 and 18 exists between the control electrode 3 and cathode 2 and hence reduces the resistance of the discharge device for reasons that are well understood in the art.

In accordance with my invention, means are provided whereby this electromotive force is neutralized so that the cathode 2 of the discharge device 1 is maintained at ground potential and thus the undesired effects of this voltage are obviated. This result is accomplished by connecting the lower terminal of anode tuning inductance 15 through condenser 20 to a point on the cathode lead dividing the inductance of the cathode lead into the two portions 17 and 18. This capacity 20 may be one of very high value such that its impedance is entirely negligible at the frequencies involved. If the inductances 17 and 18 be proportioned with respect to each other so that inductance 17 bears the same ratio to inductance 18 that the capacity 16 bears to the capacity 21, then zero voltage exists between the cathode 2 and ground 12. This capacitance 21 is represented in dotted lines in Fig. 1 and comprises such capacity as exists between the anode and cathode of device 1.

This character of the circuit is better portrayed in Fig. 2 in which the reference characters employed in Fig. 1 are applied to corresponding ele-

ments. The inductance 15 is shown as having one terminal connected to the anode of the discharge device 1 and its lower terminal connected to the point on the cathode lead between inductances 17 and 18. The input capacitance of discharge device 10 is indicated at 16 and the total capacitance between the anode and cathode of the discharge device 1 is indicated at 21. Since inductance 15 resonates with capacitances 21 and 16, the current may be considered as flowing downward through the inductance 15 and then dividing and flowing in opposite directions through inductances 17 and 18 and hence upward through condensers 16 and 21. Thus, if inductances 17 and 18 have a ratio to each other which is the inverse of that between capacitances 21 and 16, then zero voltage exists between the cathode 2 of discharge device 1 and ground 12.

Such proportioning of the circuit is highly desirable since it avoids the degeneration and reduced input resistance of discharge device 1 previously referred to and thus avoids the undesired damping of the oscillatory circuit 7, 8 of Fig. 1. This permits sharper tuning of this circuit and greater sensitivity of the apparatus.

Of course, if the tuning of the anode circuit of discharge device 1 be varied by varying either capacitance 16 or 21 a certain amount of regeneration or degeneration will be produced by reason of unequal voltages on inductances 17 and 18 and a certain amount of damping of the circuit 7, 8 results. However, no such damping, regeneration, or degeneration results from variation of tuning by varying inductance 15 over a considerable range.

The screen grid 4 of the discharge device 1 of Fig. 1 is shown as supplied with operating potential from the terminal 11 through a resistance 22 and an inductance 23 and as being connected directly to cathode 2 through a large bypass condenser 24. Likewise, the suppressor grid 5 is shown connected directly to the cathode 2 of the discharge device. These connections are conventional in amplifiers operating at such frequency, but it is desirable that the capacitance 24 be reasonably large to prevent oscillatory voltages from appearing on the screen grid 4.

If degeneration, or regeneration results to any appreciable extent from the fact that the lead to the screen grid 4, or those to condenser 24, have finite length, and therefore finite inductance, such regeneration or degeneration can be compensated for by appropriate change in relative values of inductances 17 and 18. Actually this change may be made by sliding the connection of condenser 20 to the cathode lead along the cathode lead until such compensation obtains.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto since various modifications in the circuit illustrated and instrumentalities employed may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, an electron discharge device having an anode and cathode, a capacitive load connected between said anode and cathode through an inductance and a second inductance connected between said anode and an intermediate point on said first inductance, said point being so positioned that zero voltage of the operating frequency exists between the extremities of said first inductance.

2. In combination, an electron discharge device having an anode, and cathode, a capacitive load connected between said anode and ground, an inductance connected between said cathode and ground, and a second inductance connected between said anode and an intermediate point on said first inductance of such value that said cathode is at ground potential at the operating frequency.

3. In combination, an electron discharge device having an anode, and a cathode, a capacitive load contacted between said anode and ground, an inductance between said cathode and ground and an inductance between said anode and a point dividing said first inductance into two parts having a ratio therebetween equal to the ratio of the capacity between said anode and cathode to the capacitance of said load.

4. In combination, a pair of electron discharge devices connected in cascade, one of said devices having a cathode and output electrode and the other having a cathode and input electrode, the latter of said cathodes being grounded, an inductance between said cathodes, and a second inductance having one terminal connected to said input and output electrodes and its other terminal connected to a point on said first inductance such that said first cathode is maintained at ground potential at the operating frequency.

5. The combination, in an electron discharge radio frequency amplifier having a control electrode, a cathode, and an anode, a connection between said anode and cathode including a capacitive load device, a connection between said control electrode and cathode including an oscillatory input circuit, said connections including a common conductor extending to said cathode, said common conductor having sufficient length to produce feedback resulting in undesired damping of said oscillatory circuit, and an inductance connected between said anode and a point intermediate of the length of said common conductor, said point being chosen to reduce said damping.

6. The combination, in an electron discharge radio frequency amplifier having a control electrode, a cathode, and an anode, a connection between said anode and cathode including a capacitive load device, a connection between said control electrode and cathode including a source of radio frequency electromotive force to be amplified, said connections including a common conductor extending to said cathode, said common conductor having length sufficient to produce undesired feedback from said anode to said control electrode, and an inductance connected between said anode and a point intermediate of the length of said common conductor such that substantially zero voltage exists between the ends of said common conductor.

GEORGE W. FYLER.

CERTIFICATE OF CORRECTION.

Patent No. 2,335,050. November 23, 1943.

GEORGE W. FYLER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 19, claim 3, for "contacted" read --connected--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of January, A. D. 1944.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)