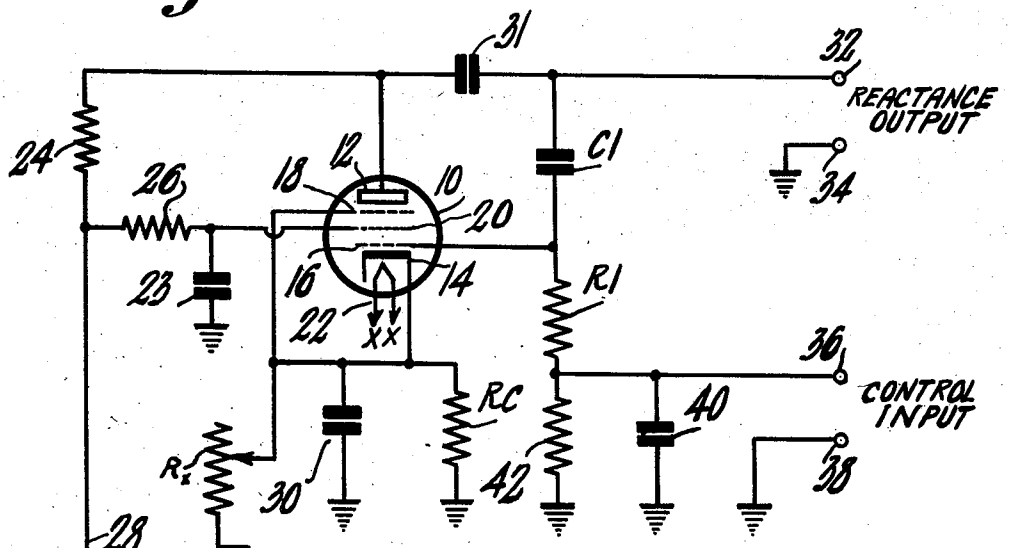
April 23, 1957 R. H. FOX 2,790,134

CONDUCTANCE REGULATION

Filed May 18, 1951

Fig. 1



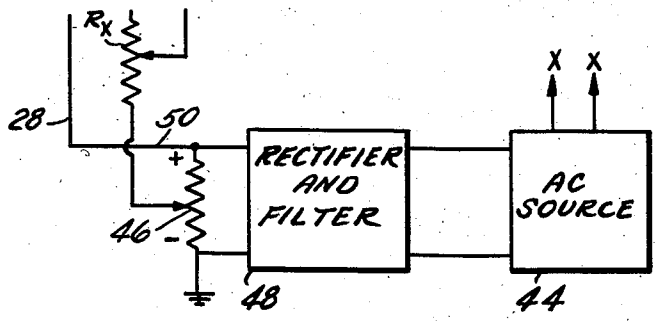


Fig. 2

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United States Patent Office 2,790,134
Patented Apr. 23, 1957

2,790,134

CONDUCTANCE REGULATION

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Application May 18, 1951, Serial No. 227,077

3 Claims. (Cl. 323—42)

This invention relates to a novel method of and means for maintaining the conductance of an electron discharge device independent of line fluctuations in the source of energizing potentials.

In the prior circuits with which I am acquainted, it is common practice to utilize a regulated voltage source to supply operating potentials to the circuit devices. In such arrangements using electron discharge devices such as vacuum tubes having heated electron emissive cathodes, it is customary only to regulate the direct current high voltage potential and not the voltage used to heat the cathode. As a result, I have found fluctuating line voltages cause a corresponding fluctuation in the heating of the cathode with a resulting variation in electron emission from the cathode. Since the potential applied across the tube remains constant, the resulting effect is a change in the apparent resistance or mutual conductance of the discharge device.

Accordingly, it is an object of my invention to provide a novel method of and means for preventing the line fluctuations of a potential source from affecting the mutual conductance of an electron discharge device energized from said source.

It is a further object of my invention to provide a novel method of and means for maintaining constant the mutual conductance of an electron discharge device energized from a voltage source subject to line voltage changes.

It is still another object of my invention to provide a novel method of and means for utilizing an electron discharge device as a variable reactance and in which the mutual conductance of the discharge device is maintained independent of line voltage changes in the potential supply of the source.

Briefly, in accordance with a preferred embodiment of my invention, the anode of the electron tube is energized with direct current voltage from the regulated portion of the supply source and the cathode heating voltage from the supply source is unregulated. The cathode return is taken through a variable resistance to the unregulated portion of the supply source at a point above ground potential. Thus, changes in line voltage which change the cathode emission and, hence, the conductivity of the tube are compensated for by a corresponding change in cathode potential.

In a modification of my invention both the electron tube anode potential and the cathode return are connected to the unregulated portion of the supply source.

The above and other objects and advantages of my invention will be made clear by a consideration of the following detailed description taken in conjunction with the accompanying drawing, wherein:

Fig. 1 represents schematically an embodiment of my invention in a reactance tube circuit; and

Fig. 2 shows a modified portion of the circuit of Fig. 1.

For many circuits the amount of change in mutual conductance, caused by the factors noted above, is so small as to be negligible and may be disregarded. For other uses, however, this change becomes important.

One such arrangement occurs when the discharge device is used as a variable reactance. Since reactance circuits are commonly used for frequency control any change in mutual conductance is reflected as a change in reactance and, hence, line voltage changes will result in erroneous frequency settings. Accordingly, I have illustrated my invention in a circuit using an electron discharge device as a reactance. It is to be understood, however, that the invention is not limited to this particular use but may find application wherever it is desired to maintain the mutual conductance of the discharge device independent of line variations in the supply source.

Referring to Fig. 1 of the drawing, the electron discharge device has been illustrated as a multi-grid vacuum tube, **10**, having an anode, **12**, a cathode, **14**, a control grid, **16**, a suppressor grid, **18**, and a screen grid, **20**. The cathode is shown as being of the indirectly heated type and is provided with a heating filament, **22**. As is customary, the suppressor grid is connected directly to the cathode and the screen grid is by-passed to ground by a condenser, **23**. The anode of the tube and the screen grid are supplied with direct current operating potentials through line resistors, **24** and **26**, respectively, via a lead, **28**. The cathode is grounded through a self-biasing arrangement consisting of the parallelly connected condenser, **30**, and constant-resistance resistor, R_c. The tube is made to reflect a capacitive reactance by means of a quadrature circuit including capacitor C_1 and resistor R_1 connected to the anode **12**, the control grid **16** and the cathode **14**. Reactance tube circuits are described starting at page 54 of the book "FM Transmission and Reception" by Rider and Uslan, 1948. As is well known, the apparent reactance of the circuit across the output terminals, **32** and **34**, is made to vary by varying the grid voltage applied to the tube.

In the illustrated embodiment the control voltage is applied to the terminals, **36** and **38**, and thence to the control grid by means of the condenser, **40**, and resistors, **42** and R_1. The filament, **22**, derives its energizing potential from an alternating current source indicated generally within the block, **44**. In order to simplify the drawing, the full filament connections have not been shown, it being understood that the terminals, *x*—*x*, are interconnected.

The remainder of the power supply source has been illustrated in block diagram as being that type which includes a rectifier and a filter within block, **48**, which provides an unregulated output (B+) potential and a voltage regulator within the block, **52**, to provide a regulated (B+) potential for the anode of tube **10**. Such supply sources are well known and are not believed to require further illustration. For those who are interested in a more detailed description of potential sources of this type, reference may be had to "The Radio Handbook," 10th edition, published by Editors and Engineers in 1946 and more particularly to the circuit shown in Figure 14 on page 328.

As is customary, the lead, **28**, over which anode and screen grid potentials are applied, is shown as being connected to the positive side of the output of the voltage regulator. However, in accordance with my invention, the cathode return is made through the variable resistance, R_x, to a tap on the potentiometer, **46**, placed across the output of the rectifier and filter. The potentiometer, **46**, may be eliminated if desired, since the potentiometer, R_x, may be set to drop the voltage to the required value.

As a result of the above circuit connections, it will be seen that a variation in the line voltage will result in a corresponding variation in the heating effect of the filament, **22**, of tube, **10**. This change in heating causes a corresponding change in cathode emission and, hence, changes the mutual conductance of the tube. However,

a corresponding change will appear at the point where the cathode return resistor, R_x, is placed across the unregulated portion of the supply source. This change in cathode potential, with no change in anode potential, will change the effective voltage across the tube and in such a manner as to compensate for the change in electron emission.

Thus, an increase in supply voltage will cause increased emission which would tend to increase the mutual conductance of the tube. However, at the same time there will be an increase in the potential above ground of the cathode. This increase in cathode potential has the effect of decreasing the potential across the tube, thus compensating for the increased emission. A similar but reversed effect results from a decrease in the line voltage.

The cathode return resistor, R_x, is chosen to have a value that will make the change in cathode potential proportional to the change in emission caused by a line fluctuation.

The proper value for the resistance, R_x, may be determined by connecting the reactance circuit to be controlled to the output terminals, **32** and **34**. The setting of the tap on the resistance, R_x, is then set at various positions. At each setting the line voltage is varied over a range of plus or minus 10%. The tap is set at that position which maintains the reactance constant over the range of line voltage change.

By way of example, in one practical arrangement which was constructed and using an RCA 6AU6 tube operated from a voltage source having an unregulated output voltage of 200 volts and a regulated output of 150 volts, the components of the circuit were given the following values:

Resistor **24**	ohms	47,000
Resistor **26**	do	120,000
Resistor **42**	do	1,000,000
Resistor R_1	do	470
Resistor R_c	do	1,200
Resistance R_x	do	68,000
Capacitor **23**	microfarads	0.01
Capacitor **30**	do	0.01
Capacitor **31**	do	0.01
Capacitor **40**	do	6.0
Capacitor C_1	micro-microfarads	5.00

It is possible to obtain compensation in a similar manner when both the anode and filament of the tube are supplied from an unregulated source. Such an arrangement is indicated in Fig. 2 by the line, **50**, showing the anode and screen grid potential being supplied from the unregulated portion of the supply source. In this instance, while there will also be a change in the anode voltage of the tube, proper adjustment of the variable resistance, R_x, will still result in the desired compensation being obtained. However, this modification makes the compensation somewhat dependent upon the particular tube in use and the first described embodiment is preferred.

Having described my invention, I claim:

1. A conductance regulating system for a vacuum tube including at least a cathode, a heating filament for said cathode and an anode, comprising, a power supply having heating current output terminals connected to said heating filament and having positive and negative direct current output terminals, said heating and direct current outputs being subject to undesired amplitude variations in the same direction, a constant-resistance resistor connecting said negative terminal to said cathode, impedance means connecting said positive terminal to said anode, and means to apply a portion of the positive potential on said positive terminal to said cathode.

2. A conductance regulating system for a vacuum tube including at least a cathode, a heating filament for said cathode and an anode, comprising, a power supply having heating current output terminals connected to said heating filament and having a negative output terminal, an unregulated positive output terminal, and a regulated positive output terminal, said heating and unregulated outputs being subject to undesired amplitude variations in the same direction, first impedance means connecting said cathode to said negative terminal, second impedance means connecting said anode to said regulated positive terminal, and means to apply a portion of the positive potential on said unregulated positive terminal to said cathode to compensate for any undesired change in emission from said cathode due to a change in heating current supplied to said filament.

3. A reactance tube circuit comprising, a vacuum tube including at least a cathode, a heating filament for said cathode, a grid and an anode, a quadrature circuit connected to said cathode, said grid and said anode, means to apply a control signal to said grid, a power supply having heating current output terminals connected to said heating filament and also having a negative output terminal, an unregulated positive output terminal and a regulated positive output terminal, said heating and unregulated outputs being subject to undesired amplitude variations in the same direction, first impedance means connecting said cathode to said negative terminal, second impedance means connecting said anode to said regulated positive terminal, and means to apply a portion of the positive potential on said unregulated positive terminal to said cathode.

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