April 28, 1942. R. E. SCHOCK 2,281,205

VOLTAGE VARIATION COMPENSATOR

Filed Aug. 20, 1938

Fig. 1

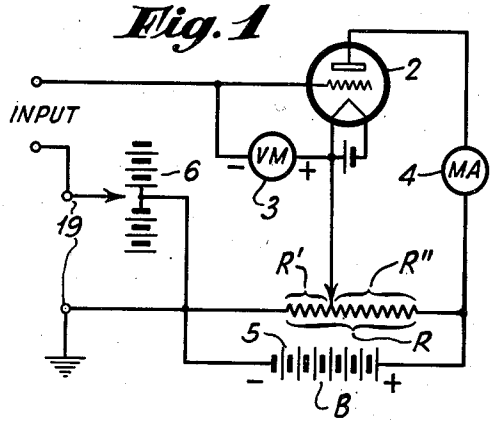


Fig. 1a

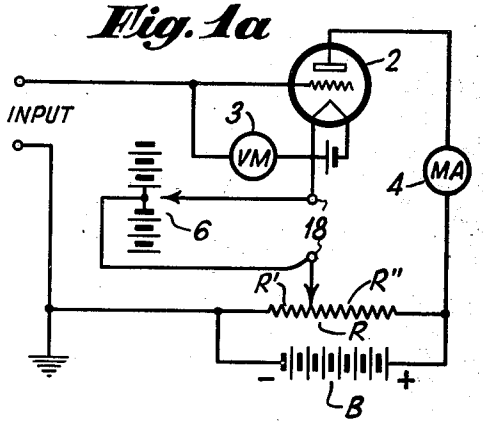


Fig. 2

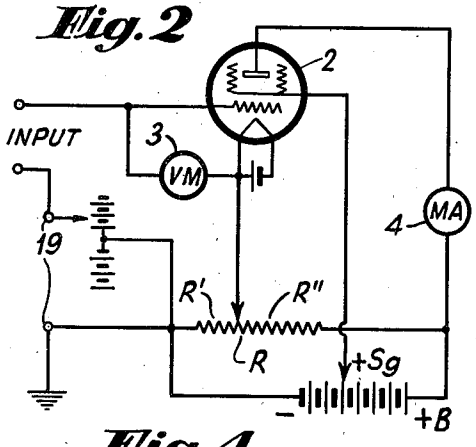


Fig. 3

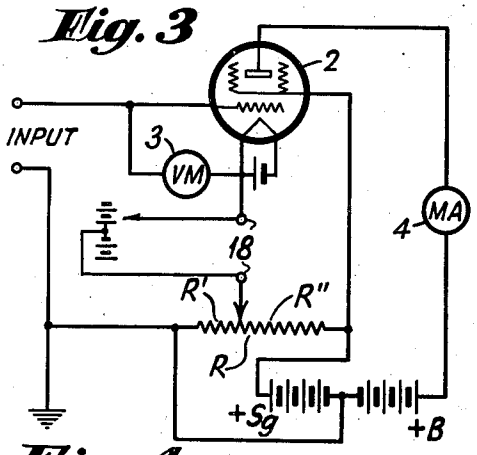


Fig. 4

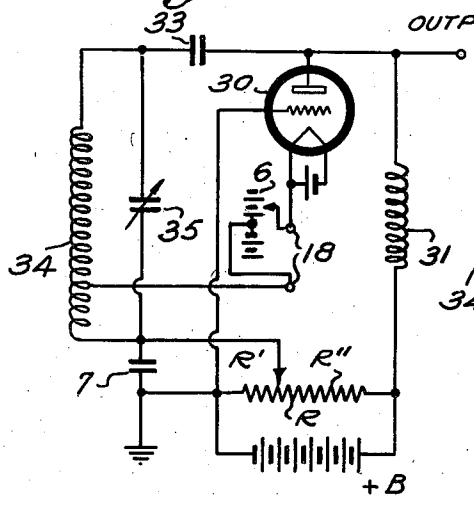
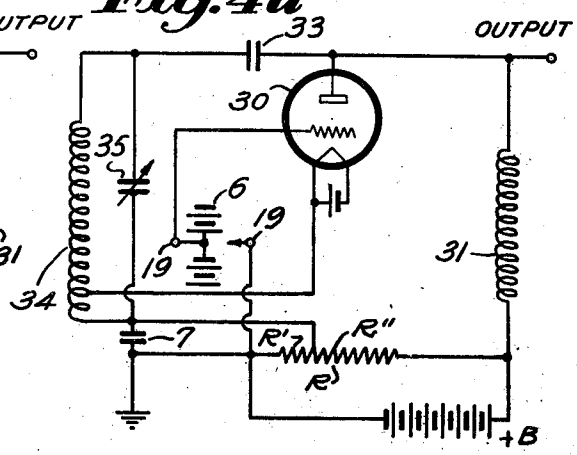


Fig. 4a



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VOLTAGE VARIATION COMPENSATOR

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Application August 20, 1938, Serial No. 225,911

3 Claims. (Cl. 250—36)

This invention relates to a new and novel circuit method of compensating for supply voltage variations in vacuum tube amplifiers, oscillators, recording devices, and other types of apparatus requiring constant voltages.

An object of this invention is to provide an improved system of voltage compensation or regulation.

Another object of this invention is to improve the voltage regulation of both an alternating current and a direct current type of amplifier.

Still another object of this invention is to improve the voltage regulation of a vacuum tube oscillator and other apparatus requiring constant voltages.

I have found that although voltage compensation devices are old in the art, it often becomes necessary that the output of amplifiers and the output frequency of oscillators be independent of variations in their supply voltage. This requirement involves either regulation of the supply voltage or some method of compensation within the amplifier or oscillator circuit for the effect of supply voltage variation. Some of the more common methods of compensation as known in the prior art involve batteries which are maintained at a voltage high from the common ground or excessive supply voltages.

The improved features and operation of my invention will best be understood by referring to the accompanying drawing, in which:

Fig. 1 is a circuit showing the principle of operation involved in this method of voltage compensation;

Fig. 1*a* is an alternative arrangement of a circuit, similar to that of Fig. 1, except that a separate voltage supply source is connected to the cathode lead;

Fig. 2 is a circuit diagram similar to that of Fig. 1, except that a tetrode type of tube is used instead of a triode;

Fig. 3 is a circuit diagram of this invention similar to that of Fig. 2, except that the potentiometer is connected across the screen voltage supply rather than across the plate or anode supply;

Fig. 4 is a circuit diagram in which the compensator circuit arrangement of this invention is applied to grid circuit a Hartley oscillator; and

Fig. 4*a* is a circuit diagram similar to Fig. 4 except that the separate voltage source is connected to the cathode lead instead of the grid lead.

Referring now in detail to Fig. 1 of the drawing, the principle of operation involved in this novel circuit arrangement is shown wherein the electron discharge device or triode tube 2 has connected in its plate circuit a current meter or milliammeter 4 to indicate the current drawn in the plate circuit and has a voltmeter 3 connected between its grid and cathode to indicate the bias voltage applied to the tube. The cathode obtains voltage for the purpose of compensating for plate supply changes from a voltage divider or potentiometer "R" which is connected across the plate supply 5. Any further grid voltage necessary to give proper bias, as indicated by the voltmeter 3, may be applied by a voltage supply device 6 connected in series with the grid cathode circuit at terminals 19 as in Fig. 1, or as another alternative circuit arrangement, as shown by Fig. 1*a*, the voltage supply device 6 may be connected in series with the cathode lead at terminals 18. The voltage supply device 6 which is inserted in series with the input or grid circuit, is connected to supply either positive or negative potential, as may be required to gain proper bias after the cathode is set at the point on divider R which is found to give complete compensation. In the operation of this device, assuming that the circuit is in operation and that complete compensation for plate supply voltage variations is found to result when the movable arm on resistor "R" is placed so that the cathode lead which is connected therto is at a point R' on the voltage divider "R," if the plate supply voltage increases, the voltage on the cathode increases simultaneously by the amount R'/R of the plate supply voltage change. Ordinarily, increasing the plate supply voltage would increase the plate current indicated by current meter 4, if there were no compensation, but in this circuit the simultaneous increase of voltage on the cathode compensates for the plate supply increase, since increasing the cathode voltage positively effectively biases the grid negatively so that the tube draws less current. Since changing the voltage on the cathode effectively changes the voltage on the grid, only a small fraction of the total plate supply voltage need be applied to the cathode to give compensation. Increasing this fraction (R'/R) above this amount will cause over-compensation so that a plate supply increase causes the cathode voltage to increase enough to actually decrease the plate current, and vice versa, for plate supply decrease. Placing a fraction of the plate supply voltage changes on the cathode of tube 2 has necessarily placed a fraction of plate supply voltage on the cathode and caused the cathode to become positive with respect to the grid. If this voltage, as indicated by the grid bias voltmeter 3, is not enough to give the voltage necessary for the correct bias, additional bias may be obtained from a voltage supply device 6 placed in the grid circuit at terminals 19, as in Fig. 1, or from a voltage supply device 6 placed in the cathode circuit at terminals 18 as in Fig. 1*a*. If this voltage is more than is required for correct bias, a bucking voltage may be obtained from the voltage supply device 6 inserted in the cathode lead at terminals 18,

as in Fig. 1*a*, to buck the cathode voltage down to that required for a correct bias, or positive voltage may be applied to the grid by placing voltage supply device **6** in the grid circuit at terminals **19**, as in Fig. 1. It will be noted that voltage supply device **6** is merely a representation of a convenient circuit for supplying voltage of either positive or negative polarity as desired, and is not limited to this particular form.

The amount of plate supply voltage change needed on the cathode for complete compensation depends on the gain of the tube, since it is this change on the cathode, multiplied by a gain of the tube, which gives compensation in the plate circuit. Therefore, the amount of plate supply voltage change necessary on the cathode for compensation will vary with different tubes and different operating conditions. The voltage divider "R" should have a resistance low enough so that the voltage drop in "R'" due to the cathode current is low compared with the bias voltage and will not cause any serious degeneration. It should be noted in connection with the circuit diagram shown in Fig. 1, that if there is a hum on the plate supply, the compensation will compensate for this also in the same manner in which it compensates for slow variations in supply voltage.

The circuit arrangement shown in Fig. 2 is generally similar to that of Fig. 1, except that a tetrode tube is used instead of a triode. However, if the tetrode plate and screen supply are separate, it may be desirable to connect the compensating voltage divider "R" across the screen supply, as is shown in Fig. 3, rather than across the plate supply indicated in Fig. 2, since the plate output of the tetrode tube is relatively independent of the plate supply variations as compared with the screen supply variations. In either case, the principle of operation remains the same as is mentioned above in connection with Figs. 1 and 1*a*. Here again, bias may be obtained of correct polarity and amount by inserting voltage supply device **6** in either the grid or cathode circuits as shown in Figs. 1 and 1*a*, respectively.

Figs. 1, 1*a*, 2 and 3 show merely demonstrative circuits to demonstrate the principle of this invention on a direct current amplifier type of circuit. However, as disclosed by Fig. 4 and 4*a*, the method of this invention may be applied to a Hartley oscillator circuit wherein the plate of oscillator tube **30** is fed through a choke **31**. The direct current plate voltage is blocked by a blocking condenser **33** from getting to the tuned plate circuit of the oscillator formed by coil **34** and condenser **35**. The cathode of tube **30** receives its compensation voltage from a tap on the voltage divider "R" which is connected across the plate supply. The desired grid bias is obtained by inserting voltage of the correct polarity and amount at the cathode lead by a device **6**, as shown in Fig. 4, which is connected to terminals **18**, or in the grid lead a voltage device may be inserted as shown in Fig. 4*a* and connected to terminals **19**. The principle of operation of the compensators is the same as has already been described above in connection with the other circuits. Results obtained from an experimental setup of this circuit indicate that its frequency stability is equal to that obtained by the use of a grid leak and condenser in the grid circuit for stability. However, the circuit of Figs. 4 and 4*a* has the advantage over the grid leak and condenser usually employed in the circuit in that the arrangement of Figs. 4 and 4*a* runs at full output capability of the tube, while the grid leak and condenser type of circuit has a relatively low output. Complete compensation which eliminates frequency changes due to voltage variations, is possible at any one frequency with the use of this compensation method of my invention. However, since shifting the tuning and consequently the frequency of the oscillator changes the gain of the tube, it is necessary to change the cathode supply tap on the compensator divider "R" whenever the oscillator frequency is changed in order to have complete compensation at the new frequency setting.

Although only a few circuit arrangements have been shown employing this novel type of voltage compensation, it is to be distinctly understood that this invention is not to be limited to the modification shown as its principle of operation is capable of being applied to other circuits.

What is claimed is:

1. A power supply system for an oscillator circuit comprising an electron discharge tube having at least an anode circuit, a grid circuit and a cathode circuit, means for voltage supply compensation of said electron discharge device comprising a potentiometer having a variable tap, a choke coil connected between said anode and one end of said potentiometer, a first source of potential connected in shunt with said potentiometer, a second source of potential connected between said grid and the other end of said potentiometer, an oscillator coil and a variable condenser connected between said anode and the variable tap on said potentiometer, and a tap for said oscillator coil connected to said cathode.

2. A power supply system for an oscillator circuit comprising an electron discharge tube having at least an anode circuit, a grid circuit and a cathode circuit, means for voltage supply compensation of said electron discharge device comprising a potentiometer having a variable tap, a choke coil connected between said anode and one end of said potentiometer, a first source of potential connected in shunt with said potentiometer, an oscillator coil, a tap on said oscillator coil, a second source of potential connected between said tap on said oscillator coil and said cathode, a variable condenser in shunt with said oscillator coil and connected between said anode and the tap on said potentiometer, and a connection from said grid to the other end of said potentiometer.

3. A power supply system for an oscillator circuit comprising an electron discharge tube having at least an anode, a grid and a cathode, means for voltage supply compensation of said electron discharge device comprising a potentiometer having a variable tap, a choke coil connected between said anode and one end of said potentiometer, a first source of potential connected in shunt with said potentiometer, a second source of potential connected in a circuit including a portion of said potentiometer between said grid and cathode, an oscillator coil and a variable condenser connected between said anode and the variable tap on said potentiometer, and a tap for said oscillator coil connected to said cathode.

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