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VACUUM TUBE CIRCUITS

Original Filed Sept. 18, 1928

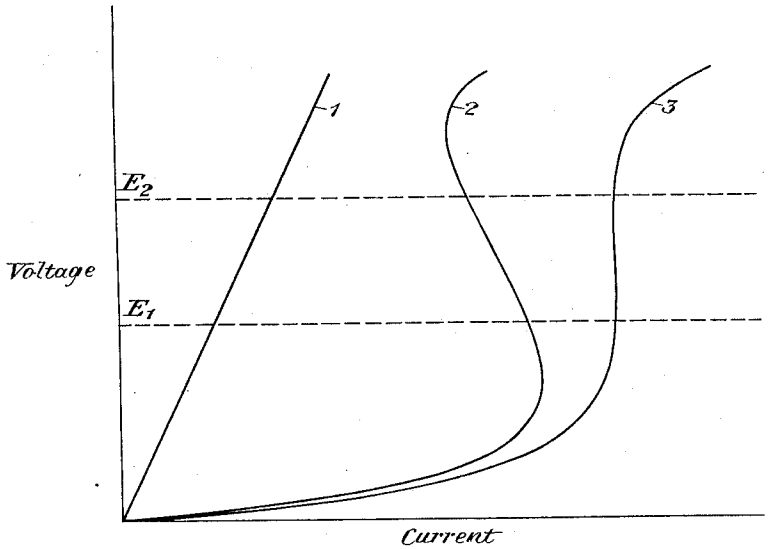


Fig. 1

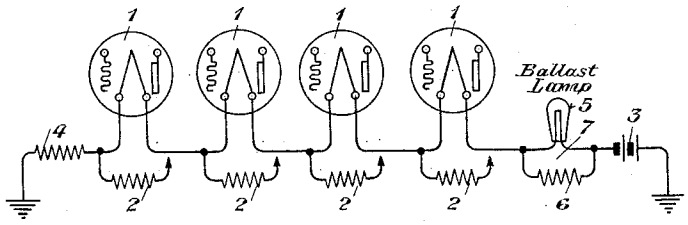


Fig. 2

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VACUUM TUBE CIRCUITS

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2 Claims. (Cl. 171—229)

This invention discloses an arrangement for delivering a constant current to a circuit supplied from a fluctuating source of potential. The scheme is especially applicable to telephone repeater circuits where it is desirable to supply the vacuum tube filaments with an approximately constant direct current from a source of potential which fluctuates within fairly narrow limits.

The constant current regulation is obtained by inserting in the circuit to be regulated, a ballast lamp shunted by a suitable resistance. Such an arrangement when properly designed, as explained below, will insure a constant current flow in the circuit under fluctuating conditions of the supply potential.

The use of such an arrangement in the filament circuit of vacuum tube repeaters has for one of its objects an increase in the useful life of the tubes for such service. For repeater use, a vacuum tube reaches the end of its useful life when under operating conditions its change in gain exceeds a specified amount. By "operating conditions" are meant the fluctuating current values to which the tubes in present practice are subjected, due to the fluctuating potential of the filament battery. By insuring a constant filament current to the tubes this fluctuation in gain is avoided and the useful life of the tubes thus considerably extended.

Even with a constant filament current supply the tubes gradually age in use to the point at which they do not emit sufficient electrons with the normal current supply. At this point the only alternative to discarding the tubes is to increase the filament current to a greater value and thus restore the original emissivity.

As a second novel feature, this invention discloses means for increasing the filament current in individual tubes as the emission begins to decrease. In this manner the useful life of the tubes is still further prolonged.

This is a division of a copending application Serial No. 306,680, filed September 18, 1928.

The novel features are best understood by reference to the drawing of which Figure 1 discloses certain voltage-current characteristics which explain the constant current regulation; while Fig. 2 discloses a circuit arrangement embodying both the novel features discussed above.

Referring to Fig. 1, curve 2 shows a typical voltage-current characteristic for a ballast lamp consisting of a filament of iron wire immersed in hydrogen at low pressure. For the voltage range E_1 to E_2 it will be noted that the slope of the characteristic curve is negative, and that the current decreases almost linearly with an increase in voltage. That is, in this range the lamp offers a constant negative resistance to voltage fluctuations. This suggests shunting the lamp by a positive resistance equal in magnitude to this negative resistance. With such an arrangement an increment of voltage across the shunt circuit in the range E_1 E_2 would cause an increment of current to flow through the shunt resistance which would exactly offset the corresponding decrement of current flowing through the ballast lamp. As a result, the total current taken by the elements in parallel remains constant and unaffected by the voltage change.

Curve 1, Fig. 1 shows the voltage-current curve for such a shunting resistance. The slope of this curve is equal in magnitude but opposite in sign to that of curve 2 between the voltages E_1 and E_2. Adding the abscissae of curves 1 and 2 gives curve 3, which represents the total current taken by the parallel circuit, i. e., ballast lamp plus resistance, for any given value of voltage impressed across the same. It is evident from curve 3, that the current taken by the parallel circuit remains constant for voltage fluctuations in the region E_1 to E_2.

Referring now to Fig. 2, a plurality of vacuum tubes 1 are connected in series. One end of the circuit is connected to ground through resistance 4, while the other end is connected through the current regulating circuit 7 and battery 3 to ground. Circuit 7 comprises ballast lamp 5 shunted by a suitable resistance 6, to insure the type of voltage current curve shown by curve 3 of Fig. 1. If the source of voltage 3 normally fluctuates so that the voltage fluctuation across the parallel circuit is only within the voltage limits E_1 to E_2, a constant current supply to the filament circuit is insured, thus extending the useful life of the tubes. The resistance 4 serves to adjust the filament current to its proper value within the voltage range E_1 to E_2.

To further extend the useful life of tubes 1, each filament at the beginning of service is shunted by a suitable resistance 2, and the ballasting combination 7 so adjusted that the filaments receive the proper current under this condition. When any tube is found to have aged in service to the point where its emission is insufficient, the corresponding resistance 2 shunting that particular filament is disconnected, thereby causing an increase of filament current sufficient to restore the tube to a condition of

satisfactory emissivity, and further prolonging its useful life.

The circuit of Fig. 2 is, of course, only one illustration of the many uses to which the ballasting combination 7 could be put in regulating current to a constant value.

It is not essential that a ballast lamp be used to obtain constant current regulation in the manner described. The same ideas could be applied to other devices having characteristics such that over a certain range the current decreased linearly with increased voltage.

What is claimed is:

1. In combination, a plurality of vacuum tubes the filaments of which are connected in series, a suitable resistance shunting the filaments of each tube, a source of potential connected in series with said filaments for supplying thereto current of such magnitude as to furnish adequate electronic emission in each tube, means, when the filament emission of any tube becomes insufficient, for disconnecting the shunt resistance associated with such tube to increase the filament current thereof and to restore the emission to a suitable value, and a pair of parallel resistors connected in series with said potential source for maintaining the current in the entire circuit substantially constant upon the disconnection of one or more of said shunt resistances, one of said pair of resistors having a voltage-current characteristic of approximately constant negative slope between the limits of the voltage fluctuation across the terminals of said pair of resistors due to the disconnection of one or more of said shunt resistances and the other of said resistors having a voltage-current characteristic of positive slope equal in magnitude to said negative slope.

2. In combination, a plurality of vacuum tubes the filaments of which are connected in series, a resistance shunting the filaments of each tube, a source of potential connected in series with said filaments for supplying current thereto, the filament current and each shunt resistance being so adjusted with respect to the electron emissive condition of the corresponding filament to furnish a predetermined rate of electronic emission, means, when the rate of electronic emission of any tube becomes less than said predetermined rate due to the condition of the filament of such tube, to disconnect the shunt resistance associated with such tube to increase the rate of emission thereof, and a pair of parallel resistors connected in series with said potential source for maintaining the current in the entire circuit substantially constant upon the disconnection of one or more of said shunt resistances, one of said pair of resistors having a voltage-current characteristic of approximately linear negative slope between the limits of the voltage fluctuation across the terminals of said pair of resistors due to the disconnection of one or more of said shunt resistances and the other of said resistors having a voltage-current characteristic of positive slope equal in magnitude to said negative slope.

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