

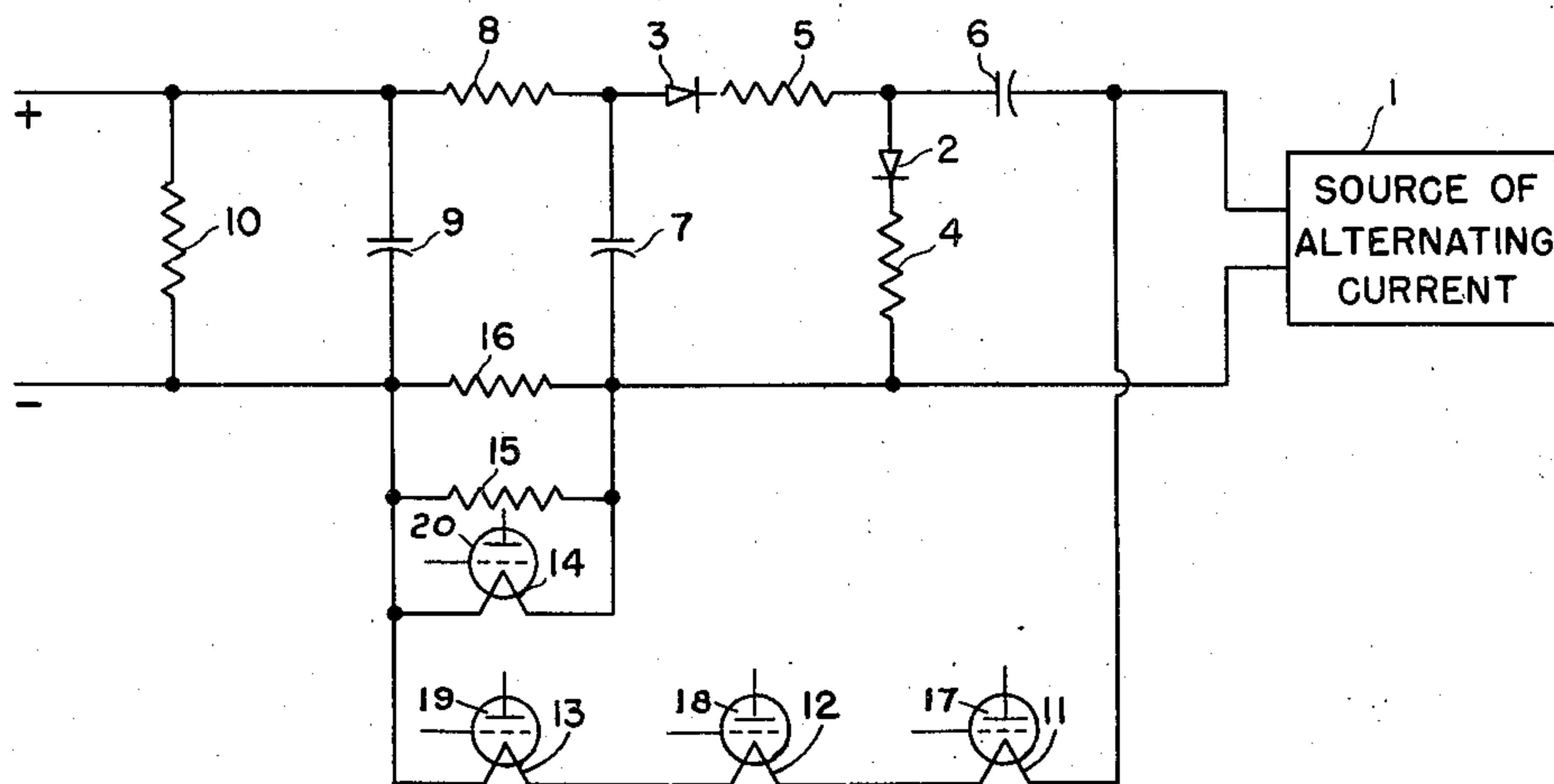
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2,466,250

FILAMENT VOLTAGE SUPPLY

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FILAMENT VOLTAGE SUPPLY

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1

This invention relates to power supply circuits for devices employing electron discharge tubes and more particularly to filament voltage supplies for series connected electron discharge tubes.

Electron discharge devices of the filament type, for example, those employing tungsten filaments, have a relatively high temperature coefficient, the cold resistance of the heater or filament being of the order of one-sixth to one-seventh that of the hot operating resistance. Therefore, if the rated filament voltage is applied to these tubes, the initial current may be six to seven times the rated operating current. This high initial surge current may be detrimental to tube life, particularly when the thermal lag of any one filament in the series string is substantially shorter than that of the rest. As a result of differences in thermal inertia, voltages as high as 400% above rated value may be reached on one filament during the first few seconds of the warm-up period which represents an overload as high as 1600%. Whereas 200% over-voltage is commonly tolerated, an over-voltage of the order of 400% is undesirable.

Moreover, in some locations where radio equipment or sound systems, such as paging or public address systems, are employed, the available alternating current voltage supply may be lower than the sum of the rated filament operating voltages. For example, it is possible to employ in a four-tube amplifier, tubes having rated filament voltages of 50, 50, 6.3, and 12.5 making a total rated voltage requirement of 118.8 whereas the alternating current supply may only be 117 volts.

It is an object of my invention to provide a new and improved filament supply for series connected electron discharge devices in which tube life of tubes having relatively substantially larger or higher thermal inertia, i. e., which reach normal operating temperatures (and, therefore, operating resistances), relatively slower than one or more other tubes is protected and filaments in a series string are operated at their rated design temperatures even though the sum of the rated filament operating voltages exceeds the voltage of the alternating current supply source.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with

2

the accompanying drawing in which the drawing illustrates the circuit arrangement of one embodiment of my invention.

Referring to the drawing, there is shown a typical direct current voltage supply comprising a suitable source of alternating current 1 and a rectifier of the half-wave voltage-doubler type, including suitable half-wave rectifiers 2 and 3, the former being connected in series with a ripple current limiting resistance 4 of suitable value across the alternating current supply, and the latter being arranged in series with a suitable ripple current limiting resistance 5 in series with one side of the alternating current supply. Capacitor 6, connected in series with resistance 5 and rectifier 3 in one side of the alternating current supply and capacitor 7, connected across the output side of rectifier 3, constitute high ripple current capacitors of suitable capacity and may be electrolytic capacitors, for example.

In order to drop the rectified direct current output of the rectifier to an amplitude satisfactory for use in the associated equipment, there is provided a suitable dropping resistor 8 which, together with a suitable capacitor 9, also forms a filter circuit. A bleeder resistance 10 may be connected across the output side of filter capacitor 9, to protect capacitors 7 and 9 from surges of voltage immediately after turning the system on.

The drawing also illustrates a suitable filament supply for the heater of four electron discharge devices, the filaments being connected in series 17, 18, 19 and 20, as indicated by the numerals 11, 12, 13, and 14, across the alternating current supply source 1. For example, filaments 11 and 12 may be included in power tubes having a relatively small or low thermal inertia (i. e., reach operating temperatures relatively quickly), filament 13 may be included in a voltage amplifier of intermediate thermal inertia, and filament 14 may be included as part of a voltage amplifier tube of relatively large or high thermal inertia, i. e., reaches its operating temperature relatively slowly, in which case filament 14 is subject to the conditions previously discussed. In order to protect the filament 14 from the effects of overload during the warm-up period, filament 14 is shunted by a resistance 15 having a suitable voltage rating and negative temperature coefficient such that its resistance drops approximately in the same manner and approximately the same rate at which the resistance of filament 14 rises, i. e. the coefficient of the resistance varies in one sense at approximately the same rate as the

3

coefficient of the filament varies in the opposite direction, and reaches its equilibrium resistance when the warm-up period is over. The inclusion of resistance 15 is necessary because as filament 14 approaches its normal operating resistance faster than filaments 11, 12, and 13, more than a proportionate share of the supply voltage appears across filament 14 and in a typical case may approximate 400% over-voltage. However, with resistance 15 shunting filament 14, the resistance of resistor 15 decreases at substantially the same rate as the resistance of filament 14 increases so that there is no appreciable change of total resistance and hence no appreciable change of voltage across the shunt combination including filament 14 and resistance 15. As soon as the surge ceases and less current flows, the resistance of resistor 15 increases and the shunting effect on filament 14 is substantially eliminated or sufficiently reduced to permit satisfactory operation.

To offset the shunting effect of resistance 15 on heater 14, in the A. C. heater loop, a portion of the direct current from the D. C. supply is fed through the parallel branch circuit consisting of filament 14 and resistance 15 to bring up the effective A. C. voltage superimposed on D. C. voltage across filament 14 as measured by a thermocouple voltmeter of suitable high resistance value. The amount of direct current shunted through the parallel branch circuit consisting of filament 14 and resistance 15 is governed by the value of resistance 16. Thus in cases where the sum of the rated filament voltages equals or exceeds the supply voltage, resistance 16 serves to overcome or compensate for the shunting effect of the negative temperature coefficient resistor 15 so that all filaments operate normally and still provide filament 14 with sufficient protection against current surges occurring during the warm-up period as well as any surges occurring thereafter.

As previously indicated, it may be that the total rated voltage of the series string may exceed the available alternating current supply voltage in which case the value of resistance 15 should be such that the parallel resistance of filament 14 and resistor 15 results in rated current flowing through filaments 11, 12, and 13. The value of resistor 16 is then chosen such that enough direct current is inserted to increase the heating effect in filament 14 to normal, bringing the effective voltage across filament 14 up to its rated value. In this manner, normal operating performance is obtained from a source of alternating current even though the normal voltage rating of the series connected filaments is greater than the voltage of the source.

What I claim is:

1. In combination, an electron discharge device of the filament type, a source of alternating current for heating said filament, and means shunting said filament for protecting said device against overload during the warm up period of said filament, said means having a temperature

4

coefficient opposite in sense to that of said filament whereby voltage changes across said filament are minimized, a source of direct current, and means for passing direct current from said source through said filament for supplementing the heating effect of said filament and for offsetting the shunting effect of said shunting means.

2. In combination, a plurality of electron discharge devices of the filament type, the filaments being connected in series across a source of alternating current, at least one of said filaments having a substantially thermal inertia than the filaments of other of said devices, and negative temperature coefficient means connected in shunt with said one filament, a source of direct current, means for passing said direct current through said one filament in order to supplement the heating effect of said filament.

3. In combination, a plurality of electron discharge devices of the filament type, the filaments being connected in series across a source of alternating current, at least one of said filaments having a substantially larger thermal inertia than the filaments of other of said devices, the total of the normal voltage ratings of said filaments exceeding the voltage of said source, a resistor of negative temperature coefficient connected across said one filament, the parallel resistance of said resistor and said one filament under normal operating conditions being such that normal current flows through the remaining filaments, and a source of direct current voltage connected across said one filament of such value as to supplement the heating effect of said alternating current of said one filament.

4. In combination, a plurality of electron discharge devices of the filament type, said filaments being connected in series across a source of alternating current, at least one of said filaments having a substantially larger thermal inertia than the filaments of other of said devices, the total of the normal voltage ratings of said filaments exceeding the voltage of said source, a resistor of negative temperature coefficient connected across said one filament, the parallel resistance of said resistor and said one filament under normal operating conditions being such that normal current flows through the remaining filaments, and a source of direct current voltage connected across said one filament of such value as to increase the heating effect to its normal value.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,777,538	Willard	Oct. 7, 1930
1,872,560	Breisky	Aug. 16, 1932
2,088,198	Geffcken et al.	July 27, 1937
2,320,958	Usselman	June 1, 1943
2,431,151	Tellegen	Nov. 18, 1947

Certificate of Correction

Patent No. 2,466,250.

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JOSEPH F. MARSHALL

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 34, cancel "17, 18, 19 and 20" and insert the same in line 33, same column, after the word "devices" and before the comma;

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 13th day of September, A. D. 1949.

[SEAL]

JOE E. DANIELS,
Assistant Commissioner of Patents.