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REFERENCE VOLTAGE SOURCE

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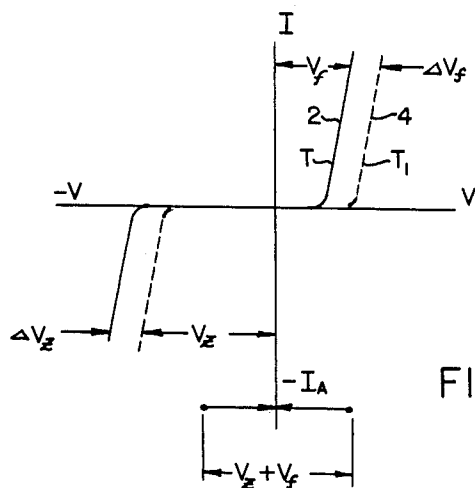


FIG. 1

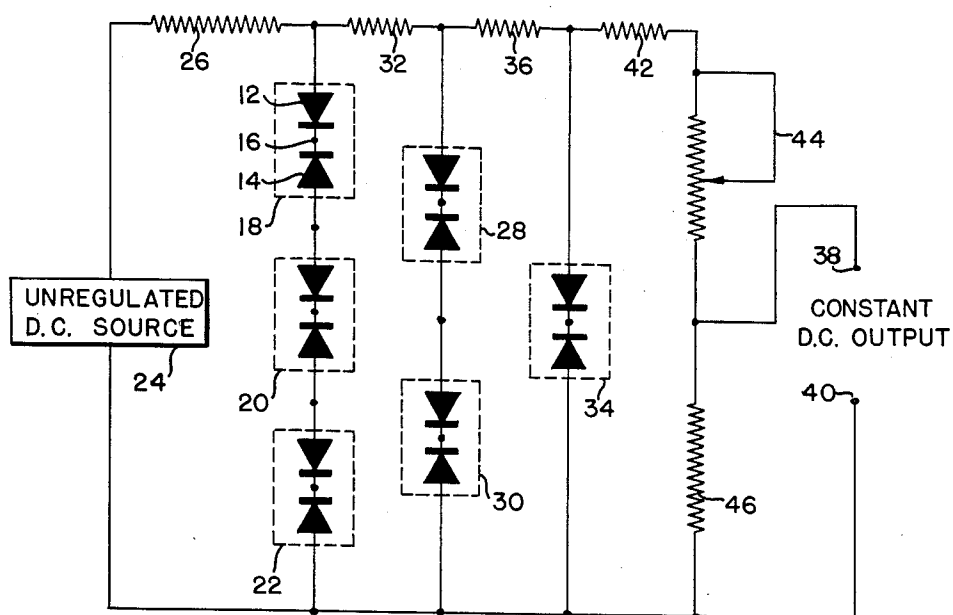


FIG. 2

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REFERENCE VOLTAGE SOURCE

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3 Claims. (Cl. 323—66)

This invention relates to D.C. reference potential sources.

A need has long existed for an improved light weight voltage reference source suitable for use aboard aircraft. Such a source is required to provide short "warm-up" time, high stability under variations in temperature from -55°C. to $+70^{\circ}\text{C.}$ and with variation of line voltage and frequency of $\pm 10\%$.

While many prior devices have been satisfactory for use in laboratory applications or where extreme accuracy or stability is not a requirement, such devices have failed to be satisfactory for aircraft use.

Accordingly it is an object of this invention to provide a D.C. reference source.

It is another object of this invention to provide a D.C. reference source which provides a stable output independently of variations in input voltage or frequency.

Another object of this invention is to provide a D.C. reference source which is stable over a temperature range of -55°C. to $+70^{\circ}\text{C.}$

Another object of this invention is to provide a D.C. reference source capable of a long service life.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a graphical representation of a family of current vs. voltage curves for a silicon diode at various temperatures.

Figure 2 is a schematic showing of the apparatus of this invention.

I have found that semiconductor type diodes and particularly silicon diodes of the low zener voltage type may be used to provide a reference voltage source meeting the above requirements. In particular a preferred type is supplied by the National Semiconductor Products Division of National Fabricated Products, Inc. of Evanston, Illinois under their number A6C-6.

These diodes have the inherent characteristics of relatively low temperature coefficients of forward and reverse (or zener) voltage drop, as well as an extremely low dynamic resistance (approximately ten ohms). The temperature characteristics are such that a change of ambient temperature from T to T_1 will result in the shift of characteristic curve as shown by dashed line 4. This corresponds to an increase in forward voltage drop of ΔV_f and a decrease in the zener voltage of ΔV_z . By choosing a pair of diodes having a matched V_z and V_f change, with change in temperature and connecting them together with electrodes in juxtaposition so that when one diode conducts in the forward direction and the other in the reverse direction, the voltage drop $V_z + V_f$ across the pair of diodes 6 and 8 will be essentially independent of temperature changes.

Referring now to Figure 2, diodes 12 and 14 are shown connected together by conductor 16 to form a double diode 18. In practice a single cathode with two anodes in a single envelope may be employed. It is to be under-

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stood that a common anode connection and separate cathodes could likewise be employed.

In series with double diode 18 there is provided additional double diodes 20 and 22. The double diodes 18, 20 and 22 are isolated from source of unregulated D.C. potential 24 by means of resistor 26. Resistor 26 has an ohmic value of resistance of about twenty to fifty times the dynamic resistance of the diodes. The exact value depends on the characteristics of the particular diodes employed and may be readily calculated in accordance with conventional practice so that the current carrying capabilities of the diodes are not exceeded.

Since the voltage across the diode is a function of the current through the diode, as is apparent from the curves of Figure 1, the nominal voltage which appears across the diode in a particular branch, say diode 34, is determined by its characteristics, the value of ohmic resistance of resistor 36 and the nominal supply voltage.

With variations of supply voltage about this nominal value, the change in current is determined by the isolating resistor 36 and the dynamic resistance of the diode. Since isolating resistor 36 is substantially greater in resistance than the dynamic resistance of the diode, the current will have approximately the same percentage change as the line voltage and therefore the change in line voltage will be apportioned across the diode and the isolating resistance to the resistance of the isolating resistor. Thus it may be appreciated a very slight change in output voltage at terminals 38 and 40 will result. The same phenomenon takes place across preceding stages.

A parallel branch is connected across the diodes 18, 20 and 22 which comprises double diodes 28 and 30 and resistor 32. In turn double diodes 28 and 30 have connected in parallel thereto double diode 34 and resistor 36. It is to be noted that because of the voltage drop across the resistor, each preceding cascaded branch requires a larger number of diodes so as to provide sufficient voltage to provide voltage breakdown of the succeeding branch. It should be appreciated that in place of a plurality of diodes, a single one of higher voltage breakdown level may be employed.

While I have shown a three section reference voltage source employing respectively three, two and one double diodes a greater or lesser number may be employed depending on the degree of stability required. For many applications two sections would suffice since a stability of $\pm 0.05\%$ for a 10% variation of D.C. source voltage would be attained. For less critical applications one double diode section would suffice.

The stable voltage output is derived across terminals 38 and 40 which are connected to a voltage divider network composed of resistors 42, variable resistor 44 and resistor 46. Rheostat 44 provides a convenient means to preset at the factory all production units to a nominal output voltage. Resistors 42 and 46 may be zero coefficient resistors, however, when tested in the course of production it may be found that the voltage reference source may show a slight instability when subjected to temperature changes. By substituting resistors having a positive or negative temperature coefficient of resistance for resistor 42, temperature compensation can be achieved. The choice of positive or negative coefficient types depending, of course, on the direction of the correction required. Such variation is the result of the differences in the characteristics of individual diodes.

While I have disclosed the best mode presently contemplated for carrying out the invention it is to be understood that modifications may be made by those skilled in the art without departing from the spirit of

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the invention and therefore I wish to be limited only by the scope of the appended claims.

What I claim as new is:

1. A constant voltage source comprising in combination: a source of D.C. potential; a resistor; a dual silicon diode characterized by a pair of anode electrodes and a cathode electrode interposed between said anode electrodes in series connection; a series circuit including said source of D.C. potential, said resistor and said dual silicon diode; and means to derive a constant D.C. potential output across said dual silicon diode.

2. Means for providing a temperature stabilized constant voltage source from a D.C. potential source, comprising a series circuit adapted to be connected to said D.C. potential source and including a resistance, a dual diode comprising a first semiconductor diode section, including a cathode and an anode, oriented for operation in the inverse break-down region, said first diode having a first temperature coefficient, and a second semiconductor diode section including an anode and said first diode cathode, oriented for easy current flow in

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the direction of normal current flow through said inversely operated first diode, said second diode section having a temperature coefficient of opposite sign to that of the temperature coefficient of said first diode section, and means to derive substantially constant D.C. potential across said dual diode.

3. The means of claim 2, wherein said dual diode employs silicon as the semiconductor.

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