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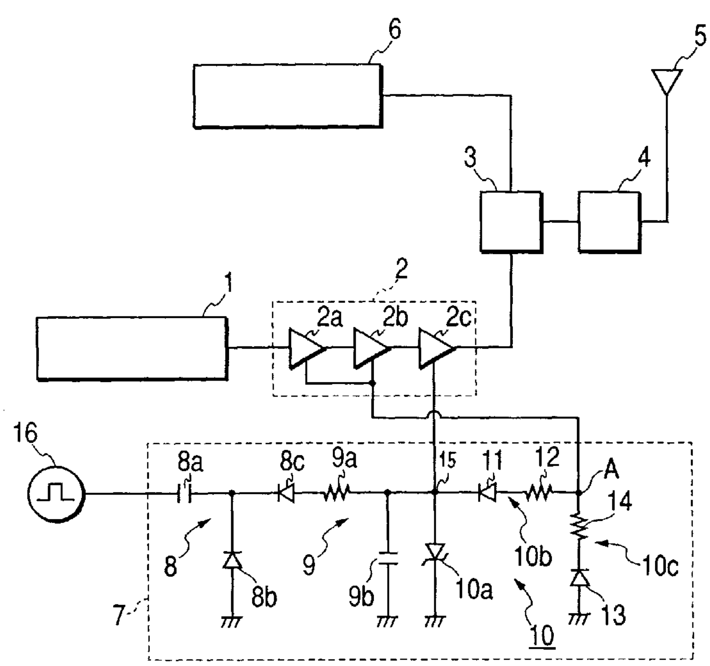
(54) Bias voltage stabilizing circuit

(57) Disclosed herein is a bias voltage stabilizing circuit which comprises a dc voltage source, a first voltage drop circuit (10b) having a first diode (11), and a second voltage drop circuit (10c) having a second diode (13). The first voltage drop circuit and the second voltage drop circuit are electrically series-connected to each other and electrically parallel-connected to the dc voltage source. Resistors (12,14) are electrically connected to at least one of the first voltage drop circuit and the second voltage drop circuit in series with either the first diode or the second diode. A closed loop is formed by the dc voltage source, the first diode, the second diode and the resistors. The voltage at a point where the first voltage drop circuit and the second voltage drop circuit are electrically connected to each other, is used as a bias voltage.

FIG. 1



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Description

[0001] The present invention relates to a bias voltage stabilizing circuit suitable for use in a bias voltage generating circuit for supplying a bias voltage to an amplifier circuit, notably a power amplifier circuit.

Description of the Related Art:

[0002] A conventional bias voltage generating circuit will be described by an example in which it is used in a communication device such as a so-called codeless telephone or the like.

[0003] In Fig. 4, a transmit signal lying within a 1.8GHz band, which has been subjected to processes such as modulation, frequency conversion, etc. by a pre-stage processing circuit 31, is amplified to a predetermined power (of about 500Mw) by a power amplifier circuit 32, followed by transmission to an antenna 35 through an antenna switch circuit 33 and a band-pass filer 34.

[0004] On the other hand, the signal received by the antenna 35 is inputted via the band-pass filter 34 and the antenna switch circuit 33 to a receiving circuit 36 where a predetermined process is effected on the signal to thereby obtain a voice or audio signal.

[0005] The power amplifier circuit 32 comprises driver amplifiers 32a and 32b corresponding to two stages and a final amplifier 32c corresponding to one stage, for example. Unillustrated gallium arsenide (GaAs) transistors (hereinafter called "transistors") are used in the respective stages. The gates of these transistors are respectively supplied with bias voltages from a bias voltage generating circuit 37.

[0006] The bias voltage generating circuit 37 has a voltage multiplying rectifier 38, a smoothing circuit 39, and a bias voltage stabilizer or stabilizing circuit 40. The bias voltage generating circuit 37 performs voltage multiplication and rectification on a clock signal of about 10MHz generated from a clock signal generator circuit 41 by using a capacitor 38a and rectifier diodes 38b and 38c and smoothes the resultant signal by use of a resistor 39a and a capacitor 39b, thereby obtaining a negative bias voltage. The resultant bias voltage is stabilized by a zener diode (whose zener voltage is about 2 volts) 40a parallel-connected to the capacitor 39b and supplied to the gate of the unillustrated transistor of the final amplifier 32c. Further, the bias voltage is reduced to about minus 1.3 volts by a diode 40b, which is also supplied to the gates of the unillustrated transistors of the driver amplifiers 32a and 32b.

[0007] Now, the reason why the diode 40b is used to obtain the bias voltage (-1.3 volts) to be supplied to the driver amplifiers 32a and 32b is intended for a reduction in a change in bias voltage due to a change in bias current flowing through the driver amplifiers 32a and 32b.

[0008] If the ambient temperature is now regarded to be constant, then the zener voltage (2 volts) of the zener diode 40a which stabilizes the bias voltage, and a drop (about 0.7 volt) in the forward voltage of the diode 40b are kept constant. However, the zener voltage and the forward voltage also change as the ambient temperature changes. Generally speaking, when the temperature rises, the zener voltage of the zener diode 40a is reduced and the forward voltage of the diode 40b is also lowered.

[0009] Therefore, the bias voltage changes with the rise and fall in temperature and the output power of the power amplifier circuit also changes. As a result, a problem arises in that transmitting power is not kept constant, thus resulting in interference with a call.

[0010] With the foregoing in view, it is thus an object of this invention to provide a bias voltage stabilizing circuit capable of maintaining a bias voltage stable even to a change in ambient temperature and thereby stabilizing transmitting power.

[0011] According to one aspect of this invention, for achieving the above object, there is provided a bias voltage stabilizing circuit comprising:

a dc voltage source:
a first voltage drop circuit having a first diode; and
a second voltage drop circuit having a second diode; and

wherein the first voltage drop circuit and the second voltage drop circuit are series-connected to each other and parallel-connected to the dc voltage source, resistors are connected to at least one of the first voltage drop circuit and the second voltage drop circuit in series with the first diode or the second diode, a closed loop is formed by the dc voltage source, the first diode, the second diode and the resistors, and the voltage at a point where the first voltage drop circuit and the second voltage drop circuit are connected to each other, is set as a bias voltage.

[0012] Further, in an embodiment of the present invention, a zener diode is parallel-connected to the dc voltage source and the resistors are connected to the second voltage drop circuit in series with the second diode.

[0013] Moreover, in an embodiment of the present invention, a zener diode is parallel-connected to the dc voltage source, a first resistor is connected to the first voltage drop circuit in series with the first diode, a second resistor is connected to the second voltage drop circuit in series with the second diode, and the resistance value of the second resistor is set larger than that of the first resistor.

[0014] While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention, the objects and features of the invention and further objects, features and advantages thereof will be better understood from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a diagram illustrating a bias voltage stabilizing circuit of the present invention;
Fig. 2 is a diagram showing the bias voltage stabilizing circuit shown in Fig. 1 in the form of an equivalent circuit;
Fig. 3 is a characteristic diagram of the bias voltage stabilizing circuit shown in Fig. 1; and
Fig. 4 is a diagram showing a conventional bias voltage stabilizing circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] A bias voltage stabilizing circuit according to the present invention will hereinafter be described with reference to Figs. 1 through 3.

[0016] Referring first to Fig. 1, a transmit signal lying within a 1.8GHz band, which has been subjected to processes such as modulation, frequency conversion, etc. by a pre-stage processing circuit 1, is amplified to a predetermined power (of about 500mW) by a power amplifier circuit 2, followed by transmission to an antenna 5 through an antenna switch circuit 3 and a band-pass filer 4.

[0017] On the other hand, the signal received by the antenna 5 is inputted via the band-pass filter 4 and the antenna switch circuit 3 to a receiving circuit 6 where a predetermined process is effected on the signal to thereby obtain a voice or audio signal.

[0018] Now, the power amplifier circuit 2 comprises driver amplifiers 2a and 2b corresponding to two stages and a final amplifier 2c corresponding to one stage, for example. Unillustrated gallium arsenide (GaAs) transistors (hereinafter called "transistors") are respectively used in the respective stages. The gates of these transistors are respectively supplied with bias voltages from a bias voltage generating circuit 7.

[0019] The bias voltage generating circuit 7 has a voltage multiplying rectifier 8, a smoothing circuit 9, and a bias voltage stabilizer or stabilizing circuit 10. The bias voltage generating circuit 7 performs voltage multiplication and rectification on a clock signal of about 10MHz generated from a clock signal generator or generating circuit 16 by using a capacitor 8a and rectifier diodes 8b and 8c and smoothes the resultant signal by use of a resistor 9a and a capacitor 9b, thereby obtaining a negative dc voltage used as a dc voltage source applied across the capacitor 9b. The resultant dc voltage is stabilized by the capacitor 9b, accordingly, a zener diode (whose zener voltage is about 2 volts) 10a parallel-connected to the dc voltage source, thus resulting in a first bias voltage, which in turn is supplied to the gate of the unillustrated transistor of the final amplifier 2c.

[0020] Further, a first voltage drop circuit 10b comprised of a first diode 11 and a first resistor 12 electrically series-connected to each other, and a second voltage drop circuit 10c comprised of a second diode 13 and a second resistor 14 electrically series-connected to each other are electrically connected in series with the zener diode 10a. Further, the first voltage drop circuit 10b and the second voltage drop circuit 10c are electrically connected in parallel to the dc voltage source. A second bias voltage is obtained from a point (i.e., a point where the first resistor 12 of the first voltage drop circuit 10b and the second resistor 14 of the second voltage drop circuit 10c are electrically connected to each other in Fig. 1) A where the first voltage drop circuit 10b and the second voltage drop circuit 10c are electrically connected to each other. Thereafter, the second bias voltage is supplied to the gates of the unillustrated transistors of the driver amplifiers 2a and 2b. Thus, the zener diode 10a, the first voltage drop circuit 10b and the second voltage drop circuit 10c constitute the bias voltage stabilizer circuit 10. Further, the first diode 11, the first resistor 12, the second diode 13 and the second resistor 14 constitutes a closed loop together with the dc voltage source. A loop current flows in the closed loop.

[0021] Now, a description will be qualitatively made of how the voltage at the point A of the connection between the first voltage drop circuit 10b and the second voltage drop circuit 10c changes depending on ambient temperatures, with reference to Figs. 2 and 3. Fig. 2 shows the bias voltage stabilizing circuit 10 shown in Fig. 1 in the form of an equivalent circuit. In the bias voltage stabilizing circuit 10, a dc voltage source 15 shows a voltage V developed across the capacitor 9b shown in Fig. 1. Fig. 3 is a diagram showing operation characteristics of the first voltage drop circuit 10b and the second voltage drop circuit 10c. In Fig. 3, a curve T1 represents a characteristic curve at ordinary temperature, for example, of two diodes: the first diode 11 and the second diode 13. A curve T2 indicates a high-temperature characteristic curve at a temperature higher than the ordinary temperature. A curve R shows a load curve of two resistors: the first resistor 12 and the second resistor 14. Incidentally, the first diode 11 and the second diode 13 will be defined as having characteristics identical to each other. For convenience of illustration, the zener diode 10a shown in Fig. 1 is omitted in Fig. 2.

[0022] First of all, the relationship in voltage and current between the first voltage drop circuit 10b and the second voltage drop circuit 10c at the ordinary temperature is given at a point P where the diode characteristic curve T1 and resistance load curve R in Fig. 3 intersect. A current I1 at the point P flows through the first voltage drop circuit 10b and the second voltage drop circuit 10c. A voltage V1 corresponding to the point P results in a voltage drop (forward voltage) developed across the two diodes of the first diode 11 and the second diode 13. Accordingly, a voltage drop of VR1 = (V - V1) is developed across or between the two resistors of the first resistor 12 and the second resistor 14.

[0023] Thus, the respective voltage drops developed across the first resistor 12 and the second resistor 14 result in voltages obtained by making a fraction of VR1 according to the magnitudes of their resistance values. As a result, the voltage at the point A of connection between the first voltage drop circuit 10b and the second voltage drop circuit 10c results in one obtained by adding the voltage drop developed across the second resistor 14 to the voltage drop Vl/2 developed across the second diode 13. Thus, if the resistance value of the first resistor 12 and the resistance value of the second resistance 14 are identical to each other, then the voltage at the connecting point A results in 1/2 the voltage V of the dc voltage source.

[0024] Next, the characteristic curves of the first diode 12 and the second diode 13 at a high temperature changes abruptly as the curve T2 shown in Fig. 3. Therefore, a current I2 corresponding to a point Q where the characteristic curve T2 and the resistance load curve R intersect each other, flows through the first voltage drop circuit 10b and the second voltage drop circuit 10c. At this time, a voltage drop of V2 is developed across the two diodes of the first diode 11 and the second diode 13. This voltage drop V2 becomes smaller than the voltage drop V1 developed across the first diode 11 and the second diode 13 at the ordinary temperature. A voltage drop of VR2 = (V - V2) is developed across the two resistors of the first resistor 12 and the second resistor 14. This voltage drop VR2 becomes larger than the voltage drop VR1 developed across the two resistors 12 and 14 at the ordinary temperature. Namely, as the temperature increases, the voltage drop developed across the first resistor 12 and the second resistor 14 becomes relatively larger than the voltage drop developed across the first diode 11 and the second diode 13.

[0025] If the resistance values of the first resistor 12 and the second resistor 14 are equal to each other from the above description, then the voltage at the connecting point A reaches the same V/2 at both ordinary and high temperatures. However, if the resistance value of the second resistor 14 is set larger than that of the first resistor 12, then the voltage at the connecting point A becomes higher at the high temperature than at the ordinary temperature. On the other hand, if the resistance value of the second resistor 14 is set smaller than that of the first resistor 12, then the voltage at the connecting point A becomes lower at the high temperature than at the ordinary temperature.

[0026] Although the first voltage drop circuit 10b includes one first diode and the second voltage drop circuit 10c includes one second diode, the number of diodes is not necessarily limited to one. They may include a plurality of diodes respectively. The voltage at the connecting point A can be set to a desired value by providing the plurality of diodes.

[0027] Thus, when the voltage of the dc voltage source 15 becomes high as the ambient temperature rises, the voltage at the connecting point A can be held constant without depending on the ambient temperature if the resistance value of the first resistor 12 in the first voltage drop circuit 10b is set larger than that of the second resistor 14 in the second voltage drop circuit 10c. When the voltage of the dc voltage source 15 becomes low in reverse as the ambient temperature rises, the voltage at the connecting point A can be kept constant without depending on the ambient temperature if the resistance value of the first resistor 12 in the first voltage drop circuit 10b is set smaller than that of the second resistor 14 in the second voltage drop circuit 10c.

[0028] When the zener diode 10a is electrically parallel-connected to the dc voltage source 15 as shown in Fig. 1, the zener voltage of the zener diode 10a becomes low with the rise in ambient temperature and hence the voltage of the dc voltage source 15 becomes low. Therefore, if the resistance value of the second resistor 14 is set greater than that of the first resistor 12, then the voltage at the connecting point A can be set equally at both the ordinary and high temperatures. Alternatively, the voltage at the connecting point A can be set equally at both the ordinary and high temperatures even when the second resistor 14 is provided only for the second voltage drop circuit 10c without the first voltage drop circuit 10b being provided with the first resistor 12.

[0029] Thus, the transmitting power of a power amplifier circuit 2 employed in a telephone set can be kept substantially constant without depending on the ambient temperatures by using such a bias voltage stabilizing circuit, whereby a normal call can be made.

[0030] As described above, the bias voltage stabilizing circuit of the present invention comprises a dc voltage source, a first voltage drop circuit having a first diode, and a second voltage drop circuit having a second diode. The first voltage drop circuit and the second voltage drop circuit are electrically series-connected to each other and electrically parallel-connected to the dc voltage source. Further, resistors are electrically connected to at least one of the first voltage drop circuit and the second voltage drop circuit in series with either the first diode or the second diode. A closed loop is formed by the dc voltage source, the first diode, the second diode and the resistors, and the voltage at a point where the first voltage drop circuit and second voltage drop circuit are electrically connected to each other, is set as a bias voltage. Therefore, the voltage at the point of connection between the first voltage drop circuit and the second voltage drop circuit can be kept substantially constant without depending on a change in ambient temperature. Further, if the voltage at the connecting point is used as a bias voltage for a power amplifier circuit, then output power thereof can be also held substantially constant.

[0031] In the bias voltage stabilizing circuit of the present invention as well, a zener diode is electrically parallel-connected to a dc voltage source, and a resistor is electrically connected to a second voltage drop circuit in series with a second diode. Therefore, the voltage of the dc voltage source can be stabilized and the voltage at a connecting point can be also held constant without depending on the temperature.

[0032] In the bias voltage stabilizing circuit of the present invention, a zener diode is electrically parallel-connected to a dc voltage source, and a first resistor is electrically connected to a first voltage drop circuit in series with a first diode. Further, a second resistor is electrically connected to a second voltage drop circuit in series with a second diode, and the resistance value of the second resistor is set larger than that of the first resistor. Therefore, the voltage of the dc voltage source can be stabilized in the same manner as described above and the voltage at a connecting point can be also kept constant without depending on the temperature.

[0033] While the present invention has been described with reference to the illustrative embodiment, this description is not intended to be construed in a limiting sense. Various modifications of the illustrative embodiment will be apparent to those skilled in the art on reference to this description. It is therefore contemplated that the appended claims will cover any such modifications or embodiments as fall within the true scope of the invention.

Claims

1. A bias voltage stabilizing circuit comprising:

    a dc voltage source:
    a first voltage drop circuit having a first diode; and
    a second voltage drop circuit having a second diode; and
    wherein said first voltage drop circuit and said second voltage drop circuit are series-connected to each other and parallel-connected to said dc voltage source, resistors are connected to at least one of said first voltage drop circuit and said second voltage drop circuit in series with said first diode or said second diode, a closed loop is formed by said dc voltage source, said first diode, said second diode and said resistors, and the voltage at a point where said first voltage drop circuit and said second voltage drop circuit are connected to each other, is set as a bias voltage.

2. The bias voltage stabilizing circuit according to claim 1, wherein a zener diode is parallel-connected to said dc voltage source and said resistors are connected to said second voltage drop circuit in series with said second diode.

3. The bias voltage stabilizing circuit according to claim 1, wherein a zener diode is parallel-connected to said dc voltage source, a first resistor is connected to said first voltage drop circuit in series with said first diode, a second resistor is connected to said second voltage drop circuit in series with said second diode, and the resistance value of said second resistor is set larger than that of said first resistor.

FIG. 1

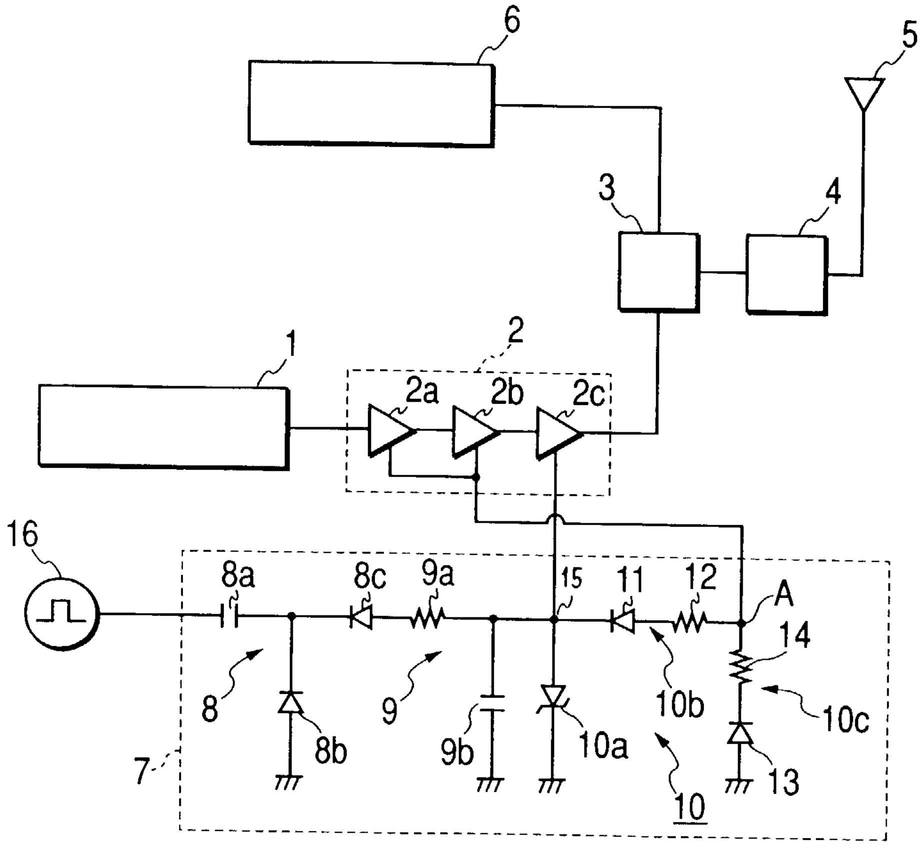
6
5
3
4
1
2
2a
2b
2c
16
8a
8c
9a
15
11
12
A
14
8
9
10b
10c
7
8b
9b
10a
13
10

FIG. 2

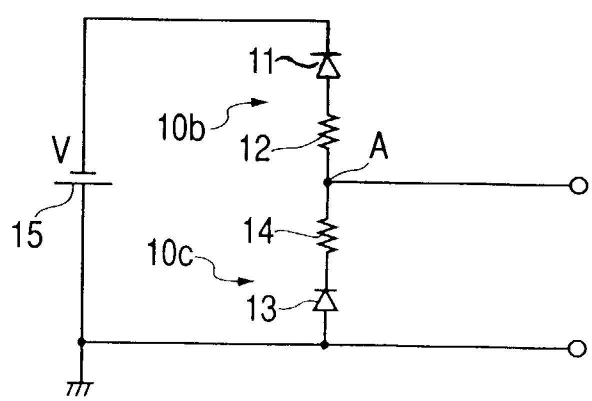
11
10b
12
A
V
15
14
10c
13

FIG. 3

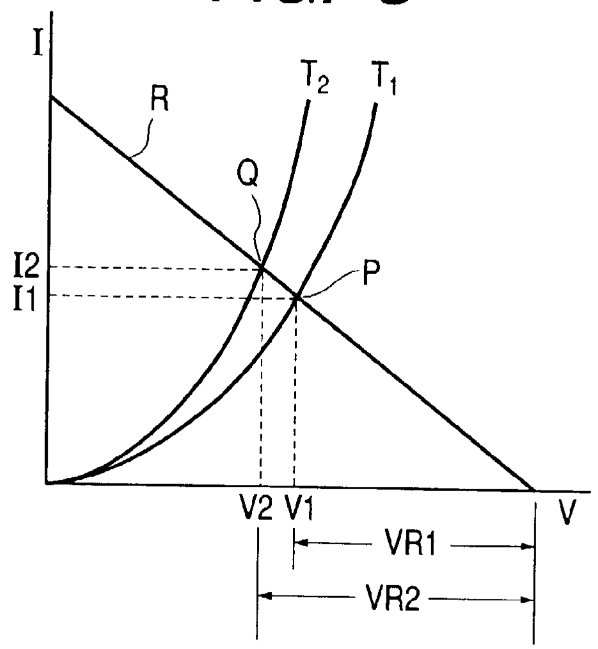

FIG. 4
PRIOR ART