CONSTANT CURRENT REGULATOR

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Filed Nov. 15, 1963, Ser. No. 324,018

4 Claims. (Cl. 323—4)

This invention relates to current regulators and more particularly to a current regulator that utilizes a transistor that is connected between a source of direct current and a load.

It is known in the art of transistor current regulators to connect a transistor between a source of voltage and an electrical load whereby the conduction of the transistor controls the current flow through the load. In order to maintain a substantially constant current through the load, one or more resistors are connected in series with the emitter electrode of the transistor and a Zener diode is connected between the base electrode of the transistor and the side of the resistors opposite their connection to the emitter electrode.

Although the just-described current regulator is capable of providing a substantially constant current through a load, it has been found that one disadvantage of this system is that the collector voltage of the transistor varies which can cause a slight variation in collector current even though the emitter current is maintained substantially constant.

It is accordingly an object of this invention to provide a current regulating system wherein a circuit is provided for compensating for changes in collector voltage. This invention contemplates a circuit arrangement wherein the change in collector voltage is sensed and wherein this signal is utilized to vary the emitter to base voltage of the transistor to compensate for changes in collector voltage and therefore maintain a substantially constant current through the load.

A more specific object of this invention is to provide a circuit for compensating for changes in collector voltage of the main current controlling transistor by use of a second transistor which has a base electrode connected with a voltage dividing bleeding network and which has a collector connected with the base of the main current controlling transistor and an emitter connected with the emitter resistors of the current controlling transistor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

The single figure drawing is a schematic circuit diagram of a current regulator made in accordance with this invention.

Referring now to the drawing, the reference numeral 10 designates a source of direct current which may be a battery or a generator as shown. The source of direct current can be regulated as to output voltage if desired so that a regulated direct current is applied across conductors 12 and 14 which form input terminals for the regulator. The conductors 12 and 14 supply an electrical load 16 which is shown as a resistor. The conductors 14 and 20 form the output terminals for the regulator.

The regulator circuit of the present invention includes a PNP transistor 18 which has a collector connected with conductor 20. The base of transistor 18 is connected with conductor 22 and a resistor 24 is connected between conductor 22 and power supply conductor 14. The emitter of transistor 18 is connected with conductor 26. A pair of resistors 28 and 30 are connected in series with the conductors 12 and 26 and these resistors have a common junction 32. A Zener diode 34 is connected between junctions 36 and 38 and is therefore connected in parallel with resistors 28 and 30 and the emitter to base circuit of transistor 18.

The circuit as thus far described is a conventional circuit and without the components to be further described, would be capable of regulating the current flow through resistor 16 to maintain a substantially constant current through this load. This circuit, however, would have the disadvantage of causing a slight variation in collector current with changes in collector voltage of transistor 18.

In order to compensate for the changes in collector voltage of transistor 18, the resistors 40 and 42 are added to the circuit as is a second PNP transistor 44. One side of resistor 40 is connected with junction 38 and the resistors 40 and 42 have a common junction 46 which is connected with the base of transistor 44 by a conductor 48. The opposite side of resistor 42 is connected with junction 50 which in turn is connected with the collector of transistor 18 and the conductor 20.

The collector of transistor 44 is connected with junction 52 on conductor 22 and the emitter of transistor 44 is connected with the junction 32 located between resistors 30 and 28.

The operation of the current regulator of this invention will now be described with particular emphasis on the part of the circuit that compensates for changes in collector voltage of the transistor 18.

The emitter current of transistor 18 is regulated by having a constant voltage across the emitter resistors 30 and 28 which is provided by the Zener diode 34. As pointed out above, however, this does not insure a constant collector current. Transistor 44 is biased such that it will provide a signal to compensate for the variation in collector current which is caused by changes in collector voltage.

If it is assumed that the resistance of the load 16 decreases, there will be more current supplied to the load and in order to maintain this current substantially constant, the collector voltage of transistor 18 and junction 38 must become more negative. This would tend to increase the collector current of transistor 18. The voltage change of the collector of transistor 18 appears attenuated at the base of transistor 44 because of its connection to the junction 46 located between the resistors 40 and 42. Since the base of transistor 44 is driven more negative by following the signal from junction 50, the transistor 44 is biased to an increased state of conduction and transistor 44 therefore has an increased collector current. This will cause more current to flow through the resistor 30. The voltage at junction 52 will therefore become more negative. The negative signal of junction 52 is transmitted through resistor 28 to the emitter of transistor 18. Since the base of transistor 18 is at a constant voltage by virtue of Zener diode 34, the voltage from the base to emitter of transistor 18 becomes less negative thus tending to reduce the conduction of transistor 18 and reducing or compensating for the increase in collector current of transistor 18.

From the foregoing, it can be seen that the resistors 40 and 42 and the transistor 44 provide a signal across the emitter and base of transistor 18 which tends to compensate for an increase in collector voltage of the transistor 18 which would cause an increase in collector current of this transistor were it not for the compensating circuit.

While the embodiments of the present invention as herein disclosed, constitute a preferred form, it is to be understood that other forms might be adopted.

I claim:

1. A current regulating circuit comprising, a pair of input terminals adapted to be connected with a source of
direct current and a pair of output terminals adapted to be connected with an electrical load, one of said input terminals and one of said output terminals being a common, first and second transistors each having emitter, collector and base electrodes, a circuit connecting the other of said input terminals with the other of said output terminals including at least one resistor and the emitter to collector circuit of said first transistor, a constant voltage device connected between the base electrode of said first transistor and the other input of said input terminals of said regulator, means connecting the base electrode circuit of said first transistor to said common terminals, means connecting the base electrode of said second transistor with the collector electrode of said first transistor, means connecting the collector electrode of said second transistor with the base electrode of said first transistor, and means connecting the emitter electrode of said second transistor with the emitter circuit of said first transistor.

2. A current regulating circuit comprising, first and second input terminals adapted to be connected with a source of voltage, first and second output terminals adapted to be connected to an electrical load said first input and said first output terminals forming a common terminal, first and second transistors each having emitter, collector and base electrodes, a circuit connecting said second input terminal and said second output terminal including in a series connection a pair of resistors having a junction and the emitter and collector electrodes of said first transistor, a Zener diode connected between said second input terminal and the base of said first transistor, a voltage divider network having a junction connected between the collector electrode of said first transistor and said second input terminal of said regulator, means connecting the collector electrode of said second transistor with the base electrode of said first transistor, means connecting the base electrode of said second transistor with said junction on said voltage divider network, and means connecting the emitter electrode of said second transistor with the junction of said first and second resistors that are connected in series with the emitter electrode of said first transistor.

3. A current regulator having an input terminal, an output terminal and a terminal which is common both to its input and output, said input terminal and said common terminal being adapted to be connected with a source of voltage, said output terminal and said common terminal being adapted to be connected with an electrical load, first and second transistors each having emitter, collector and base electrodes, a first voltage divider network having a junction, means connecting said first voltage divider network and the emitter and collector of said transistor in a series circuit between said input terminal and said output terminal, a Zener diode connected across said first voltage divider network and the emitter-base electrodes of said first transistor, a second voltage divider network having a junction connected between the input terminal of said regulator and the collector electrode of said first transistor, means connecting the base electrode of said first transistor with the collector electrode of said second transistor, means connecting the base of said second transistor with the junction of said second voltage divider, means connecting the emitter of said second transistor with the junction of said first voltage divider, and a resistor connecting the base of said first transistor with said common terminal.

4. A current regulator comprising, an input terminal, an output terminal and a common terminal, said input terminal and said common terminal being adapted to be connected with a source of voltage, said output terminal and said common terminal being adapted to be connected with an electrical load, first and second transistors each having emitter, collector and base electrodes, a first pair of resistors having a first common junction connecting the emitter electrode of said first transistor with said input terminal, means connecting the collector electrode of said first transistor with said output terminal, a Zener diode connected between said input terminal and the base of said first transistor, a second pair of resistors having a second common junction connected between said input terminal and said output terminal, means connecting the collector of said second transistor with the base of said first transistor, means connecting the base of said second transistor with said common junction, and means connecting the emitter of said second transistor with said first common junction.

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