

Description

Background of the invention

The present invention relates to circuitry for detecting a current threshold level, and more particularly, to a circuit wherein a very large output current threshold is detected with respect to a low current reference signal.

There are many applications which utilize a current threshold detector circuit. For example, a current detection circuit may be utilized as a current regulator to provide an output current the magnitude of which is maintained at a predetermined level. Thus, if the output current should vary, it is sensed or detected by the current threshold detector to provide a feedback signal to increase or decrease the output current accordingly.

There are other prior art systems in which the safe operation thereof can be exceeded if the level of operating current exceeds a certain threshold level. For instance, DC motor controlled circuits are used in many applications for providing pre-described operations such as automatic window control for automobiles among other things. It is possible that the load current supplied to the motor could, under extreme conditions, exceed the ratings of motor. If this were to happen, the motor could be damaged or even destroyed. To prevent the foregoing from occurring, prior art systems have required detection means whereby the level of the load current is detected. If the current level exceeds a predetermined threshold level an error output signal is produced which may set a latch circuit to shutdown the motor until such time that the load current therethrough becomes less than the threshold level.

Typically, prior art detection schemes require the use of a sense resistor in the high load current path (through the motor for instance). For example from US Patent US-A-3,988,644, there is known a current protection circuit acting as a current threshold detector which utilizes a sense resistor through which a load current is applied. The load current produces a voltage to be developed across the sense resistor which is monitored by an operational amplifier. The output of the operational amplifier is switched as the level of the current at the input of the operational amplifier exceeds the threshold level which activates a latch circuit to shut off the load until such time that the load current is reduced to below the predetermined threshold level.

A serious disadvantage of such prior art detection schemes is that the sense resistor is placed in the high load current path which causes excessive power to be dissipated in the resistor. If the sense resistor is fabricated as a part of an integrated detector circuit, this power dissipation provides undesirable heating of the integrated circuit chip. Moreover, any power dissipated in the sense resistor reduces the available power to the load which also may be undesirable.

Hence, there exists a need for a current threshold detector circuit which overcomes the

disadvantage of the prior art schemes as described above.

Summary of the invention.

Accordingly, it is an object of the present invention to provide an improved current threshold detector circuit.

Another object of the invention is to provide a current threshold detector wherein a very large output current threshold is detected with respect to a low current reference signal.

Another object of the invention is to provide a monolithic current detector circuit wherein the threshold trip point of an output current is made a function of an internal reference current of the current detection circuit.

A further object of the present invention is to provide a current threshold detector circuit which detects an output current level while attempting to minimize voltage drops in the output current loop.

In accordance with the present invention there is provided a current threshold detector including a differential error amplifier and circuit means for establishing a difference voltage across outputs thereof that is proportional to a load current supplied at the output of the detector such that an error signal is produced at an output of the error amplifier the sense of which changes as the magnitude of the load current varies about a predetermined threshold level, characterized by:

the differential error amplifier including a pair of multiple collector transistors each having an emitter electrode coupled to a respective output of the circuit means, interconnected base electrodes and first collector electrodes interconnected; a current supply for providing a reference current coupled both to said interconnected base electrodes and first interconnected collector electrodes; and an output circuit connected to second collector electrodes of said multiple collector transistors and having an output corresponding to the error signal output; and

the circuit means having the first one of said outputs coupled both to the output of the detector and to said emitter electrode of the first one of said pair of multiple collector transistors wherein the threshold level is a function of the magnitude of the current provided by said current supply.

Description of the drawings

Three threshold detectors in accordance with the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram illustrating the basic current threshold detector circuit of the present invention;

Fig. 2 is a schematic diagram illustrating a second embodiment of the present invention; and

Fig. 3 is a schematic diagram illustrating a third embodiment of the present invention.

Detailed description of the preferred embodiment

Turning to Fig. 1 there is shown current threshold detector 10 of the present invention. Detector 10 is suited to be manufactured in monolithic integrated circuit form and receives a power supply voltage V_{CC} across power supply conductors 12 and 14. NPN transistor 16 and 18 form a transistor circuit means for establishing a difference voltage between the respective emitters (first electrodes) thereof relative to the commonly connected base (control) electrodes. This difference voltage, as will be later described, is a function of the load current I_L supplied to load means 22 at terminal 24. The base electrodes of transistor 16 and 18 are biased at 20 by a driving circuit (not shown) which may, for example, be comprised of a PNP transistor having its collector-emitter path connected to node 20 and operated in a saturated state as is understood.

The voltage appearing at the respective emitters of transistors 16 and 18 are monitored at the inputs of error amplifier 25 which inputs correspond to the emitters of multi-collector PNP transistors 26 and 28. Error amplifier 25 is in the form of an operational amplifier having a differential-to-single ended output. Transistors 26 and 28 have their respective base electrodes commonly coupled to reference current source 30. Current source 30 is also coupled to respective collectors of transistors 26 and 28. Additional collectors of these two transistors are coupled in series with the respective collectors of NPN transistors 32 and 34 which form the differential-to-single ended output circuit of the operational amplifier. The output of error amplifier 25 is taken at 34'.

As illustrated, transistor 16 has an emitter area that is N times the emitter area of transistor 18: where N is any positive number. Likewise, in the general case, the emitter of diode connected transistor 34 is indicated as having an area that is M times greater than the emitter area of transistor 32: M being any positive number.

In operation, detector 10 produces an error signal at output 34' the sense of which is a function of the magnitude of the load current I_L . If the magnitude of I_L is less than a predetermined threshold value, the sense of the error signal is positive in that current is sourced from error amplifier 25 to output 34'. Conversely, if I_L is greater than the threshold value, error amplifier 25 would tend to cause current to be sunk at output 34': a negative sense of the error signal. At balance or at the trip point of detector 10, wherein the magnitude of I_L is equal to the threshold value the error signal is neither sourced nor sunk at output 34'.

The manner in which detector 10 produces an error signal is now described. For explanation purposes, detector 10 will be assumed to be in a balanced state. Further, it is assumed that the area ratio factor, M , is equal to 1 whereby transistors 32 and 34 are matched devices. At balance, the emitter voltages of transistor 16 and 18, which form a multiple transistor circuit means, are at equal potential relative to the base electrodes

thereof. In this state, transistor 18 sources the current I_{REF} required by current source 30 to the emitter of transistor 28 which is one input to error amplifier 25. The current I_{REF} produces a base-emitter voltage drop across transistor 18 which is also developed across the base-emitter of transistor 16. Thus, a current I flows from the emitter of the latter device which, in the balanced state, is equal to:

$$I = N \times I_{REF} \quad (1)$$

Because transistors 26 and 28 are also matched devices, at balance, these transistors will conduct the same current since their respective emitters are at the same potential and their respective bases are commonly connected. Hence, a current I_{REF} is also sourced through transistor 26 from transistor 16. Further, at balance, the load current is equal to a value:

$$I_L = I - I_{REF} \quad \text{and} \quad (2)$$

$$I_L = I_{REF} (N - 1) \quad (3)$$

The threshold level of the load current at which detector 10 changes states is therefore a function of the reference bias current I_{REF} . If, for example, I_{REF} is programmable, any desired threshold level can be set by user of the present invention.

Continuing, if the collector areas of transistors 26 and 28 are equal, a current $I_{REF}/2$ will flow from each. The current flowing from the collector of transistor 28 is sunk by diode connected transistor 34. Therefore transistor 32 will be forced to sink a current of equal magnitude which is sourced from transistor 26. Therefore, as all of the available current flowing from transistor 26 is sunk by transistor 32, error current is neither sourced nor sunk at output 34'.

Although the sum of the currents flowing into the emitters of transistors 26 and 28 is equal to I_{REF} , the ratio of these two currents is a function of the load current I_L sourced by load means 22. For instance, at a value of I_L less than the threshold value of equation 1, the voltage at the emitter of transistor 26 will be greater than the voltage at the emitter of transistor 28. Transistor 26 therefore conducts harder than transistor 28. Therefore most of the total sum of the reference bias current that is sourced by current source 30 is supplied by transistor 26. Because, the devices are matched, the collector current flowing from transistor 26 to transistor 32 will be greater than sourced from transistor 28 to transistor 34. Hence, due to the current mirror action of transistor 34 and 32, an excess current is available at output 34'.

Correspondingly, if I_L becomes greater than the threshold value, the voltage at the emitter of transistor 28 becomes more positive than the voltage at the emitter of transistor 26. Transistor 28 then conducts harder than transistor 26 which produces collector currents flowing from the former that are greater than the collector currents flowing from the latter. Transistor 32 will then be in a saturated condition wherein the net current

flow at output 34' is negative, i.e., current would tend to flow into the output.

As previously mentioned, detector 10 may be utilized in one application as a current threshold detector. In this application the load current can be detected with respect to the reference current to produce an output signal at output 34' whenever the load current exceeds a predetermined threshold value to indicate, for example, an overload condition. The error signal or overload indicating signal can then be utilized to shut down or reduce the current through the load. For instance, load 22 may be a motor and the output 34' can be used to drive a logic control circuit which controls the conduction of the current flowing through the motor. As the motor current exceeds the threshold value, the control circuit can be activated to shut down the motor in order to protect it.

Another application for detector circuit 10 may be as a current regulator circuit. In this application, output 34' could be coupled back to node 20 to provide control of the biasing of transistor 16 and 18. Hence, if I_L is too low, the error signal flowing from output 34' is utilized to increase the bias on the bases of transistor 16 and 18 to increase I_L until the balanced state is reached. The opposite would be true if the value of I_L exceeds the balanced state condition, i.e., the bias of transistor 16 and 18 can be reduced as the sense of the error signal is changed whereby I_L is then reduced.

At the trip point, the value of I_L required is a function of the area ratioing of the emitters of transistors 32 and 34. By changing this area ratio, by making the area of transistor 34 greater than transistor 32 (M greater than 1), the value of I_L is forced to increase to trip error amplifier 25 for a given I_{REF} . Thus, a larger load current can be detected with respect to a given I_{REF} by simply area ratioing the emitters of the two described transistors with respect to one another.

A feature of the present invention is that a very large load or output current can be detected with respect to a very low current bias. In addition, as previously mentioned, the current bias source 30 can be made programmable such that a user can vary the value of I_L at balance or at the threshold trip point level to fit his needs. Thus, by either internally or externally programming I_{REF} , the balance state or trip point of current detector 10 varies as a function thereof.

Referring to Figs. 2 and 3, detector 10 can be expanded to detect more than one trip point, each having a different value with respect to each other if so desired. In this embodiment, additional collectors are added to multiple collector transistors 26 and 28 which are connected to an additional current mirror or differential-to-single ended circuit comprising transistors 38 and 40 in the same manner as described above with respect to transistors 32 and 34. This additional circuitry operates in the same manner as aforescribed to produce an output error signal at output 42 as the value of I_L exceeds a threshold level that is a

function of I_{REF} times the area scaling of transistors 40 and 38, in this case the emitter area of transistor 40 is shown as being L times greater than the emitter area of transistor 38. Hence, if the value of L and M were equal, the threshold trip point at outputs 34 and 42 would be the same. However, by making the ratios of L and N different, the outputs 34' and 42 switch at different values of I_L accordingly. It should be understood, that one could also area ratio the collectors of multiple collector transistors 26 and 28 with respect to each other and to each device. This collector ratioing produces the same effect as changing either the value of I_{REF} or the ratio factors L and M as previously described.

In addition, transistors 16 and 18 are illustrated as being a multi-emitter device. Because the base electrodes of transistor 16 and 18 are common, they can be formed in the same base diffusion region during the manufacturing process of detector circuit 10 as is well understood.

Turning to Fig. 3 there is shown expanded detector circuit 10 of Fig. 2 which is modified to include resistor 44 connected between the emitters of transistors 18 and 28. The presence of resistor 44 develops a delta voltage drop between transistor 18 and transistor 28 to produce the same effect on the circuit as changing the ratio factor N . If, for instance, a very large output current I_L threshold is to be detected and I_{REF} is made very small, the value of N required to satisfy the conditions of equations (1) through (3) may become too large to realize transistor 16. Thus, if I_{REF} is fixed, the value of N is effectively raised by the addition of resistor 44. This allows the size of transistor 16 to be no larger than necessary while minimizing the size of transistor 18. Besides this feature, a significant advantage of the embodiment of the present invention is that detector circuit 10 can detect very large current thresholds while minimizing heat losses since other than transistor 16 there is no power dissipation in the high output current, I_L , path. Thus, not only is power dissipation minimized in the integrated circuit of the present invention to prevent heat problems, the available power to a load is maximized.

Thus, what has been described above is novel detector circuit which, among other functions, finds application as either a current threshold detector or current regulator. The detector circuit detects very large output current thresholds with respect to a very low internal current reference source.

Claims

1. A current threshold detector (10) including a differential error amplifier (26, 28, 30, 32, 34) and circuit means (16, 18) for establishing a difference voltage across outputs thereof that is proportional to a load current (I_L) supplied at the output (24) of the detector such that an error signal is produced at an output (34') of the error amplifier the sense of which changes as the

flow at output 34' is negative, i.e., current would tend to flow into the output.

As previously mentioned, detector 10 may be utilized in one application as a current threshold detector. In this application the load current can be detected with respect to the reference current to produce an output signal at output 34' whenever the load current exceeds a predetermined threshold value to indicate, for example, an overload condition. The error signal or overload indicating signal can then be utilized to shut down or reduce the current through the load. For instance, load 22 may be a motor and the output 34' can be used to drive a logic control circuit which controls the conduction of the current flowing through the motor. As the motor current exceeds the threshold value, the control circuit can be activated to shut down the motor in order to protect it.

Another application for detector circuit 10 may be as a current regulator circuit. In this application, output 34' could be coupled back to node 20 to provide control of the biasing of transistor 16 and 18. Hence, if I_L is too low, the error signal flowing from output 34' is utilized to increase the bias on the bases of transistor 16 and 18 to increase I_L until the balanced state is reached. The opposite would be true if the value of I_L exceeds the balanced state condition, i.e., the bias of transistor 16 and 18 can be reduced as the sense of the error signal is changed whereby I_L is then reduced.

At the trip point, the value of I_L required is a function of the area ratioing of the emitters of transistors 32 and 34. By changing this area ratio, by making the area of transistor 34 greater than transistor 32 (M greater than 1), the value of I_L is forced to increase to trip error amplifier 25 for a given I_{REF} . Thus, a larger load current can be detected with respect to a given I_{REF} by simply area ratioing the emitters of the two described transistors with respect to one another.

A feature of the present invention is that a very large load or output current can be detected with respect to a very low current bias. In addition, as previously mentioned, the current bias source 30 can be made programmable such that a user can vary the value of I_L at balance or at the threshold trip point level to fit his needs. Thus, by either internally or externally programming I_{REF} , the balance state or trip point of current detector 10 varies as a function thereof.

Referring to Figs. 2 and 3, detector 10 can be expanded to detect more than one trip point, each having a different value with respect to each other if so desired. In this embodiment, additional collectors are added to multiple collector transistors 26 and 28 which are connected to an additional current mirror or differential-to-single ended circuit comprising transistors 38 and 40 in the same manner as described above with respect to transistors 32 and 34. This additional circuitry operates in the same manner as aforescribed to produce an output error signal at output 42 as the value of I_L exceeds a threshold level that is a

function of I_{REF} times the area scaling of transistors 40 and 38, in this case the emitter area of transistor 40 is shown as being L times greater than the emitter area of transistor 38. Hence, if the value of L and M were equal, the threshold trip point at outputs 34 and 42 would be the same. However, by making the ratios of L and N different, the outputs 34' and 42 switch at different values of I_L accordingly. It should be understood, that one could also area ratio the collectors of multiple collector transistors 26 and 28 with respect to each other and to each device. This collector ratioing produces the same effect as changing either the value of I_{REF} or the ratio factors L and M as previously described.

In addition, transistors 16 and 18 are illustrated as being a multi-emitter device. Because the base electrodes of transistor 16 and 18 are common, they can be formed in the same base diffusion region during the manufacturing process of detector circuit 10 as is well understood.

Turning to Fig. 3 there is shown expanded detector circuit 10 of Fig. 2 which is modified to include resistor 44 connected between the emitters of transistors 18 and 28. The presence of resistor 44 develops a delta voltage drop between transistor 18 and transistor 28 to produce the same effect on the circuit as changing the ratio factor N . If, for instance, a very large output current I_L threshold is to be detected and I_{REF} is made very small, the value of N required to satisfy the conditions of equations (1) through (3) may become too large to realize transistor 16. Thus, if I_{REF} is fixed, the value of N is effectively raised by the addition of resistor 44. This allows the size of transistor 16 to be no larger than necessary while minimizing the size of transistor 18. Besides this feature, a significant advantage of the embodiment of the present invention is that detector circuit 10 can detect very large current thresholds while minimizing heat losses since other than transistor 16 there is no power dissipation in the high output current, I_L , path. Thus, not only is power dissipation minimized in the integrated circuit of the present invention to prevent heat problems, the available power to a load is maximized.

Thus, what has been described above is novel detector circuit which, among other functions, finds application as either a current threshold detector or current regulator. The detector circuit detects very large output current thresholds with respect to a very low internal current reference source.

Claims

1. A current threshold detector (10) including a differential error amplifier (26, 28, 30, 32, 34) and circuit means (16, 18) for establishing a difference voltage across outputs thereof that is proportional to a load current (I_L) supplied at the output (24) of the detector such that an error signal is produced at an output (34') of the error amplifier the sense of which changes as the



magnitude of the load current varies about a predetermined threshold level, characterized by:

the differential error amplifier including a pair of multiple collector transistors (26, 28) each having an emitter electrode coupled to a respective output of the circuit means, interconnected base electrodes and first collector electrodes interconnected; a current supply (30) for providing a reference current coupled both to said interconnected base electrodes and first interconnected collector electrodes; and an output circuit connected to second collector electrodes of said multiple collector transistors and having an output (34') corresponding to the error signal output; and

the circuit means having the first one of said outputs coupled both to the output (24) of the detector and to said emitter electrode of the first one (26) of said pair of multiple collector transistors wherein the threshold level is a function of the magnitude of the current provided by said current supply.

2. The detector of claim 1 wherein circuit means includes first (16) and second (18) transistors each having an emitter electrode, a base electrode and a collector electrode, said emitter electrode of said first and second transistors being coupled respectively to said first output and the second one of said outputs of said circuit means, said base electrodes being interconnected and said collector electrodes being coupled to a power supply conductor.

3. The detector of any preceding claim wherein said output circuit of said error amplifier includes first (34) and second (32) transistors each having an emitter electrode connected to a second power supply conductor, commonly connected base electrodes, and a collector electrode, said collector electrode of said first transistor of said output circuit being coupled both to its base electrode and to said second collector of said second one (28) of said multiple collector transistors, and said collector of said second transistor of said output circuit being coupled both to said second collector of said first one (26) of said multiple collector transistors and to said output (34') of the output circuit.

4. The detector of claim 3 wherein said first transistor (34) of said output circuit has an emitter area that is M times larger than the area of said emitter of said second transistor (32) where M is positive.

5. The detector of claim 3 or 4 wherein the emitter area of said first transistor (16) of said circuit means being N times larger than the emitter area of said second transistor (18) of said circuit means, where N is positive:

6. The detector of claim 1 wherein the circuit means comprises a multiple emitter transistor having first and second emitter electrodes coupled respectively to said first and second outputs of the circuit means, a base electrode to which is supplied a bias signal and a collector coupled to a first power supply conductor, said first emitter having an area that is N times larger

than the area of said second emitter where N is positive.

7. The detector of claim 6 wherein said error amplifier includes a second output circuit (38, 40) coupled to a third collector electrode of each one of said pair of multiple collector transistors with the third collector of said first multiple transistor also being coupled to a second output (42) of the error amplifier.

8. The detector of claim 7 further including a resistor (44) which is coupled between said second emitter of said multiple emitter transistor and said second output of the circuit means.

Patentansprüche

1. Stromschwellenwertdetektor (10), enthaltend einen Differenzfehlerverstärker (26, 28, 30, 32, 34) und eine Schaltungseinrichtung (16, 18) zum Einrichten einer Differenzspannung über die Ausgänge derselben, die proportional zu einem Laststrom (I_L) ist, der am Ausgang (24) des Detektors geliefert wird, so daß ein Fehlersignal an einem Ausgang (34') des Fehlerverstärkers erzeugt wird, dessen Vorzeichen sich ändert, wenn die Amplitude des Laststroms um einen vorbestimmten Schwellenwertpegel schwankt; dadurch gekennzeichnet, daß:

der Differenzfehlerverstärker ein Paar Mehrkollektortransistoren (26, 28) enthält, die jeweils eine Emittierelektrode aufweisen, die mit einem entsprechenden Ausgang der Schaltungseinrichtung verbunden ist, und die miteinander verbundene Basis Elektroden und erste miteinander verbundene Kollektorelektroden haben; eine Stromquelle (30) enthält, um einen Bezugsstrom zu liefern, der sowohl an die miteinander verbundenen Basis Elektroden als auch an die ersten miteinander verbundenen Kollektorelektroden gelegt ist; und ferner eine Ausgangsschaltung enthält, die mit den zweiten Kollektorelektroden der Mehrkollektortransistoren verbunden ist und einen Ausgang (34') hat, der dem Fehlersignalausgang entspricht; und

daß die Schaltungseinrichtung am ersten der genannten Ausgänge sowohl mit dem Ausgang (24) des Detektors als auch mit der Emittierelektrode des ersten (26) des genannten Paares Mehrkollektortransistoren verbunden ist, wobei der Schwellenwertpegel eine Funktion der Amplitude des Stroms ist, der von der Stromquelle geliefert wird.

2. Detektor nach Anspruch 1, bei dem die Schaltungseinrichtung erste (16) und zweite (18) Transistoren enthält, die jeweils eine Emittierelektrode, eine Basis Elektrode und eine Kollektorelektrode aufweisen, wobei die Emittierelektrode der genannten ersten und zweiten Transistoren jeweils mit dem ersten Ausgang und dem zweiten der genannten Ausgänge der Schaltungseinrichtung verbunden ist, wobei die Basis Elektroden miteinander verbunden sind und die Kollektorelektroden mit einem Stromzuführungsleiter verbunden sind.

3. Detektor nach einem der vorhergehenden



Ansprüche, bei dem der Ausgangskreis der Fehlerverstärkers erste (34) und zweite (32) Transistoren enthält, die jeweils eine Emittierelektrode haben, die mit dem zweiten Stromzuführungsleiter verbunden ist, gemeinsam verbundene Basisselektroden haben und eine Kollektorelektrode, wobei die Kollektorelektrode des ersten Transistors des genannten Ausgangskreises sowohl mit seiner Basisselektrode als auch mit dem zweiten Kollektor des zweiten (28) der genannten Mehrkollektortransistoren verbunden ist und der Kollektor des zweiten Transistors des Ausgangskreises sowohl mit dem zweiten Kollektor des ersten (26) der genannten Mehrkollektortransistoren als auch mit dem Ausgang (34') des Ausgangskreises verbunden ist.

4. Detektor nach Anspruch 3, bei dem der erste Transistor (34) des Ausgangskreises eine Emittierfläche hat, die M-fach größer ist, als die Fläche des Emitters des zweiten Transistors (32), wobei M positiv ist.

5. Detektor nach Anspruch 3 oder 4, bei dem die Emittierfläche des ersten Transistors (16) der Schaltungseinrichtung N-fach größer ist, als die Emittierfläche des zweiten Transistors (18) der Schaltungseinrichtung, wobei N positiv ist.

6. Detektor nach Anspruch 1, bei dem die Schaltungseinrichtung einen Mehr-Emitter-Transistor, aufweist, der erste und zweite Emittierelektroden hat, die jeweils mit ersten und zweiten Ausgängen der Schaltungseinrichtung verbunden sind, eine Basisselektrode hat, der ein Spannungssignal zugeführt wird, und einen Kollektor hat, der mit einem ersten Stromzuführungsleiter verbunden ist, wobei der erste Emitter eine Fläche hat, die N-fach größer ist, als die Fläche des zweiten Emitters, wobei N positiv ist.

7. Detektor nach Anspruch 6, bei dem der Fehlerverstärker einen zweiten Ausgangskreis (38, 40) enthält, der mit einer dritten Kollektorelektrode eines jeden aus dem Paar der Mehrkollektortransistoren verbunden ist, wobei der dritte Kollektor des ersten Mehrtransistors auch mit dem zweiten Ausgang (42) des Fehlerverstärkers verbunden ist.

8. Detektor nach Anspruch 7, weiterhin enthaltend einen Widerstand (44), der zwischen den zweiten Emittier des Mehr-Emitter-Transistors und den zweiten Ausgang der Schaltungseinrichtung geschaltet ist.

Revendications

1. Détecteur de seuil de courant (10) comportant un amplificateur différentiel d'erreurs (26, 28, 30, 32, 34) et un circuit (16, 18) pour établir une tension différentielle entre ses bornes, qui est proportionnelle à un courant de charge (I_c) fourni à la sortie (24) du détecteur de manière qu'un signal d'erreurs soit produit à une sortie (34') de l'amplificateur d'erreurs, dont les sens change quand l'intensité du courant de charge varie autour d'un niveau seuil prédéterminé, caractérisé en ce que:

l'amplificateur différentiel d'erreurs comporte

une paire de transistors à collecteurs multiples (26, 28) ayant chacun une électrode d'émetteur couplée avec une sortie respective du circuit, des électrodes de base interconnectées et des premières électrodes de collecteurs interconnectées; une source de courant (30) qui produit un courant de référence appliquée auxdites électrodes de bases interconnectées et aux premières électrodes de collecteurs interconnectées; et un circuit de sortie connecté aux secondes électrodes de collecteurs desdits transistors à collecteurs multiples et comprenant une sortie (34') correspondant à la sortie de signal d'erreurs; et

le circuit comporte la première desdites sorties couplée à la fois à la sortie (24) du détecteur et à ladite électrode d'émetteur du premier (26) de ladite paire de transistors à collecteurs multiples, dans lequel le niveau seuil est une fonction de l'intensité du courant produit par ladite source de courant.

2. Détecteur selon la revendication 1, dans lequel le circuit comporte un premier (16) et un second (18) transistors ayant chacun une électrode d'émetteur, une électrode de base et une électrode de collecteur, ladite électrode d'émetteur dudit premier et dudit second transistors étant couplée respectivement avec ladite première sortie et la seconde desdites sorties dudit circuit, lesdites électrodes de base étant interconnectées et lesdites électrodes de collecteurs étant couplées avec un conducteur d'alimentation.

3. Détecteur selon l'une quelconque des revendications précédentes, dans lequel ledit circuit de sortie dudit amplificateur d'erreurs comporte un premier (34) et un second (32) transistors comprenant chacun une électrode d'émetteur connectée à un second conducteur d'alimentation, des électrodes de base connectées en commun et une électrode de collecteur, ladite électrode de collecteur dudit premier transistor dudit circuit de sortie étant couplée à la fois avec son électrode de base et avec ledit second collecteur dudit second (28) desdits transistors à collecteurs multiples et ledit collecteur dudit second transistor dudit circuit de sortie étant couplé à la fois avec ledit second collecteur dudit premier (26) desdits transistors à collecteurs multiples et avec ladite sortie (34') du circuit de sortie.

4. Détecteur selon la revendication 3, dans lequel ledit premier transistor (34) dudit circuit de sortie a une surface d'émetteur qui est M fois supérieure à la surface dudit émetteur dudit second transistor (32), où M est positif.

5. Détecteur selon la revendication 3 ou 4, dans lequel la surface d'émetteur dudit premier transistor (16) dudit circuit est N fois supérieure à la surface d'émetteur dudit second transistor (18) dudit circuit, où N est positif.

6. Détecteur selon la revendication 1, dans lequel ledit circuit comporte un transistor à émetteurs multiples comprenant une première et une seconde électrodes d'émetteur couplées respectivement avec ladite première et ladite seconde sorties dudit circuit, une électrode de base à laquelle est appliqué un signal de polarisation et



un collecteur couplé avec un premier conducteur d'alimentation, ledit premier émetteur ayant une surface qui est N fois supérieure à la surface dudit second émetteur, où N est positif.

7. Détecteur selon la revendication 6, dans lequel ledit amplificateur d'erreurs comporte un second circuit de sortie (38, 40) couplé avec une troisième électrode de collecteur de chacun de ladite paire de transistors à collecteurs multiples,

avec le troisième collecteur dudit premier transistor multiple également couplé avec une seconde sortie (42) de l'amplificateur d'erreurs.

8. Détecteur selon la revendication 7, comportant en outre une résistance (44) qui est couplée entre ledit second émetteur dudit transistor à émetteurs multiples et ladite seconde sortie dudit circuit.

5

10

15

20

25

30

35

40

45

50

55

60

65

7

