

Description

This invention relates to an amplifier circuit comprising:

first voltage-current converter means for converting an input signal voltage into a first corresponding output current;

second voltage-current converter means having first and second input terminals for converting a negative feedback signal voltage into a second corresponding output current;

coupling means for coupling said first and second output currents of said first and second voltage-current converter means in an opposite phase relation, and for generating an output voltage corresponding to the sum of said first and second currents;

voltage amplifier means for amplifying the output voltage of said coupling means;

feedback means for supplying part of the output voltage of said voltage amplifier means as the negative feedback signal voltage to said second voltage-current converter means; and

control means for controlling the ratio of the mutual conductances of said first and second voltage-current converter means.

An amplifier of this kind is known from JP-A-59183514.

IEEE Journal of Solid-State Circuits, Vol. SC-17, No. 3, June 1982, pages 494 to 498 discloses an integrated telephone speech circuit including a line fed loudspeaker amplifier.

From this document an amplifier circuit having the features of the preamble of claim 1 is known, wherein a DC voltage of a predetermined level and the negative feedback signal voltage are respectively applied to said first and second input terminals of said second voltage-current converter means, and the DC voltage level of the output voltage of said voltage amplifier means is determined in accordance with the negative feedback signal voltage from said feedback means and the DC voltage of the predetermined level. However, this amplifier circuit comprises a feedback and a feed-forward structure from the input and output signal respectively, and moreover, comprises a complicated control unit circuit which results in high manufacturing costs.

Fig. 1 shows the construction of the conventional amplifier circuit used in an electronic device such as a radio receiver or a tape recorder. Stereo audio signals generated from signal source 1 are amplified by means of pre-amplifier 2 and then supplied to power amplifier 4 via variable resistor 3. Power amplifier 4 amplifies the audio signals and then drives audio speakers 5 according to the amplified audio signals. Variable resistor 3 is used to adjust the sound volume of speakers 5 and functions to determine the ratio of an input voltage of power amplifier 4 to an output voltage of pre-amplifier 2.

In a case where the audio signal is supplied to power amplifier 4 via variable resistor 3 as in the above amplifier circuit, power amplifier 4 will amplify the audio signal together with noise generated by the mechanical operation of the variable resistor. The quality of each variable resistor will be degraded as the duration of service becomes longer. Therefore, it becomes necessary to use the variable resistor of high quality.

In recent years, an amplifier circuit which does not require such a high quality variable resistor is proposed. The construction of the amplifier circuit is shown in Fig. 2. In the amplifier circuit, a set of variable resistors in Fig. 1 are replaced by electronic volume 6. Electronic volume 6 sets the ratio of an input voltage of power amplifier 4 to an output voltage of pre-amplifier 2 according to the voltage level of control voltage source 7. The voltage level of control voltage source 7 is changed to adjust the volume of speakers 5. In this case, control voltage source 7 does not form a signal path for the audio signal. Therefore, when the voltage level of control voltage source 7 is changed by use of an ordinary variable resistor, noise generated by operation of the variable resistor can be prevented from being amplified by means of power amplifier 4. Further, in this amplifier, it is possible to use a single variable resistor in order to adjust both speakers 5 in the same manner or use a remote-controlled switching element in order to change the voltage level of control voltage source 7.

An effort has been made to lower the manufacturing cost and enhance the reliability of the above electronic device by use of the IC technology. If electronic volume 6 is independently formed in the IC configuration, the number of parts used increases, making the manufacturing cost high. In order to avoid the increase in the number of parts used, electronic volume 6 is normally incorporated into the IC of power amplifier 4. In this case, since electronic volume 6 and power amplifier 4 are formed in the D.C. direct coupled configuration, compensation for D.C. offset becomes necessary and the linearity of amplification of the power amplifier must be taken into consideration. Therefore, electronic volume 6 becomes complex in construction, making the IC cost high.

An object of this invention is to provide an amplifier circuit capable of attaining a highly reliable volume adjustment with decreased manufacturing cost.

According to the present invention this object is solved by the characterizing features of claim 1.

The above object can be attained by an amplifier circuit comprising a first voltage-current converter for converting an input signal voltage into a corresponding current; a second voltage-current converter for converting a negative feedback signal voltage into a corresponding current; a coupling section for coupling output

currents of the first and second voltage-current converters which are set in the opposite phase relation and generating an output voltage corresponding to the sum of the coupled currents; a voltage amplifier for amplifying the output voltage of the coupling section; a feedback section for supplying the output voltage of the voltage amplifier as a negative feedback signal to the second voltage-current converter; and a control section for controlling the ratio of the mutual conductances of the first and second voltage-current converters.

With the above amplifier circuit, the ratio of the mutual conductances of the first and second voltage-current is controlled by the control section. The gain of the amplifier circuit is determined by the ratio of the mutual conductances, and therefore the control section can be used for adjusting the volume of an audio device, for example. Even if the control section is constructed by a normal variable resistor, noise generated by operation of the variable resistor will not be amplified since the control section is independent from the signal path for the input signal. Further, with the above construction, it is not necessary to take the compensation for the D.C. offset into consideration. Thus, it becomes possible to attain a highly reliable volume control operation without increasing the manufacturing cost.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 shows the construction of the conventional amplifier circuit;

Fig. 2 shows the construction of the conventional amplifier circuit in which a variable resistor in Fig. 1 is replaced by an electronic volume;

Fig. 3 is a circuit diagram schematically showing an amplifier circuit according to one embodiment of this invention;

Fig. 4 is a circuit diagram showing the amplifier circuit of Fig. 3 in detail; and

Fig. 5 is a circuit diagram showing a modification of the amplifier circuit of Fig. 4.

There will now be described an amplifier circuit according to one embodiment of this invention with reference to Figs. 3 and 4. Fig. 3 is a circuit diagram schematically showing the construction of the amplifier circuit. The amplifier circuit includes voltage-current converting amplifier 11 having mutual conductance g_{m1} (input voltage/output current), voltage-current converting amplifier 12 having mutual conductance g_{m2} , adder 13, voltage amplifier 14 having current gain A and constituting an output section, resistors R_1 and R_2 determining the feedback factor, and load R_L . The voltage gain of the amplifier circuit is expressed as follows:

$$v_0 = (v_i \cdot g_{m1} - v_0 \cdot \frac{R_2}{R_1 + R_2} \cdot g_{m2}) A \cdot R_L \quad (1)$$

Equation (1) can be re-written as follows by replacing feedback factor (R_1/R_1+R_2) by F :

$$v_0 (1 + F \cdot g_{m2} \cdot A \cdot R_L) = v_i g_{m1} \cdot A \cdot R_L$$

$$\frac{v_0}{v_i} = \frac{g_{m1} \cdot A \cdot R_L}{1 + F \cdot g_{m2} \cdot A \cdot R_L} = \frac{1}{\frac{1}{g_{m1} \cdot A \cdot R_L} + F \frac{g_{m2}}{g_{m1}}} \quad (2)$$

If gain $g_{m1} \cdot A \cdot R_L$ is extremely large, that is, $1 \ll g_{m1} \cdot A \cdot R_L$, gain G (the voltage gain of the output of amplifier 14 with respect to input v_i) is expressed as follows:

$$G = \frac{v_0}{v_i} = \frac{1}{F \cdot \frac{g_{m2}}{g_{m1}}} = \frac{1}{F} \cdot \frac{g_{m1}}{g_{m2}} \quad (3)$$

Therefore, when $g_{m1}=g_{m2}$, G is $1/F$, that is, the ratio of the feedback resistances, when $g_{m1} < g_{m2}$, G decreases, and when $g_{m1} > g_{m2}$, G increases.

Fig. 4 shows the detail circuit construction of the amplifier circuit according to the embodiment of this invention. In Fig. 4, transistors Q_1 and Q_2 constitute voltage-current converting amplifier 11 for amplifying input signal v_i , and transistors Q_3 and Q_4 constitute voltage-current converting amplifier 12 for amplifying a negative feedback signal fed back from output terminal V_0 . Further, transistors Q_5 and Q_6 serve as an active load which couples or adds output currents of amplifiers 11 and 12 together in an inverted relation. An output voltage corresponding to the added currents is supplied to amplification transistor Q_9 , and an output voltage of transistor Q_9 is further amplified by means of amplifier 21. In Fig. 4, I_0 denotes a constant current source and V_B denotes a bias voltage source. Further, transistors Q_7 and Q_8 in which currents I_1 and I_2 flow constitute a current source for setting the bias point of transistors Q_3 and Q_4 . Mutual conductance g_{m1} of amplifier 11 constituted by transistors Q_1 and Q_2 is expressed by the following equation:

$$g_{m1} = \frac{I_{D2}}{V_T} = \frac{I_1}{2V_T}, \quad V_T = \frac{kT}{q}$$

where $V_T=kT/q$, k is a Boltzmann's constant, T is an absolute temperature, and q is the charge amount of an electron.

Likewise, mutual conductance g_{m2} of amplifier 12 constituted by transistors Q_3 and Q_4 is expressed by

the following equation:

$$g_{m2} = \frac{I_{22}}{V_T} = \frac{I_2}{2V_T}$$

Thus, gain G in this embodiment can be obtained substituting g_{m1} and g_{m2} into equation (3) as follows:

$$G = \frac{V_0}{V_i} = \frac{R_2 + R_1}{R_1} \cdot \frac{g_{m1}}{g_{m2}} = \frac{R_2 + R_1}{R_1} \cdot \frac{I_1 \cdot 2V_T}{2V_T \cdot I_2} = \frac{I_1}{I_2} \cdot \frac{R_2 + R_1}{R_1} \quad (4)$$

When the bias voltage applied to the bases of transistors Q_7 and Q_8 constituting a differential amplifier is changed by operating variable resistor R_3 , the ratio of currents I_1 and I_2 is changed. Gain G is determined by the ratio of currents I_1 and I_2 .

As described above, in this embodiment, gain G can be determined by the ratio of currents ($I_1 : I_2$), and the satisfactory linearity of variation in the gain can be obtained by adequately controlling the ratio of I_1/I_2 as shown by equation (4). Further, since it is not necessary to connect an electronic volume circuit, no problem concerning the D.C. offset occurs.

This invention is not limited to the above embodiment, but can be variously modified without departing from the technical scope thereof. For example, variable resistor R_3 can be replaced by a plurality of switches S1-SN and fixed resistors RB1-RBN connected thereto, and fixed resistor RA as shown in Fig. 5. Each of the fixed resistors RB1-RBN has a common resistance. In this case, it is possible to change gain G at a constant rate by increasing or decreasing the number of switches S1-SN in the conductive state.

Claims

1. An amplifier circuit comprising:

first voltage-current converter means (Q1, Q2) for converting an input signal voltage into a first corresponding output current;

second voltage-current converter means (Q3, Q4) having first and second input terminals for converting a negative feedback signal voltage into a second corresponding output current;

coupling means (Q5, Q6, Q9) for coupling said first and second output currents of said first and second voltage-current converter means (Q1, Q2, Q3, Q4) in an opposite phase relation, and for generating an output voltage corresponding to the sum of said first and second currents;

voltage amplifier means (21) for amplifying the output voltage of said coupling means (Q5, Q6, Q9);

feedback means (R1, R2) for supplying part of the output voltage of said voltage amplifier means (21) as the negative feedback signal voltage to said second voltage-current converter means (Q3, Q4); and

control means (VB, R3, Q7, Q8, IO; VB, RA, RB1-RBN, S1-SN, Q7, Q8, IO) for controlling the ratio of the mutual conductances of said first and second voltage-current converter means (Q1, Q2, Q3, Q4);

a DC voltage of a predetermined level and the negative feedback signal voltage respectively applied to said first and second input terminals of said second voltage-current converter means (Q3, Q4), the DC voltage level of the output voltage of said voltage amplifier means (21) being determined in accordance with the negative feedback signal voltage supplied from said feedback means (R1, R2) and the DC voltage of the predetermined level; characterized in that

the DC voltage of the predetermined level, applied to the base of said first transistor (Q3), is equal to the ground level;

said control means includes a current supply circuit (IO, Q7, Q8) for supplying first and second drive currents to said first and second voltage-current converter means (Q1, Q2, Q3, Q4), respectively, and a control circuit (VB, R3; VB, RA, RB1-RBN, S1-SN) for controlling the ratio of the first and second drive currents;

said control circuit includes a constant voltage source (VB) and variable resistor means (R3; RA, RB1-RBN, S1-SN) for dividing the output voltage of said constant voltage source (VB), and said current supply circuit includes a constant current source (IO) and a differential amplifying circuit having first and second transistors (Q7, Q8) each connected to said constant current source (IO) and biased by the respective output voltages of said constant voltage source (VB) and said variable resistor means (R3; RA, RB1-RBN, S1-SN);

said second voltage-current converter means includes a differential amplifier comprising a pair of transistors (Q3, Q4) and having first and second input terminals corresponding to said first and second input terminals of said second voltage-current converter means, respectively, and the DC voltage of the predetermined level is applied to the first input terminal of said differential amplifier (Q3, Q4), and the feedback signal voltage is applied by said feedback means (R1, R2) from said voltage amplifier means (21)



the following equation:

$$g_{m2} = \frac{I_{22}}{V_T} = \frac{I_2}{2V_T}$$

Thus, gain G in this embodiment can be obtained substituting g_{m1} and g_{m2} into equation (3) as follows:

$$G = \frac{v_o}{v_i} = \frac{R_2 + R_1}{R_1} \cdot \frac{g_{m1}}{g_{m2}} = \frac{R_2 + R_1}{R_1} \cdot \frac{I_1 \cdot 2V_T}{2V_T \cdot I_2} = \frac{I_1}{I_2} \cdot \frac{R_2 + R_1}{R_1} \quad (4)$$

When the bias voltage applied to the bases of transistors Q_7 and Q_8 constituting a differential amplifier is changed by operating variable resistor R_3 , the ratio of currents I_1 and I_2 is changed. Gain G is determined by the ratio of currents I_1 and I_2 .

As described above, in this embodiment, gain G can be determined by the ratio of currents ($I_1 : I_2$), and the satisfactory linearity of variation in the gain can be obtained by adequately controlling the ratio of I_1/I_2 as shown by equation (4). Further, since it is not necessary to connect an electronic volume circuit, no problem concerning the D.C. offset occurs.

This invention is not limited to the above embodiment, but can be variously modified without departing from the technical scope thereof. For example, variable resistor R_3 can be replaced by a plurality of switches S1-SN and fixed resistors RB1-RBN connected thereto, and fixed resistor RA as shown in Fig. 5. Each of the fixed resistors RB1-RBN has a common resistance. In this case, it is possible to change gain G at a constant rate by increasing or decreasing the number of switches S1-SN in the conductive state.

Claims

1. An amplifier circuit comprising:

first voltage-current converter means (Q1, Q2) for converting an input signal voltage into a first corresponding output current;

second voltage-current converter means (Q3, Q4) having first and second input terminals for converting a negative feedback signal voltage into a second corresponding output current;

coupling means (Q5, Q6, Q9) for coupling said first and second output currents of said first and second voltage-current converter means (Q1, Q2, Q3, Q4) in an opposite phase relation, and for generating an output voltage corresponding to the sum of said first and second currents;

voltage amplifier means (21) for amplifying the output voltage of said coupling means (Q5, Q6, Q9);

feedback means (R1, R2) for supplying part of the output voltage of said voltage amplifier means (21) as the negative feedback signal voltage to said second voltage-current converter means (Q3, Q4); and control means (VB, R3, Q7, Q8, IO; VB, RA, RB1-RBN, S1-SN, Q7, Q8, IO) for controlling the ratio of the mutual conductances of said first and second voltage-current converter means (Q1, Q2, Q3, Q4);

a DC voltage of a predetermined level and the negative feedback signal voltage respectively applied to said first and second input terminals of said second voltage-current converter means (Q3, Q4), the DC voltage level of the output voltage of said voltage amplifier means (21) being determined in accordance with the negative feedback signal voltage supplied from said feedback means (R1, R2) and the DC voltage of the predetermined level; characterized in that

the DC voltage of the predetermined level, applied to the base of said first transistor (Q3), is equal to the ground level;

said control means includes a current supply circuit (IO, Q7, Q8) for supplying first and second drive currents to said first and second voltage-current converter means (Q1, Q2, Q3, Q4), respectively, and a control circuit (VB, R3; VB, RA, RB1-RBN, S1-SN) for controlling the ratio of the first and second drive currents;

said control circuit includes a constant voltage source (VB) and variable resistor means (R3; RA, RB1-RBN, S1-SN) for dividing the output voltage of said constant voltage source (VB), and said current supply circuit includes a constant current source (IO) and a differential amplifying circuit having first and second transistors (Q7, Q8) each connected to said constant current source (IO) and biased by the respective output voltages of said constant voltage source (VB) and said variable resistor means (R3; RA, RB1-RBN, S1-SN);

said second voltage-current converter means includes a differential amplifier comprising a pair of transistors (Q3, Q4) and having first and second input terminals corresponding to said first and second input terminals of said second voltage-current converter means, respectively, and the DC voltage of the predetermined level is applied to the first input terminal of said differential amplifier (Q3, Q4), and the feedback signal voltage is applied by said feedback means (R1, R2) from said voltage amplifier means (21)



to the second input terminal of said differential amplifier (Q3, Q4);

said control means includes:

- a current supply circuit (IO, Q7, Q8) for supplying first and second drive currents to said first voltage-current converter means (Q1, Q2) and said differential amplifier (Q3, Q4); and
- a control circuit (VB, R3; VB, RA, RB1-RBN, S1-SN) for controlling the ratio of the first and second drive currents; and

said differential amplifier includes :

- a first transistor (Q3) having an emitter connected to said current supply circuit (IO, Q7, Q8) to receive said second drive current, a collector connected to said coupling means (Q5, Q6, Q9), and a base to which the DC voltage of the predetermined level is applied; and
- a second transistor (Q4) having an emitter which is commonly connected to the emitter of said first transistor (Q3), a collector connected to said coupling means (Q5, Q6, Q9), and a base to which said feedback signal voltage is applied.

2. An amplifier circuit according to claim 1, characterized in that said variable resistor means includes a first fixed resistor (RA) connected at one end to one end of said constant voltage source (VB), a plurality of second fixed resistors (RB1-RBN), and connecting means (S1-SN) for selectively connecting said second fixed resistors (RB1-RBN) between the other ends of said first fixed resistor (RA) and said constant voltage source (VB).
3. An amplifier circuit according to claim 2, characterized in that said connecting means includes a plurality of switching means (S1-SN) each connected in series with a corresponding second fixed resistor (RB1-RBN) between the other ends of said first fixed resistor (RA) and said constant voltage source (VB).
4. An amplifier circuit according to claim 3, characterized in that each of said second fixed resistors (RB1-RBN) has a common resistance.

Patentansprüche

1. Verstärkerschaltung enthaltend:
 - erste Spannungs-Strom-Umsetzmittel (Q1, Q2) zum Umsetzen einer Eingangssignalspannung in einen ersten entsprechenden Ausgangsstrom;
 - zweite Spannungs-Strom-Umsetzmittel (Q3, Q4) mit ersten und zweiten Eingangsanschlüssen zum Umsetzen einer negativen Rückkopplungssignalspannung in einen zweiten entsprechenden Ausgangsstrom;
 - Kopplungsmittel (Q5, Q6, Q9) zum Koppeln der ersten und zweiten Ausgangsströme der ersten und zweiten Spannungs-Strom-Umsetzmittel (Q1, Q2, Q3, Q4) in umgekehrter Phasenrelation und zum Erzeugen einer Ausgangsspannung entsprechend der Summe der ersten und zweiten Ströme;
 - ein Spannungsverstärkermittel (21) zum Verstärken der Ausgangsspannung der Kopplungsmittel (Q5, Q6, Q9);
 - Rückkopplungsmittel (R1, R2) zum Zuführen eines Teils der Ausgangsspannung des Spannungsverstärkermittels (21) als negative Rückkopplungssignalspannung zu den zweiten Spannungs-Strom-Umsetzmitteln (Q3, Q4); und
 - Regelmittel (VB, R3, Q7, Q8, IO; VB, RA, RB1-RBN, S1-SN, Q7, Q8, IO) zum Regeln des Verhältnisses der wechselseitigen Wirkleitwerte der ersten und zweiten Spannungs-Strom-Umsetzmittel (Q1, Q2, Q3, Q4);
 - wobei eine Gleichspannung mit vorbestimmtem Pegel und die negative Rückkopplungssignalspannung jeweils an den ersten und zweiten Eingangsanschlüssen der zweiten Spannungs-Strom-Umsetzmittel (Q3, Q4) anliegen und der Gleichspannungspegel der Ausgangsspannung des Spannungsverstärkermittels (21) gemäß der von den Rückkopplungsmitteln (R1, R2) zugeführten negativen Rückkopplungssignalspannung und der Gleichspannung mit vorbestimmtem Pegel bestimmt wird;
- dadurch gekennzeichnet, daß
- die Gleichspannung mit vorbestimmtem Pegel, die an der Basis des ersten Transistors (Q3) anliegt, gleich dem Massepegel ist;
 - daß die Regelmittel eine Strom-Versorgungs-Schaltung (IO, Q7, Q8) zum Versorgen der ersten und zweiten Spannungs-Strom-Umsetzmittel (Q1, Q2, Q3, Q4) mit ersten und zweiten Treiberströ-



men enthält, sowie eine Regelschaltung (VB, R3; VB, RA, RB1-RBN, S1-SN) zum Regeln des Verhältnisses der ersten und zweiten Treiberströme;

- die Regelschaltung eine Konstantspannungsquelle (VB) und veränderliche Widerstandsmittel (R3; RA, RB1-RBN, S1-SN) zum Teilen der Ausgangsspannung der Konstantspannungsquelle (VB) enthält, und daß die Strom-Versorgungs-Schaltung eine Konstantstromquelle (IO) und eine Differenzverstärkerschaltung enthält, die einen ersten und zweiten Transistor (Q7, Q8) aufweist, der jeweils an die Konstantstromquelle (IO) angeschlossen ist und durch die einzelnen Ausgangsspannungen der Konstantspannungsquelle (VB) und der veränderlichen Widerstandsmittel (R3; RA, RB1-RBN, S1-SN) vorgespannt ist;
- das zweite Spannungs-Strom-Umsetzmittel einen Differenzverstärker mit einem Transistorpaar (Q3, Q4) enthält mit ersten und zweiten Eingangsanschlüssen, die jeweils den ersten und zweiten Eingangsanschlüssen der zweiten Spannungs-Strom-Umsetzmittel entsprechen, und daß die Gleichspannung mit vorbestimmtem Pegel an dem ersten Eingangsanschluß des Differenzverstärkers (Q3, Q4) anliegt, und daß die Rückkopplungssignalspannung des Spannungsverstärkermittels (21) durch das Rückkopplungsmittel (R1, R2) an dem zweiten Eingangsanschluß des Differenzverstärkers (Q3, Q4) anliegt;
- das Regelungsmittel enthält:
 - eine Stromversorgungsschaltung (IO, Q7, Q8) zum Zuführen erster und zweiter Treiberströme zu den Spannungs-Strom-Umsetzmitteln (Q1, Q2) und dem Differenzverstärker (Q3, Q4); und
 - eine Regelungsschaltung (VB, R3; VB, RA, RB1-RBN, S1-SN) zum Regeln des Verhältnisses der ersten und zweiten Treiberströme; und
- der Differenzverstärker enthält:
 - einen ersten Transistor (Q3) mit einem an die Stromversorgungsschaltung (IO, Q7, Q8) zur Aufnahme des zweiten Treiberstroms verbundenen Emitter, einen an das Kopplungsmittel (Q5, Q6, Q9) angeschlossenen Kollektor und eine Basis, an der die Gleichspannung mit vorbestimmtem Pegel anliegt; und
 - einen zweiten Transistor (Q4) mit einem an dem Emitter des ersten Transistors (Q3) angeschlossenen Emitter, einem an die Kopplungsmittel (Q5, Q6, Q9) angeschlossenen Kollektor und einer Basis, an der die Rückkopplungssignalspannung anliegt.

2. Verstärkerschaltung nach Anspruch 1, dadurch gekennzeichnet, daß die variablen Widerstandsmittel einen ersten festen Widerstand (RA) enthalten, der an einem Ende an der Konstantspannungsquelle (VB) angeschlossen ist, sowie eine Vielzahl von zweiten festen Widerständen (RB1-RBN) und Verbindungsmittel (S1-SN) zum wahlweisen Verbinden der zweiten festen Widerstände (RB1-RBN) zwischen den anderen Enden des ersten festen Widerstands (RA) und der Konstantspannungsquelle (VB).
3. Verstärkerschaltung nach Anspruch 2, dadurch gekennzeichnet, daß die Verbindungsmittel eine Vielzahl von Schaltmitteln (S1-SN) enthalten, die jeweils in Serie mit einem entsprechenden zweiten festen Widerstand (RB1-RBN) zwischen den anderen Enden des ersten festen Widerstands (RA) und der Konstantspannungsquelle (VB) liegen.
4. Verstärkerschaltung nach Anspruch 3, dadurch gekennzeichnet, daß jeder der zweiten festen Widerstände (RB1-RBN) einen gemeinsamen Widerstand aufweist.

Revendications

1. Circuit amplificateur comprenant :
 - un premier dispositif convertisseur de tension-courant (Q1, Q2) pour convertir une tension du signal d'entrée en un premier courant de sortie correspondant ;
 - un second dispositif convertisseur de tension-courant (Q3, Q4) ayant des première et seconde bornes d'entrée pour convertir une tension négative du signal de contre-réaction en un second courant de sortie correspondant ;
 - un dispositif de couplage (Q5, Q6, Q9) pour coupler lesdits premier et second courants de sortie



desdits premier et second dispositifs convertisseurs de tension-courant (Q1, Q2, Q3, Q4) dans une relation de phase opposée, et pour générer une tension de sortie correspondant à la somme desdits premier et second courants ;

un dispositif amplificateur de tension (21) pour amplifier la tension de sortie dudit dispositif de couplage (Q5, Q6, Q9) ;

un dispositif de contre-réaction (R1, R2) pour fournir une partie de la tension de sortie dudit dispositif amplificateur de tension (21) comme la tension négative du signal de contre-réaction audit second dispositif convertisseur de tension-courant (Q3, Q4) ; et

un dispositif de commande (VB, R3, Q7, Q8, IO ; VB, RA, RB1 à RBN, S1 à SN, Q7, Q8, IO) pour commander le rapport des conductances mutuelles desdits premier et second dispositifs convertisseurs de tension-courant (Q1, Q2, Q3, Q4) ; une tension de courant continu d'un niveau prédéterminé et la tension négative du signal de contre-réaction appliquée respectivement auxdites première et seconde bornes d'entrée dudit second dispositif convertisseur de tension-courant (Q3, Q4), le niveau de tension de courant continu de la tension de sortie dudit dispositif amplificateur de tension (21) étant déterminé en fonction de la tension négative du signal de contre-réaction fournie par ledit dispositif de contre-réaction (R1, R2) et de la tension de courant continu de niveau prédéterminé ;

caractérisé en ce que

la tension de courant continu de niveau prédéterminé, appliquée à la base dudit premier transistor (Q3) est égale au niveau de masse ;

ledit dispositif de commande comprend un circuit d'alimentation de courant (IO, Q7, Q8) pour fournir des premier et second courants de commande auxdits premier et second dispositifs convertisseurs de tension-courant (Q1, Q2, Q3, Q4) respectivement, et un circuit de commande (VB, R3 ; VB, RA, RB1 à RBN, S1 à SN) pour commander le rapport des premier et second courants de commande ;

ledit circuit de commande comprend une source de tension constante (VB) et un dispositif de résistance variable (R3 ; RA, RB1 à RBN, S1 à SN) pour diviser la tension de sortie de ladite source de tension constante (VB), et ledit circuit d'alimentation de courant comprend une source de courant constant (IO) et un circuit d'amplification différentielle ayant des premier et second transistors (Q7, Q8) reliés chacun à ladite source de courant constant (IO) et polarisés par les tensions de sortie respectives desdites sources de tension constantes (VB) et ledit dispositif de résistance variable (R3 ; RA, RB1 à RBN, S1 à SN) ;

ledit second dispositif convertisseur de tension-courant comprend un amplificateur différentiel comprenant une paire de transistors (Q3, Q4) et ayant des première et seconde bornes d'entrée correspondant auxdites première et seconde bornes d'entrée dudit second dispositif convertisseur de tension-courant, respectivement, et la tension de courant continu de niveau prédéterminé est appliquée à la première borne d'entrée dudit amplificateur différentiel (Q3, Q4), et la tension du signal de contre-réaction est appliquée par ledit dispositif de contre-réaction (R1, R2) à partir dudit dispositif amplificateur de tension (21) à la seconde borne d'entrée dudit amplificateur différentiel (Q3, Q4) ;

ledit dispositif de commande comprend :

- un circuit d'alimentation de courant (IO, Q7, Q8) pour fournir des premier et second courants de commande audit premier dispositif convertisseur de tension-courant (Q1, Q2) et audit amplificateur différentiel (Q3, Q4) ; et
- un circuit de commande (VB, R3 ; VB, RA, RB1 à RBN, S1 à SN) pour commander le rapport des premier et second courants de commande ; et

ledit amplificateur différentiel comprend :

- un premier transistor (Q3) ayant un émetteur relié audit circuit d'alimentation de courant (IO, Q7, Q8) pour recevoir ledit second courant de commande, un collecteur relié audit dispositif de couplage (Q5, Q6, Q9) et une base à laquelle la tension de courant continu de niveau prédéterminé est appliquée ; et
- un second transistor (Q4) ayant un émetteur qui est relié en commun à l'émetteur dudit premier transistor (Q3), un collecteur relié audit dispositif de couplage (Q5, Q6, Q9), et une base à laquelle ladite tension du signal de contre-réaction est appliquée.

2. Circuit amplificateur selon la revendication 1, caractérisé en ce que ledit dispositif de résistance variable comprend une première résistance fixe (RA) reliée à une extrémité de ladite source de tension constante (VB), une pluralité de secondes résistances fixes (RB1 à RBN), et un dispositif de connexion (S1 à SN) pour relier sélectivement lesdites secondes résistances fixes (RB1 à RBN) entre les autres extrémités de ladite première résistance fixe (RA) et ladite source de tension constante (VB).



3. Circuit amplificateur selon la revendication 2, caractérisé en ce que ledit dispositif de connexion comprend une pluralité de dispositifs de commutation (S1 à SN) reliés chacun en série à une seconde résistance fixe correspondante (RB1 à RBN) entre les autres extrémités de ladite première résistance fixe (RA) et de ladite source de tension constante (VB).
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4. Circuit amplificateur selon la revendication 3, caractérisé en ce que chacune desdites secondes résistances fixes (RB1 à RBN) a une résistance commune.
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