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(71) Applicant
Soundcraft Electronics Limited

(Incorporated in the United Kingdom)

Rowley Lane Industrial Park, Borehamwood, Hertfordshire, WD6 5PZ, United Kingdom

(72) Inventor
Douglas Self

(74) Agent and/or Address for Service
W H Beck, Greener & Co
7, Stone Buildings, Lincoln's Inn, London, WC2A 3SZ, United Kingdom

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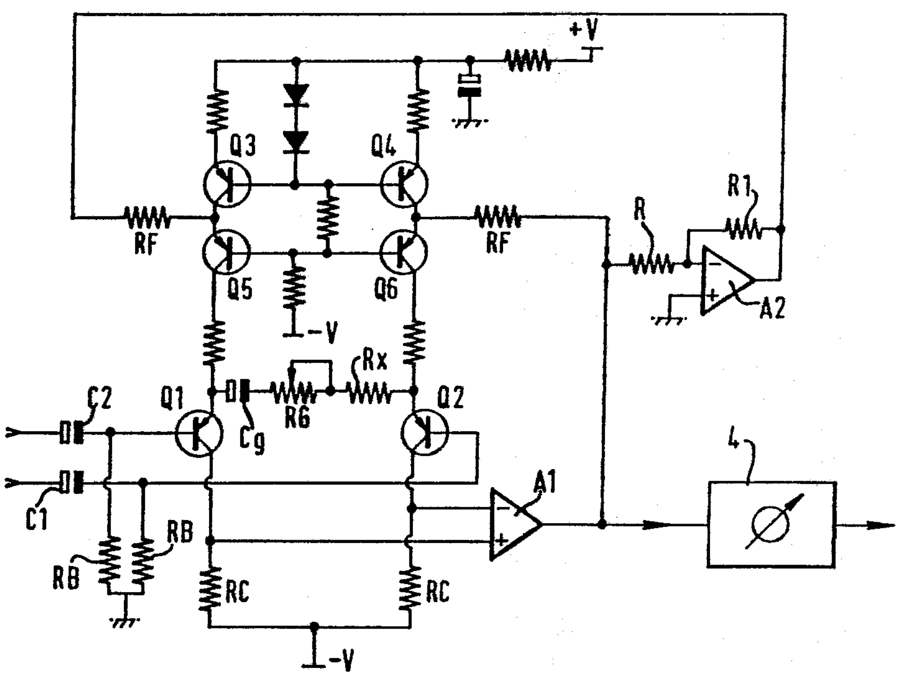
(54) A preamplifier adjustable to low gain

(57) A preamplifier circuit for amplifying low impedance sources comprises two transistors (Q1 and Q2) connected as a differential pair. The gain is varied by a gain resistor (RG). Two feedback resistors (RF) each couple the output to the emitter of a respective one of the transistors (Q1 and Q2) of the differential pair. A further transistor (Q3, Q4) connected to form a current source is coupled to each transistor (Q1, Q2) of the differential pair.



The date of filing shown above is that provisionally accorded to the application in accordance with the provisions of Section 15(4) of the Patents Act 1977 and is subject to ratification or amendment.

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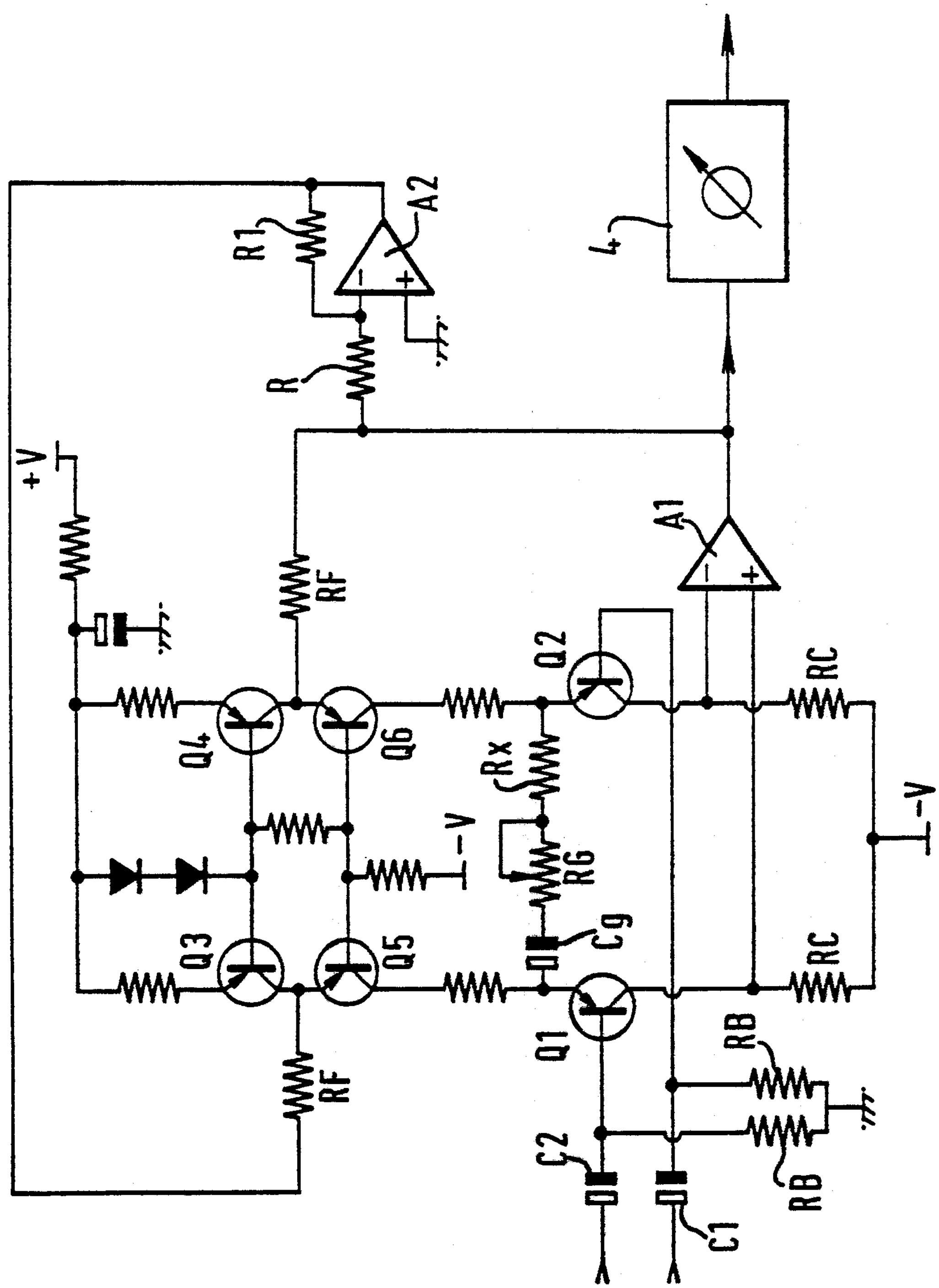
R1
A2
R
+V
RF
A1
Q2
Q4
Q6
Rx
RG
Cg
Q3
Q5
-V
RC
RB
Q1
C2
C1
4

A PREAMPLIFIER

The present invention relates to a preamplifier.

Typically, a low impedance moving coil microphone has a source resistance of the order of 200 Ohms, and with such low source impedances the signal voltages are very low and therefore the noise performance of the preamplifier must be very good.

The traditional approach to the amplification of signals from such a low-impedance source is to use a transformer to raise both the signal level and the impedance before coupling to a preamplifier. However, transformers are heavy components and relatively expensive and in recent years they have been omitted from commercial preamplifiers. There are existing transformerless preamplifier circuits which perform quite well over part of the gain range required. However, the preamplifier circuits currently available have significant distortion at the top end of the gain range. In addition, these known preamplifiers generally cannot cover the complete gain range required, and in particular cannot provide unity gain (0dB). It is therefore currently necessary to include an additional attenuator, for example a 20dB fixed attenuator or pad, to give access to the bottom end of the gain range.

The present invention seeks to provide a preamplifier circuit which has improved performance over a significant gain range.

According to the present invention there is provided a preamplifier circuit comprising an amplifying stage having two transistors connected as differential pair, a respective feedback path from the output of the stage to each transistor of the differential pair, and a variable resistor, for varying the gain of the stage, in the input circuits of the differential pair of transistors, wherein the feedback paths include feedback resistors, and a further transistor connected as a current source is coupled to each transistor of the differential pair.

In an embodiment, a respective additional transistor is connected in cascode with each of said current source transistors.

Preferably, said variable resistor is a logarithmic potentiometer.

In one embodiment, at least one further variable gain amplifying stage is provided. The gain of said first mentioned amplifying stage being arranged to rise with respect to the movement of a control member in its high gain region, whilst the gain of the second stage is attributable to a reverse logarithmic potentiometer and flattens in its high gain region. This enables a substantially linear overall gain law relative to the movement of said control member to be produced.

An embodiment of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawing, in which the Figure shows a circuit diagram of an embodiment of a preamplifier of the invention.

The preamplifier illustrated is designed to amplify very low level signals from low source impedances. For example, the preamplifier of the invention can be used in a mixing console to receive and amplify signals from a low impedance moving coil microphone.

The Figure shows a preamplifier circuit of the present invention which is substantially distortion free. This preamplifier has a gain range of the order of 3 to 80 dB, access to the whole range being by way of a single control knob without the need for a separate attenuator.

The preamplifier circuit shown has a first amplifying stage comprising two pnp transistors Q1 and Q2 connected as a differential pair. The input signals from a microphone (not shown) are coupled to the bases of the transistors Q1, Q2 by way of respective capacitors C1 and C2. The transistor bases are appropriately biased by base resistors RB. A respective collector resistor RC connects the collector of each transistor to the negative supply v-. The outputs of the transistors Q1, Q2 at their collectors are fed to an operational amplifier A1 whose output is the output of the first stage.

It will be seen that the output of the first amplifying stage is fed to a second amplifying stage 4 and by way of a feedback loop to the input circuit of the two transistors Q1, Q2. The output signal is fed back to input circuit of the transistors Q1, Q2 of the differential pair by way of respective feedback resistors RF. To maintain the symmetry of the differential amplifying circuit, the output is directly coupled to the emitter of the transistor Q2 by way of its resistor RF, whereas the output coupled to the emitter of the transistor Q1 has been inverted. This inversion is accomplished by way of a further operational amplifier A2 connected to function simply as an inverter. Thus, as shown, the output of the stage is fed to the inverting input of the amplifier A2 by way of a resistor R whilst is non-inverting input is connected to ground. There is also a feedback connection from the output of the amplifier A2 by way of a resistor R1 to the inverting input. The resistors R and R1 are substantially identical in value, and it will therefore be appreciated that the operational amplifier A2 and its associated resistors R and R1 are arranged to produce at the output of the amplifier A2 an output signal which is an inversion of that applied to the inverting input.

The operating point of the differential amplifier is determined by transistors Q3 and Q4 which replace conventional emitter resistors and are connected between the positive supply v+ and the emitters of the transistors Q1, Q2. The transistors Q3, Q4 are connected to form current sources, and thereby effectively to have an infinite output impedance which can be discounted when assessing the gain of the circuit. The provision of current sources instead of emitter resistors enables the amplifying stage to have a practical minimum gain of about 3dB.

The gain of the first amplifying stage is set by the feedback resistors RF and by a gain resistor RG connected between the emitters of the transistors Q1, Q2. The gain resistor RG is implemented by a potentiometer such that its resistance and hence the gain of the first amplifying stage can be varied. Generally, the gain resistor RG will be a reverse logarithmic potentiometer.

The circuit of the first amplifying stage of the preamplifier of the Figure is symmetrical and the operational amplifier A1 has a high loop gain. These factors provide high linearity over all of the gain range and a high common mode rejection ratio.

The circuit of the preamplifier also includes additional transistors Q5 and Q6 each connected in cascode with a respective one of the current source transistors Q3 and Q4. The cascode transistors Q5 and Q6 isolate each feedback resistor RF from the gain setting resistor RG so that the gain is not determined by potential divider action. In the circuit shown, the feedback voltage, and hence the gain, is determined by the simple ratio of the resistance of RF to that of RG and can therefore be reduced almost indefinitely by increasing the value of RF.

The second amplifying stage 4 is a conventional gain amplifier whose gain may be varied by way of a reverse logarithmic variable resistor (not shown). The gain of the second stage 4 is thus the familiar curve, flattened in the high gain region, attributable to a reverse logarithmic resistor. This logarithmic resistor is ganged together with the gain resistor RG of the first amplifying stage and controlled by a single rotatable control knob (not shown).

The first amplifying stage of the circuit can provide a gain in the range 0 to 50dB whilst the second stage 4 is generally arranged to produce a gain in the range 0 to 30dB so that the preamplifier has a useful distortionless range of 0 to 80dB. All of this gain is available by adjustment of the single control knob without the need to switch in attenuator pads or the like. In addition, the circuit is distortionless with a high common mode rejection ratio.

The circuit of the first stage includes a number of resistors, diodes and capacitors which have not been specifically identified. It will be appreciated that these components set the bias conditions for the various transistors. The reverse logarithmic potentiometer RG is connected in series with a capacitor Cg and a fixed resistor Rx whose values are chosen so that the gain response rises sharply in the high gain region. This means that the gain response of the first amplifying stage relative to the rotation of the control knob will combine with the flattened gain characteristic from the second amplifying stage to approach an overall gain law which is substantially linear in dB's with respect to the rotation of the control knob.

The preamplifier circuit described and claimed herein is also described and illustrated in our copending application no 8719014 (2208053) from which the present application is divided.

It will be appreciated that variations and modifications to the circuit particularly described may be made within the scope of the invention.

CLAIMS

1. A preamplifier circuit comprising an amplifying stage having two transistors connected as differential pair, a respective feedback path from the output of the stage to each transistor of the differential pair, and a variable resistor, for varying the gain of the stage, in the input circuits of the differential pair of transistors, wherein the feedback paths include feedback resistors, and a further transistor connected as a current source is coupled to each transistor of the differential pair.

2. A preamplifier circuit as claimed in Claim 1, wherein a respective additional transistor is connected in cascode with each of said current source transistors.

3. A preamplifier circuit as claimed in Claim 1 or 2, wherein said variable resistor is a logarithmic potentiometer.

4. A preamplifier circuit as claimed in any preceding claim, comprising at least one further amplifying stage coupled to the output of said first mentioned amplifying stage.

5. A preamplifier circuit as claimed in Claim 4, wherein said further amplifying stage is a variable gain amplifier and wherein a single control knob is arranged to vary the gain of said variable amplifier stage and to adjust said variable resistor.

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