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BILATERAL AMPLITUDE LIMITER

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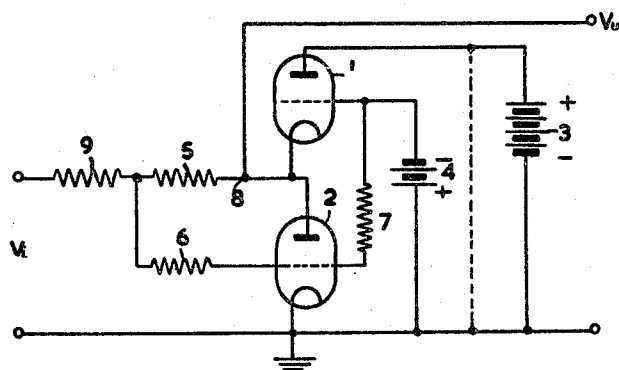


FIG. 1

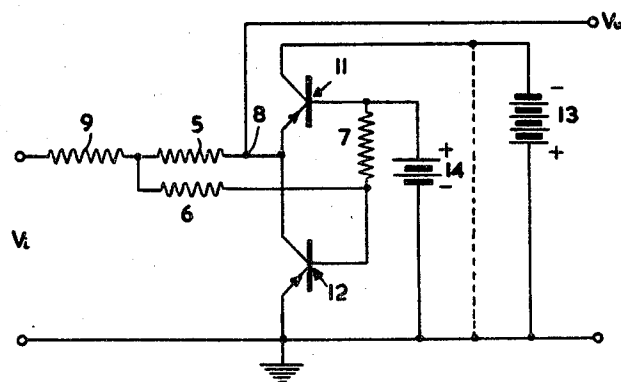


FIG. 2

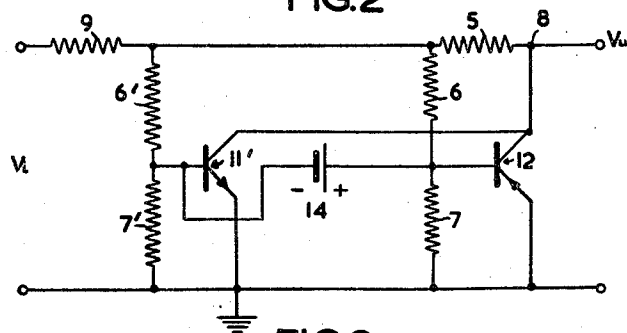


FIG. 3

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1

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The present invention relates to bilateral amplitude limiter circuit arrangements.

It is an object of the invention to provide bilateral amplitude limiters using a single threshold-voltage supply.

According to the invention, the voltage to be limited is supplied through an impedance to a common point of the main current circuits of two electronic amplifier elements, the control electrode of each of these elements being biased by means of the common threshold-voltage supply and the control electrode of at least one element being connected to a tapping point on a voltage divider which is connected between a point of constant potential and the common point of the said main current circuits so that, when the voltage to be limited exceeds a first threshold value at the said common point, the first element becomes conductive, whereas, when the voltage to be limited exceeds a second threshold value in the opposite direction, the second element becomes conductive.

The invention will now be described in detail with reference to the accompanying drawing, in which:

Fig. 1 shows the circuit arrangement of a first embodiment,

Fig. 2 the circuit arrangement of a second embodiment, and

Fig. 3 the circuit arrangement of a third embodiment.

The embodiment shown in Fig. 1 contains two electronic amplifier elements 1 and 2 which in the present case are triodes. These triodes are identical and each has an amplification factor μ of, say, twenty. The anode of the triode 1 is connected to the positive terminal of a supply source 3. Its cathode is connected to the anode of the triode 2, the cathode of which is connected to ground. The control-grid of the triode 1 is negatively biased with respect to ground by means of a threshold-voltage supply 4. A voltage divider comprising three resistors 5, 6 and 7 is connected to the common point 8 of the cathode of the triode 1 and of the anode of the triode 2 and also to the control grid of the triode 1. The input voltage V_i to be limited is applied between ground and one end of a resistor 9, the other end of which is connected to the common point of the resistors 5 and 6. The limited output voltage V_u is derived between ground and the common point 8.

Neglecting the comparatively small resistor 5, when the input voltage V_i assumes a negative value such that the grid-cathode voltage of the triode 1 exceeds its cut-off voltage said triode will become conductive and produce across the resistance 9 a voltage drop of such value that the output voltage V_u remains substantially constant. If, however, the input voltage V_i assumes a positive value such that, due to the voltage division between the resistors 6 and 7, a negative voltage of so low a value is set up at the grid of the tube 2 that the cut-off voltage of this tube is exceeded, the tube 2 begins to pass current with the result that a voltage drop of such value is produced across the resistor 9 that the voltage V_u remains substantially constant. At intermediate values of the input voltage V_i both tubes 1 and 2 remain non-conductive, so that V_u is equal to V_i .

Due to the provision of the resistor 5, V_u is kept slightly smaller than the voltage at the junction of the resistors 5 and 9.

Consequently, the positive voltages can be limited very

2

effectively, since any further increase of the voltage at this junction can be compensated by the voltage drop across the resistor 5. As a result the positive voltages can be limited by the tube 2 substantially as effectively as the negative voltages, limited by the tube 1 which operates with a fixed positive anode voltage.

When it is desired to obtain exactly the same limiting action upon the positive and upon the negative voltages, the anode of the tube 1 must be directly connected to ground, as is indicated in Fig. 1 by a broken line, and the value of R_5 must be made zero.

When the values of the resistors 6 and 7 are about equal, the positive and the negative limiting thresholds are equal to one another, so that symmetrical limiting is obtained.

In the embodiment shown in Fig. 2, the triodes 1 and 2 are replaced by P-N-P transistors 11 and 12, the collector of the first transistor 11 being connected to the negative terminal of a supply source 13 and its base to the positive terminal of a threshold-voltage supply 14. The emitter of the transistor 11 and the collector of the transistor 12 are connected together and to the common point 8 and the emitter of the transistor 12 is connected to ground. The base of the transistor 12 is connected to the junction of the resistors 6 and 7.

As long as the voltage V_i to be limited does not exceed the positive and the negative threshold values, the series-connected emitter-collector circuits of the transistors 11 and 12 pass only a leakage current $I_{10} \approx I_{20}$.

As soon as the potential of the common point 8 exceeds that of the positive terminal of the voltage supply 14, the base-emitter circuit of the transistor 11 passes a small current and, since the collector of this transistor has a negative bias of a few volts with respect to its base, a comparatively large current I_1 flows through its main current circuit (i.e. from its emitter to its collector) and also through the resistor 9 which counteracts a further increase of the voltage V_u at the point 8.

When the potential of the base of the transistor 12 becomes negative, that is to say, when V_i becomes smaller than

$$-V_d \frac{R_6}{R_7}$$

where V_d is the voltage of the supply 14, a small current begins to flow through the base-emitter circuit of the transistor 12. At this instant the collector of this transistor is at a potential substantially equal to the input voltage V_i . Consequently, the transistor 12 begins to pass current and hence produces, across the resistors 9 and eventually 5, a voltage drop such that the voltage V_u does not further increase. Due to the current flowing from the base of the transistor 12 to the common point 8, the potential of this base is however, increased as compared with its value when there is no base current. The resistor 5 can be chosen such that, when limiting occurs, this increase is exactly compensated by the voltage drop $I_2 R_5$. In this event, the limiter has substantially the same effect on positive and on negative voltages. If, in addition, R_6 is equal to R_7 , the absolute values of the positive and of the negative thresholds are identical.

In this embodiment, the collector of the transistor 11 may alternatively be directly connected to ground, as shown by the broken line. Furthermore, this embodiment has the advantage that the threshold values for the output voltage are substantially independent of the properties of the transistors used, since the base-emitter voltage at which a transistor becomes conductive has a very small value which is substantially independent of the collector voltage. Consequently, the use of transistors for the present purpose is much more attractive than the use of tubes.

In the embodiment shown in Fig. 3 the transistor 11 has been replaced by an NPN transistor 11' the base of which is connected to a tapping point on a voltage divider 6'—7' connected between the junction of the resistors 9 and 5 and ground. The bias voltage supply 14 is connected between the base electrodes of the transistors 11' and 12. This supply is a small lightweight battery which can consequently be connected so as to be electrically floating without giving rise to difficulties.

This circuit arrangement provides for both transistors, i.e. not only for the positive but also for the negative input signals, the compensating action which has been described hereinbefore with respect to the embodiments shown in Figures 1 and 2.

The polarization of the base electrodes of the transistors 11' and 12 is determined by the voltage V_d of the threshold-voltage supply 14 and by the values of the resistors 7' and 7, the part of the input voltage V_i applied to the base of the transistor 11' being determined by the voltage divider 6'—7'.

The common impedance 9 and the common resistor 5 may be replaced by a separate impedance and a separate resistor for each of the transistors 11' and 12. The voltage divider of each transistor is, in this event, connected to the common point of the corresponding impedance-resistance combination.

Both in this embodiment and in the embodiments described hereinbefore, the resistor 9 may, if desired, be omitted, whereby a heavier load is imposed upon the signal supply-source and the resistor 5 can be given a slightly higher value.

What is claimed is:

1. A circuit arrangement for bilaterally limiting the amplitude of an input voltage, comprising two amplifier elements each having electrodes defining a main current path and having a control electrode, a voltage source, means for applying said voltage source to the said control electrodes thereby to render the current paths of said elements normally substantially non-conductive, a pair of input terminals, a pair of output terminals, an impedance connected in series between an input terminal and an output terminal, means connecting said main current paths in series with each other, means connecting the main current paths of said elements in parallel with each other in opposite conducting directions across said pair of output terminals, and means connecting said impedance in series circuit arrangement with each of said main current paths across said input terminals, said last-mentioned means including said main current path connecting means, a voltage divider having a pair of end terminals and a tapping point intermediate said end terminals, one end terminal of said voltage divider being connected to a point at constant potential, means connecting at least one of said control electrodes to said tapping point and means connecting the other end terminal of said voltage divider to a point in each said series circuit arrangement intermediate said impedance and said main current path, said last-mentioned means comprising a resistor connected between said other end terminal and a point in said main current path connecting means.

2. A circuit arrangement for bilaterally limiting the amplitude of an input voltage, comprising two amplifier elements each having electrodes defining a main current path and having a control electrode, a voltage source, means for applying said voltage source to the said control electrodes thereby to render the current paths of said elements normally substantially non-conductive, a pair of input terminals, a pair of output terminals, an impedance connected in series between an input terminal and an output terminal, means connecting said main current paths in series with each other, means connecting the main current paths of said elements in parallel with each other in opposite conducting directions across said pair of output terminals, and means connecting said impedance in series circuit arrangement with each of said main current

paths across said input terminals, said last-mentioned means including said main current path connecting means, a voltage divider having a pair of end terminals and a tapping point intermediate said end terminals, one end terminal of said voltage divider being connected to a point at constant potential, means connecting at least one of said control electrodes to said tapping point and means connecting the other end terminal of said voltage divider to a point in each said series circuit arrangement intermediate said impedance and said main current path, said last-mentioned means comprising a resistor included in said impedance and connected between said other end terminal and a point in said main current path connecting means.

3. A circuit arrangement for bilaterally limiting the amplitude of an input voltage, comprising two transistors each having emitter, collector and base electrodes and an emitter-collector path, a voltage source, means for applying said voltage source to the said base electrodes thereby to render the emitter-collector paths of said transistors normally substantially non-conductive, a pair of input terminals, a pair of output terminals, an impedance connected in series between an input terminal and an output terminal, a resistor, means connecting said emitter-collector paths in series with each other, a voltage divider having one end terminal connected to a point in said voltage source applying means between said voltage source and the base electrode of one of said transistors, another end terminal connected through said resistor to a point in said emitter-collector path connecting means and a tapping point intermediate said end terminals directly connected to the base electrode of the other of said transistors, means connecting said impedance to a point in said emitter-collector path connecting means, means connecting the emitter-collector paths of said transistors in parallel with each other in opposite conducting directions across said pair of output terminals, and means connecting said impedance in series circuit arrangement with each of said emitter-collector paths across said input terminals, said last-mentioned means including said emitter-collector path connecting means and said means connecting said impedance to a point in said emitter-collector path connecting means.

4. A circuit arrangement for bilaterally limiting the amplitude of an input voltage, comprising two transistors of opposite conductivity type each having emitter, collector and base electrodes and an emitter-collector path, a voltage source connected between the base electrodes of said transistors, a pair of input terminals, a pair of output terminals, an impedance connected in series between an input terminal and an output terminal, a resistor, means connecting said emitter-collector paths in series with each other, a pair of voltage dividers each having one end terminal connected to a point at constant potential, another end terminal connected through said resistor to a point in said emitter-collector path connecting means and a tapping point intermediate said end terminals directly connected to the base electrode of a corresponding one of said transistors, and means connecting said impedance to a point in said emitter-collector connecting means whereby said impedance is connected in series circuit arrangement with each of said emitter-collector paths across said input terminals and the emitter-collector paths of said transistors are connected in parallel with each other in opposite conducting directions across said pair of output terminals.

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