

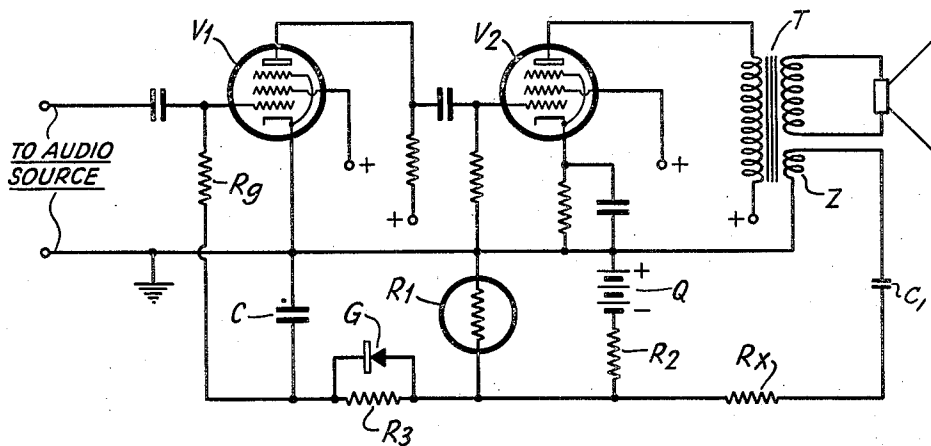
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L. BRÜCK

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AUDIO AMPLIFIER VOLUME CONTROL CIRCUIT

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BY

INVENTOR.
LOTHAR BRÜCK

H. S. Swoyer
ATTORNEY.

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AUDIO AMPLIFIER VOLUME CONTROL
CIRCUIT

Lothar Brück, Berlin, Germany, assignor to Telefunken Gesellschaft für Drahtlose Telegraphie m. b. H., Berlin, Germany, a corporation of Germany

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1 Claim. (Cl. 179—171)

For the purpose of regulation of the volume range of the audio amplifier of a receiver, it is known in the art to convert part of the output alternating potential of the amplifier into a direct current voltage roughly proportional to its amplitude, and to use the resulting direct current voltage to control the amplification of the input tube of the amplifier. In the arrangement known in the art the said direct current voltage is obtained by rectification of the output alternating potential.

According to the present invention the direct current control voltage is taken from one of the two parts of a voltage divider connected with the terminals of a source of direct current voltage supply; one of the parts thereof consisting of a resistance whose value is a function of the load and upon which the output alternating potential is impressed, while the other part consists of a resistance which is practically independent of the load or which is a function of the load in an inverse sense.

The advantage residing in the invention, in contrast with the arrangement known in the art, is that first a rectifier is saved, while, secondly, such non-linear distortions are avoided, or at least minimized, as are due to the coupling of a rectifier circuit with the amplifier output circuit. But the chief merit of the present scheme is that, if constants are judiciously chosen, it is possible to secure a high direct current control potential with a comparatively small amplitude of the alternating potential derived from the output, provided that the voltage of the direct current voltage source (with the terminals of which is connected the resistance which is a function of the load and the resistance which is independent of the load), or inversely a function of the load, and the aggregate load of the said source are chosen sufficiently high.

Fundamentally speaking, the use of load dependent resistances for volume range control is known in the prior art. In a certain circuit of this kind the transmission line of the amplifier itself contains a bridge arrangement consisting of resistors which are a function of the load. However, this circuit has the shortcoming that only a small fraction of the alternating potential impressed upon the bridge can be fed to the other amplifier part which means that there occurs a serious loss of amplification, and further that the load of the tube preceding the bridge is variable. These drawbacks are obviated in the arrangement here disclosed.

Another scheme disclosed in the prior art is to

provide negative feedback for an amplifier and to include in the feedback lead a resistance which is a function of the load so that when the volume rises the negative feedback also increases.

Contradistinct to this known scheme, the present invention offers the advantage that such difficulties as are inherent in negative feedback, particularly when the degeneration concerns several stages, are avoided. As a matter of fact, the present dynamic-volume control may be extended to include quite a number of stages without any difficulties to speak of. Indeed, it is even feasible in a receiver to insure volume range control from the output end of the receiver upon the radio frequency amplifier, or the intermediate frequency amplifier.

An embodiment of the invention is illustrated in the appended drawing which shows the circuit diagram of a two-stage resistance-coupled audio amplifier. The output transformer T included in the plate circuit of the power, or end, tube V₂ contains an additional secondary winding Z. One end of this winding is connected with the grounded return, while the other end is connected through a direct current blocking condenser C₁ with the ungrounded end of a uranium-dioxide resistance R₁. In parallel relation to resistance R₁ is the series arrangement of a source of direct current voltage supply Q and a resistance R₂. The potential of the said source of voltage Q, whose positive pole is connected with the grounded return, is, therefore, divided between the resistance R₂ and resistance R₁ in accordance with their resistance ratio. If R₂ is high in contrast to R₁, then voltage across R₁ is proportional to the prevailing value of resistance R₁.

Now, the resistance R₁ is regulated by the additional load consisting of the alternating potential which is applied by way of Z. The negative direct current voltage taken off by way of the filter mesh R₃, C, whereby it is rid of the alternating component superposed thereon, is, as a result, an approximately linear function of the volume of the amplifier. This direct current voltage is impressed, by way of the grid leak R_g, upon the control grid of the input tube V₁ the cathode of which is grounded. Tube V₁ is of the pentode type, and its plate current-control grid voltage characteristic is exponential so that the amplification of this tube is variable within wide limits of variation of grid potential. Care must be taken in this connection that the grid alternating potential to be amplified will swing the grid only within very slightly curved portions of the characteristic. But if non-linear distortions

are to be avoided entirely, it will be found more expedient to use a hexode in lieu of a pentode, and to provide the first control grid, which is fed with the alternating potential to be amplified, with a straight characteristic, whereas the control, or regulator, potential is impressed upon the second control grid.

In the presence of greater volume, the resistance value of the uranium-dioxide resistance R_1 and thus the negative grid biasing potential of the tube V_1 will be lower and the amplification higher. In other words, an expansion effect is realized. The time constant with which the amplification control proceeds, on the one hand, is a function of the time constant of the temperature rise or temperature decrease of the uranium-dioxide resistance and, on the other hand, it is a function of the filter circuit R_3, C . It is desirable to choose the time constant of R_1 so high that the resistance variation will no longer be able to follow even the lowest audio frequency to be handled.

If conditions are to be made so that the regulation time constant, that is, the time constant with which the amplification rises with increase of volume, is small in contrast with the time constant with which the amplification declines again as the volume decreases, this is attainable, on the one hand, by choosing suitable values for R_1 and, on the other hand, by connecting in parallel relation to R_3 a rectifier G of suitable polarity; say a cuprous-oxide rectifier. The negative regulator potential will then have a chance to become discharged fairly speedily through the rectifier, while it will be able to be built up substantially more slowly.

If the filter circuit R_3, C , is entirely omitted, then, apart from volume control, there will arise a negative feedback (if the output transformer be of proper polarity) and this may occasionally be desirable. If, moreover, a resistance R_x is included in the return lead, then the negative feedback, in the presence of small amplitudes, will be more marked than for large amplitudes. The negative feedback thus boosts the volume range

regulation. If desired, resistance R_x could also be of the type dependent upon the load.

If in the circuit shown in the drawing, in lieu of the uranium-dioxide resistance whose resistance value diminishes with increase of the load, there is used, a glow lamp whose resistance value rises with increase of the load, then a volume or dynamic compression results rather than a dynamic expansion. However, it is feasible to obtain a dynamic expansion also with a glow lamp if resistance R_1 is made ohmic and if R_2 is a glow lamp. In order that in this case a linear relationship may be secured between regulator potential and volume it will be necessary to make the resistance value R_2 , that is the resistance of the glow lamp, of an average value that is high compared with R_1 . It is, also, possible to use a uranium-dioxide resistance for R_1 and a glow lamp for R_2 . The regulation gradient will then turn out to be particularly great.

What is claimed is:

In an audio amplifier circuit comprising a tube having input and output electrodes, an audio output circuit coupled to the output electrodes, an audio volume expansion circuit coupled between said output circuit and said tube input electrodes, said control circuit comprising a coil coupled to the output circuit, a source of direct current in series with a resistor of predetermined value across said coil, a temperature-dependent uranium-dioxide resistive element in shunt across said series arranged current source and resistor, said resistive element being connected between said tube input electrodes in a manner to apply voltage developed thereacross to said input electrodes in a sense to vary the amplifier gain directly with audio signal level at said audio output circuit, a time constant network in circuit between said input electrodes and said resistive element, and a rectifier element connected across a resistive element of said time constant network between one of said input electrodes and a terminal of said resistive element to cause speedy discharge of said developed voltage.

LOTHAR BRÜCK.