May 27, 1941. L. BRÜCK 2,243,412

VOLUME CONTROL

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Fig. 1

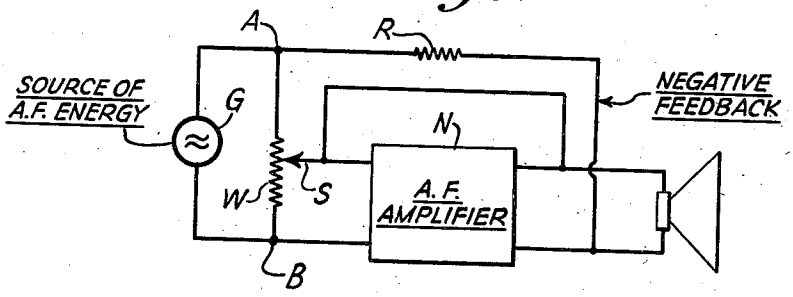


Fig. 2

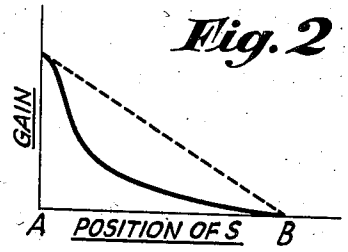
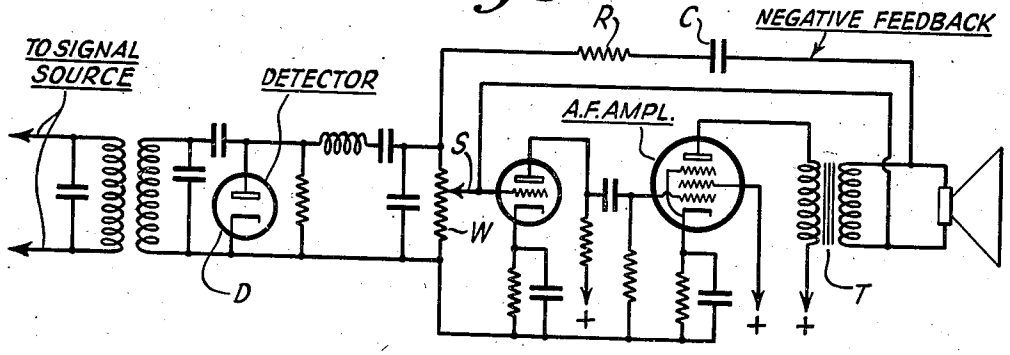


Fig. 3



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VOLUME CONTROL

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9 Claims. (Cl. 179—171)

There has been proposed in the past a receiver which includes manual volume control means and reverse feedback in which the volume, or gain, control and the regulation of the degree of reverse feedback, or anti-regeneration, are so inter-locked that the effect of the reverse feedback, in the position of maximum gain, is less than in the positions where the gain is lower. This inter-dependence, or interlocked relation was insured by impressing the audio voltage supplied from a generator with low internal resistance upon a series network comprising a fixed resistor and a voltage divider serving for volume control. The reverse feedback potential was applied to the said fixed resistance, while the regulated audio potential was taken from the series path comprising the reverse feedback resistance and the portion of the voltage divider adjacent thereto. In this arrangement, as shall be explained more fully further below, the load of the generator is increased by the reverse feedback.

According to the present invention, which is an improvement upon the above arrangement, the outer terminals of a voltage divider are impressed with the audio voltage, while the potential is taken off therefrom across one of the said outer terminals and the slide contact, or wiper, the voltage serving for the reverse coupling being impressed by way of a resistance across the other outer terminal and the shiftable contact, or slide, in such a sense that the potential thus taken off is diminished.

The advantage of the present invention is that by the reverse feedback the apparent load resistance represented by the voltage divider with the reverse feedback voltage is raised rather than reduced, as is true of the prior circuit. This means that the load of the voltage source to which the voltage divider is connected is made less by virtue of the reverse feedback. This will be desirable not only in the case where the voltage source consists of an amplifier tube (since a reduction of the external resistance would mean more marked non-linear distortion), but also in cases where the voltage source consists of the signal diode of the receiver.

In the drawing:

Fig. 1 shows a general embodiment of the invention,

Fig. 2 graphically shows the operation of the invention,

Fig. 3 illustrates a receiver employing the invention.

The audio voltage derived from the audio source G, which may have a certain internal resistance, is impressed upon the terminals A and B of the ohmic voltage divider W. Between the terminal B and the slide contact, or wiper, S is taken off the controlled potential, and thus impressed upon the audio amplifier N. The output alternating potential of the amplifier is applied by way of the ohmic resistance R across the terminal A and the slide contact S. The phase of the alternating potential must be so fixed that the potential prevailing between points A and S will be increased by the feedback voltage. As a result this causes at the same time a reduction of the potential prevailing across points B and S; in other words, there occurs negative regeneration.

If the internal resistance of the voltage source G were equal to zero so that the voltage across the points A and B would not be a function of the load, then the voltage across points B and S would diminish amounts equal to the increase of potential between points A and S. However, since in reality the voltage source G has an appreciable internal resistance (which, if desired, could be raised still further by adding resistance), it will be seen that the decrease of potential across B and S will not be of the same value as the increase of voltage between A and S. This means that the voltage between points A and B increases somewhat. The fall of potential across the internal resistance of the voltage source and the amount of the current that is taken are reduced; in other words, the active load resistance is raised by the reverse feedback and the load diminished. In the prior circuit arrangement referred to above, on the contrary, the alternating potential acting across part of the load resistance is directly diminished by the reverse feedback, and as a consequence the entire voltage across the voltage divider is reduced. This meant that more current was taken, and that thus the load of the generator was greater. As pointed out above, this is undesirable in many cases and is, in fact, avoided by the present invention.

If the slide contact happens to be in the vicinity of the terminal A, then the reverse feedback potential is practically short-circuited. In other words in the position corresponding to maximum gain, reverse feedback action is absent so that, when a very feeble station signal is coming in, it is possible to fully utilize the gain of the audio amplifier. If, now, the slide contact is moved away from terminal A in the direction towards terminal B, the reverse coupling will increase simultaneously with decrease in gain. The

transmitter stations whose signals come in very strong, and for which the shiftable tap S would be positioned about midway of the voltage divider W, would be received with greater reverse feedback and thus greatly reduce distortion.

In the neighborhood of terminal B, that is to say where the volume is very low, the effect of the reverse feedback becomes again less, for in that case the reverse feedback is applied predominantly to the internal resistance of the voltage source G, while the output voltage decreases also. Fig. 2 illustrates the dependence of the gain upon the position of the slide contact S. The dash-line curve shows the gain, assuming a linear voltage divider, in the absence of reverse feedback; while the solid line curve shows the gain in the presence of the reverse feedback.

It will be noticed that the two curves coincide in the presence of large amplification, and, also, when the gain is low they come together, for then the reverse feedback is low. In the median position of the slide contact, the reverse feedback is very high and the gain is markedly reduced. In other words as the tap S is shifted from A towards terminal B, the gain initially diminishes very markedly from maximum; in its further course, it changes only to a smaller extent. In this manner, even with a linear voltage divider, an amplifying control curve which is roughly of logarithmic shape is obtained.

Fig. 3 shows the invention as applied to a two stage audio amplifier in a receiver apparatus. The voltage divider W is here connected for alternating current in parallel relationship to the load resistance of the signal diode detector D. The reverse feedback potential is taken off from the secondary end of the output transformer T and impressed by way of the condenser C and the resistance R across the upper terminal of the voltage divider resistance W and the tap S. The condenser C is so chosen that the reverse feedback will be diminished for the lower frequencies. The capacity to ground of the secondary winding, moreover, reduces the reverse feedback for the high audio frequencies, with the result that the reverse feedback is substantially active only for the medium frequencies, so that at the same time there results an equalization or a correction of distortion of the frequency characteristic. Upon shifting the slide contact from the upper end of resistance W to about the midway position where the reverse feedback is of maximum value, it is possible to secure a physiological sound volume control inasmuch as, in the presence of lower volume of sound, the high and the low notes will become more conspicuous in relation to the median tonal frequencies.

What is claimed is:

1. In combination with a source of audio voltage, a resistor shunted thereacross, an audio utilization network having input terminals and output terminals, one of the input terminals being at the same potential as one end of said resistor, the other input terminal including a slidable tap connection to said resistor functioning as a manual volume control device, and a negative feedback circuit connected between the network output terminals and terminals comprising the opposite end of the resistor and said tap.

2. In combination with an audio amplifier having input and output terminals, an audio current source, a resistor across the said source, said resistor having a slidable tap functioning as a manual volume control device, said input terminals being connected between a point on said resistor and said tap, and a negative feedback path connnected between said output terminals and said tap and a point on said resistor which is at a higher potential than any point to which the tap can be adjusted.

3. In combination with a source of alternating current voltage, a load resistor connected in shunt across said source, a voltage utilization network having a pair of input terminals and a pair of output terminals, one of said input terminals being established at the same alternating potential as one end of said resistor, the second input terminal comprising an element adapted to be adjusted to vary the effective magnitude of said resistor included between said input terminals, and a degenerative alternating voltage feedback circuit connected from said output terminals to said adjustable element and the opposite end of said resistor whereby the feedback voltage is impressed solely between said opposite end and said adjustable element.

4. In combination with a source of alternating current voltage whose internal resistance has a relatively small value, a load resistor connected in shunt across said source, a voltage utilization network comprising at least one tube having a pair of input terminals and a pair of output terminals, one of said input terminals being established at the same alternating potential as one end of said resistor, the second input terminal comprising an element adapted to be adjusted to vary the effective magnitude of said resistor included between said input terminals, and a degenerative alternating voltage feedback circuit connected from said output terminals to said adjustable element and the opposite end of said resistor whereby the feedback voltage is impressed solely between said opposite end and said adjustable element.

5. In combination with a source of alternating current voltage, a load resistor connected in shunt across said source, a voltage utilization network having a pair of input terminals and a pair of output terminals, one of said input terminals being established at the same alternating potential as one end of said resistor, the second input terminal comprising an element adapted to be adjusted to vary the effective magnitude of said resistor included between said input terminals, a degenerative alternating voltage feedback circuit connected from said output terminals to said adjustable element and the opposite end of said resistor whereby the feedback voltage is impressed solely between said opposite end and said adjustable element, said voltage of said source including a range of frequencies, and said feedback path having at least one reactive element for rendering the path frequency discriminatory.

6. In combination with a source of audio voltage, a resistor shunted thereacross, an audio utilization network having input terminals and output terminals, one of the input terminals being at the same potential as one end of said resistor, the other input terminal including a slidable tap connection to said resistor functioning as a manual volume control device, and a negative feedback circuit connected between the network output terminals and terminals comprising the opposite end of the resistor and said tap, said feedback circuit including at least one reactive element for rendering the feedback of a portion of the audio frequencies relatively inefficient.

7. In combination with an audio amplifier having input and output terminals, an audio

current source, a resistor across the said source, said resistor having a slidable tap functioning as a manual volume control device, said input terminals being connected between a point on said resistor and said tap, and a negative feedback path connected between said output terminals and said tap and a point on said resistor which is at a higher potential than any point to which the tap can be adjusted, said feedback path including means for rendering the feedback of median audio frequencies most efficient.

8. In a system of the type including a source of audio voltage having a low internal resistance, a manual volume control device comprising a resistor shunted across said source and an adjustable contact element slidable along the resistor, a transmission network for utilizing the audio voltage, the improvement which is characterized by said network having a pair of input terminals, one of the terminals being connected to one end of said resistor, the second terminal being connected to said contact element, and a degenerative feedback circuit having input terminals connected to said network for deriving therefrom voltage transmitted therethrough, said feedback circuit having output terminals for impressing feedback voltage solely between said contact element and the opposite end of said resistor whereby the impedance of said resistor is increased and the load of said source is substantially reduced.

9. In a system of the type including a source of audio voltage having a low internal resistance, a manual volume control device comprising a resistor shunted across said source and an adjustable contact element slidable along the resistor, a transmission network for utilizing the audio voltage, the improvement which is characterized by said network having a pair of input terminals, one of the terminals being connected to one end of said resistor, the second terminal being connected to said contact element, and a degenerative feedback circuit having input terminals connected to said network for deriving therefrom voltage transmitted therethrough, said feedback circuit having output terminals for impressing feedback voltage solely between said contact element and the opposite end of said resistor whereby substantially reducing the load of said source, said feedback circuit including reactive means whereby it is frequency discriminatory.

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