June 2, 1936. W. VAN B. ROBERTS 2,042,966

AUDIO FREQUENCY AMPLIFIER

Filed April 2, 1931

Fig. 2

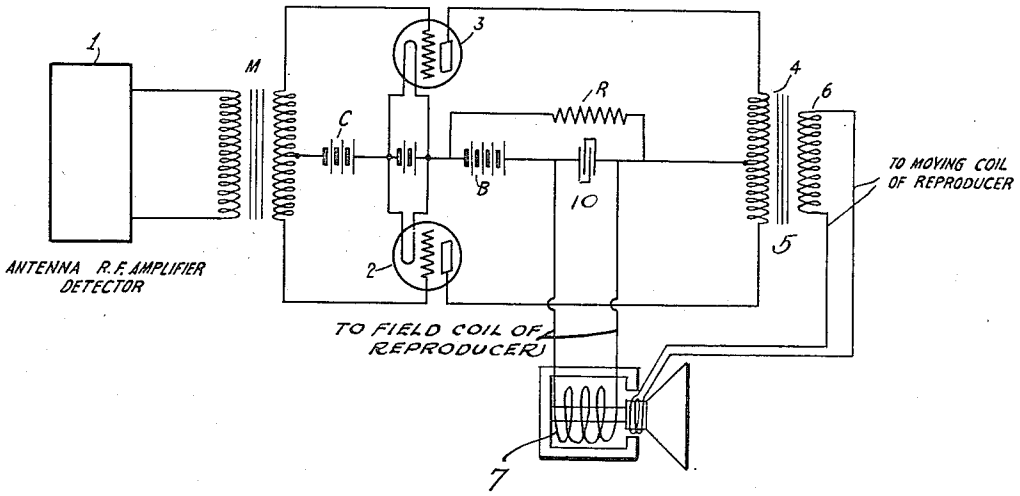
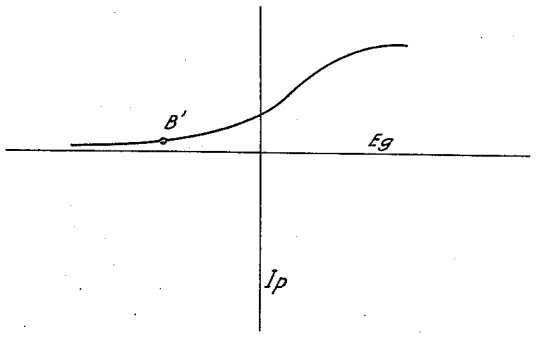


Fig. 1



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AUDIO FREQUENCY AMPLIFIER

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20 Claims. (Cl. 179—115.5)

My present invention relates to audio frequency amplification systems, and more particularly to a novel method of, and means for, amplifying audio frequency impulses in such a manner as to improve the contrast between weak and strong signals.

It is a well known fact that the broadcasting of modulated radio frequency energy, and particularly in connection with music broadcasting, is attended by restrictions with respect to modulation of carrier energy. Those skilled in the art of radio frequency broadcasting are aware that the amplitude ratio between strong and weak signals cannot be permitted to be as great as the ratio between amplitudes in the original intelligence which was broadcasted.

For example, in present radio reception of broadcast music, the contrast between weak and strong passages in an orchestral rendition emanating from an auditorium is not as marked to the ear of the radio receiver audience as it is to the ears of the audience in the auditorium. This results by virtue of the fact that broadcasting practice requires the ratio between weak and strong signals to be limited to the order of magnitude of 1:100 in order that the weaker signals be not masked by background noises produced by the constant strength carrier wave.

It will, therefore, be appreciated that it would be highly desirable to reproduce musical passages, particularly at a radio receiver, in such a manner that the contrast between weak and strong passages be in greater accordance with the original selection.

Now, I have discovered a novel and improved method of, and devised a simple means for, securing the aforementioned result. This method consists in distorting the over-all amplification of audio frequency by making the field strength of the moving coil type reproducer depend upon the average audio signal intensity in such manner that with weak signals the field is weak and vice versa.

It can, therefore, be pointed out that it is one of the main objects of my present invention to provide an audio frequency amplifier whose average output current energizes, wholly or in part, the speaker field, and varies with average input strength whereby there is secured the particular advantage of increasing, to an appreciable extent, the contrast between weak and strong broadcast intelligence, especially music, without altering the ratio of weak signals, as music, to residual hum, or other noises.

Another important object of the present invention is to provide a push-pull audio frequency amplifier employing a grid biasing arrangement sufficient to reduce output current to a small value in the absence of input signals whereby there is secured an amplifier whose average anode current varies with average strength of input, there being secured as a particular advantage of this arrangement, in the case of reproduction of music modulated audio frequency impulses, a marked contrast between weak and strong music passages.

Still other objects of the present invention are to improve generally the simplicity and efficiency of audio frequency amplifiers, and to particularly provide a push pull audio frequency amplifier which is not only reliable in operation, but economically arranged to produce the desired objects of the invention.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically one arrangement whereby my invention may be carried into effect.

In the drawing,

Fig. 1 is a graphic representation of a characteristic of the present invention,

Fig. 2 diagrammatically shows a circuit arrangement embodying the invention.

Referring to the accompanying drawing there is shown a stage of push-pull audio frequency amplification whose input is coupled by means of an audio frequency transformer M to a source I of audio frequency impulses to be amplified. While this source, in Fig. 2, is denoted as comprising a conventional arrangement consisting of an antenna, a radio frequency amplifier and a detector, it is to be clearly understood that the amplifier arrangement, to be more specifically hereinafter described, can be applied to any source of audio frequency impulses, and is not confined to use in a receiver of broadcast signals, since the amplifier can readily be employed, for example, in connection with a phonograph pick-up, and even the sound circuit of a talking moving picture apparatus. The audio frequency amplifier comprises a pair of electron discharge tubes 2, 3 having their input and output circuits connected in the well known push-pull manner.

A source B supplies potential for the anodes of the two tubes, while a source C provides bias for the control electrodes of the latter. A fixed capacity 10 is connected between the positive terminal of the source B and the mid-point of the primary 4 of the output transformer 5. The purpose of the fixed capacity will be described more fully hereinafter. The secondary 6 of the output transformer may be coupled in well known manner to the moving coil of an electrodynamic reproducer, the field coil 7 of the latter being shunted across the terminals of the capacity C. Of course, the invention is not limited to use with a reproducer of the moving coil type, but may also be employed in connection with other types of reproducers well known to those skilled in the art.

The push-pull amplifier shown is of the so-called class B type. That is to say, the source C is designed to bias the grids of the tubes 2 and 3 so that the amplifier operates at the point B on its I_p—E_g characteristic. That is, the bias on the grids of the tubes 2 and 3 which is substantially

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times the value of the plate potential from the source B, is sufficient to reduce the plate current in the output circuit to a relatively small value in the absence of input signals. When the source B, is sufficient to reduce the plate current also increases, as is shown by the characteristic Fig. 1. Thus the average plate current increases or decreases as the strength of the signal input increases or decreases.

The capacity 10 is so chosen that the field strength of the reproducer field coil 7 varies with average signal input, the capacity being sufficiently large to prevent the field strength from varying with individual cycles of input voltage, but sufficiently small whereby after a change of average signal input, the field changes within a short time, to wit: of the order of one second, more or less. To secure a constant minimum value of field strength, even in the absence of input, various simple expedients can be utilized. For example, a constantly excited auxiliary winding may be employed. Alternatively, a resistance R can be interposed between the negative terminal of the source B and the junction of coil 7 and coil 4. The auxiliary energizing circuit will be from the positive terminal of source B through winding 7 and resistance R to the negative terminal of source B.

The winding of the field coil 7 is so chosen as to produce a maximum field strength for the strongest signal input the tubes can handle without distortion. At this condition the reproducer will operate most efficiently and reproduce sound with greatest fidelity. As the signal strength decreases (the audible signal as distinguished from the carrier wave which is not present in the audio amplifier) the reproducer field strength decreases and the reproducer operates with less efficiency thus reproducing the weak or faint notes even fainter than they are transmitted.

It is believed that those skilled in the art will now readily understand the operation of the present invention. It is especially pointed out that when amplifying music modulated audio frequency impulses, the present arrangement permits increasing, to an appreciable extent, the contrast between weak and strong musical passages, this being particularly accomplished without changing the ratio of weak music to residual hum, or other, noises.

It should readily be seen from Fig. 1 that with weak signal input there is a very much smaller average output current than is the case when the amplifier has impressed upon its input circuit strong signals. It will, also, be seen that generically considered the present invention permits the expansion of the over-all amplification range for strong audio frequency impulses without affecting in any way the operation of the transmission agency or medium.

While I have indicated and described one arrangement for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. An audio frequency amplifier arrangement comprising a pair of electron discharge tubes having their input and output circuits connected in push pull, means for biasing the grids of the tubes so that average output current varies with average strength of input, a sound reproducer having its entire field coil conductively connected in the amplifier output circuit, and a reproducer moving coil connected to be energized from the output of said amplifier.

2. An audio frequency amplifier arrangement comprising a pair of electron discharge tubes having their input and output circuits connected in push pull, means for biasing the grids of the tubes so that average output current varies with average strength of input, a source of anode potential in the output circuit of said amplifier tubes, a capacity connected between the positive terminal of said source and the anodes of said tubes, a sound reproducer having its entire field coil in shunt with said capacity, and a reproducer moving coil engergized from said output circuits.

3. An audio frequency amplifier arrangement comprising a pair of electron discharge tubes having their input and output circuits connected in push pull, means for biasing the grids of the tube so that average output current varies with average strength of input, a source of anode potential in the output circuit of said amplifier tubes, a capacity connected between the positive terminal of said source and the anodes of said tubes, a sound reproducer having its entire field coil in shunt with said capacity, a resistor connected in shunt with said source and capacity, and a reproducer moving coil energized from said output circuits.

4. The method of reproducing sound by means of an acoustic device of the type having a moving coil a diaphragm connected thereto and an energizing field coil passing a unidirectional current which consists in controlling the unidirectional current energy supplied to the energizing field in such a manner that less energy is supplied to the field coil when a series of low intensity notes are to be reproduced than when a series of high intensity notes are to be reproduced.

5. The method of reproducing signals by means of a loudspeaker of the type to which energy is supplied to maintain the device in operative condition and to which other energy is supplied to operate the device which consists in supplying energy in the form of signal variations to operate the device, and in supplying other unidirectional energy which varies with the average

signal intensity to maintain the device in operative condition.

6. The method of reproducing sound by means of an acoustic device having a movable diaphragm and of the type to which energy is supplied to maintain the device in operative condition and to which other energy is supplied to operate the diaphragm which consists in supplying more unidirectional energy when the average signal strength is intense and less unidirectional energy when the average signal strength is feeble to maintain the device in operative condition, and in supplying other energy which varies in accordance with the signal to operate the diaphragm.

7. The method of reproducing sound from an audio frequency signal which consists of producing uni-directional electric current from a signal, smoothing said uni-directional current so that it varies as the average signal strength varies, and supplying the varying current to acoustic apparatus having a movable diaphragm to control the intensity of the sound reproduced.

8. Apparatus for reproducing sound comprising an acoustic device of the type to which energy is supplied to maintain the device in operative condition and to which other energy is supplied to operate the device, means for supplying energy to operate the device in accordance with the signal to be reproduced, and means for supplying energy whose average unidirectional component value varies according to the average intensity of the signal to maintain the device in operative condition.

9. Apparatus for the reproduction of sound comprising an acoustic device of the type having a moving coil and an energizing field coil, means for supplying energy variations corresponding to the signal to be reproduced to the moving coil, and means for supplying unidirectional energy varying according to the average intensity of the signal to be reproduced to the energizing field coil.

10. Apparatus for the reproduction of sound comprising an audio frequency amplifier, an acoustic device of the type adapted to be supplied with energy to maintain the device in operative condition and other energy to cause the device to operate, means for supplying energy to said acoustic device from the output of said amplifier to operate said device, and means for supplying another energy whose unidirectional component varies according to the average intensity of the signal being amplified to said acoustic device from said amplifier to maintain said device in operative condition.

11. Apparatus for the reproduction of sound comprising an amplifier, an acoustic device having a moving coil and an energizing field coil, means for supplying energy from the output of said amplifier to the moving coil, and means conductively connected to said amplifier and said field coil for supplying energy which varies according to the average intensity of the signal strength from the amplifier to the field coil.

12. Apparatus for the reproduction of sound comprising a push-pull amplifier, an acoustic device of the type having a moving coil and an energizing field coil, means for supplying energy from the output of said amplifier to said moving coil, a condenser connected in the common plate lead of said push-pull amplifier and connections from opposite sides of said condenser to said field coil to supply unidirectional current which varies according to the average signal strength to said field coil.

13. An audio frequency amplifier arrangement comprising a pair of electron discharge tubes having their input and output circuits connected in push-pull, means for biasing the grids of the tubes so that the average output current varies with average strength of input, means for obtaining an output from said output circuits in the form of amplified signal variations, and means including an inductor and a condenser conductively connected together for obtaining other energy variations from said output circuits in the form of variations corresponding to the average intensity of the signal input.

14. The method of reproducing sound by means of an acoustic device of the type having a diaphragm actuated by a moving coil and a field winding for producing a magnetic field in which said coil moves, which consists in supplying the signal to be reproduced to the moving coil and in varying the energy supplied to the field winding according to the average intensity of the signal.

15. The method of reproducing sound by means of an acoustic device of the type having a diaphragm actuated by a moving coil and a single field winding for producing the entire magnetic field in which said voice coil moves, which consists in applying the signal to be reproduced to the moving coil and in applying to the field winding uni-directional current which varies directly as the average intensity of the signal.

16. A sound reproducing system comprising a means responsive to sound energy adapted to translate said sound energy into electrical energy, means for amplifying said electrical energy, a sound reproducer having an armature coil and a field coil and means energizing said armature coil in accordance with the instantaneous value of said electrical energy and means energizing said field coil in accordance with the average value of said electrical energy over a definite time interval.

17. In a sound translating system, means responsive to sound energy, an amplifier fed thereby, a translating device fed by said amplifier, means to actuate said device in accordance with the instantaneous value of said amplified energy and means to modify the actuation thereof in accordance with an average value of said energy.

18. In a sound translating system, a first transducer, a second transducer having an armature winding and a field winding, means for energizing said armature winding according to the instantaneous value of the energy from said first transducer, and means for energizing said field winding according to an average value of the energy from said first transducer.

19. In combination, a first translating device, a second translating device fed thereby, and a field winding on said second device energized according to a moving average of the energy from said first translating device.

20. In combination, a first translating device, an amplifier fed thereby, a second translating device having an armature winding fed by said amplifier, and a field winding fed by energy under the control of said amplifier.

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