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VALVE AMPLIFYING CIRCUIT

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Fig. 1.

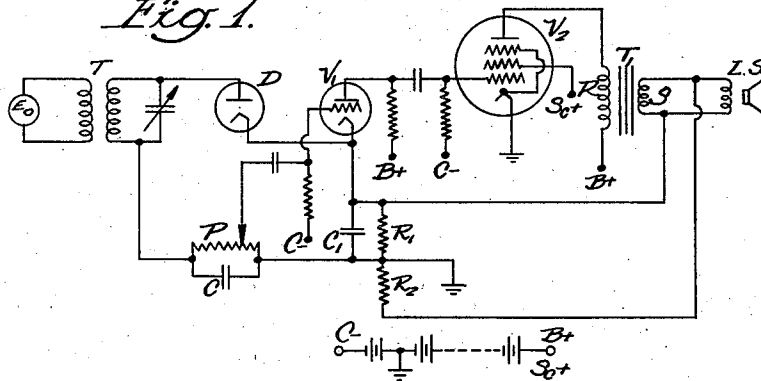


Fig. 2.

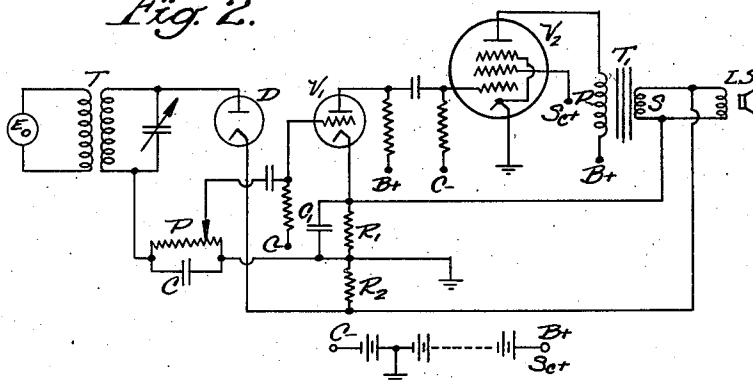
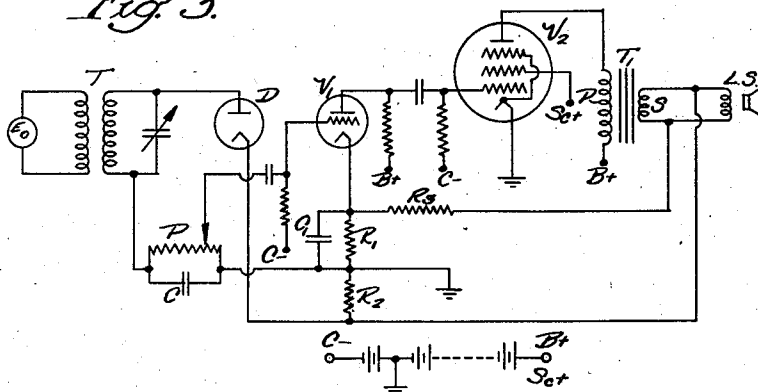


Fig. 3.



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VALVE AMPLIFYING CIRCUIT

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This invention relates to a combined detector and audio amplifier system employing a feed-back connection from the output circuit of the audio system to the input circuit thereof and also to the detector circuit, whereby distortion of the system may be minimized and certain other advantageous features may be obtained, as set forth hereinafter.

Generally speaking, the invention is adapted for use in the detector and audio amplifier circuits of any system in which intelligence is transmitted by the use of a modulated carrier signal, such as a radio receiver. The principal object of the invention is to provide means for minimizing distortion in the output system and means for improving the performance of the detector circuit by which the carrier signal is demodulated.

The invention further provides other advantageous features, including a low impedance source of feed-back signal and means for obtaining a simple frequency or tone control by which the frequency characteristic or response of the system may be modified.

The mode of operation of the circuit may be understood by reference to the accompanying drawing illustrating the application of the invention to a system including a diode detector, an audio amplifier, and a loudspeaker, in which a degenerative feed back is utilized in the audio amplifier part of the system.

In the drawing:

Fig. 1 illustrates an embodiment in which the detector is regenerative;

Fig. 2 illustrates a modification in which the detector is degenerative; and

Fig. 3 illustrates a further modification.

Referring generally to the several figures of the drawing, it will be seen that there is shown a source of signal E_0 which might be modulated carrier signal source, a tuned transformer T for supplying this signal to a diode D, an audio load impedance P—C for supplying the rectified or modulation signal to an amplifier tube V_1 , which in turn supplies the amplified signal to a power amplifier tube V_2 , which energizes a suitable utilization means, such as the loudspeaker LS, through the output transformer T_1 , whose primary P is connected to the output circuit of tube V_2 and whose secondary S is connected to the loudspeaker. A signal obtained from the secondary of the output transformer is fed back to resistances R_1 and R_2 and serves to build up voltages E_1 and E_2 across these respective resistances.

Considering the system generally, the impedances of the vacuum tubes and their associated

load circuits will be of the order of magnitude of thousands of ohms, whereas the impedance of the loudspeaker itself may be a few ohms. Thus, the resistances R_1 and R_2 may be of the order of several hundred ohms without placing an appreciable load upon the output of the circuit and yet they may constitute a signal source whose impedance is negligible as compared with other impedances in the circuit of the diode and the first audio amplifier. It will be noted that the sum of the signals E_1 and E_2 will equal the signal across the input circuit of the loudspeaker and will include any distortion signals which may have occurred anywhere within the circuit. It will be apparent that the derivation of the feed-back signal from the output circuit of the audio system is an important feature of the invention.

The amplifier tube V_1 may be supplied with an audio signal obtained from a portion of the diode leak P and its associated condenser C. It will be understood, of course, that the audio load P—C is illustrated in simple form and may, if desired, include the more complicated resistance capacitance filters and volume controls usually employed in a detector circuit. The signal supplied to V_1 will then comprise the portion of the signal across the potentiometer P plus the signal E_1 fed back from the output circuit. The polarity of the signals should be such that the signal E_1 tends to decrease the total signal between the grid and cathode of tube V_1 . When this condition obtains, that portion of the amplifier including tubes V_1 , V_2 and the transformer T, is degeneratively connected, with a resulting decrease in the amount of distortion transmitted to the output circuit. Considering a specific example, if the circuit is degenerated to the extent that twice as much signal must be supplied across the diode leak with degeneration, as that which must be supplied across the same leak without degeneration in order to obtain the same output, then the distortion incurred in the audio amplifier will be reduced to one half that in the latter case.

If desired, the amount of signal fed back to V_1 may be caused to vary with frequency, thus causing a variation in the frequency response of the circuit as a whole. For example, if the resistance R_1 is shunted by a condenser C_1 , whose impedance at higher audio frequencies is comparable with or less than that of R_1 , then the signal E_1 will decrease with increasing frequency, since the impedance across which E_1 is obtained decreases with frequency, while the impedance R_2 does not change. Thus, the use of a condenser in this position will cause the amount of signal

fed back to decrease with increasing frequency, which in turn will reduce the amount of degeneration with increasing frequency, and thus cause the amplifier to have a rising frequency characteristic. On the other hand, if the condenser C_1 were in shunt with the resistance R_2 and the other connections remained the same, then the reverse would be true and the amplifier would have a frequency response curve which would fall off at higher frequencies.

It will be noted that in Fig. 1 the cathode of the diode is connected to the cathode of the first audio amplifier tube V_1 and hence the feed-back voltage E_1 is included in the diode circuit. It appears that the amplitude of E_1 is substantially determined by the amount of signal supplied to V_1 and if E_0 remains constant, as would be the case for a receiver having automatic volume control, then for low output volume levels when only a small portion of the total signal across the diode leak is supplied to an audio amplifier, the amount of signal reinserted in the diode circuit would be quite small as compared with that built up across the leak. On the other hand, if the volume control were adjusted so that the full signal across the leak is supplied to the input circuit of V_1 , then the voltage E_1 would be of a magnitude comparable with that across the leak, although it could never be greater than the latter voltage. In some cases, it may be desirable that the voltage fed back to the diode circuit be constant with respect to the signal across the diode leak, and in this instance, the potentiometer may be replaced by a fixed resistance. Consideration of the actual voltages in the circuit shows that when the diode anode is positive with respect to its cathode and the diode is drawing current and energy from the system, the reinserted signal is such as to increase the voltage between the diode anode and cathode on modulation peaks, whereas it will decrease the voltage amplitude between the diode anode and cathode on modulation valleys. In other words, this signal effectively tends to increase the effective degree of modulation of the signal and for that reason tends to reduce the detector distortion on signals where the modulation level is low. Generally speaking, where the average modulation level is low, it is desirable and usual to supply more of the detected signal to the amplifier in order to obtain the desired output signal. Consequently, a relatively large signal will be inserted in the diode circuit and the desired minimization of detector distortion will obtain. On the other hand, where the percentage modulation is high, it is generally desirable to reduce the amount of signal supplied to the audio amplifier, and hence the amount of signal inserted in the diode circuit will be small and will have a negligible effect, as far as overloading the diode is concerned. Thus, where it is desirable to increase the effective degree of modulation of the incoming signal, the detector may be made regenerative by the circuit shown in Fig. 1.

The circuit of Fig. 2 is generally similar to that of Fig. 1 except that the cathode of the diode D in Fig. 2 is connected to resistance R_2 instead of R_1 . In this instance, therefore, the signal inserted in the detector circuit will be of opposite polarity as compared with that inserted in the input circuit of the amplifier V_1 . Under these conditions, both the detector and the amplifier will be degenerated. The reduction of distortion within the audio amplifier itself will occur as before and the same variation in frequency response may be

had. In this case, however, in the detector circuit the connections are such that considering only the time intervals during which the diode anode is positive as compared with its cathode, on modulation peaks the reinserted signal will tend to make the anode less positive with respect to its cathode, whereas on modulation valleys the circuit will tend to make the diode anode more positive with respect to its cathode. Thus, this circuit is particularly suited for use in special circuits, for example, those of the type in which a signal has its volume range compressed and later expanded to enable the transmission of a greater volume range. Since the circuit of Fig. 2 tends to decrease the effective degree of modulation, a larger degree of modulation may be used at low levels to keep the actual modulation signal above the noise level, while the degenerative detector shown in Fig. 2 may be used to reduce the degree of modulation and thus increase the effective volume range. Preferably such a circuit should be used with an audio amplifier containing a volume modifying circuit. In the latter case it is likewise desirable that a substantially linear detector should be employed.

In Fig. 3, the system of Fig. 2 has been modified to include an additional resistance R_3 in series with R_1 and R_2 insofar as the output of the transformer T_1 is concerned. If any of these three resistors are made non-linear, for example, by using a pilot light as a resistor or by using any other resistor whose resistance varies with current, a convenient volume expander or volume contractor circuit may be obtained. If, for example, R_3 were the tungsten filament of a pilot light, its resistance would increase as the output voltage increased. Consequently, the voltages E_1 and E_2 would constitute only part of the total voltage across the output circuit, and the ratio between the feed-back voltage and the output voltage would decrease as the output voltage increased. Thus, this circuit would act as a volume expanding circuit in that the gain of the amplifier would be greater for larger output voltages. If, on the other hand, R_3 were made linear and R_1 or R_2 made non-linear in the same way, then the portion of voltage fed back would increase with larger output voltages, and the circuit would act as a volume contracting circuit in that the gain of the amplifier would decrease with larger output voltages. Such a circuit is, of course, well adapted for use with the degenerative detector of Fig. 2 in that using the expander circuit the detector will be highly degenerative for low signal levels, whereas only slightly degenerative for high signal levels. Thus, for low signal levels the effective percentage of modulation will be markedly decreased, whereas for high modulation levels there will be a smaller change and thus the diode will further aid in the volume expansion function of the apparatus as a whole. Minimization of distortion and reduction of the apparent noise level will obtain as before.

A tungsten filament is particularly suited for use such as above-mentioned in audio circuits, since its thermal time lag is sufficiently low to permit rapid changes in volume and yet is not fast enough to cause distortion of low notes.

Thus, the invention contemplates an audio amplifier having an input circuit, that is, the control grid-to-cathode circuit of valve V_1 , and an output circuit such as the secondary of transformer T_1 , and a degenerative feed-back circuit which obtains by supplying part of the signal across the secondary terminals, between the

cathode and ground of V_1 . In addition, a signal from the same source is supplied in the rectifier circuit, in which the incoming modulated signal is demodulated, and the audio signal between ground and some point on the audio load obtained by the demodulation process is supplied to the control grid of V_1 . Thus the audio amplifier is degenerated while the rectifier circuit is degenerated or regenerated depending upon the circuit connections.

The invention further contemplates the use of a non-linear element in a degenerative feedback circuit by which the amount of degeneration may be made dependent upon the signal level and a volume expansion action obtained.

It will be apparent that the feed-back signal applied to the diode in the above-described systems varies the effect of the diode as an impedance on the transformer T. While a separate diode D and amplifier V_1 are employed in the illustrated devices, it will be apparent that the elements of the diode and the amplifier may be included in a single envelope to provide a single tube or valve.

Although several embodiments have been illustrated and described, the invention is capable of further modifications, as will be apparent to those skilled in the art.

I claim:

1. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, and means for deriving a signal from said output circuit, and for supplying it to the input circuit of the audio amplifier and to the rectifier circuit to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal.

2. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, a potentiometer in the rectifier circuit and connected to the input circuit of the audio amplifier for supplying a selectable portion of the audio signal voltage to said input circuit, and means for deriving a signal from said output circuit, and for supplying it to the input circuit of the audio amplifier and to the rectifier circuit to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal.

3. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance at least a portion of which is connected in both the rectifier circuit and said input circuit, and means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal.

4. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for de-

modulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance having a portion connected in the rectifier circuit and another portion connected in said input circuit, and means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal, the connections of said impedance portions being such as to apply signals of opposite polarity to said rectifier circuit and said input circuit.

5. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance at least a portion of which is connected in both the rectifier circuit and said input circuit, means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal, and means associated with said impedance for causing the amplitude of the derived signal to vary with frequency.

6. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance having a portion connected in the rectifier circuit and another portion connected in said input circuit, means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal, the connections of said impedance portions being such as to apply signals of opposite polarity to said rectifier circuit and said input circuit, and means associated with said impedance for causing the amplitude of the derived signal to vary with frequency.

7. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, a feed-back path comprising means for deriving a signal from said output circuit, transfer means in said feed-back path for transferring a portion of the derived signal, means for varying the portion of the signal transferred in an amount determined by the amplitude of the signal in said channel, and means for supplying the transferred signal to the input circuit of the audio amplifier and to the rectifier circuit to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal.

8. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, con-

nections for supplying the audio demodulation products to the input circuit of the audio amplifier, means for deriving a signal from said output circuit, means for passing the derived signal through an impedance having a non-linear characteristic, to thereby set up across said impedance a control signal whose amplitude varies with the volume level of the system, and means for supplying said control signal to the input circuit of the audio amplifier and to the rectifier circuit to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal.

9. In a carrier wave receiving system, the provision of an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance at least a portion of which is connected in both the rectifier circuit and said input circuit, means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal, and another impedance in circuit with said first-named impedance, at least one of said impedances having a non-linear characteristic, whereby the amplitude of the derived signal is caused to vary with the volume level of the system.

10. In a carrier wave receiving system, an audio amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of

modulated signal energy, rectifier means for demodulating carrier wave from said source, connections for supplying the audio demodulation products to the input circuit of the audio amplifier, an impedance having a portion connected in the rectifier circuit and another portion connected in said input circuit, means for deriving a signal from said output circuit, and for supplying it to said impedance to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the audio signal, the connections of said impedance portions being such as to apply signals of opposite polarity to said rectifier circuit and said input circuit, and another impedance in circuit with said first-mentioned impedance, at least one of said impedances having a non-linear characteristic, whereby the amplitude of the derived signal is caused to vary with the volume level of the system.

11. In a carrier wave receiving system, a modulation signal amplifier channel including an input circuit, an output circuit and an amplifier valve, a source of modulated signal energy, rectifier means for demodulating a carrier wave from said source, connections for supplying the modulation signal to the input circuit of the modulation signal amplifier, and means for deriving a signal from said output circuit, and for supplying it to the input circuit of the modulation signal amplifier and to the rectifier circuit to thereby control the amplification of the amplifier and to vary the effective degree of modulation of the modulation signal.

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