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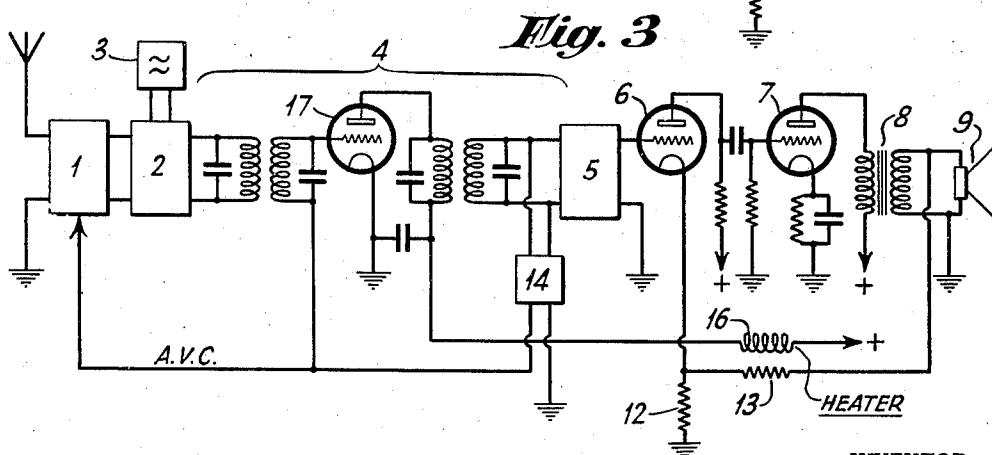
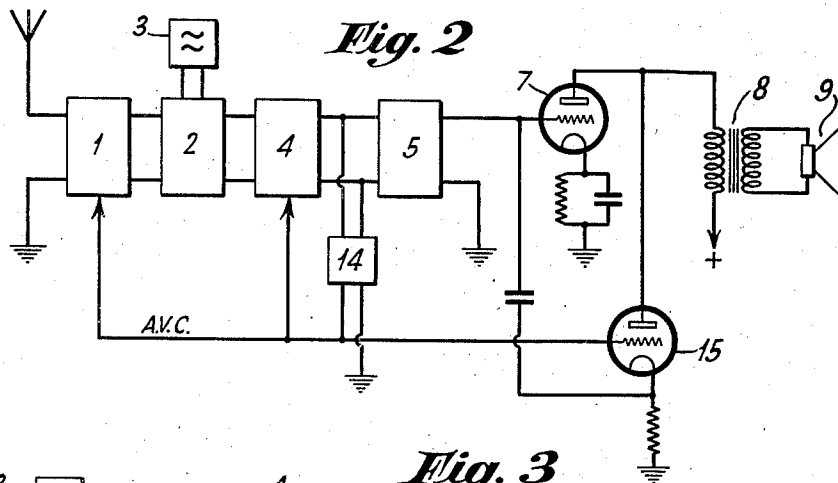
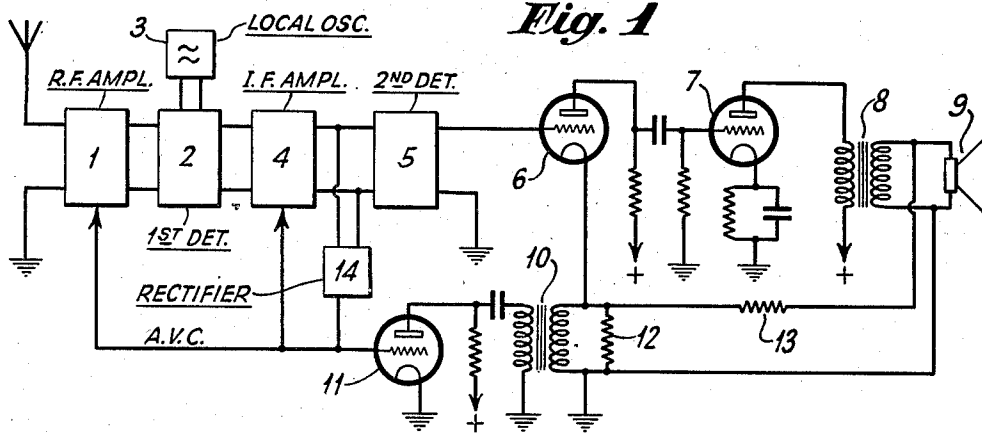
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2,340,443

CONTROLLED DEGENERATIVE FEEDBACK CIRCUITS

Filed Dec. 13, 1938

3 Sheets-Sheet 1



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Fig. 4

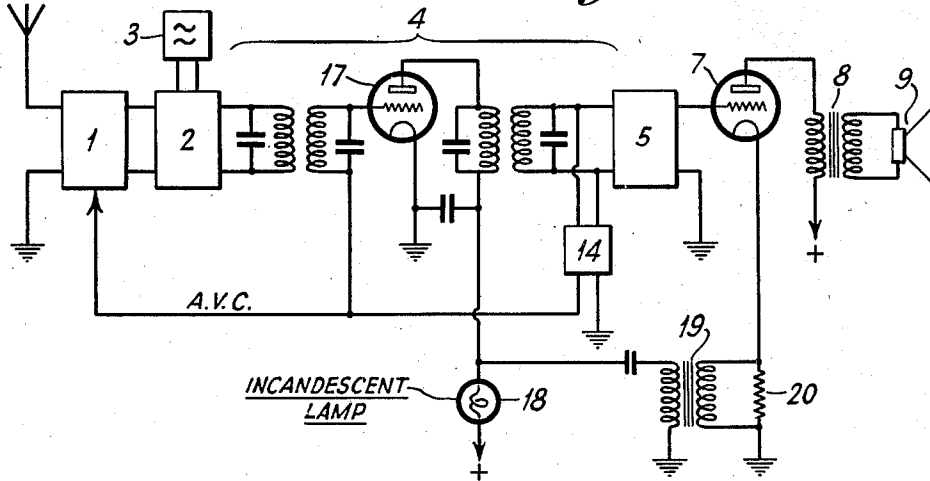
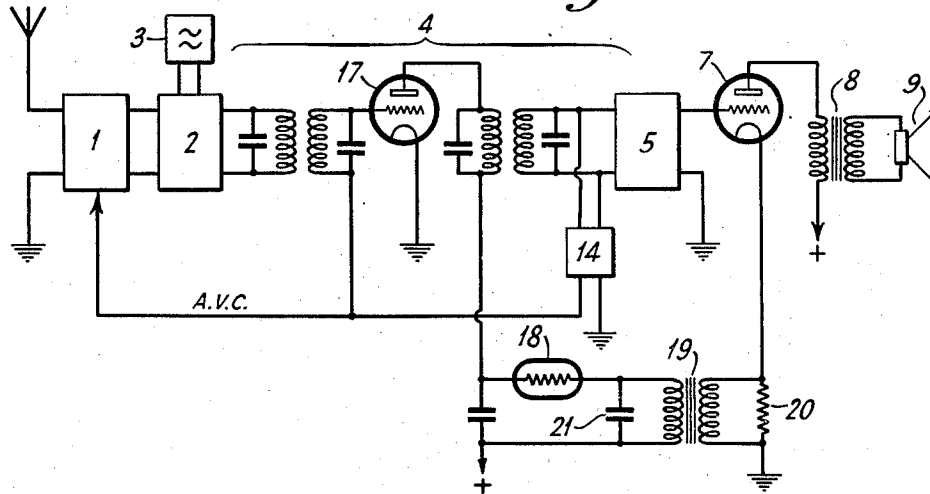


Fig. 5



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Fig. 6

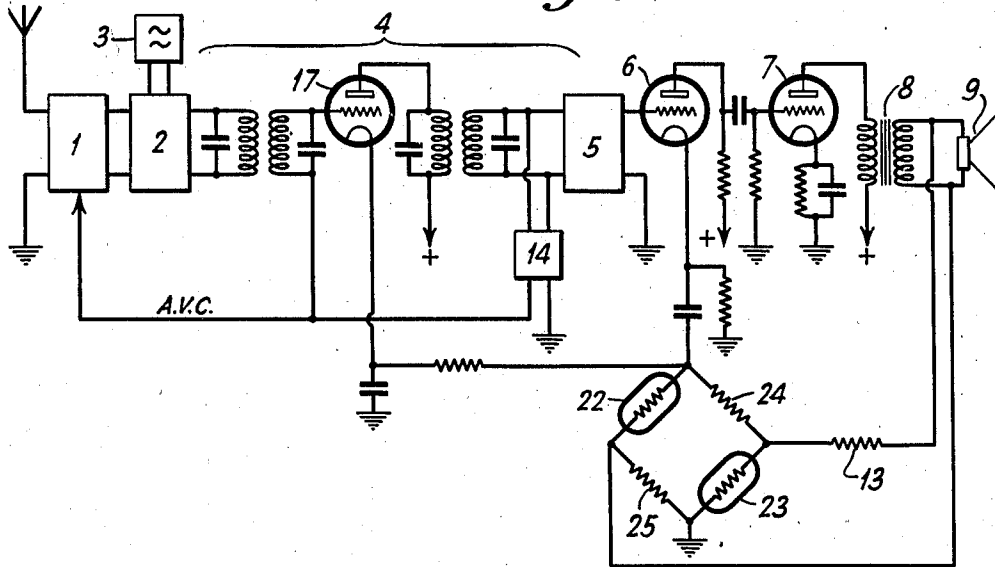
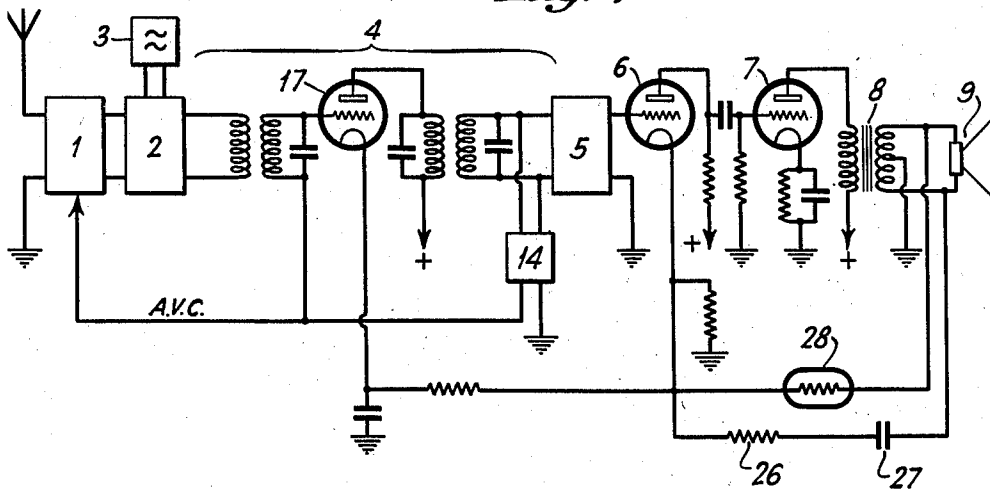


Fig. 7



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CONTROLLED DEGENERATIVE FEEDBACK
CIRCUITS

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19 Claims. (Cl. 250—20)

The present invention relates to radio receiving apparatus provided with degenerative back-coupling in order to reduce non-linear distortion. As is well-known, degenerative back-coupling reduces the amplification, and, therefore, the sensitiveness of the receiver. According to the invention, in order to be able to receive weak signals with such a receiving apparatus, the degenerative back-coupling is made dependent on the amplitude of the received signal in such manner that with small amplitudes the degenerative back-coupling has a slight value and increases with an increasing amplitude. In the degenerative back-coupling circuit should preferably be included an impedance whose value is regulated by a control voltage which depends on the amplitude of the received signal.

The invention will be more clearly understood by referring to the accompanying drawings wherein Figs. 1 to 7 inclusive show respectively different modifications of a radio receiver according to the invention, and in which similar components are denoted by the same numerals.

The radio receiving apparatus shown in Fig. 1 comprises a high-frequency amplifier 1, a mixing or first detector stage 2 provided with a local oscillator 3, an intermediate-frequency amplifier 4, a second detector 5, and a low-frequency amplifier comprising amplifying tubes 6 and 7. A loudspeaker 9 is connected, through a transformer 8, to the output circuit of the low-frequency amplifier. The cathode lead of the tube 6 comprises the internal resistance of a tube 11 which is stepped-down by means of a transformer 10. The output voltage of the transformer 8 is supplied, through a potentiometer consisting of resistances 12 and 13, to the stepped-down internal resistance in such a phase that degenerative back-coupling to the input circuit of the tube 6 is obtained.

The internal resistance of the tube 11 is controlled in dependence on the amplitude of the received signal by means of a control rectifier 14 to which the output voltage of the intermediate-frequency amplifier 4 is supplied. The control voltage which is supplied by the control rectifier, and which is dependent on the amplitude of the received signal, is utilized, in addition, for the control of the amplification of one or more tubes of the high- and intermediate-frequency amplifiers 1 and 4.

In the reception of weak signals the control voltage has a low value, and, in accordance therewith, the grid of the tube 11 has only a slight negative potential. The internal resistance of

the tube 11 is small in this case, so that the transformed internal resistance, which is connected in parallel to the resistance 12, also has a small value, and, therefore, a small proportion of the output voltage of the transformer 8 is supplied in anti-phase to the input circuit of the tube 6. The low-frequency amplifier possesses in this case a high sensitiveness, which is desirable in the reception of weak stations. When the amplitude of the received signal increases, the control voltage assumes a higher value so that the negative potential at the grid of the tube 11, and therefore the internal resistance of this tube, increases. That proportion of the output voltage of the transformer 8 which is supplied in anti-phase to the input circuit of the tube 6 consequently increases with an increasing signal strength. The degenerative back-coupling and therefore the quality of the reproduction increase in this case whereas the sensitiveness decreases.

In the circuit arrangement shown in Fig. 2 the degenerative back-coupling dependent on the signal strength is obtained by means of a tube 15 which is connected between the grid and the anode of the low-frequency amplifying tube 7. The internal resistance, which determines the value of the degenerative back-coupling, is controlled again in dependence on the control voltage provided by the control rectifier 14.

Fig. 3 represents the case in which the resistance 13 included in the degenerative back-coupling circuit depends on temperature. The temperature of this resistance is controlled in dependence on the intensity of the received signal, by means of a heating element 16 which is included in the anode circuit of an intermediate-frequency amplifying tube 17. The amplification of this tube is controlled in known manner by the control voltage of the control rectifier 14. The anode current variations developed by tube 17 act on the temperature of the heating element 16, and, therefore, on the value of the resistance 13.

In the circuit arrangement according to Fig. 4 a resistance dependent on temperature, e. g. an incandescent lamp 18, is connected into the anode circuit of the intermediate frequency amplifier 17; the amplification of the latter is controlled in dependence on the control voltage of the control rectifier 14. The resistance of the incandescent lamp 18, which has been transformed by a transformer 19, is located, in parallel to a resistance 20, in the cathode lead of the low-frequency amplifying tube 7. The variation in

the anode current of the tube 17, which is produced due to a variation in the signal strength, causes in its turn a variation in the value of the resistance 18 and thus controls the degenerative back-coupling of the tube 7.

The circuit arrangement shown in Fig. 5 is substantially similar to that according to Fig. 4, with the exception that the resistance 18, which is dependent on temperature, is connected, in series with the secondary winding of a transformer 19, into the anode circuit of the tube 17. Besides, an impedance dependent on frequency, viz. a condenser 21, is connected in parallel to the said winding so that degenerative back-coupling dependent on frequency is obtained. That is to say, such a coupling is secured that with small amplitudes of the received signal, and consequently with slight degenerative back-coupling, the band of frequencies transmitted by the low-frequency amplifier becomes narrower. This is desirable in the reception of weak stations for the purpose of obtaining a favorable ratio between signal and interference.

With the system shown in Fig. 6 the variable degenerative back-coupling is obtained by means of a bridge-connection which is connected into the cathode lead of the low-frequency amplifying tube 6, and which is constituted by two resistances 22 and 23 which are dependent on temperature and on two invariable resistances 24 and 25. The resistances 24 and 25 are so chosen that in the reception of weak signals the bridge-connection is in equilibrium, and no degenerative back-coupling occurs. The anode current of the tube 17, whose amplification is influenced by the control rectifier 14, flows through the resistances 22 and 23 from the cathode of the amplifying tube 17. As a result, with an increase in the signal strength the resistances 22 and 23 vary, and consequently disturb the equilibrium of the bridge-connection. Thus with increasing signal strength the degenerative back-coupling increases.

In the circuit arrangement shown in Fig. 7 two voltages are taken from the output transformer, one of these voltages being led back aiding in phase through a resistance 26 and a condenser 27 to the input circuit of the amplifying tube 6, and consequently affords retroactive coupling. The other voltage is led back in anti-phase through a variable and temperature-dependent resistance 28 to the input circuit of the tube 6 and consequently affords degenerative back-coupling. In the case of weak signals the retroactive coupling should preferably be equal to the degenerative back-coupling, or be only slightly smaller than this coupling. With an increasing signal strength the degenerative back-coupling increases due to the variation of the resistance 28 in dependence on the anode current of the tube 17, whose amplification is controlled by the control voltage coming from the control rectifier 14, and which anode current flows through the resistance 28.

In the above-described practical examples use has always been made of degenerative back-coupling in the low-frequency amplifier. It is evident, however, that the invention may be applied to any degenerative back-coupling; for example to a circuit arrangement in which degenerative back-coupling through at least a part of the high- or intermediate-frequency amplifier is effected by modulating a low-frequency voltage on the high- or intermediate-frequency signal. Also in these circuit-arrangements the degenerative

back-coupling circuit has connected into it a resistance, for example in the form of a discharge tube, of a resistance dependent on temperature or of a bridge-connection, whose value is influenced by a control voltage.

What is claimed is:

1. In a radio receiver of the type comprising an audio modulated carrier energy transmission network, a demodulator and an audio modulation amplifier network; the improvement comprising a degenerative audio voltage feedback path connected between the output and input of said audio network, said path having operatively associated therewith a temperature-dependent feedback control impedance, and means, connected to utilize modulated carrier energy, responsive to variations in solely carrier amplitude for automatically adjusting the magnitude of said impedance.
2. In a radio receiver of the type comprising an audio modulated carrier energy transmission network, a demodulator and an audio modulation amplifier network; the improvement comprising a degenerative audio voltage feedback path connected between the output and input of said audio network, said path having operatively associated therewith a feedback control impedance, means responsive to variations in solely carrier amplitude at said carrier network for automatically adjusting the magnitude of said impedance, said control impedance comprising at least one temperature-dependent resistance element, and said responsive means including a device for varying the temperature of said element.
3. In a radio receiver of the type comprising an audio modulated carrier energy transmission network, a demodulator and an audio modulation amplifier network; the improvement comprising a degenerative audio voltage feedback path connected between the output and input of said audio network, said path having operatively associated therewith a feedback control impedance, means responsive to variations in carrier amplitude for automatically adjusting the magnitude of said impedance, and an additional audio voltage path between the output and input of said audio network for regeneratively feeding back audio voltage.
4. In a radio receiver of the type comprising an audio modulated carrier energy transmission network, a demodulator and an audio modulation amplifier network; the improvement comprising a degenerative audio voltage feedback path connected between the output and input of said audio network, said path having operatively associated therewith a temperature-dependent feedback control impedance, means responsive to variations in solely carrier amplitude at said carrier network for automatically varying the temperature, and consequently adjusting the magnitude, of said impedance, and connections between said responsive means and carrier transmission network for regulating the transmission efficiency through the latter.
5. In an audio voltage transmission system of the type including at least one audio amplifier tube having input and output circuits, the method which includes impressing audio voltage upon the input circuit, feeding back audio voltage from the output to the input circuit in degenerative phase, impeding the feedback of said voltage, automatically adjusting the impedance to said feedback in response to variations of voltage amplitude at said input circuit, and addi-

tionally feeding back audio voltage from the output circuit to the input circuit in regenerative phase without impedance.

6. In a modulated carrier energy system of the type comprising at least one carrier energy transmission tube, a demodulator and at least one modulation voltage transmission tube, a degenerative modulation voltage feedback means operatively associated with the output and input of said modulation transmission tube, a feedback control element operatively associated with said feedback means, means for deriving a control voltage from the carrier energy, means for varying the space current of said carrier transmission tube with said control voltage, and means responsive to the varying space current for regulating said control element.

7. In a modulated carrier energy system of the type comprising at least one carrier energy transmission tube, a demodulator and at least one modulation voltage transmission tube, a degenerative modulation voltage feedback means operatively associated with the output and input of said modulation transmission tube, a feedback control element consisting of a temperature-dependent resistor operatively associated with said feedback means, means for deriving a control voltage from the carrier energy, means for varying the space current of said carrier transmission tube with said control voltage, and means responsive to the varying space current for regulating said control element.

8. In a radio receiver of the type including a carrier amplifier tube, a demodulator and an audio amplifier tube, the method which includes impressing audio modulated carrier voltage on the carrier tube, demodulating the amplified carrier voltage, amplifying the audio voltage at the audio tube, degeneratively feeding back audio voltage from the output of the audio tube to its input, deriving a unidirectional voltage from the carrier voltage, regulating the space current flow of said carrier amplifier tube with said derived voltage, and adjusting the said feedback in response to the variation in said space current flow.

9. In a radio receiver of the type including a carrier amplifier tube, a demodulator and an audio amplifier tube, the method which includes impressing audio modulated carrier voltage on the carrier tube, demodulating the amplified carrier voltage, amplifying the audio voltage at the audio tube, degeneratively feeding back audio voltage through a temperature-dependent element from the output of the audio tube to its input, deriving a unidirectional voltage from the carrier voltage, regulating the space current flow of said carrier amplifier tube with said derived voltage, and adjusting the said feedback by varying the magnitude of said element, in response to the variation in said space current flow.

10. In a modulated carrier wave receiving system of the type comprising a modulated carrier energy transmission network, detection means, a modulation voltage transmission network and means providing modulation voltage feedback from a point in the modulation voltage network to a preceding point thereof; the improvement which comprises means responsive to solely carrier amplitude variations of a modulated wave of a desired carrier frequency for producing a control voltage, and means responsive to said control voltage for controlling the magnitude of said feedback.

11. In a modulated carrier wave receiving system of the type comprising a modulated carrier

energy transmission network, detection means, a modulation voltage transmission network and means providing a degenerative modulation voltage feedback from a point in the modulation voltage network to a preceding point thereof; the improvement which comprises means responsive to solely carrier amplitude variations of a modulated wave of a desired carrier frequency for producing a proportionally variable control voltage, and means responsive to said control voltage for controlling the magnitude of said feedback in the same sense as the carrier amplitude variation.

12. In a radio receiver provided with at least one signal carrier transmission tube, a detector and an audio frequency network, means providing degenerative feedback of audio voltage from a later point in the audio network to an earlier point thereof, means responsive to signal carrier amplitude variation for controlling the gain of the transmission tube, and means responsive to variation in space current flow of the controlled tube for controlling the magnitude of said degenerative feedback.

13. In a radio receiver provided with at least one signal carrier transmission tube, a detector and an audio frequency network, means providing degenerative feedback of audio voltage from a later point in the audio network to an earlier point thereof, means, responsive to signal carrier amplitude variation, for controlling the gain of the transmission tube, and means common to the space current path of the controlled tube and said feedback means, and responsive to variation in space current flow of the controlled tube, for controlling the magnitude of said degenerative feedback.

14. In a signal carrier reception system including a carrier energy transmission network and an audio amplifier circuit, a circuit connected between two successive points of the audio circuit for feeding back audio voltage, and means connected to said carrier network and responsive to signal carrier amplitude variation for automatically adjusting the magnitude of the feedback voltage.

15. In a signal carrier reception system including a carrier energy transmission network and an audio amplifier circuit, a circuit connected between two successive points of the audio circuit for feeding back audio voltage in degenerative phase, and temperature-dependent means connected to said carrier network and responsive to signal carrier amplitude variation for automatically adjusting the magnitude of the feedback voltage.

16. In an audio-modulated carrier receiver of the type provided with an audio amplifier, means for providing degenerative audio feedback between two successive points of the amplifier, and means responsive solely to the carrier amplitude variation for automatically adjusting the magnitude of said feedback.

17. In a radio receiver provided with at least one signal carrier transmission tube, a detector and an audio frequency network, means providing degenerative feedback of audio voltage from a later point in the audio network to an earlier point thereof, means, responsive to signal carrier amplitude variation, for controlling the gain of the transmission tube, and temperature-dependent resistance means responsive to variation in space current flow of the controlled tube for controlling the magnitude of said degenerative feedback.

18. In a modulated carrier reception system of the type including a carrier amplifier, a demodulator and a modulation amplifier, the method which includes degeneratively feeding back modulation voltage from the modulation amplifier output to its input, deriving a direct current voltage from the amplified carrier energy which varies directly with the carrier amplitude, applying the direct current voltage to the carrier amplifier in a gain-reducing sense as the carrier amplitude increases, and controlling the magnitude of said feedback, in response to the variation of the car-

rier amplifier space current, in a sense such as to increase feedback as the carrier amplitude increases.

19. In combination with at least two cascaded signal transmission tubes, a signal feedback path between the output and input of the second tube, and means, including an element in the space current path of said first tube, for controlling the magnitude of signal feedback in response to the amplitude variation of the signal.

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