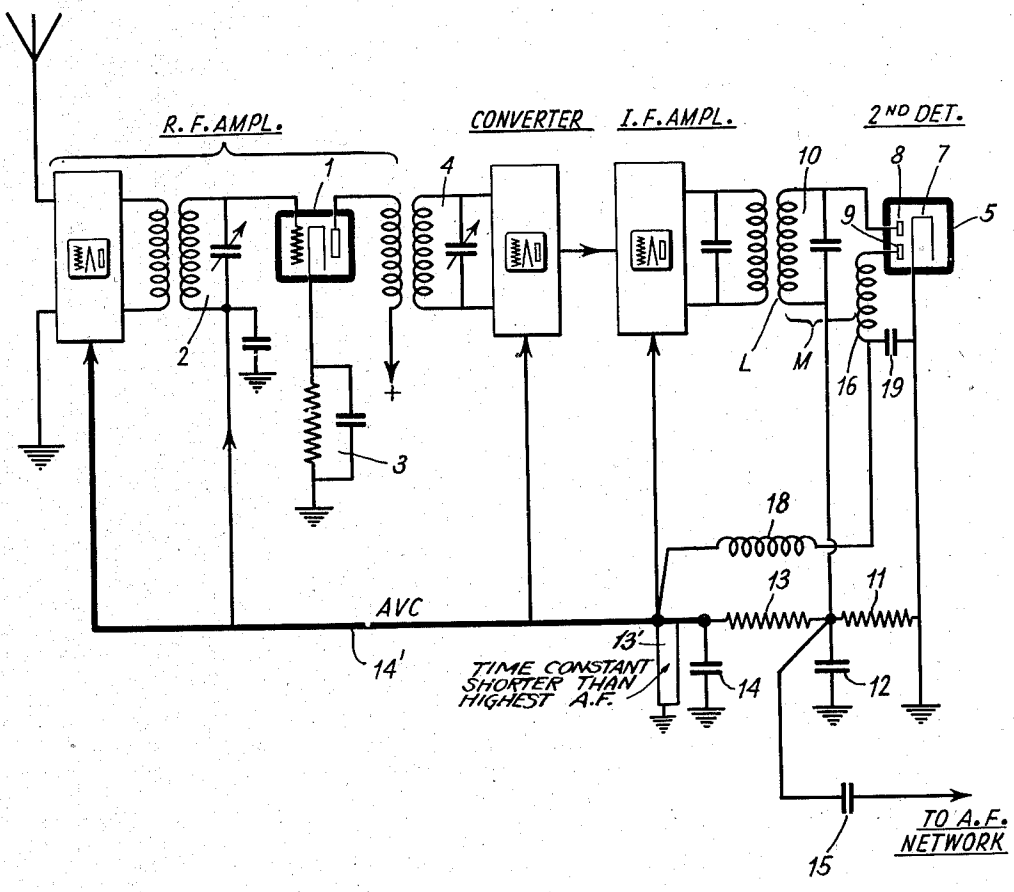
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AUTOMATIC NOISE LIMITER CIRCUIT

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AUTOMATIC NOISE LIMITER CIRCUIT

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My present invention relates to noise controls for signalling systems, and more particularly to automatic noise limiting arrangements for radio receivers.

One of the prime objects of my invention is to provide, in a radio receiving system, a network functioning automatically to limit the response of the system to peak values of twice the incoming carrier strength.

Another important object of the invention is to provide, in a radio receiver, a diode detection network functioning, in addition, as a source of amplifier gain control bias for a slow acting automatic volume control circuit; a second diode detection network being electrically associated with the first network to provide gain control bias for a quick acting volume control circuit thereby preventing crashes of static, or similar interference impulses, exceeding the audio output due to 100% modulation of the carrier, from affecting the receiver response.

Still other objects of the invention are to improve generally the simplicity and efficiency of noise limiting circuits for receivers, and more especially to provide limiting circuits which are not only reliable in operation, but are economically manufactured and assembled in radio receivers.

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 a circuit organization whereby my invention may be carried into effect.

Considering the drawing, the circuit shown is of the superheterodyne type, and comprises the customary signal collector, such as a grounded antenna circuit; a radio frequency amplifier of one, or more, tunable stages; a converter adapted to convert the amplified signals to I. F. energy; an I. F. amplifier; a second detector; and one, or more, stages of audio amplification followed by a reproducer (not shown). The tunable signal grid circuits of the radio amplifiers, local oscillator and first detector network are arranged for uni-control tuning adjustment. The resonant circuits of the I. F. amplifier are fixedly tuned to the operating I. F., which may be chosen from a range of 75 to 500 k. c. The circuits of radio amplifier tube 1 are shown in detail to illustrate the manner in which the circuits of the other controlled tubes are constructed. The amplifier tube 1 has the tunable input circuit 2 connected between its input electrodes; a signal grid biasing network 3 being disposed in the grounded cathode lead. The plate circuit of tube 1 feeds the tunable input circuit 4 of the first detector circuit of the converter network. The latter may be of the composite first detector-local oscillator type (using a 6A7 tube, for example); or it may employ separate local oscillator and first detector tubes. The tunable oscillator tank circuit is not shown; but it will be understood that the rotors of all the variable condensers will be uni-controlled.

The second detector tube 5 may be of the 6H6 type, and comprises two diode sections. The cathode 7 supplies electrons for anodes 8 and 9. The I. F. tuned input circuit 10 for the detector is connected, in series with resistor 11, between the anode 8 and cathode 7. The cathode side of resistor 11 is grounded; condenser 12 is connected to ground from the junction of resistors 11 and 13. The resistor 13 is included in the AVC connection 14' to the signal grid circuits of the controlled tubes. Those skilled in the art are fully aware of the manner of constructing the AVC network of a receiver. The direct current voltage component across load resistor 11 is applied to the signal grids of the gain-controlled tubes by connecting lead 14' to the anode side of resistor 11. The resistor 13 and condenser 14 provide a filter network to suppress pulsating components in the AVC bias.

The audio coupling path 15 is connected to a point on resistor 11 for the purpose of tapping off the audio voltage component of the detected I. F. current. The second anode 9 is connected to the cathode 7 through a path including, in series, coil 16, I. F. choke coil 18, time constant network 13', resistor 13 and resistor 11. Coil 16 is coupled, as at M, to the coil L of the detector input circuit 10. Condenser 19 is connected between the low alternating potential side of coil 16 and the cathode 7. Hence, it will be seen that the network including diode 9—7 is reactively coupled to the detection diode input circuit, and there is impressed upon coil 16 the same alternating current energy existing in circuit 10.

In considering the operation of the present invention, it is first pointed out that the function of the network including diode 9—7 is automatically to limit the response of the radio receiving system to peak values of twice the incoming carrier strength. The coupling reactance between

coils 16 and L bears a specific relation to the reactance value of coil L. Specifically,

$$\frac{M}{L}=0.5$$

for 100% modulation of the carrier.

$$\frac{M}{L}$$

is chosen as approximately 0.5 so that the peak voltage on diode plate 9 will be ½ that on plate 8. Thus, no rectification takes place unless some signal greater than that caused by 100% modulation of the received signal occurs. Under 100% modulation the received signal varies sinusoidally between zero and two times its normal value. I have assumed that the bias built up across resistor 11 is equal to the mean peak value of the signal applied to plate 8. Actually this is not true, unless the rectification efficiency of the diode is 100%. This bias may only be 80% of the peak value of the wave; in which case

$$\frac{M}{L}$$

should be 0.4.

The purpose of the limiting arrangement is to prevent crashes of static, or other undesired noise impulses, from exceeding the audio output due to 100% modulation of the carrier. The time constant of the network including resistor 11 and condenser 12 is smaller than the lowest audio frequency. The time constant of the network 13' is smaller than the period of the highest audio frequency. The direct current voltage across resistor 11, which is due to the steady carrier value, biases diode anode 9 negative with respect to the cathode 7. This follows from the fact that the anode 9 is connected to the negative side of resistor 11. As long as carrier energy is received the anode side of resistor 11 is negative with respect to ground, and, hence, the diode anode 9, being connected to the negative side of resistor 11, is at a negative potential with respect to ground. Bias is developed across resistor 13 when a peak of interference is sufficient to cause anode 9 to swing positive.

The diode 9—7 will only draw current when the alternating current peak value across coil 16 is greater in magnitude than the direct current voltage across resistor 11. When this occurs the anode 9 is at a positive potential with respect to the cathode 7, and space current flows through the series path which includes resistors 13 and 11. The direct current voltage drop across this series resistor path provides additional AVC voltage for the controlled transmission tubes. Since the lead 14' is connected to the negative side of resistor 11 through resistor 13 it necessarily follows that when the diode 9—7 becomes conductive, the direct current voltage developed by its space current flow adds to the normal AVC voltage developed across resistor 11. This additional AVC voltage is applied very rapidly by virtue of the short time constant network 13' associated with the diode 9—7. The fact that diode 9—7 is biased only by the carrier implies that when no signal is being received, diode plate 9 is not biased negatively with respect to cathode 7 and is, therefore, free to rectify any instantaneous peak of interference which occurs and pass it back to the controlled tubes. The action of this circuit is so rapid that the entire operation takes place in less than the time of one audio cycle of the highest reproduced frequency.

It will now be seen that as long as the signal peak voltage value at input circuit 10 is less than twice the incoming carrier, then the diode 9—7 is non-conductive and the signal transmission tubes are reduced in gain, in proportion to the increase in signal carrier amplitude, by the slow acting AVC network. However, when the peak voltage at input circuit 10 exceeds twice the incoming carrier amplitude then the diode 9—7 becomes conductive, and there is quickly applied to the signal transmission tubes an additional gain reduction bias which functions substantially to suppress electrical wave transmission to the second detector. It is in this manner that automatic squelching of the receiving system is accomplished when undesired noises are encountered. It will, additionally, be observed that the carrier amplitude itself determines the operation of the diode limiter, since conductivity of the diode 9—7 is dependent upon the alternating current amplitude at input circuit 10. Since the squelching action is rapid, little, if any, disturbance of the desired signal is noticed. Noise peaks are highly damped waves, and, therefore, of very short duration. If the interference consists of a long sequence of pulses, the control action simply repeats itself as often as the peak occurs.

While I have indicated and described a system 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. In combination, a signal amplifier, a relatively slow acting automatic volume control circuit electrically connected to said amplifier, a relatively quick acting automatic volume control circuit electrically connected with said amplifier, and electrical connections between said two volume control circuits constructed and arranged to maintain the second control circuit inoperative until the alternating current amplitude impressed on the first control circuit exceeds a predetermined magnitude, said two control circuits comprising independent alternating current rectifiers having the amplified signals impressed thereon, and the rectifier of the second control circuit having a load resistor, the rectifier of the first control circuit having a load resistor, the two load resistors of said rectifiers being arranged in series, the electrodes of the second control rectifier being connected across said first control rectifier load resistor, and the latter having a magnitude such as to develop sufficient direct current voltage to provide the sole means for biasing said second rectifier to said inoperative condition.

2. In combination with a wave transmission tube having input and output circuits, a wave rectifier having an input circuit upon which waves are impressed, an impedance included in circuit with the rectifier for developing a direct current voltage whose magnitude is dependent on the wave amplitude, means for applying the said voltage to said tube as a gain control bias, a second wave rectifier having an input circuit coupled to the first rectifier input circuit, a second impedance in circuit with the second rectifier developing a second direct current voltage from waves rectified thereby, said last voltage being applied to said tube as a gain reduction bias by said applying means, and the coupling

between the first and second rectifier input circuits having a magnitude such that the peak signal voltage applied to the second rectifier input circuit is between 0.4 and 0.5 that applied to the first rectifier input circuit.

3. In combination with a wave transmission tube having input and output circuits, a wave rectifier having an input circuit upon which waves are impressed, an impedance included in circuit with the rectifier for developing a direct current voltage whose magnitude is dependent on the wave amplitude, means for applying the said voltage to said tube as a gain control bias, a second wave rectifier having an input circuit coupled to the first rectifier input circuit, a second impedance in circuit with the second rectifier developing a second direct current voltage from waves rectified thereby, said last voltage being applied to said tube as a gain reduction bias by said applying means, the coupling between the first and second rectifier input circuits having a magnitude such that the peak signal voltage applied to the second rectifier input circuit is between 0.4 and 0.5 that applied to the first rectifier input circuit, and means applying the first direct current voltage to the second rectifier in a sense to prevent rectification by the latter until the peak voltage applied thereto exceeds the said first voltage.

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