

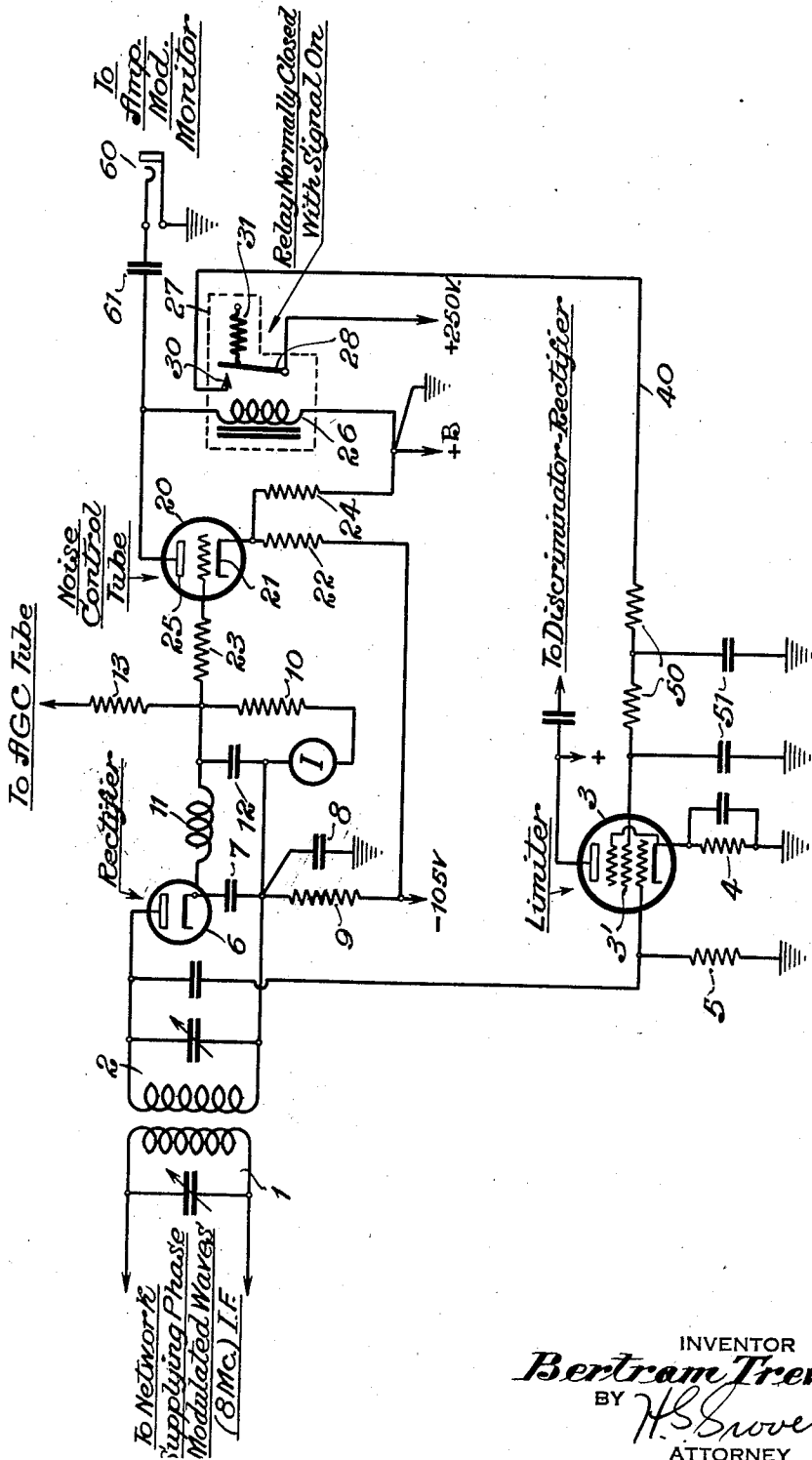
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NOISE CONTROL CIRCUIT

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NOISE CONTROL CIRCUIT

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My present invention relates to a noise control circuit for a receiver of the angular velocity-modulated carrier wave type, and more particularly to a circuit for automatically silencing such receiver in the absence of a carrier magnitude above a predetermined value.

It has been found in the past that when radio receivers are operated with automatic gain control (AGC), noise reproduction is greatly increased when the carrier amplitude drops below a predetermined magnitude. Hence, automatic silencing networks have been provided to prevent such noise reproduction when the carrier amplitude decreases to a low level which is insufficient to actuate the AGC circuit to reduce the sensitivity of the controlled pre-demodulator stages. In the case of angular velocity-modulated carrier wave receivers, and particularly those of the phase modulation type, utilization of AGC circuits also give rise to the problem of noise reproduction in the absence of a carrier of predetermined amplitude. Operation with a phase modulated carrier wave (PM) receiver in the 400–500 megacycle (mc.) range has indicated that automatic noise silencing is required if AGC is to be employed. This is particularly true in the case of a PM receiver operating as a relaying device. In an ultra-high frequency relay receiver of the PM type the noise output of the receiver, in the absence of a carrier of sufficient amplitude, is high enough to actuate a remote control stop-start relay.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide in a receiver of angular velocity-modulated carrier waves having an AGC circuit, a device responsive to a predetermined decrease of the carrier amplitude for automatically preventing transmission of electrical impulses to the discriminator-rectifier employed in the receiver for demodulation purposes.

A more specific object of the invention may be stated to reside in the provision of an ultra-high frequency PM receiver which employs a device for automatically rendering the amplitude modulation limiter thereof ineffective when the carrier amplitude decreases below a predetermined tolerable level.

Still another object of my invention is to provide in a PM receiver operating in the 400–500 mc. band an AGC circuit which inherently causes an increase in noise output of the receiver in response to a decrease of the carrier amplitude below a desired level, there being additionally provided a noise control circuit which is respon-

sive to the device actuating the AGC circuit for preventing transmission of electrical impulses to the receiver discriminator-rectifier when such carrier amplitude decreases occur.

Still other objects of my invention are to improve generally the efficiency and reliability of ultra-high frequency receivers operating as relay receivers, and to provide such efficient and reliable operation in an economical manner.

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.

Referring now, to the accompanying drawing wherein are shown only those circuits of a PM receiver of the ultra-high frequency type which are essential to a proper understanding of the invention, it will be understood that the tuned circuit 1 is the output circuit of an intermediate frequency (I. F.) amplifier. The amplifier may comprise one or more I. F. tube stages. These I. F. stages may be preceded by any type of converter stage which is capable of reducing the frequency of the collected ultra-high frequency waves to the operating I. F., in this case a value of 8 mc. As stated previously, in the specific case being considered in this application the PM waves are in the 400–500 mc. range. Specifically the center frequency of the collected waves is 402 mc. The PM waves themselves may be wide band or narrow band with respect to carrier deviation.

As is well known to those skilled in the art, the difference between the PM and FM waves resides in the fact that the former includes a wider frequency deviation at the higher modulation frequencies than in the case of the latter. The modulation amplitude is translated into a proportional carrier frequency deviation at the transmitter, while the rate of deviation corresponds to the modulation frequencies per se. The secondary circuit 2 is tuned to the operating I. F. value, and is reactively coupled to the primary circuit 1 so as to provide the proper pass band width to pass the entire carrier frequency deviation of the PM waves.

The amplitude modulation effects which may exist on the carrier wave are eliminated by a limiter tube 3. These amplitude modulation effects are caused by fading, noise impulses and

even by virtue of the cascaded tuned circuits in the various networks preceding the final demodulator. The limiter tube, for example, may be a pentode whose cathode circuit includes the usual by-passed self-biasing resistor 4, the input grid being connected to ground through a grid leak resistor 5. The plate of the limiter tube may be connected to the positive terminal of a direct current energizing source, and the limited PM waves are transmitted to any well known type of discriminator-rectifier network. As is well known to those skilled in the art, the limiter circuit is designed so as to have an input-output characteristic which is substantially horizontal beyond a predetermined input energy level.

The tube functions in the manner of a saturated amplifier, and in that way feeds to the subsequent demodulator, or discriminator-rectifier, a PM wave which is of substantially constant carrier amplitude and free of any amplitude modulation effects. The discriminator-rectifier circuit may be constructed in any well known manner, and it is not believed necessary to describe such a circuit. In general, it functions to convert the PM wave into the modulation frequencies of variable amplitude, and the latter are utilized to actuate a modulation frequency utilization circuit. Such latter circuit may be a remote control stop-start relay, printers, facsimile equipment, and the like.

AGC is provided for the pre-limiter networks; that is, for the ultra-high frequency amplifier and I. F. amplifier tubes. Furthermore, it is desired to provide a source of amplitude modulation voltage to energize a monitor so that the receiver operator may be able to observe for himself when amplitude modulation exists on the received carrier wave. Both these functions are accomplished by connecting the anode and cathode of a diode rectifier 6 across the tuned circuit 2. The anode is connected to the high potential side of input circuit 2 while the cathode is connected to the low potential side through condenser 7. The low potential terminal of condenser 7 is connected to ground through a condenser 8 having a magnitude of approximately 0.1 microfarad (mf.). The junction of condensers 7 and 8 may be connected to a source of negative bias, establishing for example a magnitude of -105 volts, through a resistor 9 of approximately 100,000 ohms.

The load resistor of rectifier 6 is designated by numeral 10, and the resistance thereof may be approximately 10,000 ohms. One end of the resistor is connected to the cathode of diode 6 through filter coil 11, while the other end of the resistor 10 is connected to the junction of condensers 7, 8 and 12 through a milliammeter I which may indicate a range of 0 to 1 milliamperes. Condensers 7 and 12 in combination with coil 11 form a low pass filter to prevent I. F. currents from reaching the load resistor 10.

The direct current voltage developed across resistor 10 is utilized for AGC purposes, and also to actuate the noise silencing tube 20. The control grid circuits of the controlled tubes are connected through a filter resistor 13 to the cathode end of resistor 10. Since that end of resistor 10 becomes increasingly positive in polarity with an increase in carrier amplitude, some polarity reversing device is utilized in the AGC lead to the controlled tubes. In the absence of received carrier waves, or when the received carrier amplitude is below a predetermined intensity level, the direct current voltage developed across resistor 10 is then in approximate proportion to the carrier amplitude

and is very small. Accordingly, the AGC bias for the controlled tubes is essentially zero with the result that the sensitivity of the controlled tubes is at its maximum.

To prevent the noise impulses from being transmitted to the discriminator-rectifier, when the carrier decreases below a predetermined amplitude, there is provided the noise control tube 20 which may be of the 6J5 type. The cathode 21 of this tube is connected through resistor 22 to the -105 volt direct current source, and the resistor 22 may have a magnitude of approximately 2500 ohms. The control grid of tube 20 is connected by resistor 23 to the cathode end of resistor 10, and resistor 23 may have a magnitude of approximately 100,000 ohms. The cathode end of resistor 22 is connected to the positive terminal of the direct current voltage source through a resistor 24 having a magnitude of approximately 35,000 ohms, and the plate 25 is connected to the grounded positive terminal of the aforesaid source through the winding 26 of the relay 27. The relay 27 is schematically represented, and is shown enclosed by dotted lines. Since those skilled in the art are fully aware of the construction of a relay of the type shown in 27, it is not believed necessary to show more than the schematic appearance thereof.

As is well known to those skilled in the art, the relay winding 26 energizes an electro-magnet which functions to attract the armature 28. The latter is normally in contact with the contact point 30 with normal signal level input to the receiver. The spring 31 will pull the armature 28 away from circuit-closing contact with point 30 when the current flow through winding 26 decreases below a desired intensity. The pivoted end of armature 28 is connected to a source of positive voltage, as for example +250 volts, and the contact point 30 is connected by lead 40 to the screen grid 3' of limiter tube 3. Lead 40 is connected to the screen grid through a filter network comprising series resistors 50 and shunt condensers 51. When the current flow through relay winding 26 is of minimum value, the spring 31 is able to pull armature 28 out of contact with contact point 30 thereby breaking the positive supply voltage to the screen grid 3'. This causes the limiter tube to be ineffective to transmit any electrical impulses to the subsequent discriminator-rectifier. On the other hand when the space current flow through tube 20 rises to an intensity such that winding 26 energizes its electro-magnet to pull armature 28 into contact with point 30, the screen grid 3' will be energized and the limiter tube will be of normal transmission efficiency.

With no I. F. energy applied to the rectifier through circuit 2 there will be substantially no direct current voltage across resistor 10, the diode load resistor. As soon as I. F. energy is applied to 2 there will flow in resistor 10 a rectified current giving a direct current potential across this resistor, the positive end of which is connected to the grid of 20 through resistor 23. The cathode of 20 connects to the voltage divider 22, 24 which puts the cathode at a positive potential with respect to the negative side of the plate supply. Since no direct current flows through either resistor 9 or 23, it can be stated that the bias between the grid and cathode of 20 is equal to the voltage across resistor 10 minus the voltage across resistor 22. The circuit values are such that this bias is always negative so that no grid current flows in tube 20.

It is to be noted that the ground on the positive side of the plate battery in no way affects the operation of tube 20, since this one point is only ground for direct potentials for the entire circuit drawn. The reason for grounding the positive side of the battery is to allow the automatic gain control circuits to function properly. In view of what has been said above, it should be clear that a decrease of I. F. input at 2 will cause an increase in bias on tube 20, since the voltage across 10 acts in a direction to decrease this bias. An increase in bias causes lower current to flow in relay 26 thereby opening its contacts. The action of the automatic gain control circuit is to maintain substantially constant I. F. input to 2, which, in turn, causes a substantially constant potential across 10 for all signal levels above the receiver noise. In order for the noise silencing circuit to operate properly it is necessary that the diode current, at full receiver gain and no signal input, be considerably less than normal diode current with signal applied. Thus, the AGC circuit cannot raise the gain of the receiver with no-signal input to such a high value that the receiver internal noise causes the diode current to come up to its normal operating value. The maximum receiver gain may be limited to the correct value by adjusting either the screen potentials, or self-bias resistors, or by any other convenient means.

The receiver is normally operated with the AGC circuit active, and with no carrier present the receiver noise level is brought up enough to give a diode current of approximately 0.2 milliamperes (ma.). Normally, the diode current is about 0.7 ma. so that a current differential of 0.5 ma. flowing through the 10,000 ohm resistor 10 produces a voltage differential of 5 volts. This is sufficient to control the grid of tube 20, and in turn operates the relay 27 in its plate circuit. Under normal conditions the relay contacts 30 and 28 are closed thereby supplying the proper positive potential to the screen grid of the limiter tube 3. When the relay contacts are open, however, the limiter tube becomes inactive thereby cutting off all noise impulses which would otherwise be transmitted to the audio utilization circuit.

A pair of amplitude modulation monitor terminals 60 may be coupled to the ends of winding 26 by means of the coupling condenser 61 having a value of 0.1 mf. The function of these monitor terminals is to permit a measurement to be made to determine the amount of amplitude modulation existing on the received carrier. The function of network 7-11-12 is that of a low pass filter, to prevent I. F. energy from appearing at the load resistor 10. The capacitor 8 serves only to ground the low potential side of the diode circuit for I. F. and audio voltages. Network 50-51 is the usual I. F. filter arrangement which prevents I. F. energy from passing between tube 3 and lead 40.

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 an angular velocity-modulated carrier wave receiver of the type including an amplitude modulation limiter tube adapted to feed a follow-

ing discriminator-rectifier; an improvement comprising a direct current circuit energizing an electrode of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, and additional means responsive to a decrease in the received carrier amplitude below a predetermined value for rendering said energizing circuit ineffective thereby to render said limiter ineffective to transmit any electrical impulses.

2. In combination in an angular velocity-modulated carrier wave receiver including an amplitude modulation limiter tube adapted to feed a following discriminator-rectifier, direct current means energizing a positive electrode of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, additional means responsive to a decrease in the received carrier amplitude below a predetermined value for impairing said energizing means thereby to render said limiter ineffective to transmit any electrical impulses, and additional means responsive to relatively slow carrier amplitude variation for automatically controlling the sensitivity of stages of said receiver prior to said limiter tube.

3. In combination in an angular velocity-modulated carrier wave receiver including an amplitude modulation limiter tube adapted to feed a following discriminator-rectifier, a direct current circuit for energizing a positive electrode of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, additional means responsive to a decrease in the received carrier amplitude below a predetermined value for opening said direct current circuit thereby to render said limiter ineffective to transmit any electrical impulses, said last means comprising a rectifier coupled to the limiter tube input electrodes, an electron discharge tube having an input electrode responsive to the rectified output of said rectifier, and means in the output circuit of said electron discharge tube for controlling said limiter tube energizing circuit.

4. In combination in a phase modulation receiver provided with a limiter tube having input and output circuits, a rectifier coupled to the limiter tube input circuit, and means responsive to the rectified voltage output of said rectifier for opening or closing the energization circuit of at least one electrode of said limiter tube, said one electrode consisting of the screen grid electrode.

5. In a phase modulation receiver of the type operating in the ultra-high frequency range and including a limiter tube provided with input and output electrodes and a screen grid electrode, a direct current circuit for keeping said screen grid at a positive voltage, a rectifier coupled to the limiter tube input electrodes for deriving from relatively slow carrier amplitude variation a proportionally variable direct current voltage, means for controlling the gain of the receiver in response to said voltage, and additional means responsive to said voltage for controlling the limiter screen grid energization circuit.

6. In combination in an angular velocity-modulated carrier wave receiver including an amplitude modulation limiter tube of the screen grid type adapted to feed a following discriminator-rectifier, means energizing the screen grid of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, and ad-

ditional means responsive to a decrease in the received carrier amplitude below a predetermined value for rendering said energizing means inoperative thereby de-energizing the screen grid of the limiter tube thereby to render said limiter ineffective to transmit any electrical impulses.

7. In combination in an angular velocity-modulated carrier wave receiver including an amplitude modulation limiter tube adapted to feed a following discriminator-rectifier, said tube having at least one positive electrode, means energizing said positive electrode of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, relay means responsive to a decrease in the received carrier amplitude below a predetermined value for rendering said energizing means inoperative thereby to render said limiter ineffective to transmit any electrical impulses, and gain control means responsive to relatively slow carrier amplitude variation for automatically controlling the sensitivity of stages of said receiver prior to said limiter tube.

8. In combination in an angular velocity-modulated carrier wave receiver including an amplitude modulation limiter tube adapted to feed a following discriminator-rectifier, said limiter tube having at least one positive electrode, a direct current energizing circuit for energizing said positive electrode of said limiter tube to render it operative for substantially minimizing amplitude modulation effects which may exist on the received carrier, additional means responsive to a decrease in the received carrier amplitude below

a predetermined value for rendering said limiter ineffective to transmit any electrical impulses, said last means comprising a rectifier coupled to the limiter tube input electrodes, an electron discharge tube having an input electrode responsive to the rectified output of said rectifier, and a relay in the output circuit of said electron discharge tube for controlling said limiter tube energizing circuit.

9. In a phase modulation receiver of the type operating in the 400 to 500 megacycle range and including a limiter tube provided with input and output electrodes and a screen grid electrode, a direct current energizing circuit for the screen electrode, a rectifier coupled to the limiter tube input electrodes for deriving from relatively slow carrier amplitude variation a proportionally variable direct current voltage, means for controlling the gain of the receiver in response to said voltage, and a relay responsive to said voltage for controlling the limiter screen grid energization circuit.

10. In a phase modulation receiver of the type including a limiter tube provided with input and output electrodes and a screen grid electrode, a rectifier coupled to the limiter tube input electrodes for deriving from relatively slow carrier amplitude variation a proportionally variable direct current voltage, means for controlling the gain of the receiver in response to said voltage, and an electromagnetic relay means responsive to said voltage for controlling the limiter screen grid energization.

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