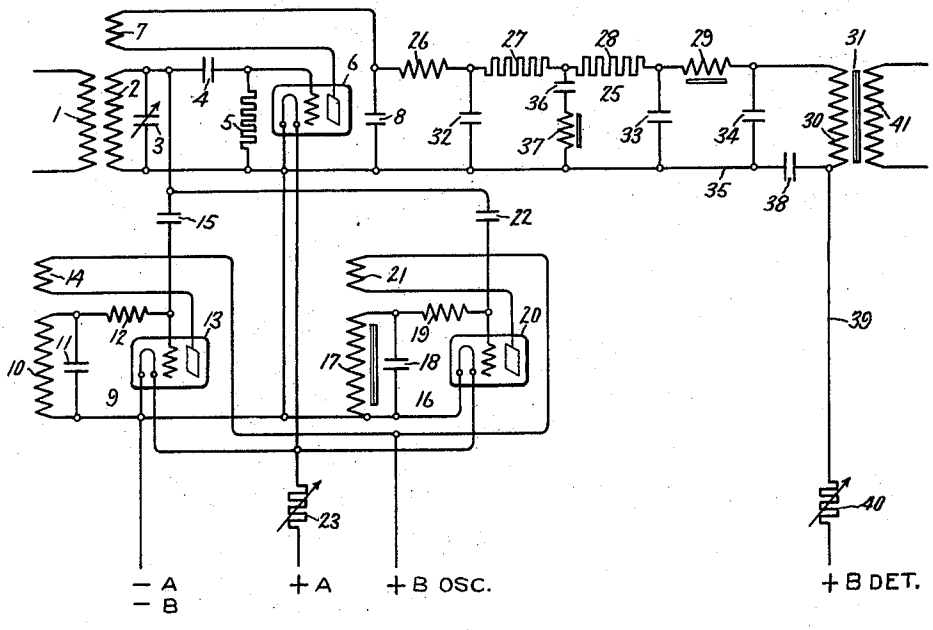
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SUPERREGENERATIVE RECEIVER

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SUPERREGENERATIVE RECEIVER

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My invention relates to regenerative radio receiving systems and more particularly to receiving systems of the type commonly called super-regenerative receivers which are readily adapted to the reception of ultra high frequency signal energy.

My invention has for one of its objects to provide means for introducing modulation and super-regeneration into an improved regenerative detector circuit which will not increase the broadening of the tuning and which will decrease the losses due to the normal damping of the detector circuit.

In accordance with my invention, I provide a pair of oscillators operating at audible and super-audible frequencies, and means for coupling these oscillators to the input circuit of a regenerative detector in such manner as to prevent interaction between the various circuits and to reduce the tendency to broaden the tuning and to reduce the losses at the signal frequency due to the normal damping of the detector circuit.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood by reference to the following description taken in connection with the accompanying drawing in which the single figure represents a radio receiver employing a preferred embodiment of my invention.

Referring to the figure of the drawing, I have illustrated therein, a super-regenerative receiving means having a coupling means 1 which is connected to a suitable source of ultra high frequency signal energy such as may be obtained from an antenna or a radio frequency amplifier. The coupling means 1 is inductively coupled to the input circuit of an electron discharge device by means of the inductor 2. The input circuit of the electron discharge device is tuned by suitable means which may be, for example, a capacitor 3. The input circuit may be provided with a grid condenser 4 and a grid leak 5 which will enable the electron discharge device to operate as a detector. This input circuit is connected to the grid element and the cathode of an electron discharge device 6, and regeneration is introduced into this circuit by means of an inductor 7 arranged in the anode circuit of the electron discharge device 6 and placed in an inductive relation to the inductor 2 of the input circuit. A capacitor 8 is connected between the regenerative inductor 7 and the cathode of the discharge device 6 to by-pass the radio frequency currents present in the output circuit. Any suitable form of input circuit and means for regeneration may be employed in the detector circuit as the arrangement disclosed is merely illustrative of a common means for obtaining this result.

A super-audible frequency oscillator 9 may be arranged as shown with an input circuit composed of an inductor 10 and a tuning capacitor 11 in parallel therewith, and a radio frequency choke 12 in series with these elements and the grid element of the oscillator discharge device 13. An inductor 14 in the anode circuit of the oscillator discharge device 13 is arranged in an inductive relation to the grid inductor 10. The electron discharge device 13 of the oscillator 9 is connected across the input circuit of the detector 6 by means of a coupling capacitor 15 connected to the grid element of the discharge device 13 and the grid condenser 4 of the detector input circuit, and a connection between the cathodes of the electron discharge devices 6 and 13. The radio frequency choke 12 arranged in the grid circuit of the oscillator 9 is of a value which presents a high impedance to the ultra high frequency energy present in the input circuit of the electron discharge detector 6, but presents a low impedance to the frequency of the oscillations generated by the electron discharge device 13. The impedance coupling member or capacitor 15 is sufficiently small in comparison with the capacitor 11 of the oscillator circuit to permit the electron discharge device 13 to oscillate at the desired frequency.

A second oscillation generator 16 is arranged to operate at a desired audible frequency. The grid circuit of the oscillator

16 is composed of an iron-cored inductor 17 having a tuning capacitor 18 in parallel therewith. A radio frequency choke 19 is connected in the grid circuit between the grid element of the oscillator discharge device 20 and the inductor 17. The anode circuit of the electron discharge device 20 is provided with an inductor 21 which is arranged in an inductive relation to the inductor 17 to permit the circuit to oscillate. The electron discharge device 20 of the oscillator circuit 16 is connected across the input circuit of the electron discharge detector 6 by means of a capacitor 22 arranged between the grid element of the oscillator discharge device 20 and the grid condenser 4 of the electron discharge detector 6, and the connection between the cathodes of the electron discharge devices 6 and 20. The impedance coupling member or capacitor 22 is of such value in comparison with the capacitor 18 of the oscillator circuit that the desired frequency of the oscillations in the oscillator 16 is not disturbed. The radio frequency choke 19 is of a value presenting a high impedance to the ultra high frequency energy present in the input circuit of the detector 6 but also presenting a low impedance to the frequency generated by the oscillations of the oscillator discharge device 20.

A variable resistor 23 is connected in the common return of the cathodes of discharge devices 6, 13 and 20 to provide a means for controlling the temperature of the cathodes. In the output circuit of the detector 6, I have arranged a filter 25 for reducing undesired frquencies such as those which comprise the background noise. This filter, while not essential to the operation of the super-regenerative detector, is a desirable feature, and is composed of an inductor 26, a resistor 27, a second resistor 28 and an iron-cored inductor 29 in series with the primary winding 30 of an output device 31. A plurality of capacitors 32, 33 and 34 are connected respectively between the elements 26 and 27, 28 and 29, 29 and 30 and the common return connection 35 which is connected to the cathodes of the electron discharge devices 6, 13 and 20. A capacitor 36 in series with an iron-cored inductor 37 is connected between the common return connection 35 and a point between the resistors 27 and 28. A capacitor 38 is connected between the return conductor 35 and the conductor 39 which is connected to one terminal of the primary winding 30 of the output device 31. A variable resistor 40 is arranged between a suitable source of potential for the anode of detector 6 and the conductor 39 for the purpose of providing a control of the potential applied to the anode of the detector 6. The secondary winding 41 of the output device 31 may be connected to an audio frequency amplifier or a suitable translating device.

In practicing my invention, the input circuit of the detector 6 is tuned by means of the variable capacitor 3 to receive desired ultra high frequency signals, and the anode potential of the detector is adjusted by means of the resistor 40 so that normally-sustained oscillations are present in the input circuit of the detector 6 and the audible frequency introduced by the oscillator 16 is present in the output only when a carrier wave is being received. With this adjustment, an audio frequency will be present in the output only at the time when continuous wave signals are being received.

The super-regenerative action is introduced into the detector 6 by means of the action of the electron discharge devices 13 and 20 operating in accordance with the frequencies generated by the oscillators 9 and 16. The incoming ultra high frequency signals which are of the continuous wave variety are modulated by the audible frequency generated by the oscillator 16 to provide a signal in the output circuit of the detector having a constant audio frequency, regardless of the frequency of the incoming signals or any variation therein. The signals produced in the output circuit of the detector 6 remain at a constant frequency regardless of any variations of the detector circuit variables as long as the frequency of the oscillator 16 is not altered.

It has been found that a certain relation exists between the signal frequency to be received and the oscillator frequency in ultra high frequency super-regenerative receivers which will produce the proper super-regenerative action resulting in optimum operation. For ultra high frequency reception, the audio frequency supplied by a source such as the oscillator 16 would be too low for proper super-regenerative action. To supply the proper frequency for such optimum operation, the oscillator 9 is provided in addition to the oscillator 16 which provides the necessary audio frequency component for the modulation of the signals. To obtain this desideratum in the operation of the receiver, the oscillator 9 is tuned so that the effect produced by the combined action of the two electron discharge devices 13 and 20 is such that the greatest sensitivity is obtained. The combined use of the electron discharge devices 13 and 20 results in a greater gain, greater ease in tuning and less critical adjustment of the component parts of the apparatus than would be the case if the proper frequency were not obtained.

In operation, the electron discharge devices 13 and 20 operate to periodically suppress the normally-sustained oscillations present in the input circuit of the detector 6, thereby varying the degree of regeneration present. These electron discharge devices 13 and 20 are enabled to perform this func-

tion by the arrangement of the coupling capacitor 15 and the radio frequency choke 12, and the coupling capacitor 22 and the radio frequency choke 19, which isolate the circuit elements associated with the electron discharge devices 13 and 20. This isolation of the associated apparatus of the discharge devices 13 and 20 from the input circuit of the electron discharge detector 6 so reduces the normal damping of the detector input circuit at the signal frequency that the losses are decreased and the system functions more readily, particularly at ultra high frequencies. When the electron discharge device 13 oscillates, it draws grid current once every cycle, and this grid current is in general, not a sine wave but a wave having a rather steep front. When the electron discharge device 13 draws grid current, the impedance between the grid element and the cathode within the device is relatively low. During the half-cycle when the grid current is not being drawn, the internal impedance between the grid element and the cathode is high, and the external circuit impedance between the grid and the cathode is at all times high because of the presence of the radio frequency choke 12. It will, therefore, be apparent that once during every cycle of the oscillation of the discharge device 13, the low grid-to-cathode impedance of this device is in shunt with the input circuit of the detector 6 which will alter the impedance of this input circuit to such an extent that the normally-sustained regenerative oscillations in the detector circuit will be suppressed until the grid element of the oscillator discharge device 13 is no longer drawing grid current. The steep wave front of the grid-to-cathode impedance change in the oscillator discharge devices 13 and 20 tends to increase the effect of the super-regeneration in the detector circuit of the electron discharge device 6. The oscillator 16 and its electron discharge device 20 operate in a manner similar to that of the oscillator 9 and the discharge device 13 except for the difference in frequency. In general, the anode potential supplied to the oscillator discharge devices should be low so as to help to produce a steep wave front on the grid current drawn by the discharge devices 13 and 20.

The manner of controlling the super-regenerative action by coupling the grid-to-cathode impedances of the oscillator discharge devices across the regenerative detector circuit has the advantage of requiring a less powerful oscillator and that undesired frequencies generated by the oscillators are not readily introduced into the detector circuit. My invention has the advantage of providing means for introducing modulation and super-regeneration into a regenerative circuit without materially increasing the losses due to the normal damping of the detector circuit, or broadening the tuning of the circuit.

While I have shown and described my invention in connection with certain specific embodiments, it will, of course, be understood that I do not wish to be limited thereto, since it is apparent that the principles herein disclosed are susceptible of numerous other applications, and modifications may be made in the circuit arrangements and in the instrumentalities employed without departing from the sprit and scope of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In combination, an electron discharge detector having an input circuit and an output circuit, said circuits being arranged to produce normally-sustained oscillations in said input circuit, an electron discharge device including a grid element arranged in an oscillatory circuit to produce high frequency oscillations having a steep wave front, impedance means for coupling said grid element to said detector input circuit whereby said electron discharge device periodically suppresses said normally-sustained oscillations in said circuit, and means included in said oscillatory circuit for isolating the circuit elements thereof from said detector input circuit.

2. A radio receiving circuit including an electron discharge detector, an input circuit and an output circuit therefor arranged in regenerative relation to produce normally-sustained oscillations, an electron discharge device arranged in an oscillatory circuit to produce high frequency oscillations having a steep wave front, means for capacitively connecting said electron discharge device across the input circuit to said detector whereby said electron discharge device periodically suppresses said normally-sustained oscillations in said input circuit, means included in said oscillator circuit for isolating the circuit elements thereof from said detector input circuit, means for modulating the signals in said input circuit, and means connected to said output circuit for reducing the background noise.

3. A radio receiving system including an electron discharge detector having an input circuit and an output circuit arranged in regenerative relation to produce normally-sustained oscillations, means for collecting high frequency signal energy, means for impressing said signal energy upon said detector input circuit, a high frequency oscillation generator including an electron discharge device, a low frequency oscillation generator including an electron discharge device, means for connecting said oscillation discharge devices across said detector input circuit, means included in each of said oscil-

lation generators for preventing the high frequency signal energy in said detector input circuit from entering said oscillation generators and for causing said oscillation generator discharge devices periodically to suppress said normally-sustained oscillations thereby to produce simultaneously a super-regenerative detector action and modulation of the high frequency signals.

4. In combination, an electron discharge detector arranged in a regenerative circuit to produce normally-sustained oscillations in said circuit, an electron discharge device including a grid element and a cathode arranged in a circuit to generate high frequency oscillations, means for coupling said grid element to said regenerative circuit whereby said electron discharge device periodically suppresses said normally-sustained oscillations to produce a super-regenerative detector action, and means connected to said grid element and included in said oscillation generator circuit to cause said grid element periodically to draw current having a steep wave front form, said means also serving to isolate said oscillation generator elements from said regenerative detector circuit.

5. In a high frequency radio receiving system, the combination of an electron discharge detector arranged in a circuit to produce normally-sustained oscillations in said circuit at the signal frequency, means for collecting high frequency signal energy and for impressing said energy upon said detector circuit, an electron discharge device including a grid element and a cathode arranged in a circuit to generate high frequency oscillations, means for coupling said grid element and said cathode to said detector circuit, whereby said electron discharge device periodically suppresses said normally-sustained oscillation to produce a super-regenerative detector action, and means connected to said grid element and included in said oscillation generator circuit to maintain at all times a high external impedance between said element and said cathode, said means also serving to prevent high frequency signal energy from entering the oscillation generator circuit.

6. A regenerative receiving circuit having an input circuit, said regenerative receiving circuit being arranged to produce normally-sustained oscillations, a plurality of electron discharge devices arranged in oscillatory circuits, each of said discharge devices having a grid element and a cathode, means for maintaining the external grid-to-cathode circuit impedance of said discharge devices high at all times and for causing the internal grid-to-cathode impedance to vary during each cycle of oscillation in accordance with a curve having a steep wave front, means for coupling the internal grid-to-cathode impedances of said discharge devices across the input circuit to said regenerative circuit whereby said discharge devices periodically suppress said normally-sustained oscillations to produce a super-regenerative action.

In witness whereof, I have hereunto set my hand.

CLARENCE A. GUNTHER.