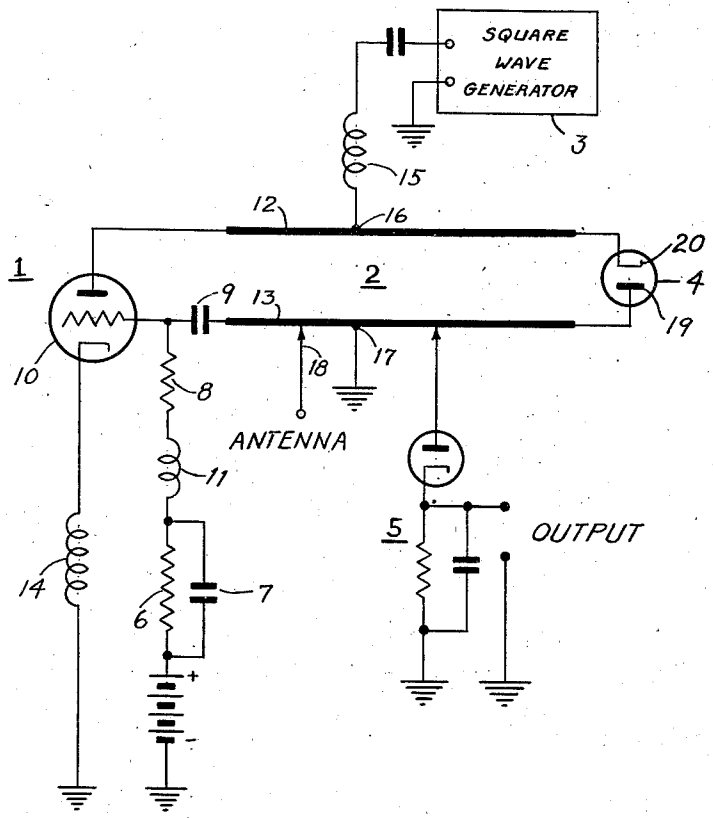
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SUPERREGENERATIVE RECEIVER QUENCHING CIRCUIT

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SUPERREGENERATIVE RECEIVER QUENCHING CIRCUIT

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The present invention relates to superregenerative receivers, and more particularly to an improved superregenerative receiver adapted for operation at high and ultra-high radio frequencies.

A superregenerative receiver may be characterized briefly as comprising a highly regenerative amplifier circuit in combination with a quenching means for alternately making the said circuit oscillatory and non-oscillatory, usually at a superaudible frequency rate. Although the superregenerative circuit has not been widely used in the past, it finds important application in certain specific instances, particularly at very high carrier frequencies, where great amplification is desired with a minimum of tubes, expense, and equipment.

The present invention is particularly directed to an improved method of, and apparatus for, quenching the oscillating circuit of a superregenerative receiver. While the said method and apparatus is applicable to superregenerative receivers generally, it is particularly useful where very high quenching frequencies, e. g. of the order of a megacycle or more, are to be employed. Quenching frequencies of this magnitude are used, for example, where it is desired to employ a superregenerative receiver in the reception of radar or radar-beacon signals. Such signals are commonly time-spaced pulses transmitted in the form of a series of ultra-high frequency pulse signals (interrupted continuous waves). A typical system may use pulses of one or two microseconds duration, occurring at a repetition rate of 500 to 1000 per second, and modulated on an ultra-high frequency carrier wave. Manifestly, where the individual pulses have a duration of only a microsecond, it would be impractical to employ superregenerative receivers utilizing quenching frequencies of less than a megacycle, since otherwise many of the received pulses might go undetected.

When superregenerative receivers employing very high quenching frequencies were first constructed, a serious problem, which had not previously been met, was encountered. It was found that when a very high quenching frequency was employed, it was impossible, by conventional quenching methods, to insure adequate quenching in the brief intervals between the oscillatory periods of the superregenerative circuit. It was soon evident, however, that, at the end of each quenching interval, it is highly important that no substantial carrier oscillation (preferably not even a microvolt) be present in the tank circuit of the quenched oscillator. If such oscillations,

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"hang-overs" from the previous oscillatory period, be present, they cause the sensitivity of the receiver to vary with incoming carrier signal frequency. In such circumstances the receiver's sensitivity vs. frequency characteristic exhibits a series of peaks separated, along the frequency axis, by distances equal to the quenching frequency. Since such a characteristic is undesirable, it is important that complete quenching be attained in each quenching interval.

Prior to the conception of the present invention it was known that reasonably complete quenching, with very high quenching frequencies, could be effected by employing a high impedance, low Q tank circuit, i. e. a tank circuit whose decrement, or self-damping factor, was very high. This was not considered a satisfactory solution to the quenching problem, however, because of the inefficiencies introduced by the low Q tank circuit.

Accordingly, in order to provide an adequate quenching arrangement, the present invention utilizes a special damping means which functions only during the quenching interval and hence does not deleteriously affect the operation of the receiver during the oscillatory period.

It is, therefore, an object of the present invention to provide an improved superregenerative receiver for operation at high and ultra-high radio frequencies.

It is another object of the present invention to provide an improved superregenerative receiver capable of efficiently receiving high frequency pulse signals of short duration.

It is still another object of the present invention to provide an improved superregenerative receiver adapted for operation with very high quenching frequencies.

It is another object of the present invention to provide an improved superregenerative detector circuit having a low impedance high Q tank circuit.

It is still another object of the present invention to provide an improved arrangement for quenching a superregenerative receiver capable of operating in the ultra-high frequency region.

These and other objects will subsequently become apparent by reference to the following description taken in connection with the accompanying drawing, wherein the single figure shows a circuit diagram of a superregenerative receiver constructed in accordance with the present invention.

Reference may now be had to the improved superregenerative receiver circuit shown schematically in the drawing. Basically, this circuit com-

prises an oscillator 1 having a resonant line tank circuit 2, a square wave generator 3 for supplying a suitable quenching voltage wave, an electronic damping element 4, and a signal detector circuit 5 for rectifying a portion of the signal developed by the oscillator 1. The resonant line 2 may, of course, be a coaxial line rather than the parallel conductor line illustrated.

The oscillator 1, with its resonant line tank circuit, is in part conventional, and will be recognized as the well known Colpitts arrangement. The oscillator includes, however, a novel grid biasing arrangement which greatly improves the performance of the oscillator, per se, and the efficiency and stability of the superregenerative system in general. This novel grid biasing arrangement, is fully described and claimed in my co-pending application Serial No. 545,078, filed July 15, 1944.

Briefly, this biasing arrangement comprises a compound grid leak and condenser circuit consisting of a first leak and condenser combination 6—7 of long time constant and a second leak and condenser combination 8—9 of short time constant. Preferably the latter time constant is less than the time constant of the resonant line 2, while the first-mentioned time constant is greater than the maximum period of the modulation signals to be received. The grid coupling condenser 9 is preferably small, e. g. of the order of the inter-electrode capacitances of the oscillator tube 10. If desired, a small, self-resonant choke 11 may be provided in series with the resistors 6 and 8, as explained in the above-mentioned co-pending application. The detector circuit 5 is also described in the said co-pending application.

The oscillator tank circuit 2 consists of a resonant transmission line comprising parallel conductors 12 and 13 The line 2 is preferably somewhat shorter than a half wave-length, so that its effective length as modified by the several terminating tube capacities, is substantially a half wavelength. The connections between the grid and plate electrodes of the triode 10 and the tank circuit 2 are conventional. The cathode of triode 10 may be connected to ground through a suitable RF choke 14.

A direct current source of plate voltage may be provided for the oscillator tube 10, if desired, but it is preferred to omit this, and to derive the necessary plate power from the square wave generator 3 which functions, in a manner well known in the art, both as an external or separate quenching voltage source and as a plate power source. Although reference is here made to the generator 3 as a square wave generator, it will be understood, of course, that the specific wave shape employed is not a critical factor, and consequently the present invention is not to be construed as limited to the use of any specific wave form.

A radio frequency choke coil 15 is preferably included in the connection between the high voltage terminal of the square wave generator 3 and the anode circuit of triode 10. Where the high voltage plate source 3 is connected to the anode of tube 10 by way of one of the conductors of the resonant line 2, it is preferred that the connection 16 be made at the point of minimum RF potential on the line conductor 12. The point 17 of minimum RF potential on the other line conductor 13 may be connected to ground as shown. In general, the points 16 and 17 will be an electrical quarter wave length (including the effect of the electrode capacities) distant from the grid and plate electrodes of the triode 10. A tap connection 18 may be provided on the line conductor 13 to serve as means for coupling a suitable antenna to the resonant tank circuit.

In accordance with the present invention, and in order to insure complete and rapid damping in each quenching interval, there is provided an electronic damping element 4, conveniently a diode, whose electrodes are connected across the open end of the resonant line 2. As shown in the drawing, the anode 19 should be connected to the grounded line conductor 13, while the cathode 20 should be connected to the high voltage line conductor 12. During the oscillatory period, i. e. the period when the high voltage positive alternation of the square wave generator 3 is applied to the line conductor 12, the diode 4 is non-conductive, since its cathode 20 is highly positive with respect to its anode 12. When the diode is thus non-conductive, it constitutes only a small capacitance across the open end of the line 2, and it has only a negligible effect on the starting time of the oscillator. However, during the negative alternations of the voltage supplied by the square wave generator 3, the diode 4 is highly conductive, and hence it constitutes a relatively low impedance short circuit across the right-hand end of the line. If the characteristic impedance of the line 2 is of the order of the internal impedance of the diode 4, the diode will have a very powerful quenching or damping action. Under these conditions the diode will absorb oscillations very quickly. Where the impedance match between the diode and the line is perfect the quenching or damping is complete after one cycle of the carrier signal. In practice it has been found that lines having characteristic impedances of the order of 500 ohms yield very satisfactory results in combination with diode structures presently available.

Although the present invention has been described with particular reference to the single embodiment of the drawing, it will be understood that the invention is capable of various forms of physical expression, and consequently is not limited to the specific disclosure, but only by the scope of the appended claims.

I claim:

1. In a superregenerative radio receiver, the combination comprising an oscillator tube having at least a grid, a cathode, and an anode, a resonant tank circuit comprising a segment of transmission line whose length is of the order of a half wave length of the carrier signal to be received, a source of alternating voltage having its terminals connected across said transmission line at a point of low radio frequency potential, said source functioning during odd half-cycles as a source of plate potential for said tube and during even half-cycles as a separate oscillation quenching means, and a diode connected across said transmission line at a point of high radio frequency potential, said diode being so connected that it acts as a short circuit on said line only during the said even half-cycles.

2. In a superregenerative radio receiver, the combination comprising a resonant line whose electrical length is somewhat less than a half wave length at the operating frequency, an oscillator tube coupled to one end of said line, a diode connected across the other end of said line, said line, modified by the shunt capacities of said oscillator tube and said diode, being effectively an electrical half wave length long at said operating fre-

quency, and a source of alternating voltage connected across said line at a point intermediate the ends thereof.

3. In a superregenerative radio receiver, the combination comprising a resonant line whose length is of the order of a half wave length at the operating frequency, said resonant line consisting of a first line conductor and a second line conductor, an oscillator tube having its anode coupled to one end of said first conductor and its grid coupled to the corresponding end of said second conductor, a diode having its cathode connected to the other end of said first conductor and its anode connected to the corresponding end of said second conductor, and a source of alternating voltage connected across said line at a point near the electrical center thereof, said source serving alternately as a source of oscillator plate voltage and as a source of oscillator quenching voltage.

4. In a superregenerative radio receiver, the combination comprising a resonant line, an oscillator tube coupled to one end of said line, said line serving as a tank circuit for said tube, damping means comprising a diode connected to the other end of said line, and a source of alternating voltage connected across said resonant line at a point intermediate the ends thereof, said source serving during positive voltage alternations as a

source of plate current for said oscillator tube, and serving during negative oscillations to render said diode conductive, whereby rapidly to damp the electrical oscillations established in said tank circuit during said positive alternations.

5. In a superregenerative radio receiver, the combination comprising a resonant line whose electrical length is somewhat less than a half wave-length at the operating frequency, an oscillator tube coupled to one end of said line, said line serving as a tank circuit for said tube, a diode connected across the other end of said line, the internal impedance of said diode being approximately equal to the characteristic impedance of said line, said line as modified by the presence of said oscillator tube and said diode being effectively an electrical half wave-length long at said operating frequency, and a source of alternating voltage connected across said resonant line at a point which electrically is substantially one-quarter wave-length from either end thereof, said source serving during positive voltage alternations as a source of plate current for said oscillator tube, and serving during negative oscillations to render said diode conductive, whereby rapidly to damp the electrical oscillations established in said tank circuit during said positive alternations.

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