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SELF-QUENCH SUPERREGENERATIVE ARRANGEMENT

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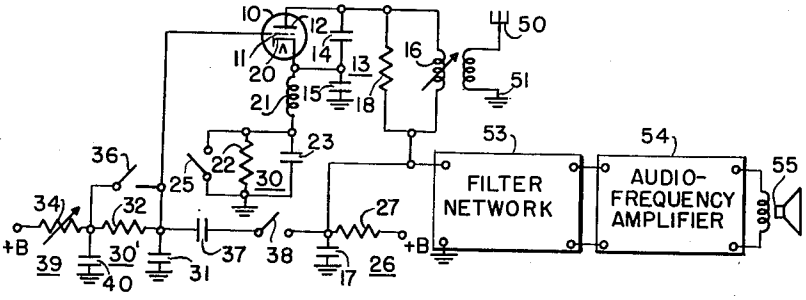


FIG. 1

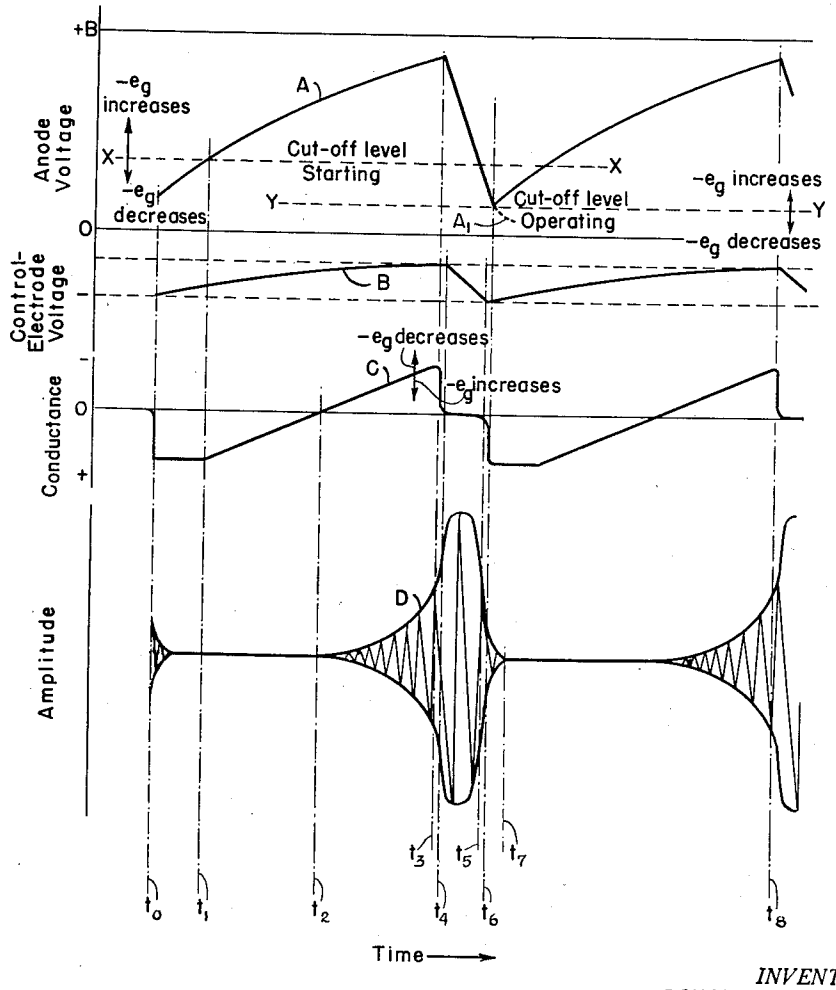


FIG. 2

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SELF-QUENCH SUPERREGENERATIVE ARRANGEMENT

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10 Claims. (Cl. 250—20)

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This invention is directed to self-quench superregenerative arrangements and, particularly, to self-quench superregenerative arrangements which include a resistor-condenser network coupled between the anode and the cathode of the regenerator tube thereof to have developed thereacross a periodic voltage which provides a major portion of the self-quenching action for the arrangement. Such superregenerative arrangements are frequently referred to as anode-circuit self-quench superregenerative arrangements.

Anode-circuit self-quench superregenerative arrangements have been found to provide a higher audio-frequency output than those self-quench superregenerative arrangements which employ in the control electrode-cathode circuit thereof a resistor-condenser network for deriving the periodic self-quench voltage. This results because the output signal of an anode-circuit self-quench arrangement is derived from the anode circuit of the regenerator tube, which circuit includes no impedance networks which may provide a degenerative action for currents of modulation-signal frequencies. Such arrangements are desirable not only because of their high audio-frequency output but also because of their simplicity of construction and their inexpensiveness. For some applications of anode-circuit self-quench superregenerative arrangements, the self-quench frequency which is employed must exceed a predetermined value in order to provide satisfactory performance. Heretofore, it has frequently been impossible to obtain with an arrangement of this type a self-quench frequency which is sufficiently high to assure such performance.

The control-electrode bias of the regenerator tube of an anode-circuit self-quench superregenerative arrangement must have a sufficiently large negative value to promote the periodic blocking action which is characteristic of such an arrangement. This large negative value of bias is effective to limit the transconductance obtainable from the regenerator tube to such an extent that operation at the desired high self-quench rates may not be possible. Attempts have heretofore been made to adjust the time constant of the self-quench network in the anode circuit of prior superregenerative arrangements to provide a higher quench frequency. This expedient resulted in unstable operation of the arrangement or produced undesired continuous-wave operation thereof.

It is an object of the invention, therefore, to

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provide a new and improved self-quench superregenerative arrangement of the type described which avoids one or more of the above-mentioned disadvantages and limitations of prior such arrangements.

It is another object of the invention to provide a new and improved self-quench superregenerative arrangement of the type described which is capable of producing an output signal of relatively large amplitude.

It is a further object of the invention to provide a new and improved self-quench superregenerative arrangement of the type described which operates stably over a relatively wide range of self-quench frequencies.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In accordance with the invention, a self-quench superregenerative arrangement comprises a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between the anode and the cathode of the tube. The aforesaid network includes a resistor and a condenser which is responsive to the anode current of the tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for the superregenerative circuit to effect alternate build-up and oscillation decay intervals in the regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to the superregenerative circuit. The arrangement further includes a second impedance network coupled between the control electrode and the cathode of the regenerator tube and responsive to the control-electrode current of the tube and including a resistor and a condenser having a capacitance large with relation to that of the first-mentioned condenser that the second network is effective to derive from the control-electrode current and to apply to the control electrode during each quench cycle a voltage effective to provide a supplementary quenching action for the superregenerative circuit.

Referring now to the drawing, Fig. 1 is a circuit diagram, partly schematic, representing a complete self-quench superregenerative receiver embodying the present invention in a particular

form; and Fig. 2 comprises graphs used in explaining the operation of the receiver of Fig. 1.

Referring now more particularly to Fig. 1 of the drawing, the superregenerative receiver comprises a self-quench regenerative circuit including a regenerator tube 10 having a control electrode 11 and an anode 12 which are effectively coupled, in a manner to be more fully described hereinafter, across a parallel-resonant or frequency-determining circuit 13. The frequency-determining circuit 13, which comprises the regenerative oscillatory circuit of the receiver includes serially connected condensers 14 and 15, which are coupled between the anode 12 of the tube 10 and ground, and also an adjustable inductor 16 which is effectively coupled in shunt with the condensers 14 and 15 through a condenser 17 which presents a low impedance to radio-frequency wave signals. A damping resistor 18 is included in the frequency-determining circuit and is coupled in shunt with the inductor 16. This resistor provides sufficient positive damping within the frequency-determining circuit during each positive-conductance interval as to ensure that the oscillations generated therein in each quench cycle decrease to an insignificant amplitude before the initiation of a succeeding quench cycle. The tube 10 has a cathode 20 which is coupled to the junction of the condensers 14 and 15 and is also coupled to ground through a radio-frequency choke coil 21 and a parallel-connected resistor 22 and condenser 23, more fully to be considered hereinafter. A switch 25 is connected across the resistor 22 for a purpose to be explained subsequently.

The receiver also includes a first impedance network 26 coupled, in a manner presently to be explained, between the anode 12 and the cathode 20 of the tube 10. This network includes a resistor 27, which is coupled between the damping resistor 18 and a source indicated as +B, and an energy-storage device comprising the condenser 17 which has developed thereacross during each quence cycle a voltage of variable magnitude providing the major portion of the quenching action for the superregenerative circuit. The network 26, therefore, essentially corresponds to a conventional time-constant network in the anode circuit of the tube 10 and has a time constant of suitable value to effect an anode-circuit self-quenching action, thereby controlling conductance variations of the regenerative circuit to provide superregenerative operation in the saturation-level mode. The values of the resistor 27 and the condenser 17 are selected in the well-known manner to provide a quench voltage having the desired wave shape for the particular application for which the superregenerative arrangement is to be employed.

The superregenerative receiver also includes a second impedance network, ordinarily having a time constant which is short with relation to the time constant of the network 26, coupled between the control electrode 11 and the cathode 20 of the tube 10. This second network includes a resistor and an energy-storage device or condenser. One of the parameters of the second impedance network has a value so selected with relation to the impedance value of the first impedance network 26 that the second network derives, for application to the control electrode 11 during each quench cycle, a voltage which is effective to provide a supplementary quenching action for the superregenerative circuit. In particular, the capacitance of the condenser of the second impedance network is selected with relation to the capacitance of the condenser 17 of the network 26 to provide the action just mentioned. This second network may comprise a network 30, including the parallel-connected resistor 22 and the condenser 23, coupled between the cathode of tube 10 and ground. Alternatively, this network may comprise a similar network 30' which is coupled between the control electrode 11 and ground. The network 30' includes a condenser 31 coupled between the control electrode 11 and ground and, in general, having a value of capacitance greater than that of the condenser 17, for example one which is about ten times the value of capacitance of the condenser 17. The last-mentioned network also includes a resistor 32, one terminal of which is connected to the control electrode 11 while the other terminal thereof is connected to the source +B through a resistor 34. A switch 36 is coupled in shunt with the resistor 32, and a serially connected condenser 37 and a switch 38 are coupled between the control electrode 11 and the junction of the resistor 27 and the condenser 17 for a purpose to be explained subsequently.

The receiver further includes a third impedance network 39 for providing stabilization of the operating characteristics of the superregenerative circuit against variations of operating conditions which tend to modify the average self-quench periodicity thereof. This network includes the resistor 34 and a condenser 40 which is coupled between ground and the junction of the resistors 32 and 34. The network 39 has a time constant which is in general longer than that of any of the networks 26, 30 or 30' and also longer than the average self-quench periodicity of the receiver; it is effective to provide grid-circuit stabilization of the type disclosed and claimed in applicant's copending application Serial No. 788,765, filed November 28, 1947, entitled "Self-Quench Superregenerative Receiver."

Received wave signals are applied to frequency-determining circuit 13 of the receiver by an antenna-ground system 50, 51 which is inductively coupled to the inductor 16. Modulation components of the received wave signal are derived across the anode resistor 27 by the operation of the superregenerative circuit and are applied to a low-pass filter network 53 which is effective to translate the derived components while removing the quench-frequency components appearing in the output signal of the superregenerative circuit. The output terminals of the filter network 53 are coupled through a conventional audio-frequency amplifier 54 to a signal-reproducing device 55.

Considering now the operation of the superregenerative receiver just described, and referring to the curves of Fig. 2, it will be assumed initially that the switches 25 and 36 are closed, that the switch 38 is open, and that the impedance network 39 provides a predetermined negative bias to the control electrode 11 of the tube 10. It will also be assumed that the magnitude of the anode-energizing potential is increased gradually from its zero value until it reaches a value indicated by the broken line X—X shown in association with curve A of Fig. 2. The magnitude of this potential, when it has the value last mentioned, is such that at a time t_1 a small anode current starts to flow so that oscillations are initiated in the receiver in the well-known manner. This value of the potential may therefore be referred to as the anode-voltage cutoff potential level for

the starting of oscillations. It will be manifest that when the magnitude of the bias potential applied to the control electrode of the tube 10 is increased in the negative direction this anode-voltage cutoff level for the starting of oscillations is shifted in the direction of the +B potential level. Conversely the anode-voltage cutoff level will be displaced downwardly toward the zero voltage level as the control-electrode bias is made more positive in value.

Assume now that the full voltage of the source +B is instantaneously applied to the receiver. The condenser 17 then charges in the manner represented by curve A, thereby gradually to increase the anode potential of the tube 10, until at time t_1 the effect of the control-electrode bias on the tube 10 is overcome by the rising anode potential and the tube is rendered conductive. At time t_3 anode-current saturation takes place, causing a large flow of anode current, and the condenser 17 thereupon proceeds to discharge through the space-current path of the tube 10. It continues to discharge to a predetermined level which depends on the parameters of the superregenerative circuit. In order for the superregenerative oscillator to block, it is necessary that the anode potential of the regenerator tube 10 fall below the X—X level to the oscillator cutoff level Y—Y. The anode-voltage cutoff level Y—Y is the level of the average anode voltage at which the circuit ceases to function as a class C oscillator. This voltage level is, of course, lower than the anode-voltage cutoff level when the superregenerative circuit is operating as a class A amplifier or oscillator. The anode-voltage cutoff level Y—Y is reached at approximately time t_6. The level Y—Y is also determined by the value of the control-electrode bias as well as the oscillator parameters. If this negative bias is too small in value, there exists the danger that the desired blocking action will not occur at time t_6 but that the anode voltage will simply decrease to some relatively stable and constant value. The receiver then might operate stably as a continuous-wave oscillator having an anode potential of value lying in a region indicated by the broken-line portion A_1, instead of having the anode potential appearing across the condenser 17 increase in the manner represented by the curve A during the interval t_6—t_8, and then decrease due to the discharge of the condenser 17 through the space-current path of the tube 10.

From the foregoing explanation, it will be clear that the control-electrode bias of the tube 10 must have a value which is sufficiently large to permit periodic blocking of the superregenerative circuit to occur by virtue of the variation in the magnitude of the anode potential effected by the condenser 17. The magnitude of this bias has a direct effect on the shape of the negative-conductance portion t_2—t_3 of the conductance-time characteristic of the superregenerative receiver which is represented by curve C. In particular the bias limits the maximum transconductance which may be obtained from the tube. When the control-electrode bias is increased in a negative direction, not only does the area under the negative-conductance portion of the conductance characteristic decrease but also the extent to which the transconductance of the tube 10 increases during the oscillatory build-up interval t_2—t_3 is reduced. Curve D represents the variation of amplitude of the oscillations which are periodically developed in the resonant circuit 13 of the receiver by the superregenerative action thereof. Since the gain of a superregenative receiver measured in napiers is proportional to the area under the negative-conductance portion of its conductance time characteristic, a high negative control-electrode bias on the tube 10 results in a low gain for the receiver in a given interval of time. With such a bias on the tube, the time required to produce the gain necessary to reach the saturation level of the superregenerative circuit is relatively long, thus resulting in satisfactory operation only at low quench rates. Consequently, the magnitude of the control-electrode bias on the tube 10 is quite critical. In fact, it is very difficult or frequently impossible under some operating conditions to procure the proper blocking action in the superregenerative receiver when arranged with a fixed bias as assumed above. This is particularly true when the operation involves high quench rates since a small control-electrode bias is required for high gain yet a small bias is conductive to undesired continuous-wave operation.

The shortcomings of the superregenerative receiver when the control electrode of the regenerator tube 10 has a substantially uniform bias thereon, and also the undesirable tendency of the receiver to operate as a continuous-wave oscillator, may be eliminated by opening the switch 36 thereby connecting the network 30' in operative relation in the receiver circuit.

The operation of the superregenerative receiver with the networks 30' and 39 in the circuit thereof, and with the switches 36 and 38 open and the switch 25 closed will now be explained. The application of energizing potentials to the receiver within the operating range of values will cause the receiver to operate in the desired superregenerative manner. When the source +B has its normal value, the potential developed across the condenser 17 of the impedance network 26 for application to the anode 12 of the tube 10 will increase in value as represented by curve A during the interval t_0—t_3. At approximately time t_2, the increasing anode voltage causes the conductance of the superregenerative circuit to change from a positive to a negative value as shown by the curve C. At time t_2, oscillations begin to build up in the resonant circuit 13 in the manner represented by curve D and thereafter reach a saturation-level value during the interval t_3—t_6. At time t_3 the tube 10 becomes highly conductive and the flow of anode current therein is effective to discharge the condenser 17 and to reduce the anode potential during the interval t_3—t_6 as shown by curve A. At time t_6, the anode potential has dropped to a sufficiently low level that tube 10 is biased to anode-current cutoff, thus terminating the saturation-level interval. Shortly thereafter at time t_7 (curve D) oscillations in the frequency-determining circuit are completely quenched.

At time t_4 control-electrode current begins to flow in the tube 10 and a negative bias, which increases in magnitude in a negative direction as represented by curve B (assuming now that the receiver has been operating for a period of several quench cycles), is developed across the condenser 31 for application to the control electrode 11 of the tube. The relatively large voltage of variable magnitude developed across the condenser 17 of the network 26, and which is shown by curve A of Fig. 2, is effective to provide the major portion of the quenching action for the superregenerative circuit. However, the voltage developed across the condenser 31 during the interval t_4—t_5, which interval substantially corresponds to the satura-

tion-level interval, is of such magnitude and sense that it is effective materially to reduce the transconductance of the regenerator tube 10 during the saturation-level interval and thereby provide a supplementary quenching action for the superregenerative circuit. Accordingly the combined action of the networks 26 and 30' makes it certain that the superregenerative receiver will periodically block, thus eliminating the possibility of the receiver operating as a continuous-wave oscillator.

During the interval t_6—t_8, the condenser 17 charges through the resistor 27 from the source +B as shown by curve A and the described cycle of operation is repeated. During the same interval, the condenser 31 is discharged through the resistor 32 so that the bias appearing across the condenser 31 becomes less negative as shown by curve B. Consequently the transconductance of the tube 10 is materially increased during this interval, and particularly during the negative-conductance interval of the receiver when it is most desirable to procure a high superregenerative gain. It will be seen, therefore, that the voltage level developed across the condenser 31 for application to the control electrode of the tube 10 is a gain-control potential varying in the same sense as the voltage developed across the condenser 17 but is smaller in magnitude with relation thereto. This gain-control voltage is effective to provide a desired supplementary quenching action for the superregenerative circuit, and preferably has a peak-to-peak value which is from 5 to 50 per cent of that value which the peak-to-peak control-electrode voltage would have if the quenching action were to be completely produced thereby in the control electrode-cathode circuit of a similar superregenerative receiver.

A supplementary quenching action similar to that just described is provided by the network 30 when the switch 25 is opened, so that the network 30 is connected in the cathode circuit of the tube, the switch 36 being then closed effectively to remove the network 30' from the superregenerative circuit. The network 30 responds to the anode current of the tube 10 and derives therefrom a voltage of variable magnitude which when applied to the control electrode of the tube 10 corresponds to that represented by curve B.

When the switches 25 and 38 are closed and the switch 36 is opened, the impedance network 30' will also respond to changes in the anode voltage of the tube 10 and develop a voltage of variable magnitude which is so related to the voltage developed across the condenser 17 of the network 26 that a supplementary quenching action is afforded by the network 30'. The condensers 37 and 31 act as a voltage divider and derive a voltage across the condenser 31 which varies in the same sense as, but having a value small with relation to, the voltage produced across the condenser 17.

Consider now the operation of the superregenerative receiver when a wave signal is applied to the frequency-determining circuit 13 by the antenna system 50, 51 and when the stabilizing network 39 is performing its desired function. The oscillatory build-up interval of each self-quench period of the superregenerative circuit tends to be decreased by the received signal since the signal amplitude is greater than the thermal-agitation noises of the receiver. That is, the oscillations tend to build up to the saturation-level amplitude sooner than when no signal is applied to the circuit 13. For reasons well known, this tends to effect an increase of the self-quench periodicity of the receiver. As more fully explained in applicant's previously mentioned copending application, variations in the operating conditions to which the receiver is normally subjected in operation (such as variations of potential of the source +B or variations of the average amplitude of the received wave signal) undesirably tend to modify the average self-quench periodicity of the receiver. However, for reasons more fully described in applicant's above-mentioned application, the impedance network 39 is responsive to the control-electrode current flowing in the network during each saturation-level interval of the superregenerative circuit to develop and apply to the control electrode 11 of the tube 10 a gain-control potential which maintains the average self-quench frequency substantially constant. This stabilizes the operating characteristics of the receiver against variations of the type mentioned above. The self-quench period of the superregenerative circuit is able, however, to vary dynamically in accordance with the amplitude modulation of the received wave signal. These dynamic variations of the quench rate are manifest as dynamic variations of the anode current of the tube 10. Accordingly, this current may be utilized to derive the modulation components of the received wave signal. In particular, the modulation components are developed across the resistor 27, are applied through the filter network 53 to the audio-frequency amplifier 54 for amplification therein, and are then translated to the signal-reproducing device 55.

Because of the action of the network 30 or 30' and the network 26 in providing a high transconductance for the tube 10 during the negative-conductance intervals, received wave signals are given a very high rate of amplification by the superregenerative receiver. The receiver is able to develop sufficient superregenerative gain to assure reliable operation at high quench frequencies. Because the modulation components of the received signal are derived in the anode circuit of the tube 10, and also because the condenser 40 in the stabilizing network 39 presents an extremely low impedance to the audio-frequency components of the received signal, degeneration of the derived modulation components does not occur. The reduced transconductance of the tube 10 effected by the network 30 or 30' and the network 26 during the discharge interval of the condenser 17 assures the desired intermittent blocking or quenching action of the superregenerative circuit over a wide range of quench frequencies including the higher quench frequencies. These operating characteristics, effected by the action of the networks 30 or 30' and 26, permit the values of the resistor 27 and the condenser 17 of the primary quench-determining network 26 to be selected with a considerable degree of freedom. Such may be desirable, for example, to provide a quench voltage having a desired wave shape and thereby to provide a desired conductance time characteristic for the receiver. Thus, since the slope of the conductance characteristic as it passes through zero value from positive to negative values is effective to determine the selectivity of the receiver, the freedom with which the parameters of the network 26 may be selected readily permits the attainment of a quench-voltage wave shape which assures a desired selectivity characteristic for the receiver.

While applicant does not intend to limit the

invention to any particular design constants, the following values have been found suitable for a particular embodiment of the invention:

Condensers 14 and 15 ___ micromicrofarads ___	30
Condenser 17 ___ do ___	200
Condenser 23 ___ microfarad ___	0.02
Condenser 31 ___ micromicrofarads ___	2,000
Condenser 37 ___ do ___	200
Condenser 40 ___ microfarads ___	10
Resistor 18 ___ ohms ___	15,000
Resistor 22 ___ do ___	100
Resistor 32 ___ do ___	1,000
Resistor 27 ___ do ___	22,000
Resistor 34 ___ megohm (max.) ___	1
Tube 10 ___ type 12AT7 ___	½
+B ___ volts ___	100
Resonant frequency of circuit 13 megacycles ___	21.75
Approximate quench frequency kilocycles ___	30

From the foregoing description of the invention, it will be manifest that a self-quench superregenerative arrangement in accordance with the invention is capable of producing an output signal having a relatively large amplitude. It will be further apparent that a self-quench superregenerative arrangement embodying the present invention is capable of operating stably over a relatively wide range of self-quench frequencies.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and a condenser which is responsive to the anode current of said tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; and a second impedance network coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube and including a resistor and a condenser having a capacitance large with relation to that of said first-mentioned condenser that said second network is effective to derive from said control-electrode current and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit.

2. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which is responsive to the anode current of said tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; and a second impedance network coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube and including a resistor and an energy-storage device having an energy-storage value sufficiently greater than that of said first-mentioned device that said second network is effective to derive from said control-electrode current and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit.

3. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which together have a predetermined time constant and which are responsive to the anode current of said tube such that there is developed across said device during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; and a second impedance network, having a time constant which is short with relation to said predetermined time constant, coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube and including a resistor and an energy-storage device having an energy-storage value so selected with relation to that of said first-mentioned device that said second network is effective to derive from said control-electrode current and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit.

4. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which is responsive to the anode current of said tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; and a second impedance network so coupled between said control electrode and said cathode as to be primarily responsive to the anode current of said tube and including a resistor and an energy-stor-

age device having an energy-storage value sufficiently greater than that of said first-mentioned device that said second network is effective to derive from said anode current and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit.

5. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which is responsive to the anode current of said tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; a condenser coupled between said control electrode and said first impedance network; and a second impedance network included in the control-electrode circuit of said tube and comprised by a resistor and an energy-storage device having an energy-storage value sufficiently greater than that of said first-mentioned device that said second network is effective to derive from said voltage and to apply to said control electrode during said each quench cycle a second voltage effective to provide a supplementary quenching action for said superregenerative circuit.

6. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which is responsive to the anode current of said tube and has developed thereacross during each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit; and a second impedance network coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube and including a resistor and an energy-storage device having an energy-storage value substantially ten times as great as that of said first-mentioned device that said second network is effective to derive from said control-electrode current and to apply to said control electrode during said each quench cycle a voltage varying in the same sense as said first-mentioned voltage but small in magnitude with relation thereto, whereby said second-mentioned voltage is effective to provide a supplementary quenching action for said superregenerative circuit.

7. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit including a regenerative oscillatory circuit, a regenerator tube having an anode, a cathode, and a control electrode and including a first impedance network coupled between said anode and said cathode, said network including a resistor and an energy-storage device which is responsive to the anode current of said tube and has developed thereacross during said each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit to effect alternate build-up and oscillation decay intervals in said regenerative oscillatory circuit, thereby to provide superregenerative amplification of a wave signal applied to said superregenerative circuit, the parameters of said superregenerative circuit being so proportioned that the oscillatory amplitude of said wave signal extends to a saturation level during an interval of each quench cycle; and a second impedance network coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube and including a resistor and an energy-storage device having an energy-storage value sufficiently greater than that of said first-mentioned device that said second network is effective to derive from said control-electrode current and to apply to said control electrode during said each quench cycle a voltage having a variable magnitude so related to that of said first-mentioned voltage that said second-mentioned voltage is effective to produce a high transconductance for said tube during the oscillatory building interval of said superregenerative circuit and a lower transconductance for said tube during the saturation-level interval of said superregenerative circuit, whereby said second-mentioned voltage provides a supplementary quenching action for said superregenerative circuit.

8. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit, including a regenerator tube having an anode, a cathode, and a control electrode, for providing superregenerative amplification of a wave signal applied thereto, the oscillatory amplitude of said circuit extending to a saturation-level mode of operation during an interval of each quench cycle; a first time-constant network coupled between said anode and said cathode and including a resistor and an energy-storage device which has developed thereacross during said each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit; a second time-constant network, having a time constant shorter than that of said first network, coupled between said control electrode and said cathode and including a resistor and an energy-storage device having an energy-storage value so selected with relation to that of said first-mentioned device that said second network is effective to derive and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit; and a third time-constant network, having a time constant longer than that of said first or said second networks, coupled between said control electrode and said cathode and responsive to an electrode current of said tube flowing during at least the saturation-level intervals of said superregenerative circuit for developing and applying to said control electrode a gain-control potential effective to stabilize the operating characteristics of said arrangement against operating conditions which tend to modify the average self-quench frequency of said arrangement.

9. A self-quench superregenerative arrangement comprising: a self-quench superregenerative

circuit, including a regenerator tube having an anode, a cathode, and a control electrode, for providing superregenerative amplification of a wave signal applied thereto, the oscillatory amplitude of said circuit extending to a saturation-level mode of operation during an interval of each quench cycle; a first time-constant network coupled between said anode and said cathode and including a resistor and an energy-storage device which has developed thereacross during said each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit; a second time-constant network, having a time constant shorter than that of said first network, coupled between said control electrode and said cathode and including a resistor and an energy-storage device having an energy-storage value so selected with relation to that of said first-mentioned device that said second network is effective to derive and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit; and a third time-constant network, having a time constant longer than that of said first or said second networks, coupled between said control electrode and said cathode and responsive to the control-electrode current of said tube flowing during the saturation-level intervals of said superregenerative circuit for developing and applying to said control electrode a gain-control potential effective to stabilize the operating characteristics of said arrangement against operating conditions which tend to modify the average self-quench frequency of said arrangement.

10. A self-quench superregenerative arrangement comprising: a self-quench superregenerative circuit, including a regenerator tube having an anode, a cathode, and a control electrode, for providing superregenerative amplification of a wave signal applied thereto, the oscillatory amplitude of said circuit extending to a saturation-level mode of operation during an interval of each quench cycle; a first time-constant network coupled between said anode and said cathode and including a resistor and an energy-storage device which has developed thereacross during said each quench cycle a voltage of variable magnitude providing the major portion of the quenching action for said superregenerative circuit; a second time-constant network, having a time constant shorter than that of said first network, coupled between said control electrode and said cathode and including a resistor and an energy-storage device having an energy-storage value so selected with relation to that of said first-mentioned device that said second network is effective to derive and to apply to said control electrode during said each quench cycle a voltage effective to provide a supplementary quenching action for said superregenerative circuit; and a third time-constant network, having a time constant longer than that of said first or said second networks and longer than the average self-quench periodicity of said arrangement, coupled between said control electrode and said cathode and responsive to an electrode current of said tube flowing during at least the saturation-level intervals of said superregenerative circuit for developing and applying to said control electrode a gain-control potential effective to stabilize the operating characteristics of said arrangement against operating conditions which tend to modify the average self-quench frequency of said arrangement.

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