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N. P. CASE

2,264,018

SIGNAL AMPLIFICATION CONTROL SYSTEM

Filed Sept. 27, 1940

2 Sheets-Sheet 1

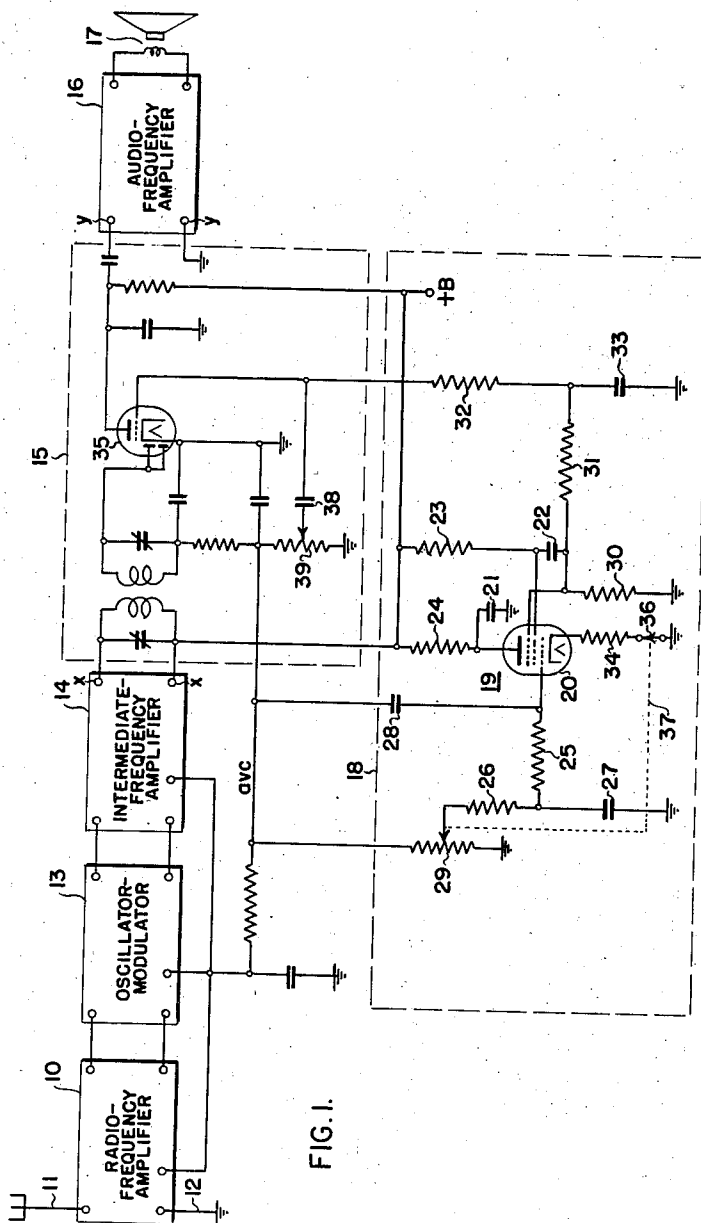


FIG. 1.

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2 Sheets-Sheet 2

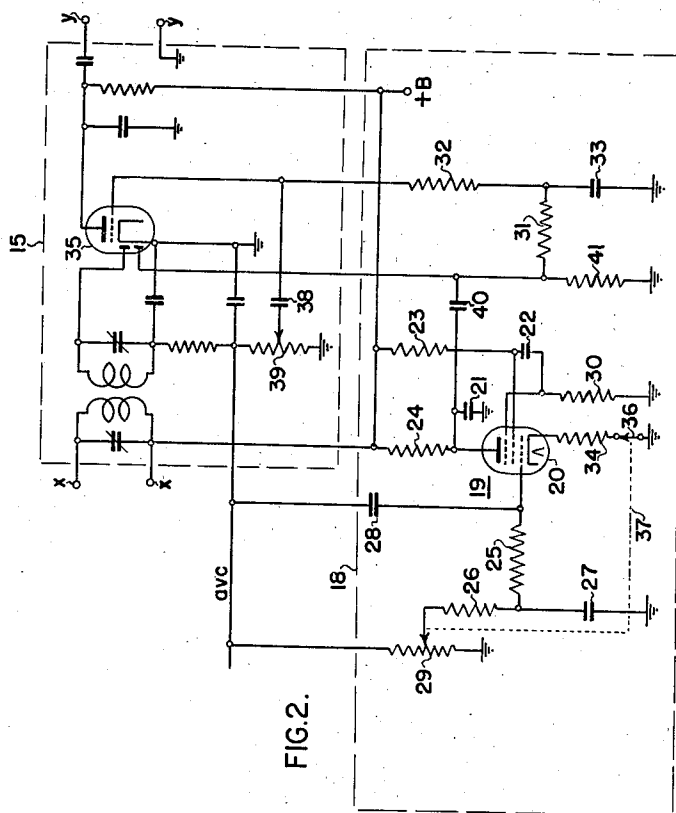


FIG. 2.

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2,264,018

SIGNAL AMPLIFICATION CONTROL SYSTEM

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Application September 27, 1940, Serial No. 358,620

8 Claims. (Cl. 250-20)

The present invention relates to an improved signal amplification control system and, more particularly, to such a system having an oscillation generator controlled in accordance with a predetermined characteristic of a signal to be amplified and controlling, in turn, the amplification of a signal amplifier in the system. While the invention is of general application, it has particular utility as a noise suppressor system for silencing a modulated-carrier signal receiver during intervals when the amplitude of received signals is below a predetermined value and the invention will, therefore, be described in that connection.

It is desirable to incorporate in a modulated-carrier signal receiver an arrangement for silencing the receiver during intervals when the signal input to the detector is below the predetermined level necessary for satisfactory reproduction, either because the received signal is near the prevailing noise level or because the receiver is considerably mistuned from a strong desired signal, in which latter case the reproduction of signals is also distorted by such mistuning.

The prior art noise suppression systems generally have used a suppressor tube arranged as a direct current amplifier to amplify and apply to the amplification control electrode of a signal amplifier a control bias derived by rectification of received carrier signals. The polarity of the control bias is such that the amplifier is biased to cutoff, or blocked, during the intervals when the amplitude of the signal input to the detector is below a predetermined value. Noise suppression systems of this character have the disadvantage that the range of control biases between that corresponding to the completely blocked and that corresponding to the completely unblocked condition of operation of the signal amplifier is relatively large so that received signals having a range of amplitudes which produce this range of control-bias potentials are translated by the signal amplifier with severe distortion due to the nonlinear characteristic of the amplifier in this region. A second and perhaps equally important disadvantage of such noise suppression systems arises from the fact that either the cathode of the signal amplifier or that of the suppressor tube operates at all times at a relatively high unidirectional potential with respect to ground, whereby there is not only a loss of otherwise available operating potential for the signal amplifier, but additionally there results a strain on the insulation between the cathode and its heater, which normally is at ground potential.

To avoid the first-mentioned disadvantage of the prior art noise suppression systems previously described, it has been proposed that an electromechanical relay be used in conjunction with a suitable relay-control amplifier, the relay being so arranged in the control system that the signal amplifier operates either with full output when the amplitude of the signal input to the detector is above a predetermined value or is completely blocked when the amplitude is below the predetermined value. Such electromechanical relays must be designed to operate upon a very small current and, therefore, involve a relatively delicate and expensive construction. Among the disadvantages of such relays involving mechanical moving parts may be mentioned the fact that their operation is so sensitive as to be greatly impaired when the relay is subjected to external vibrations and mechanical shock, as occurs when the relay is used in mobile carrier-signal receivers. Mechanical relays have the further disadvantage that their operation is impaired when the relay is subjected to corrosive atmospheres, for example, atmospheres adjacent a body of salt water. This necessitates that the relay be enclosed within a hermetically sealed housing, thereby increasing the cost of the relay and adding further disadvantages from the standpoint of adjustment and periodic servicing of the relay contacts.

It is an object of the present invention, therefore, to provide a signal amplification control system which, while of general application, is particularly suited for silencing a modulated-carrier signal receiver during intervals when the amplitude of received signals is below a predetermined value or when the receiver is mistuned a predetermined amount from a strong desired carrier signal and one which avoids one or more of the disadvantages and limitations of the prior art systems.

It is a further object of the invention to provide a signal amplification control system of simple and inexpensive construction wherein a predetermined characteristic of a signal to be amplified controls the operation of an oscillation generator, the output of which controls, in turn, the amplification of a signal amplifier.

In accordance with the invention, a signal amplification control system comprises an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to the input circuit, and a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias

voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense. The system also includes means responsive to a predetermined characteristic of the applied signals for deriving a bias voltage varying with the signal characteristic and for applying the derived voltage to the oscillator, and means responsive to the output amplitude of the oscillator for controlling the amplification of the amplifier.

In accordance with a preferred form of the invention, a signal amplification control system of the type described comprises a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of the abrupt discontinuities dividing the characteristic into a relatively large output-amplitude portion and a relatively small output-amplitude portion. The system includes means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with the signal characteristic and for applying the derived voltage to the oscillator, and means responsive to the small output and large output portions of the oscillator characteristic for respectively permitting normal amplification and reducing the amplification of the amplifier.

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 drawings, and its scope will be pointed out in the appended claims.

Referring now to the drawings, Fig. 1 is a circuit diagram, partly schematic, of a complete carrier-signal receiver embodying the invention; and Fig. 2 is a circuit diagram representing a modified form of the signal amplification control system of the invention, per se.

Referring now more particularly to Fig. 1, there is represented schematically a complete carrier-signal receiver of a conventional design embodying the present invention in a preferred form. In general, the receiver includes a radio-frequency amplifier 10 having its input circuit connected to an antenna-ground system 11, 12 and having its output circuit connected to an oscillator-modulator 13. Connected in cascade with the oscillator-modulator 13, in the order named, are an intermediate-frequency amplifier 14 of one or more stages, a combined detector, automatic amplification control system and first stage of audio-frequency amplification 15, one or more additional stages of audio-frequency amplification 16, and a sound reproducer 17. The automatic amplification control system of unit 15 is coupled in conventional manner over the conductor indicated as A. V. C. to the input circuits of one or more of the tubes of the radio-frequency amplifier 10, the oscillator-modulator 13, and the intermediate-frequency amplifier 14. A signal amplification control system 18 has its input circuit coupled to the automatic amplification control system of unit 15 and its output circuit coupled to the input circuit of the audio-frequency amplifier of unit 15 to control the amplification thereof in a manner presently to be described.

It will be understood that the various units just described may, with the exception of the sig-

nal amplification control system 18, be of a conventional construction and operation, the details of which are well known in the art, rendering detailed description thereof unnecessary. Considering briefly the operation of the receiver as a whole, and neglecting for the moment the operation of the signal amplification control system 18 presently to be described, a desired carrier signal is selected and amplified by the radio-frequency amplifier 10, converted to an intermediate-frequency carrier signal in the oscillator-modulator 13, amplified in the intermediate-frequency amplifier 14, and detected by the detector of unit 15, thereby to derive the audio-frequency modulation components. The audio-frequency components are, in turn, amplified in the audio-frequency amplifier stage of unit 15 and in the audio-frequency amplifier 16, and are reproduced by the sound reproducer 17 in a conventional manner. An automatic amplification control bias derived in unit 15 is effective to control the amplification of one or more of the units 10, 13, and 14 to maintain the signal input to unit 15 within a relatively narrow range for a wide range of received signal intensities.

Referring now more particularly to the portion of the system embodying the present invention, the signal amplification control system 18 includes a source of oscillations comprising an oscillation generator 19 which may be of any well-known type, but is shown as a single-tube multivibrator of the type disclosed in United States Letters Patent No. 2,203,519, granted June 4, 1940, to Madison Cawein. Briefly, the generator comprises a vacuum tube 20 of the pentode type having its screen and suppressor grids directly coupled together through a condenser 22, the suppressor grid being provided with a grid leak 30. The screen grid and anode of the tube 20 are energized from a source of space current +B through suitable load resistors 23, 24, respectively. A condenser 21 is connected between the anode and ground, the condenser being periodically and alternately charged through the anode load resistor 24 from the space current source +B and discharged through tube 20. A cathode-bias resistor 34 is included in the cathode lead to provide from space current of tube 20 a bias for the control electrode. The control grid of vacuum tube 20 is coupled through a time-constant circuit comprising series resistors 25, 26 and a shunt condenser 27 to the adjustable contact of a voltage divider 29 connected across the output of the automatic amplification control system of unit 15. The higher audio-frequency components which appear in the output of the automatic amplification control system are coupled to the control grid of tube 20 through a condenser 28. A negative-bias potential is developed across the suppressor grid-leak resistor 30 when the tube 20 is generating oscillations; this potential is applied through a filter network comprising series resistors 31, 32 and a shunt condenser 33 to the control grid of a vacuum tube 35. The tube 35 is connected to form the first stage of audio-frequency amplification of unit 15, its input circuit having audio-frequency signals applied thereto through a coupling condenser 38 from a volume control load resistor 39 of the detector of unit 15. A switch 36 is included in the cathode circuit of tube 20 and is preferably so mechanically connected to the adjustable contact of voltage divider 29, as indicated by the broken line 37, that the switch is opened upon movement of the adjustable contact

to the limit of its travel corresponding to amplification control by control system 18 only on carrier signals of minimum intensity. Opening the switch 36 effectively de-energizes the control system 18 and removes its control over the receiver output.

In considering the operation of the circuit just described, reference may be had to the aforementioned Patent 2,203,519 for a description of the detailed operation of the oscillation generator 19. Briefly, however, for purposes of the present description of the system operation it may be stated that the anode current of generator 19 is of pulse wave form and that the generator generates a voltage of saw-tooth wave form across the condenser 21 in its output circuit. During the time when this occurs, the oscillations of the anode circuit cause a potential of pulse wave form to be produced in the circuit of the screen grid which potential is applied through condenser 22 to develop across the suppressor-grid resistor 30 an alternating potential having small positive half-cycles and relatively large negative half-cycles. This particular type of generator possesses the important characteristic that the amplitude of the output saw-tooth oscillations developed and the grid bias developed across grid resistor 30 by grid rectification are substantially independent of variations of anode potential and, insofar as the present invention is concerned, may be said to be substantially independent of variations of bias applied to the input electrodes of the generator. The generator possesses the additional important characteristic that the generation of oscillations is suddenly terminated when the negative-biasing potential applied to its control grid exceeds a predetermined magnitude and the generator remains inactive until such negative bias is reduced to a value lower than that at which the generator ceased to oscillate. Thus, this type of oscillator has, more or less inherently, the property of either oscillating strongly or not at all, and changes in the magnitude of the control-grid bias do not appreciably change, insofar as the desired operation of the present invention is concerned, the amplitude of the generated oscillations except by a form of switch action from zero amplitude to full amplitude, or vice versa. Therefore, the speed of control of generator 19 is controlled only by the effective time constant of its input circuit comprising voltage divider 29 and the circuit elements 25, 26, and 27, and the time constant of its output circuit comprising the circuit elements 31, 33, 32, 33, and 39. These time constants can be made so small that, to the ear, the operation is substantially instantaneous. It follows, from the definite "on-off" action of the amplification control system 18, that there is no transition period where generator 19 is partially operating. Since it is the presence of a transition region which causes distortion at a critical carrier-signal intensity with conventional noise-suppressor systems, it is apparent that the amplification control system of the present invention is free from such distortion.

Obviously, there also can be no undesirable volume control effect when the bias on the first stage of amplification of unit 15 is either normal or far beyond cutoff. This further advantage of the present invention follows from the lack of a transition region.

The bias derived by the automatic amplification control system of unit 15 varies in magni-

tude directly with the intensity of received signals applied to the input circuit of unit 15. This control bias is applied as a negative bias to the control grid of vacuum tube 20 to modify the operation thereof. The automatic amplification control system of unit 15 thus comprises means responsive to the amplitude characteristic of signals applied to the input circuit of unit 15 for deriving a bias voltage varying therewith and for applying the derived voltage to the generator 19 to modify the operation thereof. Assume now that the intermediate-frequency carrier signals applied to the input circuit of unit 15 have an amplitude less than the predetermined value required to derive an automatic amplification control bias of sufficient magnitude to prevent generator 19 from generating oscillations. There is consequently developed across grid resistor 30 a relatively high negative potential. The average value of this potential is derived by the filter 31, 32, 33 and, upon application to the control grid of the audio-frequency amplifier of unit 15, is sufficiently large to bias the latter beyond cutoff, thus causing the amplifier to block. Since the amplifier of unit 15 is biased not only to cutoff but, as stated, beyond cutoff, any relatively small variations of amplitude of the generated oscillations caused by lesser values of the amplification control bias do not affect the blocked condition of the amplifier once such condition has been established. Consequently, no audio-frequency signals are translated by the audio-frequency amplifier under these conditions and the receiver is effectively silenced.

Now assume that the amplitude of the intermediate-frequency carrier signals increases somewhat above the predetermined value first assumed. The derived automatic amplification control bias becomes correspondingly larger and is now sufficient to terminate the generation of oscillations by generator 19. The potential developed across resistor 30 thereupon disappears and the audio-frequency amplifier of unit 15 now operates with full output, thereby supplying audio signals to the audio-frequency amplifier 16 and sound reproducer 17. Reproduction of the received carrier signals continues until the amplitude of the intermediate-frequency carrier signals again decreases, as by fading or by reason of the detuning of the receiver therefrom, below the predetermined value at which generator 19 may oscillate. The generator 19 generally does not again oscillate, however, until a noise pulse or other pulse of energy is applied to its control grid through the condenser 28. When this occurs, the generator suddenly breaks into oscillation and a bias is immediately developed across the grid resistor 30, thereby silencing the receiver output. The suppressor grid and its circuit elements including grid resistor 30 thus comprise means responsive to the output amplitude of the generator 19 for controlling the audio-frequency amplifier stage of unit 15 to reduce the amplification thereof with increasing values of oscillation amplitude. Furthermore, it is evident that this is accomplished in accordance with the present invention by providing in the amplification control system 18 a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, means responsive to

the output amplitude of the oscillator for controlling, in accordance with the amplitude of generated oscillations, the amplification of the controlled amplifier, and means responsive to the amplitude characteristic of applied signals in either of two ranges of values for developing bias voltages in excess of the higher of the aforesaid bias-voltage values or less than the aforesaid other of the bias-voltage values and for applying the bias voltages to the oscillation generator 19.

As descriptive of the bias voltage-output amplitude characteristic, or simply the oscillator characteristic, of the relaxation oscillation generator 19, it may be said that its characteristic has substantially zero value for values of bias voltage greater than the smaller of the two bias-voltage values which cause abrupt discontinuities in its characteristic when the bias voltage varies in the sense corresponding to decreasing values of the signal characteristic. Each of the abrupt discontinuities of the oscillator characteristic divides the characteristic into a relatively large output-amplitude portion and a relatively small output-amplitude portion. The means responsive to the output amplitude of the oscillator for controlling the amplification of the amplifier of unit 15 is responsive to the large output-amplitude portion of the oscillator characteristic for reducing the amplification of, or even blocking, the amplifier and is responsive to the small output-amplitude portion of the characteristic for permitting normal amplification of the amplifier.

The setting of the voltage divider 29, which determines the predetermined amplitude of the carrier signals necessary to terminate the generation of oscillations by generator 19, is preferably adjusted to silence the output of the receiver at or near the prevailing background noise level. By suitable selection of the value of resistance of the voltage divider 29, the carrier-signal intensity at which the amplification control system 18 becomes operative to silence the output of the receiver may be any selected one in a wide range of intensities extending from very weak to very strong carrier signals applied to unit 15.

From the above-described operation of the invention, it will be apparent that the amplification control system of the invention has the important advantage that the generation of oscillations by generator 19, when once terminated by the control potential applied to its control electrode, will not start up again when the control potential is reduced unless noise is present and, even then, only when the noise peaks are considerably greater than the carrier-signal amplitude. This means that when, for example, the voltage divider 29 is so adjusted that a relatively strong carrier signal applied to unit 15 is required to terminate the generation of oscillations by generator 19, the generation of oscillations once terminated does not begin again until the strength of the carrier signal is well below the level of moderate noise. This permits the received carrier signal to be reproduced without interruption in the event that the carrier signal exhibits only moderate fading.

Since noise pulses or similar pulses of energy are necessary to shock the generator 19 back into oscillation when the carrier signal applied to unit 15 becomes weak or is absent, it follows that the extent to which noise peaks can exceed the carrier-signal amplitude without silencing the output of the receiver is subject to a wide

degree of control by suitable choice of the values of the condenser 28 and resistor 25.

As illustrative of a specific embodiment of the invention, the following circuit constants are given for the embodiment of the invention shown in the drawings:

Vacuum tube 20	Type 6SJ7
Voltage-divider resistor 29	ohms 500,000
Resistor 23	do 68,000
Resistor 24	do 50,000
Resistor 25	do 10,000
Resistor 26	megohms 2
Resistor 30	do 1
Resistor 31	do 3
Resistor 32	do 10
Resistor 34	ohms 220
Load resistor 39	megohm 1
Condenser 21	micro-microfarads 2000
Condenser 22	do 3000
Condenser 27	do 3000
Condenser 28	do 300
Condenser 33	microfarad 0.01
Condenser 38	do 0.001
+B	volts 200

Fig. 2 is a circuit diagram representing a modified form of the invention which is essentially similar to the arrangement of Fig. 1, similar circuit elements being designated by similar reference characters, except that there is provided a different form of means responsive to a characteristic of the oscillations generated by generator 19 for deriving the control-bias potential which is utilized to control the audio-frequency amplifier of unit 15. The output circuit of generator 19 is coupled through a condenser 40, the value of which is not critical but may be of the order of 100 micro-microfarads, to one of the diode rectifier anodes of vacuum tube 35. A diode load resistor 41, the value of which may be of the order of 1 megohm, is connected between this diode anode and ground. There is thus developed across the resistor 41, by peak rectification of the oscillations generated by generator 19, a negative unidirectional potential which is applied, as in the Fig. 1 arrangement, through the filter network 31, 32, and 33 to the input circuit of the audio-frequency amplifier stage of unit 15 to control the amplification thereof. The operation of this modified form of the invention is otherwise essentially similar to that of the Fig. 1 arrangement and will, therefore, not be repeated.

From the foregoing description of the invention, it will be evident that a carrier-signal receiver embodying the invention has the advantages that the high negative potential output of the oscillation generator is substantially constant for all such values of input control-bias potential as permit the generator to oscillate, and is more than sufficient when produced to block the controlled audio-frequency amplifier, whereby the output of the receiver is either completely on or completely off and there is no intermediate range within which a distorted output can occur. Additionally, all tubes including the first audio-frequency tube operate with their cathodes substantially at ground potential. The automatic amplification control system of the invention is of simple circuit arrangement, is relatively inexpensive, and is of sufficiently sturdy construction that its operation is not impaired by mechanical vibration or shock of the type usually encountered in mobile equipment.

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 in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to the output amplitude of said oscillator for controlling the amplification of said amplifier.

2. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, said oscillator characteristic having substantially zero value for values of bias voltage greater than the smaller of said two values upon variation of said bias voltage in the sense corresponding to decreasing values of said signal characteristic, and means responsive to the output amplitude of said oscillator for controlling the amplification of said amplifier.

3. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation of one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, means responsive to a predetermined characteristic of applied signals in either of two ranges of values for developing bias voltages in excess of the higher of said values or less than the other of said values and for applying said voltages to said oscillator, and means responsive to the output amplitude characteristic of said oscillator for controlling in accordance with the amplitude of generated oscillations the amplification of said amplifier.

4. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of said abrupt discontinuities dividing said characteristic into a relatively large output amplitude portion and a relatively small output amplitude portion, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to the large output portion of said oscillator characteristic for reducing the amplification of said amplifier.

5. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of said abrupt discontinuities dividing said characteristic into a relatively large output amplitude portion and a relatively small output amplitude portion, means responsive to the amplitude characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to the large output portion of said oscillator characteristic for blocking said amplifier.

6. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of said abrupt discontinuities dividing said characteristic into a relatively large output amplitude portion and a relatively small output amplitude portion, means responsive to the amplitude characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to the small output and large output portions of said oscillator characteristic for respectively permitting normal amplification and reducing the amplification of said amplifier.

7. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, means for rectifying oscillations generated by said oscillator to derive a unidirectional control-bias potential, and means for utilizing said control-bias potential to control the amplification of said amplifier.

8. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of said abrupt discontinuities dividing said characteristic into a relatively large output amplitude portion and a relatively small output amplitude portion, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, means for rectifying oscillations generated by said oscillator to derive a unidirectional control-bias potential, and means for utilizing said control-bias potential to control the amplification of said amplifier.

9. A signal amplification control system comprising, an input circuit adapted to have signals applied thereto, a vacuum-tube amplifier coupled to said input circuit, a relaxation oscillator having a bias voltage-output amplitude characteristic which has an abrupt discontinuity at one value of bias voltage upon variation thereof in one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, each of said abrupt discontinuities dividing said characteristic into a relatively large output amplitude portion and a relatively small output amplitude portion, means responsive to a predetermined characteristic of applied signals for deriving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to the large output portion of said oscillator characteristic for blocking said amplifier.

one sense and a second abrupt discontinuity at another value of bias voltage upon variation thereof in opposite sense, said oscillator having a circuit for developing a relatively high negative-bias potential varying with said oscillator characteristic, means responsive to a predetermined characteristic of applied signals for de-

5 riving a bias voltage varying with said signal characteristic and for applying said voltage to said oscillator, and means responsive to said bias potential for controlling the amplification of said amplifier.

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