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NOISE GENERATING SYSTEM

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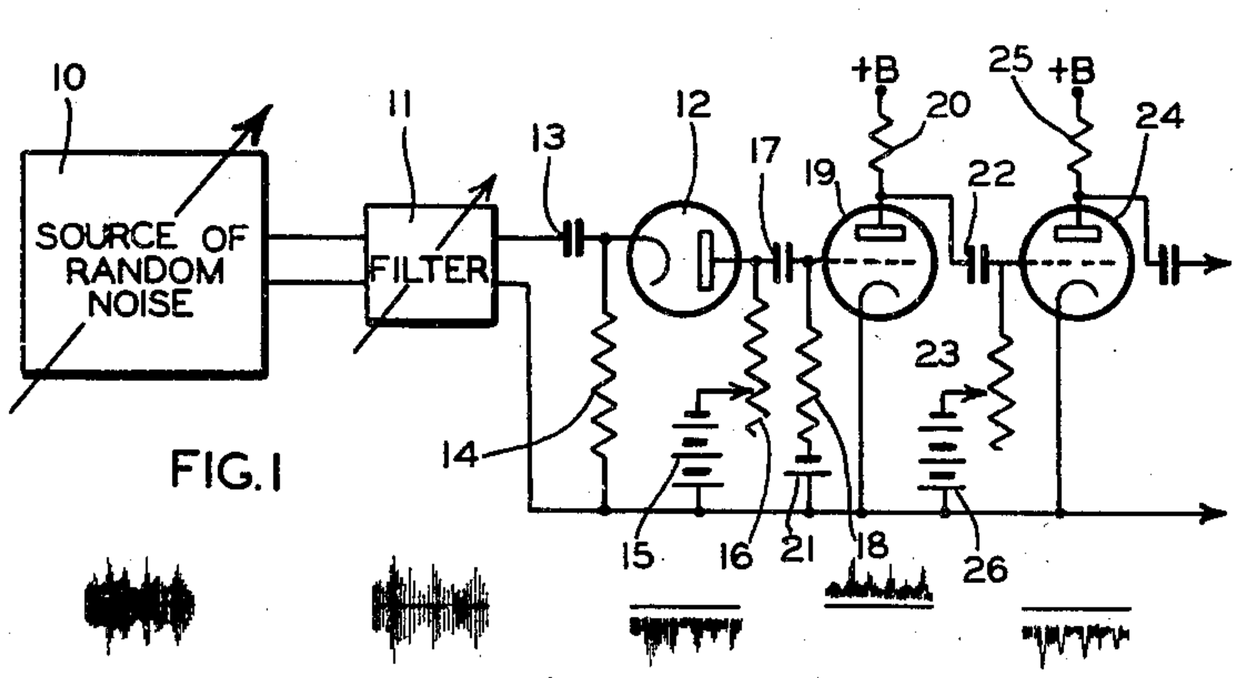

FIG. 1

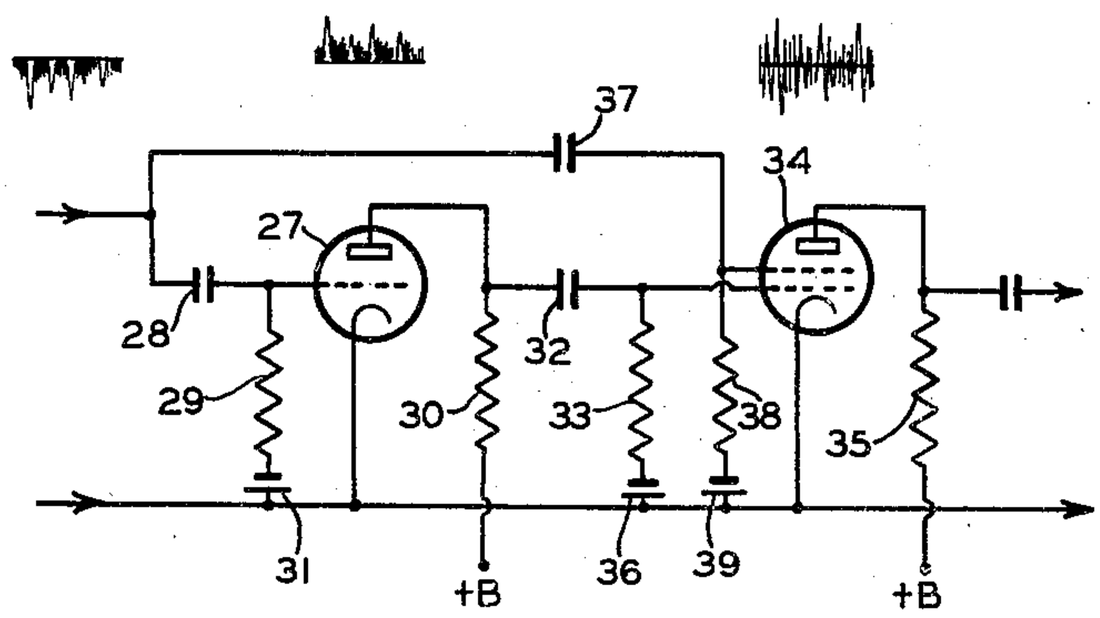

FIG. 2

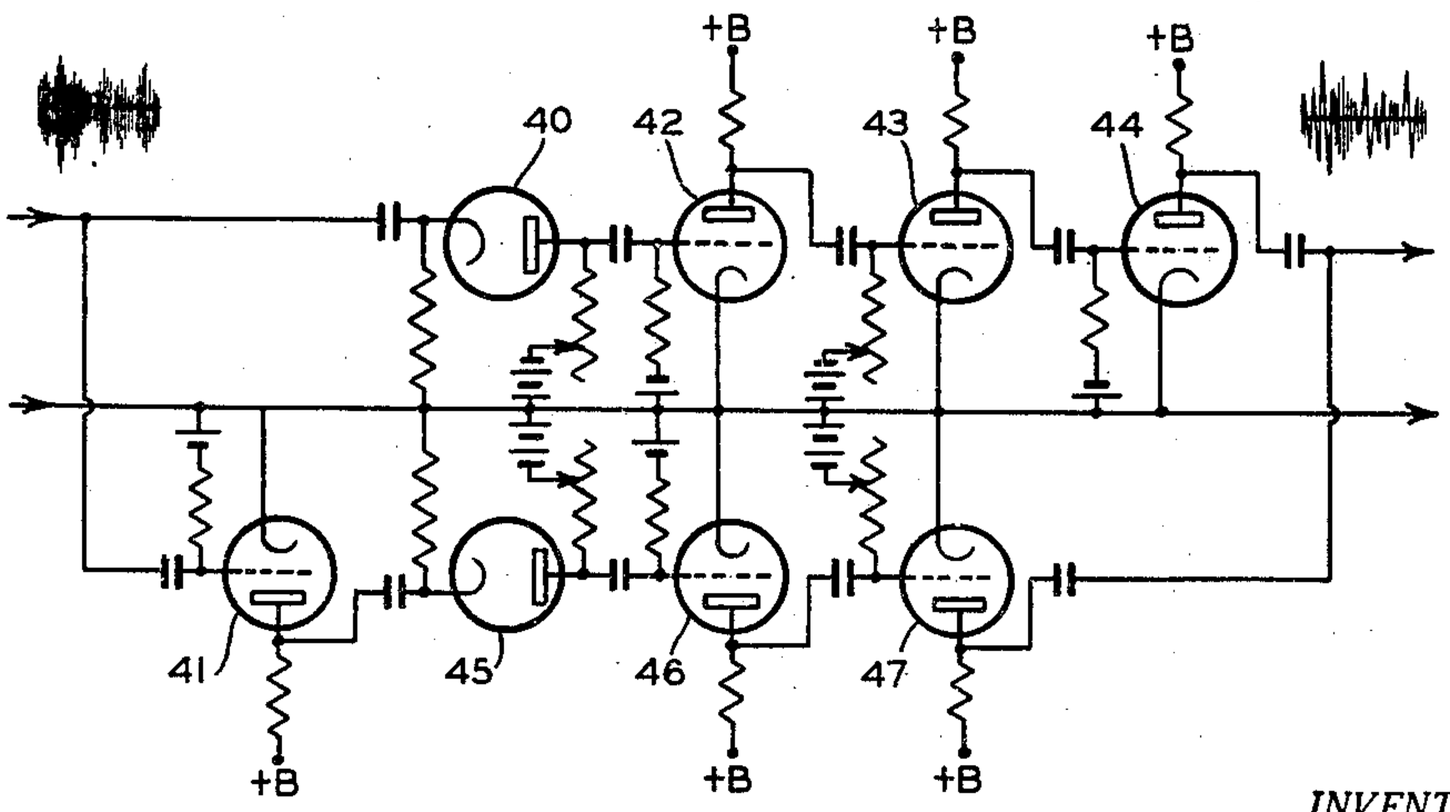

FIG. 3

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NOISE GENERATING SYSTEM

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15 Claims. (Cl. 178—44)

1

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

My present invention relates to noise generators, and more particularly to electronic devices for producing the random electrical impulses, known as "hash" or "grass," usually observed upon the screens of oscilloscopes utilized as indicating devices in aircraft detection systems, or the like.

One of the objects of my present invention is to simulate noise signals such as those resulting from thermal agitation in circuit elements generally, shot effect in electron tubes, static, and other similar electrical disturbances.

Another object is to control the frequency range and the amplitude range of the components represented in such noise signals.

A further object is to control the density of the signals generated, in other words, the number of components per unit of time.

A still further object is to produce noise signals, having the controllable characteristics referred to above, which may be either single- or double-sided, that is, rectified or balanced.

These, and other objects, which will become obvious to those skilled in the art to which the present invention relates as the detailed description thereof progresses, are attained herein in the following manner:

A source of random noise, such as a high-gain amplifier, is so designed as to have in its output, component impulses only of such frequencies as are desired to be present in the final signal. Instead of such a specially designed amplifier, a conventional high-gain amplifier may be used and the output thereof may be passed through suitable filters to attain the same result.

In either case, the random noise signals thus obtained are clipped so as to remove therefrom any components having an amplitude less than some pre-selected value. The result is a "thinned" signal. This signal may be amplified as desired, and the resulting signal is subjected to amplitude distortion, for example, by passing the same through a non-linear impedance, such as a Class C-operated vacuum tube amplifier functioning in the vicinity of the knee of the characteristic transconductance curve thereof, such mode of operation resulting in "volume expansion."

If the final signal desired is one which is single-sided, the output obtained as above may be directly used, but if it is desired that the final signal be double-sided, a portion of the signal

2

obtained as above is inverted, and the inverted signal is combined with the remaining portion of the original signal in a mixer receptive of both signals. The operation of this circuit obviously depends upon the fact that the output of an inverter is not in an exactly 180° phase opposition to the input thereto.

A modified method for obtaining a double-sided final output is to separate the positive and negative components in the noise signals obtained from the high-gain amplifier previously referred to, "thin" each component as described above in connection with the production of a single-sided final signal, and then recombine the components, for example, by the mixing method described above in connection with the first form of double-sided signal.

In the accompanying specification I shall describe, and in the annexed drawing show, several illustrative embodiments of the noise generators of the present invention. It is, however, to be clearly understood that I do not wish to be limited to the details of such illustrative embodiments inasmuch as changes therein may be made without the exercise of invention and within the true spirit and scope of the present invention as expressed in the claims hereto appended.

In said drawing, Figure 1 is a schematic diagram of a random noise generator assembled in accordance with the principles of the present invention;

Figure 2 is a modified form of said noise generator; and

Figure 3 is a further modification of the same.

Referring now more in detail to the present invention, and with particular reference to the form thereof shown in Figure 1 of the drawing, the numeral 10 generally designates any preferred source of random noise, such as a high-gain vacuum tube amplifier. Said amplifier may be conventional in design and may, if desired, include variable means for controlling the band of frequencies in the output thereof; or, if preferred, said amplifier may be designed to pass a wide band of frequencies and have associated therewith a variable filter 11 for the same purpose.

In either case, the output is fed to a chopper or rectifier circuit, comprising, for example, a diode vacuum tube 12, to the cathode of which said output is applied through a coupling condenser 13 and resistor 14. The plate of said tube is adjustably biased negatively with respect to the cathode thereof by means of a bias battery 15 and variable resistor 16. The bias is adjusted

so as to require an input of predetermined amplitude in order that the tube 12 conduct, thereby giving control over the density of the output of said tube.

Said output is inverted and amplified by applying the same, through a condenser 17 and resistor 18, to the grid of a triode vacuum tube 19. Plate voltage for the tube 19 is applied through a resistor 20, and the grid thereof is so negatively biased with respect to the cathode by means of a bias battery 21, that said tube normally draws a substantial current.

In order to control the apparent amplitude range of the components of the final output, the plate output of the tube 19 is fed, through a coupling condenser 22 and variable grid resistor 23, to a "volume expander" or non-linear vacuum tube amplifier 24. Plate voltage for said amplifier is applied through a resistor 25, and the grid thereof is so negatively biased with respect to the cathode by means of a bias battery 26, that said amplifier operates in the vicinity of the knee of its plate current-grid voltage curve. By means of this arrangement, the greater amplitude components of the input are given greater amplification and therefore, by suitably varying the bias, control is obtained over the apparent amplitude range of the final output.

In operation, the initial noise, shown beneath the source 10 thereof, is filtered to result in the "thinned" output shown beneath the filter 11. This output may be clipped, as shown beneath the tube 12, inverted, as shown beneath the tube 19, and non-uniformly amplified, as shown beneath the tube 24.

The final output may, if a single-sided noise is desired, be used directly, for example, by injecting the same into a trainer for demonstrating the "grass" usually observed upon the indicating oscilloscope of a pulse-echo radio system for aircraft detection.

If, however, double-sided or balanced "grass" is desired, the output resulting from the use of the circuit of Figure 1 may be fed to a circuit such as that shown in Figure 2. In this figure, there is shown a gain-of-one inverter 27, which is receptive of a portion of the plate output of the tube 24 in Figure 1. Said output is applied to said inverter through a coupling condenser 28 and grid resistor 29. Plate voltage is applied to said inverter through resistor 30, and the grid thereof is suitably biased with respect to the cathode by means of a battery 31 in series with a resistor 29. The plate output of the inverter, shown above the same, is fed, through a coupling condenser 32 and control grid resistor 33, to a tetrode vacuum tube 34, constituting a mixer. Plate voltage to the tube 34 is applied through a resistor 35, and the control grid thereof is suitably biased by means of a battery 36. The remaining portion of the plate output of the tube 24 is applied directly to the screen grid of the mixer tube 34 through a coupling condenser 37 and grid resistor 38, the latter being properly biased, by means of a battery 39, so that the two inputs to said tube 34 are equally amplified. The combined output of said tube, shown thereabove, is a double-sided or balanced signal.

A modified circuit for obtaining a double-sided signal is set forth in Figure 3. As there shown, the output from the high-gain amplifier alone, or the high-gain amplifier plus a suitable filter, is treated to separate the positive and negative components, and after manipulation of each

component in accordance with methods above described, they are recombined. For this purpose, the original signal is fed both to a chopper 40 and an inverter 41, the latter being biased to cutoff. The chopper passes the negative content of said original signal to an inverter-amplifier 42, similar to the inverter-amplifier 19; the positive output of the amplifier 42 is applied to a Class C amplifier 43, similar to the amplifier 24; and the negative output of the amplifier 43 is inverted in an inverter stage 44.

The positive content of the original signal, after inversion in the inverter stage 41, is passed, successively, through an additional chopper 45, inverter-amplifier 46, and Class C amplifier 47.

The plate outputs of the inverter 44 and the amplifier 47 are combined so as to obtain, as shown at the right of the inverter 44, a double-sided final signal.

This completes the description of the aforesaid illustrative embodiments of the noise generator of the present invention, including the modes of operation thereof. It will be noted from all of the foregoing that I have provided a noise generator by means of which I am able to produce a single- or double-sided signal having controllable characteristics, for example, the frequency of the components of said signal, the density of said signal, and the apparent amplitude range of the components thereof.

Other objects and advantages of the devices of the present invention will readily occur to those skilled in the art to which the same relates.

I claim:

1. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, electrical means receptive of said selected frequency components and adapted to pass such of said components as exceed a predetermined amplitude level, a nonlinear impedance network receptive of the output of said first mentioned network for nonuniformly expanding said output, means for inverting a portion of the output of said nonlinear impedance network, and a mixer for combining the remaining portion of the output of said nonlinear impedance network with said inverted portion thereof to obtain a double-sided final output.

2. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, a rectifier receptive of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, a nonlinear impedance network receptive of the output of said rectifier for nonuniformly expanding said output, means for inverting a portion of the output of said nonlinear impedance network, and a mixer for combining the remaining portion of the output of said nonlinear impedance network with said inverted portion thereof to obtain a double-sided final output.

3. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, electrical means receptive of said selected frequency components and adapted to pass such of said

components as exceed a predetermined amplitude level, an electronic "volume expander" receptive of the output of said impedance network for nonuniformly expanding said output, means for inverting a portion of the output of said electronic "volume expander," and a mixer for combining the remaining portion of the output of said electronic "volume expander" with said inverted portion thereof to obtain a double-sided final output.

4. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, a diode vacuum tube connected in series with said filter and biased to pass only such components of the output of said filter as exceed a predetermined amplitude level, a nonlinear impedance network receptive of the output of said diode vacuum tube for nonuniformly expanding said output, means for inverting a portion of the output of said nonlinear impedance network, and a mixer for combining the remaining portion of the output of said nonlinear impedance network with said inverted portion thereof to obtain a double-sided final output.

5. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, a diode vacuum tube connected in series with said filter and biased to pass only such components of the output of said filter as exceed a predetermined amplitude level, a class C-operated vacuum tube amplifier receptive of the output of said diode vacuum tube for nonuniformly expanding said output, means for inverting a portion of the output of said class C-operated vacuum tube amplifier, and a mixer for combining the remaining portion of the output of said class C-operated vacuum tube amplifier with said inverted portion thereof to obtain a double-sided final output.

6. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, means for separating the positive and negative portions of said selected frequency components, electrical means receptive of the positive and negative portions of said selected frequency components and adapted to pass such of said components as exceed a predetermined amplitude level, nonlinear impedance networks receptive of the outputs of said first mentioned networks for nonuniformly expanding said outputs, means for inverting the output of one of said nonlinear impedance networks, and means for combining the output of the remaining nonlinear impedance network with said inverted output.

7. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, rectifiers receptive of the positive and negative portions of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, nonlinear impedance networks receptive of the outputs of said rectifiers for nonuniformly expanding said outputs, means for inverting the output

of one of said nonlinear impedance networks, and means for combining the output of the remaining nonlinear impedance network with said inverted output.

8. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, means for separating the positive and negative portions of said selected frequency components, electrical means receptive of the positive and negative portions of said selected frequency components and adapted to pass such of said components as exceed a predetermined amplitude level, electronic "volume expanders" receptive of the outputs of said first mentioned networks for nonuniformly expanding said outputs, means for inverting the output of one of said electronic "volume expanders," and means for combining the output of the remaining "volume expander" with said inverted output.

9. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, diode vacuum tubes receptive of the positive and negative portions of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, nonlinear impedance networks receptive of the outputs of said diode vacuum tubes for nonuniformly expanding said outputs, means for inverting the output of one of said nonlinear impedance networks, and means for combining the output of the remaining nonlinear impedance network with said inverted output.

10. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, means for producing electrical disturbances which lie within a selected frequency band, diode vacuum tubes receptive of the positive and negative portions of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude lever, class C-operated vacuum tube amplifiers receptive of the outputs of said diode vacuum tubes for nonuniformly expanding said outputs, means for inverting the output of one of said amplifiers, and means for combining the output of the remaining amplifier with said inverted output.

11. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, a source of electrical disturbances such as those caused by thermal agitation, shot effect, etc., a band-pass filter receptive of said electrical disturbances for passing only such components thereof as fall within a frequency band, a nonlinear impedance network including a rectifier receptive of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, and a nonlinear impedance network receptive of the output of said first mentioned network for nonuniformly expanding said output.

12. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, a source of electrical disturbances such as those caused by thermal agitation, shot effect,

etc., a band-pass filter receptive of said electrical disturbances for passing only such of the components thereof as fall within a selected frequency band, a rectifier receptive of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, and a non-linear impedance network receptive of the output of said rectifier for nonuniformly expanding said output.

13. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, a source of electrical disturbances such as those caused by thermal agitation, shot effect, etc., a band-pass filter perceptive of said electrical disturbances for passing only such components thereof as fall within a selected frequency band, a nonlinear impedance network including a rectifier receptive of said selected frequency components and biased to pass only such of said components as exceed a predetermined amplitude level, and an electronic "volume expander" receptive of the output of said impedance network for nonuniformly expanding said output.

14. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including a source of electrical disturbances such as those caused by thermal agitation, shot effect, etc., a band-pass filter receptive of said electrical disturbances for passing only such of the components thereof as fall within a selected frequency band, a diode vacuum tube connected in

series with said filter and biased to pass only such components of the output of said filter as exceed a predetermined amplitude level, and a nonlinear impedance network receptive of the output of said diode vacuum tube for nonuniformly expanding said output.

15. Means for generating random noise signals and controlling the frequency, density, and amplitude range of the components thereof including, a source of electrical disturbances such as those caused by thermal agitation, shot effect, etc., a band-pass filter receptive of said electrical disturbances for passing only such of the components thereof as fall within a selected frequency band, a diode vacuum tube connected in series with said filter and biased to pass only such components of the output of said filter as exceed a predetermined amplitude level, and a class C-operated vacuum tube amplifier receptive of the output of said diode vacuum tube for nonuniformly expanding said output.

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