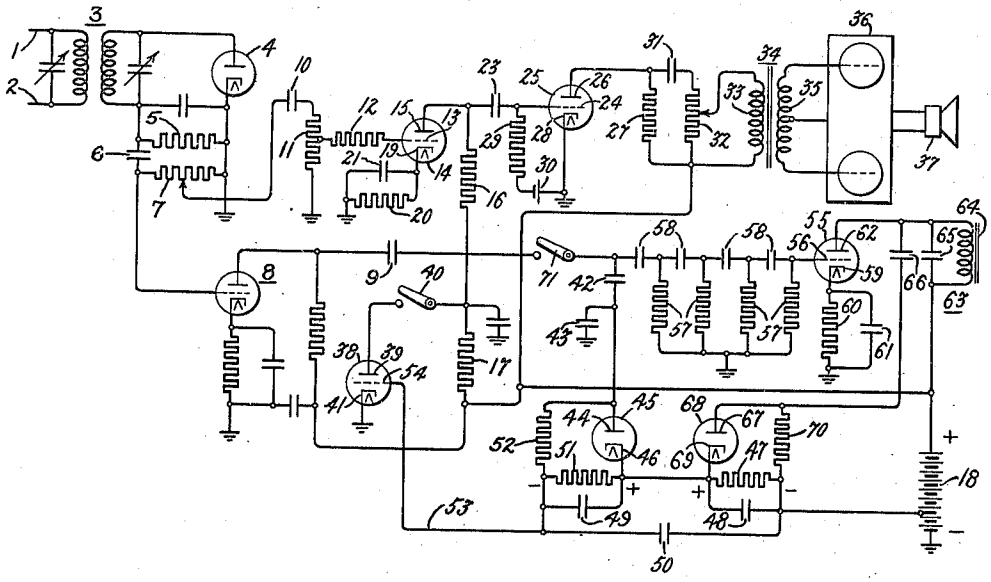
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AMPLIFIER

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Inventor:
Stanford Goldman,
by Harry E. Dunham
His Attorney.

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AMPLIFIER

Stanford Goldman, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

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My invention relates to an improved amplifier for a signaling system such as a radio receiver, and more particularly to an amplifier arrangement whose amplification characteristic is controlled in such a manner that the amplifier output is greatly reduced when the frequency characteristic of the oscillations supplied to the input of the amplifier is of the type which is predominantly characteristic of noise.

An object of my invention is to provide in an amplifier system an arrangement which automatically distinguishes between noise and signal oscillations and effects a substantial reduction in the power output of the amplifier when the ratio of the noise oscillations to the desired signal oscillations exceeds a predetermined value.

A further object of my invention is to provide in an amplifier a control arrangement for decreasing the power output of the amplifier by controlling the operating potential supplied to the amplifier, and my invention contemplates that the control shall become effective to reduce the amplifier output whenever the ratio of noise oscillations to desired signal oscillations in the input circuit of the amplifier exceeds a predetermined value.

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

Referring to the drawing, my invention is illustrated as embodied in an audio frequency amplifier arrangement for a signalling system. The input circuit 1, 2 of the amplifier is connected to a source, not shown, of modulated oscillations. The oscillations are normally modulated only by desired signals but there are times during the operation of the signalling system when the oscillations contain, in addition to the signal frequency modulation components, extraneous and undesirable noise frequency modulation components. These modulated oscillations are supplied from the input circuit 1, 2 through an input transformer 3 to a diode rectifier 4 and a diode load resistor 5. The oscillations are demodulated by the diode rectifier and the demodulation components appear as potentials of audio frequency across the resistor 5.

The audio frequency potentials are supplied through a condenser 6 to a voltage divider 7, which in practice is generally used as a manual volume control, to reduce to a desirable value the magnitude of the potentials before supplying them through a coupling condenser 10 to the control electrode 13 of an electron discharge device 14. The device 14 is connected as a first stage of audio frequency amplification with its anode 15 connected through the resistors 16 and 17 to the positive terminal of a source of operating potential 18. A cathode 19 is provided in the discharge device 14 and is connected through a cathode biasing resistor 20 and parallel connected condenser 21 to ground and through ground to the negative terminal of the operating potential 18.

Amplified audio frequency potentials appearing in the output circuit of the device 14 are supplied through a condenser 23 to the grid 24 of a second electron discharge device 25. The device 25 has an anode 26 which is connected through a resistor 27 to the positive terminal of the source of operating potential 18. A cathode 28 included in the device 25 is connected directly to ground. Normal operating bias for the grid 24 is supplied through a resistor 29 from a source of biasing potential 30.

The amplified audio frequency potentials appearing in the output circuit of the electron discharge device 25 are in turn supplied through a condenser 31 to a voltage divider 32. A portion of the potential appearing across the voltage divider 32 is supplied to a primary winding 33 of an audio frequency transformer 34. The secondary winding 35 of the transformer 34 is connected to one or more additional stages of audio frequency amplification, represented conventionally by the rectangle 36. The output of the amplifier 36 is supplied to a translating device 37 which may, for example, be a loud speaker.

It was previously pointed out that the oscillations supplied to the input circuit 1, 2 of the amplifier arrangement thus far described may be modulated both by desirable signal frequencies and by undesirable noise frequencies, the latter arising from noise disturbances either external to the signaling system or originating, as by a switching operation or by thermal agitation of a preceding high gain amplifier stage, within the signaling apparatus itself. The energy of the noise frequencies during a normal period of operation of the system is generally so small as not seriously to interfere with the satisfactory reception of signals. At other times, however, the energy of the noise frequencies may reach seri-

ous proportions and predominate over the signal frequencies. With the extended low and high frequency response now obtainable in signaling apparatus having an output of several watts, there is the very great possibility of producing large and disturbing sound outputs of undesirable noise, particularly during those brief periods when the energy of the noise frequencies greatly predominates over that of the signal frequencies.

Extensive studies have shown that while the range of the signal frequencies at times extends over the entire frequency range to which the amplifier is capable of responding, the greater portion by far of the signal energy appears in the relatively low signal frequencies. It has further been found that an appreciable amount of the energy of the noise frequencies lies in the band of relatively high audio frequencies between about 3,000 to about 4,000 cycles per second. Advantage is taken in my invention of this distribution of the energy between the signal and noise frequencies and the energy of the noise frequencies is used, after separation from the signal frequencies, greatly to reduce or even silence the output of the audio frequency amplifier during periods when the ratio of the noise frequencies to the signal frequencies exceeds a predetermined value.

To this end, the noise and signal potentials which appear across the resistor 7 are supplied to the input circuit of an additional stage of amplification 8. The output of the latter amplifier is supplied through a condenser 9 and through a manually operable switch 71 to a pair of series-connected condensers 42, 43. These condensers operate as a voltage divider, and that portion of the total potential which appears across the condenser 43 is supplied to the anode element 44 of a diode rectifier 45. The cathode 46 of the rectifier 45 is connected to a point of small positive potential on the source of operating potential 18 through a pair of paths, the first of which is comprised by the parallel connected resistor 47 and condenser 48 and the second of which is comprised by the serially connected condensers 49 and 50. A resistor 51 is connected in parallel with the condenser 49, the left-hand end of the resistor 51 being connected through a resistor 52 to the anode element 44 of the diode rectifier. A conductor 53 connects the left-hand end of the resistor 51 to the control electrode 54 of an amplification control discharge device 38.

The amplification control discharge device 38 is provided with an anode 39 which is connected through a manually operable switch 40 to the upper terminal of the resistor 17. The cathode 41 of the device 38 is connected through ground to the negative terminal of the source of operating potential 18. It is evident that the operating current of both the amplification control device 38 and of the amplifier device 14 flows through the common anode resistor 17. By controlling the potential on the control electrode 54 of the device 38, more or less operating current is consumed by the device 38 and, since the operating current of this device flows through and produces a potential drop across the resistor 17, more or less operating potential is supplied to the anode 15 of the amplifier device 14.

The use of the cathode resistor 20 and the condenser 21 insures that the operating bias on the control electrode 13 of the amplifier device 14 is at all times correct for the particular value of anode potential supplied to this device. However, it is well known that the gain and maximum power output of an amplifier stage operating in this manner varies in accordance with the magnitude of the operating potential supplied to the stage. Therefore, by controlling through the operation of the amplification control device 38 the magnitude of the operating potential supplied to the device 14, the gain and maximum output of the latter device may be readily controlled in accordance with the bias which is supplied to the control electrode 54 of the amplification control device 38.

The output of the amplifier 8 is likewise supplied to the grid 56 of additional electron discharge amplifier device 55 through a low frequency attenuation network comprised by the resistors 57 and condensers 58. A cathode 59 provided in the device 55 is connected through a cathode biasing resistor 60 and parallel connected condenser 61 to ground. The device 55 includes an anode 62 which is connected through a resonant circuit 63 to the positive terminal of the source of anode potential 18. The resonant circuit 63 is comprised of an iron core inductance 64 and parallel connected condenser 65 and is tuned to a frequency between about 3,000 to about 4,000 cycles per second.

The output of the electron discharge amplifier device 55 is supplied through a condenser 66 to the anode electrode 67 of a second diode rectifier 68. The diode 68 has a cathode 69 which is directly connected to the left-hand end of the resistor 47 and to the cathode 46 of the diode rectifier 45. The right-hand end of the resistor 47 is connected through a resistor 70 to the anode 67 of the diode rectifier 68.

The operation of my amplification system will now be considered. Assuming the manually operable switches 40 and 71 to be closed, signal and noise frequencies appearing in the output circuit of the amplifier 8 are supplied through the switch 71 and condenser 42 to the diode rectifier 45. The latter rectifies the noise and signal frequency potentials to produce across the resistor 51 a unidirectional potential having the polarity indicated on the drawing. The condenser 49 is sufficiently large that only syllabic or lower frequency variations occur in the magnitude of this unidirectional potential. By syllabic frequencies are meant that range of frequencies from one to approximately 10 cycles per second which frequency range is substantially that of the occurrence of syllables in ordinary speech. It will be recognized that this range of frequencies is below the range occupied by voice and music frequencies.

Simultaneously, the output of the amplifier 8 is supplied through the low frequency attenuation network comprised by the resistors 57 and condensers 58 to the grid 56 of the discharge device 55. The attenuation network supplies a band of relatively high audio frequencies above about 3,000 cycles per second from the output circuit of the amplifier 8 to the input circuit of the device 55. The tuned circuit 63 included in the output circuit of the device 55 is tuned to a frequency of from about 3,000 to about 4,000 cycles per second. Substantially only those frequencies therefore appear in the output circuit of the device 55 which lie in a band of from about 3,000 to about 4,000 cycles per second.

A considerable amount of the energy of noise frequencies is found to lie in this band of relatively high audio frequencies whereas a relatively small amount of the energy of the signal fre-

quencies falls within this frequency band. This difference in the distribution of energy between the noise and signal frequencies is therefore made use of as a means of distinguishing between the undesirable noise and the desirable signal. The output of the device 55, which consists almost entirely of noise frequencies of from about 3,000 to about 4,000 cycles per second, is supplied through the condenser 66 to the diode rectifier 68.

The noise frequencies are rectified by the rectifier 68 to produce across the resistor 47 a unidirectional potential having a polarity as indicated on the drawing. This potential is supplied to the control electrode 54 of the device 38 in opposition to the potential appearing across the resistor 51. It should be noted that the device 55 and its associated circuit serve not only to distinguish between the noise frequencies and the signal frequencies, but further serve greatly to amplify the noise frequency energy before supplying it to the diode rectifier 68. This is necessary in order that the potential appearing across the resistor 47 may predominate over the potential appearing across the resistor 51 during the occurrence of excessive noise.

The unidirectional potential which appears across the resistor 51 and the unidirectional potential produced by noise frequencies which appears across the resistor 47 are added (with the opposing polarity indicated on the drawing) to control the bias on the control electrode 54 of the amplifier control discharge device 38. The bias supplied to the control electrode 54 in turn controls the operating current consumed by the device 38 through the resistor 17 from the source of operating potential 18 and, in doing so, controls the operating potential supplied to and the gain and maximum output of the amplifier device 14. When the bias on the control electrode 54 is positive, as during the occurrence of excessive noise, there is a large potential drop across the resistor 17 and the operating potential supplied to the amplifier device 14 is greatly reduced. As was previously pointed out, the magnitude of the operating potential directly affects the gain and output of the amplifier device 14 so that the output of this device is greatly reduced or even silenced whenever there is a predominance of noise frequencies. However, when the signal frequencies predominate, the bias supplied to the control electrode 54 is negative, the operating current consumed by the amplification control device 38 is reduced, and the operating potential supplied to the amplifier device 14 thereupon becomes sufficiently large in magnitude that the device 14 is capable of amplifying without distortion large values of signal potentials supplied to its input circuit.

In practice, the magnitude of the potentials developed across the resistors 47 and 51 is so adjusted that normal signals are freely amplified, but upon the occurrence of a condition of excessive noise (where the noise frequencies predominate over the signal frequencies), the output of the amplifier device 14 is effectively reduced or even silenced. The operating characteristic of the amplification control device 38 and the magnitude of the unidirectional potentials developed across the resistors 51 and 47 are such that, with suitable adjustment of the circuit constants, the transition from normal operation to reduced output of the amplifier device 14 is accomplished in a fraction of a second when a critical value of the noise to signal ratio is exceeded.

The extended operation over a period of several months of a radio receiving system embodying my invention has shown that, contrary to what might be supposed by some persons, transmitted radio programs do not have such a frequency distribution that the signal energy itself operates to reduce or silence the amplifier output.

The switches 40 and 71 may be opened to terminate the automatic control of the gain of the device 14 by the device 38 during periods when the occurrence of noise does not seriously disturb the proper reception of signals. When the automatic control is used in a radio receiver, the switches 40 and 71 are preferably mechanically connected to be operated with the tone control switch usually provided in the receiver, the switches 40 and 71 being normally open but movable to closed position upon manual movement of the tone control knob to a predetermined position especially designated for the elimination of static and noise disturbances.

Where in the appended claims the reduction or increase of the amplifier "output" is referred to, I wish it to be clearly understood that by this expression I intend to include all changes in the amplifier operating characteristic whether the change is in the nature of a changed amplifier gain or a changed amplifier power output or both.

While I have illustrated a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto since many modifications may be made in the circuit elements employed and in their arrangement, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In a signaling system, the combination of a source of oscillations having relatively low signal frequencies mixed with undesirable relatively high noise frequencies, means for amplifying said signal frequencies and therewith said noise frequencies, and means responsive to the occurrence of a preponderance of said high noise frequencies over said low signal frequencies for reducing the output of said last named means at all frequencies.

2. In a signaling system, the combination of a source of oscillations, said oscillations having relatively low frequency signal components and relatively high frequency undesirable noise components, means for amplifying said oscillations, and means for controlling said last named means to increase the output of said last named means in response to a preponderance of said signal components over said noise components and to reduce the output of said last named means at all frequencies in response to a preponderance of said noise components over said signal components.

3. In a signal amplifier, the combination of a source of oscillations having relatively low frequency signal components and relatively high frequency undesirable noise components, means for amplifying said oscillations, means for separating out of said oscillations said high frequency noise components, and means including said last named means for reducing the output of said amplifying means at all frequencies in response to occurrence of a preponderance of said high frequency noise components over said low frequency signal components.

4. The combination, in a signal amplifier, of a

source of oscillations having relatively low frequency signal components and relatively high frequency undesirable noise components, means for amplifying said oscillations, means for distinguishing between said low frequency signal components and said high frequency noise components, and means including said last named means for controlling the output of said amplifying means at all frequencies in accordance with the relative proportions in which said low frequency signal components and said high frequency noise components occur in said oscillations, the output of said amplifying means being increased to its normal value upon the occurrence of a preponderance of low frequency components and being substantially reduced upon the occurrence of a preponderance of said high frequency components.

5. In a signaling system, the combination of a source of oscillations having relatively low frequency signal components and relatively high frequency undesirable noise components, means for amplifying said oscillations, means for developing from said low frequency components a first control potential and from said high frequency components a second control potential, and means responsive to the relative magnitudes of said control potentials for controlling the output of said amplifying means, said oscillations being amplified to the full output of said amplifying means while said low frequency components preponderate over said high frequency components and being amplified to a lesser degree by said amplifying means while said high frequency components preponderate over said low frequency components.

6. In a signaling system, the combination of a source of oscillations having relatively low signal frequencies mixed with undesirable relatively high noise frequencies, means for amplifying said signal frequencies and therewith said noise frequencies, means for supplying operating potential to said last named means, and means responsive to the occurrence of a preponderance of said high noise frequencies over said low signal frequencies for reducing the magnitude of the potential supplied to said amplifying means from said last named means whereby the output of said amplifying means is reduced at all frequencies.

7. The combination, in a radio receiver, of an audio frequency amplifier for amplifying the received audio frequency currents, means to rectify said audio frequency currents and to produce therefrom a unidirectional voltage varying in accordance with the syllabic components thereof, means to rectify a portion of said currents having frequencies above three thousand cycles to produce a second unidirectional potential, means to increase the amplification of said amplifier in response to the first of said unidirectional potentials and to reduce said amplification in response to said second of said unidirectional potentials, said variations being such as to produce normal amplification during normal reception of signals and substantially to render said amplifier inoperative during reception of undesired noise currents of high frequency.

8. In a radio receiver having audible response, the combination of an audio frequency amplifier arranged to amplify received audio frequency voice and music currents from which said response is produced, a noise reducing system, comprising means to rectify the low frequency components of said audio frequency currents to produce a unidirectional potential, means to rectify a portion of the high frequency components above three thousand cycles to produce a second unidirectional potential, and means to vary the amplification of said amplifier in response to said unidirectional potentials, said amplification being increased in response to the first of said unidirectional potentials and reduced to such an extent as substantially to silence said receiver in response to the second of said unidirectional potentials.

9. The combination, in a noise reducing system for radio receivers for voice and music currents of an amplifier for said currents, means responsive predominantly to the range of frequencies between three and four thousand cycles for reducing the amplification of said amplifier during reception of undesired noise currents, and means to render said last means ineffective during normal reception of voice or music currents including frequencies in said range.

10. The combination, in a noise reducing system for radio receivers for voice and music currents, of an amplifier for said currents, means responsive predominantly to the range of frequencies between three and four thousand cycles for reducing the amplification of said amplifier during reception of undesired noise currents, and means predominantly responsive to currents of low frequency to increase the gain of said amplifier during normal reception.

STANFORD GOLDMAN.