AUTOMATIC GAIN CONTROL DEVICE FOR HIGH FIDELITY AUDIO SYSTEMS

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FIG. 2

FIG. 3

FIG. 4

INVENTORS
GEORGE ALEXANDROVICH
KEITH MORRIS

BY
Darby + Darby
ATTORNEYS
AUTOMATIC GAIN CONTROL DEVICE FOR HIGH FIDELITY AUDIO SYSTEMS

Keith Morris, Montclair, N.J., and George Alexandrovich, Richmond Hill, N.Y., assignors to Fairchild Recording Equipment Corporation, Long Island City, N.Y., a corporation of New York
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The present invention relates to automatic gain control devices for use with audio signals and particularly to an automatic attenuator for opening or closing an audio channel when the signal level changes.

More particularly the invention relates to such a device which introduces a desired amount of attenuation (by using less than 60 db) in the amount of reverbation in the audio channel when the audio signal falls below a predetermined threshold level, and in which the threshold at which the attenuation is initiated is adjustable and can be set so that all audio signals below this threshold will be greatly attenuated and signals above the threshold will pass without decrease in level. Additionally means is provided for introducing an adjustable "release time," which is the time interval between the moment the applied signal drops below the threshold value and the instant the attenuation is introduced into the channel. The release time governs the time required for the automatic attenuator to take over after the signal has dropped below the selected threshold. In one particular instance the release time may be adjusted from 0.1 second to 7.0 seconds, although this range may be varied.

At the present time in audio work it is often desirable to eliminate some audio signals from the program such as low-level signals, or to select only signals with higher intensity or level. For example, in an audio system with a number of microphones, it is desirable to automatically close unused microphones, so as to improve signal-to-noise ratios and to reduce the danger of extraneous noise pick-up on an unused microphone. One example is in picking up sound signals from an orchestra or a performer plus orchestra, with multiple microphones, where the present invention can automatically cut out a microphone when its particular orchestra section or performer is silent. In the case of a multi-microphone set up, the present invention attains these advantages without requiring continued manual switching among microphones. In the case of stereo systems, improved separation may be obtained by using the present invention to have only performances open, which also minimizes some acoustic phasing problems.

As an example of another of the various uses of the present device, may be mentioned the recording or broadcasting from a studio or hall where the acoustics are such as to cause a considerable amount of reverberation. It may well be desirable to prevent the "echoes" from being effective on microphones not in use at some instants, while at the same time assuring that the same microphones are fully operative to convert the sound signals to effective electrical signals when those sound signals are received directly from a source thereof, usually at higher level.

As another illustration of the use of this invention "print-through" problems can be reduced or eliminated. Print-through of a magnetic recording tape occurs when one heavily recorded layer of the tape on the spool transfers or imprints its recorded magnetic signal on an adjacent layer. If the latter layer has a very low level for its desired recorded signal or none at all, in playing the tape back the print-through signal will be heard. This annoying condition can be eliminated by this invention. If one selects the threshold value so that all print-through information, which is always at low amplitudes, is below the threshold, then all such unwanted signals will be greatly reduced in intensity below the audible level. Without this automatic attenuation these sounds originating in print-through would be played back and would detract from the quality of the recording.

In a similar manner the automatic attenuator is effective to prevent noise in the audio channel resulting during the silent spiral portion of a disc recording, as well as other noise originating during the unrecorded portions of the groove between selections in a long-play record.

As a further example of use of the automatic attenuator, one may be placed in each of the voice and music channels of a broadcasting station in order to compensate for the so-called "disc jockey" broadcasts, in which an announcer both operates the record turntable and makes announcements. In this situation the announcer may be assured that low-level noise or sounds will not be broadcast by the way of the voice microphone but announcements, being at a higher level, will be broadcast.

Furthermore, the attenuator in the sound pickup channel will permit the operator to merely activate the turntable motor to cause the recorded music to be broadcast since the signal level in the pickup channel will be so attenuated as not to be effective until the pickup stylus has reached a portion of the record which has recorded material thereon in comparison to grooves without program material.

A still further use of the automatic attenuator is as a "ducker" either in broadcasting or public address systems. In this use the automatic attenuator is activated from one channel and controls the attenuation of a second channel, so that when the level of signal input of the first channel increases above threshold the attenuation of the second channel increases whereby the first channel is the controlling channel and the second the controlled channel. By way of example, the first channel may be an announcer who wishes to break into and speak over a recorded musical program. He can do this by the present invention by merely talking into his microphone (first channel) to cut down the program (second channel). Automatic mixing is thereby accomplished and the invention serves as a "third hand" for such a situation.

Although the primary use of the attenuator of the present invention is as a discretionary switch, there are some instances where the device may be utilized as an expander, that is, as a device to increase signal level in a non-linear manner, so that as the signal level of the sound source increases, the level of the output signal increases at a greater rate. Such an expander arrangement is frequently used in high-fidelity sound playback systems to compensate for the compression which has occurred in recording, for example, compression to prevent over-modulation of the sound groove on the disc and a break-through of one groove into another during intervals of recording at high amplitude.
In all the uses heretofore referred to, except the expander usage, it is also desirable to have the release time variable. The desirability of this feature is illustrated when recording or broadcasting of brass instruments is contrasted with such instruments as the piano. With the brass instruments the sound decreases rapidly from its maximum volume or amplitude to zero, and it is therefore desirable to have the release time short to prevent extraneous sounds from being effective on the microphone. On the contrary, when a piano is considered, the amplitude frequently diminishes slowly and if the release time of the attenuator were to be short the final note of a passage might well be cut off. By providing a variable presettable release time the automatic attenuator of this invention can be effectively utilized in both of these situations, for the variable release time provides discretion as to the amount of time taken for complete attenuation to occur.

The attenuator of our invention is furthermore so designed that there is no feedback from its power amplifier to the automatic network either directly or indirectly and it is therefore adapted for utilization over a wide range of input impedances and can be used between any two pre-amplifiers and power amplifiers, or more generally, between any two amplifiers. This attenuator is capable of operation with impedances in a wide range of 150 ohms to 47,000 ohms and may be utilized in both balanced and unbalanced lines.

Moreover, the automatic attenuator of our invention utilizes a light-sensitive resistor as the attenuating element and there is therefore no direct coupling of the control signal to the circuitry of the attenuator and no signal distortion results, as is the case with conventional types of attenuators or other automatic devices having similar functions. Additionally, the unit operates without frequency discrimination so long as it is within the impedance values set forth above.

The action of the automatic attenuator of this invention is smooth and continuous as contrasted with the step type of operation of mechanical attenuators. Further, the attenuator of this invention is intended to utilize a power supply to its amplifier at a normal voltage and can thus be utilized with any normal signal channel circuit having a 6.3-volt A.C. supply for the amplifier tubes or the conventional 9 volts D.C. supply for transistor amplifier operation.

It is an object of the invention to provide an automatic attenuator which is capable of handling signals over a wide range of signal level and which, throughout that range, is distortionless and does not discriminate as to frequency.

It is another object of the invention to provide such an automatic attenuator which utilizes a light-sensitive resistor and which operates essentially as a smoothly operating switch.

It is a still further object of the invention to provide such an automatic attenuator having means to preset the threshold signal level, i.e., the level of input signal which when exceeded will be effective to cause the switching operation to occur and the attenuation to be reduced to a value at which the signals will be effective in the following transducer.

It is a still further object of the invention to provide an automatic attenuator in which the release time is adjustable whereby the restoration of the attenuation to its original value is delayed a predetermined desired time after the signal level falls below the threshold thereby making it possible to utilize the attenuator in many different circuits, examples of which have been set forth hereinabove.

Other objects and features of the invention will be apparent when the following description is considered in connection with the annexed drawings, in which:

FIGURE 1 is a schematic diagram of the automatic attenuator of our invention;

FIGURE 2 is a block diagram showing the attenuator as used between the pre-amplifier and power amplifier of a sound channel, the channel in this case being a balanced line. This figure also shows in dotted lines the mode of utilizing external resistors to connect the attenuator to an expander for certain operations;

FIGURE 3 is a block diagram similar to FIGURE 2 but showing the attenuator as used in an unbalanced line; and

FIGURE 4 is a block diagram illustrating the use of the attenuator as a "ducker."

Referring now to the drawings and particularly to FIGURE 1, audio signals from any source such as a microphone or pickup pre-amplifier following a microphone or pickup are fed to input terminals 13 and 14 and thereby to the primary of coupling transformer 15. Signals generated in the secondary 16 of the coupling transformer 15 are supplied by way of an adjustable potentiometer 17 (which thus functions as a threshold control) to a conventional first amplifier stage utilizing a transistor 20 provided with the usual direct voltages by means of conventional bias circuits and the power source represented as a rectifier bridge 12 with a smoothing circuit 51, the bridge fed from an alternating voltage source connected to terminals 5 and 6. The output of amplifier stage 20 is supplied to a second conventional stage formed by a transistor 11 and its associated circuitry.

The output of transistor 11 is coupled by means of capacitor 18 to the base of an NPN transistor 20. The transistor 20 is normally biased to cutoff by bias circuit 35, which comes from the output of the collector of this transistor 20 is fed to the base of an NPN transistor 21, which transistor is, by means of the voltage divider comprising the leakage resistance of transistor 20 and resistor 27, normally biased to cutoff when (a) switch 38 is closed and (b) transistor 20 is not conductive and (c) transistor 26 (to be described later) is likewise not conductive.

The emitter of transistor 21 is directly coupled to the base of NPN transistor 22 which is also normally biased to cutoff. The emitter of transistor 22 is connected to one terminal of an incandescent lamp 23, the other terminal of which is connected to the positive side of the power supply 12 whose negative side is connected to the collectors of transistors 21 and 22.

Thus, when the signal level at input terminals 13 and 14 or the setting of threshold control 17 is sufficient, it is amplified by transistors 10 and 11, and the amplified signal overcomes the bias on transistor 20 to cause current to flow in its output resistor 27 (with switch 38 closed). This unblocks transistor 21 which in turn causes transistor 22 to conduct and the lamp 23 is energized. This circuit is a type of latching circuit, which maintains transistor 22 conductive once it has been unblocked, so that lamp 23 remains excited until the circuit is released.

This lamp 23 is placed in a light-proof housing 51 in which the light-sensitive or light-dependent resistors 24 and 25 are also placed. These resistors present maximum (nearly infinite) resistance when in total darkness, the resistance decreasing as the intensity of light falling upon them increases. The light-dependent resistors may, for example, be cadmium sulfide cells.

The operation is such that the lamp is usually maintained dark during periods of below-threshold input; however, where desired, for the faster response or more limited attenuation change, a bias current may be supplied to continuously traverse the lamp so as to keep it at a very faint glow or dull red. When the input exceeds the threshold, the circuit unblocks to energize the lamp for a limited input-signal range above the threshold (of the order of 4 or 5 db) the lamp excitation varies in correspondence with the input; for input levels above that limited range, the lamp excitation remains fixed. This action provides a smooth transition from high to low attenuation, rather than an abrupt switching action. This lamp excitation is sufficient to cause resistors 24, 25 to decrease...
to a very low level of resistance, of the order of a few ohms to a few hundred ohms, as may be desired.  As will appear herinafter, when the attenuator is used in a balanced circuit configuration both resistors 24 and 25 are included in the circuit whereas in an unbalanced circuit configuration only one of the resistors is effectively in circuit.

As has been indicated, a holding circuit is provided whereby the lamp 23 may be maintained in energized condition for a predetermined time interval after the input signal falls below the set threshold level and then extinguished.

The holding or release circuit comprises the PNP transistor 26 together with the diode 32, capacitor 33, resistor 30 and variable resistor 31. The circuit cooperates with the voltage divider formed by transistor 20 and resistor 27, in performing its function of timing the release and extinguishing of the lamp.

When transistor 22 conducts and lamp 23 is energized as heretofore described, capacitor 33 is substantially instantaneously charged through the diode 32. The voltage at the junction of transistor 22 and capacitor 33 is applied to the base of the normally cutoff transistor 26 rendering that transistor conductive and causing transistors 21 and 22 to likewise become slightly more conductive and maintaining the voltage of lamp 23 at a slightly higher level.

This condition continues until the input signal level falls below the predetermined threshold value, at which time transistor 20 cuts off and as a result transistor 21 becomes slightly less conductive, the amount being determined by the parameters of the resistor 27 and transistor 20. As a result the voltage supplied to capacitor 33 falls slightly and the capacitor discharges through resistors 30, 31 and rendering transistor 26 slightly less conductive which in turn, by modifying the current in resistor 27, causes transistor 21 and, in turn transistor 22, to become less conductive. This again decreases the voltage applied to the capacitor 33, which discharges through resistors 30, 31 and reduces the conduction of transistor 26 and hence of transistor 22. This process continues until the capacitor 33 is fully discharged at which time the lamp becomes entirely extinguished due to the transistor 26 being rendered substantially non-conductive.

In this way, the lamp is gradually extinguished over the range of the potentiometer, so the attenuation is gradually increased, avoiding undesirable sharp changes.

Since the capacitor 33 discharges through the fixed resistor 30 and the variable resistor 31, the time required for it to fully discharge can be predetermined and adjusted by movement of the arm of the adjustable resistor 31.

The time interval for capacitor 33 to discharge depends upon the time constant of the RC circuit 30-31-32, which can be selected to have desired values and can be varied over wide limits by means of adjustment of resistor 31.

It is desirable also to have a means of causing the lamp 23 to be continuously energized to thereby reduce the attenuation of the resistors 24 and 25 to the maximum extent and thus operate as if the automatic attenuator were not present in the circuit. In the present instance this is accomplished by means of the switch 28 which switch open-circuits the resistor 27 thus causing the base of transistor 21 to be constantly biased to conduction, thus retaining the lamp 23 energized continuously, and effectively disabling the attenuator to cause no attenuation.

In practice the switch 28 is preferably mechanically connected to the arm or slider of the variable resistance 31 so that as introducing attenuation switch 28 is closed, after which the slider is moved along the resistor 31 to vary the release time from minimum to maximum. Preferably, the resistor 31 is tapped and the switch moved by predetermined increments to thereby vary the time in like manner by calibrated steps.

The release circuit operates as described to deenergize the lamp 23 after a time corresponding to the setting of the slider or contactor along the variable resistance 31, the particular results described being achieved when the various circuit elements have the following representative values:

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transistor 20</td>
<td>Type 2N35.</td>
</tr>
<tr>
<td>Transistor 21</td>
<td>Type 2N323.</td>
</tr>
<tr>
<td>Transistor 22</td>
<td>Type 2N307.</td>
</tr>
<tr>
<td>Transistor 26</td>
<td>Type 2N323.</td>
</tr>
<tr>
<td>Resistor 34</td>
<td>12,000 ohms.</td>
</tr>
<tr>
<td>Resistor 36</td>
<td>4,700 ohms.</td>
</tr>
<tr>
<td>Resistor 27</td>
<td>10,000 ohms.</td>
</tr>
<tr>
<td>Resistor 30</td>
<td>4,700 ohms.</td>
</tr>
<tr>
<td>Capacitor 33</td>
<td>50 microfarads.</td>
</tr>
<tr>
<td>Capacitor 36</td>
<td>50 microfarads.</td>
</tr>
<tr>
<td>Capacitor 37</td>
<td>5 microfarads.</td>
</tr>
<tr>
<td>Diode 32</td>
<td>Type IN96.</td>
</tr>
</tbody>
</table>

As is indicated in FIGURE 2, the light-sensitive resisters 24 and 25 are provided with terminals 40 and 41 and with terminals 42 and 43, respectively.

Referring now to FIGURE 2, there is shown a mode of using the automatic attenuator of our invention in a sound channel of balanced configuration. In this figure the signal source is designated 44, and its output feeds a pre-amplifier 45, the output of which is connected to the automatic attenuator of FIGURE 1 generally designated 46.

One side of the line from the pre-amplifier 45 is connected to terminals 13 and 40 while the other side of the line is connected to terminals 14 and 41. The output terminals 42 and 43 of the attenuator are connected to an amplifier 47 which is in turn connected to a transmitter 48 which is in this instance a loudspeaker, although it might of course be a modulator for impressing the output signals upon the carrier wave of a radio or television transmitter. The signal source 44 may be a microphone, a playback head of a tape recorder, a pickup cartridge of a record player or other such device.

As will be clear from the description of the attenuator, the threshold level control 17 thereof is set to a desired value as is the release control 31.

When the signal at point 13, 14, is below the level required to excite the lamp 23, the resistors 24, 25 have a very large value, reducing the input to power amplifier 47 by a maximum amount, of the order of 60 db, when input signals exceed this threshold value, lamp 23 is fully excited, reducing resistors 24, 25 to a very low value, and allowing substantially full signal to pass to the power amplifier 47.

It should be noted that the only elements in the path of the signal are resistors 24, 25 which are essentially frequency-dependent and linear, so that no distortion is introduced in the main channel. Any non-linearity or rectification in the control portion of attenuator 46 is isolated from the main signal and cannot cause signal distortion. This is an important advantage of the present system.

The release time adjustment is effective as has been heretofore pointed out to vary the time after signals fall below the threshold level at which the attenuation will be restored to its original value, thus causing different types of signals as desired. The settings of the threshold and release time controls are largely empirical and the user of the attenuator will, by experience, utilize such settings as yield the best result. It might be stated at this point that the release time can be varied from 0.1 to 7.0 seconds with the values for the circuit elements illustratively set forth above.

FIGURE 3 is very similar to FIGURE 2 and the elements have therefore been given the same reference characters as in FIGURE 2. The difference between the two figures lies in the fact that in FIGURE 3 an unbalanced
circuit configuration is shown and in this configuration the terminals 14 and 43 are directly connected together and to ground, thus shorting out the light-sensitive resistor 25. The operation of the circuit is, however, substantially identical with that described in connection with FIGURE 2.

FIGURE 4 is a schematic representation of the use of the attenuator of our invention as a "ducker." In this figure two signal sources 44 and 54 are shown, each being connected to its pre-amplifier respectively designated 45 and 55. Output leads of amplifier 55 are connected to the input terminals 13 and 14 of the attenuator and in addition are connected to a mixer 60 feeding any desired circuit. The output of pre-amplifier 45 is connected through a resistor 49 to terminal 40 of the attenuator 46. Output terminal 42 of the attenuator 46 is connected through a resistance 50 to the other side of the output of the pre-amplifier 45 by means of the conductor 51 and is also connected to the mixer 60. There is also a connection by means of conductor 52 from the input terminal 40 of attenuator 46 to the other side of the line entering mixer 60.

We may now assume for illustrative purposes that the signal source 44 is a phonograph pickup for producing audio signals from a recorded program, and that the source 54 is a microphone, intended to be dominant. So long as the microphone output produces an input signal level for the attenuator 46 below its adjusted threshold level, the lamp 23 will be unexcited and resistor 24 will be very large. The voltage divider formed by resistor 49 and by resistors 24, 50 together, will reduce the level in channel 52, 51 very little, and this channel supplies signal to mixer 60 without hindrance. If desired, a second attenuator may be inserted between pre-amplifier 55 and the shown terminals 13, 14 to cut off all signal from source 54 at the mixer 60.

When the signal from source 54 exceeds the threshold level, the lamp 23 will be excited and will reduce the resistance presented by the light-sensitive resistor 24 to a very low value. Since this resistor 24 is in series with resistors 49, 50, shunted across the channel between pre-amplifier 45 and the mixer 60, the signal level appearing in the mixer 60 from the source 44 will be reduced (to an extent depending upon the relation between resistor 49, 50) and thus the volume of the recorded program will be reduced so that voice signals impressed upon the source 54 will predominate in the output of the mixer 60. It is, therefore, evident that an arrangement of this type is extremely useful in connection with broadcast systems. In public address systems it may be desirable to utilize this arrangement also. For example, in a public address system utilized in a factory where music is broadcast throughout the day but it is desirable at times to make announcements, this "ducker" arrangement provides for automatically decreasing the volume of the broadcast music during times of making announcements so that music forms merely a low-level background for the announcement.

The attenuator of this invention may also be utilized as an expander. Illustrations of use in this manner are shown in FIGURES 2 and 3 wherein a dotted resistor 52, 53 is shown in shunt with each of the light-sensitive resistors 24 and 25 or in the case of FIGURE 3 in shunt with the effective light-sensitive resistor 24 only. The shunting resistors are variable resistors and are so adjusted that the degree of expansion required. When below threshold signals are applied to the terminals 13, 14, light dependent resistors 24, 25 have large resistances (much larger than resistors 52, 53) and accordingly have little effect on the net resistance in the channel, which net resistance is then determined primarily by the settings of resistors 52, 53 and creates a predetermined attenuation. When the threshold is exceeded, the very low value of resistors 24, 25 shunts resistors 52, 53 to reduce the attenuation to nearly zero. Hence not only has the signal level itself increased, but the attenuation has decreased, producing an expansion for all above threshold signals, but not disturbing the linearity of the channel. As has been indicated, the expander can be utilized in restoring dynamic realism to theatre or public address systems and to the higher fidelity home playback systems. In like manner the expander can be utilized with particular advantage to provide noise reduction in motion picture or tape recording. Whenever the recorded signal falls to a low level, where noise would be particularly troublesome, the system offers greater attenuation, and for higher levels, expansion is provided.

The variable release time (whether with or without expansion) offers further advantages. In combination with the fast attack time which is obtained here, it can modify the acoustics of a hall or studio. It permits maintaining "light" sound on a microphone in a "live" hall, particularly for "close-up" microphones, for desirable performance and intelligibility effects.

It will be obvious that many further uses of this system exist or may be found, and that those skilled in the art will readily conceive variations within the general principles outlined herein. While we have described a preferred embodiment of the invention, it will be understood that we wish to be limited not by the foregoing description, but solely by the claims granted to us.

What is claimed is:

1. In a signal magnitude control device adapted for use with a source of signals and a utilization means the combination comprising:
   light dependent impedance means whose impedance varies as a function of the light impinging thereon adapted to be connected between said source and said utilization device, and a signal source arranged to illuminate said light dependent impedance means,
   control means responsive to the amplitude of the signals from the source adapted for connection to said signal source and connected to said light source to control its energization, said control means including means for controlling the energization of said light source from a first condition of illumination to a second condition of higher intensity illumination when the signals from said source exceed a predetermined amplitude, and release circuit means connected to said control means and to said light source and responsive to the amplitude of the signals from the source to operate said control means to control energization of the light source to decrease its illumination intensity in a predetermined time responsive manner after said signals from said source fall below said predetermined amplitude.

2. A control device as in claim 1 wherein said means for controlling the energization of the light source comprises an amplifier, and means electrically connected to said amplifier to bias it to cut off at a selected amplitude of the signals from the source, which selected amplitude determines said predetermined amplitude above which the illumination intensity of the light source is increased from said first condition of illumination.

3. A control device as in claim 1 wherein said means for controlling the energization of the light source comprises an amplifier, means electrically connected to said amplifier to bias it to cut off and hold the light source in said first condition of illumination until the signals from the source reach said predetermined amplitude, and release circuit means includes further biasing means electrically connected to said amplifier for changing the bias on said amplifier means in a predetermined manner after the signals from the source fall below said predetermined amplitude to return said amplifier means to the cut off condition.
4. A control device as in claim 3 wherein said further biasing means includes a resistor and capacitor time constant circuit, means electrically connecting said capacitor to said light source to electrically charge said capacitor with a voltage when said light source is in a condition of illumination other than said first condition, the voltage on said capacitor being discharged through said resistor with the signals from the source fall below said predetermined amplitude.

5. The control device of claim 4 wherein said resistor is variable to thereby vary the time constant of the voltage discharge of the capacitor.

6. A signal magnitude control device for use with a circuit utilizing signals from an audio signal source, said control device comprising: light-responsive variable impedance means for electrical connection between the output of the signal source and the input of said circuit for controlling the magnitude of the audio signals applied to said circuit, a light source positioned to illuminate said light responsive means, means electrically connected to said light source and responsive to the audio signals from the signal source for energizing said light source from a first toward a second condition of illumination as the level of said audio signals from said signal source increases from a first toward a second amplitude level, and means electrically connected to said energizing means and responsive to the audio signals from the source below a predetermined amplitude level for controlling the operation of said energizing means to energize said light source toward said first condition of illumination at a predetermined time after the audio signals from the source fall below said predetermined amplitude level.

7. A control device as in claim 6 wherein said predetermined amplitude level at which said controlling means operates is said first amplitude level.

8. A control device as in claim 6 further comprising means electrically connected to said energizing means for selecting the first amplitude level at which said energizing means becomes effective to change the illumination condition of the light source in response to the audio signals.

9. In a signal magnitude control device for use with a circuit utilizing audio signals from an audio signal source the combination comprising: light responsive variable impedance means adapted for connection between the output of the signal source and the input to said circuit, a light source arranged to illuminate said light responsive variable impedance means, amplifier means adapted to be connected to the output of the signal source, means connecting said amplifier means to said light source for supplying electrical energy thereto, control means electrically connected to said amplifier means and responsive to the amplitude of the audio signals from the source to normally hold said amplifier in a condition to apply a predetermined amount of electrical energy to said light source, said control means being responsive to an increase in the audio signals above a predetermined amplitude level to operate said amplifier means to supply an amount of electrical energy greater than said predetermined amount to said light source to increase its light output, and means connected to said control means and responsive to a decrease in the audio signals from an amplitude exceeding said predetermined level to said predetermined level to gradually change the operation of the amplifier means over a period of time to reduce the amount of electrical energy supplied to the light source back to said predetermined amount to reduce the light output of the light source.

References Cited by the Examiner

UNITED STATES PATENTS

2,681,989 6/1954 Cunniff 328—99 X
3,014,135 12/1961 Hewlett et al. 250—217 X
3,076,145 1/1963 Copeland et al. 328—165

ROY LAKE, Primary Examiner.

N. KAUFMAN, Assistant Examiner.