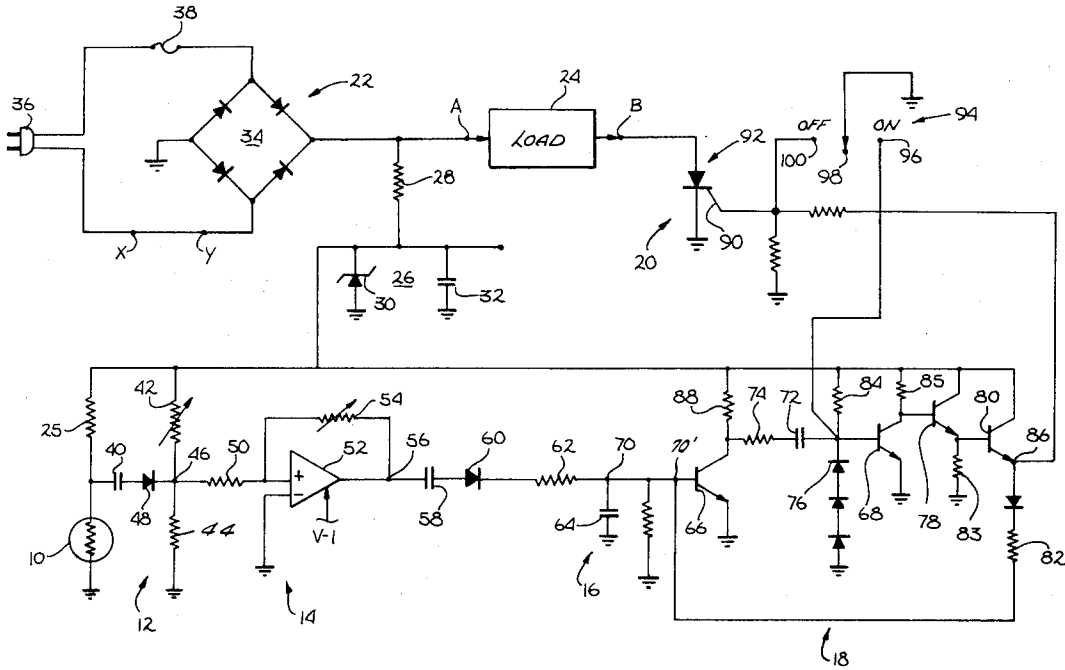


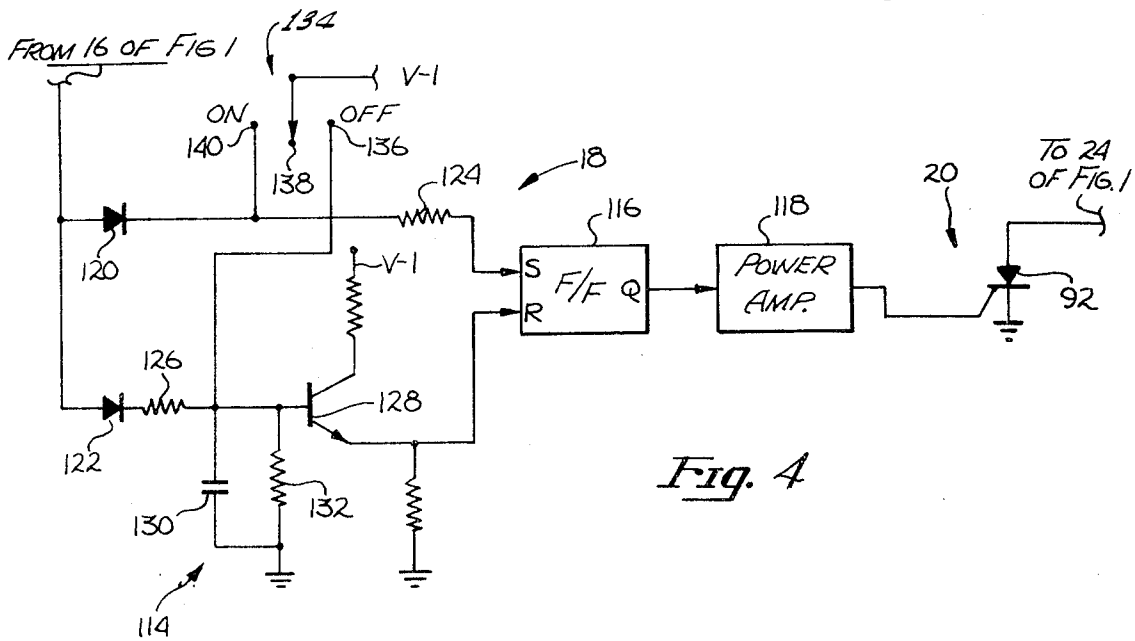
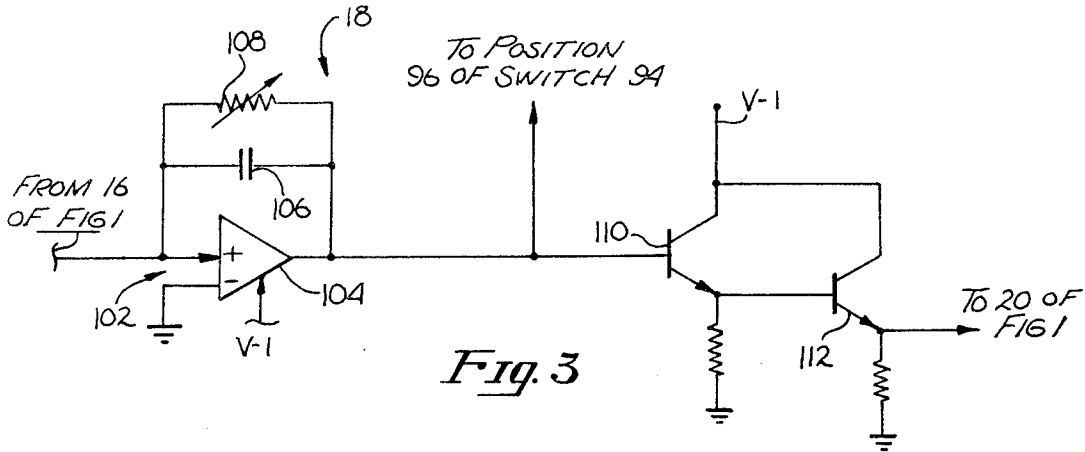
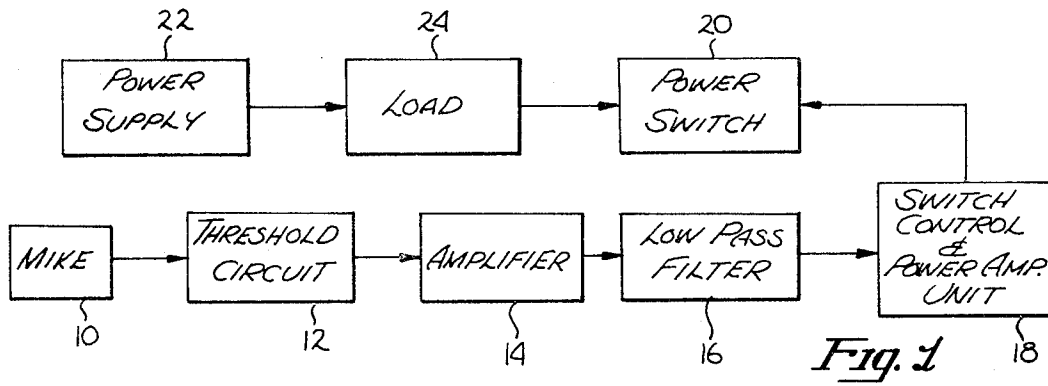
[54] **SOUND ACTIVATED CONTROLLER**
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328/1
[51] Int. Cl. **H03k 17/56**
[58] Field of Search 328/1; 307/252 W,
307/308; 179/1 VC
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[57] **ABSTRACT**
According to one preferred embodiment, a controller in accordance with the invention includes a microphone, threshold circuit and high gain amplifier arrangement for selectively converting sound energy into digital signals which after filtering are used to energize a control circuit that provides an enabling signal, of a controlled time duration, to a switching device.
8 Claims, 4 Drawing Figures





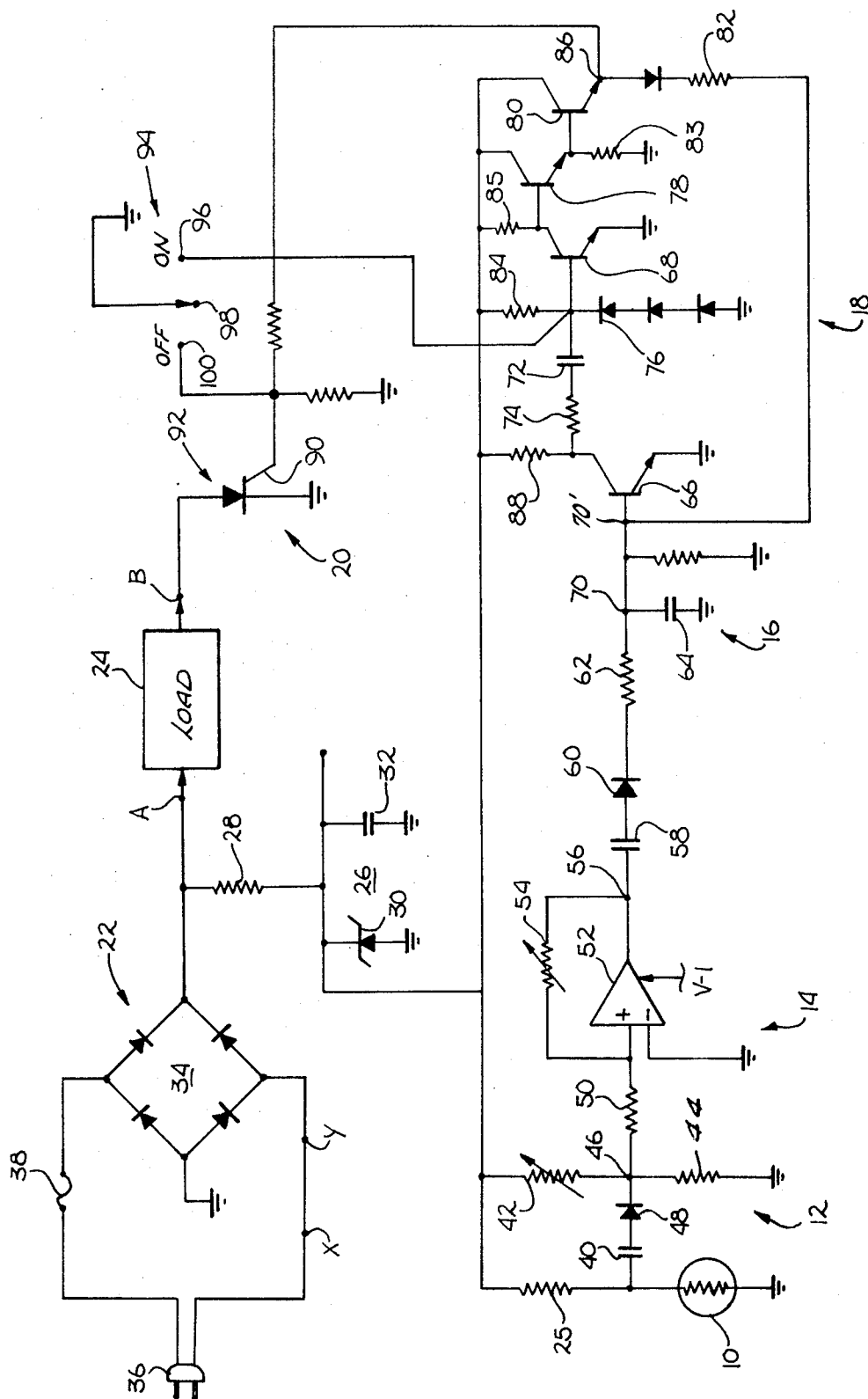


Fig. 2

SOUND ACTIVATED CONTROLLER

BACKGROUND OF THE INVENTION

This invention relates generally to sound activated controllers and more particularly to controllers which activate a load circuit for a controlled time period in response to an audio command signal.

Prior acoustically actuated switches have generally been either very costly or of potentially unstable designs; and therefore unusable for applications requiring low cost, reliable, maintenance free operation, such as lighting control or alarm circuits. One such prior art switching device is disclosed in U.S. Pat. No. 3,536,836 by Pfeiffer, which inherently incorporates an adaptive threshold feature. Although such a device, in which the response is adaptive to ambient acoustical noise (background noise), may be useful in many applications; the varying threshold feature is unacceptable for other applications in which it is required that the switch always be activated by the same level of audio command signal — such as in alarm devices, for example. Also systems of the type disclosed in the above patent are restricted to the use of relatively expensive crystal microphones and are subject to changes in operating conditions due to temperature and aging effects on their transistor components. Further the Pfeiffer patent does not provide a practical method of controlling the "on" time of the switch once it is activated. Other prior art devices such as the type described in U. S. Pat. No. 2,391,882 to Conn, are responsive to successive bursts of audio energy in such a manner that the load is energized and then deenergized on alternate audio energy bursts; and this is undesirable for many applications in which a controlled "on" time is required regardless of the audio environment.

SUMMARY OF THE INVENTION

In accordance with one preferred embodiment of the subject invention, audio energy is selectively converted into a digital type control signal by a threshold-high gain amplifier combination, and the output signal therefrom is processed by a low pass filter and then applied to a monostable multivibrator which in turn activates a solid state switch for a preselected time interval. An extended on period is provided by a configuration in which the "RC" time constant circuit of the multivibrator is enabled only during a fraction of each cycle of the prime power. In a second embodiment the output signal of the amplifier is applied to an integrator circuit which activates the switching device for a time period determined by the amplitude and/or the duration of the audio energy. In a third embodiment, a flip-flop circuit is set by an audio command of a first duration so as to energize the load and is reset by an audio command of a second duration.

Thus, it is an object of the invention to provide an economical and reliable sound activated controller which will energize a load circuit for a controlled time period in response to an audio command.

Another object is to provide an acoustically activated switch which is responsive to a preselected level of sound energy regardless of the ambient noise level, and which is immune to continuous cycling by alternate bursts of audio signals.

A further object is to provide a sound activated controller having an on time which is a function of the level and/or the duration of acoustical command signals.

Another object is to provide a sound activated controller which is activated by an audio command of a first duration and inactivated by an audio command of a second duration.

Still another object is to provide an acoustically activated switch having an extended on time, of a predetermined duration, produced by a monostable multivibrator circuit arranged such that the multivibrator's time constant circuit is activated only during a small portion of each cycle of the applied AC power.

Yet another object is to provide a sound activated controller which activates a load in response to an audio command, and which continuously energizes the load as long as audio commands occur at periodic intervals.

Still other objects, features and attendant advantages of the present invention, together with various modifications, will become apparent to those skilled in the art from a reading of the following detailed description of the preferred embodiments constructed in accordance therewith, taken in conjunction with the accompanying drawings wherein like numerals designate like parts in the several figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a sound activated controller in accordance with the invention;

FIG. 2 is a schematic and block diagram of one embodiment of a sound activated controller incorporating a monostable multivibrator to provide a predetermined on time interval;

FIG. 3 is a schematic and block diagram of an integrator-amplifier combination which may be used for the switch control unit of FIG. 1, to provide an on time which is a function of the amplitude and/or duration of the audio command signals;

FIG. 4 is a schematic and block diagram of a flip-flop circuit and control logic therefor; which may be used for the switch control unit of FIG. 1 to provide a sound activated controller which is activated by an audio command signal of a first duration and inactivated by an audio command signal of a second duration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, and more particularly to FIG. 1 thereof, there is shown a block diagram of one preferred embodiment of the subject invention. A microphone 10 which may be of the relatively inexpensive carbon type, converts received audio energy to electrical signals which are selectively coupled through a threshold circuit 12 to a high gain amplifier 14. The output signals from amplifier 14 are processed through a lowpass filter 16 and used to activate a switch control and power amplifier unit 18. Unit 18 in turn controls a power switch 20 which, when activated, completes a conduction path between a power supply 22 and a load 24.

FIG. 2 shows one preferred embodiment in greater detail. As there shown, microphone 10 is biased by current applied through a resistor 25 from a DC power supply 26 which includes a resistor 28, a Zener diode 30 and a filter capacitor 32. Unfiltered, fullwave rectified voltage is applied to resistor 28 from a diode bridge circuit 34, which is energized by AC power applied from a prime power source (not shown) through a plug 36 and a fuse 38.

Microphone 10 converts received acoustical energy to electrical signals which are coupled through a capacitor 40 to threshold circuit 12. Circuit 12 includes a resistor divider network having a potentiometer 42 and a resistor 44 coupled between the output terminal of DC supply 26 and a reference potential plane (ground). The setting of potentiometer 42 determines the potential at a junction point 46, which in turn determines the conduction level of a diode 48; and hence the threshold level of circuit 12. The signals passed by threshold circuit 12 are applied through a resistor 50 to a high gain amplifier 52, which may be of the solid state integrated circuit type such as UA741 manufactured by the Fairchild Electronic Company. The gain of amplifier 52 is determined by the ratio of the resistive values of a feedback potentiometer 54 and resistor 50. Adjustment of potentiometer 54 allows for a wide range of gain settings such as from 1,000 to 30,000, for example.

In the embodiment of FIG. 2, the gain of amplifier 52 is set to a high level so that signals which exceed the threshold level of circuit 12, saturate the amplifier to provide a digital type output signal at terminal 56. This digital output signal is applied through coupling capacitor 58 and diode 60 to lowpass filter 16, which comprises a resistor 62 and a capacitor 64. The output signal of filter 16 is applied to switch control and power amplifier unit 18.

In the embodiment shown in FIG. 2, unit 18 comprises a multivibrator arrangement in which a transistor 66 is normally non-conductive in the absence of an enabling signal from filter 16; and a transistor 68 is normally conducting. When an enabling signal is applied to junction point 70, one end of a capacitor 72 is effectively grounded through transistor 66 and a low value resistor 74 (100 ohms, for example); and so the opposite end of capacitor 72 goes to a negative potential, thereby turning off transistor 68. Diode chain 76 protects transistor 68 against excessive back bias. When transistor 68 is turned off, power amplifier stages 78 and 80 are switched on so as to apply the voltage V-1 through a resistor 82 to junction point 70', and thereby hold unit 18 in the on state until capacitor 72 charges up through a resistor 84 to a positive potential sufficient to turn on transistor 68. At this point, the unit 18 will be turned off, i.e., the voltage at output terminal 86 will drop to zero. It is noted that signals applied to unit 18 (junction 70) immediately after turnoff will not activate the unit, as capacitor 72 must first charge up through resistor 88. This allows the device to control audio equipment such as radio and tape recorders without continuously recycling. Also, as will be explained subsequently, this feature allows the device to turn itself off if load 24 is located between points X and Y in the prime power line; instead of across points A and B, which would be shunted in this second arrangement. Further, this second arrangement allows the device to be used in applications where just one AC line is available such as in a wall-mounted light switch for example.

The enabling signal from unit 18 is applied to the gate terminal 90 of a silicon controlled rectifier (SCR) 92 which conducts in response thereto; thereby completing a conduction path for fullwave rectified power from diode bridge 34. Due to the unfiltered nature of the power applied to the SCR, it ceases conduction within less than one cycle after the enabling signal is removed from its gate terminal.

A mode selection switch 94 has three positions designated 96, 98 and 100. In center position 98, the controller is in the sound activated mode; in the position 96 the load is continuously energized; and in position 100 the load is never energized.

The operation of the embodiment of FIG. 2 may be explained by way of an example in which load 24 is an electrical lamp. With switch 94 in position 98, the controller responds to an audio command such as "LIGHT ON" to light the lamp. The audio command is converted to electrical signals by microphone 10 which is processed in threshold circuit 12 and amplifier 14 to provide a digital type signal at the output of filter 16. In this embodiment, the gain of amplifier 52 (FIG. 2) is set such that signals which exceed the threshold of circuit 12 saturate the amplifier to provide a maximum output. Filter 16 reduces interference from extraneous high frequency signals.

If the activating sound is of sufficient amplitude and duration, such as the command "LIGHT OFF", capacitor 64 charges to a level sufficient to turn on transistor 66. This couples one end of capacitor 72 to ground (through resistor 74) and puts a negative potential on the base of transistor 68. The resulting high output at the collector of transistor 68 is amplified through transistors 78 and 80; and is used to gate on SCR 92, and to maintain transistor 66 on. When capacitor 72 eventually charges up through resistor 84, the SCR is turned off due to the unfiltered fullwave power and the controller is returned to its original state. Hence, in response to the audio command the light is turned on for a predetermined time period.

As mentioned previously, if the load 24 is placed in the prime power line between points X and Y, and points A and B are shunted, an extended on time is provided. This is due to the fact that in this configuration, DC supply 26 is shunted by SCR 92, and hence capacitor 72 is charged only during the portion of each prime power cycle in which the SCR ceases conduction.

In switch position 96, the lamp would remain on as the base of transistor 68 is grounded. Hence, a person entering a dark room could command the light to turn on (position 98) and would then have time (one minute, for example) to walk over and permanently turn the light on or off. In position 100 the gate of SCR 92 is grounded and so the light is off.

Table I lists the component values used in one configuration of the circuit of FIG. 2. It is understood that these values are included by way of an example so as to provide the fullest possible disclosure, and they should not be interpreted as in any way restricting the scope of the invention.

TABLE I

Reference number	Component value
25	680 ohms
28	2.7 K ohms
30	15 volt zenier
32	250 uf
34	IN4004
40	0.1 farad
42	1 to 10 Meg. ohms
44	1.0 Meg. ohms
50	100 ohms
52	uA741
54	0 to 1 Meg. ohms
58	0.1 farad
62	1 K ohms
64	1 u farad
66	2N5137
72	250 uf
74	100 ohms

78	2N5137
80	2N5137
82	2.2 K ohms
83	82 K ohms
84	1.0 Meg. ohms
85	82 K ohms
88	5.6 K ohms

In another embodiment of the invention, switch control unit 18 comprises an integrator-amplifier combination as shown in FIG. 3. Integrator 102 includes an amplifier 104 having a feedback capacitor 106 paralleled by a potentiometer 108; and the output therefrom is amplified in transistor stages 110 and 112. The base of transistor 110 is coupled to a switch, such as position 96 of switch 94, shown in FIG. 2; and the output signal from transistor stage 112 is applied to the gate of an SCR, such as 92 of FIG. 2.

In the operation of the controller incorporating the integrator circuit of FIG. 3, if the gain of amplifier 14 is set high enough so that it saturates on the signals which are applied thereto from threshold circuit 12, then the charge held by integrator 102 is a function of the duration of the audio command. The discharge rate of the integrator may be set by adjustment of potentiometer 108. Hence for the above discussed lamp example, the time duration the light is on is controlled by the length of the audio command. If audio commands are periodically applied (such as from a conversation in the room) the light will remain on.

In the embodiment incorporating the integrator of FIG. 3, if the gain of amplifier 14 is adjusted such that it operates linearly over the range of its input signals, then the on time will be a function of the intensity of the audio command as well as its duration. For example, a quiet voice will produce a shorter on time.

Another embodiment of the subject invention uses the circuit shown in FIG. 4 for the switch control unit 18. The output signals from filter 16 (FIG. 1) are applied to a logic circuit 114 which controls a flip-flop 116. The output of flip-flop 116 is amplified by power amplifier 118 and then applied to the gate of an SCR, such as 92 of FIG. 2. The output signal from filter 16 is applied in parallel to diodes 120 and 122. Diode 120 is coupled through a resistor 124 to a "set" input terminal of flip-flop 116; and diode 122 is coupled through resistor 126 to the base of a transistor 128. A capacitor 130 and a resistor 132 are connected between the base of transistor 128 and ground in an integrator configuration; and the emitter of transistor 128 is coupled to the "Reset" terminal of flip-flop 116.

In the operation of the circuit of FIG. 4, the load is activated by the "setting" of flip-flop 116 in response to a quick audio command such as "On". To turn the light off, a longer command such as "Please turn the light off" is used. The longer command allows capacitor 130 to charge up through diode 122 and resistor 126. Resistor 132 provides for the discharge of capacitor 130, and the discharge time is of sufficient duration such that transistor 128 will be biased on after the command signal, also applied through diode 120 to the set terminal, has ended. Switch 134 allows selection of the operating mode. In position 136 the flip-flop is always reset and the load cannot be energized; in position 138 the controller responds to audio commands; and in position 140 the flip-flop is always set and the load is energized.

Thus, there has been described an economical and reliable controller which in response to audio com-

mand signals activates a load circuit for a controlled time period. It is understood that many changes and modifications may be made to the disclosed embodiments within the scope of the invention. Also, although a light control application has been described to illustrate the operation of the invention, it is in no way restricted to this area of utility. For example, the invention is directly adaptable to use with alarm systems such as for nursery or pool surveillance.

What is claimed is:

1. A device for activating a load in response to sound energy comprising:

a sound to electrical signal transducer for converting sound energy into electrical signals;

a threshold circuit for providing output signals when said electrical signals exceed a preselected threshold level;

control means responsive to said output signals for providing enabling signals having a controlled time duration;

switching means controlled by said enabling signals, for activating said load during the time of occurrence of said enabling signals;

said control means includes a high gain amplifier for amplifying said output signals applied thereto;

said control means further includes a monostable multivibrator coupled to said amplifier, so as to provide enabling signals of a predetermined duration when triggered by said amplified output signals; and

said switching means includes a source of unfiltered fullwave rectified power, and a silicon controlled rectifier coupled in series with said load and said source of rectified power so as to activate said load in response to said enabling signals.

2. The device of claim 1 wherein

said monostable multivibrator includes a capacitance element coupled therein such that the charging time of said capacitance element is determinative of the duration of said enabling signal; and said device further includes means for inhibiting the charging of said capacitance element except during a fractional portion of each cycle of said unfiltered fullwave rectified power.

3. The device of claim 2 including

means for applying direct current supply voltage to said monostable multivibrator, and wherein said inhibiting means includes means for coupling said silicon controlled rectifier across said direct current supply means; whereby said monostable multivibrator is energized, and hence said capacitance element is allowed to charge, only during said fractional portion of each cycle of said unfiltered fullwave rectified power.

4. The device of claim 2 wherein

said control means further comprises a lowpass filter coupled between said amplifier and said monostable multivibrator; whereby the response of said control means to high frequency amplified output signals is attenuated.

5. The device of claim 1 wherein

the gain of said amplifier is such as to cause the amplitude of said amplified output signals to be approximately at the saturation level of said amplifier; and said control means includes an integrator circuit for providing enabling signals having a time

duration proportional to the duration of the output signals from said threshold circuit.

6. The device of claim 1 wherein the gain of said amplifier is such as to cause said amplifier to operate in approximately the non-saturated portion of its operating range; and said control means includes an integrator circuit for providing enabling signals having a time duration proportional to the amplitude and duration of the output signals from said threshold circuit.

7. The device of claim 1 wherein said control means includes a flip-flop circuit; and logic means for setting said flip-flop circuit in re-

sponse to amplified output signals of a first duration, and for resetting said flip-flop circuit in response to amplified output signals of a second duration.

8. The device of claim 7 wherein

said logic means includes means for applying said amplified output signals to a set input terminal of said flip-flop; means for also applying said amplified output signals to an integrator type circuit; and means for coupling said integrator type circuit to a reset input terminal of said flip-flop.

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