ABSTRACT: A sound-responsive light illuminated by an audio-actuated serially connected switch. The audio-actuated switch includes a thyristor, preferably an SCR, the gate of which is triggered by an audio frequency signal from a microphone and audio amplifier. The amplifier is a class A audio amplifier with biasing and loading provided so that the light will be illuminated by sound above a selected level. A nonlinear potentiometer is used for the load impedance of one of the amplifier stages to permit selection of the desired audio level which triggers the thyristor. The input terminals of a rectified power supply are connected across the principal terminals of the SCR so that the parallel combination may be connected in series with the electric light and an alternating current power source. Coupling is provided from the output of the audio amplifier to the gate of the thyristor by means of a series capacitor and a shunt gate resistor of approximately 1000 ohms.
This invention relates to an audio-actuated electrical device, and more particularly relates to an electric light which is illuminated in response to the presence of sound above a selected level.

Electric lights have traditionally been used for a variety of purposes including illumination and signalling. I have found that there is a need for a device which can provide an instantaneous, active, visual representation of an immediate sound environment.

As an example, many persons have found it pleasurable to listen to stereo music with the aid of stereo earphones. However, with such earphones positioned over the listener's ears, and with music being reproduced by the earphones, a listener, relaxing in a chair, would be unable to hear a ringing telephone or a statement made to him by another person standing in the room. However, with the aid of my audio-actuated light, such sounds would be immediately indicated to the listener.

The audio-actuated light also can find use with children born without hearing, or other persons hard of hearing or deaf. My light is useful in teaching such persons to speak because it gives an immediate indication of the effect of their voices, especially in the presence of other voices. Furthermore, the characteristics of the light flicker vary somewhat according to the type of sound reaching the light. Therefore, my audio-actuated light can be used to indicate the nature of a sound.

My light can also be used in places such as libraries, hospitals, or study rooms where a low level of noise is desired. Such a light would flicker when the sound level rises above an acceptable level and should serve as an alarm to discourage the making of such noise. The sound-responsive light is also an effective tool for deterring burglars and thieves. For example, the noise created by the opening of a window, walking, or the removal of loot, would create a flash or flashes of light which would alert neighbors and possibly scare a thief or cause him to flee.

The audio-actuated light can also have an interesting effect on conversation between two or more persons. The illumination of the light, modulated by the speaker's voice, seems to make a person more conscious of his manner of speaking. Finally, a light which is audio responsive will provide a stimulus for teaching a songbird to sing by reinforcing him for his sounds. A captive bird, such as a canary, may be rewarded for its singing by the pleasing light variations created by my light in response to his sounds. In effect, this would be a teaching machine for the canary which would not require the attention of the owner.

It is therefore an object of my invention to provide an improved audio-actuated switch.

Another object of my invention is to provide an improved audio-actuated illumination means.

Another object of my invention is to provide an audio-actuated illumination means which is instantaneous in that there is no perceptible time delay between the beginning or the cessation of audio stimulus and the beginning or cessation of the illumination.

It is a further object of my invention to provide a light which is illuminated in a manner characteristic of its audio stimulation.

Fig. 1 is a block diagram of the invention.

Fig. 2 is a schematic diagram of the preferred embodiment of the invention.

Fig. 3 is a mixed schematic and block diagram illustrating an alternative embodiment of the invention.

In describing the preferred embodiment of the invention illustrated in the drawings, specific terminology will be resorted to for the sake of clarity. However, it is not intended to be limited to the specific terms so selected, and it is to be understood that each specific term includes all technical equivalents which operate in a similar manner to accomplish a similar purpose.

SUMMARY OF THE INVENTION

Fig. 1 illustrates the general principals of the invention. The invention comprises a transducer, such as a microphone 1, for converting an input mechanical audio signal, such as sound waves in air, to an electrical audio signal output. A thyristor having a control gate 2 is provided with suitable circuitry to operate as a switch 3. Means, such as an audio amplifier 4, is connected between the output of the transducer 1 and the gate 2 of the thyristor switch 3 for impressing an audio frequency trigger signal derived from the transducer on the gate 2. The principal terminals 5 and 6 of the thyristor are connected to an electrical device 7, such as an electric light, which is series connected to a source of electrical energy 8 in order to control the electrical current flow through the electrical device 7.

The word thyristor is used to include not only the more commonly known devices such as the triac and silicon-controlled rectifiers but also other types of controlled rectifiers such as thyatrons, devices not yet so popularly known, and devices yet to be invented which exhibit the characteristics necessary for switching in the manner of my invention.

Furthermore, I have chosen the word signal and intend it to include not only ordinary sinusoidal waveforms but also pulses of various shapes. Thus when I refer in the above summary, to an audio frequency trigger signal on the gate of the thyristor, I mean a signal which exhibits substantial magnitude variations at an audio rate. I do not include in the term “audio frequency signal,” a voltage or current which, although it may have some audio or ripple noise present, is used for its average value averaged over several audio or ripple cycles.

DETAILED DESCRIPTION

Briefly described, the preferred embodiment of my invention, as illustrated in FIG. 2, has a source of electrical energy which is a 117 volt outlet at terminals 9 and 10 of the type commonly available in a home, in series connection with a mechanical on-off switch 11, an electrical device such as light 12, and a thyristor such as the SCR 13, which has a control gate 14. The principal terminals 15 and 16 of the SCR 13 are connected in series with the light 12 and the source of electrical energy at terminals 9 and 10. The SCR 13 operates as a switch which will permit or prevent current flow through the light 12. A microphone 17 converts an input mechanical audio signal, such as sound waves, to an electrical audio signal output. The electrical audio signal output from the microphone 17 is amplified by the class A audio amplifier 18 and then impressed to the gate 14 of the SCR 13.

In more detail, the preferred embodiment has a microphone 17 which is connected to the input of a first audio amplifier stage having a transistor 19 with a load resistor 20. For a ceramic microphone I use a Darlington pair. The amplified output from the transistor 19 is directly coupled to the next audio amplifier stage having a transistor 22 and biasing and load resistors 24 and 26 respectively. An emitter capacitor 28 is provided to perform its conventional function of bypassing the signal around the resistor 24. The load resistor 26, which I prefer, is the stator of a nonlinearly varying potentiometer.

The adjustable wiper 30 of the potentiometer provides a variable audio sensitivity control and is connected by a coupling capacitor 32 to the input of a third audio amplifier stage having a transistor 34. A feedback resistor 44 is provided for temperature stability and biasing. The third stage has a load resistor 42 and a feedback resistor 43 for providing operating bias and stability. The output from the third transistor 34 is coupled to the gate 14 of the SCR 13 by a capacitance 48. A gate resistor 50 is provided for biasing and current overload protection and to prevent floating of the gate.
A rectified power supply 51 for biasing and supply power to the audio amplifier 18 is connected across the principal terminals 15 and 16 of the SCR 13. This is preferred so that all of the electrical circuitry which makes up the audio-actuated switch can be connected in series with the light 8 and the source of power at terminals 9 and 10. With such a connection, removal or burning out of the light 8 completely deenergizes the audio-actuated switch circuitry. Furthermore, the light 8 serves as an impedance which limits the current through the audio-actuated switch. The half-wave power supply 15 illustrated comprises an input resistor 52, a diode 54, a filter resistor 56, and a pair of filter capacitors 58 and 60. Although the power supply can be connected across an SCR it ordinarily can not be connected across a triac. With an SCR, the on time never exceeds one-half cycle so that the other half-cycle is available for the rectified power supply 51. A triac can be on for a full 360° thus in effect shorting any power supply connected across its principal terminals. However, an alternative arrangement using a triac is illustrated in Fig. 3 and described below.

In the preferred embodiment of Fig. 2, the series-connected light 12, SCR 13 and power source at terminals 9 and 10 are arranged so that the amplifier and the bulb socket are both at signal ground. This is done to reduce the coupling of any spurious noise from the power lines to the amplifier which might cause firing of the SCR. Several noise sources exist in a home and examples include light dimmers and electric motors.

The operation of the preferred embodiment begins with the closing of the mechanical switch 11. With the switch 11 closed, the light 12 is ready to be illuminated. In the absence of sound in the environment of the microphone 17, no trigger signal will be present at the gate 14 and the light 12 will not be illuminated. If sound is incident on the microphone 17, the sound will be converted to an electrical audio signal and amplified by the stages of the audio amplifier 18. An audio signal will be present at the gate 14. If the peaks of the audio signal at the gate 14 are below the gate-firing voltage, the lamp will still not be illuminated; if, however, the peaks of the audio signal at the gate 14 are greater than the gate-firing voltage, the lamp 12 will be energized during part of each half-cycle that the principal terminals 15 and 16 of the SCR 13 are forward biased.

The magnitude of the audio signal of the gate 14 is dependent not only on the level of sound input to the microphone 17 but also on the position of the wiper 30 along the resistance 26. The wiper 30 has a sensitivity control which can be adjusted so that a desired sound input level fires the SCR 13. Preferably, the resistance 26 varies logarithmically in order to give good control at low levels of audio input to the microphone 17 as well as at higher levels.

In the preferred circuit, then, the voltage at the gate 14 is an audio signal resulting from the sound input to the microphone 17. Within an amplitude range for each setting of the wiper 30 the amplitude of the gate signal controls the apparent brightness of the lamp 8. The SCR will almost always be fired at or near the beginning of its conducting half-cycle if the magnitude of the gate signal is sufficient because the audio signal frequency is ordinarily at least ten times larger than the frequency of its source of electrical energy at terminals 9 and 10 (which is applied to the principal terminals of the SCR).

Most sounds, such as that of a human voice, are continuous streams of varying magnitude. If the wiper is positioned to make the circuit very sensitive, almost all spoken sound will illuminate the lamp.

If a low sensitivity is used only the occasional higher magnitude sound will cause the light to be energized. The lamp will be energized for only a few half-cycles. At an intermediate sensitivity, the apparent brightness of the light will seem to flicker during a series of utterances depending upon the relationship of half-cycles the lamp is not energized.

One important feature of the preferred embodiment is that, because the trigger pulses at the gate 14 are at the same frequency as the input at the microphone 17, there is substan-

tially no visible time delay from the time the sound ceases at the microphone 17 until the time that the light 12 is no longer illuminated. This enables the light 12 to flicker more nearly and closely in response to the words and syllables of a speaker talking into the microphone 17. At the beginning of a sufficiently loud word or syllable the light will be partially illuminated; and when the word is ended or a sentence is ended, it will immediately shut off. This gives the speaker a great awareness that the light is indeed directly reacting to his voice. Conventional audio-actuated switches provide rectifier and filter capacitors which rectify and filter the audio signal. This results in a light which will be turned on in a conventional system in response to the sound but which when the sound stops, especially for a small instant of time, maintains the light on until the capacitor can decay. Such a system is not intended to give and does not give a close correspondence between the light illumination and the sounds of a speaker.

The coupling of the output of an audio amplifier by a capacitor to the gate of a thyristor is believed to be new. To accomplish this, I have used a capacitor which provides an impedance 18, small enough so that the input impedance to the gate circuit as the terminal 62 and ground is matched with the output impedance of the third transistor 34 amplifier stage.

It is the intention of my invention that any suitable means could be used to connect the output of the transistor 17 to the gate 14 of the thyristor 13 for impressing an audio frequency trigger signal on the gate. Some clipping of the signal is permissible so that one or more of the transistors 16, 22 and 34 could be biased to operate class AB, class B or class C. These would in effect clip off a portion of the audio signal. Also substantial nonlinear distortion of the audio signal is permissible and therefore the amplifier stage can be operated in the nonlinear range of their characteristics. It is only necessary that the audio rate of substantial magnitude variation be preserved. Therefore, even with clipping or distortion and provided there is no smoothing capacitor used anywhere, an audio frequency trigger signal will be impressed upon the gate 14. Such a signal will provide operation very similar to that provided by the preferred embodiment illustrated in Fig. 1. Such operation would, unlike previously known circuits, provide a light flicker which appears to be an instantaneous representation of the audio input to the transducer 17.

In Fig. 3, I illustrate an alternative embodiment of my invention. It illustrates two alternatives. First it illustrates the use of a triac 113 rather than an SCR and second it illustrates a rectified power supply 151 which is not connected in parallel to the thyristor switch.

The circuit of Fig. 3 has a microphone 117 which provides an electrical audio signal input to the audio amplifier 118. The output of the amplifier 118 is coupled by a capacitor 148 onto the gate 114 of the triac 113. A standard 117 volt house voltage may be connected at the terminal 109 and 110 so that when the triac 113 is conducting, the light 112 will be illuminated.

In Fig. 4 I illustrate yet another embodiment of my invention. This circuit has a full-wave rectifier (but no filtering) connected to an alternate source of electrical energy at terminals 202 and 203 so that the source of electrical energy at terminals 209 and 210 is full-wave rectified sinousoid. This rectification provides solely positive half-cycles on the SCR 213 so that its principal terminals are essentially always biased for conduction. Conduction can then occur for nearly the full 360° therefore providing the advantage of triac-type output with SCR gate sensitivity.

Since rectification is provided by the full-wave rectifier 201, only a filter 255 need be connected to the rectifier 201 in order to provide power supply to the amplifier 218 having a microphone 217.

It is to be understood that while the detailed drawings and specific examples given described preferred embodiments of my invention, they are for the purposes of illustration only, that the apparatus of the invention is not limited to the precise details and conditions disclosed and that various changes may
be made therein without departing from the spirit of the invention which is defined by the following claims.

I claim:

1. An audio-actuated switch for controlling electrical current flow through an electrical device which is in series with a source of electrical energy, the switch comprising:
   a. a transducer for converting an input mechanical audio signal to an electrical audio signal output;
   b. a thyristor having a control gate, the principal terminals of the thyristor being in series with the electrical device; and
   c. means connecting the output of the transducer to the gate of the thyristor for impressing on said gate a nonfiltered audio frequency trigger signal, derived from the transducer, for producing instantaneous on and off operation of the electrical device.

2. A switch according to claim 1, wherein said means comprises an audio amplifier, biasing means, and coupling means.

3. A switch according to claim 2, wherein the audio amplifier is a class A amplifier and the gate trigger signal is substantially analogous to the mechanical audio signal.

4. A switch according to claim 2, wherein the thyristor is an SCR, wherein there is provided a rectified power supply, for biasing and supplying power to said audio amplifier, the power supply having two input terminals connected to the principal terminals of the SCR, wherein said source of electrical energy, said electrical device, and the parallel combination of the SCR and the rectified power supply are series connected so that disconnection of the electrical device deenergizes the SCR and the rectified power supply and so that the current through the SCR and the power supply is limited by the impedance of the electrical device.

5. A switch according to claim 2, wherein the audio amplifier comprises a plurality of amplifier stages, one of the stages having a load impedance comprising the stator of a potentiometer and having the wiper of the potentiometer coupled to the input of the subsequent stage for permitting variable adjustment and selection of a desired audio signal level for triggering the thyristor.

6. A switch according to claim 5, wherein the impedance along the stator of the potentiometer is logarithmic.

7. An audio-actuated light for illumination in response to sound, the light comprising a switch according to claim 1, wherein said electrical device is an illumination means.

8. An audio light according to claim 7, wherein said source of electrical energy is an alternating current.

9. An audio light according to claim 8, wherein the connecting means comprises an audio amplifier and coupling means for impressing an audio signal on the gate which is derived from said mechanical audio signal and wherein biasing means is provided for triggering the gate in response to a selected audio level.

10. An audio-actuated light comprising a switch according to claim 4, wherein
   a. the electrical device is a light;
   b. the amplifier is an audio amplifier for providing a gate trigger signal which is derived from the input mechanical audio signal and the amplifier comprises a plurality of amplifier stages, one of the stages having a load impedance comprising the stator of a nonlinearly varying potentiometer and having the wiper of the potentiometer coupled to the input of the subsequent stage for variable adjustment and selection of an audio signal level which triggers the thyristor.