United States Patent

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[54] **SOUND-CONTROLLED LIGHTING SYSTEM**
14 Claims, 10 Drawing Figs.

[52] U.S. Cl. 84/464
[51] Int. Cl. A63j 17/00
[50] Field of Search 84/464

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ABSTRACT: A light display for connection with the speaker of a radio, phonograph or other sound-producing system. The light display comprises a housing and a plurality of lamps mounted within the housing. A control circuit is provided for delivering power to the lamps, the circuit including leads for connection with the audio output of the speaker. A control element such as a silicon-controlled rectifier is connected in the line between a power source and the lamps whereby the power input to the lamps is varied in response to the audio output since the audio output will control the conductivity of the control element.

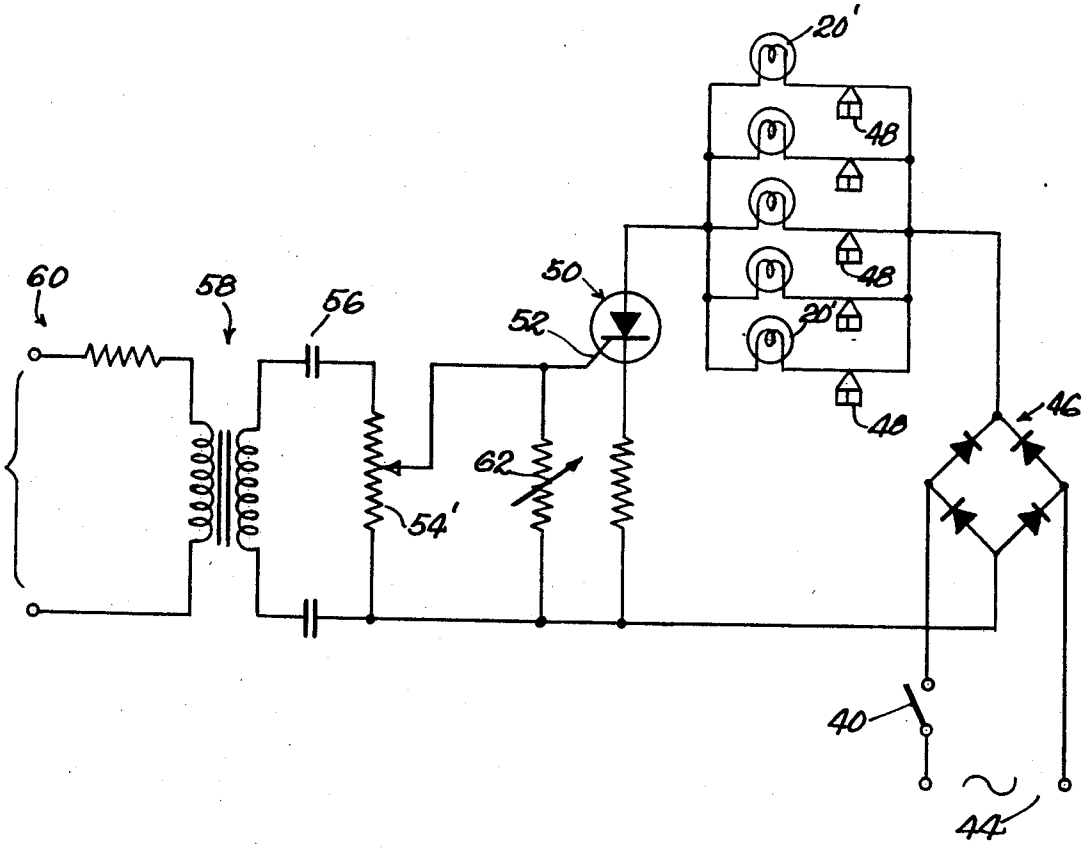

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FIG. 1

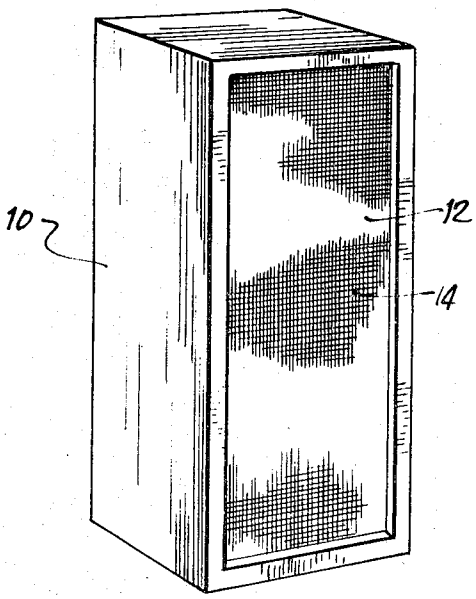


FIG. 2

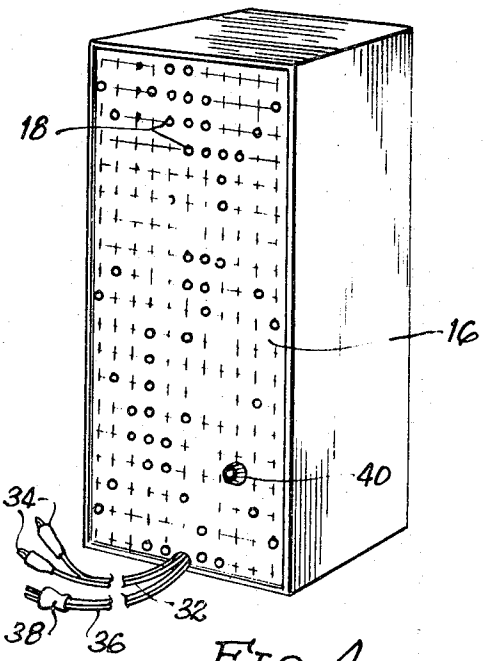


FIG. 3

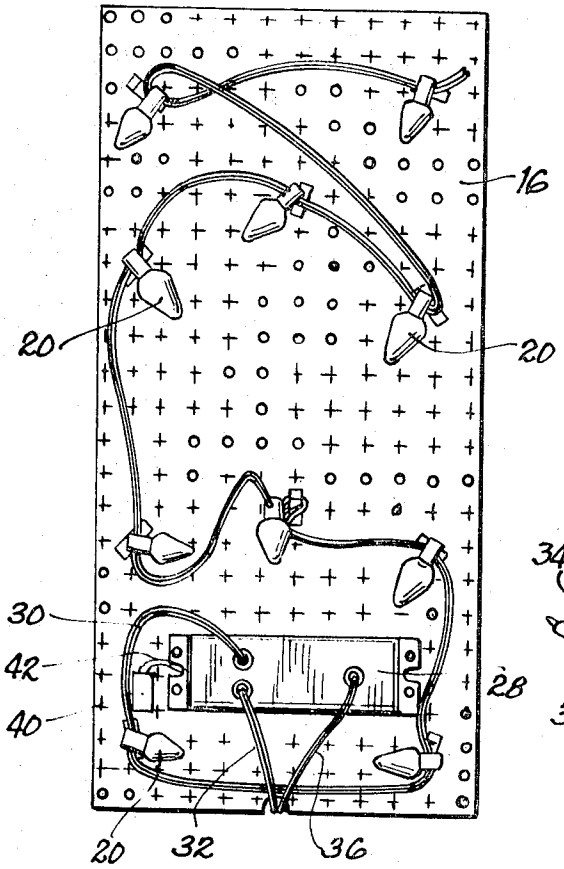
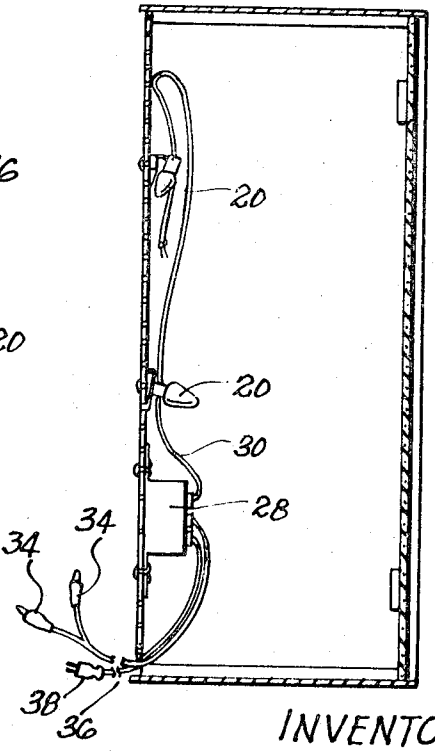


FIG. 4



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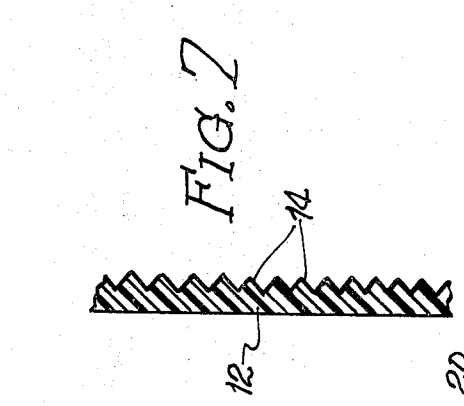


FIG. 7

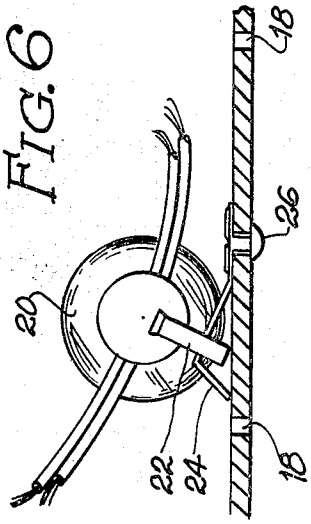


FIG. 6

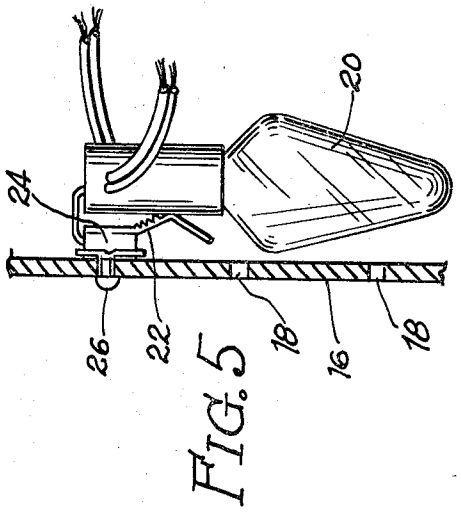


FIG. 5

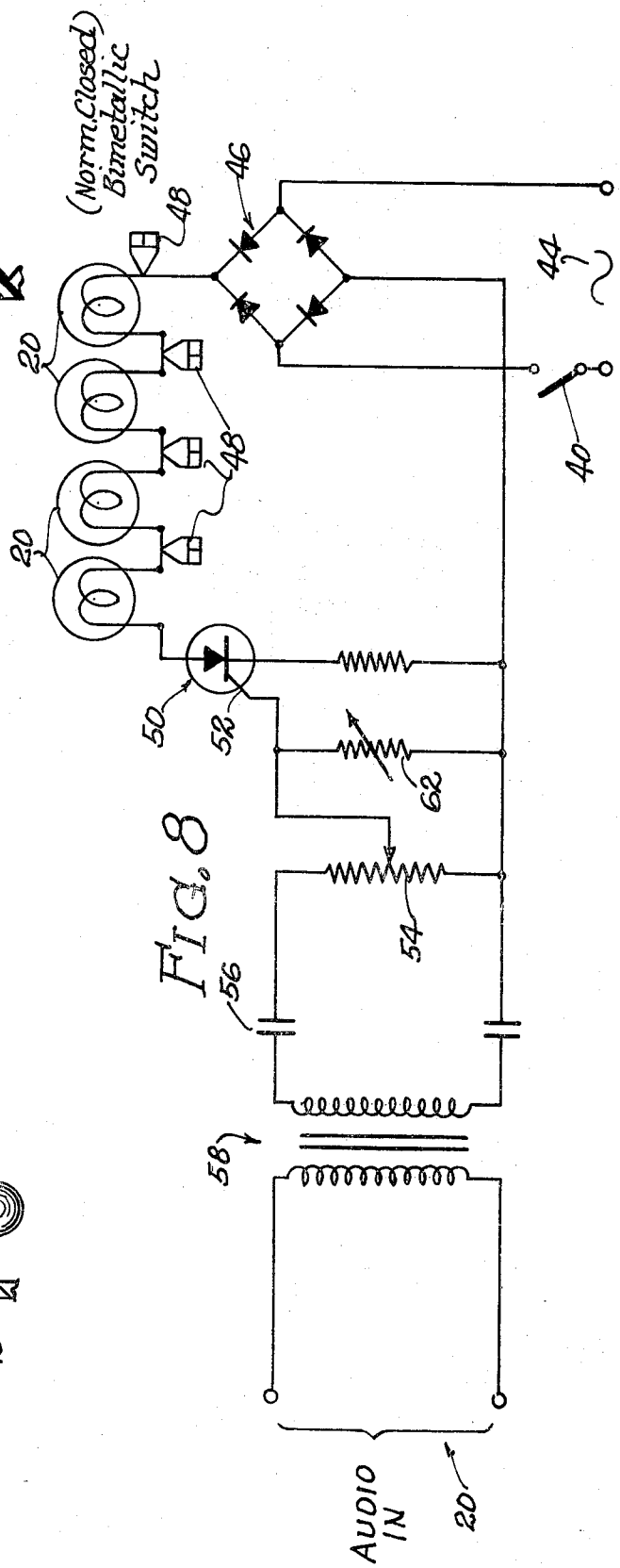


FIG. 8

FIG. 9

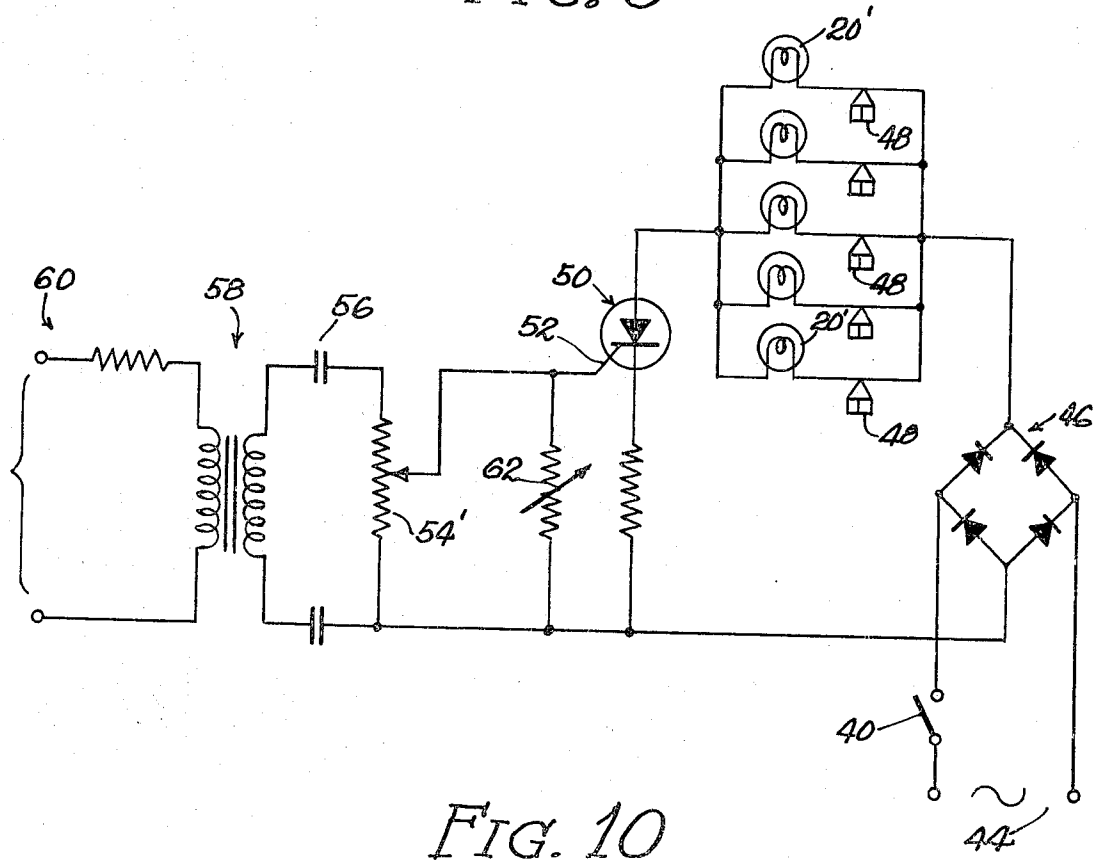
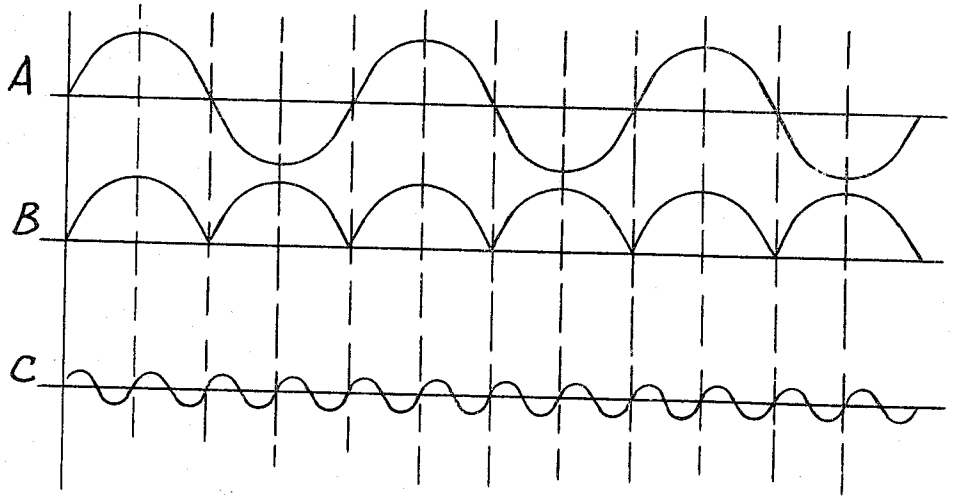


FIG. 10



SOUND-CONTROLLED LIGHTING SYSTEM

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of U.S. Pat. application Ser. No. 776,071, filed Nov. 15, 1968 and now abandoned, for "Sound-Controlled Lighting System".

This invention relates to light display systems. More specifically, it relates to light display systems for connection to audio systems so that variations in the light display are achieved in response to variations in the output of such systems. Various attempts have been made to provide lighting systems which are used in conjunction with audio systems. These devices usually comprise a lighting system connected to some stage in an audio system and include appropriate controls so as to produce a light pattern or variation in light intensity in response to variations in the audio signal. The effect desired to be achieved is one wherein the light pattern follows the variations in rhythm, tone, loudness and frequency content of the audio system. Typically, of course, such systems are used when music is being reproduced or broadcast. The effect that is desired to be achieved is a total effect on the viewer and listener so that both the audible and visual senses are involved in the enjoyment of or response to the presentation.

Heretofore, the control circuits of such systems, in order to achieve the variation in light pattern with an audio signal, have been relatively complicated devices including frequency and amplitude circuits of various kinds and relatively complicated switching arrangements responsive to such circuits. This, of course, has proven relatively costly to build and market, and in addition, as with all such relatively complicated equipment, maintenance is frequently required to ensure continuous operation.

Therefore, it is an object of this invention to provide novel light-displaying systems which can be effectively used in conjunction with sound reproduction and which can be built and marketed economically.

It is another object of this invention to provide novel light display systems which while responsive to variations in the amplitude and frequency content of an audio signal achieve such response without the necessity of relatively complicated and costly circuits and switching arrangements.

These and other objects of the invention are achieved in a preferred embodiment of the invention which utilizes a relatively simple switching circuit using static electronic components to control the energization of a plurality of lamps in such a way as to make their light emission responsive to variations in the audio signal. In another aspect of the invention simple optical means intensify the effect of the presentation.

BRIEF DESCRIPTION OF THE FIGURES

Other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of the invention are shown in the accompanying drawings in which:

FIG. **1** is a front perspective view illustrating the exterior of a housing suitable for use with the apparatus of the invention;

FIG. **2** is a rear perspective view of the structure shown in FIG. **1**;

FIG. **3** is a plan view of the rear panel utilized in the construction for mounting of operating elements;

FIG. **4** is a vertical, sectional view of the structure;

FIGS. **5** and **6** comprise fragmentary detailed views illustrating the manner in which lamp means are secured to the rear panel;

FIG. **7** is an enlarged fragmentary, detailed view illustrating the prismatic panel preferably employed in the structure;

FIG. **8** is a diagrammatic illustration of the control circuit employed;

FIG. **9** is a schematic diagram of an alternative embodiment of the invention; and

FIG. **10** is an illustration of typical wave shapes present in the control circuit.

DETAILED DESCRIPTION

The apparatus of this invention generally comprises a light display which includes a plurality of lamps mounted in a supporting housing. In referring to the use of a housing, it will be understood that the housing may comprise an independent unit such as shown in the accompanying drawings or the lamps and other circuit elements may be associated with a housing which also encloses other elements. For example, the system of this invention could be utilized in association with a jukebox or a suitable space could be provided for the operating elements by making the necessary provisions in a standard phonograph.

The display construction includes a control circuit comprising a power input leading to the lamps and means for connecting the lamps to the audio output of a speaker. Control means are located in the line between the power input and the lamps, the control means being adapted to control the current through the lamps in direct correspondence with variations in the sound output. A silicon-controlled rectifier having its triggering input connected to an audio transformer is particularly suitable for this purpose.

The accompanying drawings illustrate a housing **10** suitable for holding a system of the type contemplated by this invention. The housing defines a front opening and a light-transmitting panel **12** is located in this opening. As best shown in FIG. **7**, this panel defines a prismatic surface **14** whereby light directed onto the panel will be dispersed to provide a particularly eye-catching display.

A rear panel **16** includes a plurality of openings **18** which facilitate the attachment of elements on the surface of this panel. As shown in FIGS. **3** through **6**, a plurality of lamps **20** are secured in spaced-apart positions over the surface of the panel. Each of the lamps includes a spring hook element **22** which is received by bracket **24** for holding the lamps in place. The brackets **24** are secured by means of rivets **26**.

A housing **28** may also be provided for the various electrical components employed in the control circuit of the invention. This housing is also secured to the panel **16**. The wire **30** extending out from the housing is connected to the lamps. A second wire **32** includes a pair of clips **34** for attachment to the audio output of a speaker. The wire **36** extends to a plug **38** for insertion in a standard a.c. outlet. An on-off switch **40** is also connected to the panel with wires **42** extending into the housing **28**.

The control circuit illustrated in FIG. **8** includes an a.c. input **44** which is connected through switch **40** to rectifier bridge **46**. The output of the rectifier bridge extends to the series-connected lamps **20**. Bimetallic switches **48** are located adjacent each of the lamps. In accordance with the conventional operation of this mechanism, the bimetallic elements will become heated as current flows thereby causing the switches to open. This occurs in an irregular fashion so that a flickering lighting arrangement is obtained.

A silicon-controlled rectifier **50** is connected beyond the lamps, and the gate **52** is connected through potentiometer **54**, capacitor **56** and transformer **58** to audio input **60**. A variable resistor **62** may also be connected to the gate, this element being employed to control the leakage current of the cathode and anode.

The operation of the system can be understood by reference to FIG. **8** and FIG. **10**. As may be seen, wave shape A of FIG. **10** represents the a.c. input to the rectifier bridge **46**. The output of this bridge is supplied to the lamps **20** in the form of a pulsating unidirectional or direct current represented by wave shape B. Since the output of the bridge consists of a series of half waves of the same polarity, assuming the bimetallic switches **48** are closed, the silicon control rectifier **50** may conduct on each half cycle and will cease conducting when the voltage in a half cycle decreases to a value insufficient to maintain current. If no voltage other than the output of the bridge were presently between the anode and cathode of the silicon control rectifier, it would function as a switch capable of being turned on at some portion of a half cycle and turned

off toward the end of a half cycle. However, the audio signal input, in addition to appearing between the gate and cathode electrode to furnish the necessary triggering signal, also appears across the anode and cathode electrodes. The audio signal modifies or modulates the pulsating direct current voltage from the rectifier bridge **46** so that the actual anode to cathode voltage is not a pure sine wave. Such modulated voltage, if one considers a half wave after it has started to go positive from zero, will either reach values sufficient to advance the turn on or conduction of the silicon controlled rectifier ahead of the point where a sine wave alone would do it assuming a gate signal of sufficient amplitude and duration, or to turn on the SCR. Whether the turn on is advanced or delayed may therefore be seen to a function of the frequency and the amplitude of the audio signal. In addition, the phase relationship of the applied half wave and the audio signal may cause variations, but this is believed to be a second order effect.

It should be appreciated that even though the applied half wave is derived typically from a 110 volt source and the audio signals are most commonly less than one volt the modulation of the turn on is still effected for the value of anode to cathode voltage required to permit conduction in many commercially available SCR's is not large. Thus, small values of positive anode to cathode voltage to provide a forward current will permit a SCR to maintain conduction when triggered and the presence of a positive audio signal will provide such a voltage. It may be expected that inasmuch as the voltage supplied by the half sine wave is rising rapidly at the beginning of that wave, if the SCR is turned on, sufficient voltage will be present to provide the necessary "latching current" to maintain conduction.

Near the end of a half cycle the audio signal will be effective to vary the turnoff of the SCR by virtue of its modulation of the pulsating direct current by reducing the forward current to less than its "holding" value. This effect will occur as again primarily a function of the frequency and amplitude of the audio signal.

The total effect is that an ability to respond to variations in an audio signal is provided by modulating the anode to cathode voltage and using the audio signal as a gating signal.

In a typical installation, of course, the a.c. source is 60 hertz at 110 volts. The audio signal commonly has a frequency range output extending from 50 out to 12,000 cycles or more depending upon the band pass capabilities of the audio system.

Wave shape C represents 120 hertz signal such as would be present when an audio tone of that frequency is present. It is, of course, to be understood that this is for purposes of illustration only for the wave shape C could have any frequency within the range and in fact in a typical audio presentation a voice or musical instrument sound is producing a signal which is a composite of many fundamental frequencies. In any case, these signals added to the 60 hertz pulsating d.c. represented by wave shape B are of such an amplitude as to modify the anode and cathode voltage, particularly, adjacent the portions of the half waves near the zero crossing so as to affect the anode to cathode voltage so that the control rectifier is in a condition to be turned on when the proper signal is supplied to its gate electrode and will be turned off at times dependent upon the audio signal. In this manner, a frequency responsive characteristic is provided in the circuit.

An additional variation in the light pattern is achieved by the provision of the bimetallic switches **48**. As noted above, their operation occurs in an irregular fashion determined by the time constant of each such switch so as to provide a flickering light.

In another embodiment of the control circuit of the invention, those elements which correspond to identical elements of FIG. **8** have been given the same reference numerals. In this embodiment, the lights identified by reference numeral **20'** are connected in a parallel rather than a series arrangement. As before, these lights are selected to be of different colors and their associated bimetallic switches **48** generally have varying time constants so that they operate in a random fashion. By virtue of the parallel arrangement, any one of the lights **20'** may be turned off by the opening of its associate bimetallic switch while any one or more of the others will remain on. This produces the flickering pattern as before, but the turning off of one light does not necessarily coincide with the turning off of any other light and the lights remaining on will continue to be operated as the silicon control rectifier **50** turns off and on in response to the combined effect of the pulsating d.c. and the variations in the audio signal supplied.

If desired, the input transformer **58** could be constructed to have varying frequency response characteristics and in a single housing more than one control and lighting circuit provided. For instance, one such circuit might be responsive to frequencies in the 100 to 5,000 hertz range and another to a higher range of frequencies. In this arrangement, when the lights are distributed over a support such as the rear panel **16** in a desired pattern, greater frequency response will be achieved.

The use of a prismatic light-transmitting panel is particularly desirable since a more highly appealing diffusion of light can be obtained. The panel can be fabricated with different prism arrangements on it. That is, the prisms can be in a linear configuration or circular or combinations of these two with perhaps the linear arrangement extending in varying planes throughout the panel. To provide additional variations lamps of different colors may be employed.

It will be understood that other changes and modifications may be made in the above-described systems which provide the characteristics of this invention without departing from the spirit thereof, particularly, as defined in the following claims.

I claim:

1. An apparatus for connection to an audio signal-producing system comprising: a plurality of lamps connected to each other; a source of unidirectional pulsating power connected to said lamps; a controllable switching device connected in series with said lamps and said power source; and means including audio input connections connected to said controllable switching device to control the conduction thereof and means connecting said audio input connections to said power source for operating said switching device in response to variations in the audio signal.

2. The apparatus of claim **1** wherein said lamps are connected in series with each other.

3. The apparatus of claim **1** including a housing having a light-transmitting panel forming one side thereof, said panel having a prismatic surface and wherein said lamps, power source, controllable switching device and said means connected thereto are mounted in said housing.

4. The apparatus of claim **1** wherein said power source is a bridge rectifier having input connections for a source of alternating current and output connections to said lamps.

5. The apparatus of claim **1** wherein said controllable switching device is a semiconductor controlled rectifier and said means connected thereto is connected to its gate electrode.

6. The apparatus of claim **5** wherein said means connected to the gate electrode of said controllable switching device includes an audio input transformer having an input for connection to a source of audio signals, an output and a potentiometer connected between said output and gate electrode.

7. The apparatus of claim **1** wherein said lamps are connected in parallel with each other.

8. The apparatus of claim **7** wherein: said power source is a bridge rectifier having input connections for a source of alternating current and output connections to said lamps; and said controllable switching means is a semiconductor switching device having its anode and cathode electrodes connected in series with said lamps and said bridge rectifier; and said means connected to said controllable switching means includes an audio input transformer having an input for connection to a source of audio signals, an output and a potentiometer con-

nected between said output and the gate electrode of said semiconductor switching device.

9. The apparatus of claim 8 including a housing having a light-transmitting panel forming one side thereof, said panel having a prismatic surface, and wherein said lamps, power source, controllable switching device and said means connected thereto are mounted in said housing.

10. The apparatus of claim 9 wherein each lamp has connected in series therewith a thermally responsive switch device.

11. Apparatus for connection to an audio signal-producing system comprising: a full wave bridge rectifier having input terminals for connection to an alternating current power source and a pair of output terminals, a plurality of lamps connected to one of said rectifier output terminals, a semiconductor controllable rectifier having anode, cathode and gate electrodes, means connecting said anode electrode to said lamps, means connecting said cathode electrode to the other of said

rectifier output terminals, said lamps and the anode to cathode circuit of said semiconductor controllable rectifier, an input transformer having a primary winding for connection to a source of audio signals and a secondary winding, a potentiometer having end terminals and a movable tap, means coupling said potentiometer to said secondary winding, a connection from one of said end terminals to said cathode electrode, and means connecting said movable tap to said gate electrode.

12. The apparatus of claim 11 wherein said lamps are connected in parallel with each other.

13. The apparatus of claim 12 wherein each lamp has connected in series therewith a thermally responsive switch device.

14. The apparatus of claim 11 wherein each lamp has connected in series therewith a thermally responsive switch device.