

[54] AUDIO RESPONSIVE LIGHT DISPLAY

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[22] Filed: Feb. 9, 1972

[21] Appl. No.: 224,707

[52] U.S. Cl. 340/366 B, 340/333, 84/464, 330/29, 330/59, 328/175
[51] Int. Cl. G08b 5/00
[58] Field of Search 340/366 B, 333; 84/464; 330/29, 59, 131; 328/175; 325/303

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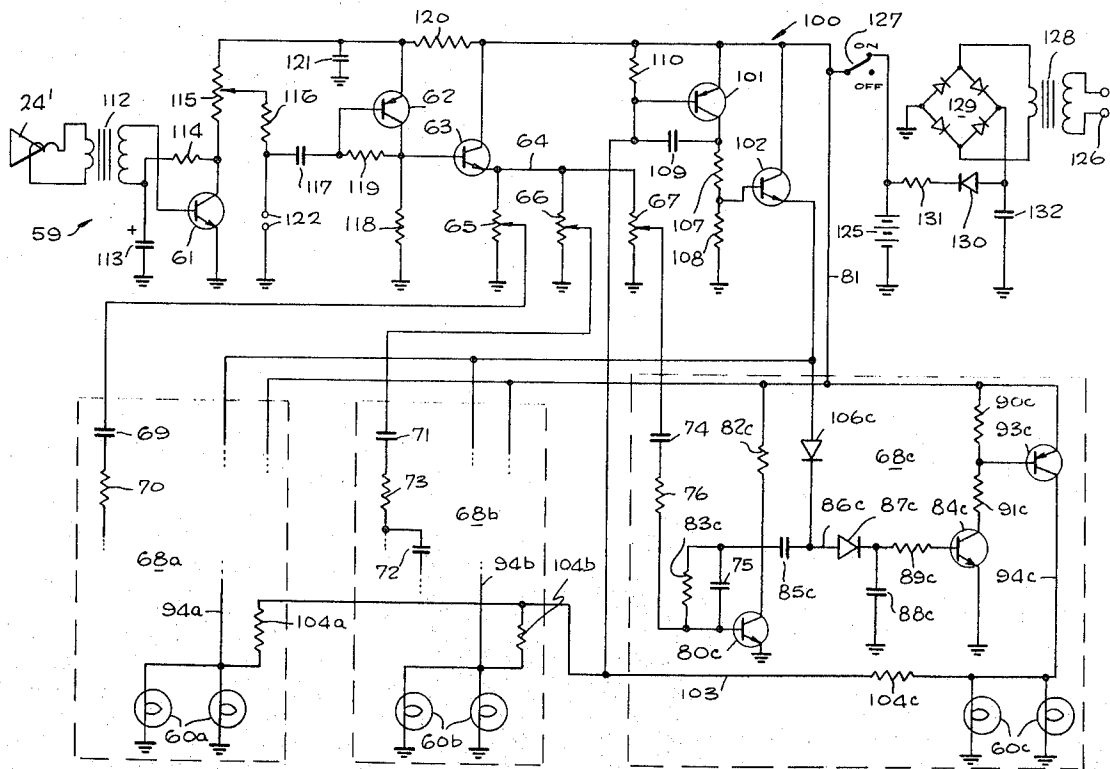
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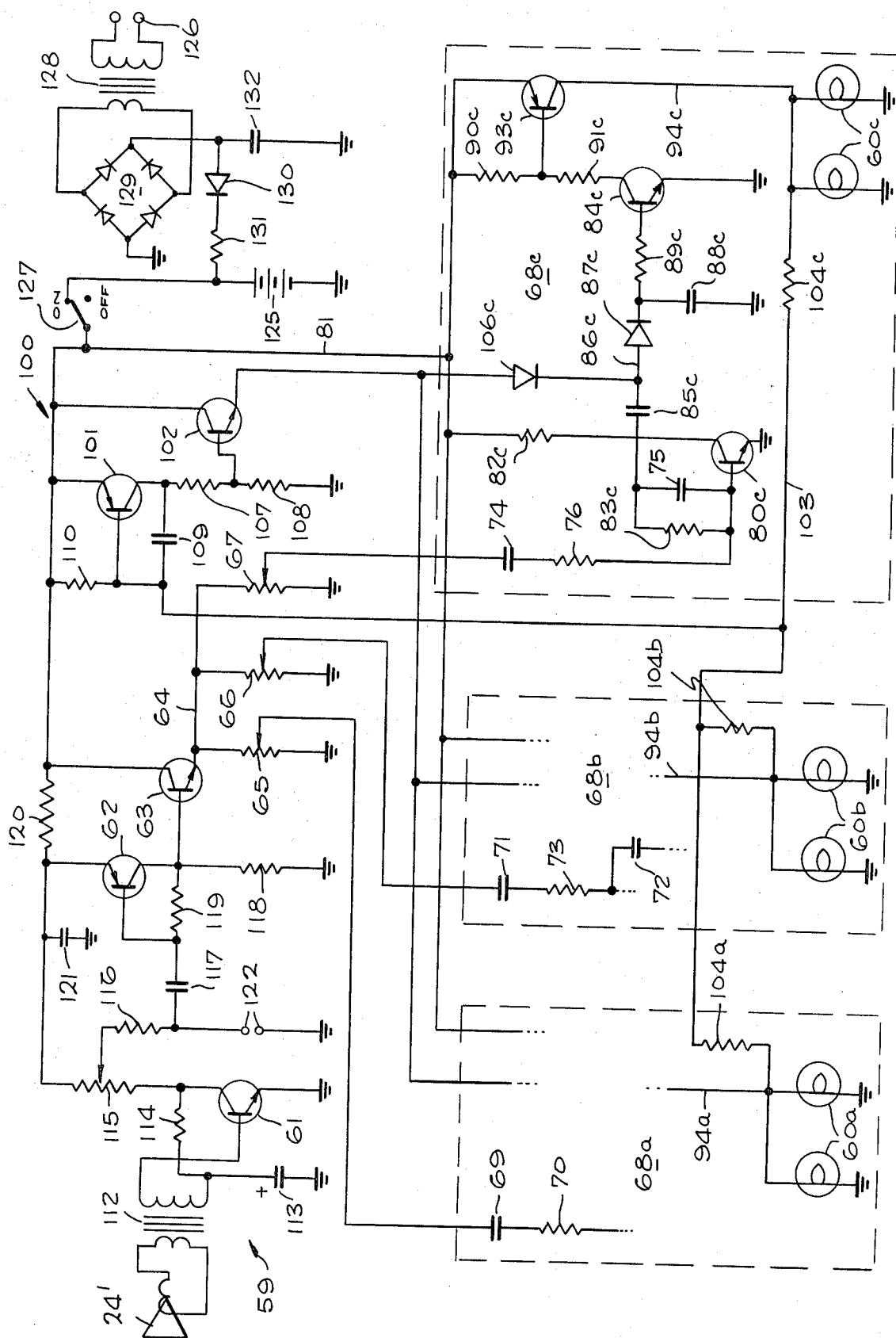
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[57] ABSTRACT

Lamp driver circuitry which permits one or more lamps to be driven from a battery for a significantly longer duration of time between battery recharging or replacement than is possible with prior art driver circuits. The circuit employs two transistors in a voltage gain arrangement driving the lamps at a voltage slightly above their nominal rating. Minimum power is drawn by the lamps. The driver circuits advantageously are incorporated in an audio responsive light display wherein several sets of lamps are modulated in response to selected frequency components of an audio signal.

6 Claims, 1 Drawing Figure





AUDIO RESPONSIVE LIGHT DISPLAY

In a preferred embodiment, the light display employs a speaker as an inexpensive microphone, the output of which is amplified and provided via separate filter networks to a plurality of lamp driver circuits. These circuits insure minimum power consumption when the lamps go on in response to audio signals picked up by the microphone in the selected frequency ranges. Automatic gain control prevents saturation to insure that light modulation is relatively independent of the audio signal level. A novel ac/battery power supply utilizes the batteries as a voltage regulator for rectified ac power, and implements charging of the batteries when the display is off.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to lamp driver circuitry, and to audio responsive light displays incorporating such circuitry.

2. Description of the Prior Art

Light displays wherein various colored lamps flash on and off or change intensity in response to an audio signal have gained recent widespread popularity. When used in conjunction with a radio, phonograph or other music source, the visual display provides an added dimension to enjoyment of the music. An objective of the present invention is to provide such a display wherein one or more sets of lamps are lit in response to selected frequency components of the audio signal, with the brightness relatively independent of signal amplitude. The result is a pleasing display synchronized with the music or other audio source.

Particularly advantageous would be a battery operated light display. However, prior art devices of this type had relatively high current drain, severely limiting how long the device could operate without replacing or recharging the batteries. The driver transistor used to control the lamp often was driven into saturation so that each lamp drew maximum current for the entire time that it was lit. Maximum battery drain resulted. A principal objective of the present invention is to provide a lamp driver circuit which minimizes current drawn by the lamps, so that when used in an audio responsive or other display, the device can be battery operated for a significantly longer period of time than is possible with prior art circuitry.

Another object is to provide a light display including a microphone providing the audio signal. When battery operated, such a unit is self-contained and will provide audio synchronized lighting effects with no wired connections either for signal or power.

SUMMARY OF THE INVENTION

These and other objectives are implemented by an audio responsive display system employing a driver circuit which minimizes current drain of the lamps while in effect providing voltage amplification. The lamp is driven at a voltage greater than its nominal rating supplied by two transistor stages each providing voltage gain. The second transistor is of low current capability and a third transistor of opposite conductivity type is used to drive the lamp in a follower-type circuit. The lamp draws less power than if driven by a prior art circuit.

An audio responsive light display is implemented using one or more of these circuits to drive sets of lamps. Appropriate filter networks supply to the driver circuits selected frequency components of an input audio signal provided by a loudspeaker functioning as an inexpensive microphone.

Other features of the circuit include automatic gain control sensitive to the maximum intensity of any of the lamps in the display, and operative simultaneously to control the gain of all of the lamp driver circuits. A power supply utilizes either batteries or an ac source. When connected to the ac source, the batteries provide voltage regulation when the light responsive display is in use, and are recharged when the display itself is turned off.

BRIEF DESCRIPTION OF THE DRAWINGS

Still other objects, features, and attendant advantages of the present invention 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 and wherein:

FIG. 1 is an electrical schematic diagram of an audio responsive light display in accordance with the present invention, including automatic gain control and an ac/battery power supply.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following detailed description is of the best presently contemplated mode of carrying out the invention. This description is not to be taken in a limiting sense but is made merely for the purpose of illustrating the general principles of the invention since the scope of the invention best is defined by the appended claims.

Circuitry 59 for an audio responsive light display utilizing the present invention is shown in FIG. 1. The display may be contained in a housing (not shown) having a translucent front panel. Mounted within the housing are a plurality of lamps 60a, 60b, 60c which are lit in response to an audio signal detected by a speaker 24' mounted in the housing and utilized as an inexpensive microphone. The circuit 59 may be mounted on a board within the housing, and used to drive the lamps 60a, 60b, 60c in response to an audio signal derived from the speaker 24'.

As described below, various of the lamps 60a, 60b, 60c are driven in response to different frequency components of the detected audio signal; such lamps may be provided with differently colored filters. The result is an unusual display related to frequencies present in the audio signal, and relatively independent of the amplitude of that signal. Use of the inventive circuitry enables the display to operate with batteries 125 such as ordinary flashlight cells for a considerably longer duration of time than is possible with prior art light displays.

Referring to FIG. 1 the three sets of lamps 60a, 60b, 60c are driven in response to different frequency components of an audio signal derived from a speaker 24' functioning as a microphone. This audio signal is amplified by a circuit including three transistors 61, 62, 63 and supplied on a line 64. Separate gain controls 65, 66, 67 connect the amplified signal line 64 to the circuits 68a, 68b, 68c which drive the respective lamps 60a, 60b, 60c.

A filter network comprising a capacitor 69 and a resistor 70 couples only high frequency audio components to the lamp driver circuit 68a. Intermediate frequency components are coupled to the driver circuit 68b by a filter network comprising a pair of capacitors 71, 72 and a resistor 73, while low frequency components of the audio signal on the line 64 are coupled to the lamp driver circuit 68c by a filter network comprising a pair of capacitors 74, 75 and a resistor 76. The values of the components 69 through 76 are appropriately chosen to establish the passbands to the respective lamp driver circuits 68a, 68b, 68c. For example these passbands may be centered at 6 kHz, 1,800 Hz and 400 Hz to provide an attractive display.

The typical driver circuit 68c includes a transistor 80c providing amplification for the low frequency audio components. Collector voltage is supplied from a positive buss 81 via a resistor 82c, and a resistor 83c provides base bias for the transistor 80c. The amplified signal is supplied to a second transistor 84c via a coupling capacitor 85c, a line 86c, a diode 87c, a bypass capacitor 88c and a resistor 89c.

When the transistor 84c is driven into conduction, current is drawn through a pair of resistors 90c, 91c connected in series between the voltage buss 81 and the collector of the transistor 84c. As a result, the voltage at the junction of the resistors 90c, 91c becomes less positive, turning on a PNP transistor 93c connected between the positive buss 81 and a line 94c to the lamps 60c. The lamps 60a go on. The amount of current drawn by the lamps 60c is minimized by the operation of the circuit 68c.

A significant feature of the driver circuit 68c concerns the voltage gain of the various transistors. Presence of an input signal in the appropriate frequency range causes the transistor 80c to go on; the voltage measured from the transistor 80c collector to ground typically may be 2.5 volts with 7.2 volts supplied on the line 81. The transistor 84c may provide a 3 to 1 voltage gain, so that the voltage measured from the transistor 84c collector to ground will be about 7.5 volts. Since the transistor 84c does not directly supply current to the lamps 60c, a very inexpensive, low current transistor such as a Motorola type 2N3903 can be used.

The transistor 93c provides some gain, but primarily provides current to the lamps 60c. Typically the voltage measured from the transistor 93c collector to ground, i.e., across the lamps 60c, will be between 7 and 8 volts. The nominal voltage rating of each lamp 60c preferably is less than this measured voltage. As a result, relatively less current will be drawn by the lamps 60c than were the lamps either connected directly across the power supply or driven by the prior art circuit of FIG. 1. For example, a lamp 60c rated at 6 volts, 40 ma may draw about 25 ma when driven at between 7 and 8 volts. Despite the reduced power consumption, the lamps 60c will light up to full brightness in response to an appropriate input audio signal.

The lamp driven circuits 68a, 68b operate in the same manner as the circuit 68c. By using such driver circuits, the audio responsive light display 59 can operate on a set of batteries for a much longer period of time between recharging or battery replacement than is possible using prior art circuitry.

The circuit 59 (FIG. 1) also includes automatic gain control enabling the light displaying to operate over a

wide range of audio signal amplitude levels. This automatic gain control (AGC) is implemented by a circuit generally designated 100 including a pair of transistors 101, 102. Input to the circuit 100 is via an AGC input buss 103 connected to the lines 94a, 94b, 94c by the respective resistors 104a, 104b, 104c. Thus the voltage on the line 103 is indicative of the maximum voltage level supplied to any of the lamps 60a, 60b, 60c. The automatic gain control circuit 100 includes an AGC output line 105 connected to each of the lamp driver circuits 68a, 68b, 68c.

When none of the lamps 60a, 60b, 60c are lit, voltage on the input line 103 is at a minimum, and the AGC output voltage on the line 105 is at a maximum. This AGC output voltage is supplied via the respective diodes 106a, 106b, 106c to the respective line 86a, 86b, 86c resulting in maximum gain for the respective driver circuits 68a, 68b, 68c.

Should any of the lamps 60a, 60b, 60c be lit, a higher voltage will be present on the line 103. This voltage will tend to bias the transistor 101 to a lower conduction level. As a result, the voltage across a pair of resistors 107, 108 series connected between the collector of transistor 101 and ground will decrease. Since the junction of the resistors 107, 108 is connected to the base of the transistor 102, that transistor will tend to go off, reducing the voltage level on the line 105. As a result, the gain of all three lamp driver circuits 68a, 68b, 68c will decrease. The response time of the AGC circuit 100 is effected by a capacitor 109 connected between the base and collector of the transistor 101. Additional base bias for the transistor 101 is provided via a resistor 110 from the positive voltage buss 81.

The automatic gain control circuit 100 functions to insure that turn-on of the lamps 60a, 60b, 60c is relatively independent of the amplitude level of the detected signal. Thus if a relatively loud signal is picked up by the microphone 24', the presence of certain frequency components will cause one or more of the lamps 60a, 60b, 60c to light up. As one of these lamps reaches its maximum intensity, the AGC circuit 100 will decrease the gain of all of the lamp drivers 68a, 68b, 68c thereby effectively insuring that the lamps 60a, 60b, 60c will not saturate, but rather will go on and off only with respect to the presence or absence of corresponding frequency components in the detected signal.

The audio amplifier portion of the circuit 59 (FIG. 1) includes an input transformer 112 which couples the microphone 24' output to the base of the transistor 61. Bias is established by a capacitor 113, and a resistor 114 provides feedback for this first stage of amplification. Current to the transistor 61 is provided via a potentiometer 115 which functions as a master gain control for the device 60.

Input to the second stage of amplification is derived from the master gain control 115 tap which is connected via a resistor 116 and a capacitor 117 to the base of the transistor 62. The collector of the transistor 62 is connected to ground via a load resistor 118, and back to the base via a feedback resistor 119. Output from the transistor 62 collector also is supplied directly to the base of the transistor 63 which functions as an emitter follower driving the line 64. A resistor 120 provides interstage isolation, and a capacitor 121 filters the voltage supplied to the transistors 61, 62. An externally supplied audio signal may be connected to the cir-

cuit 59 via terminals 122 associated with the capacitor 117. In this instance, the light display 20 will be responsive to the externally supplied signal, which may originate from a radio or phonograph.

In the embodiment of FIG. 1, a unique power supply facilitates operation of the circuit 59 either by batteries 125 or from an ac source connected via the terminals 126. The batteries 125 may comprise six flashlight D cells in series. The batteries 125 are connected to the positive buss 81 via an on-off switch 127. When no ac source is connected to the terminals 126, the batteries 125 will power the circuit 59. With ac connected and the switch 127 on (i.e., closed), the batteries 125 function to regulate the rectified ac voltage. With the switch 127 off, the batteries 125 will recharge continuously.

To accomplish this, a step down transformer 128 is connected between the ac source terminals 126 and a bridge rectifier 129. The negative output terminal of the bridge 129 is grounded, and the positive terminal is connected via a diode 130 and a resistor 131 to the positive terminal of the batteries 125. Filtering is provided by a capacitor 132.

Intending to claim all novel, useful and unobvious features as shown or described, the applicant:

1. An audio responsive light display comprising:
 - a dc voltage source,
 - a first set of lamps,
 - a first circuit for supplying power to said first set of lamps from said source in response to a first input signal,
 - a second set of lamps,
 - a second circuit for supplying power to said second set of lamps from said source in response to a second input signal,
 - each of said first and second circuits including a transistor amplifier the gain of which is controlled in response to a gain control bias voltage which is provided in common to both said first and second circuits,
 - means providing an audio signal,
 - filter means for supplying selected frequency portions of said audio signal as said first and second input signals, said sets of lamps thereby lighting in frequency response to said audio signal, and
 - an automatic gain control circuit including a single input line receiving a voltage derived from both of said sets of lamps, and means for providing said

gain control bias voltage in inverse proportion to said derived voltage.

2. A light display according to claim 1 wherein said first and second circuits each comprise;

- a first transistor receiving a respective input signal and providing voltage gain therefor,
- a second transistor of the same conductivity type as said first transistor and receiving the output thereof, said gain control bias voltage being applied to the base of said second transistor to control the amount of additional gain provided thereby, and
- a third transistor connected in a follower-type circuit between said second transistor and said respective set of lamps.

3. A light display according to claim 2 wherein said first and second transistors are NPN type and wherein said third transistor is a PNP type, said first set of lamps being connected in the collector circuit of said third transistor, said voltage source supplying a positive voltage to the collector of said second transistor via a series-connected pair of resistors, the base of said third transistor being connected to the junction of said pair of resistors.

4. A light display according to claim 3 wherein the collector of said first transistor is connected to said positive voltage source via a third resistor and is connected to the base of said second transistor via a series connected capacitor and fourth resistor.

5. A light display according to claim 3 wherein said automatic gain control circuit input line is connected via a resistor to the junction between each lamp and the associated third transistor supplying power to that lamp, and having an output line supplying said gain control bias voltage via a diode to the base of the second transistor of each lamp supply circuit, the gain control bias voltage on said output line changing inversely in response to the voltage on said input line.

6. A light display according to claim 1 wherein said voltage source comprises:

- one or more batteries,
- a rectifier connectable between an ac source and said batteries, said batteries functioning as said voltage source when said ac source is disconnected, said rectifier providing said voltage source when said ac source is connected, said batteries functioning to regulate voltage from said rectifier.

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