

Dec. 28, 1965

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3,226,601

LIGHT DISPLAY WITH SOUND SIGNAL CONTROL

Filed June 1, 1962

4 Sheets-Sheet 1

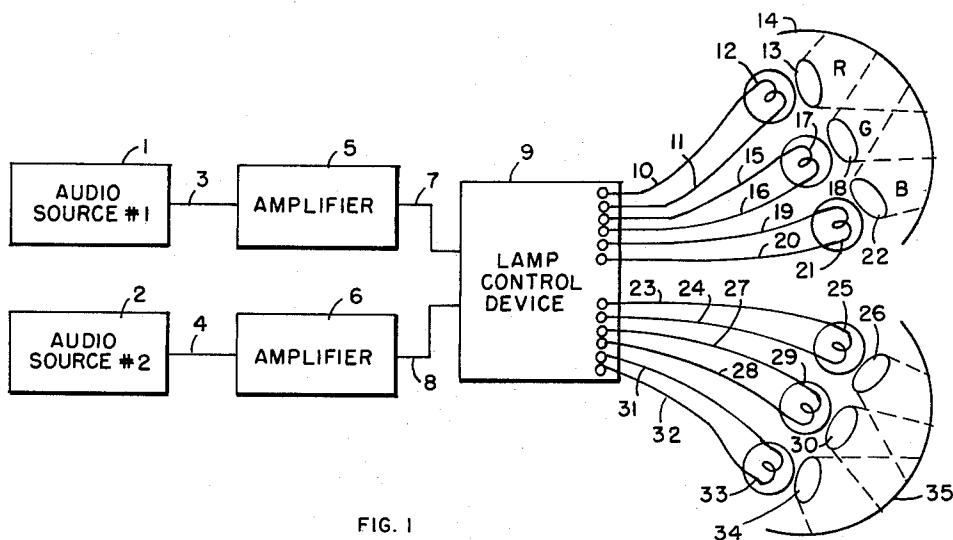


FIG. 1

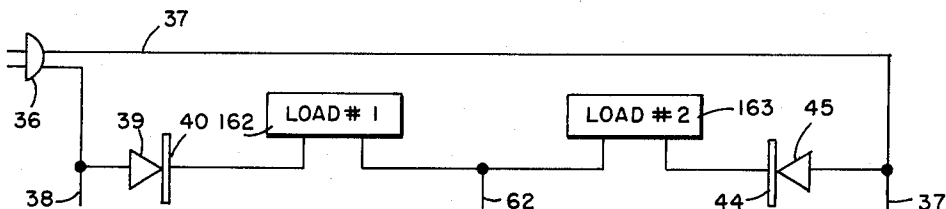


FIG. 4

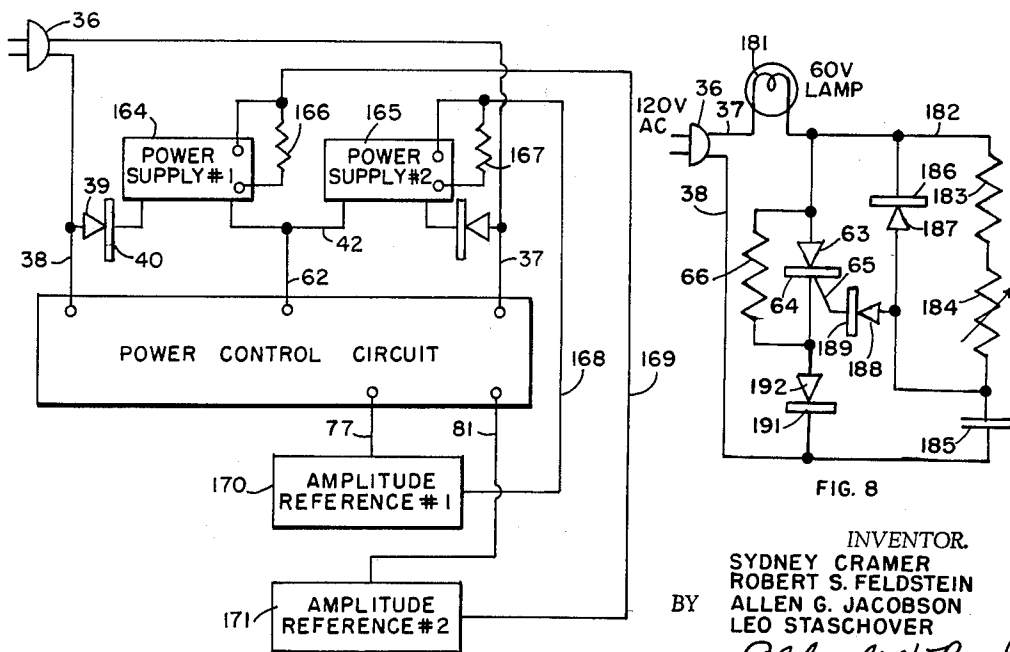


FIG. 5

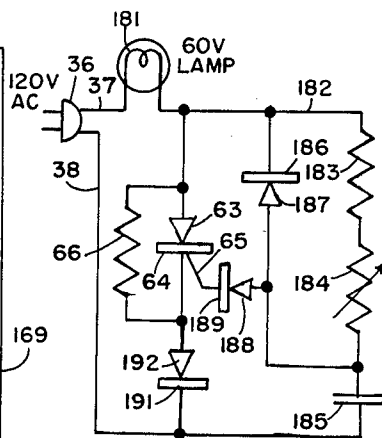


FIG. 8

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4 Sheets-Sheet 2

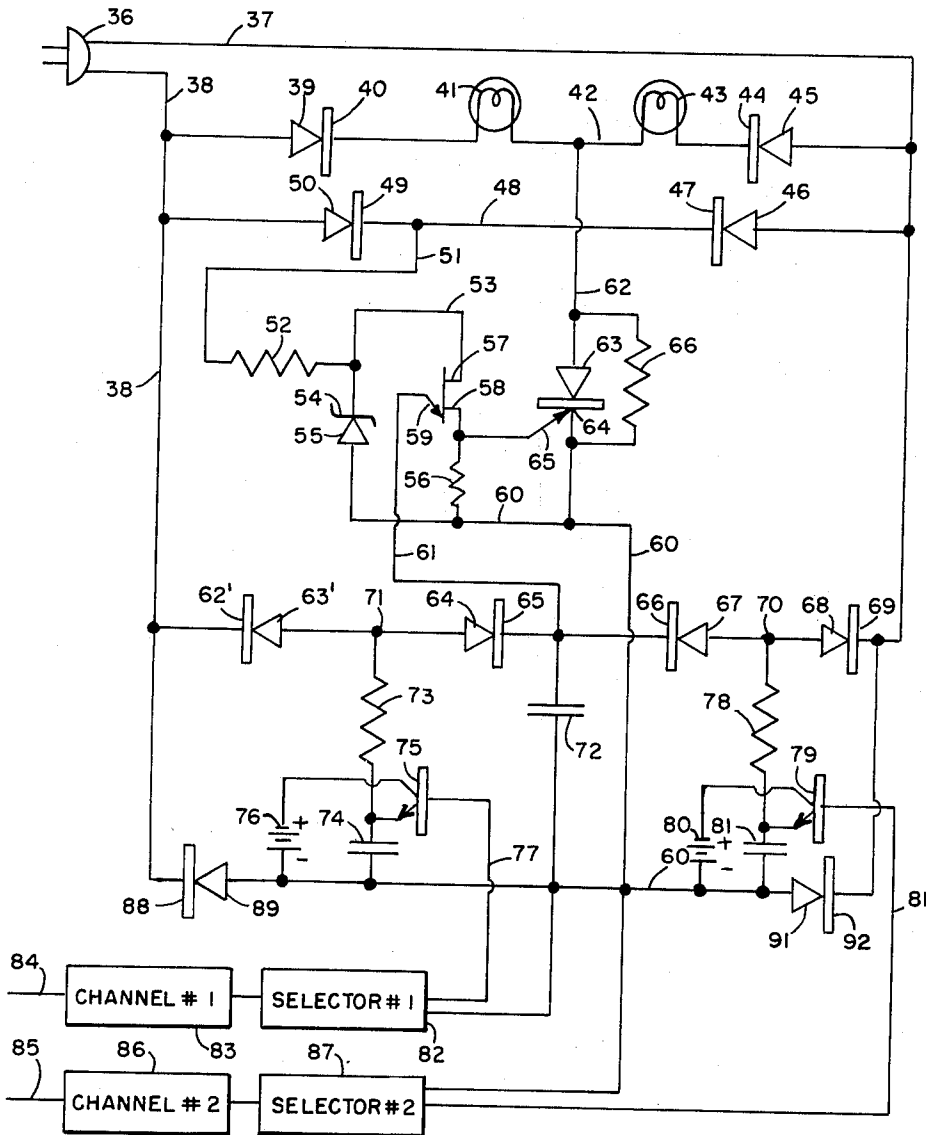


FIG. 2

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4 Sheets-Sheet 3

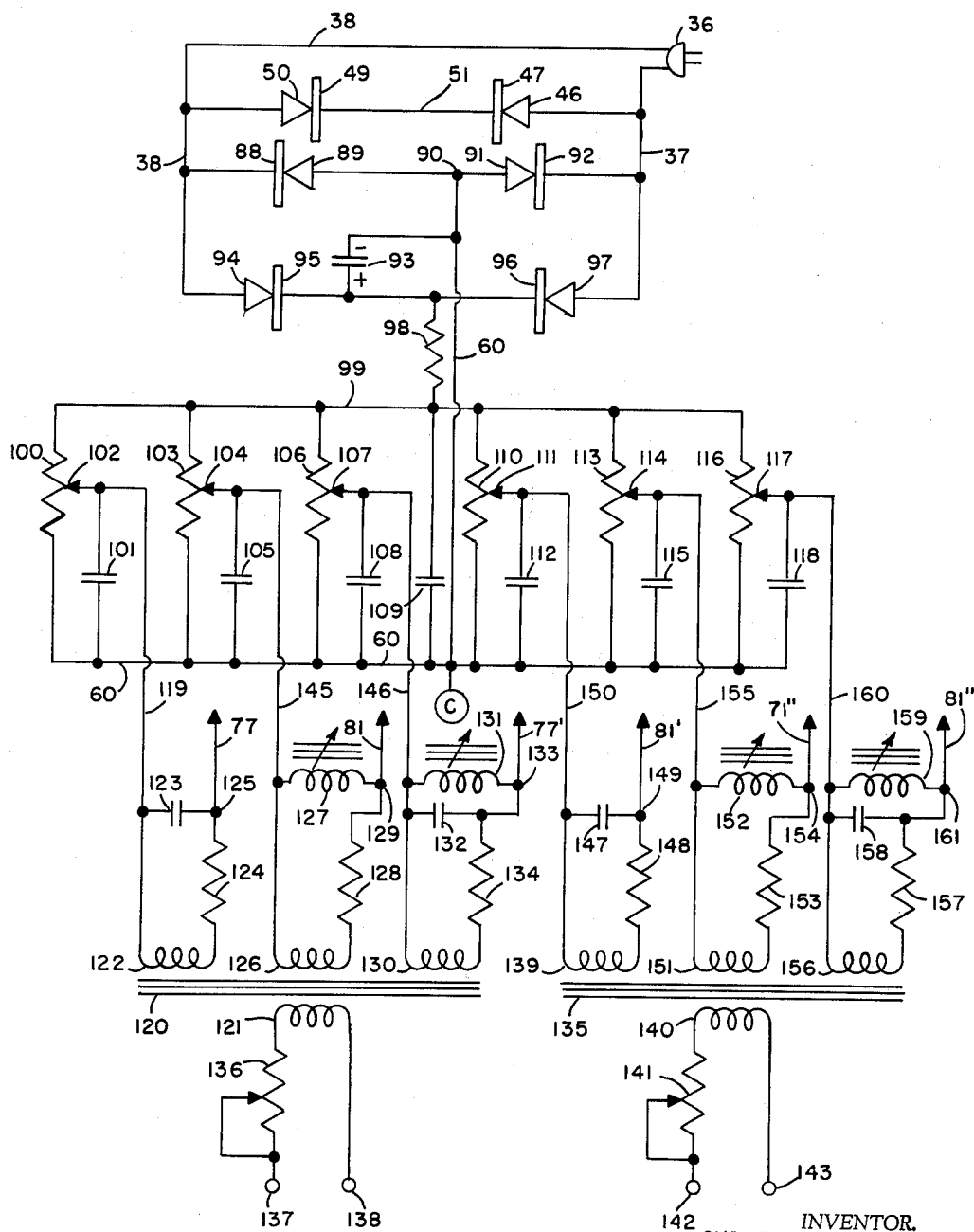


FIG 3

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4 Sheets-Sheet 4

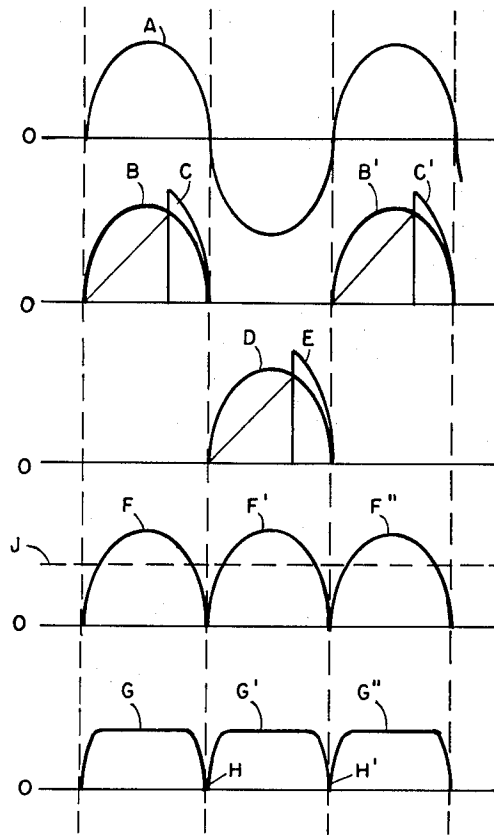
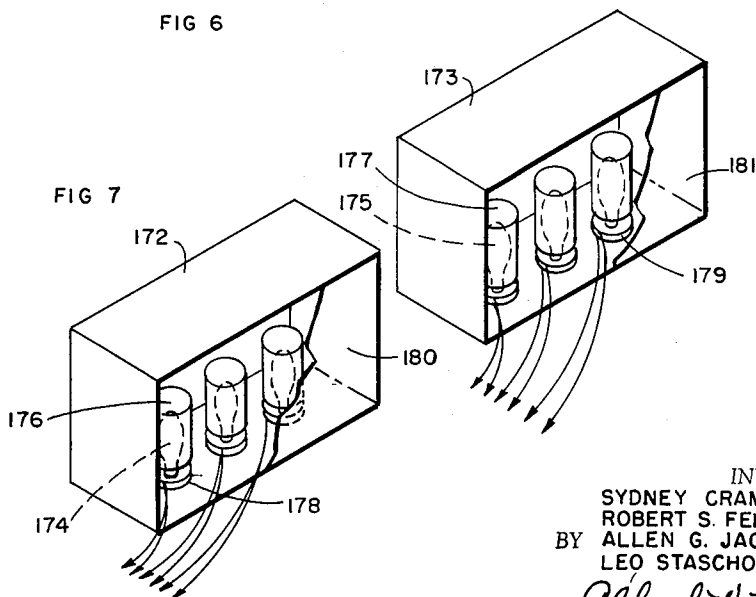


FIG 6



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3,226,601

LIGHT DISPLAY WITH SOUND
SIGNAL CONTROL

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10 Claims. (Cl. 315-210)

The present invention concerns power control circuits in which a single control device such as a silicon controlled rectifier is controlled by two independent signals to supply two independent load devices on a time sharing basis from a source of single phase alternating current power.

There are a number of applications calling for the control of electrical power in response to an electrical control signal. One area of application is in the control of current to electric lamps as in dimmers or various illuminated displays. In this area current to one or more electric lights is controlled by means of signals in order to produce a desired visual effect. In another area one or more sources of power are regulated in order to provide a constant output in the presence of varying input voltage or output load. Still other areas of application exist and will suggest themselves upon an understanding of the present invention.

In the past various methods have been used for controlling electric power to utilization devices which were of varying complexity and cost. Methods using vacuum tubes resulted in very responsive devices but which became very expensive and cumbersome if more than a few watts had to be controlled. The silicon controlled rectifier is a relatively new circuit component which has found wide application in the power control field. This control device is small and responsive and capable of handling considerable amounts of power. On the other hand the silicon controlled rectifier is a relatively expensive item and cannot be used indiscriminately where cost is a factor.

The present invention concerns methods of and means for making use of a single silicon controlled rectifier to control two independent load circuits. Briefly, a single silicon controlled rectifier is utilized to control independent load circuits on alternate halves of an alternating current power cycle. A system of rectifiers is connected to switch the loads and corresponding control circuits so that during one half cycle a first control signal controls the power to a first load and during the next half cycle a second control signal circuit is switched in to control the power to a second and independent load. Thus in a system for controlling power to two or more independent load circuits, only half of the usual number of silicon controlled rectifiers is required. The same basic control circuit is used for both signal responsive controlling to provide varying amounts of power to loads as in the case of a visual display and to provide a constant regulated output as in the case of a regulated power supply. Another feature of the present invention is the use of lamps rated at one-half the line voltage so that full brilliance is achieved on one half cycle of power. In a display utilizing two or more lamps, two such lamps are supplied by each silicon controlled rectifier. However, in at least one application, that of a simple dimmer circuit, only one half voltage lamp may be utilized or several such lamps may be used in parallel on a single half wave controlled circuit utilizing a single silicon controlled rectifier.

One of the principal applications of the present invention is in a visual display in which six lamps are con-

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trolled by three silicon controlled rectifiers from a source of stereophone sound. In this case three lamps are controlled by each of the two sound channels. The lamps are provided with color as by means of red, green and blue filters. The controlling sound is divided into low, medium and high frequency bands by means of suitable frequency selectors. The low register is applied to control say the red lamp, the middle register to control the green lamp and the high register to control the blue lamp. The same division is made for each channel with the result that six lamps are independently controlled. The visual display for the left sound channel may be provided in a three lamp housing placed on the left while the right sound channel may be provided in a three lamp display on the right side.

Accordingly one object of the present invention is to provide methods of and means for controlling two independent load circuits in response to two independent control signals through the medium of a single silicon controlled rectifier.

Another object is to provide a stereo sound responsive display utilizing two sets of red, green and blue lights and controlled by three silicon controlled rectifiers.

Still another object is to provide a full visual brilliance display from a half voltage lamp excited from half cycles of an alternating current power source.

These and other objects will be apparent from the detailed description of the various figures of the drawing given below.

In the drawing:

FIGURE 1 is a diagrammatic representation of the preferred form of the present invention.

FIGURE 2 is a schematic circuit diagram of the preferred form of a portion of the present invention.

FIGURE 3 is a schematic circuit diagram of the preferred form of another portion of the present invention.

FIGURE 4 is a circuit diagram partly in block form illustrating a modification of a portion of the circuit of the present invention.

FIGURE 5 is a combined circuit and block diagram of a modified form of the present invention.

FIGURE 6 is a series of alternating current wave forms useful in explaining the operation of the present invention.

FIGURE 7 is a simplified representation of a further modified form of a portion of the present invention.

FIGURE 8 is a circuit diagram of still another modified form of the present invention.

FIG. 1 shows without circuit details how, in accordance with the present invention, a first source of audio signals 1 is amplified by an audio amplifier 5 connected by line 3 and in turn feeding a lamp control device 9 over line 7. Also a second source of audio signals 2 is amplified by an audio amplifier 6 connected by line 4 and in turn feeding the lamp control device 9 over line 8. The preferred form of lamp display includes lamps 12, 17 and 21 connected to lamp control device 9 over leads 10-11, 15-16 and 19-20 respectively and concentrated on a viewing screen 14 by a suitable filter means 13, 18 and 22 which may be external to the lamps or a part of their envelope construction. These filters are designated as R, G and B indicating that they are to provide the color projections red, yellow and blue respectively. These first three lamps will be understood to be controlled by sound signals from audio source 1 through the control device 9 as will be set forth in detail below. The red filtered lamp 12 is energized in accordance with low frequency sound signals from source 1; the yellow filtered lamp 17 is energized in accordance with middle register sound signals from source 1; and the blue filtered lamp 21 is energized in accordance with

the high register sound signals from source 1 as determined by frequency selective means contained in the control device 9, details of which are given below in connection with the detailed circuit diagrams of some of the other drawing figures. In a similar manner the other three lamps 25, 29 and 33 are energized from control device 9 over leads 23-24, 27-28 and 31-32 respectively. These lamps are also filtered by suitable means such as filters 26, 30 and 34 to project red, yellow and blue light respectively on the viewing screen 35. Also the control device 9 includes frequency selective means so that lamp 25 is energized in accordance with low frequency components of the audio signals from source 2, lamp 29 in accordance with middle range and lamp 33 in accordance with high frequency components. It will be understood that the lamp colors and methods of obtaining the colors, lamp arrangements, viewing means and the various interrelationship between sound ranges and lamp colors may be changed in any desired manner without departing from the spirit and scope of the invention. Also it will be understood that the invention is not departed from by changing the number of lamps, or number of channels of sound or the number of frequency ranges selected nor by substituting other signal sources for the sound source shown. A preferred form of the invention, however, utilizes stereophonic sound sources as where source 1 would be the sound from the left and the source 2 would be the sound from the right and lamps 12-17-21 would display correspondingly on the left and lamps 25-29-33 would display correspondingly on the right.

FIG. 2 shows a silicon controlled rectifier including anode 63, cathode 64 and gate 65 connected to a unijunction transistor including first base 58, second base 57 and emitter 59. The circuit of FIG. 2 receives A.C. power from a suitable source connected as by plug 36 which connects opposite sides of the A.C. line to leads 37 and 38. This figure shows the two lamps 41 and 43 as load devices since the circuit is capable of supplying two loads under independent control. (For six lamps as shown in FIG. 1, three circuits like that of FIG. 2 would be used.) The silicon controlled rectifier is rendered conducting during part of each half cycle of the alternating current as will be explained below. During the half cycle when line 37 is positive with respect to line 38 lamp 43 will be energized as long as the silicon controlled rectifier is conducting by current which flows from line 37 from anode 45 to cathode 44 of rectifier 44-45, through lamp 43, over leads 42 and 62, through silicon controlled rectifier 63-64-65 to line 60 and from anode 89 to cathode 88 of rectifier 88-89 to line 38 completing the circuit. On the alternate half cycle when line 38 is positive with respect to line 37, lamp 41 will be energized as long as the silicon controlled rectifier is conducting by current which flows from line 38 from anode 39 to cathode 40 of rectifier 39-40, through lamp 41, over line 62, through silicon controlled rectifier 63-64-65 to line 60, from anode 91 to cathode 92 of rectifier 91-92 and so to line 37. It has been found, since the inverse voltage across the silicon controlled rectifier 63-64-65 is at all times in series with either rectifiers 39-40, 91-92 or 44-45, 88-89 also subject to inverse voltage, that a resistor 66 connected from anode 63 to cathode 64 will insure a proportionally lower voltage to appear across the silicon controlled rectifier than across the other series rectifiers. By this expedient a silicon controlled rectifier having a lower inverse voltage rating can be safely used than would otherwise be possible. When unijunction transistor 57-58-59 conducts, the voltage drop across series resistor 56 which is common to the transistor and to the emitter 65 of the silicon controlled rectifier causes the silicon controlled rectifier to conduct completing the power circuit just traced above. A bias voltage is supplied to transistor 57-58-59 from lead 48 connected to cathodes 47 and 49 of rectifiers

46-47 and 49-50 respectively. Anode 50 is connected to line 38 while anode 46 is connected to line 37 so that positive voltage pulses are impressed between lead 48 and common lead 60 which automatically returns to the line of opposite polarity through either rectifiers 88-89 or 91-92 as described above in tracing the lamp power circuits. This positive voltage will have the form shown by curves F through F' in FIG. 6 and will be present for every half cycle of the power line alternating current illustrated at A in FIG. 6. The positive voltage pulses on line 48 are applied through dropping resistor 52 to cathode 54 of Zener diode 54-55, anode 55 of which is connected to reference line 60 so that a constant positive voltage equal to the Zener voltage (J of FIG. 6) is provided to the transistor over lead 53 for a major part of each half cycle as shown by curves G through G' in FIG. 6. The sharp return to zero portions of the curves as shown at H and H' of FIG. 6 due to the zero returns of the alternating current serve to reset the unijunction transistor at the end of each half cycle readying it for a new control effect on the succeeding half cycle.

The control of the unijunction transistor is effected by building up a voltage across capacitor 72 connected from emitter 59 over lead 61 to return line 60. During the half cycles when line 37 is positive with respect to line 38 the charging circuit through rectifying transistor 79-80, resistor 78 and rectifier 66-67 from channel #2 is effective. Input control signals on line 85, amplified in channel 86 and selected by selector 87 feed signals through rectifying transistor 79 (supplied with suitable collector bias by battery 80) to capacitor 81 and through rectifier 67-66 to charge capacitor 72. When capacitor 72 reaches the break down voltage of emitter 59, the unijunction transistor conducts developing a voltage drop across resistor 56 at gate 65 causing current to flow (as set forth above) through lamp 43. This current through lamp 43 under control of signals over channel #2 is illustrated by curves C and C' of FIG. 6. During these half cycles the second control circuit through resistor 73 is disabled by rectifiers 62'-63' and 64-65. Rectifier 62'-63' will effectively short point 71 to line 38 since line 38 is negative and rectifier 64-65 will effectively open the circuit from point 71 to capacitor 72 since the incoming control voltage will be positive through rectifier 75-76. Similarly, during the alternate half cycles when line 38 is positive with respect to line 37, the channel 1 will control by means of signals on line 84, amplified in channel 83 and selected by selector 82 which are applied over lead 77 to rectifying transistor 75 (supplied with suitable collector bias by battery 76) to charge capacitor 74, from which current passes through resistor 73 and rectifier 64-65 to charge capacitor 72. As in the first case above when capacitor 72 reaches the transistor breakdown voltage the silicon controlled rectifier is fired. This second controlled current passes through lamps 41 so that its brilliance will be controlled by signals from line 84. Here again the other control circuit is automatically rendered ineffective this time by rectifier 68-69 which shorts point 70 to line 37 and rectifier 66-67 which opens the circuit from point 70 to capacitor 72. These second controlled current pulses, i.e. the ones through lamp 41 are illustrated at E in FIG. 6.

Thus, the circuit of FIG. 2 illustrates how two independent loads such as lamps 41 and 43 can be controlled independently and by independent signals through the medium of a single silicon controlled rectifier. It has also been found according to the present invention that full brilliance on full on control for each alternate half cycle can be provided by using lamps rated at half voltage. Thus, with a 120 volt line power source, the use of 60 volt lamps provides a device which can be controlled from full off to full on at normal full lamp brilliance.

FIG. 3 illustrates a further embodiment of the invention, particularly pointing out control signal deriving circuits in which three selected signals are provided from each of two channels providing six signals. These six selected signals will control six loads such as six lamps by utilizing three sets of the dual control circuits shown in FIG. 2. Here in FIG. 3 the circuits are only shown up to lines 77 and 81 of FIG. 2 since the completion of the circuits will involve only the multiplication of the circuits of FIG. 2 as required. One circuit, such as one channel of a stereo sound system is applied to terminals 137 and 138 so that these first channel signals are applied through a level control resistor 136 to primary 121 of an audio transformer wound on core 120. Secondary windings are provided, one for each load circuit, and in this case the three windings 122, 126 and 130. In this case being illustrated the sound is to be divided into three frequency ranges, namely, low, middle and high frequency ranges. Series resistor 124 feeding capacitor 123 connected across winding 122 provides signals which are of substantially full amplitude in the low register but fall off with increasing frequency so that low or bass register signals are selected at point 125 and applied to line 77 corresponding to control signal line 77 of FIG. 2. Further control in the circuit can be provided by establishing an adjustable initial bias for each of the control signal circuits. A convenient method is shown with rectifiers 94-95 and 96-97 charging capacitor 93 so that a positive voltage is applied to resistor 98 with reference to common line 60. The positive voltage through resistor 98 is applied to line 99 placing a bias voltage across potentiometers 100, 103, 106, 110, 113 and 116. The bias to each selected circuit is made adjustable by means of adjustable contacts 102, 104, 107, 111, 114 and 117 by-passed by capacitors 101, 105, 108, 112, 115 and 118 respectively. The adjustable bias is thus established on each selector circuit by return leads 119, 145, 146, 150, 155 and 160 respectively. Each of these circuits operates in a similar manner to the low register selector where adjustment of contact arm 102 places an initial bias on the signal control circuit completed over lead 77 and advances or retards the point at which the selected signals cause its control circuit to fire and its lamp to light.

In a similar manner other frequency selection may be carried out as by the middle register selector fed by winding 130. Inductor 131 tuned by capacitor 132 forms a selective circuit enhancing middle register signals (if tuned to 1000 cycles, say) applied through resistor 134 and providing selected middle register control signals at point 133 to control line 77' of a second dual lamp control circuit. High register signals may be selected by means such as inductor 127 exhibiting a rising impedance with frequency and fed from winding 126 through resistor 128 to provide control signals to line 81 (corresponding with line 81 of FIG. 2) at point 129. Middle register initial bias is supplied from adjustable contact 107 and high register from contact 104.

A second channel as the second channel of a stereo sound system, for example, is treated in the same way utilizing a transformer wound on core 135. Input signals are applied to terminals 142 and 143 providing an input voltage through adjustable resistor 141 to primary 140. Secondary 139 feeds the low frequency selector 147-148 and control line 81' at point 149. Middle register selector 158-159 is fed by winding 156 through resistor 157 providing control signals to line 81'' at point 161. High register selector 152 is fed from winding 151 through resistor 153 and provides control signals to line 71'' at point 154. Parts of FIG. 3 bearing numbers also shown in FIG. 2 are intended to indicate the same or corresponding parts.

FIG. 4 shows a portion of a dual control system in accordance with the present invention as set forth in detail in connection with FIGS. 2 and 3 but in which

the generalized loads 162 and 163 are substituted for lamps 41 and 43 respectively to indicate that the present invention can be utilized with other than lamp loads.

FIG. 5 shows how the methods of the present invention can be applied to control two independent regulated power supplies with a single silicon controlled rectifier. Similar numbers indicate circuits and parts as shown in FIGS. 2 and 3. Here power supply 164 is connected in place of lamp 41 and power supply 165 is connected in place of lamp 43. The power is supplied under signal control as detailed in FIGS. 2 and 3 as will be understood where leads 77 and 81 provide the input control signals eventually controlling the silicon controlled rectifier and the controlled alternate half cycles of power are applied to the loads 164 and 165 over lead 62. Amplitude control signals may be generated in a conventional manner by comparing output voltages across loads 166 and 167 over leads 169 and 168 to amplitude voltage references (Zener diode or battery references) 171 and 170 respectively to develop difference control voltages over leads 81 and 77 to control the silicon control rectifiers.

FIG. 7 illustrates an alternate form of display in which a plurality of colored lamps are mounted in two groups, representing two channels of a stereo system. These lamps are mounted in two cabinets with frosted glass fronts. The color may be provided by surrounding lamps 174, 175 etc. with colored cellophane or other plastic 176, 177 etc. These color filtered lamps 174, 175 etc. are mounted in two similar cabinets 172 and 173 where one group, for example, in cabinet 172 represent the sound from the left and the second group in cabinet 173 represent the sound from the right. Each cabinet is provided with a ground glass or similar translucent sheet covering its front side 180 and 181. The effect of the varying intensity of the various colored lights on the translucent screen is light patches which apparently grow larger and brighter as the intensity of illumination in the lamps increases and which contract and dim on decreasing intensity.

FIG. 8 is a single lamp circuit in accordance with the present invention. The light intensity may be controlled from zero or a very low value up to full brilliance. The full brilliance in the half wave circuit is provided, as set forth above, by utilizing a lamp adapted for operation at essentially one-half the input A.C. voltage of the system. Component designations corresponding with those of FIG. 2 are similarly numbered. The input voltage will be taken as 120 volts and the lamp 181 will be designed to operate at 60 volts. For other input voltages, other lamp ratings will be called for, as a 120 volt lamp for a 240 volt line, etc. The input circuit through plug 36 passes over line 37, through lamp 181, silicon controlled rectifier 63-64-65, rectifier 192-191 and returns over line 38. A control circuit is provided over line 182 by suitable resistors 183 and 184 which provide a limited charging current on positive half cycles of the A.C. input to capacitor 185. The voltage across capacitor 185 is applied through rectifier 188-189 to gate 65 of the silicon controlled rectifier so that it will break down at its critical anode and gate voltages. The break down point on the A.C. input cycle may be controlled by varying resistor 184 to vary the rate of charge of capacitor 185. When the silicon controlled rectifier breaks down line 37 is positive with respect to line 38 and the current direction is such as to readily pass through rectifier 191-192 from its anode 192 to its cathode 191. On the alternate half cycles both silicon controlled rectifier 63-64-65 and rectifier 191-192 will be under reverse bias and resistor 66 will hold down the voltage across the silicon controlled rectifier. The rectifier 186-187 connected between capacitor 185 and line 182 serves to discharge capacitor 185 on the alternate half cycles of the A.C. when line 182 goes negative with respect to line 38.

While only a few forms of the present invention have been shown and described, many modifications will be apparent to those skilled in the art and within the spirit and scope of the invention as set forth in the appended claims.

What is claimed is:

1. In a system for controlling power from an alternating current source, the combination of, a first load device and a second load device, a first source of control signals and a second source of control signals, a silicon controlled rectifier, means responsive to the first said control signals for firing said silicon controlled rectifier through said first load on alternate half cycles of said alternating current and means responsive to the second control signal for firing said silicon controlled rectifier through said second load on the half cycles of said alternating current which alternate with the first said alternate half cycles.
2. A system as set forth in claim 1 in which said load devices are colored lamps.
3. A system as set forth in claim 1 in which said sources of control signals include sources of audio frequency signals and frequency selective circuits.
4. A system as set forth in claim 1 and including a plurality of rectifiers in series with said loads for determining the alternate half cycle current to be applied to each load.
5. A system as set forth in claim 1 in which said control signals are selected from audio frequency signals to correspond with predetermined colors of lamps acting as said loads.
6. A system as set forth in claim 1 in which said control signal means include means for selecting predetermined frequency bands from stereo audio signals.
7. In a system for controlling power from an alternating current source including first and second lines, the

combination of, a first load device, a second load device, a silicon controlled rectifier, a first rectifier, a second rectifier, circuit connections directing current from said source through said first load, said first rectifier and said silicon controlled rectifier, additional circuit connections directing current from said source through said second load, said second rectifier and said silicon controlled rectifier, whereby said rectifier is connected to conduct on positive half cycles of said first line with respect to said second line and said second rectifier is connected to conduct on positive half cycles of said second line with respect to said first line, means for triggering said silicon controlled rectifier and polarity responsive control means connected to said triggering means adapted to exert one degree of control in response to positive half cycles of said first line with respect to said second line and another degree of control in response to positive half cycles of said second line with respect to said first line.

8. A system as set forth in claim 7 in which said load devices are incandescent lamps.

9. A system as set forth in claim 7 in which said triggering means includes a unijunction transistor.

10. A system as set forth in claim 7 in which said independent control means are responsive to signals generated by audible sounds.

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