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Remarks:

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divisional application to the application mentioned
under INID code 62.

(54) **Power supply for an infrared transmitter**

(57) The invention relates to a power supply for an
infrared transmitter having at least one LED driver. The
power supply includes a power supply capacitor (102),
a filter network (108) comprising a filter capacitor (112)
and resistor (110) connected in series with the power

supply capacitor (102). The filter network (108) supplies
current pulses to the LED driver. The power supply further
includes a diode (114) connected in parallel with the re-
sistor (110) of the filter network (108) to provide isolation
between the filter capacitor (112) and the power supply
capacitor (102).

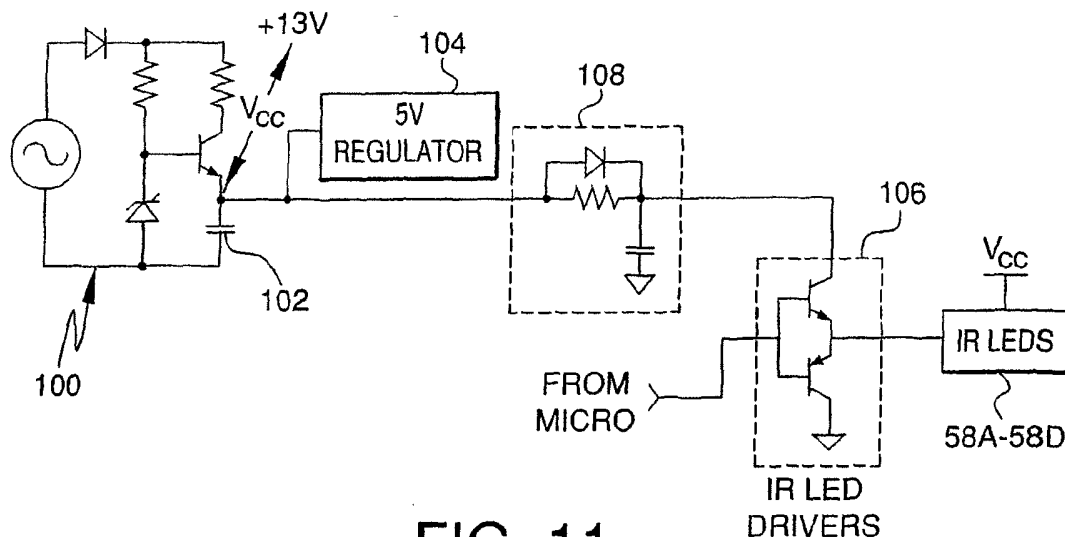


FIG. 11

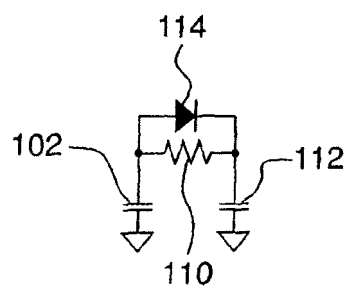


FIG. 12

Description

Cross Reference to Related Application

[0001] This application claims priority from United States Provisional Application Serial No. 60/309,929, filed August 3, 2001, which is incorporated herein by reference in its entirety.

Field of the Invention

[0002] The present invention relates to dimmer control systems comprising a transmitter and more particularly to power supplies for infrared transmitters having at least one LED driver.

Background of the Invention

[0003] Dimmers have become increasingly popular for controlling light intensity. Dimmers typically employ solid-state devices such as triacs, silicon-controlled rectifiers, or field-effect transistors for varying the phase angle of an applied a.c. sinusoidal voltage. Known dimmers are responsive to command signals directed at the dimmer in the form of radiant energy, typically in the infrared range. Infrared transmissive windows or sections allow the command signal to reach an IR receiver housed within the dimmer.

[0004] IR responsive dimmers allow for dimmer control systems in which an IR command signal can be "blasted" from one source of IR radiation for receipt by multiple dimmers. An example of a dimmer control system that uses infrared radiation to communicate command signals from one source of IR to multiple dimmers is the SPACER SYSTEM™ sold by Lutron Electronics Co., Inc. of Coopersburg, Pennsylvania. The SPACER SYSTEM™ utilizes a master control having an optically clear back cover that allows command signals from a source of IR radiation located within the master control to be "blasted" outwardly from the master control into the wallbox that houses the master control. The system also includes multiple dimmers housed in the same wallbox. Each of the dimmers includes an optically clear back cover and an internal IR receiver. The IR receiver of each dimmer receives infrared command signals that are blasted into the wallbox from the master control. The system is also disclosed in U.S. Patent Application Serial No. 09/220,632, issued as U.S. Pat. No. 6,380,696, assigned to Lutron Electronics Co., Inc., the Assignee of this application.

Summary of the Invention

[0005] According to the present invention there is provided a power supply for an infrared transmitter having at least one LED driver. The power supply includes a power supply capacitor and a filter network, the filter network including a filter capacitor and a resistor connected

in series with the power supply capacitor. The power supply further includes a diode connected in parallel with the resistor of the filter network to provide isolation between the filter capacitor and the power supply capacitor.

Brief Description of the Drawings

[0006] Figure 1 is a schematic illustration of a dimmer control system;

[0007] Figure 2 is a perspective view of a remote infrared transmitter mounted to an attachment bracket;

[0008] Figure 3 is an exploded perspective view of the remote infrared transmitter and attachment bracket of Figure 2;

[0009] Figure 4 is a perspective view of the remote infrared transmitter and attachment bracket of Figure 2 adjacent a dimmer back cover;

[0010] Figure 5 is a perspective view of the remote infrared transmitter and attachment bracket of Figure 2 engaged to a dimmer back cover;

[0011] Figure 6A is a perspective view of the enclosure of the remote infrared transmitter of Figure 2;

[0012] Figure 6B is a bottom plan view of the enclosure of Figure 6A;

[0013] Figure 6C is side elevational view of the enclosure of Figure 6A;

[0014] Figure 6D is a sectional view of the enclosure of Figure 6B taken along the lines A-A;

[0015] Figure 6E is a sectional view of the enclosure of Figure 6C taken along the lines B-B;

[0016] Figure 6F is an end view of the enclosure of Figure 6A;

[0017] Figure 7 is a top view of the enclosure and LEDs of a remote infrared transmitter;

[0018] Figure 8 is a side view of the enclosure and LEDs of Figure 7;

[0019] Figure 9 is side view of one of the LEDs of Figures 7 and 8 having notations thereon;

[0020] Figure 10 is an electrical schematic for a remote infrared transmitter;

[0021] Figure 11 is an electrical schematic of a power supply circuit according to the present invention for a remote infrared transmitter;

[0022] Figure 12 is a simplified schematic representation of the circuit of Figure 11;

[0023] Figure 13 is a graphical illustration of power supply waveforms;

[0024] Figure 14 is a schematic illustration of a dimmer control system set for operation in a first mode; and

[0025] Figure 15 is a schematic illustration of the dimmer control system of Figure 14 set for operation in a second mode.

Detailed Description of the Preferred Embodiments

[0026] Referring to the drawings, where like numerals identify like elements, there is shown a dimmer control system 10. The control system 10 includes a master con-

trol 12 shown schematically in Figure 1 located within a first wallbox 14. Hot and neutral wires connect the master control 12, in the well-known manner, to a power supply, such as the power distribution panel of a dwelling, for example.

[0027] The control system 10 also includes two sets of dimmers 16 located in separate second and third wallboxes 18 and 20, respectively. As shown in Figure 1, the first wallbox 14 in which the master control 12 is located is separate from the second and third wallboxes 18 and 20 in which the dimmers 16 are located. Each of the dimmers 16 is capable of controlling the current supplied to an electrical load, such as a light, for example.

[0028] An example of a suitable master control 12 and suitable dimmers 16 for use in the control system is described in U.S. Patent Application Serial No. 09/220,632, issued as U.S. Pat. No. 6,380,696, which is hereby incorporated by reference. Features and operation of the dimmers are also described in U.S. Pat. Nos. 5,248,919 and 5,909,087, which are also hereby incorporated by reference. Each dimmer 16 includes a large actuator for a single non-latching switch. Within the border of the large actuator is an infrared receiving window 24 for receipt of infrared signals by an infrared receiver located behind window 24. Such signals may come from a hand held remote controller, for example. The dimmers 16 further include a user adjustable intensity actuator 26 for raising and lowering the light level of an attached load. An LED array 28 displays information including information about the light level of the attached load. The dimmers are capable of memory storage of preset light levels, associated with preferred lighting "scenes" for example. The dimmers are responsive to infrared command signals received by the IR receiver, to set the dimmers to the preset light levels stored by the dimmers for example.

[0029] The master control 12 includes an "ON" actuator 30, an "OFF" actuator 32, four preset actuators 34, an intensity actuator 36, LED indicators 38 and an IR receiving window 40 in one of the preset actuators 34. The master control includes a microprocessor (not shown) that performs various functions such as output of control signals to the dimmers 16 including setting of the dimmers to the preset light level stored in memory by the dimmers.

[0030] The dimmer control system 10 includes a pair of electrical conductors, referred to herein as traveler wires, 42 and 44 for carrying dimmer control signals from the master control 12 in the first wallbox 14 to the dimmers 16 located in the second and third wallboxes 18 and 20 as will be described in greater detail below. The traveler wires are preferably No. 14 AWG at a minimum. As seen in Figure 1, each of the traveler wires 42, 44 splits into separate traveler wires 42A, 42B and 44A, 44B, respectively, for carrying control signals from the master control 12 to the separate sets of dimmers 16 in the second and third wallboxes 18, 20.

[0031] The control system 10 includes an infrared (IR) transmitter 46 for each of the wallboxes 18, 20 of the

dimmers 16. Each of the IR transmitters 46 is connected to one pair of the traveler wires, either 42A, 44A or 42B, 44B, for receipt of dimmer control signals from the master control. Each of the IR transmitters 46, schematically shown in Figure 1, is removably secured to the back cover of a dimmer 16 for locating the IR transmitter in the dimmer wallbox behind one of the dimmers, as will be described further hereinafter.

[0032] Referring to Figures 2-9, the construction and operation of the IR transmitter 46 associated with wallbox 18 is shown in greater detail. The IR transmitter 46 for wallbox 20 is similar in construction and operation to the IR transmitter shown in Figures 2-9. The transmitter 46 includes an optically clear enclosure 48 that is transmissive to both visible and IR light. A suitable material for forming the optically clear enclosure 48 is Lexan® resin number 241R available from General Electric.

[0033] The IR transmitter 46 includes conductive terminals 50 each having a pair of upstanding legs 52 for receipt of conductive leads 54 of the traveler wires 42A and 44A that extend into the enclosure 48. The terminals 50 are supported on an upper surface of a printed wire board 56. The transmitter 46 includes four LEDs 58A-58D that provide the source of infrared radiation for blasting the IR command signals to the IR receivers through the IR transmissive enclosure 48.

As seen in Figures 2 and 3, the LEDs 58A-58D are arranged such that LEDs 58A and 58B are located at an opposite end of the elongated enclosure 48 from LEDs 58C and 58D. Electrically, the LEDs are connected in anti-parallel fashion as shown in Figure 10. This arrangement provides for a polarity insensitive wiring, to be described in greater detail hereinafter, in which one of the LEDs 58A-58D at each of the opposite ends of the elongated enclosure will blast IR signals regardless of which of the terminals 50 is used to connect the respective traveler wires 42A, 44A.

[0034] The IR transmitter 46 also includes an attachment bracket 60, preferably made of an electrically conductive material such as stainless steel, for securing the IR transmitter 46 to one of the dimmers 16. The attachment bracket secures the transmitter 46 to the dimmer 16 such that the transmitter is positioned adjacent to a back cover 62 of the dimmer 16. The back cover 62 is made from an optically clear material, such as the Lexan® resin material from which the transmitter enclosure 48 is made, to allow for passage of the IR signal blasted from transmitter 46 to an IR receiver enclosed by the back cover 62. It is preferable that the transmitter 46 be attached to a centrally located dimmer 16 of a dimmer set to facilitate transmission of the IR signal to each of the dimmers 16 of the set.

[0035] The attachment bracket 60 includes a generally planar support portion 64 for supporting the printed wire board 56 and enclosure 48. The support portion includes slots 66 for receipt of tabs 68 of enclosure 48 for removably attaching of enclosure 48 to the attachment bracket 60. The attachment bracket 60 further includes position-

ing clips 70 extending generally perpendicularly to the plane of the support portion 64. As best seen in Figures 4 and 5, the clips 70 are received by sidewalls 72 of the dimmer back cover 62. The primary function of the positioning clips is to center the transmitter 46 with respect to the dimmer 16 as seen in Figure 5.

[0036] The attachment bracket also includes mounting clips 74 that provide the primary means of attaching the transmitter 46 to the dimmer 16. The attachment bracket 60 further includes a second set of clips 74 having a U-shaped cross section forming a channel 76. The clips 74 extend from an extension 78 of the support portion 64 oppositely from clips 70. As best seen in Figure 5, the clips 74 engage a yoke 80 of dimmer 16 such that an end portion 82 of the yoke is received in the channels 76 of clips 74. As seen in Figure 5, the attachment and positioning of the transmitter 46 provided by clips 70 and 74 of attachment bracket 60 orients the enclosure 48 adjacent the back cover 62. This construction facilitates blasting of IR signals into the dimmer 16 through the back cover.

[0037] The use of an electrically conductive material for the attachment bracket 60 provides for use of the attachment bracket to ground the IR transmitter to the wallbox through the yoke 80. This construction eliminates the need for a separate grounding wire to make the grounding connection within the wallbox.

[0038] Referring to Figures 6A-F the construction of the enclosure 48 is shown in greater detail. As best seen in Figures 6A and 6D, the enclosure includes a pair of rounded notches 84 in one side to provide for passage of the traveler wires 42A, 44A through the enclosure 48. The location of the notches along the lower edge of the enclosure 48 provides for securement of the enclosure to the attachment bracket 60 with the conductive leads 54 engaging the legs of the terminals 50. The enclosure 48 also includes posts 86 that, as best seen in Figure 6D, extend downwardly from the enclosure. The posts engage locating holes 87 that are provided in the printed wire board 56 (best seen in Figure 3).

[0039] The posts 86 serve two primary functions. They serve to temporarily locate the printed wire board 56 within the enclosure 48 while the enclosure 48 is being snapped into position on the attachment bracket 60. The posts 86 also serve to prevent the LEDs 58A-58D mounted on the printed wire board 56 from striking the enclosure 48. As seen in Figure 6D, the enclosure includes shoulder portions surrounding each of the posts 86 that serve to maintain separation between the LEDs 58A-58D and the upper portion of enclosure 48.

[0040] The enclosure 48 further includes a central rib 89 extending transversely across the enclosure. The central rib 89, acting in conjunction with the shoulder portions of the posts 86, serves to pin the printed wire board 56 between the enclosure 48 and the attachment bracket 60 when the tabs 68 engage the slots 66. This prevents the printed wire board 56 from floating within the enclosure 48. The central rib 89 also acts in conjunction with

the shoulder portions of the posts 86 to prevent the LEDs 58A-58D from striking the enclosure 48. The transversely extending central rib 89 further serves to bisect the enclosure 48 thereby providing for additional electrical isolation between the leads 54 of traveler wires 42A, 44A.

[0041] As best seen in Figures 6A-6D and in Figures 7 and 8, the enclosure 48 includes a pair of indented portions 88 extending inwardly from an upper portion 90 of the enclosure. Each of the indented portions includes generally planar first and second legs 92 and 94, respectively. As best seen in Figure 8, the angle of the first leg 92 with respect to the upper portion 90 is less than the angle of the second leg 94 such that the first leg 92 is longer than the second leg 94. The indented portions 88 are located on the enclosure 48 such that when the enclosure is secured to the printed wire board 56, the LEDs 58A-58D are located below the first leg 92. This is best seen in Figures 7 and 8.

[0042] The inclusion of the indented portions 88 of enclosure 48 serves to direct the IR radiation blasted from the LEDs 58A-58D. The direction of the IR emitted from the transmitter 46 is further enhanced by the construction of the LEDs 58A-58D. As illustrated in Figure 9, in which LED 58A is shown, the LEDs are constructed to emit an upwardly directed cone of IR radiation with respect to the plane of the printed wire board 56, having a half-angle of 30 degrees. As the cone of IR light strikes the first leg 92 of the indented portion 88, the majority of the IR light, approximately 80 percent, is reflected parallel to the plane of the printed wire board 56 through one of the opposite ends of the elongated enclosure 48. A minority of the IR light, approximately 20 percent, passes vertically through the first leg 92. Directing the IR radiation in this manner facilitates blasting the IR signal into outwardly located dimmers 16 when the IR transmitter is secured to a centrally located dimmer of a set of dimmers.

[0043] Turning to Figure 10, a wiring schematic is shown for LEDs 58A-58D. As may be seen, the diodes are arranged in two sets of diodes that are connected in parallel with one another. LEDs 58A and 58C form the first set and LEDs 58B and 58D form the second set. The LEDs are connected in the electrical circuit such that the polarity of the LEDs of the first set is reversed from the polarity of the second set. This "anti-parallel" connection of the two sets of LEDs ensures that one of the sets will operate to generate infrared signals regardless of which of the terminals 50 the respective traveler wires 42A and 44A are connected to. In this manner, the connection of traveler wires is rendered polarity insensitive such that IR signals will be directed out of the opposite ends of the elongated enclosure regardless of the connection chosen.

[0044] Referring to Figures 11-13, the present invention provides for an improved power supply system for the IR transmitters. As seen in Figure 11, the power supply for the master control system 10 includes a power supply circuit 100 that includes a power supply capacitor 102. The traveler wires 42, 44 that extend from the master

control 12 will typically be at 120 volts with respect to ground. As shown in Figure 11, the voltage required to drive the LEDs 58A-58D of transmitter 46 will be provided by a separate 13-volt supply. This 13-volt supply is used to power the IR LEDs 58A-58D, drive a 5-volt regulator 104 and supply current pulses that operate drivers 106 for the LEDs.

[0045] The present invention provides an improved filter 108, shown enclosed by dotted lines in Figure 11, for running the LED drivers 106. Referring to Figure 12, a filtering resistor 110 and capacitor 112 are included in the filter 108. The use of a resistor/capacitor (R-C) network is the conventional manner of running noisy circuitry such as the LED drivers from a main power supply capacitor such as capacitor 102. However, an R-C network alone would fail to protect the main power supply capacitor against sharp current spikes caused by the operation of the LED drivers. The lack of isolation between the two capacitors provided by an R-C network would result in charge being pulled from the main power supply capacitor as well as the filter capacitor. As a result, the performance of the main power supply could be degraded.

[0046] The improved filter 108 of the present invention includes a diode 114 which serves to limit the amount of current that can be drawn by the LED drivers 106 directly from the main supply capacitor 102. The diode 114 is placed in parallel with the resistor 110. The inclusion of the diode has no effect on the filtering performance of the R-C network. Referring to Figure 13, the graphs illustrate the effect that the addition of the diode has on the power supply line. The inclusion of the diode 114 serves to limit the amount of charge that may be drawn from the main supply capacitor 102. As shown in Figure 13, the inclusion of the diode 114 serves to reduce the voltage spikes that would otherwise appear on the power supply line.

[0047] Referring now to the schematic illustrations of Figures 14 and 15, the dimmer control system 10 provides for toggling of the control system 10 between two modes of operation. Each of the dimmers 16 is capable of receiving IR signals through the IR window 24 from in front of the dimmer. Each of the dimmers 16 is also capable of receiving IR signals through the back cover 26 in the wallbox behind the dimmer. This creates the possibility of "collisions" between IR signals received by the dimmer both from direct reception of an infrared signal through window 24 (from a handheld remote control, for example) as well as from indirect reception of the signal if the same signal is received by the master control 12 and relayed to the dimmers 16 by the IR transmitter 46.

[0048] Referring to Figure 14 there is shown a first mode, or "room" mode of operation. The "room" mode of operation is useful for situations where collisions between a direct IR signal and an indirect relayed IR signal are possible. Such a situation might occur, for example, where the wallboxes containing the master control 12 and the dimmers 16 are located in the same room. In the room mode, the master control 12 is disabled from relay-

ing an IR signal that is received by the master control 12, from a handheld remote control for example. Although the master control 12 is prevented from relaying a received IR signal, the master control remains enabled to transmit IR signals to the dimmers 16 directly in response to use of the actuators of master control 12 shown in Figure 1.

[0049] Referring to Figure 15, the second or "closet" mode of operation is shown. This mode of operation is useful where the possibility of a collision between a direct IR signal and an indirect retransmitted IR signal is limited. This would occur, for example, where a physical barrier 48 such as a wall, is located between the wallbox of the master control 12 and the wallbox of the dimmers 16. When set to the "closet" mode, the master control is enabled to send IR command signals to the dimmers 16 through the transmitters 46 either in response to use of the actuators of the master control 12 or in response to an IR signal that is received by the master control.

Claims

1. A power supply for an infrared transmitter having at least one LED driver, the power supply comprising:

- a power supply capacitor;
- a filter network comprising a filter capacitor and resistor connected in series with the power supply capacitor for supplying current pulses to the LED driver; and
- a diode connected in parallel with the resistor of the filter network to provide isolation between the filter capacitor and power supply capacitor.

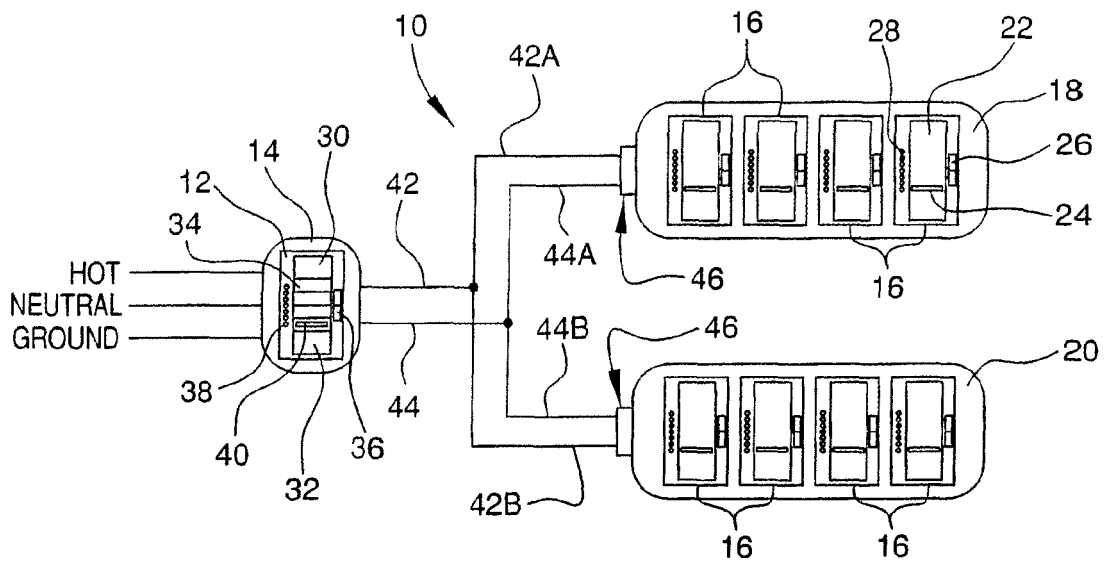


FIG. 1

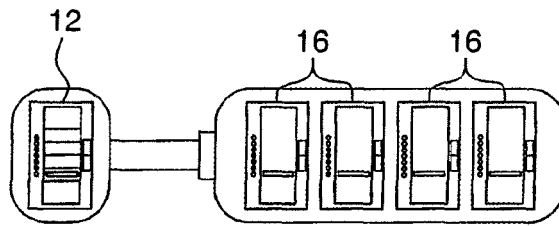


FIG. 14

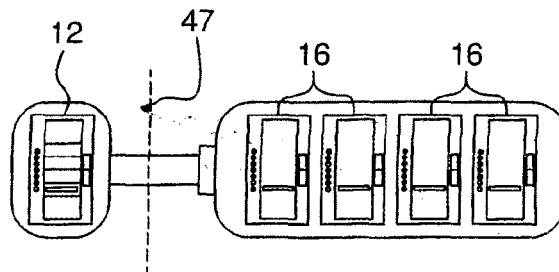


FIG. 15

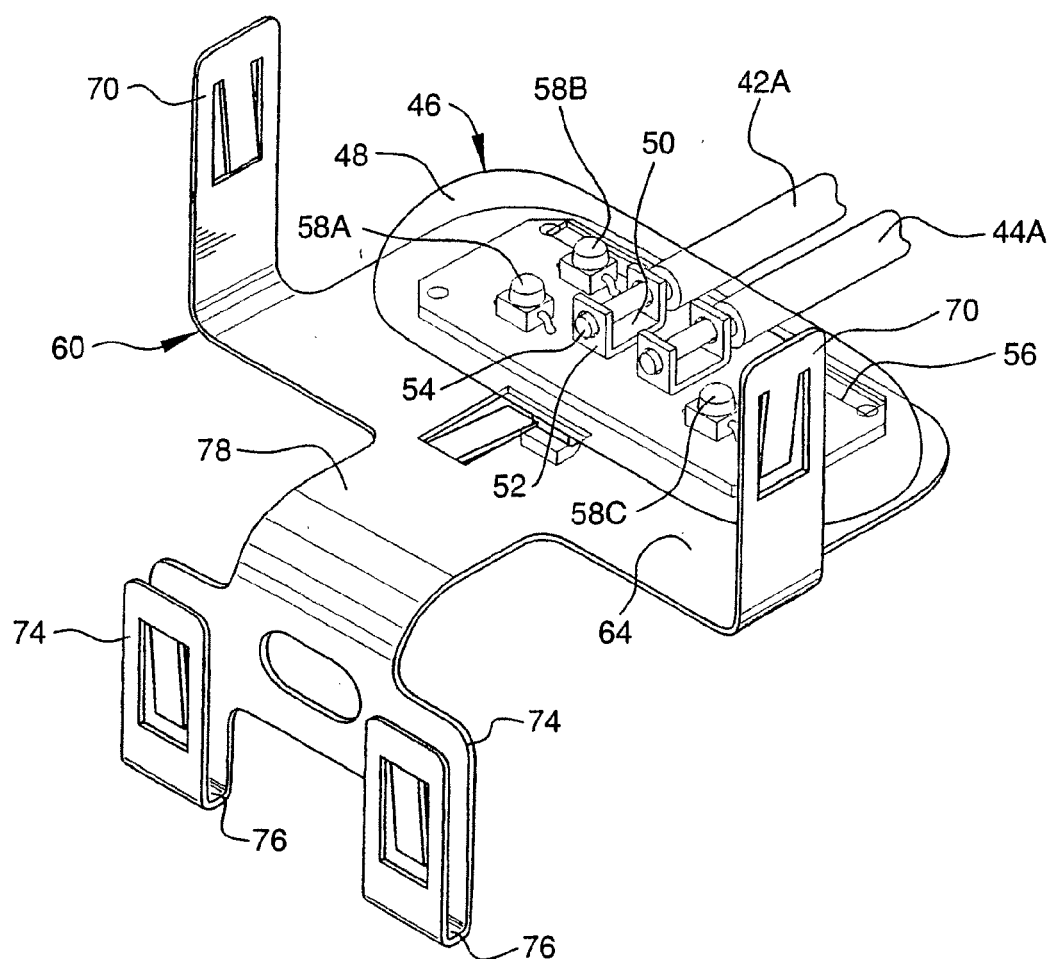


FIG. 2

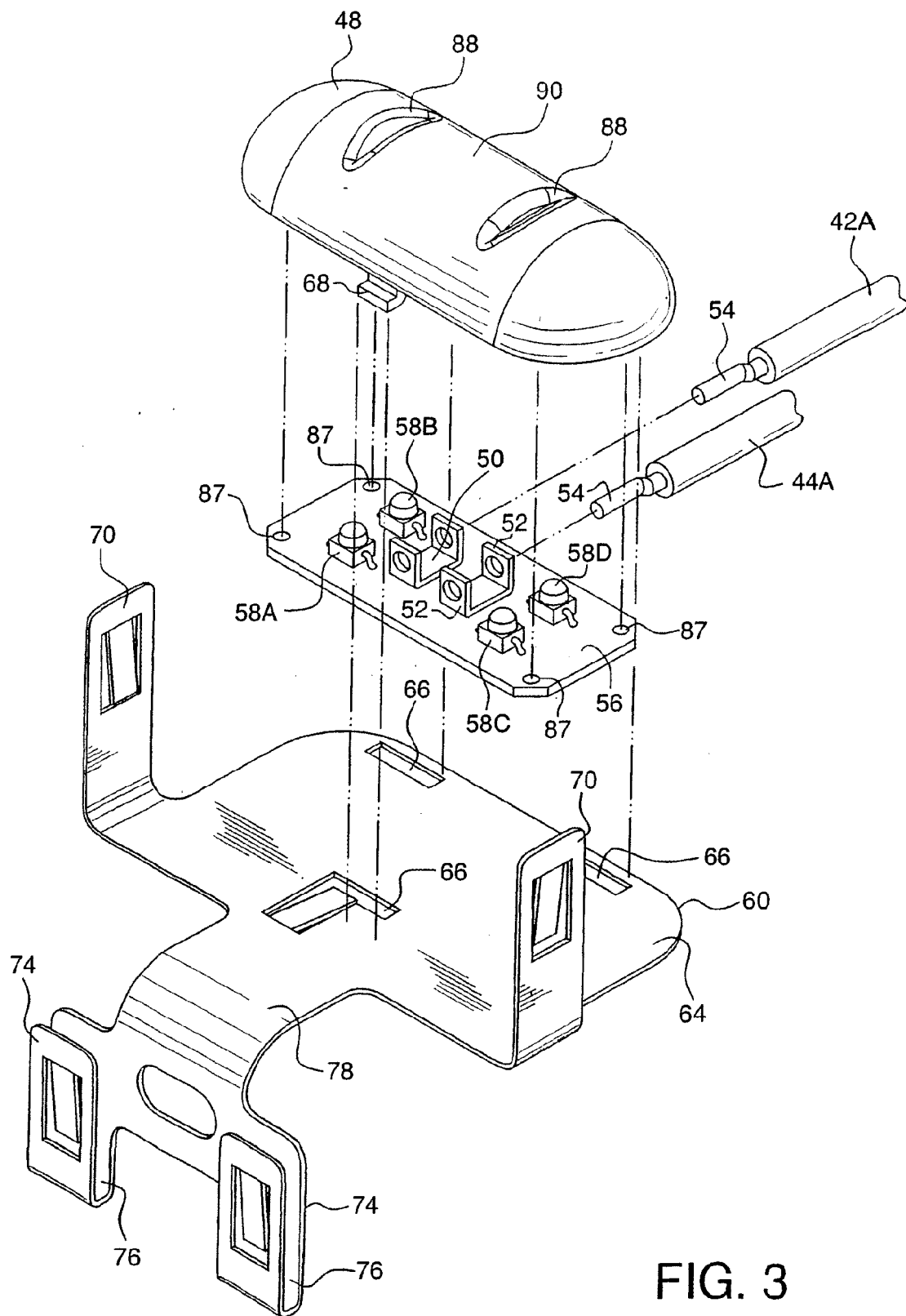


FIG. 3

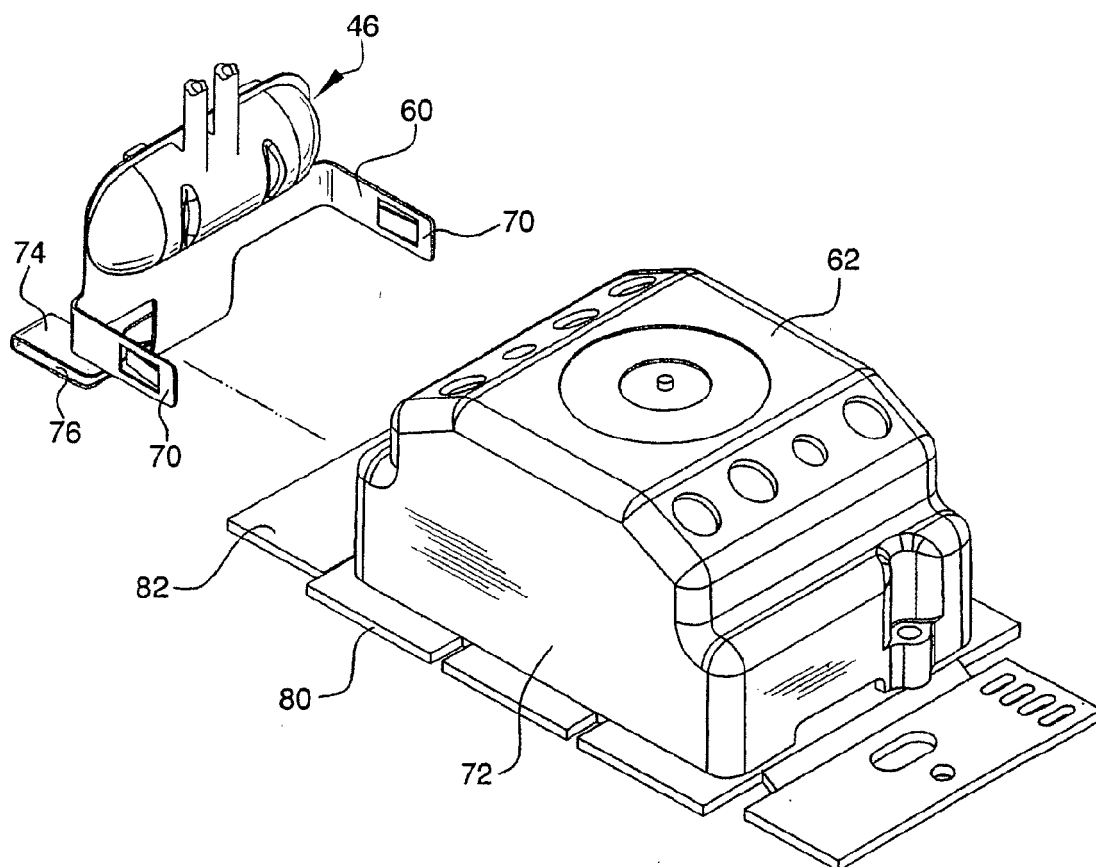


FIG. 4

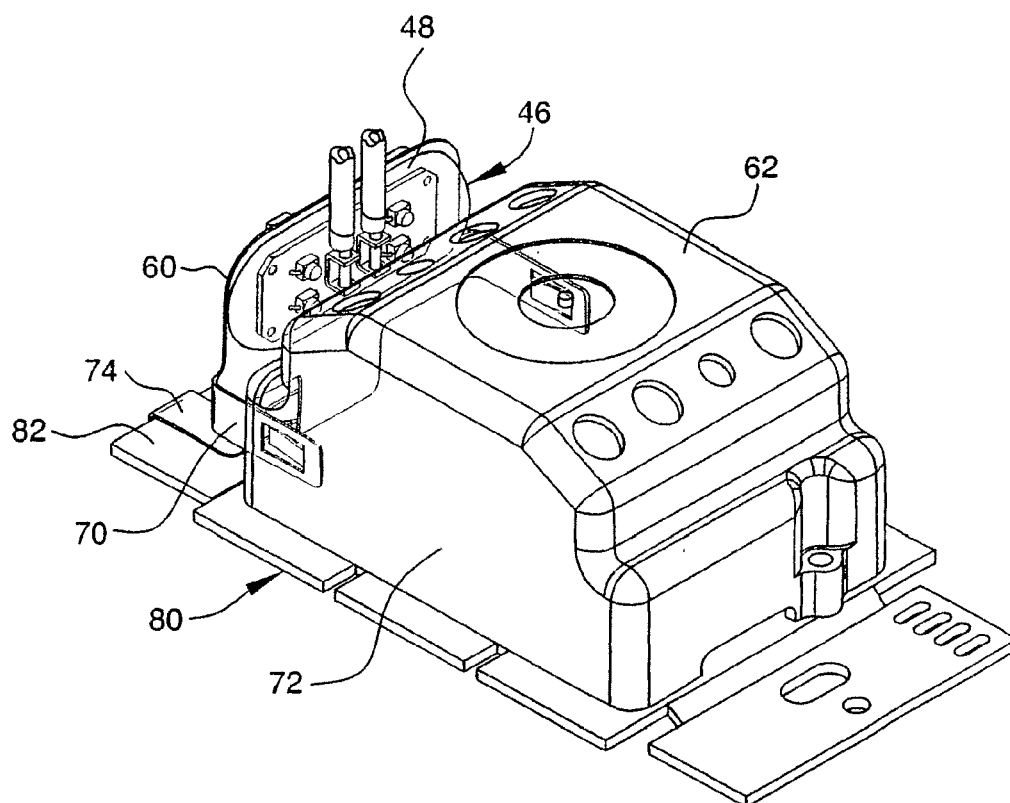


FIG. 5

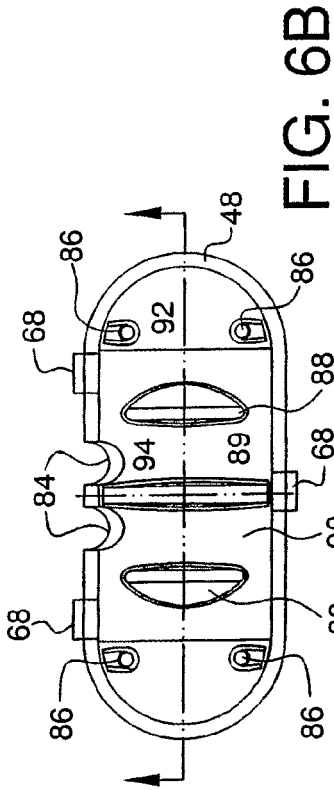


FIG. 6B

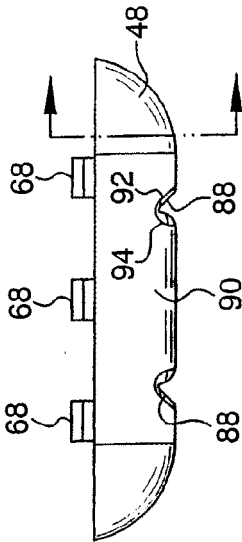


FIG. 6C

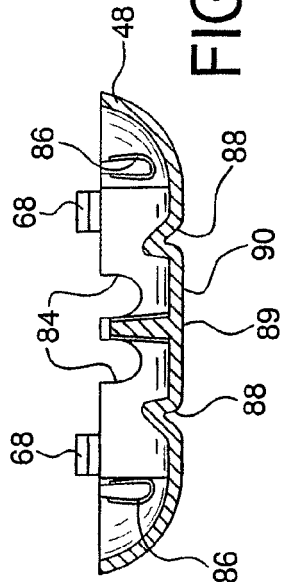


FIG. 6D

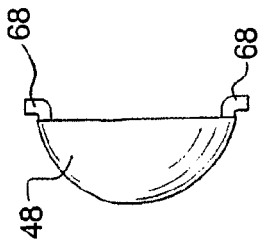


FIG. 6F



FIG. 6E

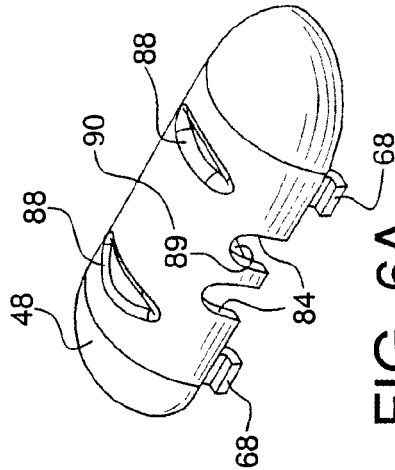


FIG. 6A

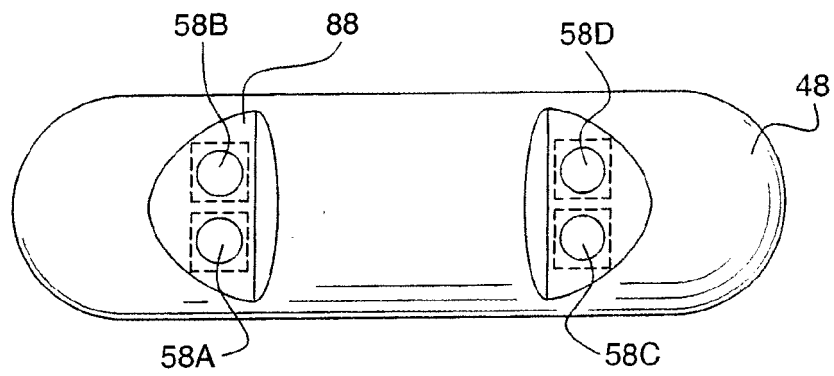


FIG. 7

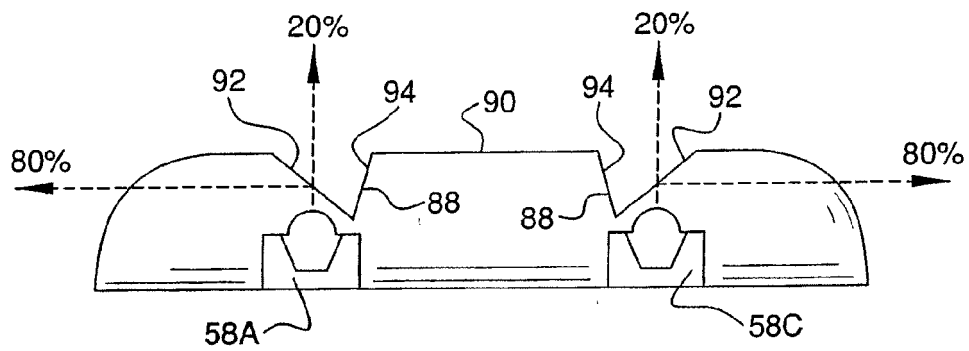


FIG. 8

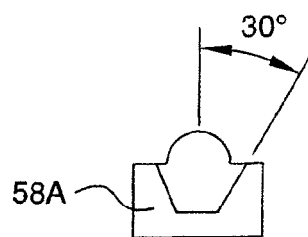


FIG. 9

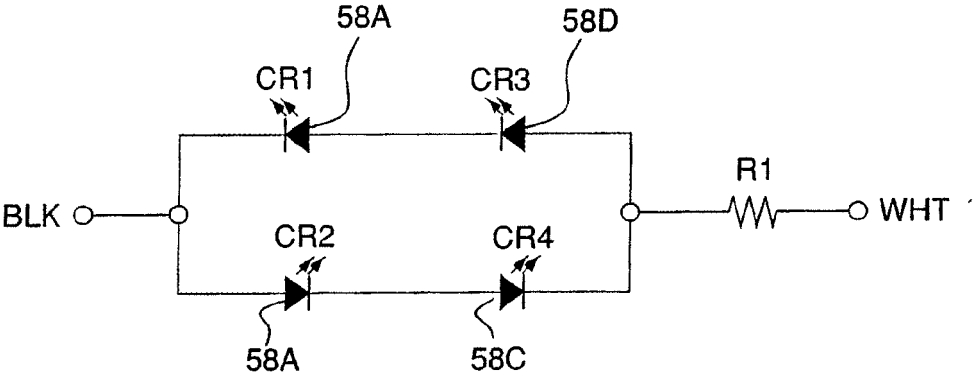


FIG. 10

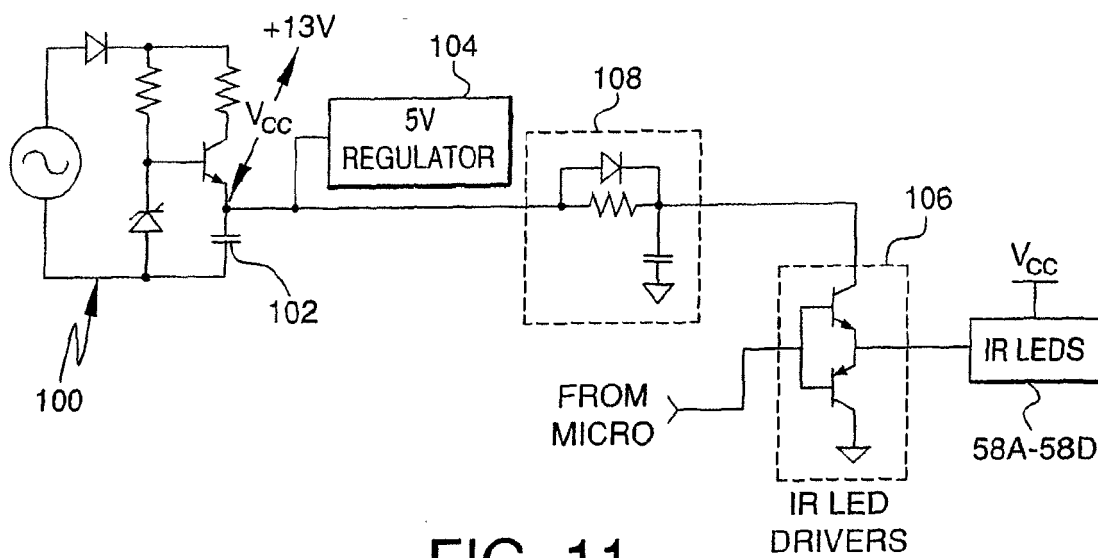


FIG. 11

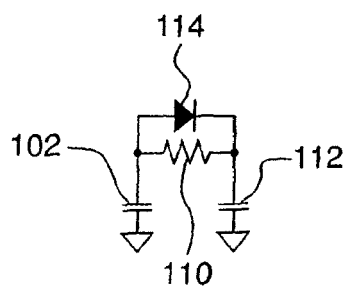


FIG. 12

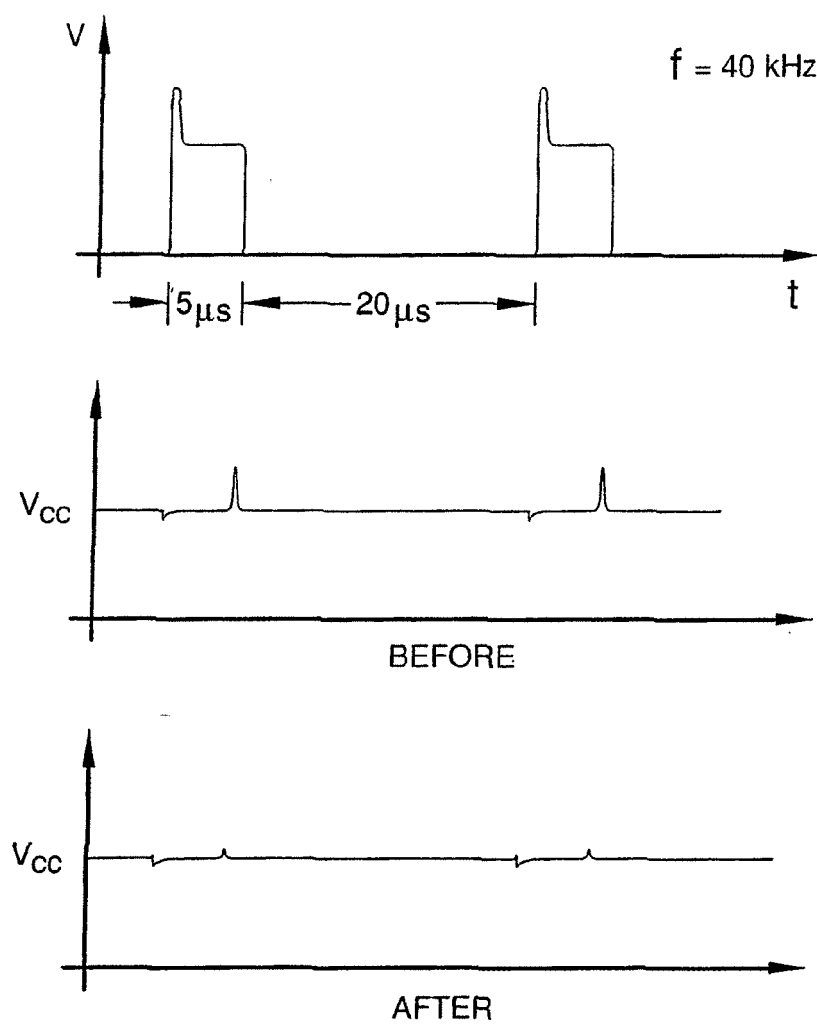


FIG. 13

REFERENCES CITED IN THE DESCRIPTION

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