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(54) Titre : CIRCUIT D'ALIMENTATION CONTROLE A CONDITION DE CHARGE  
 (54) Title: LOAD CONDITION CONTROLLED POWER CIRCUIT

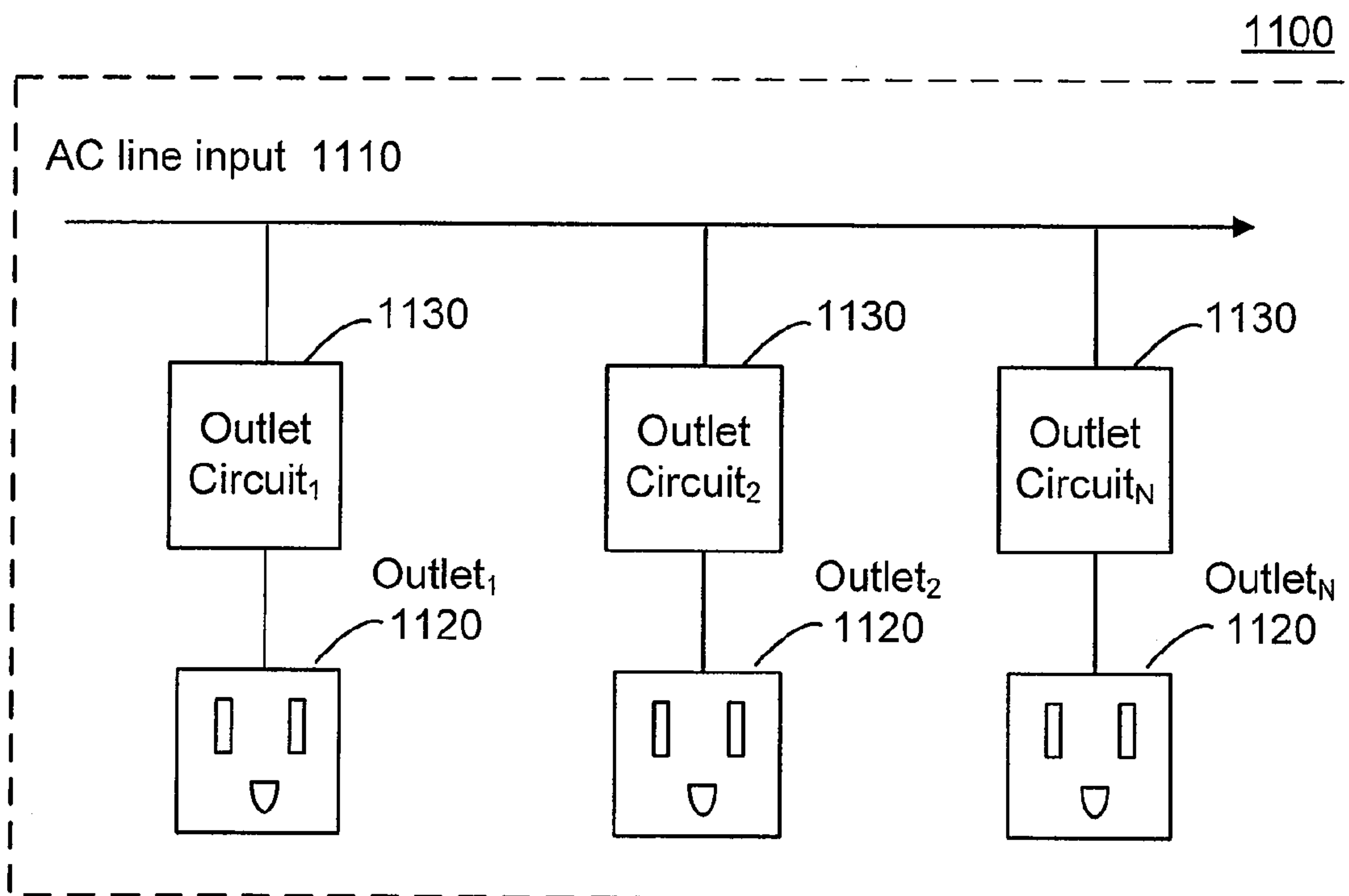


Figure 11A

(57) Abrégé/Abstract:

In accordance with various aspects of the present invention, a method and circuit for reducing power consumption of a power strip, wall outlet system, power module and the like is provided. In an exemplary embodiment, a power circuit is configured for reducing

(57) **Abrégé(suite)/Abstract(continued):**

or eliminating power during idle mode by disengaging an electrical connection from power input. An exemplary power circuit may be in communication with an AC power input, and may include a current transformer, a control circuit, and a switch. The current transformer secondary winding provides an output power level signal proportional to the outlet load. If behavior of the current transformer secondary winding indicates that the power circuit is drawing substantially no power from the AC power input, the switch facilitates disengaging of the current transformer primary from the power circuit.

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(54) Title: LOAD CONDITION CONTROLLED POWER CIRCUIT

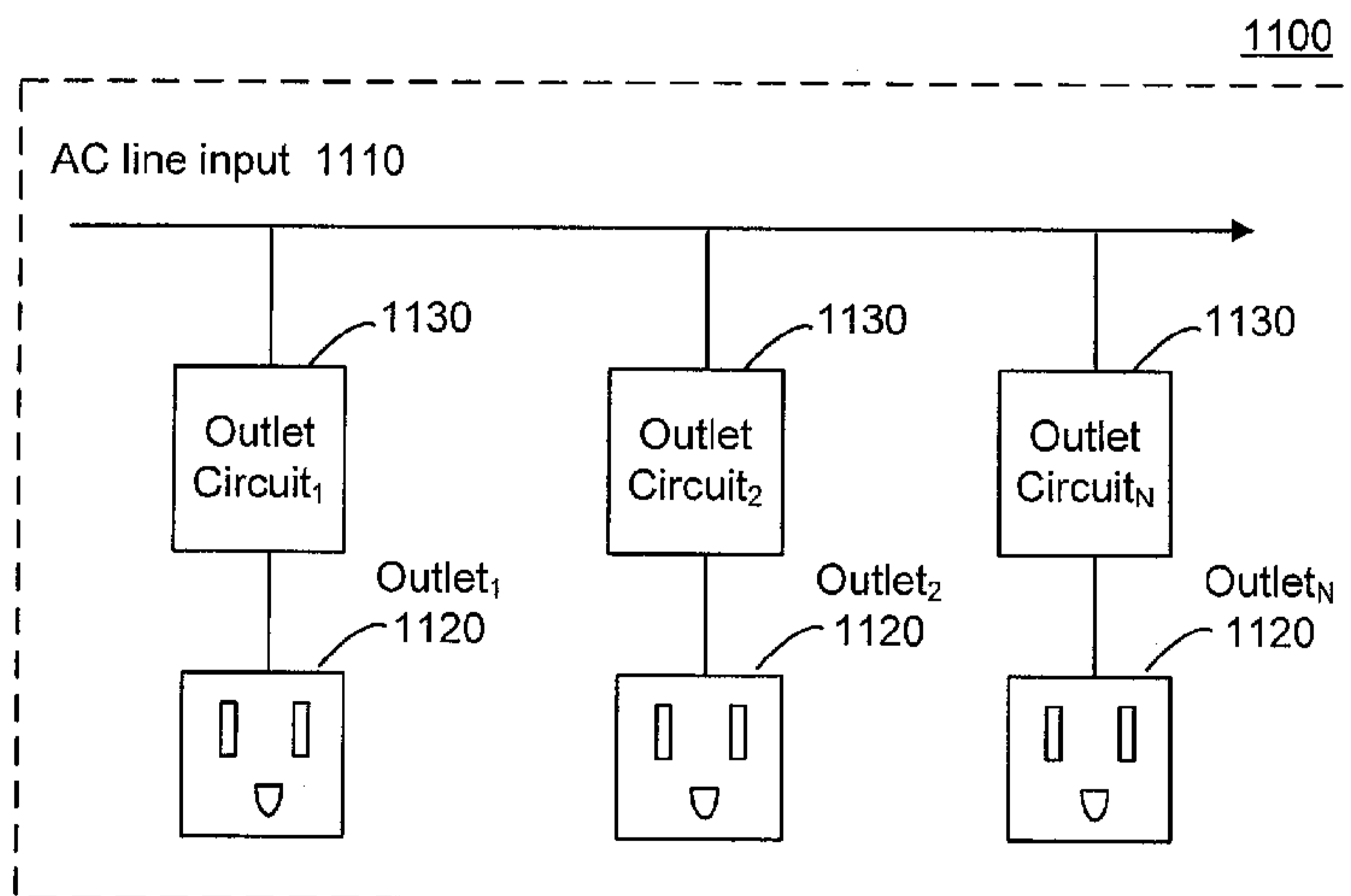


Figure 11A

(57) Abstract: In accordance with various aspects of the present invention, a method and circuit for reducing power consumption of a power strip, wall outlet system, power module and the like is provided. In an exemplary embodiment, a power circuit is configured for reducing or eliminating power during idle mode by disengaging an electrical connection from power input. An exemplary power circuit may be in communication with an AC power input, and may include a current transformer, a control circuit, and a switch. The current transformer secondary winding provides an output power level signal proportional to the outlet load. If behavior of the current transformer secondary winding indicates that the power circuit is drawing substantially no power from the AC power input, the switch facilitates disengaging of the current transformer primary from the power circuit.

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## LOAD CONDITION CONTROLLED POWER CIRCUIT

### Field of Invention

The present invention relates to reducing power consumption in electronic devices. More particularly, the present invention relates to a circuit and method for disengaging an a  
5 power output from a power input in a power module, a wall plate system, and/or a power strip when idle load conditions are present.

### Background of the Invention

The increasing demand for lower power consumption and environmentally friendly consumer devices has resulted in interest in power supply circuits with “green” technology.  
10 For example, on average, a notebook power adapter continuously “plugged in” spends 67% of its time in idle mode. Even with a power adapter which conforms to the regulatory requirement of dissipating less than 0.5 watts/hour, this extended idle time adds up to 3000 watt hours of wasted energy each year per adapter. When calculating the wasted energy of the numerous idle power adapters, the power lost is considerable.

15 Each appliance and power adapter in a commercial or residential building will be plugged into an outlet of a wall plate in some fashion. The standard wall plate has two outlets, though variations exist from a single outlet to more than two outlets. In an office or home environment, a computer, monitor, printer, scanner, and other electronic devices are connected to the wall plate. When not in use, these connected devices will often be left on  
20 and go into self-imposed idle modes that typically consume less than 1 watt per device. Even though each device is consuming standby power, the total power delivered by the wall plate can be as much as the number of outlets used times the idle power, perhaps as great as 4 watts or more. Similarly, power strips are used to multiply the number of AC outlets available from a single AC socket. In an office or home environment, a computer, monitor,  
25 printer, scanner, and other electronic devices are often connected to the same power strip. When not in use, these connected devices will often be left on and go into self-imposed idle modes that typically consume less than 1 watt per device. Even though each is consuming standby power, the total power delivered by the power strip can be as much as the number of outlets used times the idle power, perhaps as great as 6 watts or more. This multiplicity of  
30 wasted idle power can be reduced or eliminated if the wall plate or power strip can learn or be programmed to sense the idle condition of each outlet and turn that outlet off if idle conditions are present.

### Summary of the Invention

In accordance with various aspects of the present invention, a method and circuit for reducing power consumption of a power module, wall plate system, power strip and the like during idle conditions is provided. In an exemplary embodiment, a load condition controlled power module may be configured for reducing or eliminating power during idle mode by disengaging at least one power output from a power input. A power module may be connected to one or more power outputs, and a power input which may provide alternating current (AC) to the one or more power outputs. The power module may include a current measuring system, a control circuit, and a switch. The current measuring system provides an output power level signal that is proportional to the load at the power output. In an exemplary embodiment, if behavior of the current measuring system indicates that at least one power output is drawing substantially no power from the AC power input, the switch facilitates disengaging of the power input from such power output.

In an exemplary embodiment, a wall plate system is configured for reducing or eliminating power during idle mode by disengaging at least one outlet from a power input. A wall plate system may include one or more outlets and one or more wall plate circuits, with AC power input connected to the outlets through the wall plate circuit(s). The wall plate circuit may include a current measuring system, a control circuit, and a switch. The current measuring system provides, through the switch, an output power signal that is proportional to the load at the outlet. In an exemplary embodiment, if behavior of the current measuring system indicates that at least one outlet is drawing substantially no power from the AC power input, the switch facilitates disengaging of the power input from such outlet.

The wall plate system may also include both a standard wall plate and circuitry to reduce power during idle mode. The wall plate circuitry may be housed inside and to the rear of a standard wall plate. In another embodiment, the wall plate system may be a wall plate adapter configured to fit over and connect to a standard wall plate. The wall plate adapter may connect to the standard wall plate by plugging into either one or more than one of the outlets of the standard wall plate, and an electronic device can plug into the wall plate adapter instead of the standard wall plate.

In an exemplary embodiment, a power strip is configured for reducing or eliminating power during idle mode by disengaging at least one outlet from a power input. A power strip may include one or more outlets and one or more outlet circuits, with AC power input

connected to the outlets through the outlet circuit(s). The outlet circuit may include a current transformer, a control circuit, and a switch. In an exemplary embodiment, the secondary winding of the current transformer provides an output power level signal that is proportional to the load at the outlet. In an exemplary embodiment, if behavior of the secondary winding of the current transformer indicates that at least one outlet is drawing substantially no power from the AC power input, the switch facilitates disengaging of the primary circuit of the current transformer from such outlet.

#### **Brief Description of the Drawings**

A more complete understanding of the present invention may be derived by referring to the detailed description and claims when considered in connection with the Figures, where like reference numbers refer to similar elements throughout the Figures, and:

FIG. 1 illustrates a block diagram of an exemplary load condition controlled power module in accordance with an exemplary embodiment;

FIG. 2 illustrates a block diagram of an exemplary load condition controlled power module in accordance with an exemplary embodiment;

FIG. 3 illustrates a block diagram of an exemplary load condition controlled power module in accordance with an exemplary embodiment;

FIG. 4 illustrates a circuit diagram of an exemplary control circuit for use within an exemplary load condition controlled power module circuit in accordance with an exemplary embodiment.

FIG. 5A illustrates a block diagram of an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment;

FIG. 5B illustrates another block diagram of an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment;

FIG. 5C illustrates yet another block diagram of an exemplary load condition controlled wall plate system;

FIG. 6 illustrates a block diagram of an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment;

FIG. 7 illustrates a circuit diagram of an exemplary control circuit for use within an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment;

FIG. 8 illustrates a block diagram of an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment;

FIG. 9 illustrates a schematic diagram of an exemplary control circuit for use within an exemplary load condition controlled wall plate system in accordance with an exemplary embodiment; and

FIG. 10 illustrates a drawing of an exemplary load condition controlled wall plate system as an adaptive device in accordance with an exemplary embodiment.

FIG.11A illustrates a block diagram of an exemplary load condition controlled power strip;

FIG. 11B illustrates another block diagram of an exemplary load condition controlled power strip in accordance with an exemplary embodiment;

FIG. 12 illustrates a block diagram of an exemplary load condition controlled power strip in accordance with an exemplary embodiment;

FIG. 13 illustrates a circuit diagram of an exemplary control circuit for use within an exemplary load condition controlled power strip in accordance with an exemplary embodiment; and

FIG. 14 illustrates a block diagram of an exemplary load condition controlled power strip in accordance with an exemplary embodiment.

#### **Detailed Description of Exemplary Embodiments of the Invention**

The present invention may be described herein in terms of various functional components and various processing steps. It should be appreciated that such functional components may be realized by any number of hardware or structural components configured to perform the specified functions. For example, the present invention may employ various integrated components, such as buffers, current mirrors, and logic devices comprised of various electrical devices, for example, resistors, transistors, capacitors, diodes and the like, whose values may be suitably configured for various intended purposes. In addition, the present invention may be practiced in any integrated circuit application. However for purposes of illustration only, exemplary embodiments of the present invention will be described herein in connection with a sensing and control system and method for use with power strip circuits, power modules, outlets, and the like. Further, it should be noted that while various components may be suitably coupled or connected to other components within exemplary circuits, such connections and couplings can be realized by direct connection between components, or by connection through other components and devices located thereinbetween.



### Power Module

Various embodiments are possible of a power module configured for reducing or eliminating power during idle mode. In an exemplary embodiment, a circuit for implementing the power module is integrated into or otherwise a part of a larger device and controls power input to the larger device based on various load conditions. In another exemplary embodiment, the power module is a component that could be removable or fixed as part of an electronic device. The power module may be a printed circuit board, a potted block, an integrated circuit, a MEMS device, or any other structure configured for implementation in a larger device or system. In another exemplary embodiment, the power module may be within a housing configured to facilitate simple installation of the power module. This embodiment may be added to existing electrical devices.

In accordance with various aspects of the present invention, a power module configured for reducing or eliminating power during idle mode by disengaging a power input is disclosed. In an exemplary embodiment, and with reference to Figure 1, a power module 100 comprises a power input 110, a power output 120 and a power module circuit 130. Accordingly, power module 100 can comprise any configuration of system where a power input is received, power is provided at a power output, and a circuit disengages the power provided to the power output in order to reduce power consumption.

In an exemplary embodiment, power input 110 and power output 120 are 3-pin or 2-pin plugs or receptacles. In another exemplary embodiment, power input 110 and power output 120 comprise flying leads for connection to various electrical components. Other connections may be made by terminal strips, spade connectors, or fixed connectors mounted on a printed circuit board. However, power input 110 and power output 120 can be suitably configured in any other input and/or output configuration. Furthermore, power input 110 may be connected to a 110 volt or 220 volt power source in an exemplary embodiment.

In an exemplary embodiment, power module 100 comprises power input 110 communicatively coupled to power module circuit 130, which in turn is communicatively coupled to power output 120 as shown in Figure 2. Power output 120 may also be connected or otherwise coupled to a ground line and a neutral line in one embodiment. The power module circuit 130 comprises a current measuring system 231, a control circuit 232, and a switch 233. In an exemplary embodiment and for illustration purposes, current measuring system 231 comprises a current transformer 231 having a primary circuit and a secondary winding. However, current measuring system 231 may also comprise a resistor

with a differential amplifier, a current sensing chip, a Hall-effect device, or any other suitable component configured to measure current as now known or hereinafter devised. Current transformer 231 provides an output power level signal to control circuit 232 that is proportional to the load at power output 120. Furthermore, switch 233 connects the primary  
5 circuit of current transformer 231 to power output 120.

In an exemplary embodiment, control circuit 232 may comprise at least one of, or a combination of: a latching circuit, an analog circuit, a state machine, and a microprocessor. In one embodiment, control circuit 232 monitors the condition of the secondary winding of current transformer 231 and controls the operation of switch 233. Furthermore, in an  
10 exemplary embodiment, control circuit 232 receives a low frequency or DC signal from current transformer 231. The low frequency signal, for example, may be 60 Hz. This low frequency or DC signal is interpreted by control circuit 232 as the current required by the load at power output 120.

Control circuit 232 can comprise various structures for monitoring the condition of  
15 the secondary winding of current transformer 231 and controlling the operation of switch 233. In an exemplary embodiment and with reference to Figure 3, control circuit 232 includes a current sensor 301 and a logic control unit 302. Current sensor 301 monitors the output of a current measuring system, such as for example, the secondary winding of current transformer 231, which is an AC voltage proportional to the load current. Also, current  
20 sensor 301 provides a signal to logic control unit 302. In one embodiment, the signal may be a DC voltage proportional to the current monitored by current sensor 301. In another embodiment, the signal may be a current proportional to the current monitored by current sensor 301.

In an exemplary embodiment, logic control unit 302 is powered by an energy storage  
25 capacitor. Logic control unit 302 may briefly connect the storage capacitor to power input 110 in order to continue powering logic control unit 302. In another embodiment, logic control unit 302 may be powered by a battery or other energy source. This energy source is also referred to as housekeeping or hotel power; it functions as a low auxiliary power source. In one embodiment, auxiliary power is taken from power input 110. For further  
30 detail on similar current monitoring, see U.S. Provisional Application 61/052,939, entitled "Circuit and Method for Ultra-Low Idle Power", hereby incorporated by reference.

In an exemplary embodiment, logic control unit 302 is a microprocessor capable of being programmed prior to, and after integration of power module 100 in an electronic

device. In one embodiment, a user is able to connect to logic control unit 302 and customize the parameters of power module 100. For example, a user may set the threshold level and a sleep mode duty cycle of power module 100. Data from power module 100 could be transmitted regarding, for example, the historical power consumption and/or energy saved.

5 The bidirectional data transfer between power module 100 and a display device may be achieved through a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal. The data transfer may also be achieved using a wired connection, such as for example, a USB connection or other similar connection.

In accordance with an exemplary embodiment, control circuit 232 may further  
10 comprise a power disconnect 303 in communication with logic control unit 302. Power disconnect 303 is configured to isolate logic control unit 302 from power input 110 and reduce power loss. While isolated, logic control unit 302 is powered by the storage capacitor or other energy source and logic control unit 302 enters a sleep mode. If the storage capacitor reaches a low power level, power disconnect 303 is configured to  
15 reconnect logic control unit 302 to power input 110 to recharge the storage capacitor. In an exemplary embodiment, power disconnect 303 is able to reduce the power loss from a range of microamperes of leakage current to a range of nanoamperes of leakage current.

In another exemplary embodiment, control circuit 232 receives a control signal that is impressed upon power input 110 by another controller. The control signal may be, for  
20 example, the X10 control protocol or other similar protocol. Control circuit 232 may receive the control signal through the secondary winding of current transformer 231, from a coupled power input 110, or any other suitable means configured to couple power input 110 to control circuit 232 as now known or hereinafter devised. This control signal may come from within power module 100 or may come from an external controller. The control signal  
25 may be a high frequency control signal or at least a control signal at a frequency different than the frequency of power input 110. In an exemplary embodiment, control circuit 232 interprets the high frequency control signal to engage or disengage switch 233. In another embodiment, an external controller may transmit a signal to turn power module 100 to an “on” or “off” condition.

30 In an exemplary embodiment, if behavior of the secondary winding of current transformer 231 indicates that power output 120 is drawing substantially no power from power input 110, switch 233 facilitates or controls disengaging of the primary circuit of current transformer 231 from power output 120. In other words, switch 233 facilitates the

disengaging of a power source from power outlet 120. In an exemplary embodiment, the secondary winding of current transformer 231 is monitored for an AC waveform at the AC line frequency of power input 110, where the AC waveform has an RMS voltage proportional to the load current passing through the primary circuit of current transformer 231 to power output 120. In another embodiment, the AC waveform is rectified and filtered to generate a DC signal before being received by control circuit 232. The DC signal is proportional to the load current passing through the primary circuit of current transformer 231 to power output 120.

In one embodiment, the phrase “substantially no power” is intended to convey that the output power is in the range of approximately 0 – 1% of a typical maximum output load. In an exemplary embodiment, switch 233 is configured to control the connection of the primary circuit of current transformer 231 to power output 120 and comprises a switching mechanism to substantially disengage the primary circuit of current transformer 231 from power output 120. Switch 233 may comprise at least one of a relay, latching relay, a TRIAC, and an optically isolated TRIAC.

By substantially disabling the primary circuit of current transformer 231, the power consumption at power output 120 is reduced. In one embodiment, substantially disabling power output 120 is intended to convey that the output signal of the secondary winding of current transformer 231 has been interpreted by control circuit 232 as sufficiently low so that it is appropriate to disengage switch 233 and remove power from power output 120.

In another exemplary embodiment, and with reference to Figures 2 and 3, power module circuit 130 further comprises a reconnection device 234, which is configured to enable the closure of switch 233 through logic control unit 302. The closure of switch 233 reconnects power output 120 to the primary circuit of current transformer 231 and power input 110. In an exemplary embodiment, reconnection device 234 comprises a switch device that may be closed and opened in various manners. For example, reconnection device 234 can comprise a push button that may be manually operated. In one embodiment, the push button is located on the face of power module 100. In another embodiment, reconnection device 234 is affected remotely by signals traveling through power input 110 that control circuit 232 interprets as on/off control. In yet another embodiment, reconnection device 234 is controlled by a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal.

In an exemplary embodiment, and with reference to Figures 3 and 4, power module circuit 130 further comprises a reconnection device memory state 304. Reconnection device memory state 304 is configured to indicate whether reconnection device 234 was recently activated so that logic control unit 302 can determine the circuit conditions upon power up.

5 In the exemplary embodiment, reconnection device memory state 304 comprises a capacitor C5, which charges when reconnection device 234 is activated. Logic control unit 302 can then measure the voltage on capacitor C5 as an indication of whether reconnection device 234 was activated. In one exemplary embodiment, reconnection device memory state 304 provides a digital reading to the PB1 input of logic control unit 302. If there is sufficient

10 voltage at capacitor C5, the PB1 input reads a "1". If there is insufficient voltage at capacitor C5, the PB1 input reads a "0". The determination of what voltage is sufficient is dependent in part on the ratio of resistors R6 and R7 and can be interpreted by logic control unit 302, as would be known to one skilled in the art. Capacitor C5 serves to store the state of reconnection device 234 until the voltage of capacitor C5 can be read by logic control

15 unit 302.

In accordance with another exemplary embodiment, switch 233 is automatically operated on a periodic basis. For example, switch 233 may automatically reconnect after a few or several minutes or tens of minutes, or any period more or less frequent. In one embodiment, switch 233 is automatically reconnected frequently enough that a battery

20 operated device connected to power module 100 will not completely discharge internal batteries during a period of no power at the input to the connected device. After power output 120 is reconnected, in an exemplary embodiment, power module circuit 130 tests for or otherwise assesses load conditions, such as the power demand at power output 120. If the load condition on power output 120 is increased above previously measured levels, power

25 output 120 will remain connected to the primary circuit of current transformer 231 until the load condition has returned to a selected or predetermined threshold level indicative of a "low load". In other words, if the power demand at power output 120 increases, power is provided to power output 120 until the power demand drops and indicates a defined idle mode. In an exemplary embodiment, the determination of load conditions at re-connect are

30 made after a selected time period had elapsed, for example after a number of seconds or minutes, so that current inrush or initialization events are ignored. In another embodiment, the load conditions may be averaged over a selected time period of a few seconds or minutes so that short bursts of high load average out. In yet another exemplary embodiment, power

module 100 comprises a master reconnection device that can re-engage all power outputs 120 to power input 110.

In an exemplary method of operation, power module 100 has switch 233 closed upon initial power-up, such that power flows to power output 120. When load conditions at power output 120 are below a threshold level, control circuit 232 opens switch 233 to create an open circuit and disengage power output 120 from the input power signal. This disengaging effectively eliminates any idle power lost by power output 120. In one embodiment, the threshold level is a predetermined level, for example approximately one watt of power or less flowing to power output 120.

In an exemplary embodiment, different power outputs 120 may have different fixed threshold levels such that devices having a higher power level in idle may be usefully connected to power module 100 for power management. For example, a large device may still draw about 5 watts during idle, but would never be disconnected from power input 110 if the connected power output 120 had a threshold level of about 1 watt. In various embodiments, certain power outputs 120 may have a higher threshold levels to accommodate high power devices, or lower threshold levels for lower power devices.

In another embodiment, the threshold level is a learned level. The learned level may be established through long term monitoring by control circuit 232 of load conditions at power output 120. A history of power levels is created over time by monitoring and may serve as a template of power demand. In an exemplary embodiment, control circuit 232 examines the history of power levels and decides whether long periods of low power demand were times when a device connected at power output 120 was in a low, or lowest, power mode. In an exemplary embodiment, control circuit 232 disengages power output 120 during low power usage times when the period of low power matches the template. For example, the template might demonstrate that the device draws power through power output 120 for eight hours, followed by sixteen hours of low power demand.

In another exemplary embodiment, control circuit 232 determines the approximate low power level of the electronic device connected at power output 120, and sets a threshold level to be a percentage of the determined approximate low power level. For example, control circuit 232 may set the threshold level to be about 100-105% of the approximate low power level demand. In another embodiment, the threshold demand may be set at about 100-110% or 110-120% or more of the approximate low level power demand. In addition,

the low power level percentage range may be any variation or combination of the disclosed ranges.

Additionally, the learned threshold level can be manually set. In accordance with an exemplary embodiment, a threshold level is set based in part by activating reconnect device 234 for a period of time and measuring a current power level. For example, a user may hold down reconnect device 234 for a few seconds when power module 100 operates in idle mode and measure the power level. The measured power level is used to set the power threshold level. In one exemplary embodiment, the threshold level is set to a measured power level plus an offset value. The offset value can be configured at various power levels. Furthermore, the offset value may be increased or decreased as is suitable for a particular configuration. For example, if the measured threshold is about 1 W, and an offset value of about 0.5 W is used, then the threshold value is about 1.5 W. In an exemplary embodiment, power module 100 is configured to operate in ultra-low idle mode if the load drops below about 1.5 W in this example. Advantageously, the threshold level is set more accurately by manually initiating a power level measurement.

Having disclosed various functions and structures for an exemplary power module configured for reducing or eliminating power during idle mode by disengaging power input, a detailed schematic diagram of an exemplary power module 400 can be provided in accordance with an exemplary embodiment of the present invention. With reference to Figure 4, in an exemplary embodiment of power module 400, power module circuit 130 comprises current transformer 231, current sensor 301, logic control unit 302, power disconnect 303, reconnection device memory state 304, and switch 233.

In one embodiment, current transformer 231 and current sensor 301 combine to measure the current from power input 110 and convert said current to a proportional DC voltage that can be read by logic control unit 302. Furthermore, switch 233 may comprise a latching relay, such as relay coil K1, that provides a hard connect/disconnect of power input 110 to power output 120 after a command from logic control unit 302. Switch 233 alternates between open and closed contacts. Furthermore, switch 233 holds its position until reset by logic control unit 302, and will hold position without consuming any power in a relay coil K1.

In an exemplary embodiment, logic control unit 302 comprises a microcontroller that receives input of the current in the power input line, controls the state of switch 233 and reads or otherwise assesses the state or position of the contacts of reconnection device 234

and switch 233. In addition, logic control unit 302 learns and stores the power profile for an electronic device connected to power output 120. In another exemplary embodiment, power module circuit 130 further comprises reconnection device 234 and reconnection device memory state 304. Reconnection device 234 is activated to turn on power output 120 when power module circuit 130 is first connected to power input 110 or when full power is needed immediately at power output 120. Reconnection device memory state 304 is configured to indicate to logic control unit 302 whether reconnection device 234 was recently activated.

In an exemplary embodiment, power disconnect 303 comprises a network of transistors Q1, Q2, Q3 which are used in conjunction with zener diodes Z1, Z2 to condition power input 110 to a safe level suitable for logic control unit 302 and isolate logic control unit 302 from power input 110. In another embodiment, power disconnect 303 comprises relays in addition to, or in place of, the transistors of the prior embodiment.

Initial connection of power module 400 involves connecting power module 400 to a power source, which may be AC or DC. In an exemplary method, upon initial plug-in of power module 400 to a power source, all circuits of power module circuit 130 are dead and switch 233 is in the last position or state set by logic control unit 302. This initial condition may or may not provide power to power output 120. When all the circuits are dead, there is no current flow into power module circuit 130. This is due to the isolation provided by power disconnect 303 and reconnection device 234 in a normal, open position. In an exemplary embodiment, power disconnect 303 comprises transistors Q1, Q2, Q3 and capacitor C3. In this state, only leakage current will flow through transistors Q1, Q2 and the leakage current will be on the order of approximately tens of nanoamperes. Furthermore, current transformer 231 provides dielectric isolation from primary side to secondary side so that only small leakage current flows due to the inter-winding capacitance of current transformer 231.

With continued reference to Figure 4, in an exemplary embodiment and for illustration purposes, a user may reconnect the circuit using reconnection device 234 to establish a current path through diode D1, zener diode Z1, reconnection device 234, resistor R4, diode D6, and zener diode Z3. Diode D1 serves to half-wave rectify the AC line to drop the peak to peak voltage in half. Zener diode Z1 further reduces the voltage from diode D1, for example to about 20 volts. Zener diode Z3 and resistor R4 form a current limited zener regulator that provides an appropriate DC voltage at the VDD input to logic control unit 302 while reconnection device 234 is held. In addition, capacitor C2 smoothes the DC signal on



zener diode Z3 and provides storage during the contact bounce of reconnection device 234. Capacitor C2 is sized to provide sufficient storage during the start-up time of logic control unit 302, and capacitor C2 in combination with resistor R4 provides a fast rising edge on the VDD input to properly reset logic control unit 302. Furthermore, diode D5 isolates capacitor C2 from capacitor CS so the rise time constant of capacitor C2 and resistor R4 is not affected by the large capacitance of capacitor CS. When capacitor CS is powering logic control unit 302, the current of capacitor CS passes through diode D5. Diode D6 serves to isolate the voltage on capacitor C2 when reconnection device 234 is released. This allows the voltage stored on capacitor C5 during the closed time of reconnection device 234 to be retained when reconnection device 234 is open and inform logic control unit 302 of the open condition.

In an exemplary method, if reconnection device 234 is activated for a few milliseconds, logic control unit 302 is configured to initialize and immediately set up to provide its own power before reconnection device 234 is released. This is accomplished from voltage doubler outputs VD1-VD3 and ZG1 of logic control unit 302. First, output ZG1 is driven high to turn on transistor Q2. With transistor Q2 on, a current path is established through resistor R3 and zener diode Z2 providing a regulated voltage at the drain of transistor Q1. This regulated voltage is similar to that produced by zener diode Z3 and is appropriate for the VDD input of logic control unit 302. Second, after the voltage on zener diode Z2 has stabilized for a few microseconds, outputs VD1-VD3 of logic control unit 302 begin switching to produce a gate drive signal to turn on transistor Q1. The signals produced by outputs VD1-VD3 and components including capacitor C3, transistor Q3, capacitor C4, diode D3 and diode D4 produce a voltage at the gate of transistor Q1 that is about twice the voltage on VDD input of logic control unit 302. This voltage doubling turns transistor Q1 on hard. Once transistor Q1 is on, the voltage at zener diode Z2 charges capacitor CS. In an exemplary embodiment, capacitor CS is a large storage capacitor that is used to power logic control unit 302 when reconnection device 234 is not being activated. After capacitor CS has been charged for a few milliseconds, outputs VD1-VD3 and ZG1 return to a rest state and transistors Q1 and Q2 are turned off. In this embodiment, logic control unit 302 is operating off the stored charge in capacitor CS and not drawing power from power input 110. When reconnection device 234 is no longer active, capacitor CS will continue to power logic control unit 302.

If power output 120 is idling and drawing substantially no power, logic control unit 302 may be able to disengage from drawing power and enter a “sleep” mode. In an exemplary method, and with further reference to Figure 4, when logic control unit 302 is operating from the stored energy in capacitor CS, a timing function is enabled in logic control unit 302 that uses capacitor C6 to perform the timing function. Capacitor C6 is briefly charged by the CAPTIME output of logic control unit 302 and over time capacitor C6 discharge rate will mimic the decay of the voltage on capacitor CS. Once capacitor C6 voltage at input CAPTIME reaches a low level, logic control unit 302 will set the state of outputs VD1-VD3 and ZG1 to again recharge capacitor CS from the AC line. This process repeats over and over so power is never lost to logic control unit 302. The recharge process takes only a few milliseconds or less to operate, depending on the size of capacitor CS.

Furthermore, in an exemplary method, when logic control unit 302 is not busy recharging capacitor CS, switching relay K1, or measuring power drawn from power output 120, logic control unit 302 is operating in a deep sleep mode that stops all, or substantially all, internal activity and waits for capacitor C6 to discharge. This sleep mode consumes very little power and allows the charge on storage capacitor CS to persist for many seconds. If reconnection device 234 is activated during the sleep mode, capacitor C5 will be recharged and logic control unit 302 will resume normal operation and set or reset relay K1. Alternatively, if capacitor C6 voltage falls too low, logic control unit 302 will again recharge capacitor CS and then return to sleep mode.

While an electronic device is in an idle mode, power module 100 may continue to monitor for changes in the power drawn by the electronic device. In an exemplary method, while logic control unit 302 continuously goes in and out of sleep mode to re-power itself, logic control unit 302 will also periodically test the power being drawn from power output 120. The period of power testing is much greater than that of capacitor CS charging and, for example, may be only tested every ten or more minutes. In accordance with an exemplary method, there are at least three possible outcomes from the result of power testing: 1) the device is operating and the switch is not in standby condition, 2) the device is not operating but the switch is not in a standby condition, or 3) the switch is in a standby condition.

For the outcome when the device is operating and the switch is not in a standby condition, relay K1 has been previously set to deliver power to power output 120 and power testing shows an appreciable load current is being drawn by the electronic device connected. An “appreciable load” may be defined by some fixed value programmed into logic control

unit 302, or it may be the result of a number of power tests and be the typical load current for this electronic device. A power test result here will be interpreted as normal conditions and logic control unit 302 will go back into sleep mode cycling until another time period, such as ten minutes, has passed when the power test will be made again. In another  
5 exemplary embodiment, the duration of the sleep mode cycling is determined by a user. For example, a user may set the sleep mode duration to be one, two, or five minutes and may do so using a dial, a digital input, a push button, keypad or any other suitable means now known or hereinafter devised.

For the outcome when the device is not operating but the switch is not in a standby  
10 condition, relay K1 has been previously set to deliver power to power output 120 and power testing shows a negligible load current being drawn by the device connected. The “negligible load” may be some fixed value programmed into logic control unit 302, or it may be the result of a number of power tests and be the typical minimum found for this electronic device. In either case the action taken by logic control unit 302 will be to set  
15 relay K1 to an open condition by using outputs RELAY1-RELAY2 of logic control unit 302 to energize relay coil K1. The state of relay K1 is determined by logic control unit 302 testing for the presence of resistor R5 at RELAY3, since logic control unit 302 may not know the previous state of relay K1, for example, starting from power off state.

For the outcome when the switch is in a standby condition, that is, relay K1 has been  
20 set to remove power from power output 120, logic control unit 302 must set relay K1 to a closed condition to allow AC power to be applied to the power output. In an exemplary method, once relay K1 is set, a period of time is allowed to elapse before the power testing is done. This delay allows for the electronic device attached to power output 120 to initialize and enter a stable operating mode. Power measurements may now be made over  
25 some period of time to determine if the electronic device is in a low or high power state. If a high power state is determined, relay K1 remains set. If a low power state is determined, relay K1 is reset to open condition and power is again removed from power output 120. Also, logic control unit 302 will again begin sleep mode cycling and power testing after a determined time period, for example, every ten minutes.

30 If a user wants to operate a device that is connected to power output 120 and that power output is turned off, in an exemplary embodiment, activating reconnection device 234 will immediately wake logic control unit 302 from sleep mode. Since the wake up was from the activation of reconnection device 234 and not due to power testing or capacitor CS

recharging, logic control unit 302 will immediately set relay K1 to closed position to power the electronic device connected to power output 120.

In addition to the embodiments described above, various other elements may be implemented to enhance control and user experience. One way to enhance user control is to allow a user to select the operating mode of a power output. In an exemplary embodiment, power module 100 further comprises a "Green Mode" switch that enables or disables the "green" mode operation. The green mode switch may be a hard, manual switch or it may be a signal to logic control unit 302. "Green" mode operation is the disengaging of power output 120 from power input 110 when substantially no load is being drawn at power output 120. A user may use the green mode switch to disable green mode operation on various power outputs when desired. For instance, this added control may be desirable on power outputs that power devices with clocks or devices that need to be instantly on, such as a fax machine.

In one embodiment, power module 100 includes LED indicators, which may indicate whether a power output is connected to the power line and drawing a load current. The LED indicators may indicate that whether a power output is active, that is, power is drawn by an electronic device and/or the power output has power available even if an electronic device is not connected. In addition, a pulsing LED may be used to show when power testing is being done or to indicate the "heartbeat" of sleep mode recharging.

In another embodiment, power module 100 comprises at least one LCD display. The LCD display may be operated by logic control unit 302 to indicate the load power being provided to power output 120, for example during times of operation. The LCD may also provide information about the power saved or power consumed by operating power module 100 in or out of a "green" mode. For example, LCD may display the sum total of watts saved during a certain time period, such as the life of power module 100 or in a day.

Various embodiments may also be used to enhance the efficient use of the power module and/or individual power outputs in the power module. One such embodiment is the implementation of a photocell or other optical sensor monitored by logic control unit 302. The photocell determines whether light is present in the location of power module 100 and logic control unit 302 can use this determination to disengage power output 120 depending on the ambient light conditions. For example, logic control unit 302 may disengage power output 120 during periods of darkness. In other words, the power outputs of the power module may be turned off at night. Another example is devices that do not need power if

located in a dark room, such as an unused conference room in an office. Also, the power outputs may be turned off when the ambient light conditions exceed a certain level, which may be predetermined or user determined.

In another embodiment, power module 100 further comprises an internal clock. Logic control unit 302 may use the internal clock to learn which time periods show a high power usage at power output 120. This knowledge may be included to determine when a power output should have power available. In an exemplary embodiment, the internal clock has quartz crystal accuracy. Also, the internal clock does not need to be set to an actual time. Furthermore, the internal clock may be used in combination with the photocell for greater power module efficiency and/or accuracy.

### Wall Plate System

Various embodiments are also possible for a wall plate system configured for reducing or eliminating power during idle mode. In an exemplary embodiment, the wall plate system and associated circuitry is configured for coupling or engagement with a wall plate having one or more outlets. For example, the wall plate system can be housed inside and to the rear of a standard wall plate. This embodiment may be added to existing standard wall plates in residential or commercial locations. In another exemplary embodiment, the wall plate system includes both a standard wall plate and circuitry to reduce power during idle mode. In yet another exemplary embodiment, and with reference to Figure 10 for illustration purposes, a wall plate system as used herein may be defined as a wall plate adapter which is configured to fit over and connect to a standard wall plate. The wall plate adapter may connect to the standard wall plate by plugging into either one or more than one of the outlets of the standard wall plate. In this embodiment, an electronic device can plug into the wall plate adapter instead of the standard wall plate. Other configurations for coupling and/or engaging the wall plate system with electrical outlets are also contemplated within various embodiments of the present invention.

In accordance with various aspects of the present invention, a wall plate system configured for reducing or eliminating power during idle mode by disengaging power input from at least one outlet is disclosed. In an exemplary embodiment, and with reference to Figure 5A, a wall plate system 500 comprises two or more outlets 520 and a wall plate circuit 530. In another exemplary embodiment, wall plate system 500 comprises a single outlet 520 and a single wall plate circuit 530. In yet another exemplary embodiment, and with reference to Figure 5B, wall plate system 500 comprises at least one outlet 520 coupled

with wall plate circuit 530 and at least one outlet 520 directly connected to an AC line input 510. In another exemplary embodiment, and with reference to Figure 5C, wall plate system 500 comprises two or more outlets 520 and two or more wall plate circuits 530, with an individual wall plate circuit configured to control power input to an individual outlet 520.

5 Accordingly, wall plate system 500 can comprise any configuration of system where a power input is received, power is provided at an outlet, and a circuit disengages the power provided to the outlet in order to reduce power consumption.

In an exemplary embodiment, and with reference to Figure 6, wall plate system 500 comprises AC line input 510 communicatively coupled to wall plate circuit 530, which in  
10 turn is communicatively coupled to outlets 520. Outlet 520 is also connected or otherwise coupled to a ground line and a neutral line. Furthermore, AC line input 510 may be connected to a 110 volt or 220 volt power source in an exemplary embodiment. The wall plate circuit 530 comprises a current measuring system 631, a control circuit 632, and a switch 633. In an exemplary embodiment and for illustration purposes, current measuring  
15 system 631 comprises a current transformer 631 having a primary circuit and a secondary winding. However, current measuring system 631 may also comprise a resistor with a differential amplifier, a current sensing chip, a Hall-effect device, or any other suitable component configured to measure current as now known or hereinafter devised. Current transformer 631 provides an output power signal that is proportional to the load at outlet  
20 520. Furthermore, switch 633 connects the primary circuit of current transformer 631 to outlet 520.

In an exemplary embodiment, control circuit 632 may comprise at least one of, or a combination of: a latching circuit, an analog circuit, a state machine, and a microprocessor. In one embodiment, control circuit 632 monitors the condition of the secondary winding of  
25 current transformer 631 and controls the operation of switch 633. Furthermore, in an exemplary embodiment, control circuit 632 receives a low frequency or DC signal from current transformer 631. The low frequency signal, for example, may be 60 Hz. This low frequency or DC signal is interpreted by control circuit 632 as the current required by the load at outlet 520.

30 Control circuit 632 can comprise various structures for monitoring the condition of the secondary winding of current transformer 631 and controlling the operation of switch 633. In an exemplary embodiment, with reference to Figure 7, control circuit 632 includes a current sensor 701 and a logic control unit 702. Current sensor 701 monitors the output of a

current measuring system, such as for example, the secondary winding of current transformer 631, which is an AC voltage proportional to the load current. Also, current sensor 701 provides a signal to logic control unit 702. In one embodiment, the signal may be a DC voltage proportional to the current monitored by current sensor 701. In another  
5 embodiment, the signal may be a current proportional to the current monitored by current sensor 701. In another exemplary embodiment, and with momentary reference to Figure 8, wall plate circuit 530 of the wall plate system comprises a logic control unit 702 that is in communication with, and controls, more than one current transformer 631 and more than one switch 633.

10 In an exemplary embodiment, logic control unit 702 is powered by an energy storage capacitor. Logic control unit 702 may briefly connect the storage capacitor in order to continue powering logic control unit 702. In another embodiment, logic control unit 702 may be powered by a battery or other energy source. This energy source is also referred to as housekeeping or hotel power; it functions as a low auxiliary power source. In one  
15 embodiment, auxiliary power is taken from AC line input 510. For further detail on similar current monitoring, see U.S. Provisional Application 61/052,939, entitled "Circuit and Method for Ultra-Low Idle Power".

In an exemplary embodiment, logic control unit 702 is a microprocessor capable of being programmed prior to, and after integration of wall plate system 500 in an electronic  
20 device. In one embodiment, a user is able to connect to logic control unit 702 and customize the parameters of wall plate system 500. For example, a user may set the threshold level and a sleep mode duty cycle of wall plate system 500. Data from wall plate system 500 could be transmitted regarding, for example, the historical power consumption and/or energy saved. The bidirectional data transfer between wall plate system 500 and a display device may be  
25 achieved through a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal. The data transfer may also be achieved using a wired connection, such as for example, a USB connection or other similar connection.

In accordance with an exemplary embodiment, control circuit 632 may further comprise a power disconnect 703 in communication with logic control unit 702. Power  
30 disconnect 703 is configured to isolate logic control unit 702 from AC line input 510 and reduce power loss. While isolated, logic control unit 702 is powered by the storage capacitor or other energy source and logic control unit 702 enters a sleep mode. If the storage capacitor reaches a low power level, power disconnect 703 is configured to

reconnect logic control unit 702 to AC line input 510 to recharge the storage capacitor. In an exemplary embodiment, power disconnect 703 is able to reduce the power loss from a range of microamperes of leakage to a range of nanoamperes of leakage.

In another exemplary embodiment, control circuit 632 receives a control signal that is impressed upon AC line input 510 by another controller. The control signal may be, for example, the X10 control protocol or other similar protocol. Control circuit 632 may receive the control signal through the secondary winding of current transformer 631, from a coupled AC line input 510, or any other suitable means configured to couple AC line input 510 to control circuit 632 as now known or hereinafter devised. This control signal may come from within wall plate system 500 or may come from an external controller. The control signal may be a high frequency control signal or at least a control signal at a frequency different than the frequency of AC line input 510. In an exemplary embodiment, control circuit 632 interprets the high frequency control signal to engage or disengage switch 633. In another embodiment, an external controller may transmit a signal to turn wall plate system 500 to an “on” or “off” condition.

In an exemplary embodiment, if behavior of the secondary winding of current transformer 631 indicates that outlet 520 is drawing substantially no power from AC line input 510, switch 633 facilitates or controls disengaging of the primary circuit of current transformer 631 from outlet 520. In other words, switch 633 facilitates the disengaging of a power source from outlet 520. In an exemplary embodiment, the secondary winding of current transformer 631 is monitored for an AC waveform at the AC line frequency, where the AC waveform has an RMS voltage proportional to the load current passing through the primary circuit of current transformer 631 to outlet 520. In another embodiment, the AC waveform is rectified and filtered to generate a DC signal before being received by control circuit 632. The DC signal is proportional to the load current passing through the primary circuit of current transformer 631 to outlet 520.

In one embodiment, the phrase “substantially no power” is intended to convey that the output power is in the range of approximately 0 – 1% of a typical maximum output load. In an exemplary embodiment, switch 633 is configured to control the connection of the primary circuit of current transformer 631 to outlet 520 and comprises a switching mechanism to substantially disengage the primary circuit of current transformer 631 from outlet 520. Switch 633 may comprise at least one of a relay, latching relay, a TRIAC, and an optically isolated TRIAC or other switching mechanisms for disengagement.



By substantially disabling the primary circuit of current transformer 631, the power consumption at outlet 520 is reduced. In one embodiment, substantially disabling outlet 520 is intended to convey that the output signal of the secondary winding of current transformer 631 has been interpreted by control circuit 632 as sufficiently low so that it is appropriate to  
5 disengage switch 633 and remove power from outlet 520.

In another exemplary embodiment, wall plate circuit 530 further comprises a reconnection device 634, which is configured to enable the closure of switch 633 through logic control unit 702. The closure of switch 633 reconnects outlet 520 to the primary circuit of current transformer 631 and AC line input 510. In an exemplary embodiment,  
10 reconnection device 634 comprises a switch device that may be closed and opened in various manners. For example, reconnection device 634 can comprise a push button that may be manually operated. In one embodiment, the push button is located on the face of wall plate system 500. In another exemplary embodiment, reconnection device 634 is a wall switch remote to wall plate system 500 to allow a user to re-enable power to an outlet of  
15 wall plate system 500. In another embodiment, reconnection device 634 is affected remotely by signals traveling through AC line input 510 that control circuit 632 interprets as on/off control. In yet another embodiment, reconnection device 634 is controlled by a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal.

In accordance with another exemplary embodiment, switch 633 is automatically  
20 operated on a periodic basis. For example, switch 633 may automatically reconnect after a few or several minutes or tens of minutes, or any period more or less frequent. In one embodiment, switch 633 is automatically reconnected frequently enough that a battery operated device connected to wall plate system 500 will not completely discharge internal  
25 batteries during a period of no power at the input to the connected device. After outlet 520 is reconnected, in an exemplary embodiment, wall plate circuit 530 tests for or otherwise assesses load conditions, such as the power demand at outlet 520. If the load condition on outlet 520 is increased above previously measured levels, outlet 520 will remain connected to the primary circuit of current transformer 631 until the load condition has returned to a  
30 selected or predetermined threshold level indicative of a "low load". In other words, if the power demand at outlet 520 increases, power is provided to outlet 520 until the power demand drops and indicates a defined idle mode. In an exemplary embodiment, the determination of load conditions at re-connect are made after a selected time period had

elapsed, for example after a number of seconds or minutes, so that current inrush or initialization events are ignored. In another embodiment, the load conditions may be averaged over a selected time period of a few seconds or minutes so that short bursts of high load average out. In yet another exemplary embodiment, wall plate system 500 comprises a  
5 master reconnection device that can re-engage all outlets 520 to AC line input 510.

In an exemplary method of operation, wall plate system 500 has switch 633 closed upon initial power-up, such that power flows to outlet 520. When load conditions at outlet 520 are below a threshold level, control circuit 632 opens switch 633 to create an open circuit and disengage outlet 520 from the AC power signal. This disengaging effectively  
10 eliminates any idle power lost by outlet 520. In one embodiment, the threshold level is a predetermined level, for example approximately one watt of power or less flowing to outlet 520.

In an exemplary embodiment, different outlets 520 may have different fixed threshold levels such that devices having a higher power level in idle may be usefully  
15 connected to wall plate system 500 for power management. For example, a large device may still draw about 5 watts during idle, but would never be disconnected from AC line input 510 if the connected outlets 520 had a threshold level of about 1 watt. In various embodiments, certain outlets 520 may have a higher threshold levels to accommodate high power devices, or lower threshold levels for lower power devices.

In another embodiment, the threshold level is a learned level. The learned level may be established through long term monitoring by control circuit 632 of load conditions at outlet 520. A history of power levels is created over time by monitoring and may serve as a template of power demand. In an exemplary embodiment, control circuit 632 examines the  
20 history of power levels and decides whether long periods of low power demand were times when a device connected at outlet 520 was in a low, or lowest, power mode. In an exemplary embodiment, control circuit 632 disengages outlet 520 during low power usage times when the period of low power matches the template. For example, the template might demonstrate that the device draws power through outlet 520 for eight hours, followed by 16 hours of low power demand.

In another exemplary embodiment, control circuit 632 determines the approximate  
30 low power level of the electronic device connected at outlet 520, and sets a threshold level to be a percentage of the determined approximate low power level. For example, control circuit 632 may set the threshold level to be about 100-105% of the approximate low power

level demand. In another embodiment, the threshold demand may be set at about 100-110% or 110-120% or more of the approximate low level power demand. In addition, the low power level percentage range may be any variation or combination of the disclosed ranges.

5 Additionally, the learned threshold level can be manually set. In accordance with an exemplary embodiment, a threshold level is set based in part by activating reconnect device 634 for a period of time and measuring a current power level. For example, a user may hold down reconnect device 634 for a few seconds when wall plate system 500 operates in idle mode and measure the power level. The measured power level is used to set the power threshold level. In one exemplary embodiment, the threshold level is set to a measured  
10 power level plus an offset value. The offset value can be configured at various power levels. Furthermore, the offset value may be increased or decreased as is suitable for a particular configuration. For example, if the measured threshold is about 1 W, and an offset value of about 0.5 W is used, then the threshold value is about 1.5 W. In an exemplary embodiment, wall plate system 500 is configured to operate in ultra-low idle mode if the load drops below  
15 about 1.5 W in this example. Advantageously, the threshold level is set more accurately by manually initiating a power level measurement.

Having disclosed various functions and structures for an exemplary wall plate system configured for reducing or eliminating power during idle mode by disengaging power input, a detailed schematic diagram of an exemplary wall plate system can be provided in  
20 accordance with an exemplary embodiment of the present invention. In an exemplary embodiment and with reference to Figure 9, a wall plate system 900 including wall plate circuit 530 comprises current transformer 631, current sensor 701, logic control unit 702, power disconnect 703, and switch 633.

In one embodiment, current transformer 631 and current sensor 701 combine to  
25 measure the current in AC line input and convert said current to a proportional DC voltage that can be read by logic control unit 702. Furthermore, switch 633 may comprise a latching relay that provides a hard connect/disconnect of AC line input 510 to outlet 520 after a command from logic control unit 702. Switch 633 alternates between open and closed contacts. Furthermore, switch 633 holds its position until reset by logic control unit 702,  
30 and will hold position without consuming any power in a relay coil K1.

In an exemplary embodiment and similar to logic control unit 302, logic control unit 702 comprises a microcontroller that receives input of the current in the AC line, controls the state of switch 633 and reads or otherwise assesses the state or position of the contacts of

reconnection device 634 and switch 633. In addition, logic control unit 702 learns and stores the power profile for an electronic device connected to outlet 520. In another exemplary embodiment, wall plate circuit 530 further comprises reconnection device 634, which is activated to turn on outlet 520 when wall plate circuit 530 is first connected to AC  
5 line input 510 or when full power is needed immediately at outlet 520.

In an exemplary embodiment, power disconnect 703 comprises a network of transistors Q1, Q2, Q3 which are used to condition AC line input 510 to a safe level suitable for logic control unit 702 and isolate logic control unit 702 from AC line input 510. In another embodiment, power disconnect 703 comprises relays in addition to, or in place of,  
10 the transistors of the prior embodiment.

Initial connection of wall plate system 900 involves connecting wall plate system 900 to an AC power source. In an exemplary method, upon initial plug-in of wall plate system 900 to a power source, all circuits of wall plate circuit 530 are dead and switch 633 is in the last position set by logic control unit 702. This initial condition may or may not  
15 provide power to outlet 520. When all the circuits are dead, there is no current flow into wall plate circuit 530. This is due to the isolation provided by power disconnect 703 and reconnection device 634 in a normal, open position. In an exemplary embodiment, power disconnect 703 comprises transistors Q1, Q2, Q3 and capacitor C3. In this state, only leakage current will flow through transistors Q1, Q2 and the leakage current will be on the  
20 order of approximately tens of nanoamperes. Furthermore, current transformer 631 provides dielectric isolation from primary side to secondary side so that only small leakage current flows due to the inter-winding capacitance of current transformer 631.

With continued reference to Figure 9, in an exemplary embodiment and for illustration purposes, a user may reconnect the circuit using reconnection device 634 to  
25 establish a current path through diode D1, zener diode Z1, resistor R4, reconnection device 634 and zener diode Z3. Diode D1 serves to half-wave rectify the AC line to drop the peak to peak voltage in half. Zener diode Z1 further reduces the voltage from diode D1, for example to about 20 volts. Zener diode Z3 and resistor R4 form a current limited zener regulator that provides an appropriate DC voltage at the VDD input to logic control unit 702  
30 while reconnection device 634 is held. In addition, capacitor C2 smoothes the DC signal on zener diode Z3 and provides storage during the contact bounce of reconnection device 634. Capacitor C2 is sized to provide sufficient storage during the start-up time of logic control unit 702, and capacitor C2 in combination with resistor R4 provides a fast rising edge on the

VDD input to properly reset logic control unit 702. Furthermore, diode D5 isolates capacitor C2 from capacitor CS so the rise time constant of capacitor C2 and resistor R4 is not affected by the large capacitance of capacitor CS. When capacitor CS is powering logic control unit 302, the current of capacitor CS passes through diode D5.

5 In an exemplary method, if reconnection device 634 is activated for a few milliseconds, logic control unit 702 is configured to initialize and immediately set up to provide its own power before reconnection device 634 is released. This is accomplished from voltage doubler outputs VD1-VD3 and output ZG1 of logic control unit 702, similar to the reconnection operation associated with logic control unit 302. If outlet 520 is idling and  
10 drawing substantially no power, logic control unit 702 may be able to disengage from drawing power and enter a "sleep" mode. In an exemplary method, and with further reference to Figure 9, when logic control unit 702 is operating from the stored energy in capacitor CS, a timing function is enabled in logic control unit 702 that uses capacitor C5 to perform the timing function. Capacitor C5 is briefly charged by the CAPTIME output of  
15 logic control unit 702 and over time capacitor C5 discharge rate will mimic the decay of the voltage on capacitor CS. Once capacitor C5 voltage at input CAPTIME reaches a low level, logic control unit 702 will set the state of outputs VD1-VD3 and output ZG1 to again recharge capacitor CS from the AC line. This process repeats over and over so power is never lost to logic control unit 702. The recharge process takes only milliseconds to operate,  
20 depending on the size of capacitor CS.

Furthermore, in an exemplary method, when logic control unit 702 is not busy recharging capacitor CS, switching relay K1, or measuring power drawn from outlet 520, logic control unit 702 is operating in a deep sleep mode that stops all, or substantially all, internal activity and waits for capacitor C5 to discharge. This sleep mode consumes very  
25 little power and allows the charge on storage capacitor CS to persist for many seconds. If reconnection device 634 is activated during the sleep mode, logic control unit 702 will resume normal operation and set or reset relay K1. Alternatively, if capacitor C5 voltage falls too low, logic control unit 702 will again recharge capacitor CS and then return to sleep mode.

30 While an electronic device is in an idle mode, wall plate system 500 may continue to monitor for changes in the power drawn by the electronic device. In an exemplary method, while logic control unit 702 continuously goes in and out of sleep mode to re-power itself, logic control unit 702 will also periodically test the power being drawn from outlet 520. The

period of power testing is much greater than that of capacitor CS charging and, for example, may be only tested every ten or more minutes. In accordance with an exemplary method, there are at least three possible outcomes from the result of power testing: 1) the device is operating and the switch is not in standby condition, 2) the device is not operating but the switch is not in a standby condition, or 3) the switch is in a standby condition. The characteristics and actions associated with each of these possible outcomes are similar to the possible outcomes described with respect to power module 100.

If a user wants to operate a device that is connected to outlet 520 and that outlet is turned off, in an exemplary embodiment, activating reconnection device 634 will immediately wake logic control unit 702 from sleep mode. Since the wake up was from the activation of reconnection device 634 and not due to power testing or capacitor CS recharging, logic control unit 702 will immediately set relay K1 to closed position to power the electronic device connected to outlet 520.

In addition to the embodiments described above, various other elements may be implemented to enhance control and user experience. One way to enhance user control is to allow a user to select the operating mode of an outlet. In an exemplary embodiment, wall plate system 500 further comprises a "Green Mode" switch that enables or disables the "green" mode operation. The green mode switch may be a hard, manual switch or it may be a signal to logic control unit 702. "Green" mode operation is the disengaging of outlet 520 from AC line input 510 when substantially no load is being drawn at outlet 520. A user may use the green mode switch to disable green mode operation on various outlets when desired. For instance, this added control may be desirable on outlets that power devices with clocks or devices that need to be instantly on, such as a fax machine.

In one embodiment, wall plate system 500 includes LED indicators, which may indicate whether an outlet is connected to the power line and drawing a load current. The LED indicators may indicate that whether an outlet is active, that is, power is drawn by an electronic device and/or the outlet has power available even if an electronic device is not connected. In addition, a pulsing LED may be used to show when power testing is being done or to indicate the "heartbeat" of sleep mode recharging.

In another embodiment, wall plate system 500 comprises at least one LCD display. The LCD display may be operated by logic control unit 702 to indicate the load power being provided to outlet 520, for example during times of operation. The LCD may also provide information about the power saved or power consumed by operating wall plate system 500

in or out of a “green” mode. For example, LCD may display the sum total of watts saved during a certain time period, such as the life of wall plate system 500 or in a day.

Various embodiments may also be used to enhance the efficient use of the wall plate system and/or individual outlets in the wall plate system. One such embodiment is the implementation of a photocell or other optical sensor monitored by logic control unit 702. The photocell determines whether light is present in the location of wall plate system 500 and logic control unit 702 can use this determination to disengage outlet 520 depending on the ambient light conditions. For example, logic control unit 702 may disengage output 520 during periods of darkness. In other words, the outlets of the wall plate system may be turned off at night. Another example is devices do not need power if located in a dark room, such as an unused conference room in an office. Also, the power outputs may be turned off when the ambient light conditions exceed a certain level, which may be predetermined or user determined.

In another embodiment, wall plate system 500 further comprises an internal clock. Logic control unit 702 may use the internal clock to learn which time periods show a high power usage at outlet 520. This knowledge may be included to determine when an outlet should have power available. In an exemplary embodiment, the internal clock has quartz crystal accuracy. Also, the internal clock does not need to be set to an actual time. Furthermore, the internal clock may be used in combination with the photocell for greater wall plate system efficiency and/or accuracy.

### **Power Strip**

In accordance with various aspects of the present invention, a power strip configured for reducing or eliminating power during idle mode by disengaging power input from at least one outlet is disclosed. In an exemplary embodiment, and with reference to Figure 11A, a power strip 1100 comprises two or more outlets 1120 and two or more outlet circuits 1130. In another exemplary embodiment (not shown), power strip 1100 comprises a single outlet 1120 and a single outlet circuit 1130. In yet another exemplary embodiment, and with reference to Figure 11B, power strip 1100 comprises at least one outlet 1120 coupled with outlet circuit 1130 and at least one outlet 1120 directly connected to an AC line input 1110.

In an exemplary embodiment, and with reference to Figure 12, power strip 1100 comprises AC line input 1110 connected to outlet circuit 1130, which in turn is connected to outlet 1120. The outlet circuit 1130 comprises a current measuring system 1231, a control circuit 1232, and a switch 1233. In an exemplary embodiment, current measuring system

1231 comprises a current transformer 1231 having a primary circuit and a secondary winding for illustration purposes. However, current measuring system 1231 may also comprise a resistor with a differential amplifier, a current sensing chip, a Hall-effect device, or any other suitable component configured to measure current as now known or hereinafter  
5 devised. Current transformer 1231 provides an output power level signal that is proportional to the load at outlet 1120. Furthermore, switch 1233 connects the primary circuit of current transformer 1231 to outlet 1120.

Furthermore, in one embodiment, AC line input 1110 is a standard 3 wire grounded plug and cord set that connects to the body of power strip 1100. However, AC line input  
10 1110 can be suitably configured in any AC power input configuration or replaced with any other input power configuration. The AC line input 1110 is connected in parallel to a number of similar outlet circuits 1130 that lie between the AC line input 1110 and outlets<sub>1-N</sub> 1120. Furthermore, AC line input 1110 may be connected to a 110 volt or 220 volt power source in an exemplary embodiment.

15 In an exemplary embodiment, control circuit 1232 may comprise at least one of, or a combination of: a latching circuit, an analog circuit, a state machine, and a microprocessor. In one embodiment, control circuit 1232 monitors the condition of the secondary winding of current transformer 1231 and controls the operation of switch 1233. Furthermore, in an  
20 exemplary embodiment, control circuit 1232 receives a low frequency or DC signal from current transformer 1231. The low frequency signal, for example, may be 60 Hz. This low frequency or DC signal is interpreted by control circuit 1232 as the current required by the load at outlet 1120.

Control circuit 1232 can comprise various structures for monitoring the condition of the secondary winding of current transformer 1231 and controlling the operation of switch  
25 1233. In an exemplary embodiment, with reference to Figure 13, control circuit 1232 includes a current sensor 1301 and a logic control unit 1302. Current sensor 1301 monitors the output of a current measuring system, such as for example, the secondary winding of current transformer 1231, which is an AC voltage proportional to the load current. Also, current sensor 1301 provides a signal to logic control unit 1302. In one embodiment, the  
30 signal may be a DC voltage proportional to the current through current sensor 1301. In another embodiment, the signal may be a current proportional to the current through current sensor 1301. In another exemplary embodiment, and with momentary reference to Figure 14, outlet circuit 1130 of the power strip comprises a logic control unit 1302 that is in



communication with, and controls, more than one current transformer 1231 and more than one switch 1233.

In an exemplary embodiment, logic control unit 1302 is powered by an energy storage capacitor. Logic control unit 1302 may briefly connect the storage capacitor to AC line input 1110 in order to continue powering logic control unit 1302. In another embodiment, logic control unit 1302 may be powered by a battery or other energy source. This energy source is also referred to as housekeeping or hotel power; it functions as a low auxiliary power source. In one embodiment, auxiliary power is taken from AC line input 1110. For further detail on similar current monitoring, see U.S. Provisional Application 61/052,939, entitled "Circuit and Method for Ultra-Low Idle Power".

In an exemplary embodiment, logic control unit 1302 is a microprocessor capable of being programmed prior to, and after integration of, power strip 1100 in an electronic device. In one embodiment, a user is able to connect to logic control unit 1302 and customize the parameters of power strip 1100. For example, a user may set the threshold level and a sleep mode duty cycle of power strip 1100. Data from power strip 1100 could be transmitted regarding, for example, the historical power consumption and/or energy saved. The bidirectional data transfer between power strip 1100 and a display device may be achieved through a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal. The data transfer may also be achieved using a wired connection, such as for example, a USB connection or other similar connection.

In accordance with an exemplary embodiment, control circuit 1232 may further comprise a power disconnect 1303 in communication with logic control unit 1302. Power disconnect 1303 is configured to isolate logic control unit 1302 from AC line input 1110 and reduce power loss. While isolated, logic control unit 1302 is powered by the storage capacitor or other energy source and logic control unit 1302 enters a "sleep" mode. If the storage capacitor reaches a low power level, power disconnect 1303 is configured to reconnect logic control unit 1302 to AC line input 1110 to recharge the storage capacitor. In an exemplary embodiment, power disconnect 1303 is able to reduce the power loss from a range of microamperes of leakage to a range of nanoamperes of leakage.

In another exemplary embodiment, control circuit 1232 receives a control signal that is impressed upon AC line input 1110 by another controller. The control signal may be, for example, the X10 control protocol or other similar protocol. Control circuit 1232 may receive the control signal through the secondary winding of current transformer 1231, from

a coupled AC line input 1110, or any other suitable means configured to couple AC line input 1110 to control circuit 1232 as now known or hereinafter devised. This control signal may come from within power strip 1100 or may come from an external controller. The control signal may be a high frequency control signal or at least a control signal at a frequency different than the frequency of AC line input 1110. In an exemplary embodiment, control circuit 1232 interprets the control signal to engage or disengage switch 1233. In another embodiment, an external controller may transmit a signal to turn power strip 1100 to an “on” or “off” condition.

In an exemplary embodiment, if behavior of the secondary winding of current transformer 1231 indicates that outlet 1120 is drawing substantially no power from AC line input 1110, switch 1233 facilitates or controls disengaging of the primary circuit of current transformer 1231 from outlet 1120. In other words, switch 1233 facilitates the disengaging of a power source from outlet 1120. In an exemplary embodiment, the secondary winding of current transformer 1231 is monitored for an AC waveform at the AC line frequency, where the AC waveform has an RMS voltage proportional to the load current passing through the primary circuit of current transformer 1231 to outlet 1120. In another embodiment, the AC waveform is rectified and filtered to generate a DC signal before being received by control circuit 1232. The DC signal is proportional to the load current passing through the primary circuit of current transformer 1231 to outlet 1120.

In one embodiment, the phrase “substantially no power” is intended to convey that the output power is in the range of approximately 0 – 1% of a typical maximum output load. In an exemplary embodiment, switch 1233 is configured to control the connection of the primary circuit of current transformer 1231 to outlet 1120 and comprises a switching mechanism to substantially disengage the primary circuit of current transformer 1231 from outlet 1120. Switch 1233 may comprise at least one of a relay, latching relay, a TRIAC, and an optically isolated TRIAC.

By substantially disabling the primary circuit of current transformer 1231, the power consumption at outlet 1120 is reduced. In one embodiment, substantially disabling outlet 1120 is intended to convey that the output signal of the secondary winding of current transformer 1231 has been interpreted by control circuit 1232 as sufficiently low so that it is appropriate to disengage switch 1233 and remove power from outlet 1120.

In another exemplary embodiment, outlet circuit 1130 further comprises a reconnection device 1234, which is configured to enable the closure of switch 1233 through

logic control unit 1302. The closure of switch 1233 reconnects outlet 1120 to the primary circuit of current transformer 1231 and AC line input 1110. In an exemplary embodiment, reconnection device 1234 comprises a switch device that may be closed and opened in various manners. For example, reconnection device 1234 can comprise a push button that  
5 may be manually operated. In one embodiment, the push button is located near outlet 1120 on power strip 1100, for example, on the same surface of power strip 1100 as outlet 1120 or on an adjacent side of power strip 1100 to outlet 1120. In another exemplary embodiment, reconnection device 1234 is located remote to power strip 1100 to allow a user to re-enable power to an outlet of power strip 1100 without having direct contact with power strip 1100.  
10 In another embodiment, reconnection device 1234 is affected remotely by signals traveling through AC line input 1110 that control circuit 1232 interprets as on/off control. In yet another embodiment, reconnection device 1234 is controlled by a wireless signal, such as for example, an infra-red signal, a radio frequency signal, or other similar signal.

In accordance with another exemplary embodiment, switch 1233 is automatically  
15 operated on a periodic basis. For example, switch 1233 may automatically reconnect after a few or several minutes or tens of minutes, or any period more or less frequent. In one embodiment, switch 1233 is automatically reconnected frequently enough that a battery operated device connected to power strip 1100 will not completely discharge internal batteries during a period of no power at the input to the connected device. After outlet 1120  
20 is reconnected, in an exemplary embodiment, outlet circuit 1130 tests for, or otherwise assesses, load conditions. If the load condition on outlet 1120 is increased above previously measured levels, outlet 1120 will remain connected to the primary circuit of current transformer 1231 until the load condition has returned to a selected or predetermined threshold level indicative of a "low load". In an exemplary embodiment, the determination  
25 of load conditions at re-connect are made after a selected time period had elapsed, for example after a number of seconds or minutes, so that current inrush or initialization events are ignored. In another embodiment, the load conditions may be averaged over a selected time period of a few seconds or minutes so that short bursts of high load average out. In yet another exemplary embodiment, power strip 1100 comprises a master reconnection device  
30 that can re-engage all outlets 1120 to AC line input 1110.

In an exemplary method of operation, power strip 1100 has switch 1233 closed upon initial power-up, such that power flows to outlet 1120. When load conditions at outlet 1120 are below a threshold level, control circuit 1232 opens switch 1233 to create an open circuit

and disengage outlet 1120 from the AC power signal. This disengaging effectively eliminates any idle power lost by outlet 1120. In one embodiment, the threshold level is a predetermined level, for example approximately one watt of power or less flowing to outlet 1120.

5 In an exemplary embodiment, different outlets 1120 may have different fixed threshold levels such that devices having a higher power level in idle may be usefully connected to power strip 1100 for power management. For example, a large device may still draw about 5 watts during idle, but would never be disconnected from AC line input 1110 if the connected 1120 had a threshold level of about 1 watt. In various embodiments, certain  
10 outlets 1120 may have a higher threshold levels to accommodate high power devices, or lower threshold levels for lower power devices.

In another embodiment, the threshold level is a learned level. The learned level may be established through long term monitoring by control circuit 1232 of load conditions at outlet 1120. A history of power levels is created over time by monitoring and may serve as  
15 a template of power demand. In an exemplary embodiment, control circuit 1232 examines the history of power levels and decides whether long periods of low power demand were times when a device connected at outlet 1120 was in a low, or lowest, power mode. In an exemplary embodiment, control circuit 1232 disengages outlet 1120 during low power usage times when the period of low power matches the template. For example, the template might  
20 demonstrate that the device draws power through outlet 1120 for eight hours, followed by 16 hours of low power demand.

In another exemplary embodiment, control circuit 1232 determines the approximate low power level of the electronic device connected at outlet 1120, and sets a threshold level to be a percentage of the determined approximate low power level. For example, control  
25 circuit 1232 may set the threshold level to be about 100-105% of the approximate low power level demand. In another embodiment, the threshold demand may be set at about 100-110% or 110-120% or more of the approximate low power level demand. In addition, the low power level percentage range may be any variation or combination of the disclosed ranges.

Additionally, the learned threshold level can be manually set. In accordance with an  
30 exemplary embodiment, a threshold level is set based in part by activating reconnect device 1234 for a period of time and measuring a current power level. For example, a user may hold down reconnect device 1234 for a few seconds when power strip 1100 operates in idle mode and measure the power level. The measured power level is used to set the power

threshold level. In one exemplary embodiment, the threshold level is set to a measured power level plus an offset value. The offset value can be configured at various power levels. Furthermore, the offset value may be increased or decreased as is suitable for a particular configuration. For example, if the measured threshold is about 1 W, and an offset value of  
5 about 0.5 W is used, then the threshold value is about 1.5 W. In an exemplary embodiment, power strip 1100 is configured to operate in ultra-low idle mode if the load drops below about 1.5 W in this example. Advantageously, the threshold level is set more accurately by manually initiating a power level measurement.

Having disclosed various functions and structures for an exemplary power strip  
10 configured for reducing or eliminating power during idle mode by disengaging power input, a detailed schematic diagram of an exemplary power strip circuit is similar to the components and functions of wall plate system as described with reference to Figure 9. Further understanding of the operation of an exemplary power strip is available with reference to the detailed described of Figure 9.

15 In addition to the embodiments described above, various other elements may be implemented to enhance control and user experience. One way to enhance user control is to allow a user to select the operating mode of an outlet. In an exemplary embodiment, power strip 1100 further comprises a "Green Mode" switch that enables or disables the "green" mode operation. The green mode switch may be a hard, manual switch or it may be a signal  
20 to logic control unit 1302. "Green" mode operation is the disengaging of outlet 1120 from AC line input 1110 when substantially no load is being drawn at outlet 1120. A user may use the green mode switch to disable green mode operation on various outlets when desired. For instance, this added control may be desirable on outlets that power devices with clocks or devices that need to be instantly on, such as a fax machine.

25 In one embodiment, power strip 1100 includes LED indicators, which may indicate whether an outlet is connected to the power line and drawing a load current. The LED indicators may indicate whether an outlet is active, that is, power is drawn by an electronic device and/or the outlet has power available even if an electronic device is not connected. In addition, a pulsing LED may be used to show when power testing is being done or to  
30 indicate the "heartbeat" of sleep mode recharging.

In another embodiment, power strip 1100 comprises at least one LCD display. The LCD display may be operated by logic control unit 1302 to indicate the load power being provided to outlet 1120, for example during times of operation. The LCD may also provide

information about the power saved or power consumed by operating power strip 1100 in or out of a "green" mode. For example, LCD may display the sum total of watts saved during a certain time period, such as the life of power strip 1100 or in a day.

5 Various embodiments may also be used to enhance the efficient use of the power strip and/or individual outlets in the power strip. One such embodiment is the implementation of a photocell or other optical sensor monitored by logic control unit 1302. The photocell determines whether light is present in the location of power strip 1100 and logic control unit 1302 can use this determination to disengage outlet 1120 depending on the ambient light conditions. For example, logic control unit 1302 may disengage power output  
10 1120 during periods of darkness. In other words, the power strip may be turned off at night. Another example is devices do not need power if located in a dark room, such as an unused conference room in an office. Also, the power outputs may be turned off when the ambient light conditions exceed a certain level, which may be predetermined or user determined.

In another embodiment, power strip 1100 further comprises an internal clock. Logic  
15 control unit 1302 may use the internal clock to learn which time periods show a high power usage at outlet 1120. This knowledge may be included to determine when an outlet should have power available. In an exemplary embodiment, the internal clock has quartz crystal accuracy. Also, the internal clock does not need to be set to an actual time. Furthermore, the internal clock may be used in combination with the photocell for greater power strip  
20 efficiency and/or accuracy.

The present invention has been described above with reference to various exemplary embodiments. However, those skilled in the art will recognize that changes and modifications may be made to the exemplary embodiments without departing from the scope of the present invention. For example, the various exemplary embodiments can be  
25 implemented with other types of power strip circuits in addition to the circuits illustrated above. These alternatives can be suitably selected depending upon the particular application or in consideration of any number of factors associated with the operation of the system. Moreover, these and other changes or modifications are intended to be included within the scope of the present invention, as expressed in the following claims.

30

**Claims**

1. A power strip configured to reduce power during idle operation of an electronic device, said power strip comprising:
  - an alternating current (AC) line input comprising a plug and a cord configured to be  
5 connected to an external outlet;
  - a plurality of outlets configured to transmit power to an electronic device, said external outlet is distinct from said plurality of outlets; and
  - an outlet circuit configured to receive power from said AC line input and transmit power to at least one outlet of said plurality of outlets, wherein said outlet circuit disengages  
10 transmitting power to said at least one outlet in response to said at least one outlet drawing substantially no power.
2. The power strip of claim 1, said outlet circuit comprising:
  - a current measuring system configured to monitor the current from said AC line input, wherein said current measuring system provides an output power level signal that is  
15 proportional to the load at said at least one outlet;
  - a switch in communication with said current measuring system and said at least one outlet; and
  - a control circuit configured to receive said output power level signal and control the opening and closing of said switch to disengage said at least one outlet from power.
- 20 3. The power strip of claim 2, wherein said control circuit is at least one of a latching circuit, an analog circuit, a state machine, and a microprocessor.
4. The power strip of claim 2, wherein said switch is at least one of a relay, a latching relay, a TRIAC, and an optically isolated TRIAC.
5. The power strip of claim 2, wherein said control circuit is configured to receive a  
25 control signal to facilitate the opening and closing of said switch.
6. The power strip of claim 1, further comprising a green mode switch configured to select an operating mode of said at least one outlet, wherein said operating mode is at least one of a normal mode and a green mode.
7. The power strip of claim 1, further comprising at least one LED indicator  
30 configured to indicate if said electronic device at said at least one outlet is active.
8. The power strip of claim 7, wherein said at least one LED indicator is further configured to flash if said outlet circuit is testing said at least one outlet.

9. The power strip of claim 1, further comprising a liquid crystal display (LCD) configured to display data, wherein said data is at least one of load power provided to said at least one outlet, power saved by said at least one outlet, power saved by said power strip, and power consumed by said power strip.

5 10. The power strip of claim 2, further comprising a reconnection device configured to override said control circuit and reengage said switch to a closed state.

11. The power strip of claim 10, wherein said reconnection device is further configured to disengage said switch to an open state.

12. The power strip of claim 10, wherein said reconnection device is a push button.

10 13. The power strip of claim 10, wherein said reconnection device is located remotely from said power strip.

14. The power strip of 10, wherein said reconnection device is controlled by at least one of an infra-red signal and a radio frequency signal.

15 15. The power strip of claim 10, wherein said reconnection device is configured to override a single control circuit and reengage a single switch to a closed state.

16. The power strip of claim 15, wherein said reconnection device is further configured to disengage a single switch to an open state.

17. The power strip of claim 10, wherein said reconnection device is configured to override a plurality of control circuits and reengage a plurality of switches to a closed state.

20 18. The power strip of claim 10, wherein said reconnection device is further configured to disengage a plurality of switches to an open state.

19. The power strip of claim 2, further comprising a power disconnect configured to electrically isolate said control circuit from said AC line input.

25 20. The power strip of claim 1, wherein substantially no power is approximately 0-1% of a typical maximum output load of said electronic device at said at least one outlet.

23. The power strip of claim 1, further comprising means for setting the duration of a sleep mode duty cycle.

24. The power strip of claim 1, wherein said outlet circuit is configured such that parameters of said power strip may be modified by a user.

30 25. An outlet circuit in a power strip, said outlet circuit configured for receiving power and transmitting power to an outlet, and said outlet circuit comprising:

a current measuring system configured to provide an output signal proportional to a load at the outlet;



a switch configured to disengage power from the outlet; and  
a control circuit configured to interpret said output signal and control said switch;  
wherein said switch disengages power if the load at the outlet is below a threshold level.

5           26. The outlet circuit of claim 25, further comprises a reconnection device connected to said control circuit, wherein said reconnection device is configured to re-engage power to the outlet.

10           27. The outlet circuit of claim 25, wherein said control circuit further comprises a power disconnect device configured to isolate an electrical component from a power input if said electrical component is in an idle mode.

28. A power strip configured to efficiently provide power to an electronic device, said power strip comprising:

at least one outlet configured to provide power to said electronic device;  
a switch having at least an open state and a closed state, wherein said switch is in  
15 communication with said at least one outlet and an alternating current (AC) line input;  
a current measuring system configured to monitor the current drawn by said at least one outlet; and

a control circuit configured to control the state of said switch;  
wherein said control circuit sets said switch to the open state if the current drawn by  
20 said at least one outlet is below a threshold level, such that said at least one outlet is effectively disengaged from said AC line input.

29. The power strip of claim 28, wherein said control circuit tests a load condition at said at least one outlet by setting said switch to the closed state and determining if the current drawn by said at least one outlet is below the threshold level.

25           30. The power strip of claim 28, wherein said control circuit controls said at least one outlet individually.

31. The power strip of claim 28, wherein said control circuit controls a plurality of said at least one outlet.

30           32. The power strip of claim 28, wherein said current measuring system is a current transformer.

33. The power strip of claim 28, wherein said current measuring system is at least one of a resistor with a differential amplifier, a current sensing chip, and a Hall-effect device.

34. The power strip of claim 28, further comprising a reconnection device configured to override said control circuit and re-engage said switch to the closed state.

35. The power strip of claim 28, further comprising a power disconnect configured to electrically isolate said control circuit from said AC line input.

5 36. The power strip of claim 28, wherein said control circuit comprises a current sensor and a logic control unit.

37. The power strip of claim 36, further comprising a photocell configured to indicate a level of ambient light surrounding said power strip, wherein said logic control unit is configured to disengage said at least one outlet based upon the level of ambient light.

10 38. The power strip of claim 36, further comprising an internal clock, wherein said logic control unit uses said internal clock to determine periods of use of said at least one outlet.

39. The power strip of claim 28, wherein said threshold level is a predetermined level.

15 40. The power strip of claim 39, wherein said predetermined level is about 1 watt or less.

41. The power strip of claim 28, wherein said threshold level is a learned level determined by long term monitoring of the load conditions at said at least one outlet.

20 42. The power strip of claim 28, wherein said threshold level is manually set by activating a reconnection device and wherein said threshold level is based in part by measuring a power level during an idle mode of said power strip.

43. The power strip of claim 28, wherein said threshold level is a percentage of a determined approximate low power level of said electronic device.

25 44. The power strip of claim 43, wherein said percentage of a determined approximate low power level is at least one range of approximately 100-105%, approximately 100-110%, and approximately 110-120%.

45. The power strip of claim 28, wherein said at least one outlet comprises a first outlet with a first threshold level and a second outlet with a second threshold level, wherein said first threshold level is different from said second threshold level.

30 46. A method of facilitating a power strip with low power consumption, said method comprising:

providing power to an electronic device at an outlet;

monitoring, at a current measuring system, a load condition at said outlet;

transmitting the load condition to a control circuit;  
controlling, at said control circuit, the state of a switch; and  
setting the state of said switch to open if the load condition is below a threshold level  
and disengaging said outlet from an AC line input.

5           47. The method of claim 46, further comprising a testing method of the load  
condition at said outlet, said testing method comprising:

setting said switch to a closed state; and  
determining if the load condition is below the threshold level.

10           48. The method of claim 46, further comprising:  
overriding said control circuit using a reconnection device; and  
reengaging said switch to a closed state.

49. The method of claim 46, further comprising electrically isolating said control  
circuit from said AC line input using a power disconnect.

15           50. The method of claim 46, further comprising:  
monitoring the load condition at said outlet; and  
determining said threshold level based upon the monitoring of the load condition.

51. A power disconnect circuit configured to isolate an electrical component from a  
power input if said electrical component is in an idle mode, said power disconnect circuit  
comprising:

20           a network of transistors in communication with said power input and said electrical  
component;

said network of transistors comprising:  
a first transistor configured to disconnect said power input; and  
a second transistor configured to regulate a voltage to said first transistor;

25           wherein said electrical component draws substantially no power when isolated from  
said power input by said power disconnect circuit;

52. The power disconnect circuit of claim 51, wherein said power disconnect circuit  
is further configured to regulate said power input to a suitable power level for said electrical  
component.

30           53. The power disconnect circuit of claim 51, wherein said electrical component is a  
control circuit.

54. The power disconnect circuit of claim 51, wherein said power disconnect circuit  
is integrated into a power supply system.

55. The power disconnect of claim 51, wherein said electrical component comprises an energy storage unit, and wherein said network of transistors periodically reconnects said electrical component to said power input in order to recharge said energy storage unit.

56. A wall plate system configured to reduce power during idle operation of an electronic device, said wall plate system configured to be within or plugged into a wall plate, said wall plate system comprising:

an alternating current (AC) line input;

at least one outlet of said wall plate system configured to transmit power to an electronic device; and

10 a wall plate circuit configured to receive power from said AC line input and transmit power to said at least one outlet, and said wall plate circuit configured to disengage transmitting power to said at least one outlet in response to said at least one outlet drawing substantially no power;

wherein said wall plate system is configured to be rigidly mounted to a wall.

15 57. The wall plate system of claim 56, wherein said wall plate circuit is engaged behind the face of said at least one outlet.

58. The wall plate system of claim 56, further comprising at least one additional outlet and wherein said wall plate circuit is engaged to the face of said at least outlet.

20 59. A power module configured as a component of an electronic device to reduce power consumption during idle operation of the electronic device, said power module comprising:

a power input of said power module;

at least one power output of said power module configured to transmit power to an electronic device; and

25 a power module circuit configured to receive power from said power input and transmit power to said at least one power output;

wherein said power module circuit disengages transmitting power to said at least one power output in response to said at least one power output drawing substantially no power.

30 60. The power module of claim 59, wherein said power module is integrated into the electronic device.

61. The power module of claim 59, wherein said power module is removable from the electronic device.

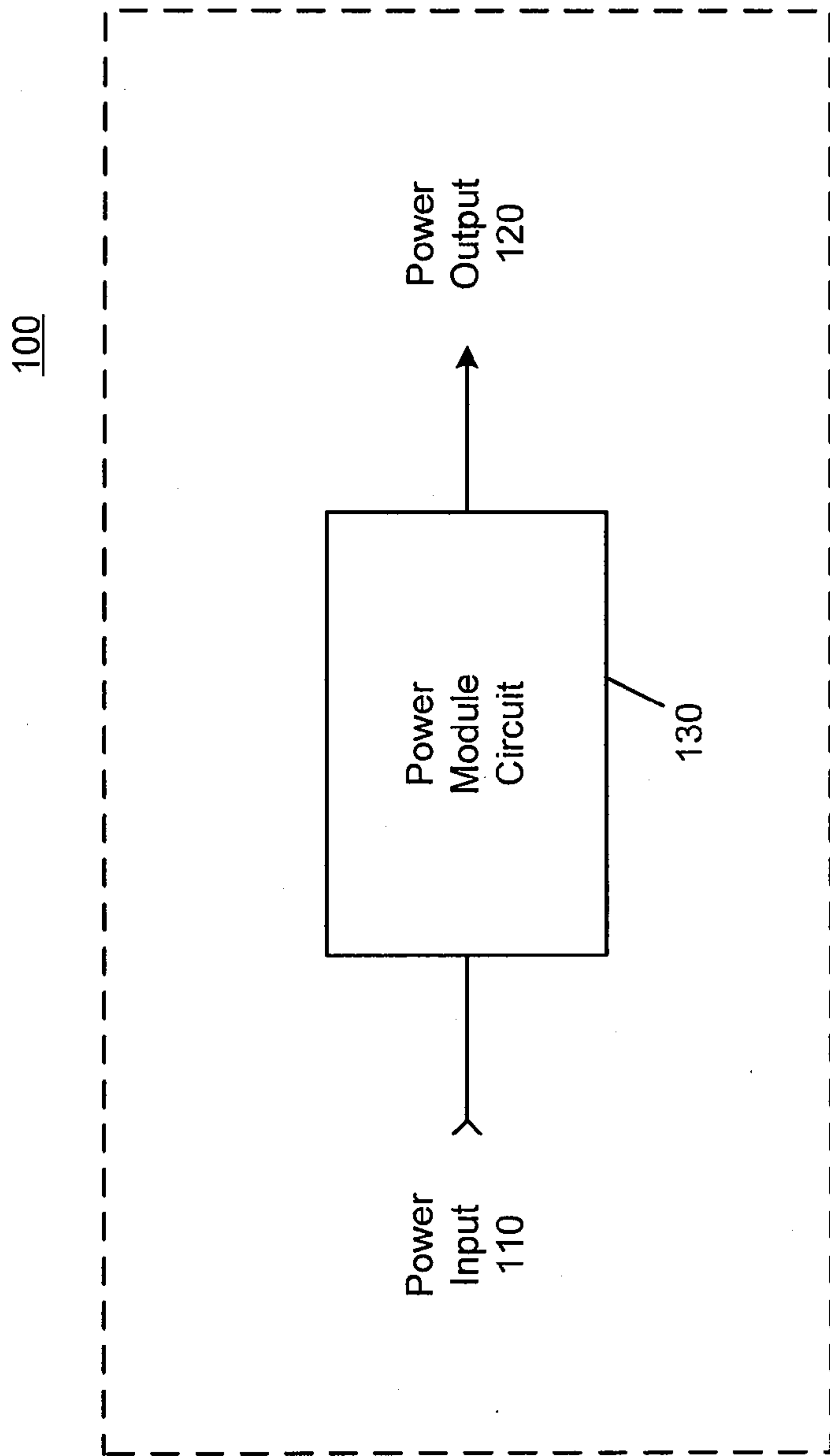


Figure 1

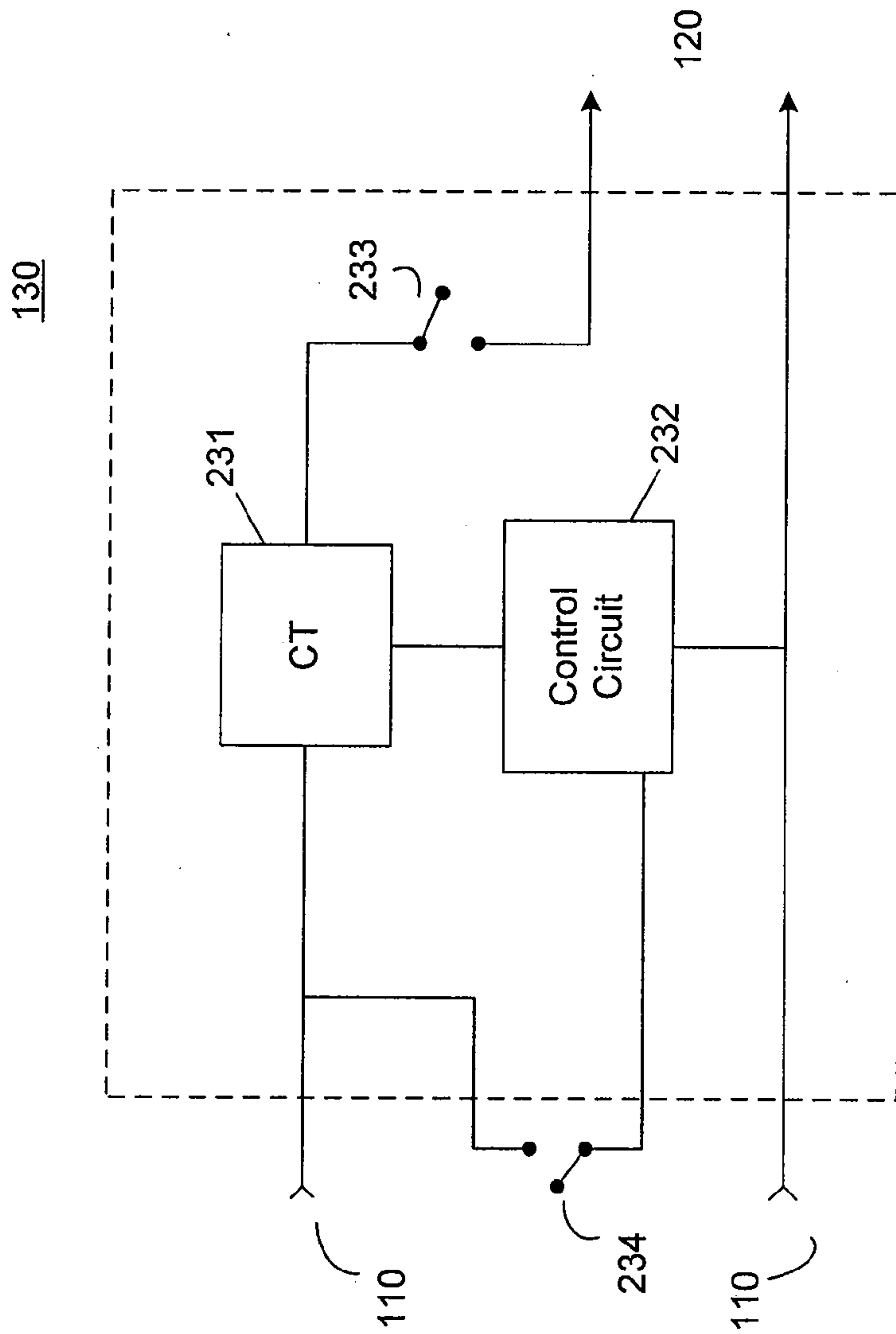


Figure 2

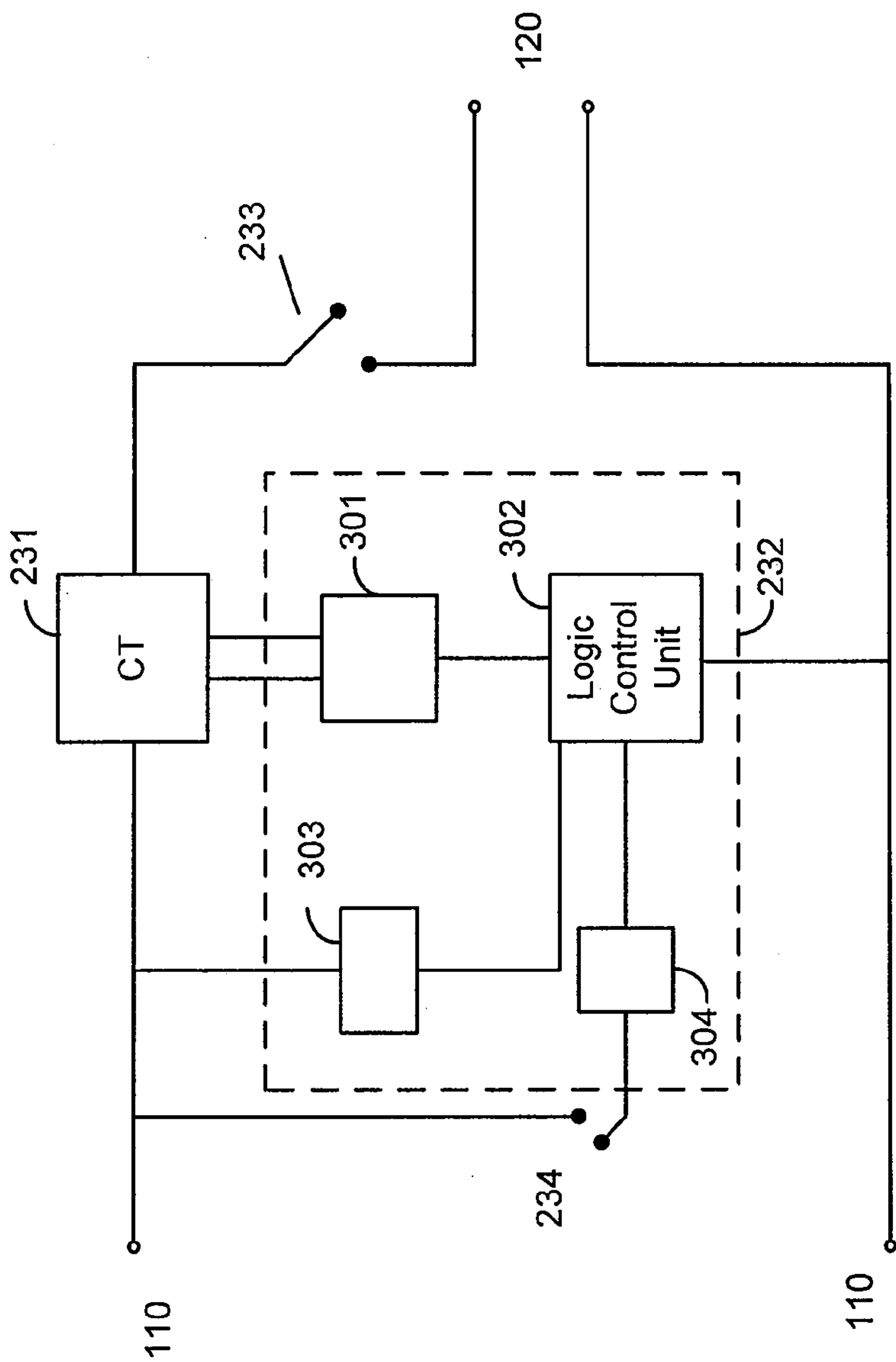


Figure 3

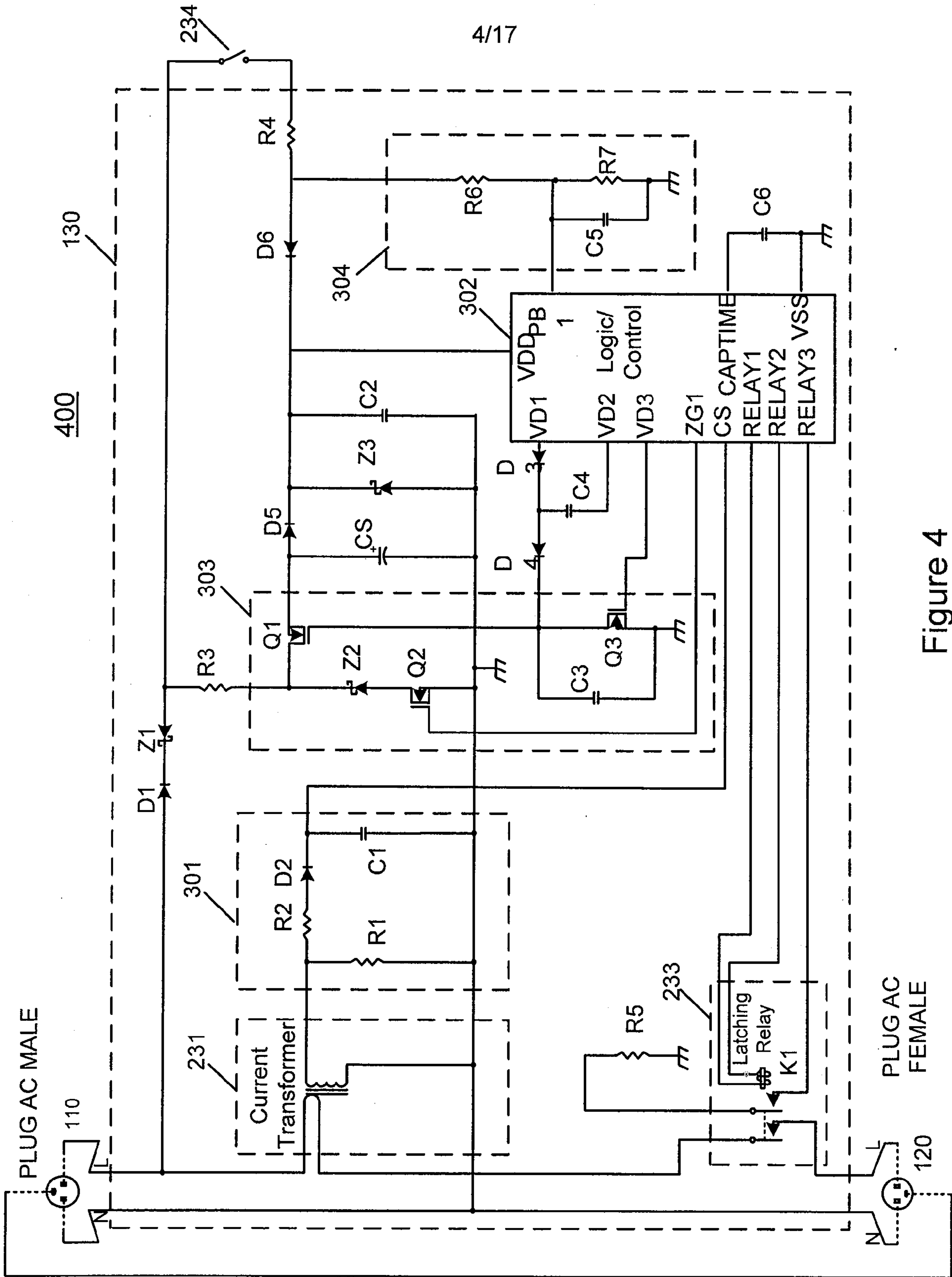


Figure 4



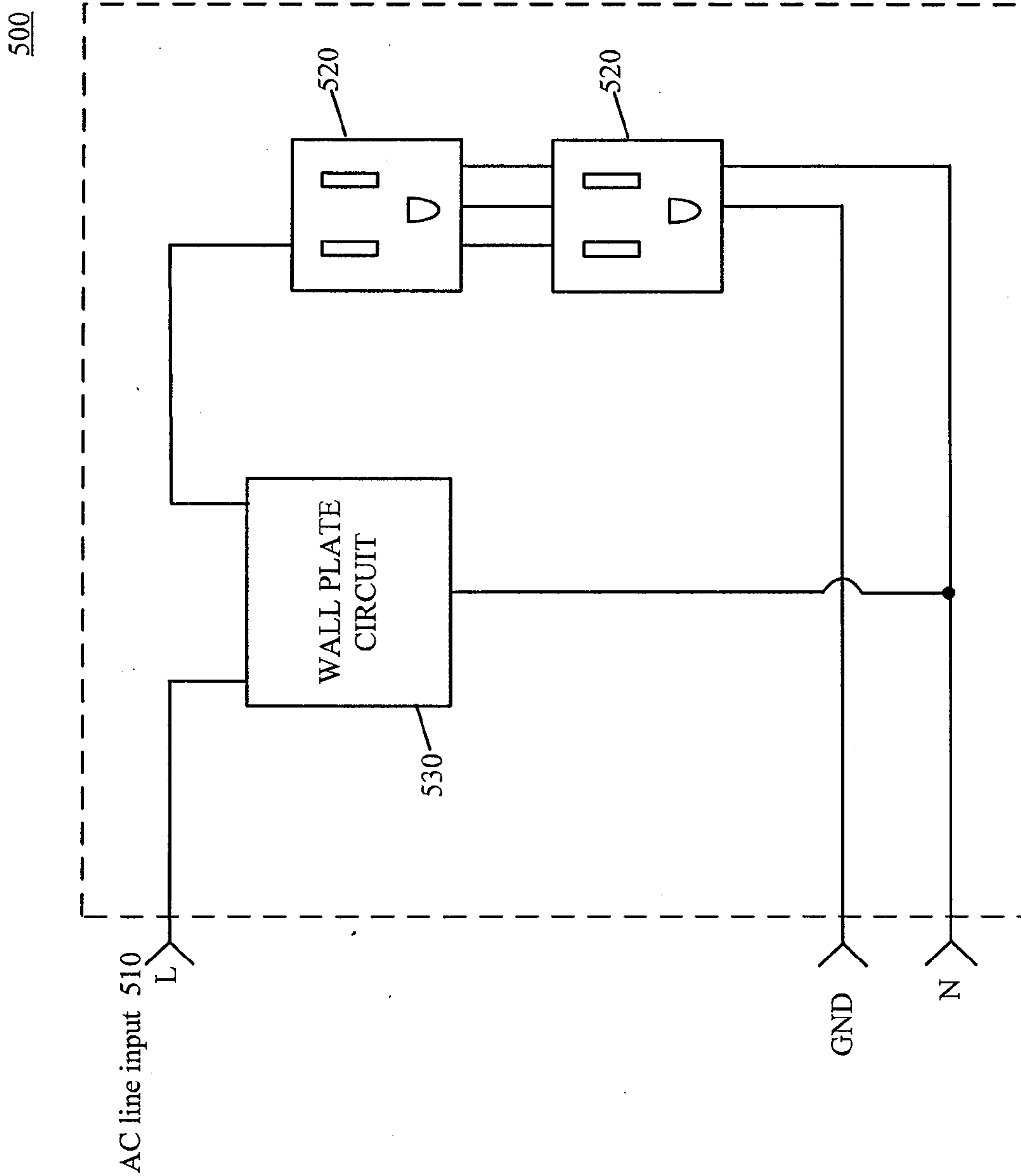


Figure 5A

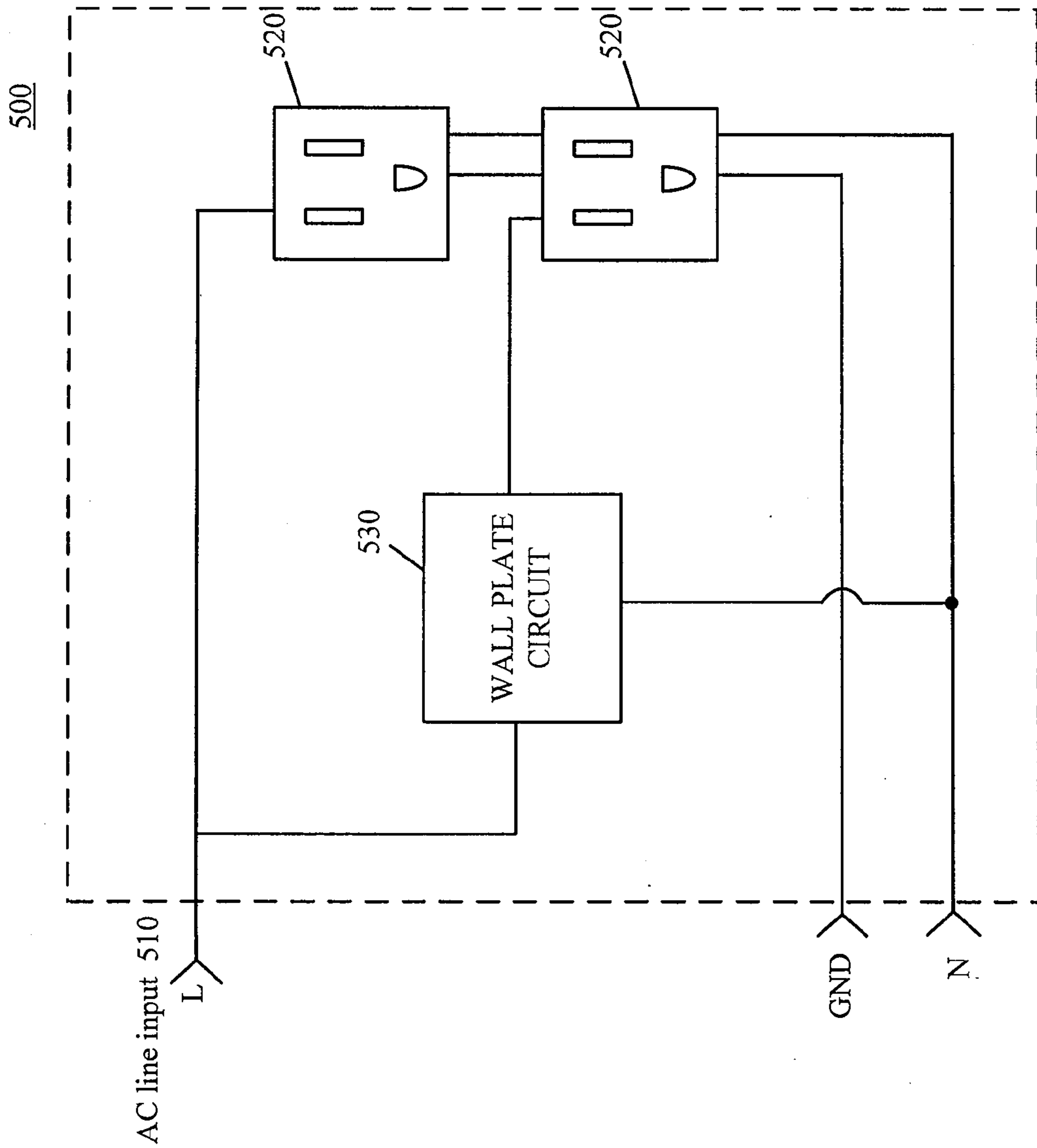


Figure 5B

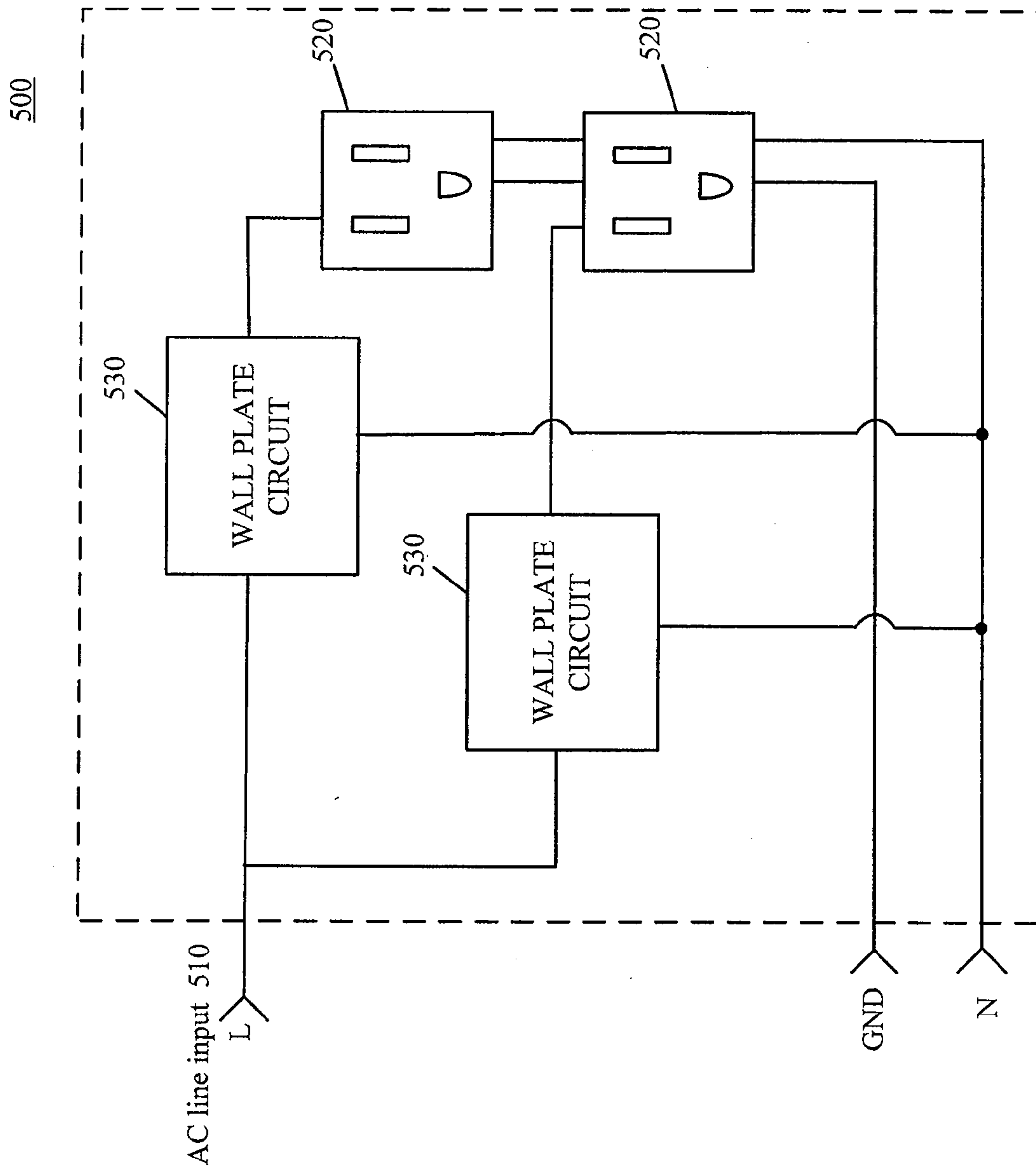


Figure 5C

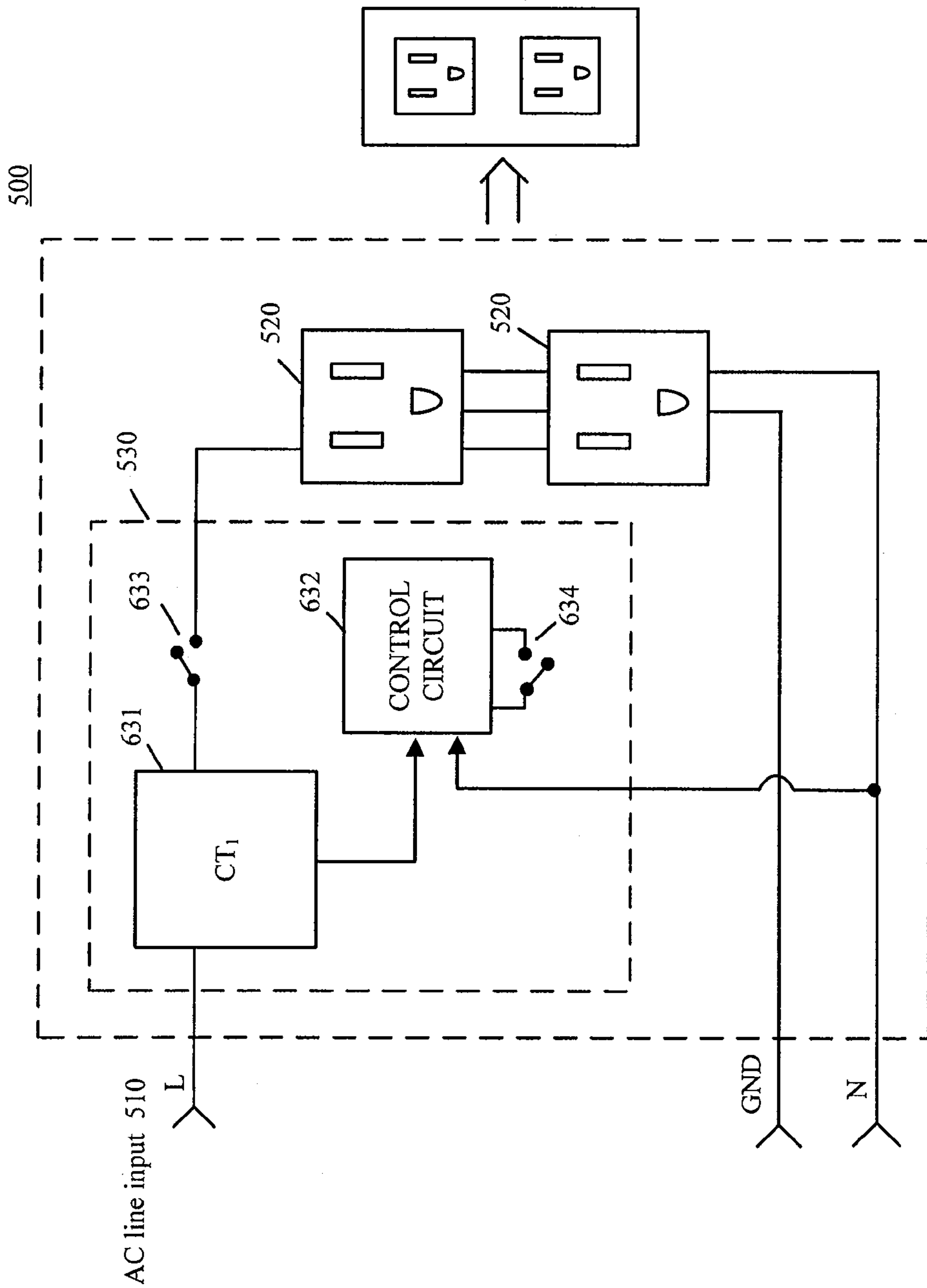


Figure 6

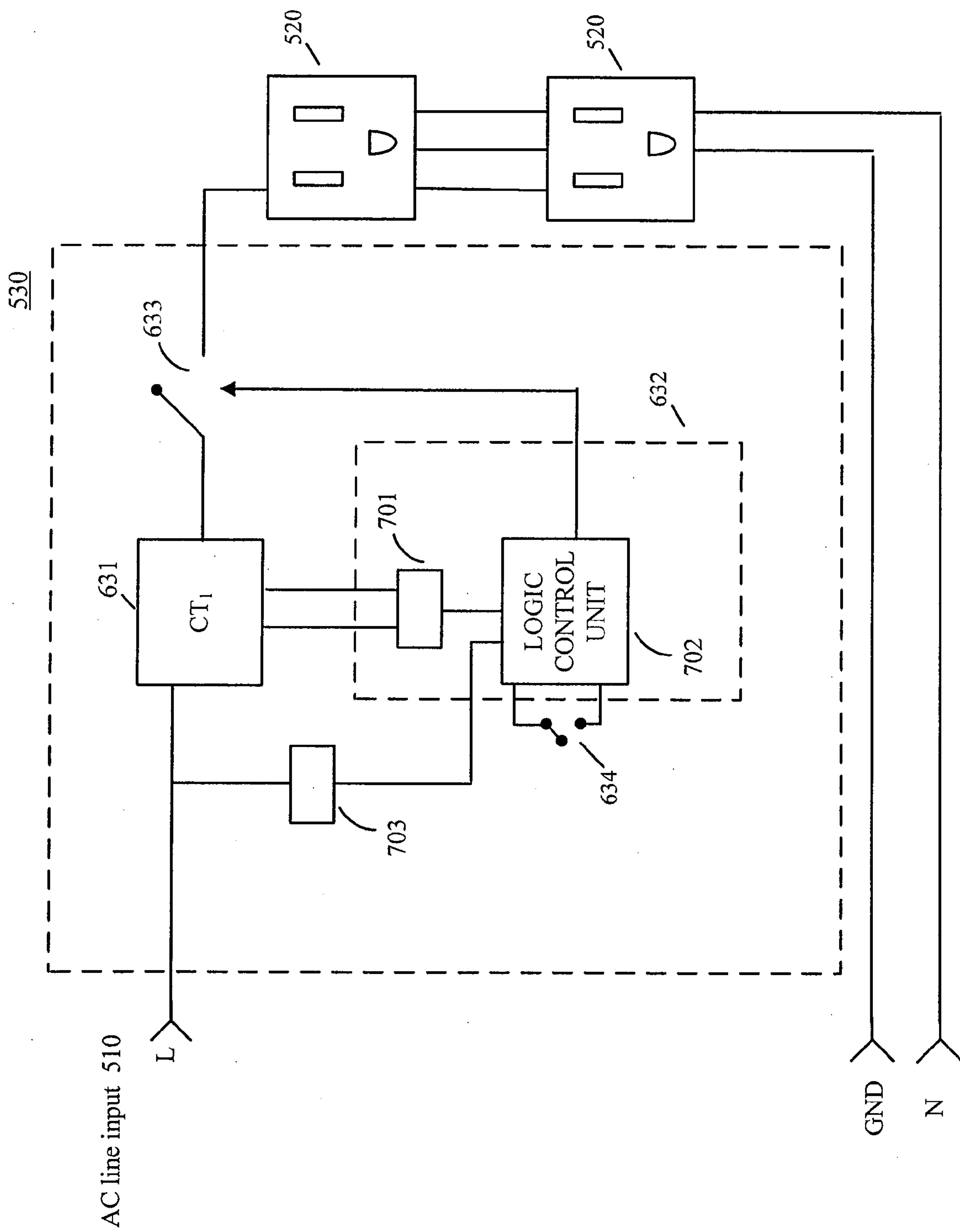


Figure 7

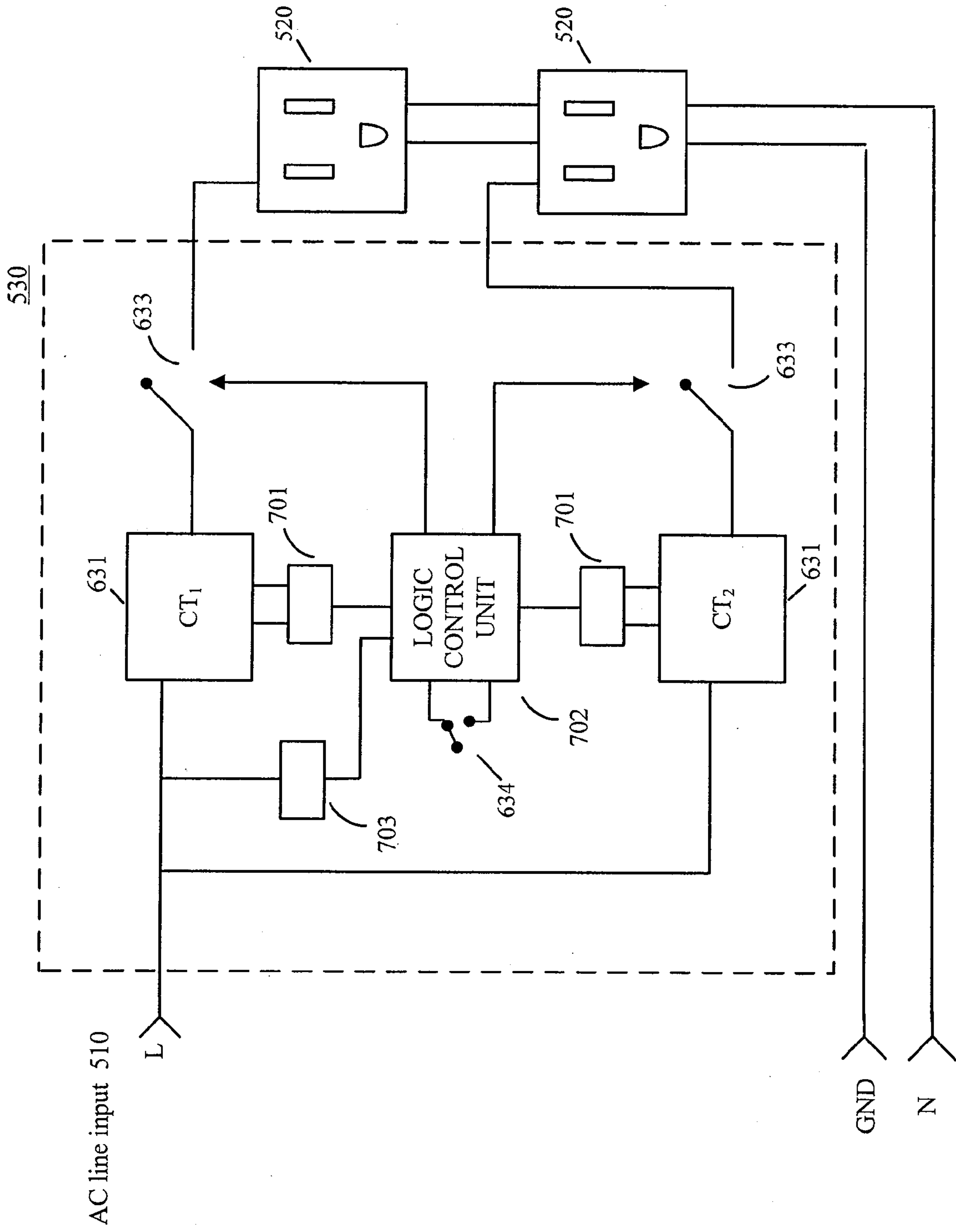


Figure 8

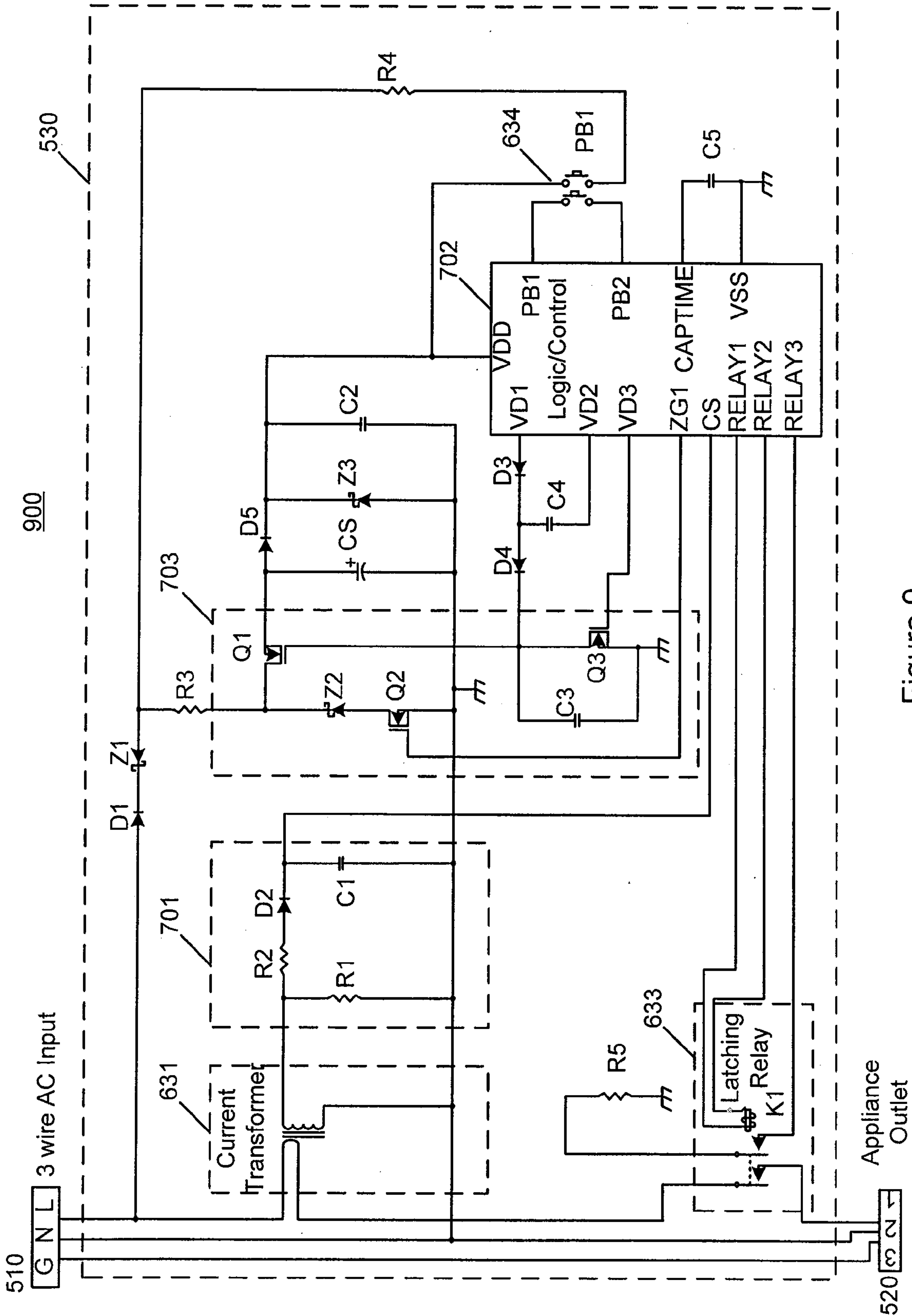


Figure 9

12/17

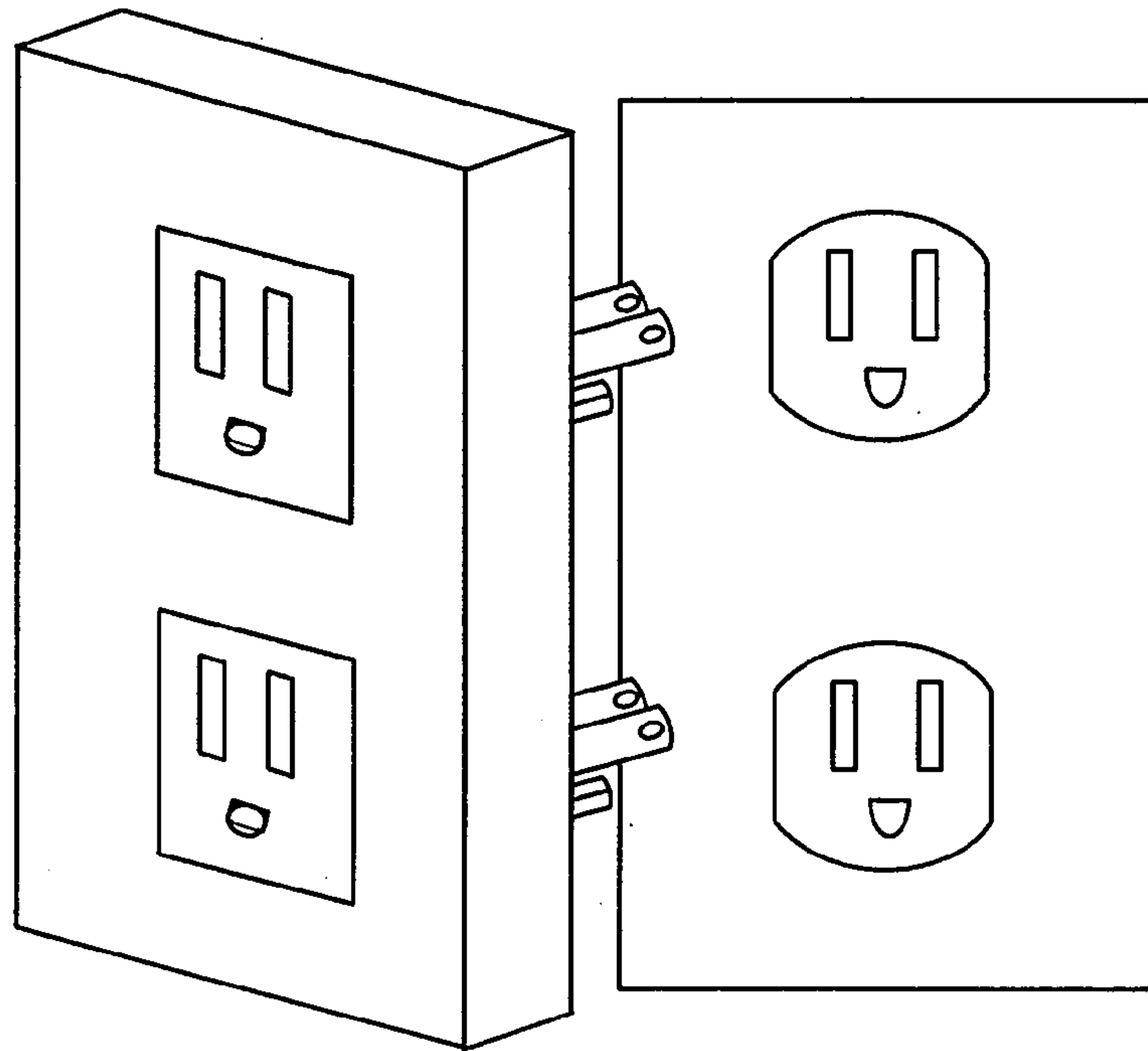


Figure 10



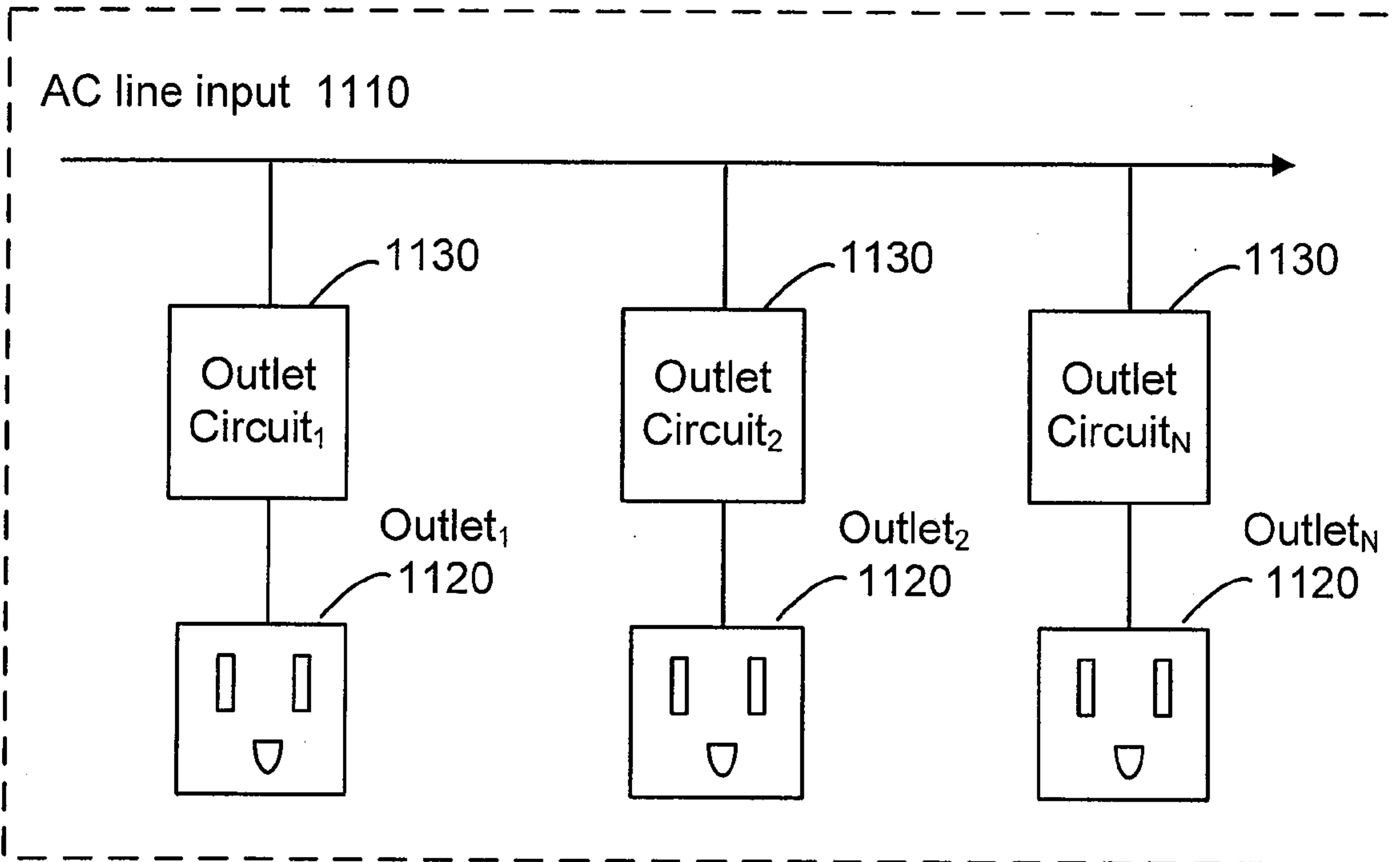


Figure 11A

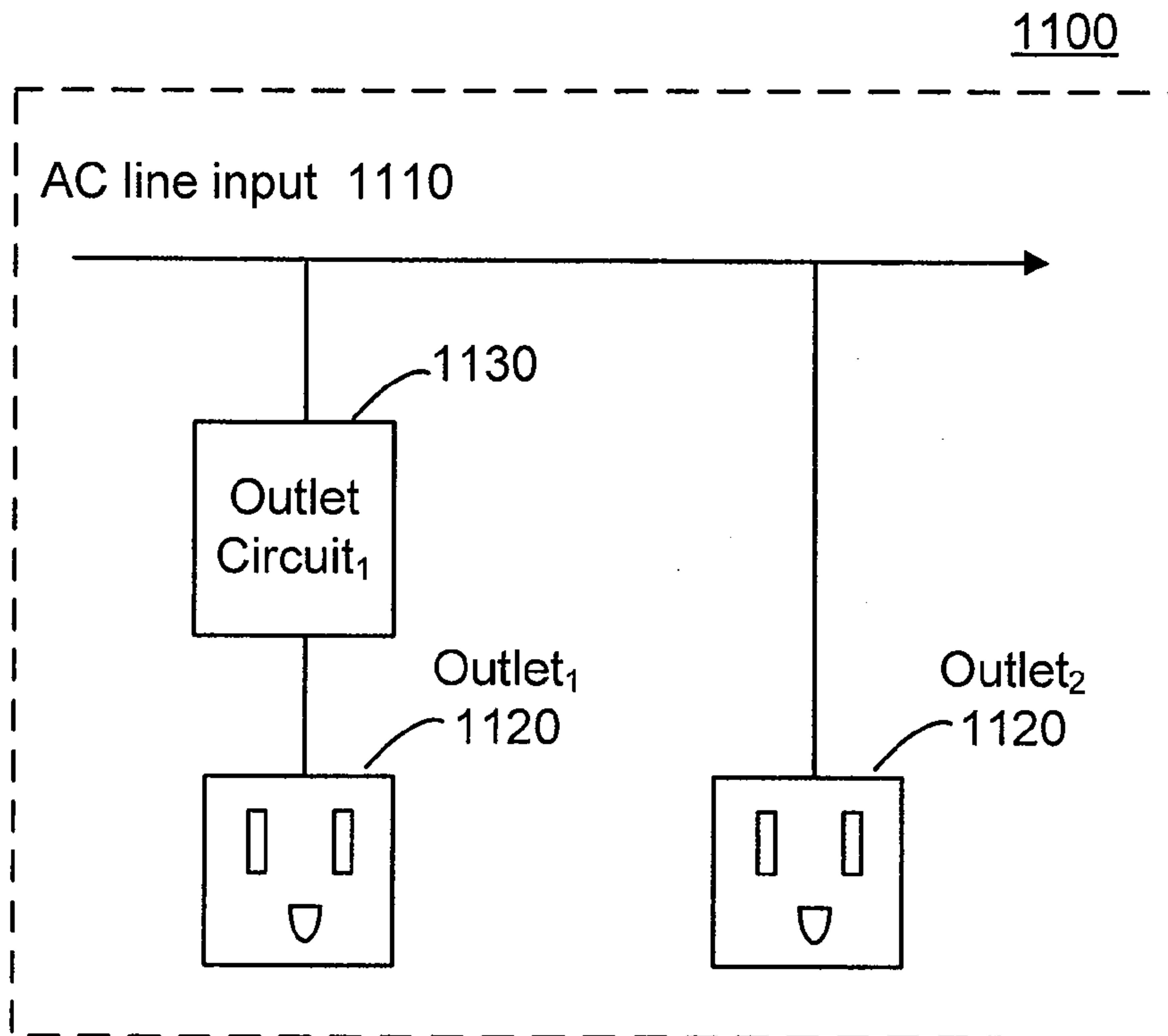


Figure 11B

1100

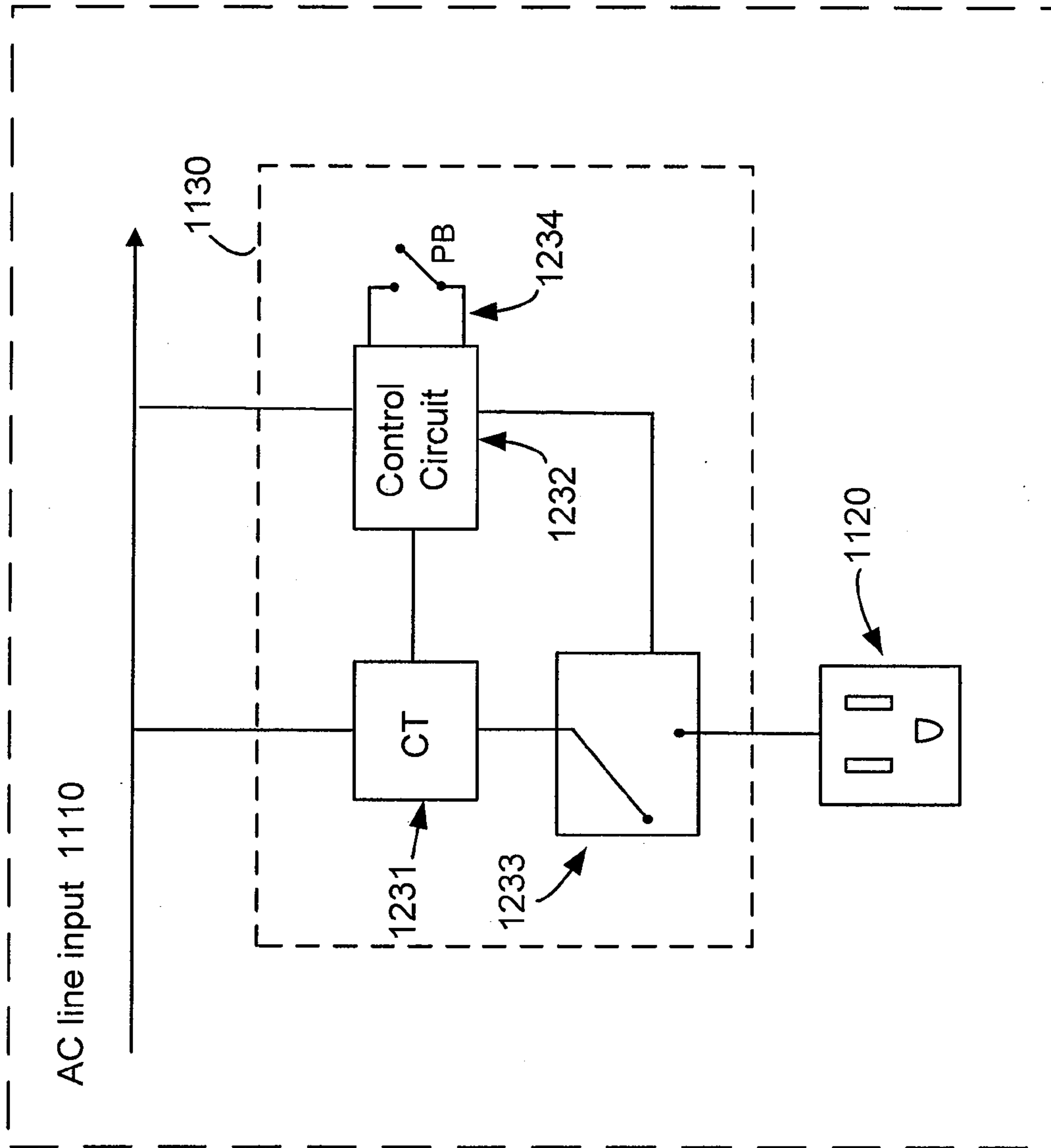


Figure 12

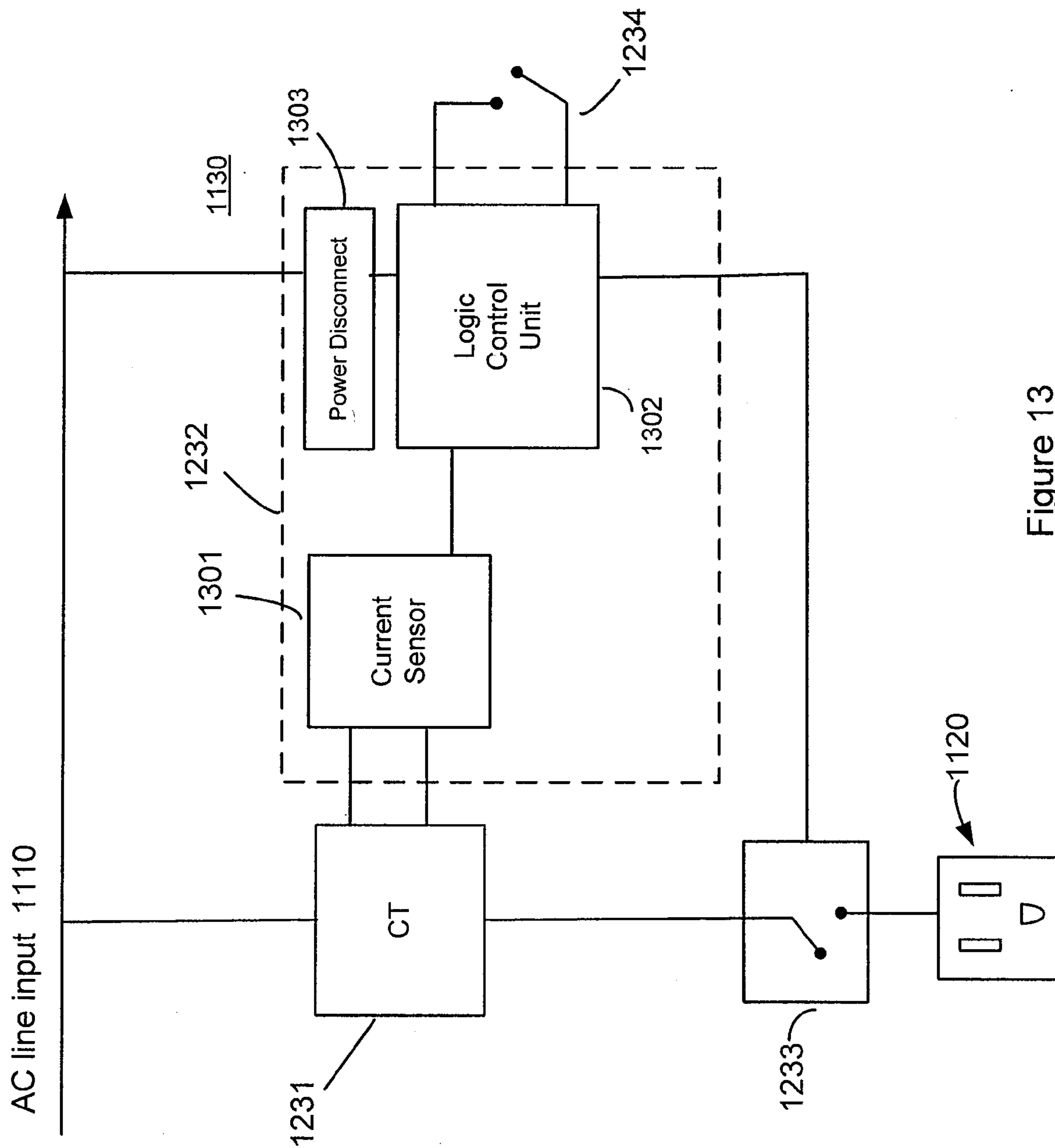


Figure 13

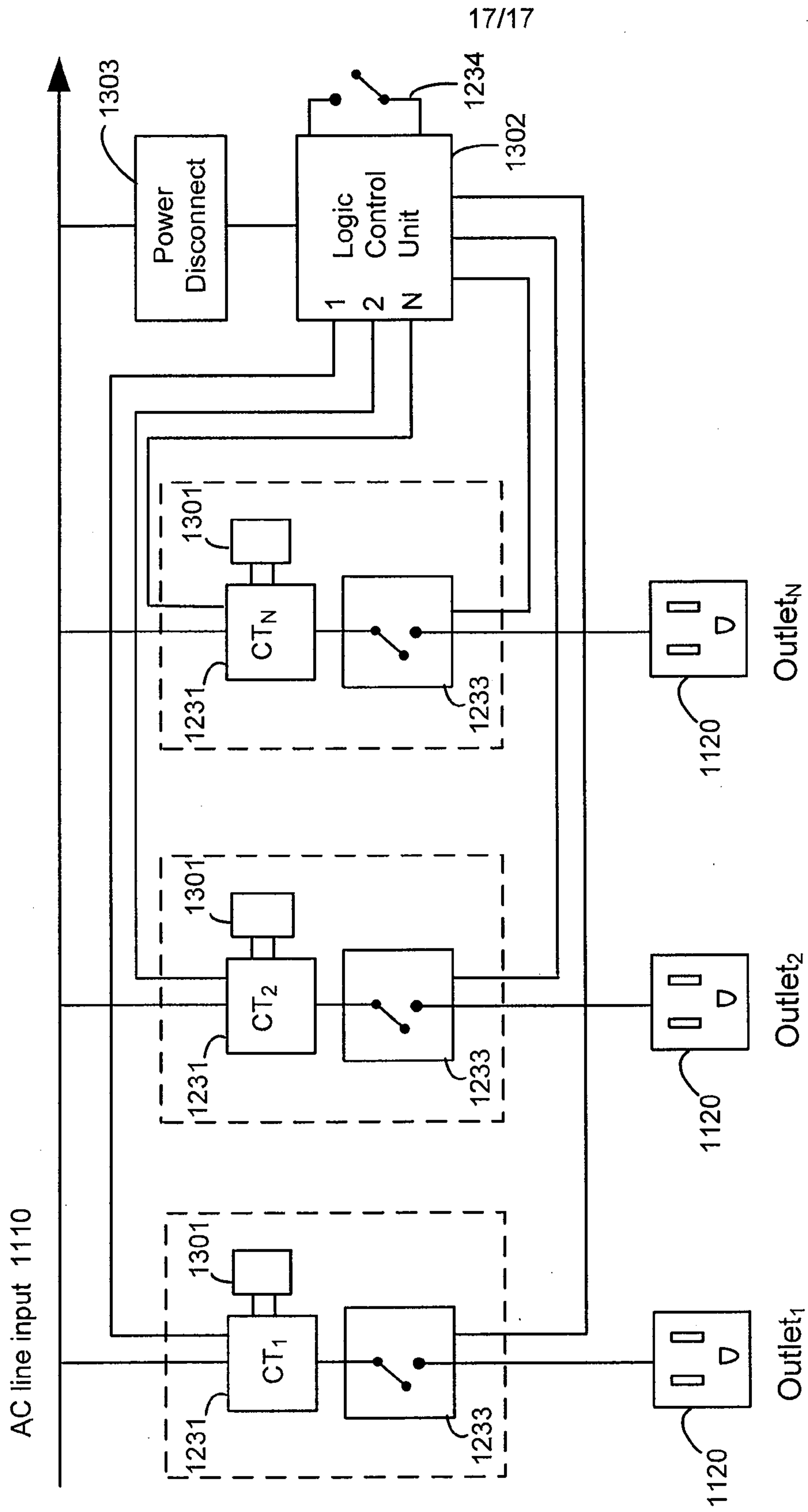


Figure 14

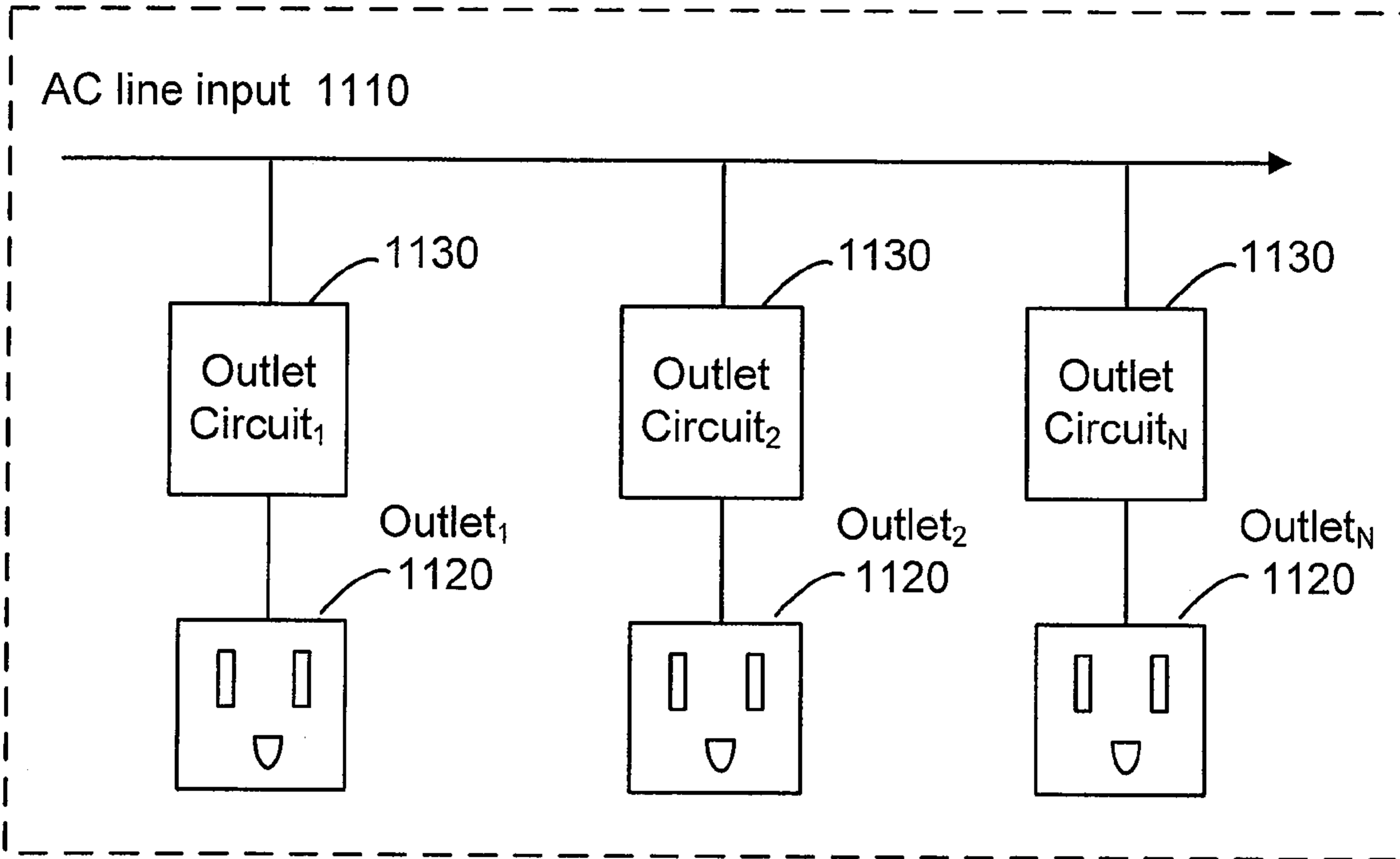


Figure 11A