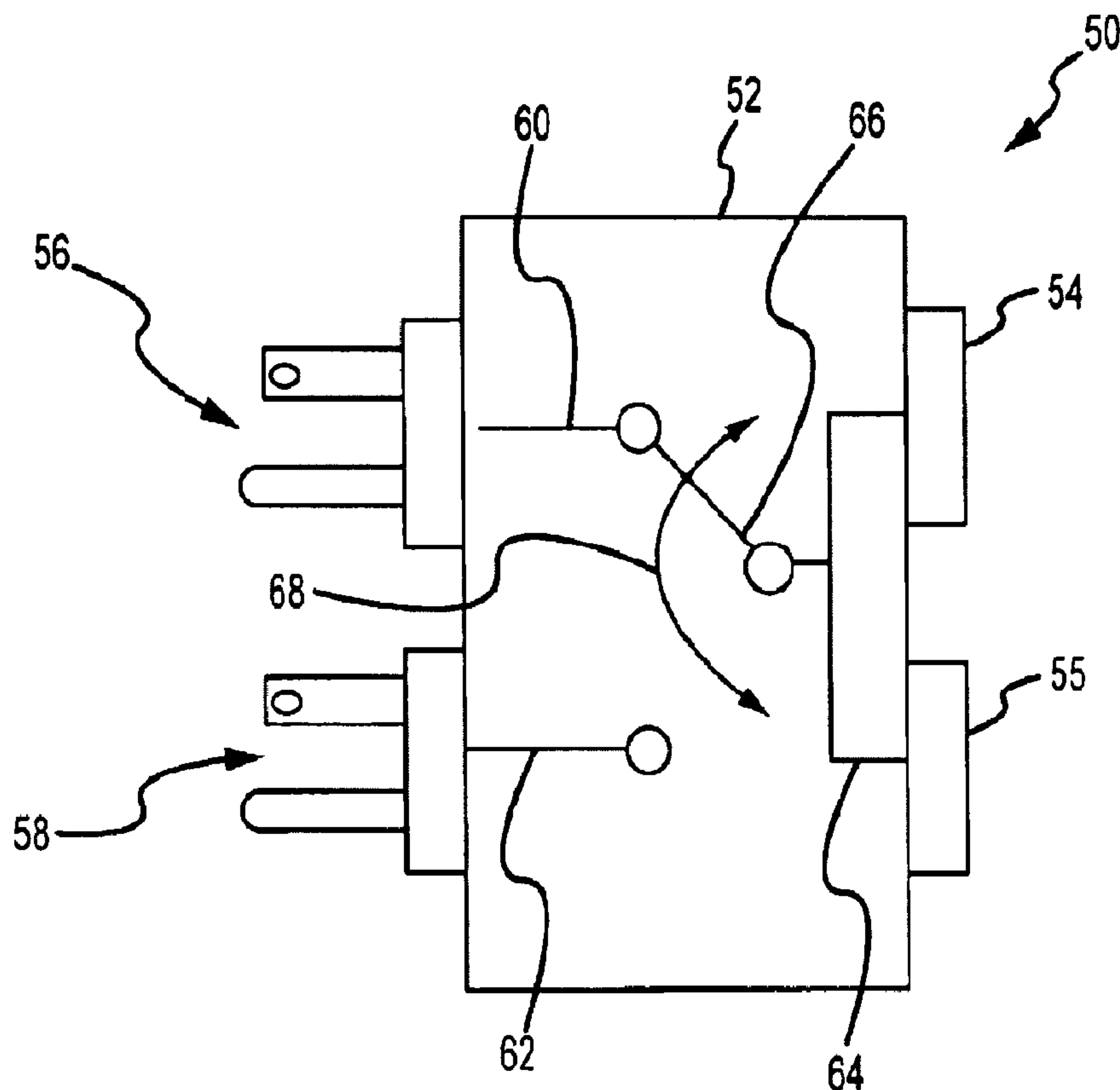




(86) Date de dépôt PCT/PCT Filing Date: 2008/03/14
(87) Date publication PCT/PCT Publication Date: 2008/09/18
(45) Date de délivrance/Issue Date: 2013/05/28
(85) Entrée phase nationale/National Entry: 2009/09/14
(86) N° demande PCT/PCT Application No.: US 2008/057144
(87) N° publication PCT/PCT Publication No.: 2008/113049
(30) Priorité/Priority: 2007/03/14 (US60/894,848)

(51) Cl.Int./Int.Cl. *H01R 13/70* (2006.01),
H01R 25/00 (2006.01), *H02J 3/06* (2006.01)
(72) Inventeurs/Inventors:
CHAPEL, STEVE, US;
PACHOUD, WILLIAM, US
(73) Propriétaire/Owner:
ZONIT STRUCTURED SOLUTIONS, LLC, US
(74) Agent: JOHNSON, ERNEST PETER

(54) Titre : MODULE DUPLEX A AUTOCOMMUTATION NEMA
(54) Title: NEMA AUTO-SWITCHING DUPLEX MODULE



(57) Abrégé/Abstract:

A system and method, i.e., a utility (50) for providing power to an electrically powered device from alternate, redundant power sources via a single power cord. The utility (50) is operable to provide redundant power to an electrical device having a power cord



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

terminating in a standard plug. The utility (50) is operable to sense an interruption of power from one power source, and to switch a connection to another power source in response to the interruption. The housing (52) of the utility (50) may be configured to match the form factor of a standard (e.g., NEMA or other electrical standard) duplex receptacle unit. The utility may be incorporated into a standard outlet box or may plug into a standard outlet box.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
18 September 2008 (18.09.2008)

PCT

(10) International Publication Number
WO 2008/113049 A1(51) International Patent Classification:
H02J 7/00 (2006.01)(US). **PACHOUD, William** [US/US]; 2385 Balsam Drive,
Boulder, Colorado 80304 (US).(21) International Application Number:
PCT/US2008/057144(74) Agent: **MARSH FISCHMANN & BREYFOGLE LLP**;
Bobby B. Soltani, 3151 S. Vaughn Way, #411, Aurora, Col-
orado 80014 (US).

(22) International Filing Date: 14 March 2008 (14.03.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/894,848 14 March 2007 (14.03.2007) US(71) Applicant (for all designated States except US): **ZONIT
STRUCTURED SOLUTIONS, LLC** [US/US]; 1790
30th Street, #140, Boulder, Colorado 80301 (US).(81) **Designated States** (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE,
EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID,
IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC,
LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN,
MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH,
PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV,
SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN,
ZA, ZM, ZW.

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CHAPEL, Steve**
[US/US]; 30037 County Road 56, Iliff, Colorado 80736(84) **Designated States** (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,

[Continued on next page]

(54) Title: NEMA AUTO-SWITCHING DUPLEX MODULE

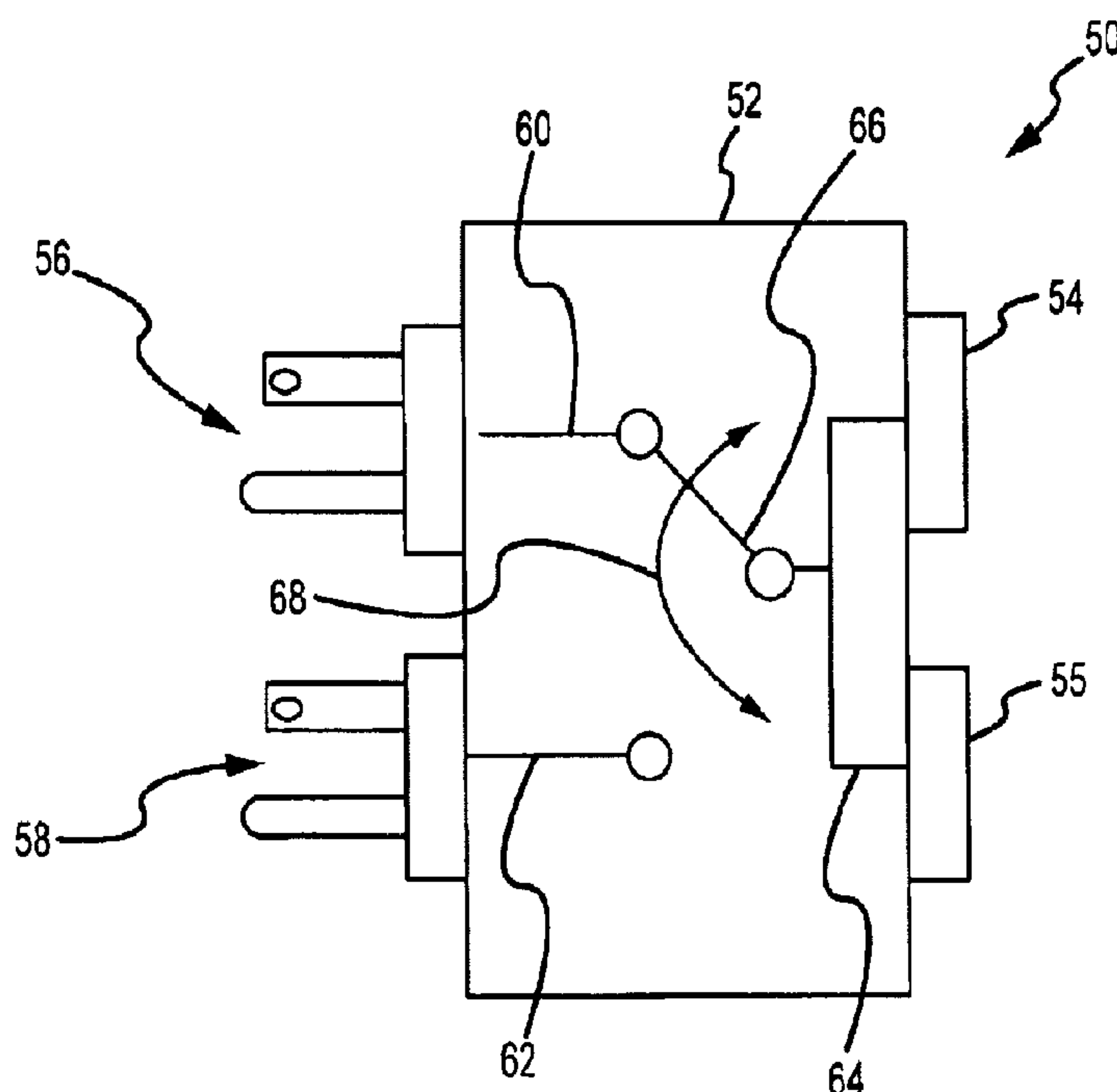


FIG.4

(57) **Abstract:** A system and method, i.e., a utility (50) for providing power to an electrically powered device from alternate, redundant power sources via a single power cord. The utility (50) is operable to provide redundant power to an electrical device having a power cord terminating in a standard plug. The utility (50) is operable to sense an interruption of power from one power source, and to switch a connection to another power source in response to the interruption. The housing (52) of the utility (50) may be configured to match the form factor of a standard (e.g., NEMA or other electrical standard) duplex receptacle unit. The utility may be incorporated into a standard outlet box or may plug into a standard outlet box.

WO 2008/113049 A1

WO 2008/113049 A1



ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,
NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG,
CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

NEMA AUTO-SWITCHING DUPLEX MODULE

BACKGROUND

It is often the case that data processing equipment and medical devices have only
5 one power supply, and therefore, one power cord. These types of equipment may often
be employed in critical applications. For example, medical equipment may be used in
situations where a person's life may be dependent upon the continuing operation of the
medical device. Additionally, electronic data processing (EDP) equipment may be used
in various systems where "downtime" may be extremely costly. Therefore, it is desirable
10 to minimize the downtime of these devices.

One of the most significant causes of downtime for electronic equipment is loss of
power. This may occur due to human error, failure of a component in the device, or
failure of a component in the power delivery path that leads to the device. To provide for
greater reliability, redundancy is often provided in these "mission-critical" applications
15 by implementing systems that greatly increase the complexity of the application. Further,
this redundancy often comes at a high price because each system generally will have a
duplicate standby power supply to provide power in the event of an interruption of power
from the main power supply.

It is against this background that the auto-switching duplex module of the present invention has been developed.

SUMMARY

5 The present invention is directed to a system for providing power to an electrically powered device -- e.g., such as a critical network device, critical medical device, or other critical or non-critical device, from alternate, redundant power sources via a single power cord. In this manner, a higher degree of reliability can be achieved for conventional electrical devices having a single power cord. Moreover, such reliability can be achieved
10 by appropriately configuring conventional outlets without requiring additional power cords. The invention can therefore be implemented simply and with minimal expense, thus enabling higher reliability in many contexts.

In accordance with one aspect of the present invention, an apparatus is provided for use in delivering power to a device having a power cord terminating in a standard
15 plug. The apparatus includes a first standard receptacle for receiving a standard plug, first and second terminal assemblies for interconnection to respective first and second power sources, and a switch for selectively interconnecting the first standard receptacle to either the first terminal assembly or the second terminal assembly. In this manner, a single standard receptacle allows access to alternate power sources for enhanced reliability.

20 For example, the switch may operate automatically upon interruption of power. That is, the switch may be operative for sensing an interruption of power from one of the power sources and for switching a connection of the receptacle in response to the interruption. In addition, the apparatus may be configured to approximate the form factor of a standard (e.g., NEMA or other electrical standard) duplex receptacle unit. That is,
25 the apparatus may be incorporated into a standard outlet box or may plug into a standard

outlet box. In this regard, the apparatus may include a second standard receptacle, which may also be switchable between the two power sources. In one implementation, the apparatus can be used in conjunction with an appropriately configured conventional power strip. For example, where the power strip provides outlets associated with first and
5 second power sources, the apparatus may be plugged into the power strip to provide an auto-switching receptacle. Alternatively, the strip may be plugged into the auto-switching receptacle such that the strip provides a number of auto-switching receptacles to provide power to various electrical devices.

The auto-switching module may be implemented in a small device suitable for
10 deployment in back of a rack-mounted device. For example, a single cord from a device is connected to two power strips, associated with two power sources, by way of a “y” configured set of cords. The auto-switching module can be used to provide auto-switching as between the two sources (e.g., at the “y” intersection) so as to implement auto-switching at the device, rather than at the rack level, as may be desired.

15 In accordance with another aspect of the present invention, a method for operating an auto-switching receptacle is provided. The method involves providing a first standard receptacle for receiving a standard plug where the receptacle is selectively associated with first and second power sources via a switch. An auto-switch device senses an interruption of power from one of the power sources and, responsive to the interruption, the switch
20 cycles to provide power from the other source via the standard receptacle.

According to a still further aspect of the present invention, a method for using an auto-switching receptacle is provided. The method involves providing a module, including a module receptacle for receiving a standard plug, and a switch for switching a

power source connection of the module receptacle. The method further involves connecting the module to first and second power sources and connecting a standard plug to the module receptacle.

For example, the module may be connected to the first and second power sources
5 by providing a standard duplex electrical outlet configured to provide power from first and second power sources and connecting the module to the standard outlet. Similarly, the module may be connected to the first and second power sources by providing a power strip having receptacles to provide power from the first and second sources and connecting the module to the power strip. The standard plug may be connected to the
10 module by plugging the standard plug into the receptacle or may be indirectly connected.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a block diagram of an application for an auto-switching module of the present invention.

15 Figure 2 illustrates an exemplary auto-switching module of the present invention.

Figure 3 illustrates another exemplary auto-switching module of the present invention.

Figure 4 illustrates another exemplary auto-switching module of the present invention.

20 Figure 5A illustrates an application for the auto-switching module shown in Figure 4.

Figure 5B illustrates an application for an exemplary auto-switching module.

Figure 6 illustrates an application for the auto-switching module shown in Figure 2.

Figure 7 illustrates another application for the auto-switching module shown in
25 Figure 4.

Figure 8 illustrates a schematic diagram for an exemplary auto-switching module.

DETAILED DESCRIPTION

While the invention is susceptible to various modifications and alternative forms,
5 specific embodiments thereof have been shown by way of example in the drawings and
are herein described in detail. It should be understood, however, that it is not intended to
limit the invention to the particular form disclosed, but rather, the invention is to cover all
modifications, equivalents, and alternatives falling within the scope and spirit of the
invention as defined by the claims.

10 Figure 1 illustrates a block diagram of an application for an auto-switching duplex
module 1 of the present invention. The module 1 may be configured to match the form
factor of a standard (e.g., NEMA or other electrical standard) duplex receptacle unit.
That is, the module 1 may be incorporated into a standard outlet box or may plug into a
standard outlet box. The module 1 may be coupled to one or more electronic devices
15 (e.g., electronic devices 7, 9) that may each include a single power cord that terminates in
a standard plug. The electronic devices may be any electrically powered device, such as a
critical network device, critical medical device, or other critical or non-critical devices.
The module 1 may include one or more standard receptacles for receiving a standard plug
of the electronic devices 7 and 9. Further, the module 1 may be adapted to include
20 terminal assemblies or wire-lead connections that permit coupling to a power source 3
and a power source 5.

The module 1 may include logic for selectively interconnecting the standard
receptacles to the terminal assembly that is coupled to either the power source 3 or the
power source 5. In this regard, each standard receptacle, and therefore each electronic
25 device, is provided with access to alternate power sources for enhanced reliability. The

logic for selectively interconnecting the standard receptacles to the terminal assemblies may include a switch that is operable to automatically cycle upon the interruption of power. That is, the switch may be operative for sensing an interruption of power on one of the power sources (e.g., the power source 3), and for switching a connection of the
5 standard receptacles in response to the interruption.

Figure 2 illustrates an auto-switching module 10 that is configured to match the form factor of a standard (e.g., NEMA or other electrical standard) duplex receptacle unit. The housing 12 of the module 10 may include terminal assemblies (e.g., plugs 16 and 18) that are configured to plug into a standard duplex receptacle unit. The module 10 may
10 further include a standard receptacle 14 for receiving a standard plug from an electronically powered device (e.g., a network device, a medical device, etc). Inside the housing 12, the electrical connection 24 of the receptacle 14 may be selectively interconnected with the electrical connections 20 and 22 of the plugs 16 and 18, respectively, via a switching means represented by an arrow 28 and an electrical
15 connection 26. Although depicted as a single line, it should be readily understood that the electrical connections 20, 22, 24, and 26 may generally comprise multiple electrical conductors (e.g., line, neutral, ground wires, etc.).

In operation, the plugs 16 and 18 may be plugged into a standard-sized duplex receptacle unit that is configured to provide power from a first power source (e.g., the
20 power source 3 of Figure 1) at a first receptacle, and a second power source (e.g., the power source 5 of Figure 1) at a second receptacle. In this manner, the module 10 may be operable to receive power from one power source at plug 16, and to receive power from another power source at plug 18. Further, an electronically powered device that has a single power cord that terminates in a standard plug may be plugged into the module 10 at
25 the standard receptacle 14.

The switching means 28 may be operable to couple the electrical connection 26 between the electrical connection 24 of the receptacle 14 and the electrical connection 20 of the plug 16 when there is sufficient power available at plug 16 (e.g., there is no interruption of power on the power source coupled to the plug 16). The switching means 5 28 may further be operable to sense an interruption of power at the electrical connection 20 (e.g., due to an interruption of power from the power source that is coupled to the plug 16), and to then automatically couple the electrical connection 26 between the electrical connection 24 of the standard receptacle 14 and the electrical connection 22 of the plug 18, which is coupled to a separate power source. In this manner, the electronic device 10 that is plugged into the receptacle 14 of the module 10 may continue to receive power despite an interruption of power at the power source coupled to the plug 16. The switching means 28 may be any device that is suitable for this application. For example, as discussed below in relation to Figure 3, the switching means 28 may comprise one or more relay switches. Further, the switching means 28 may include one or more solid- 15 state devices. Those having skill in the art will readily recognize that various types of circuitry may be used to achieve the function of the switching means 28.

The switching means 28 may also be operable to sense a restoration of power at the plug 16, and further to switch the electrical connection 26 back to the power source coupled to the plug 16 when the power has returned to an acceptable level. In this 20 configuration, the power source coupled to the plug 16 may be designated as the primary power source, while the power source coupled to the plug 18 may serve as a secondary power source. In another configuration, the switching means 28 may be operable to sense the voltage level at both of the plugs 16 and 18, and to only cycle when an interruption of power occurs at the power source that is then coupled to the receptacle 14. That is, in this

configuration, the power sources function as alternate sources, rather than primary and secondary power sources.

It should be appreciated that the electrical wiring that supplies standard wall duplex receptacles can easily be modified during construction to supply the necessary
5 separate branch circuits to the module 10 (i.e., one branch circuit coupled to one of the receptacles of the duplex pair, and an alternate branch circuit coupled to the complementary receptacle of the duplex pair. Currently available duplex receptacles are designed to allow electrical separation of each of the receptacles of a duplex pair. Thus, retrofitting wired locations may be accomplished by delivering the required branch
10 circuits to desired locations and modifying the present configuration of the existing duplex receptacle. In this regard, the modified traditional receptacle may then be used to supply the module 10 for its intended purpose.

Figure 3 illustrates the module 10 shown in Figure 2, wherein the switching means
28 includes a relay 30. In operation, the relay 30 may be coupled to the electrical
15 connection 20 via a conductor 32. The relay 30 may be operable to couple the electrical connection 24 to the electrical connection 20 via the electrical connection 26 by a control mechanism represented by the dashed line 34 when the voltage at the plug 16 is above a predetermined threshold. That is, the voltage at the electrical connection 20 may
“energize” the relay 30 such that the control mechanism 34 couples the connection 26
20 between the connections 20 and 24. The relay 30 may further be operable to sense the voltage at the plug 16, and, in response to an interruption of power, cycle the switching means 28 by coupling the electrical connection 26 between the electrical connections 22, 24. In this manner, an electrical device that is plugged into the receptacle 14 will receive continuous power despite an interruption of power at the power source that is coupled to
25 the plug 16. In other words, the electrical device will receive power from the power

source that is coupled to the plug 18 only when the power from the power source coupled to the plug 16 is interrupted.

Figure 4 illustrates another embodiment of an auto-switching duplex module 50. In this embodiment, the housing 52 of the module 50 includes two standard receptacles 54 and 55 for receiving standard plugs from electronic devices that have power cords that terminate in standard plugs. Further, similar to the module 10 of Figure 2, the housing 52 may include standard plugs 56 and 58 that are configured to plug into a standard receptacle unit (e.g., NEMA or other electrical standard). The receptacles 54 and 55 may be coupled to an electrical connection 64, which may be selectively interconnected to alternate power sources through the switching means 68 and the electrical connections 60 and 62 that are coupled to the plugs 56 and 58. In this regard, the auto-switching duplex module 50 provides for two electrical devices to receive redundant power, which may enable higher reliability in many contexts. Further, when coupled to a standard duplex receptacle, the module 50 operates to maintain the receptacle count in the branch circuit. That is, the designed per receptacle power density of the branch circuit is preserved.

Figure 5A illustrates an exemplary application for the auto-switching module 50 shown in Figure 4. As shown, the power cords 51 and 53 of two electrical devices (now shown) may be plugged into the standard receptacles 54 and 55 of the housing 52 of the module 50. In turn, the plugs 56 and 58 of the module 50 may be plugged into standard receptacles 72 and 74 of a standard duplex receptacle unit 70 (e.g., NEMA or other electrical standard). The standard receptacle unit 70 may include terminal assemblies 76 and 78 that are adapted to couple with two power sources 80 and 82. In this manner, two electrical devices that terminate in a single standard plug may be provided with redundant power through the auto-switching duplex module 50.

Figure 5B illustrates an exemplary application for an auto-switching duplex module 40. In this embodiment, the module 40 is incorporated into the form factor of a standard duplex receptacle unit (e.g., NEMA or other electrical standard). In this regard, the power cords 51 and 53 of two electrical devices (not shown) may be plugged into the standard receptacles 43 and 44 of the module 40. Further, the module 40 may include terminal assemblies 41 and 42 for coupling to the power supplies 80 and 82, respectively. In this configuration, two electrical devices are provided with redundant power by connecting them with the module 40. Advantageously, the module 40 may be installed in any location where a conventional standard receptacle unit may be installed (e.g., a wall, a rack, a power strip, etc...).

Figure 6 illustrates an exemplary application for the auto-switching module 10 shown in Figure 2. In this application, the module 10 may be coupled to two power sources 95 and 96 through terminal assemblies 16 and 18, which may be standard plugs or any other suitable coupling mechanism. Further, a standard receptacle unit (e.g., NEMA or other electrical standard) may be included between the module 10 and the power sources 95 and 96 to provide the coupling. A conventional power strip 90 that includes a plurality of receptacles may be coupled to the module 10 at the receptacle 14. The power strip 90 may include a power cord 92 that terminates in a standard plug 94, so as to provide the necessary coupling with the module 10. In this configuration, the module 10 serves to provide the plurality of receptacles of the power strip 90 with redundant power. As can be appreciated, multiple electrical devices may be plugged into the power strip 90, and operated with redundant power sources 95 and 96.

Figure 7 illustrates yet another exemplary application for the auto-switching duplex module 50 of Figure 4. As shown, a power strip 100 is adapted to provide multiple sets of duplex receptacles (e.g., four sets of duplex receptacles). A first portion 106 (i.e.,

the top row of receptacles) of the power strip may include receptacles that are coupled to a power source 110 through a power cord 102 and a standard plug 103. Similarly, a second portion 108 (i.e., the bottom row of receptacles) of the power strip 100 may be coupled to a second power source 112 through a power cord 104 and a plug 105. Further, 5 the auto-switching duplex module 50 may be plugged into the power strip 100, such that one plug of the module 50 is plugged into one receptacle of each of the portions 106 and 108. In this manner, two electrical devices may be plugged into the receptacles 54 and 55 of the module 50, and be provided with redundant power from the power sources 110 and 112. As can be appreciated, multiple modules 50 may be plugged into the power strip 90 10 to provide additional sources of redundant power. Furthermore, the auto-switching means of the module 50 may be directly incorporated into the power strip 90, so that the power strip 90 itself provides redundant power from the power sources 110 and 112.

Figure 8 illustrates a schematic diagram of another embodiment of an auto-switching module 150. The basic functionality of the module 150 is to facilitate the fast 15 transfer of power delivered to a load power connection 172 between a primary power source connection 152 and an alternate power source connection 154. For example, the module 150 may transfer the power during a period that is less than about 15 milliseconds, and preferably less than 10 milliseconds. Generally, the module 150 operates to couple the primary power source connection 152 to the load power connection 20 172 when the power at a primary power source is stable. Further, in response to an interruption of power at the power source coupled to the primary power source connection 152, the module 150 is operable to couple the load power connection 172 to the alternate power source connection 154 that is connected to an alternate power source until power at the primary power source connection 152 is restored. The module 150 may 25 be operable to sense various power quality features on the primary power source

connection 152, and to switch the power connection in response to these features. The power quality features sensed by the module 150 may include interruptions, voltage sag, voltage fluctuations, frequency variations, or the like. The specific features and operation of the module 150 are described in detail below.

5 The module 150 includes two single pole double throw (SPDT) relays 166 and 168 to facilitate the transfer of power between the primary power source connection 152 and the alternate power source connection 154. As shown, the relay 166 couples the hot conductor 156 of the primary power source connection 152 to the hot conductor 170 of the load power connection 172. The relay 166 also couples the hot node 158 of the
10 alternate power source 154 with the hot conductor 170 of the load power connection 172. Similarly, the neutral conductors 157, 159 of the primary power source connection 152 and the alternate power source connection 154, respectively, are also coupled to the neutral conductor 171 of the load power connection 172 through relay 168.

 The module 150 also includes a third SPDT relay 164 that is positioned in the path
15 of the primary power source connection 152. The relay 164 serves to protect against an undesirable effect referred to herein as “arc carryover.” Arc carryover occurs when the current through the contacts of a relay is great enough to allow an arc generated by the breaking of a contact to which a load was previously connected to continue until the contact reaches the alternate source. This may result in an effective short-circuit between
20 two power sources, which under certain conditions, may cause the current to increase rapidly, which could damage equipment or trip a circuit protection device, causing system downtime. One way to reduce the probability of arc carryover is to ensure a sufficient separation gap between the primary input relay contact and the secondary relay contact. However, in space-limited applications, the size restrictions for the module 150 may
25 preclude the use of relays having a sufficient separation gap.

To reduce the probability of arc carryover, the relay 164 is introduced in the path of the primary power source connection 152 as a disconnect relay. That is, the alternate pole of the relay 164 is unconnected. The relay 164 functions in a timed relationship with the relays 166, 168 in a manner such that during a transfer sequence from one power source to the other, the disconnect relay 164 disengages the primary power path from the secondary power path during the short period when the transfer relays 166 and 168 change from one position to the other. By slightly offsetting the timing of the actions of the disconnect relay 164 from the switching action of the transfer relays 166 and 168, it can be assured that the AC power will pass through a zero current level during the transfer cycle. This, in conjunction with the addition of the third separation gap provided by the relay 164, increases the arc suppression capacity of the module 150 significantly. To control the timing and driving of the relays 164, 166, and 168, a Relay Driver and Synchronization section 184 is provided. The section 184 may include various analog and digital electronics to drive the relays 164, 166, and 168. Driving the relays using electronics, as opposed to direct actuation from the power sources, has advantages that are discussed below.

To further protect against arc carryover, a fuse or circuit breaker 162 is positioned in the path of the alternate power source connection 154. It should be appreciated that a fuse or circuit breaker may be applied in the path of the primary power source connection 152 in addition to, or instead of, the path of the alternate power source connection 154. The fuse or circuit breaker 162 may be a fast acting device that is operable to open prior to the opening of a branch circuit breaker, which may prevent localized overload conditions from affecting other attached equipment on the same branch circuit. In one embodiment, a 20 A power-limiting fast-acting fuse is used, but other values or other

circuit protection devices may be substituted to provide the desired protection in various applications of the module 150. Further, the circuit breaker 162 may be resettable.

The inventors have further recognized that it may be desirable to introduce a delay when returning power from the alternate power source connection 154 to the primary power source connection 152 following an interruption on the primary power source. In this regard, a delay may help reduce the number of transitions in the event that the primary power source is intermittent, or in a low-voltage condition that may cause the relays to transfer back and forth unnecessarily. As an example, a delay of three to five seconds may be introduced from the time the primary power source is stable to the time the module 150 returns power from the alternate power source to the primary power source. To provide this delay, a Voltage Sense and Return Transfer Delay section 180 is provided. The section 180 is operable to sense the voltage at the primary power source connection 152 via nodes 174 and 175. Once the section 180 has determined that the voltage at the primary power source 152 has been available for a predetermined period of time (e.g., 3 to 5 seconds), the section 180 provides a signal to the Relay Driver and Synchronization section 184. As shown, the sections 180, 184 are coupled together by an optical isolator 182 that functions to electrically isolate the primary power source connection 152 from the alternate power source connection 154. After receiving a signal from the section 180, the Relay Driver and Synchronization section 184 may then use electronic control circuitry to activate the relays 164, 166, and 168, which in turn returns power from the alternate power source connection 154 to the primary power source connection 152. It should be appreciated that the sections 180 and 184 may include various digital and/or analog components to achieve the voltage sensing and delay functions. For example, in one embodiment the section 180 includes a digital timer.

The use of electronic control circuitry by section 184 to drive the relays 164, 166, 168, instead of direct actuation by the primary power source, may provide significant advantages. In previous embodiments, the relays are energized by the primary power source, such that the primary power source remains connected to the load power connection when the primary power source is stable. In the event of a failure of the primary power source, the relays are not held, and therefore release, which in turn connects the load to the alternate power source. Upon return of power to the primary source, the relays immediately energize, therefore reconnecting the load to the primary power source. As discussed above, this configuration does not allow for a delay to be introduced when transferring from the alternative power source back to the primary power source. Further, this configuration requires the relays to be energized the majority of the time (i.e., whenever the primary power source is stable), causing unnecessary power consumption and reduced relay life expectancy, which reduces the overall reliability of the module 150.

To solve the aforementioned problems, the relays 164, 166, 168 are driven from the alternate power source connection 154. This is accomplished by coupling the relay driver section 184 to the alternate power source connection 154 through nodes 176 and 177. Therefore, the previously described electronic delay circuitry may now use the available alternate power source to operate from during the delay period. Further the relays 164, 166, and 168 may be energized only during an outage period of the primary power source 152, which may be a relatively rare event. Therefore, this configuration may significantly extend the probable life expectancy of the relays, reduce power consumption, and improve the overall reliability of the module 150. For example, in one embodiment, the average power dissipation of the module 150 is less than about 200 milliwatts, and preferably less than about 125 milliwatts.

Although not shown, it should be appreciated that various types of circuit protection devices (e.g., varistors, Zener diodes, etc.) may be coupled across the input or output conductors to limit voltage spikes due to external or switching transients. Also, various types of line filters may be included if necessary or desired.

5 While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description is to be considered as exemplary and not restrictive in character. For example, certain embodiments described hereinabove may be combinable with other described embodiments and/or arranged in other ways (e.g., process elements may be performed in other sequences). Accordingly, it
10 should be understood that only the preferred embodiment and variants thereof have been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

CLAIMSWhat is claimed:

1. A power strip for use in delivering power to a plurality of devices, comprising:

5 a first power cord for coupling with a first power source;
 a second power cord for coupling with a second power source;
 a first set of receptacles electrically coupled with the first power cord;
 a second set of receptacles electrically coupled with the second power cord; and
 a third set of receptacles electrically coupled with an auto-switching module, the
 10 auto-switching module configured to sense a reduction of power quality from one of the
 first or second power sources and to selectively interconnect the third set of receptacles to
 either the first power cord or the second power cord responsive to the reduction of power
 quality.

2. The power strip as set forth in Claim 1, wherein the auto-switching
 15 module comprises a first plug for electrically coupling with one of the first set of
 receptacles and a second plug for electrically coupling with one of the second set of
 receptacles, such that selectively interconnecting the third set of receptacles to either the
 first power cord or the second power cord responsive to the reduction of power quality
 comprises electrically coupling the third set of receptacles either to the one of the first set
 20 of receptacles via the first plug or to the one of the second set of receptacles via the
 second plug.

3. The power strip as set forth in Claim 1, wherein the third set of
 receptacles is removably coupled with the first and second sets of receptacles via the
 auto-switching module.

25 4. The power strip as set forth in Claim 1, wherein the first set of receptacles
 is arranged in a first row and the second set of receptacles is arranged in a second row
 adjacent to the first row.

5. The power strip as set forth in Claim 1, wherein the first power cord terminates in a standard power plug for plugging into a standard receptacle.

6. The power strip as set forth in Claim 1, wherein the first power cord and the second power cord are disposed in a single power cable that terminates in two power
5 plugs for plugging into two standard receptacles.

7. The power strip as set forth in Claim 1, further comprising:
an arc carryover suppresser operable to force an interrupt in current flowing into the third set of receptacles during a time when the auto-switching module is switching responsive to the reduction of power quality.

8. The power strip as set forth in Claim 1, wherein the first power source is
10 mains line power.

9. The power strip as set forth in Claim 1, wherein the auto-switching module is configured to selectively interconnect the third set of receptacles to either the first power cord or the second power cord responsive to the reduction of power quality
15 after a predetermined period of time.

10. The power strip as set forth in Claim 1, wherein the auto-switching module is configured to switch interconnection of the third set of receptacles from the first power cord to the second power cord responsive to the reduction of power quality in a period of time that is less than about 15 milliseconds.

11. The power strip as set forth in Claim 1, wherein the auto-switching
20 module comprises one or more relays.

12. The power strip as set forth in Claim 1, wherein the auto-switching module comprises a timer.

13. The power strip as set forth in Claim 1, wherein the auto-switching
25 module comprises an optical isolation circuit for isolating the first and second power sources.

14. The power strip as set forth in Claim 1, wherein the power quality includes at least one of interruptions, undervoltage, overvoltage, voltage fluctuations, or frequency variations.

15. The power strip as set forth in Claim 1, wherein the auto-switching
5 module has an average power dissipation at full load of less than about 5 watts.

16. The power strip as set forth in Claim 1, wherein the auto-switching module has an average power dissipation at no load of less than about 200 milliwatts.

17. The power strip as set forth in Claim 1, wherein the reduction in power quality corresponds to a change in value of a parameter selected from the group
10 consisting of: interruptions, under-voltage, over-voltage, under-current, over-current, voltage fluctuations, current fluctuations, and frequency variations.

18. A method for use in delivering power to a device having a power cord terminating in a standard plug, said method comprising the steps of:

coupling a power strip electrically with a first power source and a second power
15 source, so that a first set of receptacles of the power strip is electrically coupled with the first power source, a second set of receptacles of the power strip is electrically coupled with the second power source, and a third set of receptacles of the power strip is electrically coupled with the first power source via an auto-switching module;

sensing a reduction in power quality from the first power source using the auto-
20 switching module; and

switching the third set of receptacles to be electrically coupled with the second power source responsive to sensing the reduction in power quality.

19. The method as set forth in Claim 18, further comprising:

suppressing arc carryover during the step of switching the third set of receptacles
25 to be electrically coupled with the second power source.

20. The method as set forth in Claim 18, further comprising:

coupling a first plug of the auto-switching module electrically with one of the first set of receptacles so that the third set of receptacles is electrically coupled with the first power source prior to the step of switching; and

5 coupling a second plug of the auto-switching module electrically with one of the second set of receptacles,

wherein switching the third set of receptacles to be electrically coupled with the second power source responsive to sensing the reduction in power quality comprises electrically coupling the third set of receptacles with the second power source via the
10 second plug subsequent to the step of switching.

1/8

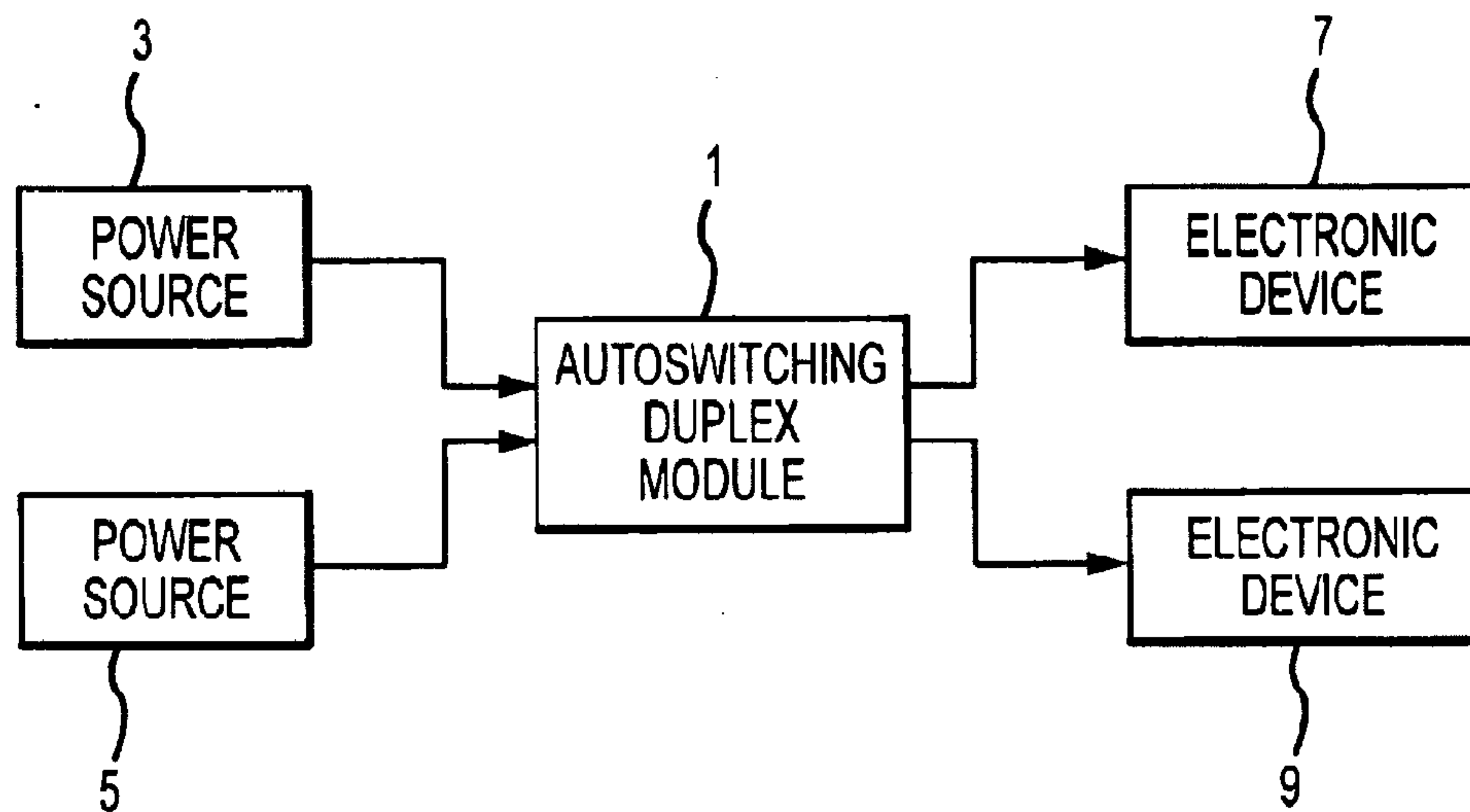


FIG.1

2/8

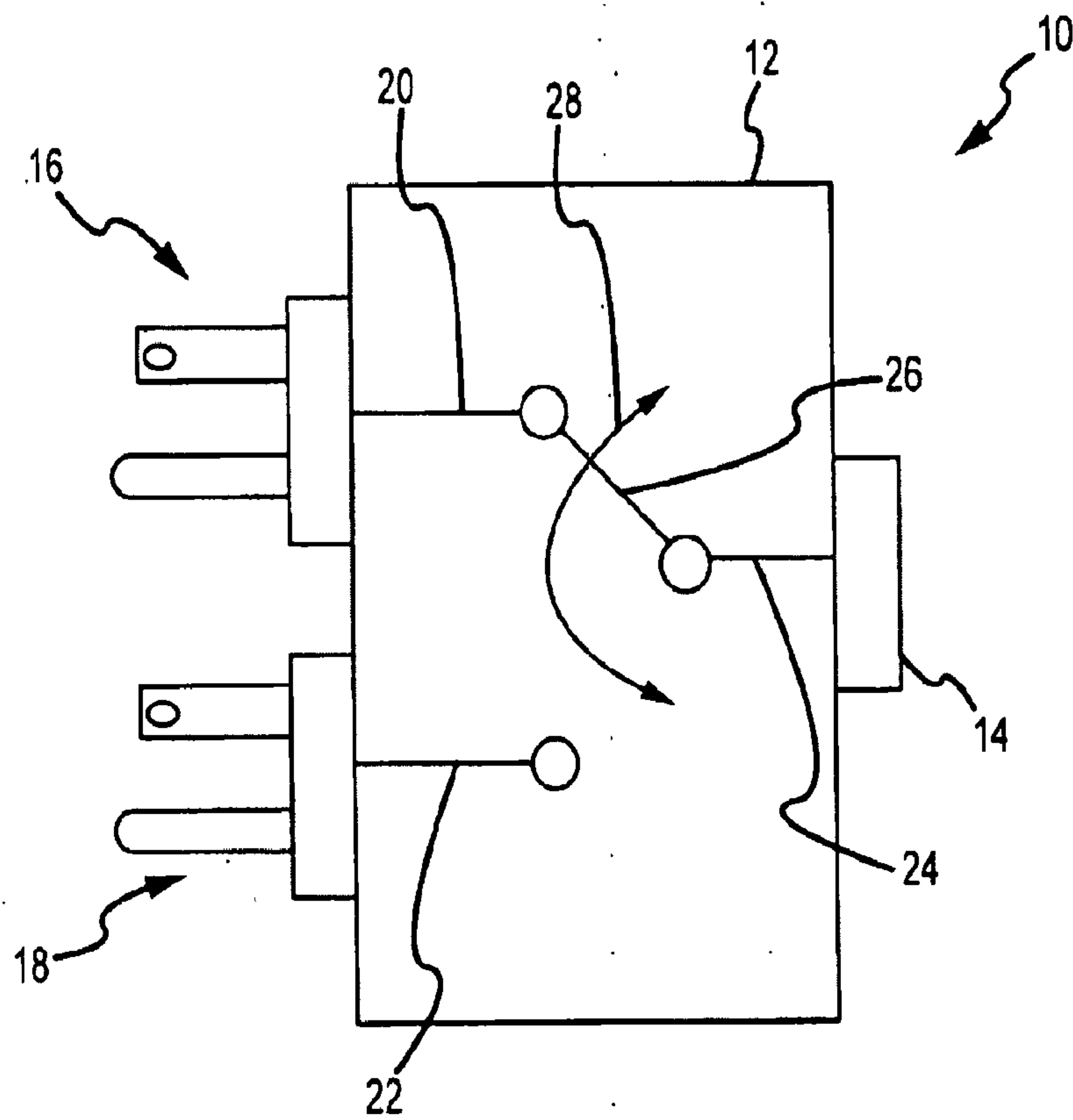


FIG.2

3/8

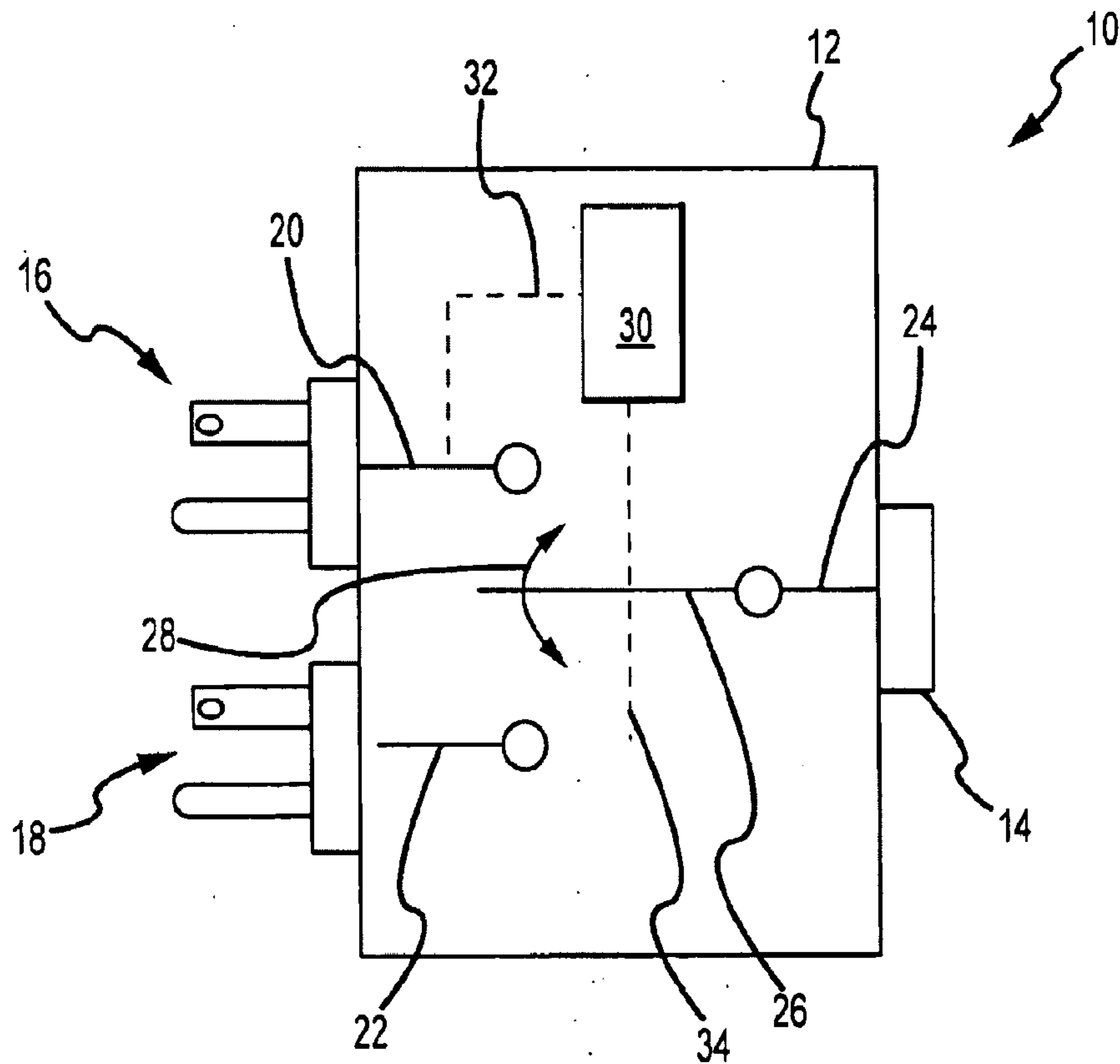


FIG.3

4/8

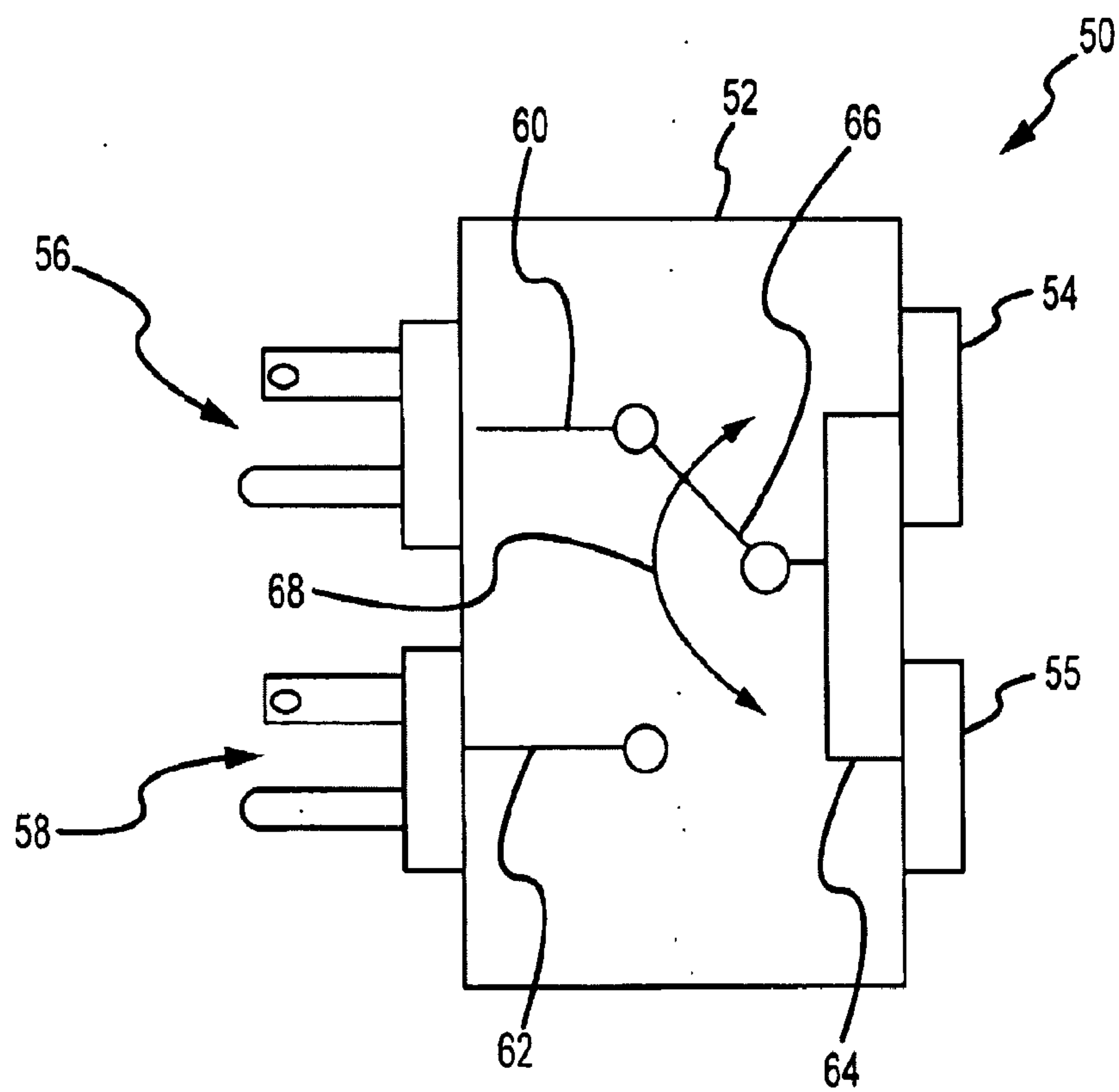
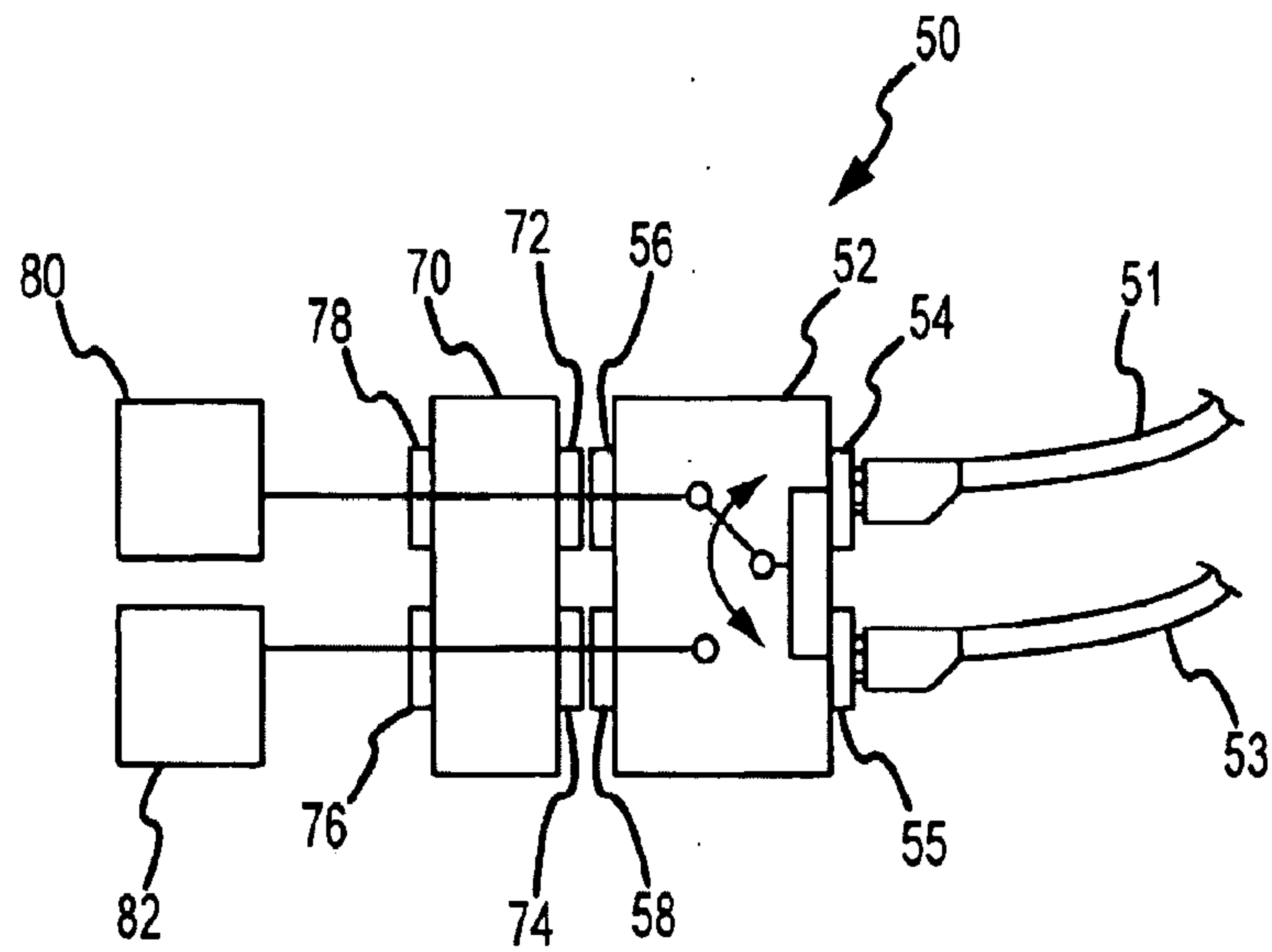
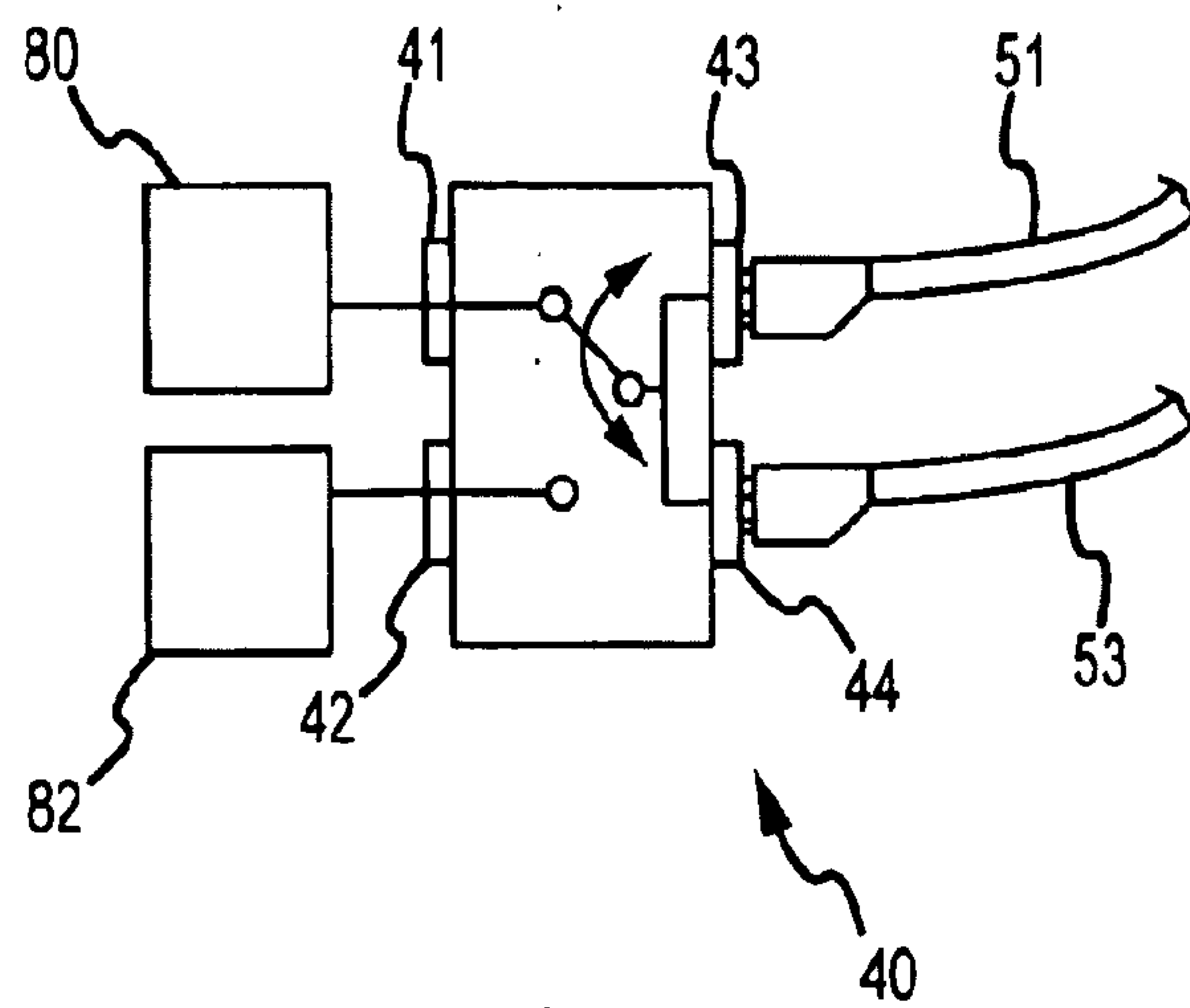


FIG.4

5/8**FIG. 5A****FIG. 5B**

6/8

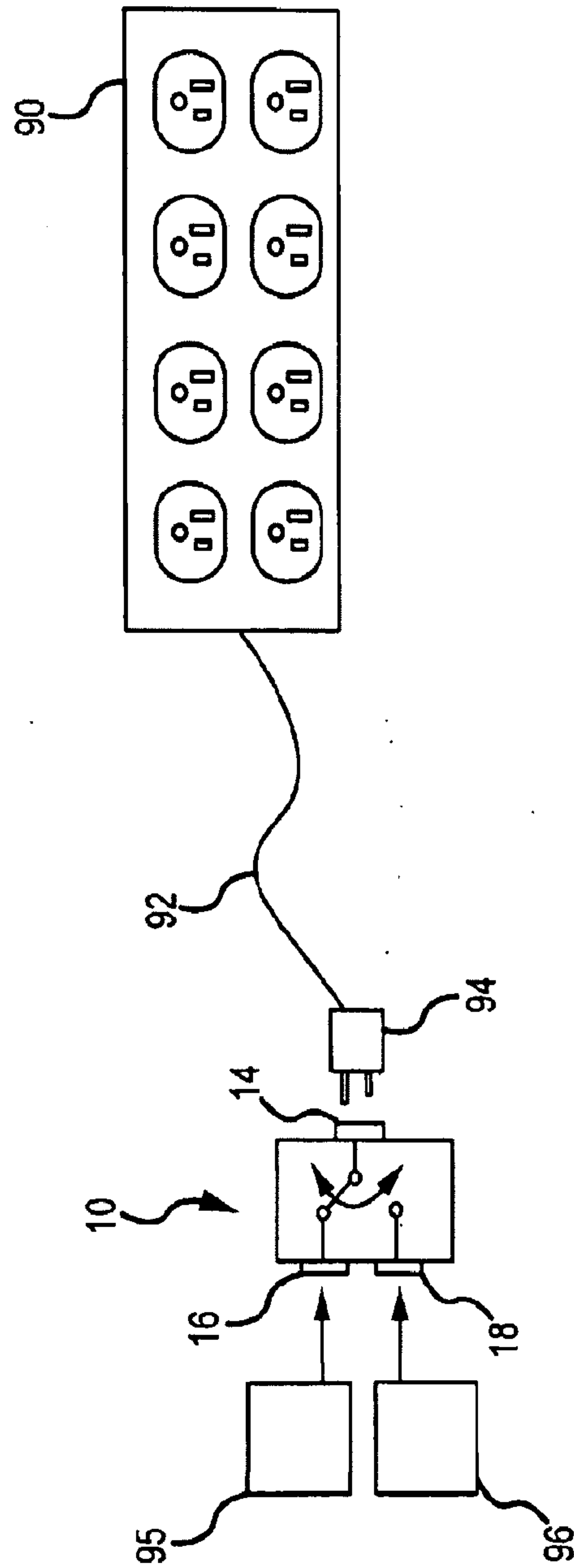


FIG. 6

7/8

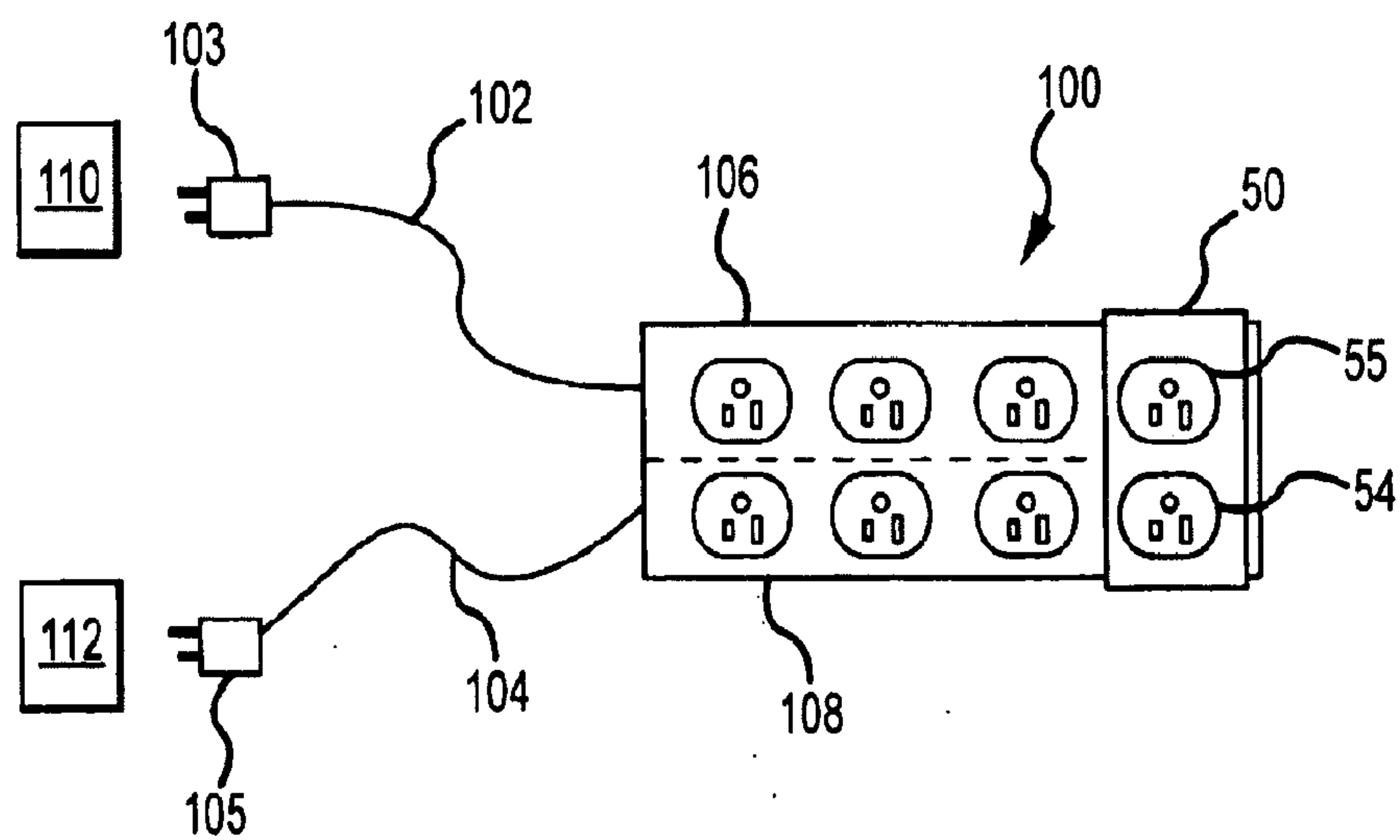
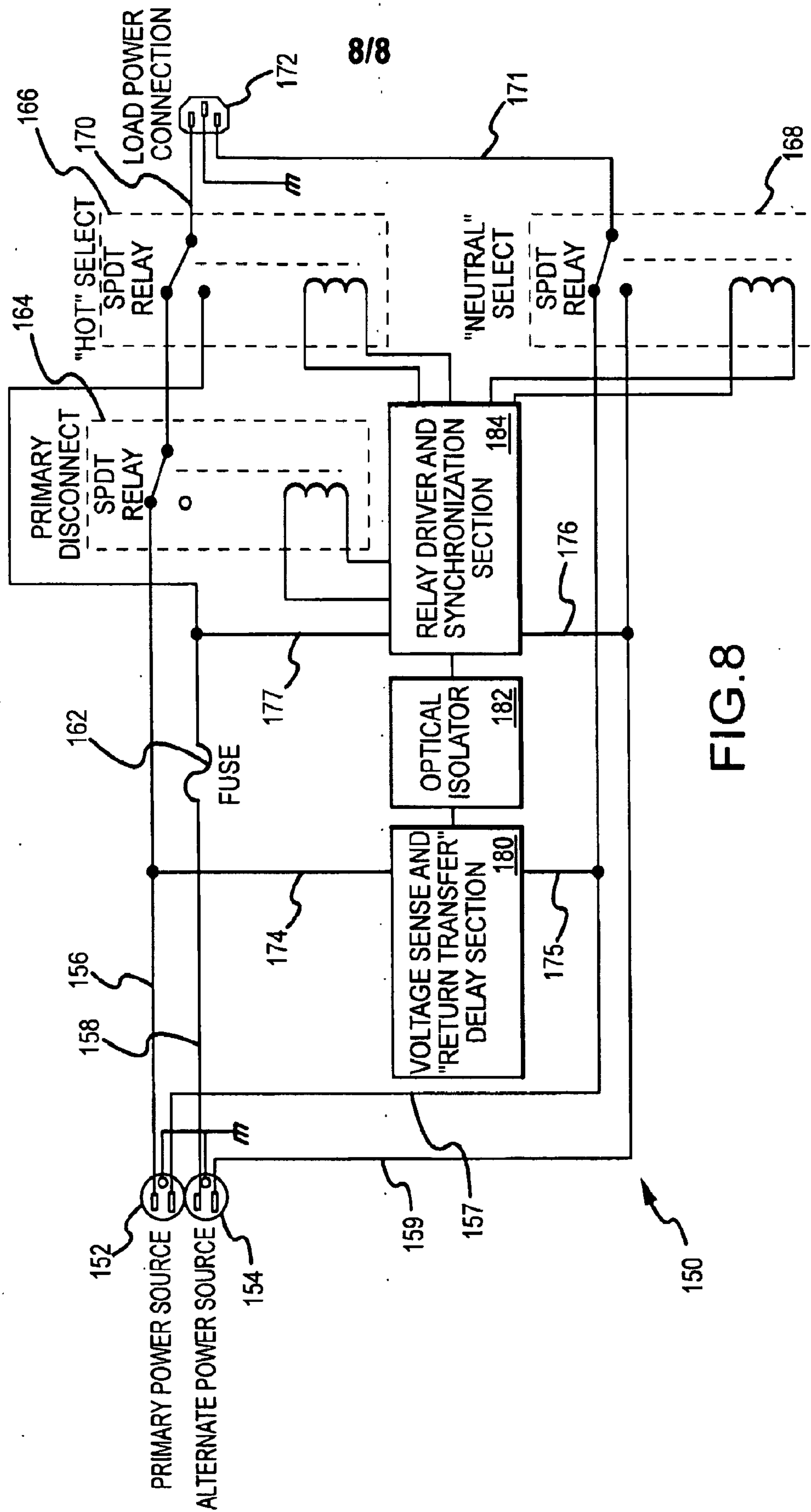


FIG. 7

**FIG.8**

