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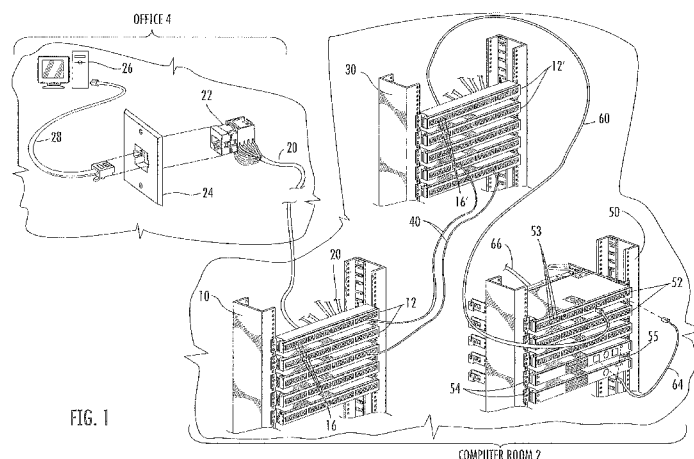
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(54) Title: MODULAR RACK CONTROLLERS FOR PATCHING SYSTEMS



(57) Abstract: A modular rack controller for an intelligent patching system includes a base unit comprising a processor and memory that monitor and log patch cord connectivity in the patching system, and a separate display unit comprising a user interface. The base unit and display unit are in electrical communication with each other via a patch cord, and the display unit displays patch cord connectivity information monitored by the base unit. The rack controller may include a separate Ethernet interface unit that allows the rack controller to communicate with other rack controllers. A mounting bracket having front and rear sides is mounted to a patch panel rack. The display unit is secured to the front side of the mounting bracket and the base unit is secured to the rear side of the mounting bracket. The mounting bracket may have a hinge that pivots the display unit relative to a patch panel rack.

MODULAR RACK CONTROLLERS FOR PATCHING SYSTEMS

RELATED APPLICATION

This application claims the benefit of and priority to U.S. Provisional Patent Application No. 61/120,197, filed December 5, 2008, the disclosure of which is incorporated herein by reference as if set forth in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to communications systems and, more particularly, to communications patching systems.

BACKGROUND

Many businesses have dedicated communications systems that enable computers, servers, printers, facsimile machines and the like to communicate with each other, through a private network, and with remote locations via a telecommunications service provider. In, for example, commercial office buildings, the dedicated communications system may be hard wired using communications cables that contain conductive wire. In such hard wired systems, individual connector ports such as modular wall jacks are mounted in offices throughout the building. Communications cables are run through, for example, the walls and/or ceilings of the building to electrically connect each connector port to network equipment (e.g., network servers) that are located in, for example, a telecommunications closet or computer room. Communications cables from external telecommunication service providers may also terminate within the computer room or telecommunications closet.

Communications patching systems are often used to interconnect

the various communication cables within a computer room or telecommunications closet. These communications patching systems may facilitate terminating the cables in an organized fashion, and may also simplify the process for later making changes to the connections between communications cables. Typically, a communications patching system includes one or more mounting frames, usually in the form of equipment racks. Network equipment such as, for example, network servers and switches may be mounted on these mounting frames, as may one or more "patch panels." As is known to those of skill in the art, a "patch panel" refers to an interconnect device that includes a plurality of connector ports such as, for example, communications jacks or fiber optic couplers on at least one side thereof. Each connector port (e.g., a jack) is configured to receive a communications cable that is terminated with a mating connector (e.g., a plug). One or more communications cables may also be terminated into a reverse side of the patch panel (the communications wires of each cable can be terminated into individual contacts or couplers such as, for example, insulation displacement contacts that are often used to terminate the conductors of a twisted pair cable, or may be terminated using a connector port such as would be the case with an RJ-45-to-RJ-45 patch panel). Each connector port on the patch panel may provide communications paths between a communications cable that is plugged into the connector port and a respective one of the communications cables that is terminated into the reverse side of the patch panel. Communications patching systems are typically used to connect individual connector ports in offices throughout the building to, for example, network equipment in the computer room of the building.

Fig. 1 is a simplified example of one way in which a computer **26** in an office or other room **4** of a building may be connected to network equipment **52**, **54** located in, for example, a computer room **2** of the building. As shown in **Fig. 1**, the computer **26** is connected by a patch cord **28** to a modular wall jack **22** that is mounted in a wall plate **24** in office **4**. A communications cable **20** is routed from the back end of the modular wall jack **22** through, for example, the walls and/or ceilings of the building, to the computer room **2**. As there will often be hundreds or thousands of wall jacks **22** within an office building, a large number of cables **20** are routed into the computer room **2**.

A first equipment rack **10** is provided within the computer room **2**. A

plurality of patch panels **12** are mounted on the first equipment rack **10**. Each patch panel **12** includes a plurality of connector ports **16**. In **Fig. 1**, each connector port **16** comprises a modular RJ-45 jack that is configured to receive a modular RJ-45 plug connector. However, it will be appreciated that other types of patch panels may be used such as, for example, patch panels with optical fiber connector ports **16** (e.g., SC, ST, and LC ports) or patch panels with other types of twisted copper wire pair connector ports **16** (e.g., RJ-11 ports).

As shown in **Fig. 1**, each communications cable **20** that provides connectivity between the computer room **2** and the various offices **4** in the building is terminated onto the back end of one of the connector ports **16** of one of the patch panels **12** on equipment rack **10**. A second equipment rack **30** is also provided in the computer room **2**. A plurality of patch panels **12'** that include connector ports **16'** are mounted on the second equipment rack **30**. A first set of patch cords **40** (only two exemplary patch cords **40** are illustrated in **Fig. 1**) are used to interconnect connector ports **16** on the patch panels **12** to respective ones of the connector ports **16'** on the patch panels **12'**. The first and second equipment racks **10**, **30** may be located in close proximity to each other (e.g., side-by-side) to simplify the routing of the patch cords **40**.

As is further shown in **Fig. 1**, network equipment such as, for example, one or more switches **52** and network routers and/or servers **54** ("network devices") are mounted on a third equipment rack **50**. Each of the switches **52** may include a plurality of connector ports **53**. A second set of patch cords **60** connect the connector ports **53** on the switches **52** to the back end of respective ones of the connector ports **16'** on the patch panels **12'**. As is also shown in **Fig. 1**, a third set of patch cords **64** may be used to interconnect other of the connector ports **53** on the switches **52** with connector ports **55** provided on the network devices **54**. In order to simplify **Fig. 1**, only a single patch cord **60** and a single patch cord **64** are shown. Finally, one or more external communications lines **66** are connected to, for example, one or more of the network devices **54**. In many instances, the communication lines **66** would terminate onto a patch panel and be connected to the network device **54** via a patch cord. For simplicity, the external communication line **66** is pictured as a cable/cord **66** in **Fig. 1**, which may be the actual external communication line or, alternatively, may be a patch cord that is connected to a patch panel connector

port which the actual external communication line is terminated into.

The communications patching system of **Fig. 1** may be used to connect each computer, printer, facsimile machine and the like **26** located throughout the building to local area network ("LAN") switches **52**, the LAN switches **52** to network routers **54**, and the network routers **54** to external communications lines **66**, thereby establishing the physical connectivity required to give devices **26** access to both local and wide area networks. In the patching system of **Fig. 1**, connectivity changes are typically made by rearranging the patch cords **40** that interconnect the connector ports **16** on the patch panels **12** with respective connector ports **16'** on the patch panels **12'**.

The equipment configuration shown in **Fig. 1**, in which each wall jack **22** is connected to the network equipment **52**, **54** through at least two patch panels **12**, **12'**, is referred to as a "cross-connect" patching system. In another commonly used equipment configuration, which is typically referred to as "inter-connect" patching system, the communications path from each modular wall jack **22** to the network devices **54** typically passes through a single patch panel **12**.

Fig. 2 depicts a simplified version of an inter-connect patching system that is used to connect a plurality of computers **126** (and other networked equipment) located in the various offices **104** throughout an office building to a plurality of network devices **154** that are located in a computer room **102** of the building. As shown in **Fig. 2**, a plurality of patch panels **112** are mounted on a first equipment rack **110**. Each patch panel **112** includes a plurality of connector ports **116**. A plurality of communications cables **120** are routed from wall jacks **122** in offices **104** into the computer room **102** and connected to the reverse side of the patch panels **112**. The computers **126** are connected to respective modular wall jacks **122** by patch cords **128**.

As is further shown in **Fig. 2**, network equipment such as, for example, one or more network devices **154**, are mounted on a second equipment rack **150**. One or more external communications lines **166** are connected (typically through one or more patch panels and patch cords) to one or more of the network devices **154**. A plurality of switches **152** that include a plurality of connector ports **153** are also provided. The switches **152** may be connected to the network devices **154** using a first set of patch cords **164** (only one patch cord **164** is shown in **Fig. 2**). A second set of patch cords **160** (only

one patch cord **160** is shown in **Fig. 2**) are used to interconnect the connector ports **116** on the patch panels **112** with respective ones of the connector ports **153** on the switches **152**. In the patching system of **Fig. 2**, connectivity changes are typically made by rearranging the patch cords **160** that interconnect the connector ports **116** on the patch panels **112** with respective connector ports **153** on the switches **152**.

"Intelligent" patch panels are now available that are capable of automatically determining when a patch cord is plugged into or removed from any of their connector ports. These intelligent patch panels can also determine, either by themselves or in conjunction with a rack controller (which is discussed below), the specific connector port on another patch panel or network switch that a patch cord that is plugged into a connector port on a first patch panel or switch is connected to. Intelligent patching systems which provide such automatic connectivity tracking capabilities are described, for example, in U.S. Patent Nos. 6,350,148 and 6,222,908.

A rack controller for intelligent patching systems may be mounted to an equipment rack of intelligent patch panels and is used to collect and store information about patch cord insertions and removals occurring at these intelligent panels. A rack controller may communicate with other rack controllers to exchange information about inter-rack patching activity.

An exemplary rack controller **200** for an intelligent patching system is illustrated in **Fig. 3**. The illustrated rack controller **200** includes an LCD display **202** that displays information about patching activity in progress (i.e., what patch cords are being inserted and removed from what connector ports, etc.), patch cord trace activity in progress, and electronic work orders for new patching activity that have been issued, etc. Typically, a technician can read a log of patch cord changes directly from the rack controller display **202** or can remotely access the log via a remote computer in communication with the rack controller **200**. Typically, the rack controller **200** also provides a network interface by which local patching and system status information can be conveyed via Ethernet (or other networking technologies) to patching system management software applications, and by which electronic work orders can be received from such management applications. Conventional rack controllers, such as rack controller **200**, may also provide a keypad interface that allows users to view detailed

information about circuits being traced, to run diagnostic tests on patch panels, and to select the language used on the display **202**, among other functions.

Conventional rack controllers, such as rack controller **200**, include a processor that executes software or firmware for implementing the various functions

described above.

Rack space within wiring closets is becoming increasingly valuable.

Because conventional rack controllers typically occupy multiple spaces within a patch panel rack, it would be desirable to reduce the footprint of conventional

rack controllers. In addition, conventional rack controllers typically include

Ethernet circuitry for connection to the Ethernet LAN of a building. However, only

one rack controller in a wiring closet is conventionally connected to the Ethernet

LAN of a building. As such, when multiple rack controllers are utilized in a wiring

closet, the Ethernet circuitry in the additional rack controllers is not utilized and is

an extra cost. Moreover, the Ethernet circuitry in conventional rack controllers

may not be modifiable when a customer wishes to upgrade to newer LAN

technologies. Typically, a new rack controller has to be purchased.

SUMMARY

It should be appreciated that this Summary is provided to introduce

a selection of concepts in a simplified form, the concepts being further described

below in the Detailed Description. This Summary is not intended to identify key

features or essential features of this disclosure, nor is it intended to limit the

scope of the invention.

According to some embodiments of the present invention, a

modular rack controller for an intelligent patching system includes a base unit

comprising a processor and memory that monitor and log patch cord connectivity

in the patching system, and a separate display unit comprising a user interface.

The base unit and display unit are in electrical communication with each other

via a patch cord, and the display unit is configured to display patch cord

connectivity information monitored by the base unit. In some embodiments, the

rack controller includes a separate Ethernet interface unit that is in electrical

communication with the base unit.

In some embodiments, a mounting bracket having front and rear

sides is configured to be mounted to a patch panel rack. The display unit is

secured to the front side of the mounting bracket, and the base unit and, optionally, an Ethernet interface unit, is secured to the rear side of the mounting bracket. The Ethernet interface unit, if included, and base unit are in electrical communication with each other.

5 In other embodiments, a mounting bracket with a hinge mechanism is configured to be secured to a patch panel rack. A display unit is secured to the mounting bracket and is pivotable relative to the patch panel rack between a first position overlying and covering a portion of a patch panel that is secured to the patch panel rack and a second position extending away from the patch panel
10 and permitting access to the patch panel.

According to some embodiments of the present invention, a communications patching system includes a cabinet having an interior space, a door pivotally secured to the cabinet and movable between a closed position closing the cabinet interior space and an open position exposing the cabinet
15 interior space, a patch panel rack disposed within the cabinet interior space, the patch panel rack having a front portion and a rear portion, one or more patch panels secured to the front portion of the rack, and a modular rack controller. The modular rack controller includes a base unit secured to the rear portion (e.g., to one of the vertical rails, etc.) of the rack or to some other structure within
20 the cabinet (e.g., on the inside wall of the cabinet, etc.). The base unit comprises a processor and memory that monitor and log patch cord connectivity in the patching system. A display unit is secured to the cabinet door, and includes a user interface. The base unit and display unit are in electrical communication with each other via a patch cord, and the display unit is configured to display
25 patch cord connectivity information monitored by the base unit. In some embodiments, the door includes an aperture formed therein, and the display unit is secured to an inside surface of the door and is visible through the aperture.

According to some embodiments of the present invention, a communications patching system includes a plurality of patch panel racks in
30 adjacent, spaced-apart relationship. Each rack supports one or more patch panels and a respective panel bus extender. A rack controller is supported by one of the racks and is electrically connected to each of the panel bus extenders. The rack controller is configured to monitor and log patch cord connectivity in all of the patch panels via the panel bus extenders.

According to some embodiments of the present invention, a communications patching system includes a patch panel rack, one or more patch panels secured to the rack, a rack controller secured to the rack that monitors and logs patch cord connectivity in the patching system, and one or more
5 environment monitors. The rack controller comprises a monitor interface module that collects measurement data from the one or more environment monitors. Exemplary environment monitors include, but are not limited to, temperature monitors, humidity monitors, airflow monitors, water/flood detection monitors, smoke monitors, physical movement monitors, power consumption monitors,
10 and the like. The monitor interface module is configured to process incoming data from the one or more monitors and to detect threshold violations of the incoming data.

In some embodiments, the monitor interface module is configured to send commands to one or more devices, wherein the commands direct the
15 one or more devices to perform a function. For example, a patch panel rack may be located within a cabinet having a locking door. The monitor interface module collects data from the locking door as to whether the door is locked or unlocked. The monitor interface module is also configured to send lock and unlock commands to the door that cause the door to lock if unlocked and to unlock if
20 locked.

According to some embodiments of the present invention, a communications patching system includes a cabinet having a locking door. A patch panel rack is located within the cabinet and one or more patch panels secured to the rack. A rack controller is also secured to the rack, and is
25 configured to monitor and logs patch cord connectivity for the one or more patch panels. The rack controller includes a monitor interface module that collects data from the locking door as to whether the door is locked and/or unlocked. The monitor interface module is also configured to send lock and/or unlock commands to the locking door. The rack controller monitors and logs who
30 performs patch cord changes when the door is unlocked. As such, unauthorized patching changes and/or erroneous patching changes can be attributed to particular personnel.

It is noted that aspects of the invention described with respect to one embodiment may be incorporated in a different embodiment although not

specifically described relative thereto. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination. Applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to be able to amend any originally filed claim to
5 depend from and/or incorporate any feature of any other claim although not originally claimed in that manner. These and other objects and/or aspects of the present invention are explained in detail in the specification set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

10 **Fig. 1** is a schematic view of a simplified prior art cross-connect communications patching system.

Fig. 2 is a schematic view of a simplified prior art inter-connect communications patching system.

15 **Fig. 3** is a front plan view of a conventional rack controller for a patching system.

Fig. 4 illustrates a modular rack controller, according to some embodiments of the present invention.

20 **Fig. 5** is a perspective view of a mounting bracket that supports the modular rack controller of **Fig. 4**, according to some embodiments of the present invention.

Figs. 6A-6B are perspective views of a mounting bracket that supports the modular rack controller of **Fig. 4**, according to other embodiments of the present invention.

25 **Fig. 7** is a top plan view of a patch panel rack located within a cabinet, wherein the display unit of the modular rack controller of **Fig. 4** is secured to the cabinet door, and wherein the base unit of the rack controller is secured to a back rail of the rack.

30 **Fig. 8** is a front view of a plurality of adjacent patch panel racks, wherein each rack includes at least one patch panel and a respective panel bus extender, according to some embodiments of the present invention.

DETAILED DESCRIPTION

The present invention now is described more fully hereinafter with reference to the accompanying drawings, in which some embodiments of the

invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Like numbers refer to like elements throughout. In the figures, the thickness of certain lines, layers, components, elements or features may be exaggerated for clarity.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the specification and relevant art and should not be interpreted in an idealized or overly formal sense unless expressly so defined herein. Well-known functions or constructions may not be described in detail for brevity and/or clarity.

It will be understood that when an element is referred to as being "on", "attached" to, "connected" to, "coupled" with, "contacting", etc., another element, it can be directly on, attached to, connected to, coupled with or contacting the other element or intervening elements may also be present. In contrast, when an element is referred to as being, for example, "directly on", "directly attached" to, "directly connected" to, "directly coupled" with or "directly contacting" another element, there are no intervening elements present.

It will be understood that, although the terms "first", "second", etc. may be used herein to describe various elements, components, patch panels, etc., these elements, components, patch panels etc. should not be limited by these terms. These terms are only used to distinguish one element, component, patch panel, etc. from another element, component, patch panel. Thus, a "first" element, component, or patch panel discussed below could also be termed a "second" element, component, or patch panel without departing from the teachings of the present invention. In addition, the sequence of operations (or steps) is not limited to the order presented in the claims or figures unless specifically indicated otherwise.

Modular Rack Controller

Referring to **Fig. 4**, a modular rack controller **300**, according to some embodiments of the present invention, is illustrated. The illustrated rack controller **300** has three physically separate units: a base unit **320** which contains the rack controller's microprocessor, memory, and panel interfaces, a display unit **310** which provides the rack controller's user interface functions (e.g., LCD display screen, keypad, speaker, and status LEDs), and an optional Ethernet interface unit **330**. The base and display units **320**, **310** communicate with one another via an RS-485 interface routed over a standard RJ-45 (or other type) patch cord **312**, with the base unit **320** providing power to the display unit **310** over this interface. The optional Ethernet interface unit **330** sits on the same bus that is used by the rack controller **300** to communicate with other rack controllers residing on adjacent equipment racks. In some embodiments, the Ethernet interface unit **330** is powered from an independent AC power adapter, and is connected to the rack controller LAN daisy chain. In other embodiments, the Ethernet interface unit **330** can be mated to another rack controller and receive power from that unit.

Referring to **Fig. 5**, a mounting bracket **400** that fits in a standard equipment rack and that takes up 1U (one unit) of space, according to some embodiments of the present invention, is illustrated. As known to those of skill in the art of the present invention, the height of electronic equipment or patch panels mounted in 19" equipment racks is standardized in the industry to be equal to or a multiple of 1.75". By convention, equipment or panels that are 1.75"

high are said to occupy 1 "rack unit." Similarly, equipment or patch panels that are 3.5" high are said to occupy 2 "rack units" (2U), etc.

The bracket **400** is configured to position the display unit **310** of the modular rack controller **300** of **Fig. 4** on the front side of a rack (not shown), and the base unit **320** and Ethernet unit **330** on the rear side of the rack. The illustrated mounting bracket **400** includes a front surface **402** to which the display unit **310** is mounted and a rear surface **404** to which the base unit **320** is mounted. An aperture **406** is formed through the bracket **400**, as illustrated. Patch cord **312** extends through the aperture **406** and connects the display unit **310** and base unit **320** together. As described above, the Ethernet unit **330** is optional for the modular rack controller **300**, and need only be included when the rack controller **300** is to handle communications with the intelligent patching system's management software for the patch panels located in the wiring closet.

Referring to **Figs. 6A-6B**, a display unit mounting bracket **500** associated with a patch panel for supporting a display unit **310**, according to other embodiments of the present invention, is illustrated. The illustrated patch panel **12** is configured to be mounted on a rack (not shown) using fasteners (not shown), such as screws, etc. During installation on a rack, the display unit mounting bracket **500** is positioned such that apertures **502** in the bracket **500** align with corresponding apertures in the end portion of the patch panel **12**. Fasteners are inserted within the apertures **502** to attach both the patch panel **12** and the display unit mounting bracket **500** to the front side of a rack. A base unit **320** and (optional) Ethernet unit **330** (not shown) can be mounted on the back side of the rack. In some embodiments, depending on the design of the particular rack or cabinet, the base and Ethernet units **320**, **330** could be secured to the back side of one of the rack rails. In other embodiments, an arcuate (e.g., U-shaped, etc.) bracket (not shown) can be used to ensure that the base and Ethernet units **320**, **330** do not interfere with cables that are terminated to the back side of patch panel **12** (or other patch panels on the rack mounted above or below patch panel **12**) and that are typically routed to cable troughs on either side of the rack, passing in close proximity to the back sides of the rack rails.

The illustrated bracket **500** has a hinge mechanism **506** that is pivotable between first and second positions. When the hinge mechanism **506** is in the first position, the display unit **310** overlies and covers a portion of a patch

panel **12** secured to the patch panel rack (not shown), as illustrated in **Fig. 6A**. When the hinge mechanism **506** is in the second position, the display unit **310** is pivoted away from a patch panel **12** to allow access to the patch panel, as illustrated in **Fig. 6B**. In the illustrated embodiment, the hinge mechanism **506** maintains the display unit **310** in spaced-apart, adjacent relationship with the patch panel **12**. Thus, the hinge mechanism **506** allows the display unit **310** to be conveniently located for displaying information about a patching system and to be easily moved out of the way to facilitate access to a patch panel **12** (or other device) as needed.

Referring to **Fig. 7**, according to other embodiments of the present invention, the base and Ethernet units **320**, **330** of the modular rack controller **300** of **Fig. 4** are configured to be mounted to the back rail **602** of an equipment rack **600**. The illustrated rack **600** is located within a cabinet **604** having a door **606** that is movable between closed and open positions. In **Fig. 7**, the cabinet door **606** is in a closed position.

The display unit **310** is mounted on the inside of the cabinet door **606** and is visible through an aperture (not shown) in the cabinet door **606**. In some embodiments, the display unit **310** is movably secured to the cabinet door **606** and is configured to rotate when the cabinet door **606** is moved between closed and open positions such that the display unit **310** is visible through the door aperture when the cabinet door **606** is closed and such that the display unit **310** is visible through the door aperture when the cabinet door **606** is open. As illustrated in **Fig. 7**, when the cabinet door **606** is closed, the display unit **310** overlies and covers a portion of a patch panel **12** secured to the patch panel rack **600**. The illustrated display unit **310** is connected to the base unit **320** via a patch cord **312**.

Panel Bus Extenders

In certain types of installations, one or more racks in a wiring closet may contain only a few patch panels **12**. The use of a single rack controller for each rack, particularly when only a few patch panels **12** are mounted to each rack, can be expensive. According to embodiments of the present invention, a rack controller can include one or more panel bus extenders that can be mounted on adjacent racks in a wiring closet and can allow a single rack

controller to support patch panels **12** on these adjacent racks. **Fig. 8** illustrates a conventional rack controller **200** coupled to a plurality of panel bus extenders **700** on four adjacent racks **600**, according to other embodiments of the present invention. The rack controller **200** collects and stores information about patch cord insertions and removals occurring at the patch panels on these adjacent racks via the panel bus extenders **700**.

The panel bus in a patch panel **12** uses an industry standard bus referred to as I2C. This bus is traditionally used to connect up electronics that are separated by very short distances, typically less than 3 meters. The panel bus extenders **700** of the present invention utilize integrated circuits that amplify the I2C bus signals, thus making it possible to extend the range of the panel bus to 60 meters, thus making it possible to extend the panel bus from one rack controller **200** to a couple of adjacent racks to either side of the rack holding the controller **200**. As such, the use of bus extenders **700** can reduce the number of rack controllers **200** required in a patching system.

Monitoring

According to other embodiments of the present invention, a rack controller can be configured to perform various monitoring functions including, but not limited to, environmental monitoring, access monitoring, etc. Exemplary environmental conditions that can be monitored include, but are not limited to, temperature, humidity, airflow, water/flood detection, and smoke detection. Other conditions within a cabinet and/or computer room that can be monitored include, but are not limited to, electrical power consumption, cabinet door open/close detection, and equipment movement (e.g., vibration, physical movement of a patch panel, patch cord, switch, router, etc.).

A rack controller, according to some embodiments of the present invention, can include one or more sensor interface modules that are configured to collect and report raw sensor measurement data. The rack controller includes firmware configured to process incoming sensor data, monitor sensor thresholds, and report any threshold violations to patch panel management software. The management software can use existing Simple Network Manager Protocol (SNMP) capabilities to notify network management systems of environmental or other alarm conditions.

Sensors can either be built into a rack controller base unit itself, or can be attached to a panel bus, such that they would receive power from and communicate with the rack controller in a fashion similar to the patch panels themselves. A hybrid approach, where the most commonly used sensors would be built directly into the rack controller base unit, while less common sensors could be added to a rack's panel bus, is also possible.

According to other embodiments of the present invention, control interface modules that plug into an existing rack controller panel bus can be used to receive commands from the rack controller firmware by way of the panel bus to perform various functions. For example, a control interface module can have the ability to unlock a cabinet door upon command from a local rack controller which in turn can respond to commands issued by patch panel management software from a remote location.

According to some embodiments of the present invention, a cabinet door has a latching mechanism that can be moved between open and closed states via either a servo motor, or electromagnets also present in the door. A control unit that could detect whether the door is in the locked or unlocked state, and which would also have the ability to drive the servo motor or electromagnets in the cabinet door, would be attached to the panel bus. A rack controller would be able to query this controller via messages sent over the panel bus to determine the current state of the door lock, and could also issue commands to the controller to move the lock to the open or closed position. Upon receipt of such a command, the controller would issue the appropriate control signals to the servo motor or electromagnets to drive the door lock into the desired state (locked or unlocked).

In some embodiments, a technician is sent a patching work order via email that contains a job ID and a password. Upon arriving at the wiring closet where the job is to be performed, the technician finds the electronic job on the rack controller's work queue, and enters the password received in the email in order to unlock the cabinet door(s).

In some embodiments, a patching system is able to detect whether a technician moved any patch cords other than the ones specified in a work order while the cabinet doors were unlocked, and can report any illicit patching changes to an administrator. In other embodiments, a technician may be given a

unique code that would allow him/her to unlock any cabinet door at their site. Any patching change that occurred while the door was opened would be attributed to the technician whose code was used to open the door. This would allow administrators to determine who was responsible for making any particular patching change that occurred at their site.

Table 1 lists various functions that can be supported according to some embodiments of the present invention.

Table 1

Remote locking/unlocking of cabinet doors
Remote relay closure that allows a customer to turn power on/off to any equipment they choose to connect to the closure device
Visual/audio warning device activation based on error conditions detected locally by rack controller, or based on instructions received from patch panel management software

According to other embodiments, a cabinet housing a rack of patch panels therein may be configured to perform various monitoring functions including, but not limited to, environmental monitoring, access monitoring, etc. Exemplary environmental conditions that can be monitored include, but are not limited to, temperature, humidity, airflow, water/flood detection, and smoke detection. Other conditions that can be monitored include, but are not limited to, electrical power consumption, cabinet door open/close detection, and movement (e.g., vibration, physical movement, etc.). Monitoring equipment can be mounted into the ceiling or flooring of a cabinet to avoid using rack mounting space. In other embodiments, the monitoring equipment can be secured to the back side of a patch panel supporting rack within the cabinet.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. The invention is defined by the

following claims, with equivalents of the claims to be included therein. The following exemplary claims are presented in the specification to support one or more devices, features, and methods of embodiments of the present invention. While not particularly listed below, Applicant preserves the right to claim other features shown or described in the application.

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THAT WHICH IS CLAIMED IS:

1. A modular rack controller for a communications patching system, comprising:
 - a base unit comprising a processor and memory that monitor and log patch cord connectivity in the patching system; and
 - 5 a separate display unit comprising a user interface, wherein the base unit and display unit are in electrical communication with each other via a cable, and wherein the display unit is configured to display patch cord connectivity information monitored by the base unit.
- 10 2. The rack controller of Claim 1, further comprising a separate Ethernet interface unit, wherein the Ethernet unit and base unit are in electrical communication with each other.
- 15 3. The rack controller of Claim 1, further comprising a mounting bracket having front and rear sides, wherein the mounting bracket is configured to be mounted to a patch panel rack, wherein the display unit is secured to the front side of the mounting bracket, wherein the base unit is secured to the rear side of the mounting bracket, and wherein the base unit and display unit are in electrical communication with each other via a patch cord.
- 20 4. The rack controller of Claim 3, further comprising an Ethernet interface unit secured to the rear side of the mounting bracket, and wherein the Ethernet unit and base unit are in electrical communication with each other, wherein the Ethernet interface is configured to allow the base unit to
- 25 5. The rack controller of Claim 1, comprising a mounting bracket with a hinge mechanism configured to be secured to a patch panel rack, wherein the display unit is secured to the mounting bracket and is pivotable
- 30 relative to the patch panel rack between a first position overlying and covering a portion of a patch panel secured to the patch panel rack and a second position

extending away from the patch panel and permitting access to the patch panel.

6. The rack controller of Claim 1 in combination with a communications patching system, wherein the communications patching system
5 comprises:

a cabinet having an interior space;

a door pivotally secured to the cabinet and movable between a closed position closing the cabinet interior space and an open position exposing the cabinet interior space;

10 a patch panel rack disposed within the cabinet interior space, the patch panel rack having a front portion and a rear portion;

one or more patch panels secured to the front portion of the rack;

and

wherein the modular rack controller base unit is secured to the rear
15 portion of the rack, and wherein the display unit is secured to the cabinet door.

7. The rack controller of Claim 6, wherein the door includes an aperture formed therein, and wherein the display unit is secured to an inside surface of the door and is visible through the aperture both when the door is in a
20 closed position and an open position.

8. A communications patching system, comprising:

a patch panel rack;

one or more patch panels secured to the rack; and

25 a rack controller secured to the rack, wherein the rack controller monitors and logs patch cord connectivity for the one or more patch panels, wherein the rack controller comprises a monitor interface module that collects measurement data from one or more environment monitors.

30 9. The communications patching system of Claim 8, wherein the one or more environment monitors are selected from the group consisting of temperature monitors, humidity monitors, airflow monitors, water/flood detection monitors, smoke monitors, physical movement monitors, power consumption monitors.

10. The communications patching system of Claim 8, wherein the one or more environment monitors are attached to the rack controller.

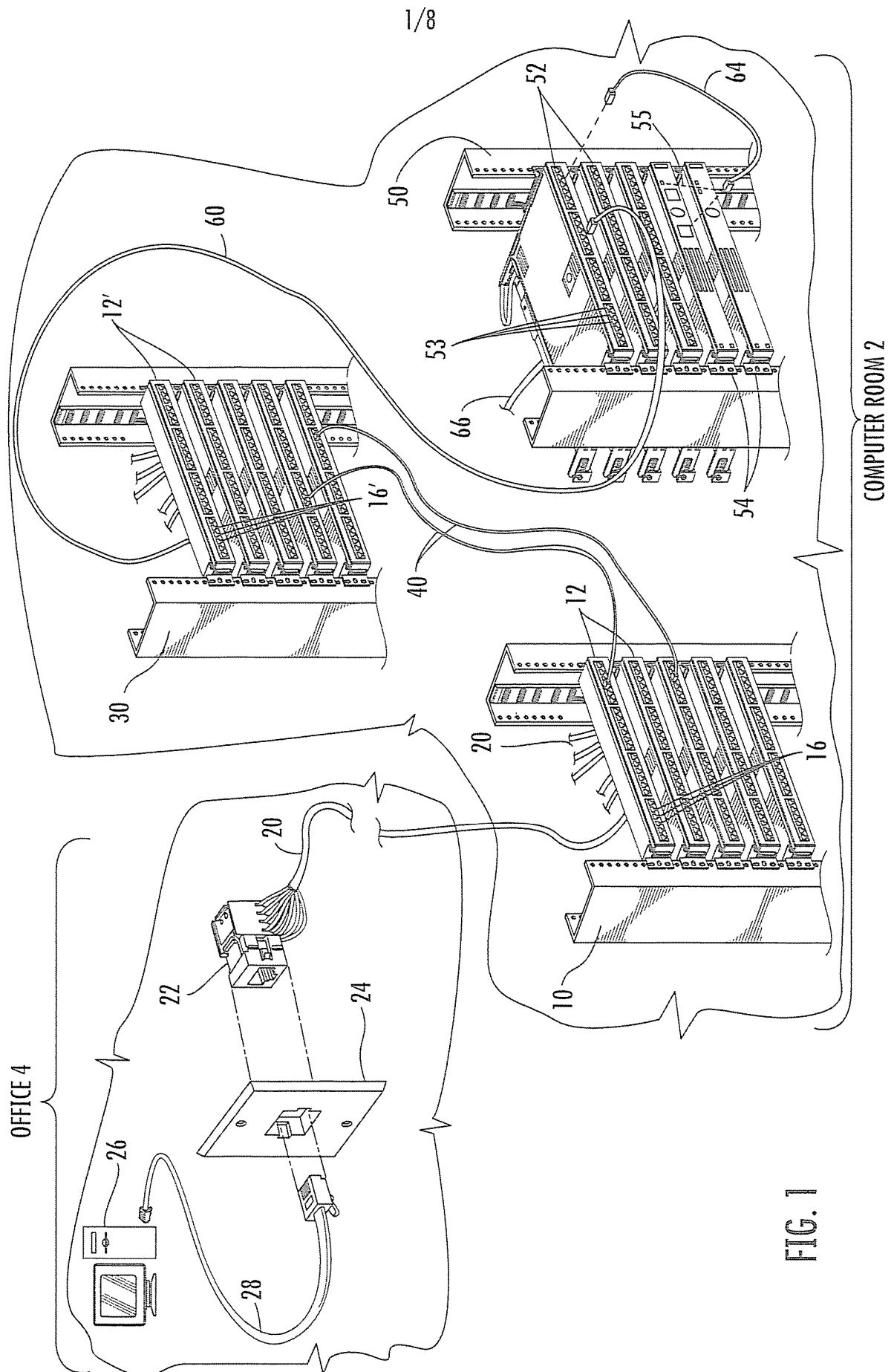
5 11. The communications patching system of Claim 8, wherein the monitor interface module is configured to process incoming data from the one or more monitors and to detect threshold violations of the incoming data.

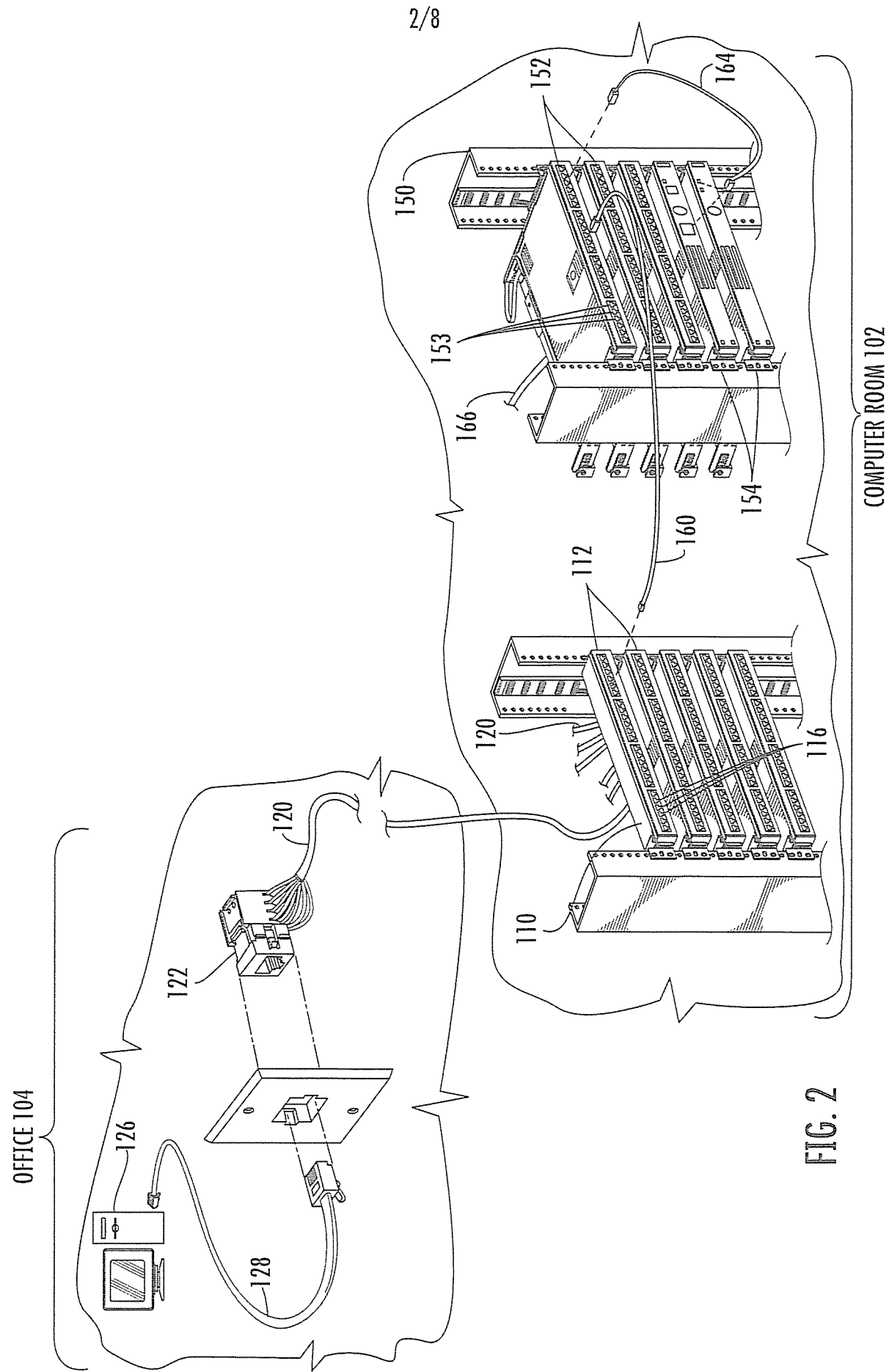
12. The communications patching system of Claim 8, wherein
10 the monitor interface module is configured to send commands to one or more devices, wherein the commands direct the one or more devices to perform a function.

13. The communications patching system of Claim 8, wherein
15 the monitor interface module is configured to turn off power to user selected equipment associated with the patching system.

14. The communications patching system of Claim 8, wherein the patch panel rack is located within a cabinet having a locking door, wherein
20 the monitor interface module collects data from the locking door as to whether the door is locked and/or unlocked, and wherein the monitor interface module is configured to send lock and/or unlock commands to the locking door.

15. A communications patching system, comprising:
25 a cabinet having a locking door;
a patch panel rack located within the cabinet;
one or more patch panels secured to the rack; and
a rack controller secured to the rack, wherein the rack controller monitors and logs patch cord connectivity for the one or more patch panels,
30 wherein the rack controller comprises a monitor interface module that collects data from the locking door as to whether the door is locked and/or unlocked, wherein the monitor interface module is configured to send lock and/or unlock commands to the locking door, and wherein the wherein the rack controller monitors and logs who performs patch cord changes when the door is unlocked.





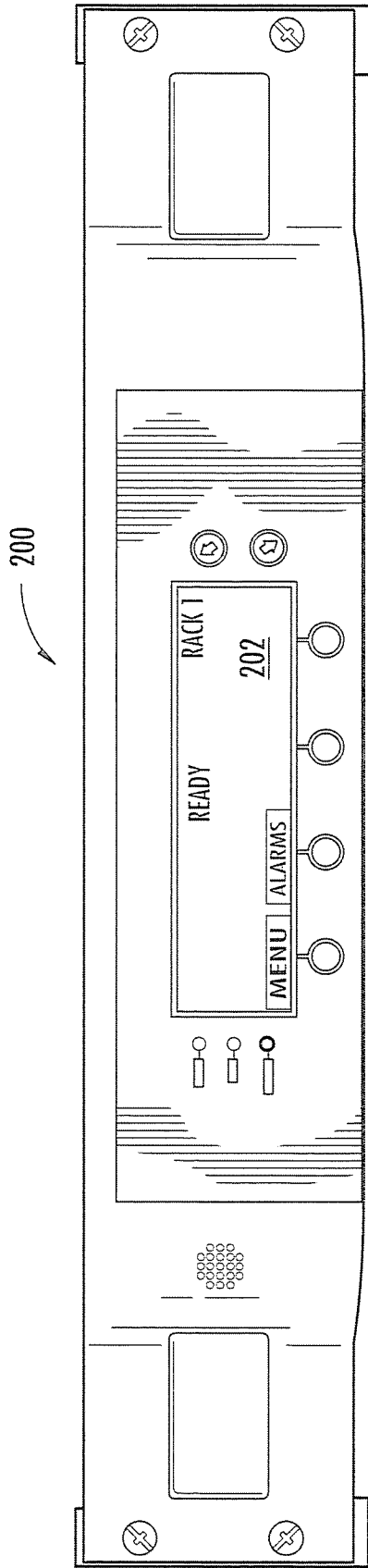


FIG. 3

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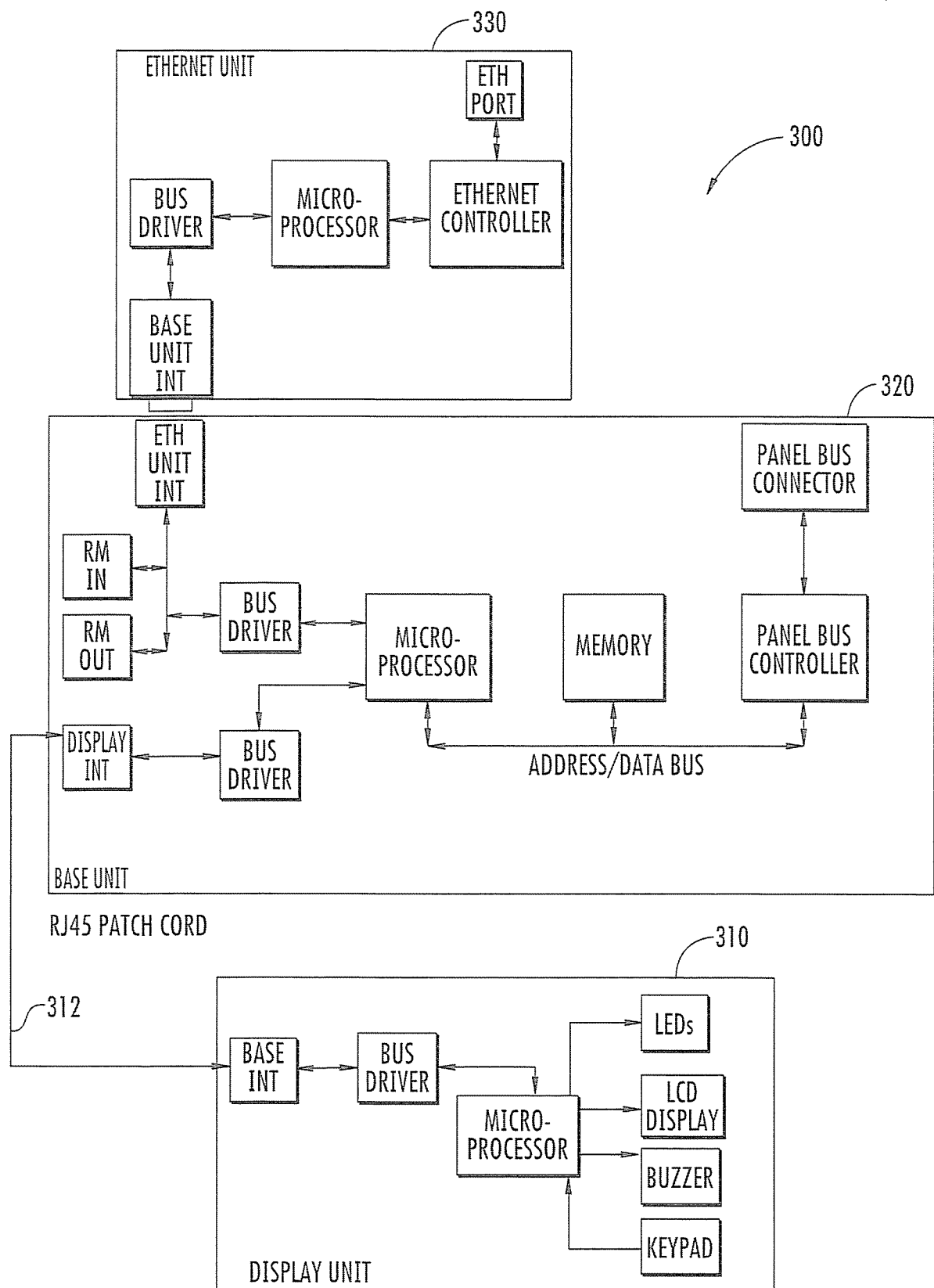
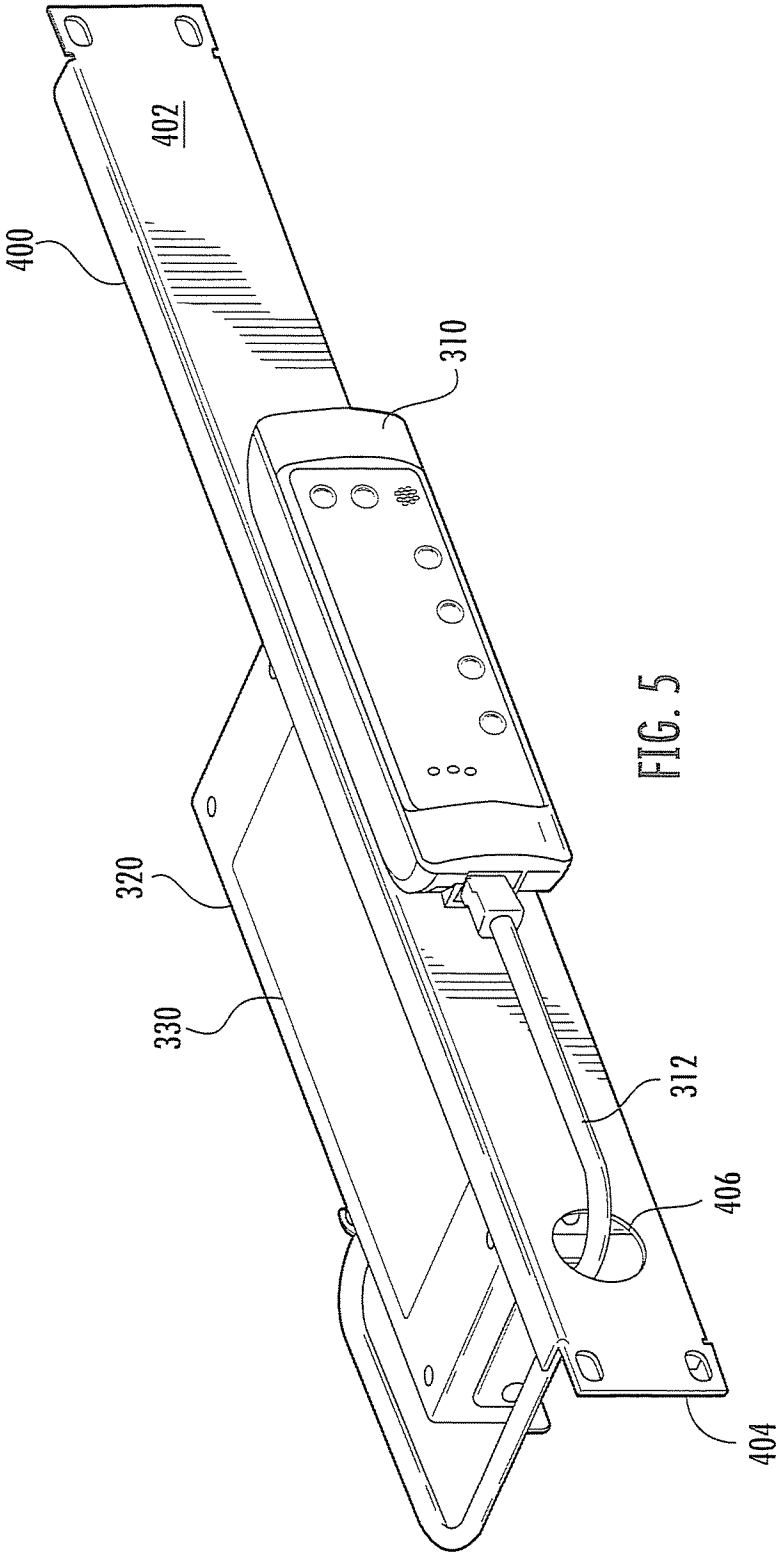


FIG. 4



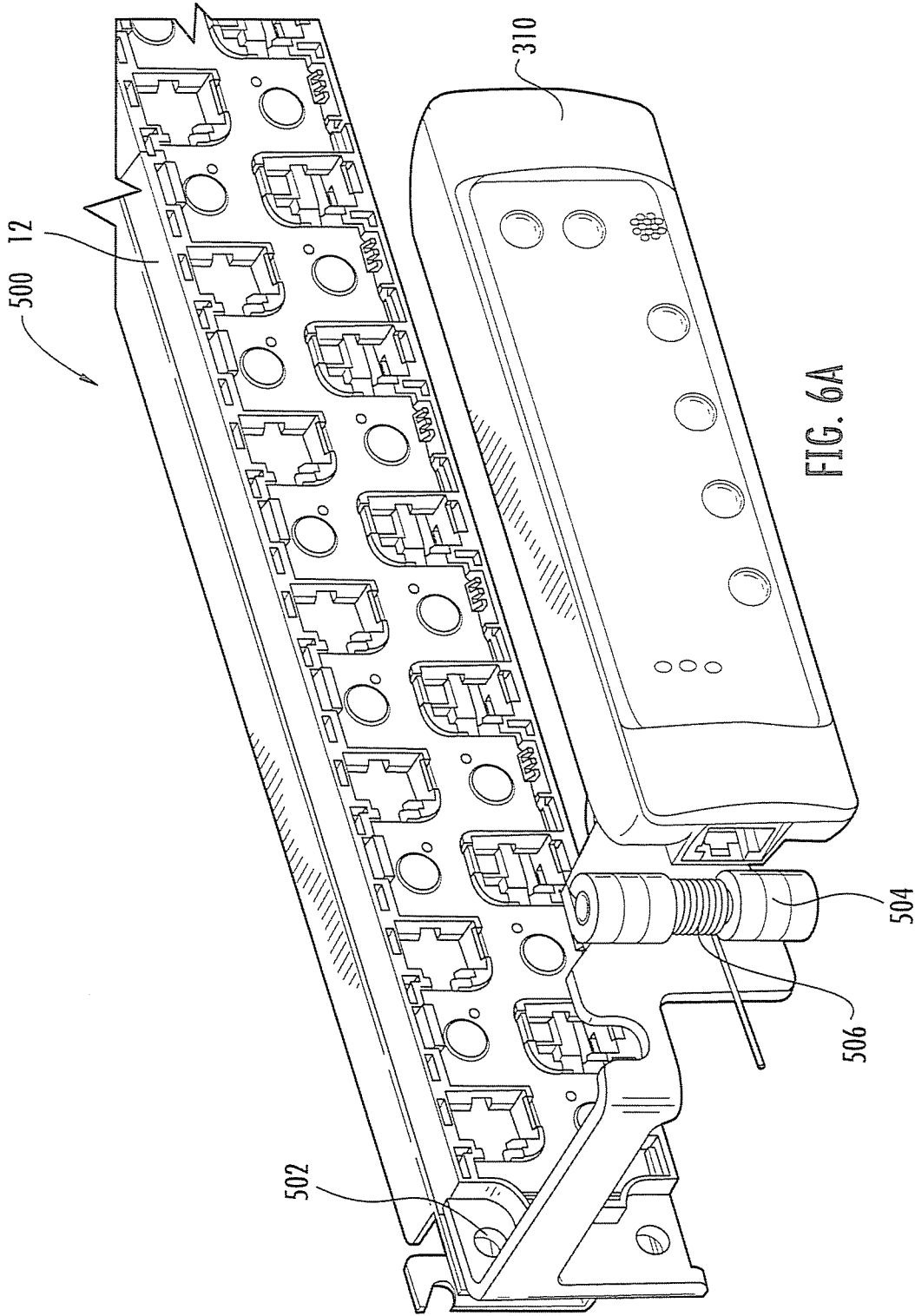
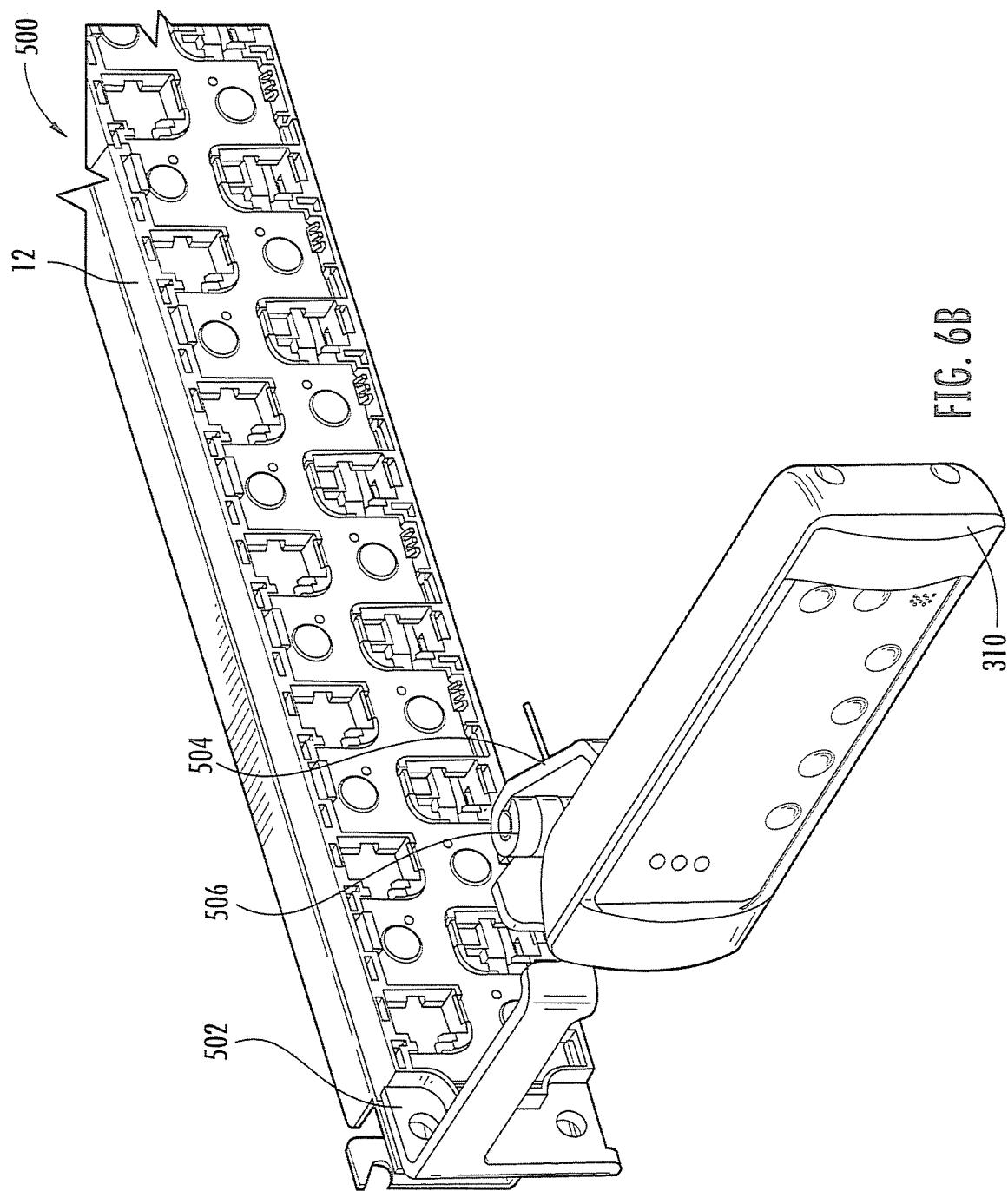
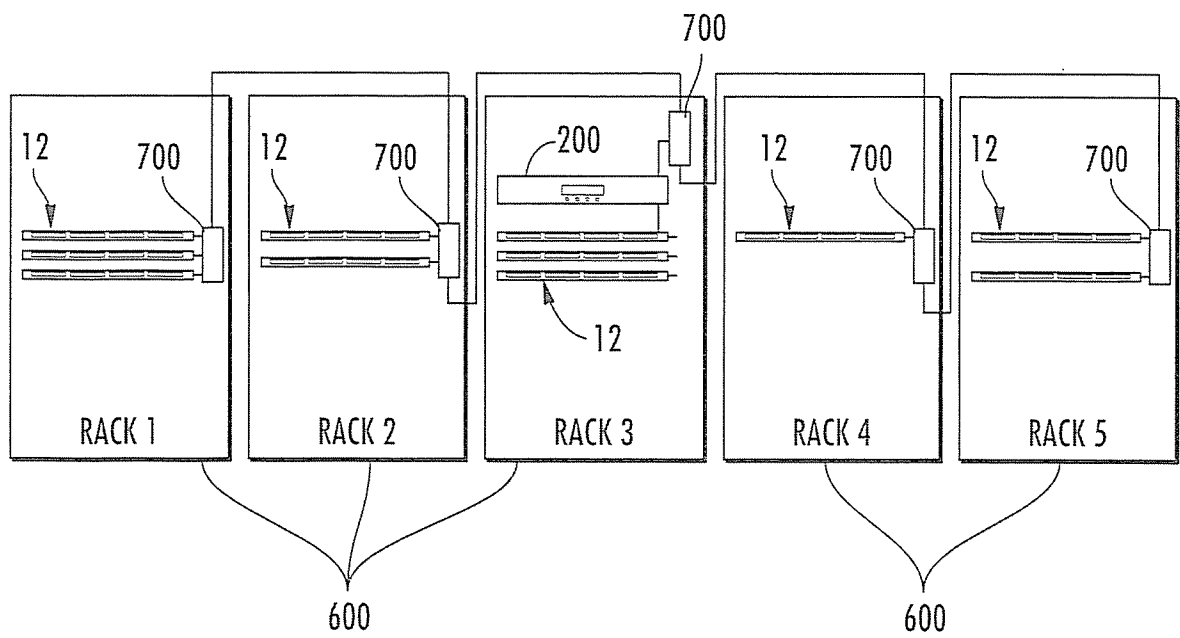
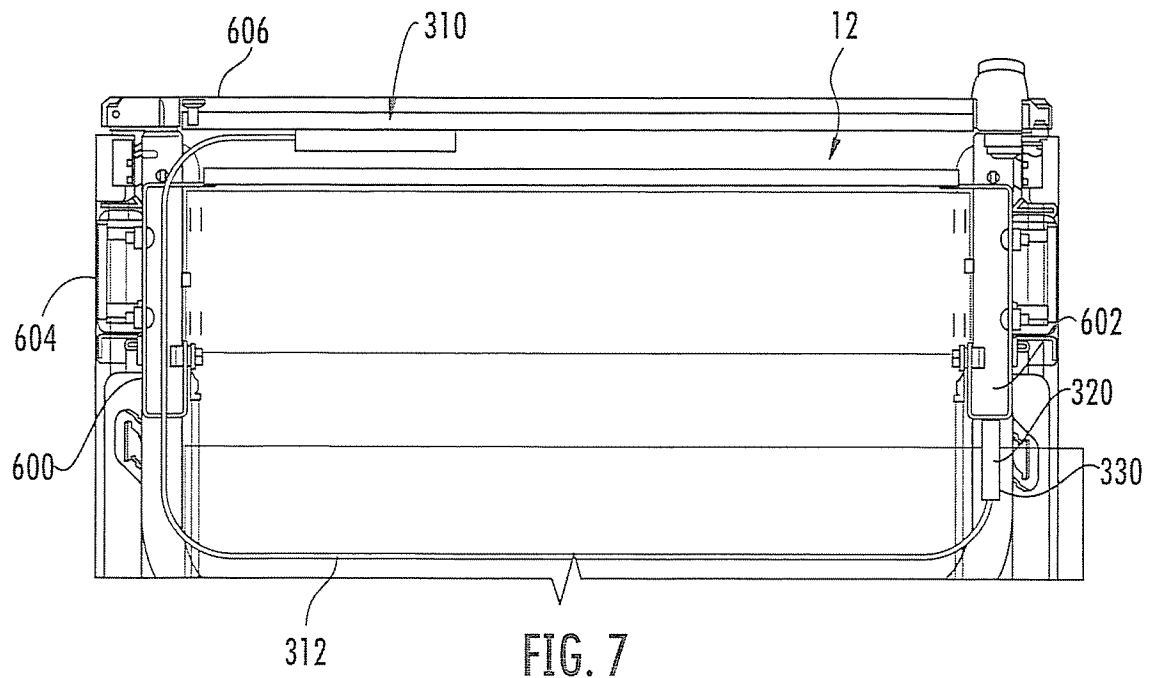


FIG. 6A



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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/066684

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04Q1/14

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 347 508 A (LUCENT TECHNOLOGIES INC [US]) 6 September 2000 (2000-09-06)	1-7
Y	abstract page 4, line 15 - page 5, line 10 page 9, line 15 - page 10, line 27 -----	8-14
Y	KR 2002 0040073 A (HYNIX SEMICONDUCTOR INC [KR]) 30 May 2002 (2002-05-30) abstract -----	8-14
Y	US 2005/179546 A1 (LANIGAN WILLIAM P [US] ET AL) 18 August 2005 (2005-08-18) abstract paragraphs [0049], [0050], [0051] -----	14
A	US 2008/186173 A1 (GATES TELL A [US]) 7 August 2008 (2008-08-07) abstract -----	14, 15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/066684

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