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(54) **RACK CABLING SYSTEM**

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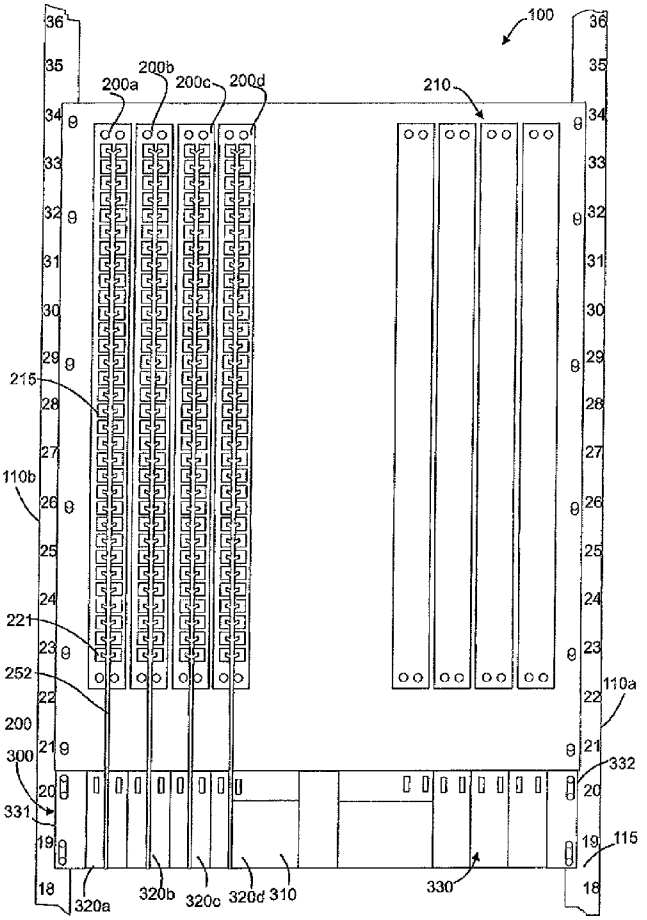
(57) **ABSTRACT**

A rack cabling system including a rack having mounted thereon a first hardware component and a patch panel housing mounted on the rack adjacent the first hardware component. The patch panel housing populates no more than a three rack unit (RU space), the patch panel housing including a first end having cable pathway openings and a second end having connector elements mounted therein. The patch panel may have a first cable pathway opening located adjacent the first side of the housing and defining a primary position and a first connector element mounted on the second end and the first connector element having a first position corresponding to the primary position of the first cable pathway opening. Cable harnesses are routed with less than three bends of the cables between the first hardware component and the patch panel housing, so that the first cable harness is terminated at the first connector element in the first position.



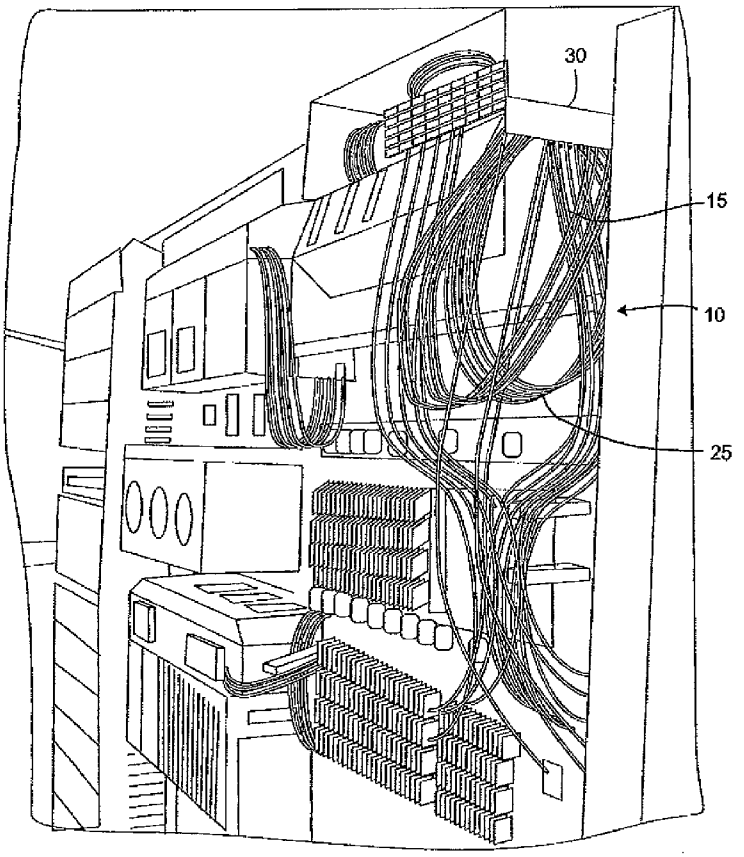


FIG. 1 (Prior Art)

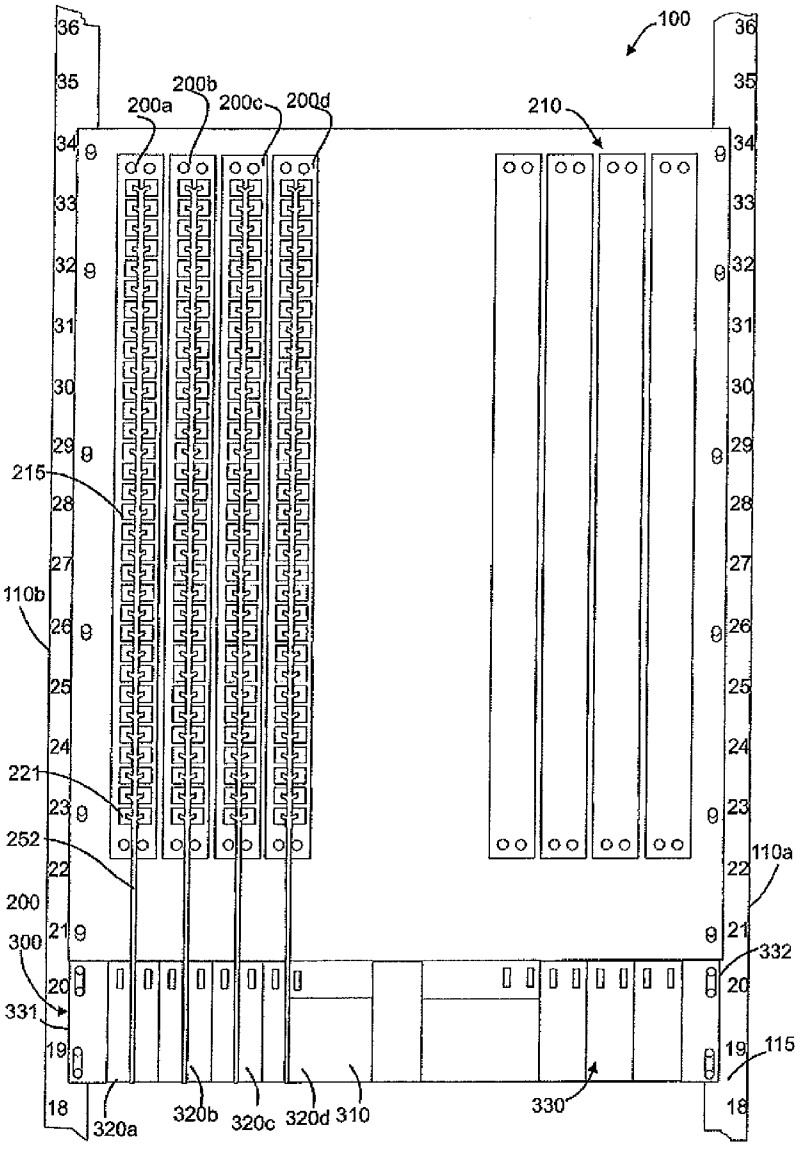

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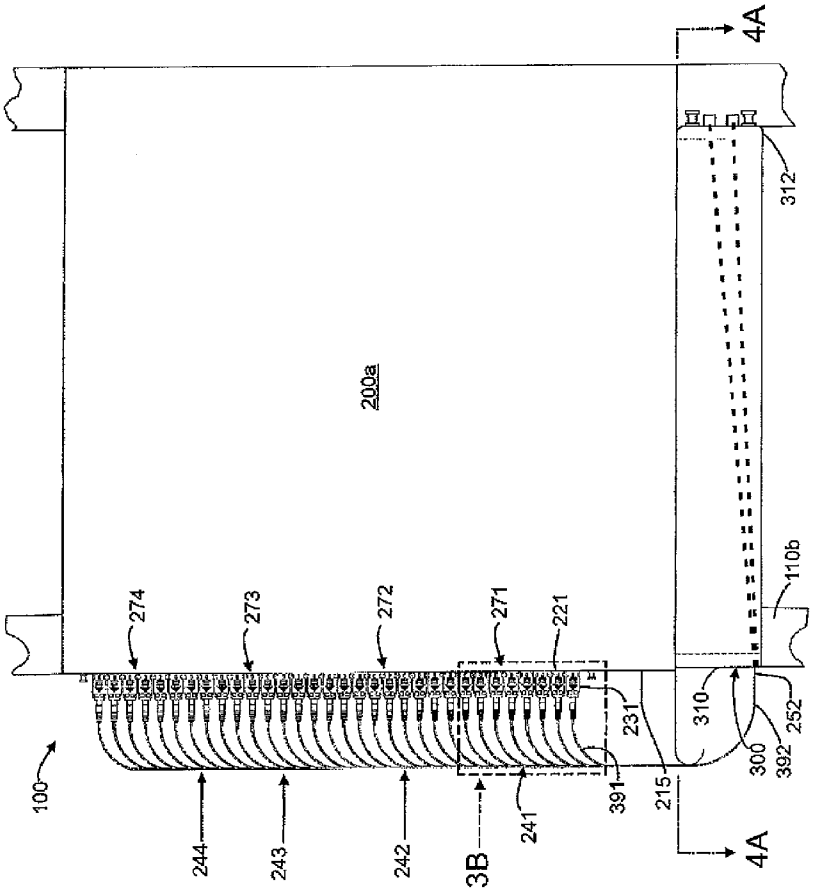
FIG. 2

FIG. 3A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3B
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4A

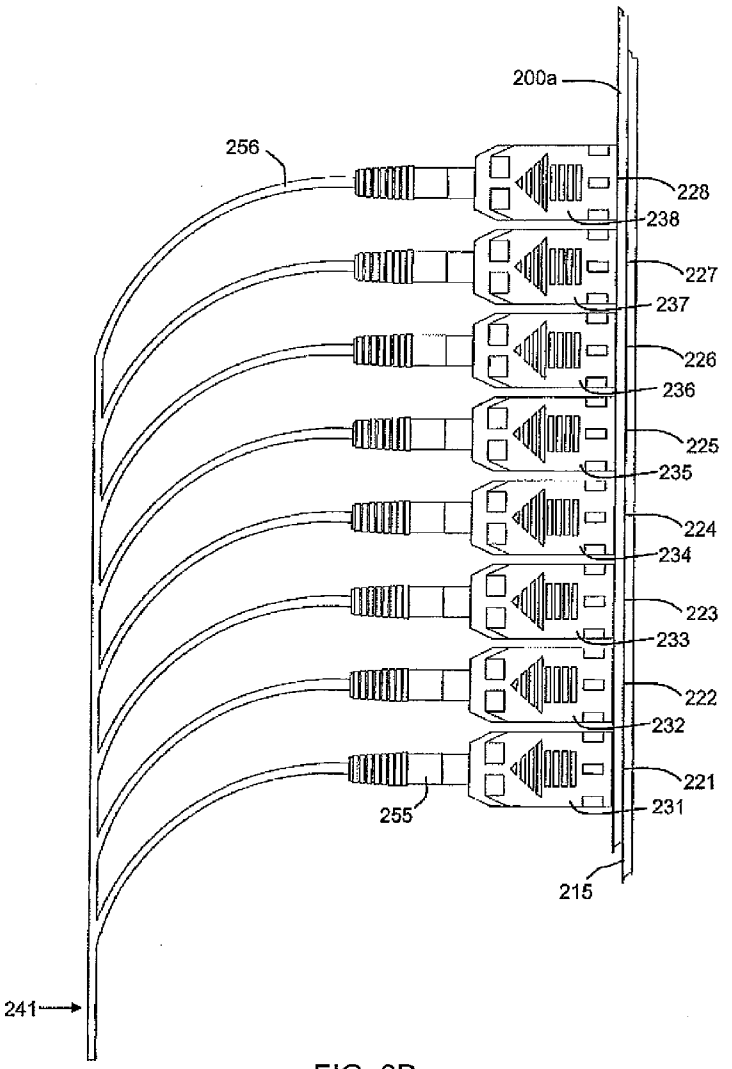
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FIG. 3B

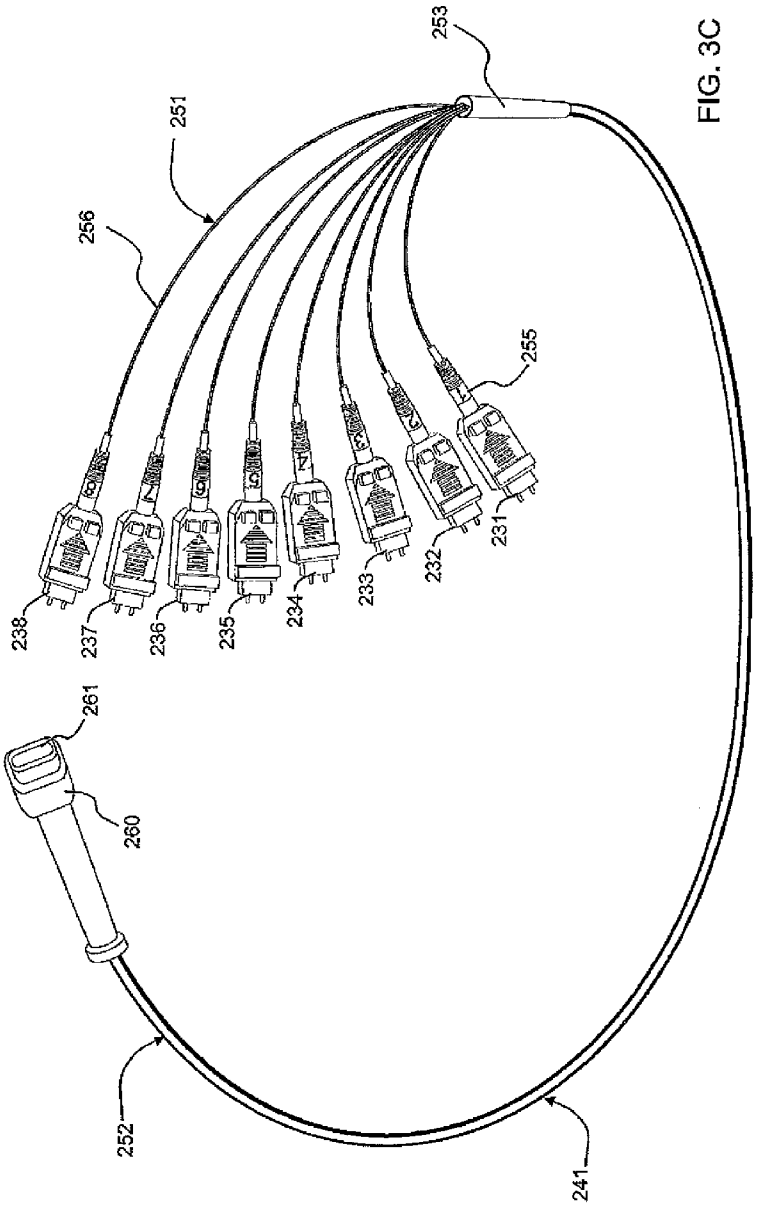
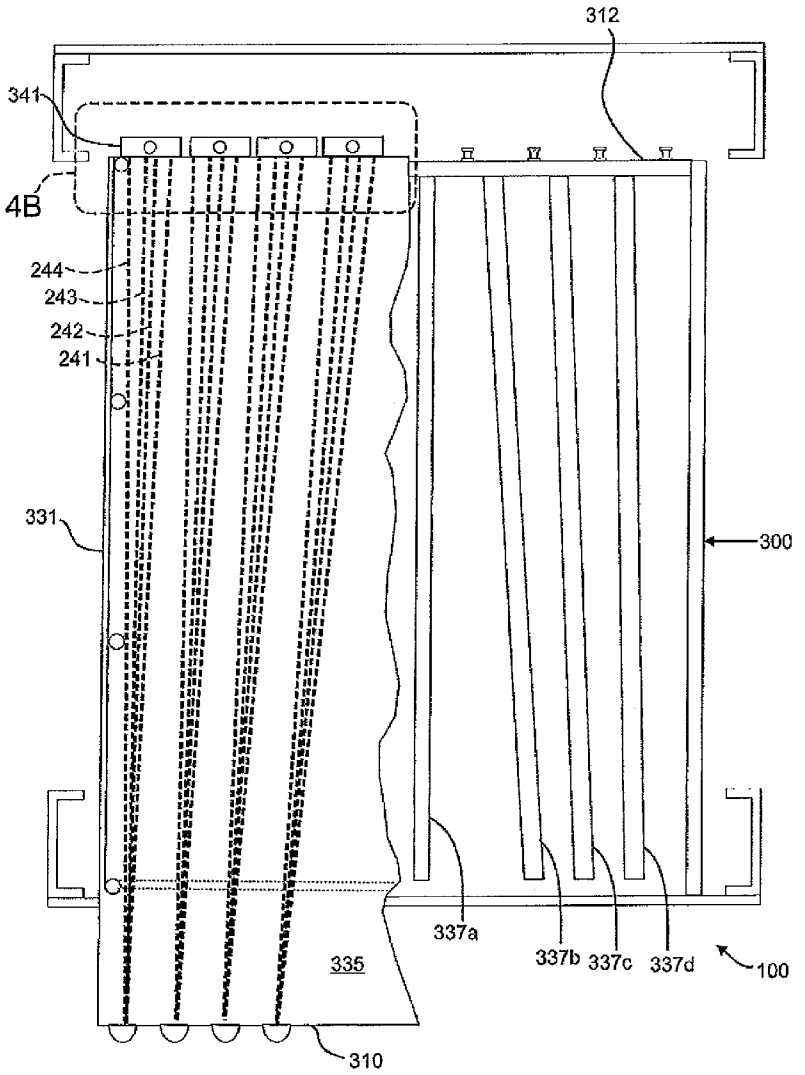


FIG. 3C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310

FIG. 4A

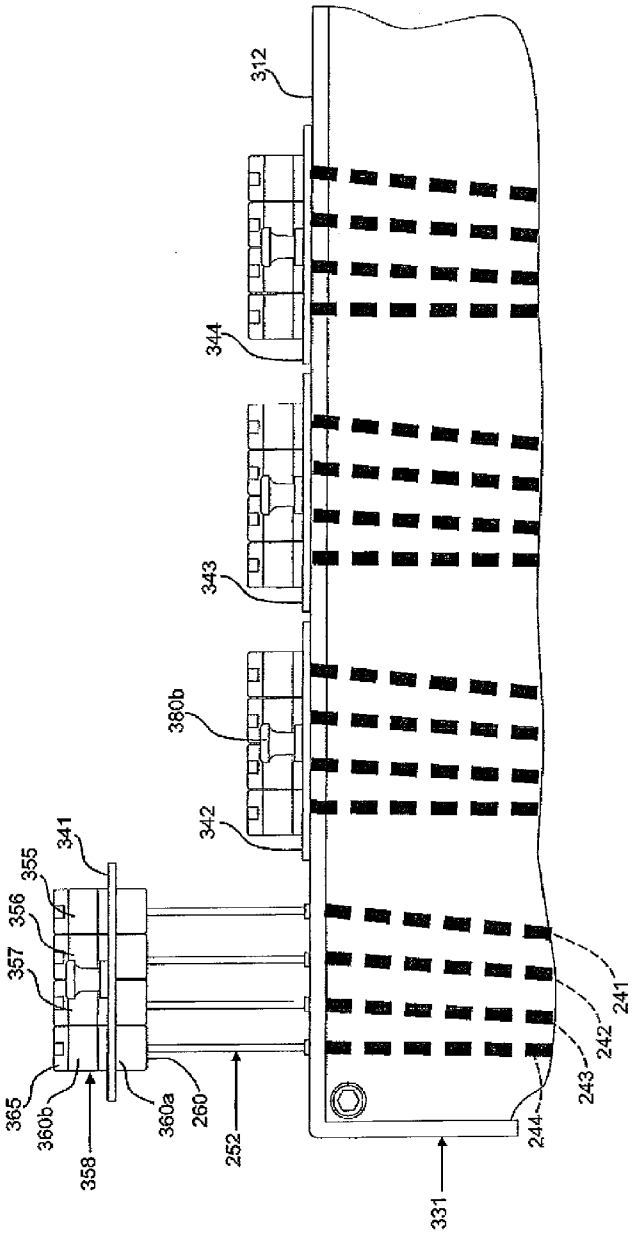
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FIG. 4B

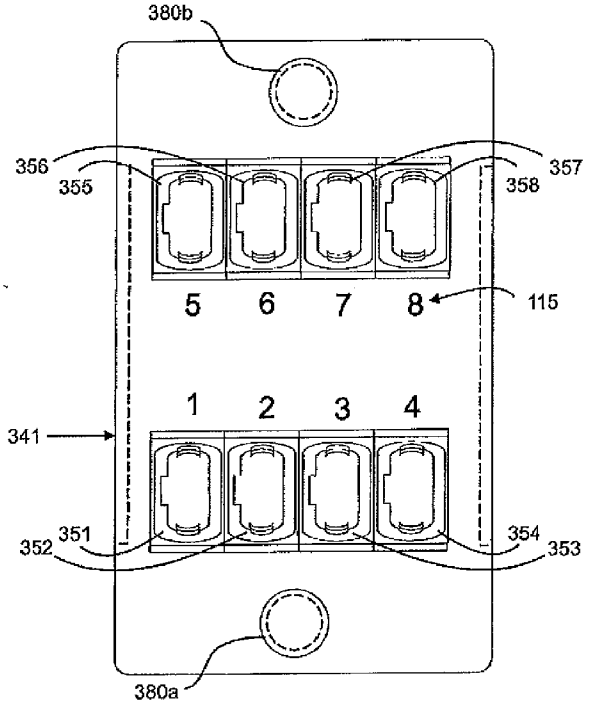

FIG. 4C

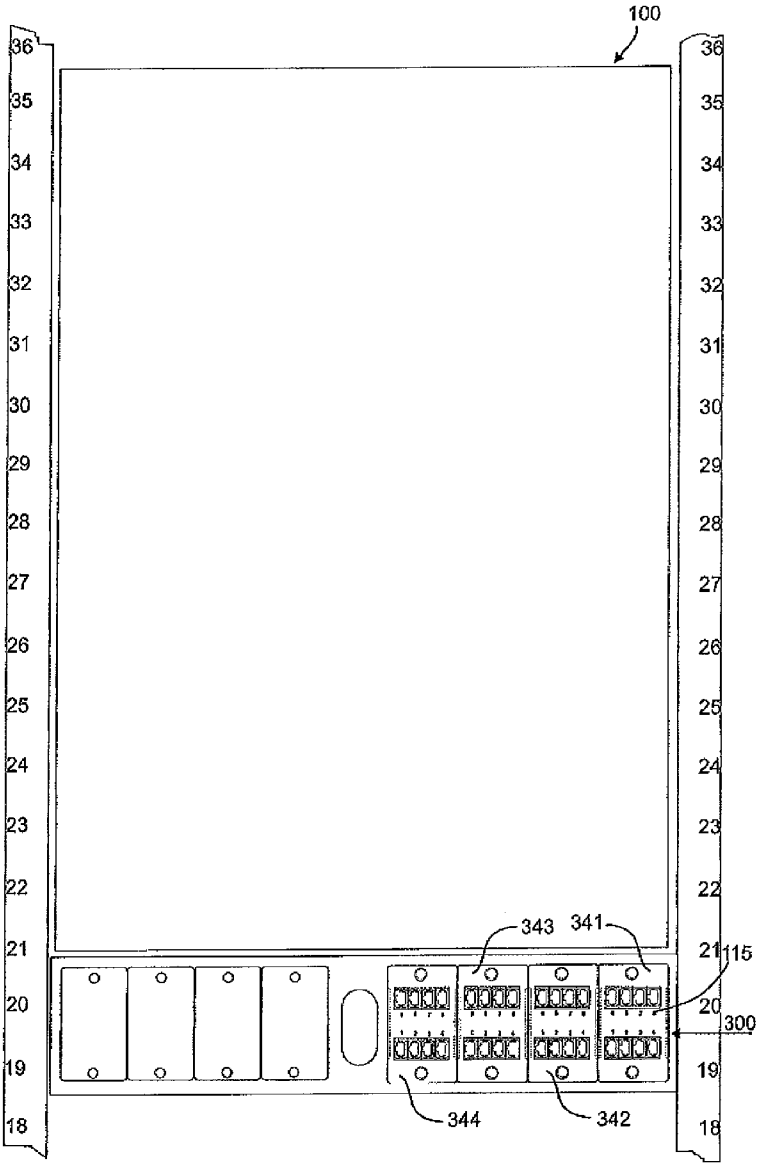
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FIG. 5

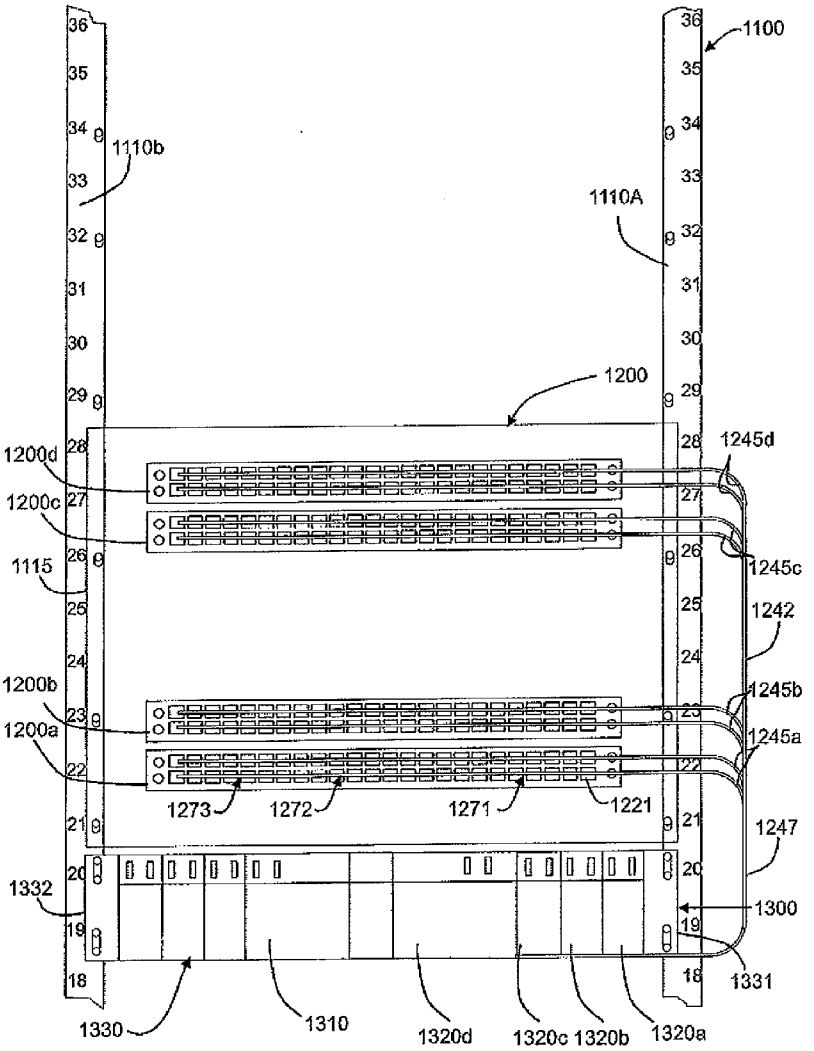
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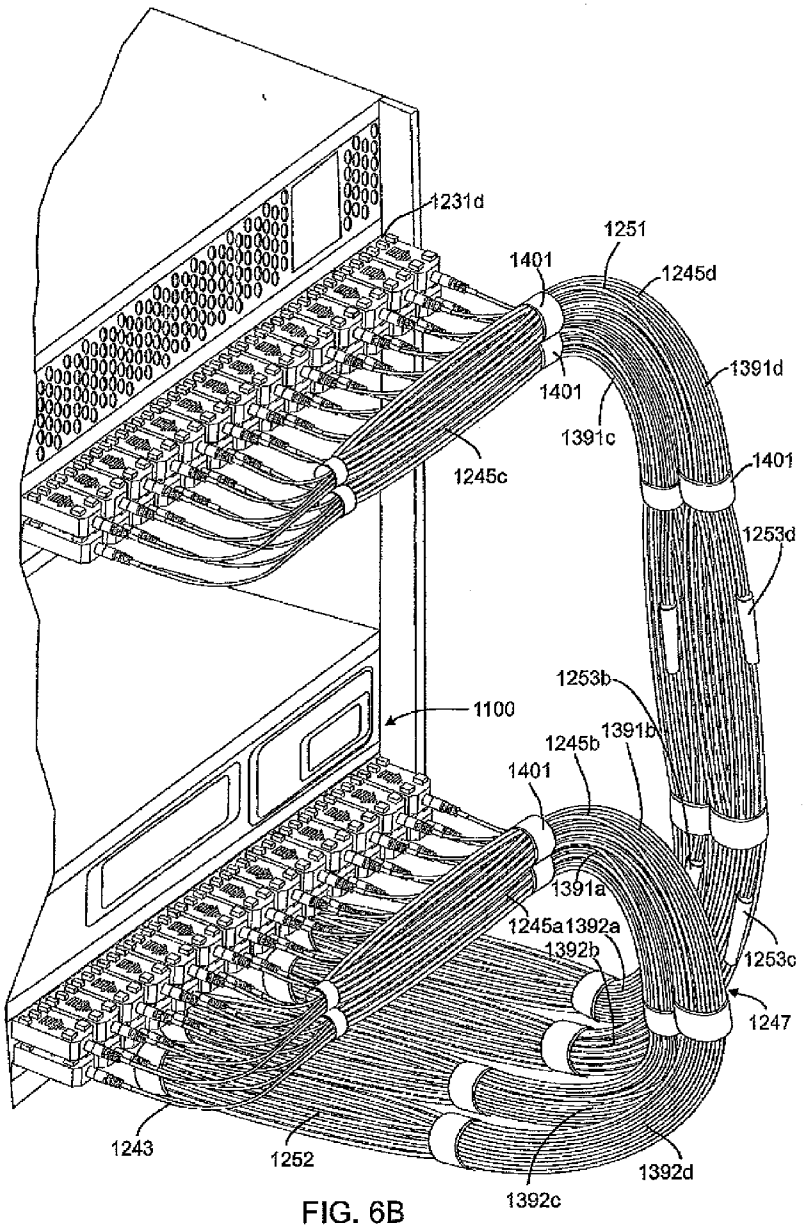
FIG. 6A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1401
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1253b
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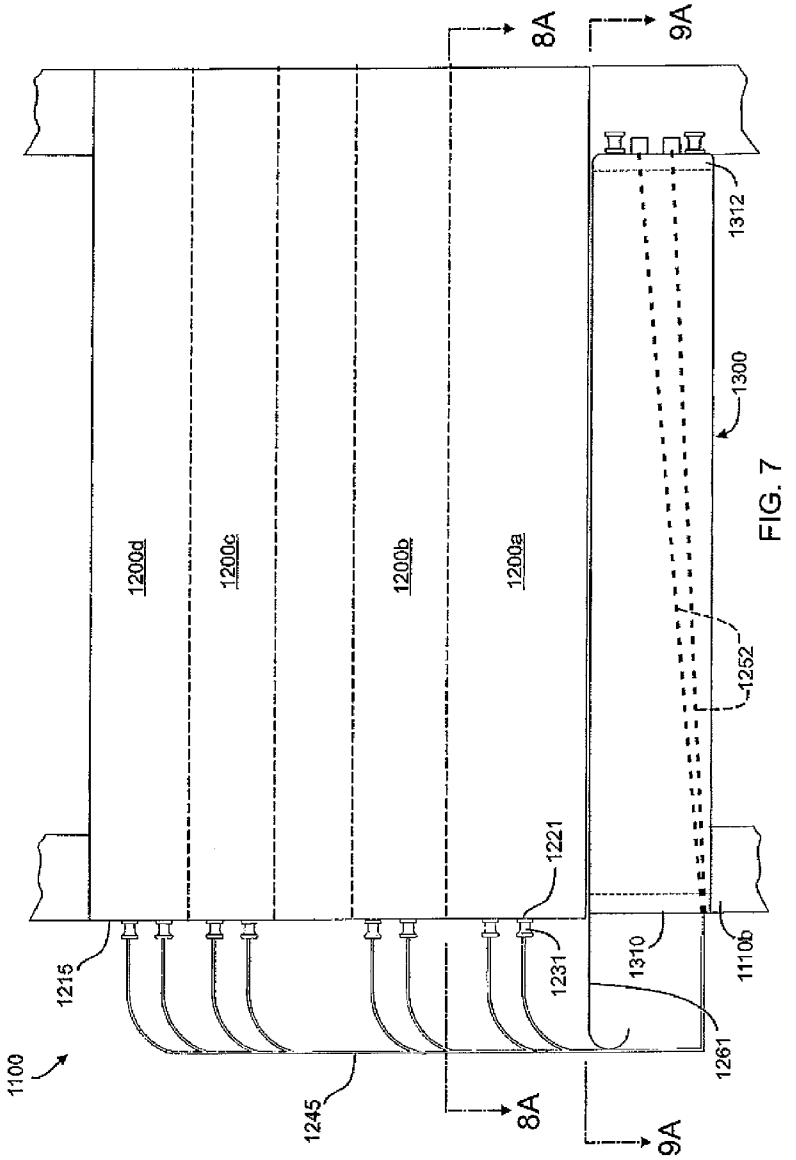
1392d
1392c

FIG. 6B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8A
9A

FIG. 7

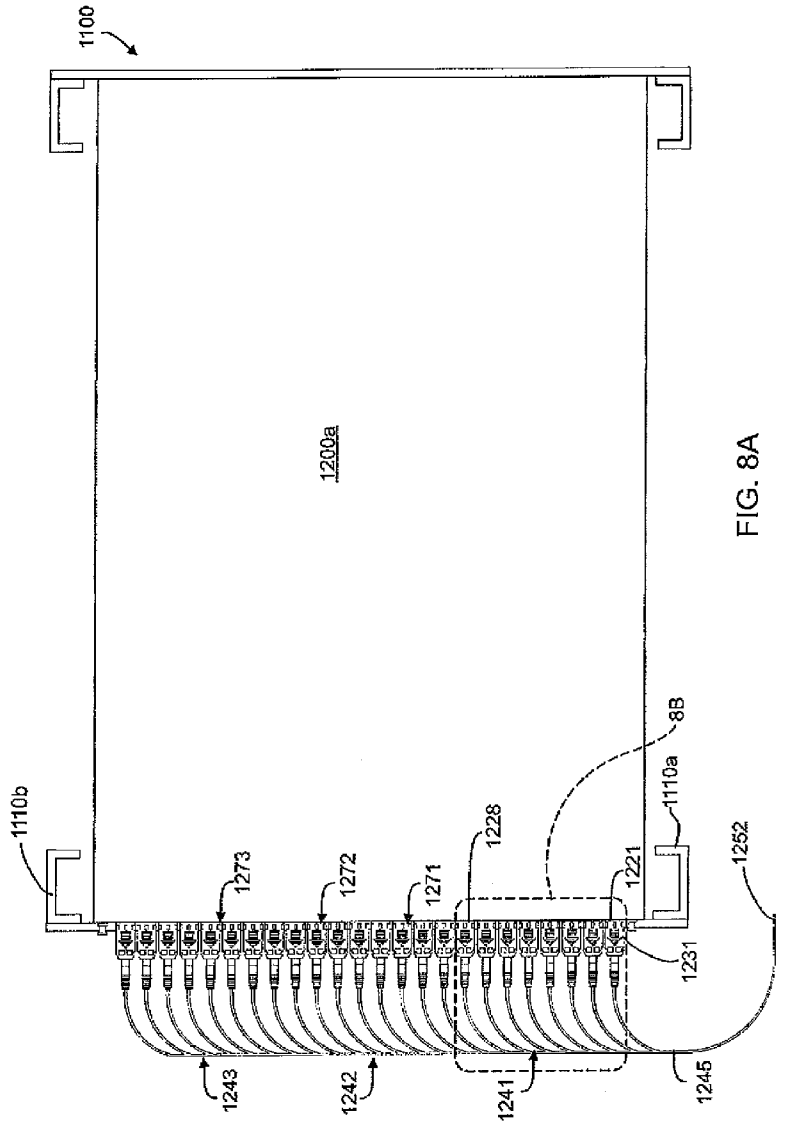
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FIG. 8A

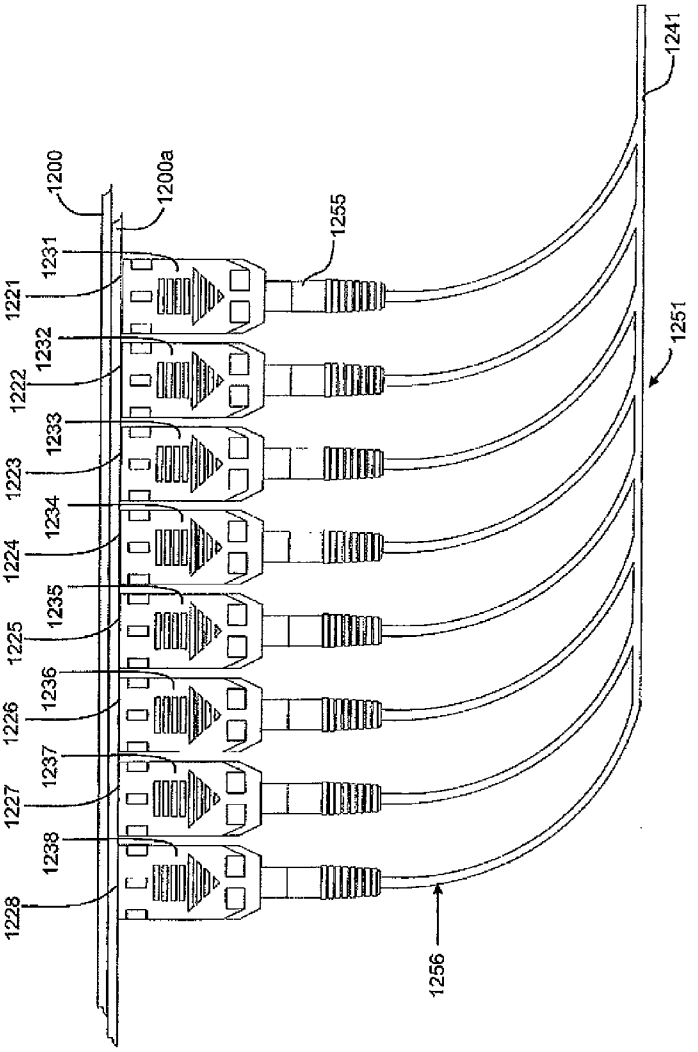
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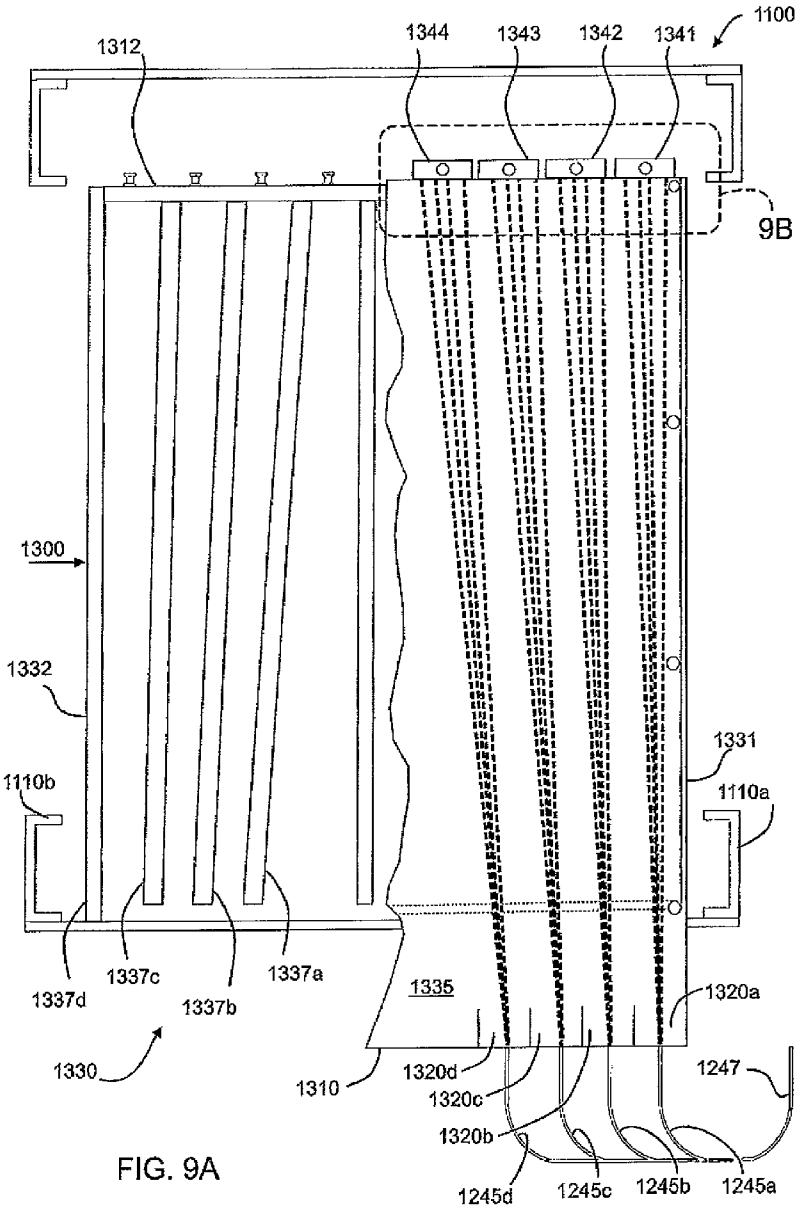
FIG. 8B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1337a
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1245c
1245b
1245a

FIG. 9A

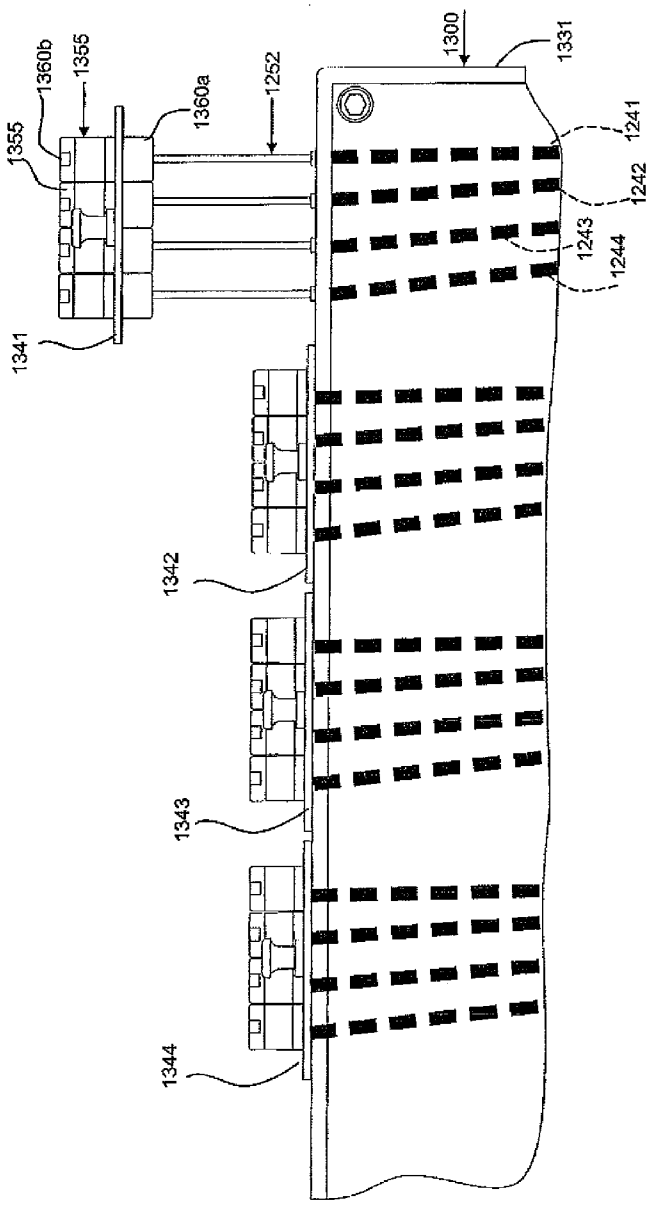
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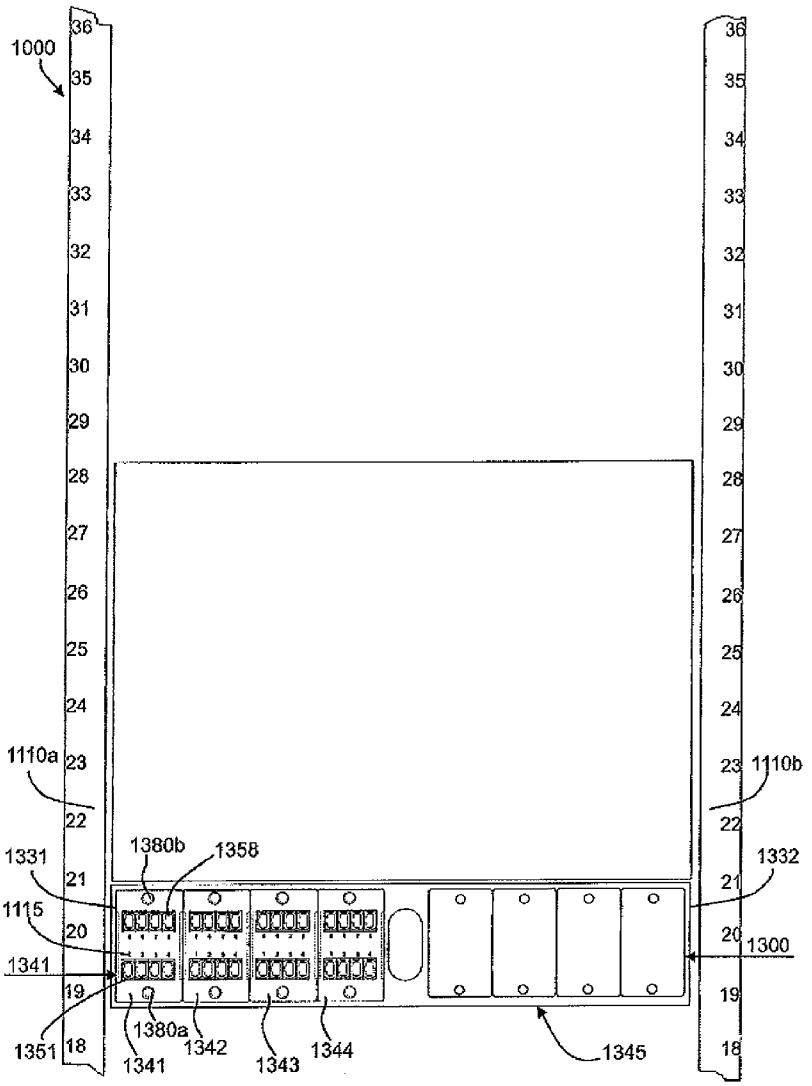
FIG. 9B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1110b
1331
1332
1115
1341
1300
1351
1380b
1358
1380a
1342
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1345

FIG. 10

RACK CABLING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation application and claims priority from co-pending U.S. patent application Ser. No. 13/114,928 filed May 24, 2011, the entirety of which is hereby incorporated by reference.

[0002] The present invention relates to a rack cabling system and provides for an efficient system for attaching and routing cables to components mounted on a rack.

BACKGROUND

[0003] Data centers have become very densely populated spaces where multiple components such as switches, routers, directors or servers are interconnected by a multitude of cables. These hardware components are typically mounted on racks so that multiple components may be interconnected using short lengths of cables. Such cables may be fiber optic cables including cable harnesses. Longer jumper cables or trunk cables (multiple fibers enclosed under one jacket) are used for interconnecting equipment within a data center room or to other equipment in a local area network (LAN).

[0004] A rack may be used to mount a hardware component described as a blade; due to the small size (thin profile) and high density of the component. For example, a Brocade DCX Fiber Channel Switch, or CISCO 9513 Fiber Channel Switch or like backbone component provides, a 8 Gbps network switching platform for a data center storage area network (SAN) or telecommunications system; including as many as 512 fiber channel ports by combining up to 11 "blades," containing 16-, 32-, 48-, or 64-port fiber channel blades in a single rack chassis.

[0005] Such hardware blade components are interconnected by fiber optic cables including terminations at the ends of the cables with fiber optic connectors. For example, individually channeled fiber connectors may be LC type connectors, such as LC Pro-Slide or mSFP-LC-Pro-Slide connectors as described in U.S. Pat. No. 7,588,373. A typical fiber-optic cable harness has multiple individually channeled fiber connectors furcated at a first end and a single cable at a second end terminated by a multi-fiber connector, such as an MTP® connector.

[0006] A typical means for handling cables on a rack **10** is depicted in FIG. **1**. Fiber-optic cables **15** are routed to or from a distribution shelf **30** from the components below. Since the cables are generally the same length, there is slack in the cables which require that the cables are hanging loosely and may have sharp bends **25** in the cable; which may cause damage to the cables. Although, a sleeve **30** may be used to attempt to contain the cables **15**, this organizing means is usually unsuccessful and the cables may fall out of the sleeve **30**. Bends **25** in the cables may damage or break the fiber inside the cables and affect the transmission character and the efficiency of the cables. Without a specific cable management system, installation and servicing of such cables is difficult and extremely time consuming.

[0007] Other approaches for managing cables include modules or cassettes that may be installed or removed from the front or rear of a patch panel housing. However, the use of such modules requires extra space in the rack. Thus, a cost effective system for managing slack and organization of fiber optic cables within a rack for hardware components is desired to overcome the above problems with previously known systems.

SUMMARY

[0008] The present invention provides for a rack cabling system comprising a rack having mounted thereon a first hardware component and a patch panel housing mounted on the rack adjacent the first hardware component. The patch panel housing populates no more than a three rack unit (RU space), the patch panel housing including a front end having cable pathway openings and a rear end having connector coupler plates mounted therein. The patch panel housing is mounted on the rack so that its front end is aligned with a front end of the first hardware component. The cable pathway openings are arranged within the patch panel housing between a first side and second side of the housing, the patch panel having a first cable pathway opening located adjacent the first side of the housing and defining a primary position and a first connector coupler plate mounted on the rear adjacent on the first side and the first connector plate having a first position corresponding to the primary position of the first cable pathway opening and a second position adjacent the first position. The first hardware component having a first cable harness extending therefrom, each harness including a group of individually channeled fiber connectors terminating on a group of cables at a first end of the harness and a multi-fiber connector at an opposite second end of the harness. The group of cables at the first end, each have different lengths and each cable is progressively longer with respect to an adjacent cable at the first end of the harness.

[0009] A hardware component having at least a first and second cable harness extending therefrom, the hardware blade component having a first and second area for connecting the first end of each cable harness. The first cable harness has its first end mounted to the first hardware blade component in the first area on the component and the second end received in the primary position of the patch panel, so that the first cable harness is routed with the three bends or less of the cables from the first hardware blade component into the first cable pathway opening and extending without a bend through the patch panel housing so that the multi-fiber connector is terminated at the first connector coupler plate in the first position.

[0010] The second cable harness is routed with three bends or less of the cables from the second area of the hardware component into the cable pathway opening of the patch panel and extends without a bend through the patch panel housing to the rear end so that the multi fiber connector is terminated at the second position of the connector coupler plate offset from the first position and the length of each of the cables comprising the second cable harness being longer than each of the cables comprising the first cable harness wherein a minimum amount of slack is provided in each of the first and second cable harnesses.

[0011] In an embodiment, the patch panel may include at least eight cable pathway openings and each numbered sequentially 1-8. In an embodiment, the patch panel may include at least eight connector coupler plates. In an embodiment, the connector coupler plates may include up to eight couplers on each plate and each coupler numbered sequentially, 1-8. In an embodiment, the second cable harness multi-fiber connector is terminated in a second position at a coupler numbered "2".

[0012] In an embodiment, each of the first and second cable harnesses may include the first end having up to twelve individually channeled LC type connectors terminated on up to twelve individual cables forming the group of cables at the first end and each harness including the second end having up to twelve individual cables to form a multi-fiber cable terminated with a MTP type connector. The multi-fiber connector and the multi-fiber cable are furcated to provide up to twelve individual cables at the first end of the harness. In an embodiment, the LC type connector may comprise an LC of a standard LC, Pro-Slide or mSFP-LC Pro-Slide connector. In an embodiment, the first and second hardware component may each include up to twelve fiber optic connectors for mating with up to twelve individually channeled LC type connectors at the first end of the cable harness. In an embodiment, at least four cable harnesses may be routed from each plate component and each cable harnesses having a length of 36" up to 90," respectively and the first end of each harness of up to twelve individual cables staggered by a difference in length of ½" connector to connector with a tolerance of approximately ¼" to ½".

[0013] In an embodiment, the bend of the first and second cable harness may comprise a change of direction of the second end of the harness of more than 5° in any continuous arc of the cable comprising a single bend, until the cable runs in a straight path for at least three inches and then changes direction to begin a second bend. The rack may include trunk cables attached to couplers on coupler plates on the patch panel housing and a horizontal trunk management bar for managing the trunk cables. The rack may include a second hardware component each of the first and second hardware components being mounted in a vertical orientation within the rack. In an embodiment, each of the first and second cable harnesses extend downward from the first hardware component and the second end of each cable harness may form approximately a radiused 90° bend in order to enter the front end of the patch panel housing so that the first and second cable harnesses are received in the first cable pathway opening "1".

[0014] In an embodiment, the rack may include a second hardware component, each of the first and second hardware components being mounted in a horizontal orientation within the rack. Each of the first and second cable harnesses may extend sideways from the first hardware blade component toward a first side of the rack, a third cable harness may extend from the second hardware blade component sideways toward the first side of the rack, the third cable harness having a first and second end, each of the first ends of the first, second and third cable harnesses forming approximately a radiused 90° bend in order to extend downward along the first side of the rack and the second end of each of the first, second and third cable harnesses forming approximately a radiused 90° bend in order to enter the front end of the patch panel housing so that the first and second cable harnesses are received in the first cable pathway opening numbered "1." In an embodiment the first cable pathway opening may receive up to eight cable harnesses. In an embodiment, the third cable harness routed from the second hardware component is received in a second cable pathway opening numbered "2." The first hardware component including a blade including one of a switch, router, director, data management tool and server.

[0015] A further embodiment of the invention provides for a rack cabling system comprising a rack having mounted thereon a first hardware component and second hardware component and second hardware component, a patch panel housing mounted on the rack adjacent the first hardware component, the patch panel housing populating no more than a three rack unit (RU) space, the patch panel housing having a front and having cable pathway openings and a rear end having connector coupler plates mounted therein, the patch panel housing mounted in the rack so that its front end is aligned with a front end of the first and second hardware blade components. The cable pathway openings are arranged within the patch panel housing between a first side and second side of the housing, the patch panel having a first cable pathway opening located adjacent the first side of the housing and defining a primary position and a first connector coupler plate mounted on the rear end adjacent the first side and in the primary position corresponding to the first cable pathway opening and the patch panel housing having a second cable pathway opening. The first hardware component has a first cable harness bundle extending therefrom, the second hardware component having a second cable harness bundle extending therefrom, each of the first and second cable harness bundles having at least two harnesses each comprising a group of individually channeled fiber connectors terminating on a group of cables at a first end and a multi-fiber connector at an opposite second end.

[0016] The first cable harness bundle has its first end mounted to the first hardware blade component and the second ends received in the primary position of the patch panel so that the first cable harness bundle is routed with three bends or less of the cables from the first hardware blade component into the first cable pathway opening and extending without a bend through the patch panel housing to the rear end so that the multi-fiber connectors are terminated at the first connector coupler plate.

[0017] The second cable harness bundle is routed with three bends or less of the cables from the second hardware blade component into the second cable pathway opening offset from the primary position of the patch panel and extending without a bend through the patch panel housing to the rear end so that the multi-fiber connectors are terminated at a second connector coupler plate off-set from a primary position and the length of each of the cables comprising the second cable harness bundle being longer than each of the cables comprising the first cable harness bundle wherein a minimum amount of slack is provided in each of the first and second cable harness bundles.

[0018] In an embodiment, each of the first and second hardware blade components may be mounted in a horizontal orientation within the rack. Each of the first and second cable harness bundles may extend sideways from the first and second hardware blade component, respectively toward a first side of the rack and each of the first ends of the first and second cable harness bundles forming an approximately radiused 90° bend in order to extend downward along the first side of the rack and the second end of each of the first and second cable harness bundles forming an approximately radiused 90° bend in order to enter the front end of the patch panel housing so that the first cable harness bundle is received in the first cable pathway opening numbered "1" and the second cable harness bundle is received in a second cable pathway opening numbered "2".

[0019] In an embodiment, the first cable harness bundle may comprise at up to twelve individual cables having up to twelve individually channeled fiber connectors at a first end extending from a first area of the first hardware blade com-

ponent and a second end from which up to twelve individual cables are furcated. The second cable harness bundle may comprise at least up to twelve individual cables having up to twelve individually channeled fiber connectors at a first end extending from a first area of the second hardware blade component and a second end from which up to twelve individual cables are furcated.

[0020] In an embodiment, the first cable harness bundle further comprises at least up to twelve individual cables having up to twelve individually channeled fiber connectors at a first end extending from a second area of the first hardware blade component and a second end from which up to twelve individual cables are furcated. The second cable harness bundle may further comprise at least up to twelve individually channeled fiber connectors at a first end extending from a second area of the second hardware blade component and a second end in which the second up to twelve individual cables are furcated.

[0021] The present invention further comprises a method of assembling cabling for a rack of hardware blade components comprising the steps of assembling a rack having first and second hardware blade components, locating no more than a three rack unit (RU) space on the rack and mounting a patch panel housing thereto, the patch panel housing having a front and having a cable pathway opening in a rear end having connector coupling plates, or entering the patch panel on the rack so that the front end is aligned with a front end of the first hardware blade component and a primary position of the cable pathway opening is oriented in accordance with the position with the first hardware blade component, attaching a first end of a first cable harness to the first hardware blade component, routing a second end of the first cable harness to the cable pathway opening of the patch panel housing with three or less bends of the first cable harness, routing the second end of the first cable harness through the patch panel housing to the rear end, terminating the second end of first cable harness at the coupler plate, attaching a first end of the second cable harness to the second hardware blade component, routing a second end of the second cable harness channel opening of the patch panel housing with three or less bends of the second cable harness, routing the second end of the second cable harness through the patch panel housing to the rear end in a position adjacent to the primary position and terminating the second end of the second cable harness at the second coupler plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The invention may be more completely understood in consideration of the following description of various embodiments of the invention in connection with the accompanying drawings, in which:

[0023] FIG. **1** is a perspective view of a rack system of the prior art;

[0024] FIG. **2** is a front elevation view of a rack system of the present invention;

[0025] FIG. **3***a* is a side elevation view of the rack system of FIG. **1**;

[0026] FIG. **3***b* is an enlarged view of a first end of a cable harness assembly from an isolated area marked **3***b* depicted in FIG. **3***a;*

[0027] FIG. **3***c* is an enlarged view of an entire loose cable harness;

[0028] FIG. **4***a* is a section view taken at line **4***a*-**4***a* of FIG. **3***a* depicting a patch panel mounted on the rack;

[0029] FIG. **4***b* is an enlarged view of an isolated area marked **4***b* of the rear end of the patch panel of FIG. **4***a* depicting an exploded view of a coupler plate;

[0030] FIG. **4***c* is an enlarged plan view of one of the coupler plates of FIG. **4***b;*

[0031] FIG. **5** is a rear elevation view of the rack of FIG. **2**;

[0032] FIG. **6***a* is a front elevation view of an alternate embodiment of the rack system of the present invention;

[0033] FIG. **6***b* is a perspective enlarged view of a rack system similar to the rack system FIG. **6***a;*

[0034] FIG. **7** is a side elevation view of the rack of FIG. **6***a;*

[0035] FIG. **8***a* is a section view taken at line **8***a*-**8***a* of FIG. **7**, depicting the patch panel mounted on the rack of FIG. **7**;

[0036] FIG. **8***b* is an enlarged plan view of the first end of a cable harness assembly from an isolated area marked **8***b* depicted in FIG. **8***a;*

[0037] FIG. **9***a* is a section view taken at line **9***a*-**9***a* of FIG. **7**, depicting the patch panel housing in a partial cut-away view;

[0038] FIG. **9***b* is an enlarged view of the rear end of the patch panel from an isolated area marked **9***b* depicted in FIG. **9***a* and depicting an exploded view of a coupler plate; and

[0039] FIG. **10** is a rear elevation view of the rack of FIG. **6***a*.

[0040] While the invention is amendable to various modifications and alternate forms, specific embodiments have been shown by way of example in the drawings and will be described in detail, it should be understood that the intention is not to limit the invention to the particular embodiments described. The intention is to cover all modifications, equivalents and alternatives falling within the spirit and the scope of the invention.

DETAILED DESCRIPTION

[0041] The present invention will be described with respect two embodiments, however it is to be understood that the invention may be used in other alternate embodiments not depicted specifically in this description. The two embodiments involve a rack having a hardware blade component in 1) a vertical orientation and 2) a horizontal orientation. The first embodiment of the invention having the hardware blade component mounted in a vertical orientation will be described with respect to FIGS. **2**-**5**. A rack **100** is provided, as is known in the data center industry having side rails **110***a*, **110***b* formed by metal C-channels and bracket and shelving components mounted between the rails. The rails **110***a, b* include indicia **115**, such as numeric markings for indicating the positioning of components on the rack by, for example in inches. Such markings can aid in determining the rack unit (RU space) the components mounted on the rack populate. The partial rack **100** as shown in FIG. **2**, is 31.5" tall, however, an additional chassis or equipment may be stacked above this chassis or a single rack may be provided that is at least twice as high as the rack depicted in FIG. **2**.

[0042] The chassis **200** is populated with hardware blade components **200***a*-*x*. First hardware blade component **200***a* has a first side and a second side each with thirty-two ports, the second hardware blade component **200***b* has a first side and a second side each with thirty-two ports, the third hardware component **200***c* and fourth hardware component **200***d* have two parallel rows of thirty-two ports. The hardware components **200***a, b, c, d* are operational and have cabling and connectors mounted thereto. Other hardware components

210 are also provided in the rack **100** (FIG. **2**), but are not presently operational and do not have cabling or connectors mounted thereto.

[0043] The hardware blade component **200** may include a switch, router, director or server. For example, a Brocade DCX FC8-64 high density Fiber Channel Switch blade or DCX FC8-48 mounted in a DCX or DCX-4s chassis, or CISCO 9513 Fiber Channel Switch may operate appropriately with the cabling system of the present invention. As depicted, each of the hardware blade components **200***a, b, c, d* have thirty-two ports/channels on each side that populate a front of each hardware blade component **200** with a total of sixty-four ports per component **200**. However, the present invention may be applicable to any high density hardware component simply by changing the channel count on the corresponding harness.

[0044] Each port **221** (inside blade) receives a fiber optic connector, such as an individually channeled fiber connector **231**. As depicted in FIG. **3***a*, a first individually channeled fiber connector **231** is mounted in port **221** on the front end **215** of the hardware blade component **200***a* in a first position. FIG. **3***b* is an enlarged view of the first eight connectors **231-238** mounted on the front end **215** of the hardware blade component **200***a*. In alternate embodiments there may be between up to twelve connectors and up to twelve corresponding ports and cables. In the embodiment depicted in FIG. **3***b*, the group of eight connectors **231-238** comprise a cable harness **241**.

[0045] An example of an entire harness, prior to connection to the rack system **100** is depicted in FIG. **3***c*. In an embodiment, the individual channel fiber optic connector may be an LC duplex type connector such an LC or mSFP/LC Pro-Slide connector. As depicted in FIG. **3***a*, cable harness assemblies **241**, **242**, **243** and **244** are aligned along the length of the blade **200***a*, so that a total of thirty-two connectors **231** are mated to the ports **221** at the front end of the hardware blade component **200***a*. It is to be understood that while the embodiment depicted in these drawings includes eight connectors **231** in each harness **241-244**, the present invention may comprise cable harnesses which have more or less connectors and individual cables **256** in each harness. In addition, it is to be well understood that a hardware component having more or less than sixty-four ports may be accommodated by the present invention and cable harnesses having varying numbers of connectors **231** and cables **256**.

[0046] It is to be understood that FIG. **3***a* depicts one side of the hardware blade component **200***a* and only depicts the thirty-two ports **221** and connectors **231** running vertically along the first side of the blade **200***a* and there are correspondingly thirty-two other ports on the other side of the hardware blade component **200***a* for receiving an additional thirty-two fiber optic connectors to make a total of sixty-four ports (and connectors) per blade component **200**.

[0047] As shown in FIG. **3***c*, the harness **241** has a first end **251** including individual fiber cables **256** attached to each of the eight fiber optic connectors **231-238** and a second end **252** to which a multi-fiber connector **260** is attached. In an embodiment, a multi-fiber connector **260** may be used such as an MTP connector. Such connectors include a ferrule **261** which can accommodate up to twenty-four optical fibers. In the cable harness **241**, it is to be understood that the eight optical connectors **231-238** are terminated with the multi-fiber connector **260** so that only sixteen optical fibers are populated in the ferrule **261**. It is to be understood that the cable harness can have up to four more fiber optic connectors attached at the first end **251** without having to modify the MTP connector **260**. In other embodiments, other multi-fiber connectors may be used to increase or decrease the amount of optical fibers in order to provide for different size cable harnesses depending on the number of ports **221** in the hardware blade component **200***a* to be populated.

[0048] The cable harness **241** has the second end **252** which is furcated at furcation point **253** in order to provide the eight individual cables at the first end **251**. Finally each individual cable is terminated with a connector **231-238**. Each connector **231-238** may have a boot **255**. Each boot **255** may be numbered 1-8, in order to help the operator to keep the fanned-out first end **251** of the harness **241** organized (FIG. **3***c*). As depicted in FIG. **3***b*, the first connector **231** will be mated in the first port **221** (and will have the numeral "1" on the boot **255**) and the second connector **232** is mated to second port **222** (and will have the numeral "2" on its boot **255**) etc.

[0049] As can be seen in FIG. **3***c*, the first end **251** of each individual cable is progressively longer for each connector **231-238**. For example, the individual cable at the first end **251** for the eighth connector **238** will be approximately about ½" longer than its adjacent connector **237** etc. It may be understood that the first end **251** of the individual cable to which the eighth connector **238** is terminated will be approximately 4" longer than the individual cable at the first end **251** to which the first connector **231** is terminated. Due to the custom assembly of these cable harnesses, a ¼" to 1" tolerance can be maintained. As will be discussed in more detail later, the staggering of the lengths of the first end **251** of the fanned-out cables on each cable harness **241-244** and a narrow tolerance range allows for the orderly connection of the harness to each hardware blade component **200***a* and eliminates slack and provides for a neat and organized cabling system.

[0050] Turning again to FIG. **3***a*, the staggered lengths of each of the adjacent cables for the first cable harness **241** is shown mated to the hardware blade component **200***a* in a orderly fashion. It may be understood that the first connector **231** is closer to the second end **252** of the harness assembly **241** and therefore its cable can be shorter than the cable **256** for the eighth connector **228**, further along the length of the front end **215** of the hardware blade component **200***a*, eight channels away (FIG. **3***b*). The first cable harness **241** has its connectors **231** mated to the hardware blade component **200***a* at a first area **271** having eight ports **221**; the second harness assembly **242** has its connectors mated to the hardware blade component **200***a* at a second area **272** having eight ports; the third cable harness **243** has its eight connectors mounted to the hardware blade component **200***a* at a third area **273** having eight ports and the fourth cable harness **244** has its eight connectors mated to the hardware blade component **200***a* at a fourth area **274** having eight ports provided. It may be understood in other embodiments, that the hardware blade component areas **271**, **272**, **273** and **274** may have varying numbers of ports depending on the grouping of the number of connectors **231** terminated on each cable harness **241**, **242**, **243**, **244**. In addition, hardware blade component areas may by located on the multiple hardware blade components.

[0051] Mounted in the rack **100**, is a patch panel housing **300** having a front end **310** and rear end **312** (FIG. **3***a*). The patch panel housing **300** is mounted in the rack **100** so that the front end **310** is adjacent the front end **215** of each of the hardware blade component **200***a, b, c, d*. The patch panel housing **300** includes a first cable pathway opening **320***a*, a

second cable pathway opening **320***b*, a third cable pathway opening **320***c* and a fourth cable pathway opening **320***d* (FIG. **2**). Other cable pathway openings **330** are also provided in the patch panel housing **300**. The first cable pathway opening **320***a* is the primary position located adjacent the first side **331** of the patch panel housing **300**. In an embodiment, the front end **310** of the patch panel housing **300** includes indicia marked thereon to help an operator locate the proper pathway openings **330**. For example, the front end **310** may be numbered "1" to "8" from left to right as oriented in FIG. **2**. The numeral "1" identifies the first cable pathway opening **320***a*, numeral "2" designates the second cable pathway opening **320***b*, etc.

[0052] In an embodiment, the front end **310** may include two sets of routing indicia to allow a single patch panel housing **300** to be used in different rack configurations. For example, the front end **310** may have a first set of routing indicia being numbered "1" to "8" from left to right in a first color and the front end **310** may have a second set of routing indicia being numbered "1" to "8" from right to left in a second color as oriented in FIG. **2**. The first set of indicia, for example, may be used by an operator in the condition discussed above when the hardware component **200** is mounted vertically in the rack **100** and the primary position "1" corresponds with cable pathway opening **320***a* on the left side of the patch panel **300**. The second set of indicia may be used by an operator in a condition discussed below with respect to FIGS. **6***a*-**10**, when the hardware component is mounted horizontally in the rack and the primary position "1" correspond with a cable pathway opening on the right side of the patch panel. Having dual routing indicia on the front end **310** allows a single model of the patch panel housing **300** to be mounted in a rack, whether it will be populated at a later time with either horizontally or vertically oriented hardware components.

[0053] FIG. **4***a* is a section view of the rack **100** taken at line **4***a*-**4***a* from FIG. **3***a* and depicts a plan view of the patch panel housing **300** partially broken away. As viewed in FIG. **4***a* on the left side the housing cover **135** is depicted. The housing cover **335** on the right of the drawing FIG. **4***a* has been removed and depicts the interior of the patch panel housing **300** exposing a view of the interior walls **337***a, b, c, d* that provide harness pathways inside the housing **300**. Similar walls **337** are provided on the other side of the interior of the housing **300**.

[0054] The rear end **312** of the housing **300** has mounted thereon a first connector coupler plate **341**, a second connector coupler **342**, a third connector coupler **343** and a fourth connector coupler plate **344** (FIG. **4***b*). Each coupler plate **341** includes eight coupler connectors **351**-**358** (FIG. **4***c*). Each coupler connector **351**-**358** includes an internal facing side **360***a* for receiving a multi-fiber connector **260** and an external facing side **360***b* (FIG. **4***b*) for receiving a jumper cable connector (not shown). As depicted in FIGS. **4***b* and **4***c*, each coupler connector **351**-**358** has a dust cover **365** mounted thereto. As depicted in FIG. **4***c*, the coupler plate has indicia **115** provided thereon which identify the positions of the connector couplings **351**-**358**. As shown in FIG. **4***c*, numerals 1-8 are provided to designate the positioning of the coupler connectors **351**-**358**. Thus it is understood that the primary position is the coupler connector with numeral "1" in the lower left position, as shown in FIG. **4***c*. This is the position in which connector coupler **351** is mounted on the plate **341**. As will be discussed in more detail, the first cable harness **241** includes multi-fiber connector **260** which is terminated at the primary position on the coupler plate **341** at connector coupler **351**.

[0055] To understand the invention further, the steps of mounting and routing the cables on the rack **100** will be discussed in sequence. The first cable harness **241** is arranged so that the first end **251** has each of the connectors **231**-**238** fanned-out, so that the first connector **231** may be inserted in the first port **221** on the first hardware blade component **200***a* in a first position (FIG. **3***a, b*). Each of the next connectors **232**-**238** are likewise mated to its corresponding port **222**-**228** in the first area **271** on the hardware blade component **200***a*. The second end **252** of the cable harness **241** is allowed to dangle downward towards the ground while the next step is completed. The second cable harness **242** is then arranged so that its first end is fanned-out, so that each of the eight connectors may be mated to the second area **272** of the hardware blade component **200***a*. Likewise, the second end **252** of the second cable harness **242** is allowed to dangle downward toward the bottom of the rack **100**. The third cable harness **243** is organized so that the eight connectors at the first end **251** may be sequentially mated at the third area **273** on the hardware blade component **200***a*. The second end **252** of the third cable harness **243** is dangled downward toward the bottom of the rack **100**. Finally, the fourth cable harness **244** has each of its eight connectors at the first end mated to the fourth area **274** at each of the ports therein on the hardware blade component **200***a*.

[0056] Thus, it is understood that each of the second ends **252** of the cable harnesses **241**, **242**, **243** and **244** are each lying side by side in a vertical orientation as shown in FIG. **2** (single line **252** is representative of multiple harnesses **241**, **242**, **243**, **244**). In the embodiment depicted in FIG. **2**, the cable harnesses **241**-**244** will have a total length of between 36" and 90." The length of the cable harness may vary depending on the specific hardware component and port configuration. Thus, it may be understood that when the second ends **252** of each of the cable harness **244** assemblies **241**-**244** are allowed to dangle downward, each of the multi-fiber connectors **260** will be side-by-side, since the positioning of each cable harness is higher along the length of the vertically oriented hardware blade component **200** from the first area **241** to the fourth area **244**.

[0057] Each of the second ends **252** of the cable harnesses **241**-**244** are routed through the cable pathway openings **320** at the front end **310** of the patch panel housing **300**. A tool may by used to pull each individual multi-fiber connector **260** from the front end **310** to the rear end **312** of the patch panel housing **300**. In a preferred embodiment, the first cable harness **241** is routed through the first cable pathway opening **320***a* and the multi-fiber connector **260** terminated at position "1" on the coupler plate **341**. Then the second end **252** of the second cable harness **242** is routed through the first cable pathway opening **320***a* and its multi-fiber connector **260** is terminated in position "2" on the coupler plate **341** adjacent the primary position where the first cable harness has its connector **260** terminated to coupler connector **351**. Then the second end **252** of the third connector cable harness **243** is routed through the first cable pathway opening **320***a* and its connector **260** mated to the coupler connector **353** on the first coupler plate **341**. Finally, the second end **252** of the fourth cable harness **244** is routed through the first cable pathway opening **320***a* and its multi-fiber connector **260** mated to the fourth coupler connector **354** on the first coupler plate **341**.

[0058] As depicted in FIG. **4***b*, it is preferable to remove the coupler plate **341** from the rear end **312** of the patch panel housing **300** to attach the multi-fiber connector **260** to its corresponding coupler connector **351-354**. Once each of the connectors **260** are mated to the coupler plate **341** the plate is mounted to the rear end **312** of the housing **300** via snap fit fasteners **380***a*, **380***b* (FIG. **4***c*). In an alternate embodiment, fasteners may be used, such as screws or other types of hardware. According to the orientation of the preferred embodiment of the hardware blade component **200***a* having thirty-two channels on a single side; the use of only four cable harnesses **241-244** is necessary coming from the first hardware blade component **200***a*. In that instance, only four cable harnesses are routed through the first channel opening **320***a* and likewise and only the first four positions and coupler connectors **351-354** are used on the coupler plate **341**.

[0059] However, it is to be understood that a hardware blade component **200***a* having more channels will require additional cable harnesses and in that instance there are non-populated coupler connectors **351-358** (FIG. **4**B, **4**C) on first coupler plate **341** (and additional coupler plates **342-344**) to accommodate additional multi-fiber connectors **260** that are routed from the additional cable harnesses.

[0060] The assembly of the rack **100** would continue in a similar way with respect to the second hardware blade component **200***b* and the second ends of each of the four harness assemblies are be routed through the second cable pathway opening **320***b* and each of its multi-fiber connectors **260** is terminated at the second coupler plate **342**. Likewise the cable harnesses for the third hardware blade component **200***c* is routed through the third cable pathway opening **320***c* and the multi-fiber connector **260** of each of those cable harnesses is terminated at coupler plate **343**. The cable harnesses extending from the fourth hardware blade component **200***d* is routed through the fourth cable pathway opening **320***d* and each of the multi-fiber connectors **260** is terminated at the fourth coupler plate **344** at the rear **312** patch panel housing **300**. If there were additional hardware blade components being used on the rack **100** the assembly of the cabling to the rack **100** would continue moving from first side **331** towards the second side **332** of the patch panel housing **300** and routing the corresponding cable harnesses through each of the additional cable openings **330** similar as discussed above.

[0061] In assembling the cables to the rack **100** in this manner, each of the cable harnesses **241-244** has a first radiused 90° bend **391** when the first end **251** is routed from the front end **215** of the hardware blade component and a second radiused 90° bend **392** (FIG. **3***a*) when the second end **252** of the harness is routed into the channel openings **320** *a, b, c, d*. A bend of the cable harness comprises a change in direction of the second end **252** of the harness of more than five degrees and any continuous arc of the cable comprising a single bend until the cable runs in a straight path for at least three inches and then changes direction to begin a second bend.

[0062] The routing of the second ends **252** of the cable harnesses from the front end **310** to the rear end **312** of the patch panel housing **300** is done in a straight line, so that there are no bends. Since the length of the second ends **252** are carefully tailored to the size of the patch panel housing **300** and with respect to the orientation on the rack with relation to each of the hardware blade components populated thereon, so there is little slack and minimum bending of the cables on the rack **100**. The rack system **100** limits the severity and number of bends of the cables in and helps to maintain transmitted power and avoids micro-bends and macro-bends. Also due to the structured orientation of the cabling **241-244** from the first area **271** of the patch panel housing **300** to the primary position **351** on the coupler plate **341** and the ordered assembly of the routing of cables **241-244** in a sequential orientation, there is little slack in each of the cable harnesses **241-244**; which provides for an organized and orderly rack cabling system. The orderly and organized system as described above also allows for a more rapid assembly of the cables **241-244** to the rack system **100**.

[0063] As well due to the minimal bends of the cable harnesses **241-244** the fiber optic cable are well maintained, have increased longevity and maintain high performance. Finally, due to the organizational structure of the patch panel housing **300** having each of the separated cable pathway openings **320**, divider walls **337** and the housings orientation where the cable pathway openings **320** are oriented at the front end **310** being adjacent to the front end **215** of the hardware blade component **200***a* and terminating at the rear end **312**, provides for a patch panel housing **300** that takes up a minimal amount of space. For example, as depicted in FIG. **2**, it can be seen that the patch panel housing **300** takes a two (RU) space.

[0064] The second embodiment of the invention having the hardware blade components mounted in a horizontal orientation will be described with respect to FIGS. **6***a*-**10**. A rack **1100** is provided, as is known in the data center industry having side rails **1110***a*, **1110***b* formed by metal C-channels and bracket and shelving components mounted between the rails. The rails **1110***a, b* include indicia **1115**, such as numeric markings. The partial rack **1100** as shown in FIG. **6***a*, is appropriately 31" tall, however, an additional chassis **1100** may be stacked above chassis **1200** that has at least twice as many blades as the rack depicted in FIG. **6***a*. The chassis **1200** is populated with hardware blade components **1200***a-d*. First hardware blade component **1200***a* has a first side and a second side each having twenty-four ports, the second blade component **1200***b* has a first side and a second side each having twenty-four ports, a third hardware blade component **1200***c* and fourth hardware blade component **1200***d* each have two parallel sides with twenty-four ports each.

[0065] Each of the hardware blade components **1200***a, b, c, d* have twenty-four ports on each side that populate a front end **1215** of each blade component **1200** to provide a total of forty-eight ports per chassis component **1200**. Each port **1221** receives a fiber optic connector, such as an individually channeled fiber connector **1231**. As depicted in FIG. **8***a*, a first individually channeled fiber connector **1231** is mounted in port **1221** on the front end **1215** of the hardware blade component **1200***a* in a first position. FIG. **8***b* is an enlarged view of the first eight connectors **1231-1238** mounted on the front end **1215** of the hardware blade component **1200***a*. In the embodiment depicted in FIG. **8***b*, the group of eight connectors **1231-1238** and their cabling comprise a cable harness **1241** (similar to the harness **241** depicted in FIG. **3***c*). In alternate embodiments there may be between up to twelve connectors and up to twelve corresponding ports and cables.

[0066] In an embodiment, the individual channel fiber optic connector may be an LC type connector such an mSFP-LC Pro-Slide connector. As depicted in FIG. **8***a*, cable harness assemblies **1241**, **1242** and **1243** are aligned along the length of the blade **1200***a*, so that a total of twenty-four connectors **1231** are mated to the ports **1221** at the front end **1215** of the hardware blade component **1200***a*. It is to be understood that while the embodiment depicted in these drawings includes

eight connectors **1231** in each harness **1241-1243**, the present invention may comprise cable harnesses which have more or less connectors in each harness (or more or less harnesses). In addition, it is to be well understood that a hardware component having more or less than forty-eight ports may be accommodated by the present invention and cable harnesses having varying numbers of connectors **1231** and corresponding cables **1256**.

[0067] It is to be understood that FIG. **8***a* depicts one side of the hardware blade component **1200***a* and only depicts the twenty-four ports **1221** and connectors **1231** running horizontally along the first side of the blade **1200***a* and there are correspondingly twenty-four other ports on the other side of the hardware blade component **1200***a* for receiving an additional twenty-four fiber optic connectors to make a total of forty-eight ports per blade component **1200**.

[0068] As shown in FIG. **8***b*, the harness **1241** has a first end **1251** including individual fiber cables **1256** attached to each of the eight fiber optic connectors **1231-1238** and a second end **1252** to which a multi-fiber connector **1260** is attached (FIG. **8***a*). The cable harness **1241** has the second end **1252** which is furcated at furcation points in order to provide the eight individual cables at the first end **1251**. Finally each individual cable is terminated with a connector **1231-1238**. Each connector **1231-1238** may have a boot **1255** (FIG. **8***b*). Each boot **1255** may be numbered 1-8, in order to help the operator to keep the fanned out first end **1251** of the harness **1241** organized.

[0069] As can be understood from FIG. **8***b*, the first end **1251** of each individual cable is progressively longer for each cable **1256** corresponding to each connector **1231-1238**. For example, the individual cable **1256** at the first end **1251** for the eighth connector **1238** will be approximately about ½" longer than its adjacent connector **1237** etc. It may be understood that the first end **1251** of the individual cable to which the eighth connector **1238** is terminated will be approximately 4" longer than the individual cable at the first end **1251** to which the first connector **1231** is terminated. The staggering of the lengths of the first end **1251** of the fanned out cables on each cable harness **1241-1243** allows for the orderly connection of the harness to each hardware blade component **1200** and eliminates slack and provides for a neat and organized cabling system.

[0070] Turning to FIG. **8***a*, the staggered lengths of each of the adjacent cables for the first cable harness **1241** is shown mated to the hardware blade component **1200***a* in a orderly fashion. It may be understood that the individual cable for the first connector **1231** is closer to the second end **1252** of the harness assembly **1241** and therefore can be shorter than the individual cable **1256** for the eighth connector **1228**, further along the length of the front end **1215** of the hardware blade component **1200***a*, eight channels away. The first cable harness **1241** has its connectors **1231** mated to the hardware blade component **1200***a* at a first area **1271** having eight ports **1221**; the second harness assembly **1242** has its connectors mated to the hardware blade component **1200***a* at a second area **1272** having eight ports; and the third cable harness **1243** has its eight connectors mounted to the hardware blade component **1200***a* at a third area **1273** having eight ports. It may be understood in other embodiments, that the hardware blade component areas **1271**, **1272**, **1273** may have varying numbers of ports depending on the grouping of the number of connectors **1231** and cables **1256** terminated on each cable harness **1241**, **1242**, **1243**. In addition, hardware blade component areas may by located on the multiple hardware blade components.

[0071] Mounted in the rack **1100**, is a patch panel housing **1300** having a front end **1310** and rear end **1312** (FIG. **9***a*). The patch panel housing **1300** is mounted in the rack **1100** so that the front end **1310** is adjacent the front end **1215** of each of the hardware blade component **1200***a, b, c, d*. The patch panel housing **1300** includes a first cable pathway opening **1320***a*, a second cable pathway opening **1320***b*, a third cable pathway opening **1320***c* and a fourth cable pathway opening **1320***d* (FIG. **6***a*). Other cable pathway openings **1330** are also provided in the patch panel housing **1300**. The first cable pathway opening **1320***a* is the primary position located adjacent the first side **1331** of the patch panel housing **1300**.

[0072] FIG. **9***a* is a section view of the rack **1100** taken at line **9***a*-**9***a* of FIG. **7** and depicts a plan view of the patch panel housing **1300** partially broken away. As viewed in FIG. **9***a*, on the right side, the housing cover **1335** is depicted. The housing cover **1335** on the left of the drawing FIG. **9***a* has been removed and depicts the interior of the patch panel housing **1300** exposing a view of the interior walls **1337***a, b, c, d* that provide harness pathways inside the housing **1300**. Similar walls **1337** are provided on the other side of the interior of the housing **1300**.

[0073] The rear end **1312** of the housing **1300** has mounted thereon a first connector coupler plate **1341**, a second connector coupler plate **1342**, a third connector coupler plate **1343** and a fourth connector coupler plate **1344** (FIG. **9***b*). Each coupler plate **1341** includes eight coupler connectors **1351-1358** (FIG. **10**). Each coupler connector **1351-1358** includes an internal facing side **1360***a* for receiving a multi-fiber connector **1260** and an external facing side **1360***b* (see FIG. **9***b*) for receiving a jumper cable connector (not shown). As depicted in FIG. **9***b*, each coupler connector **1351-1358** has a dust cover mounted thereto. As depicted in FIG. **10**, the coupler plate has indicia **1115** provided thereon which identify the positions of the connector couplings **1351-1358**. As shown in FIG. **10**, numerals 1-8 are provided to designate the positioning of the coupler connectors **1351-1358**. Thus it is understood that the primary position is the coupler connector with numeral "1" in the lower left position, (similar to FIG. **4***c*). This is the position in which connector coupler **1351** is mounted on the plate **1341**.

[0074] To understand the invention further, the steps of mounting and routing the cables on the rack **1100** will be discussed in sequence with respect to FIGS. **6***a*-**10**. The first cable harness **1241** is arranged so that the first end **1251** has each of the connectors **1231-1238** fanned-out, so that the first connector **1231** may be inserted in the first port **1221** on the first hardware blade component **1200***a* in first position. Each of the next connectors **1232-1238** are likewise mated to its corresponding port **1222-1228** in the first area **1271** on the hardware blade component **1200***a*. The second end **1252** of the cable harness **1241** is routed to the right towards the first side of **1100***a* of the rack. The second cable harness **1242** is then arranged so that its first end is fanned-out, so that each of the eight connectors may be mated to the second area **1272** of the hardware blade component **1200***a*. Likewise, the second end **1252** of the second cable harness **1242** is routed to the right to form a cable bundle **1245** with the first harness **1241**. The third cable harness **1243** is organized so that the eight connectors at the first end **1250** may be sequentially mated at the third area **1273** on the hardware blade component **1200***a*.

The second end **1252** of the third cable harness **1243** is routed to the right to form a cable bundle **1245** with the first and second harnesses **1241**, **1242** at first side **1110***a* of the rack **1100**.

[0075] Thus, it is understood that each of the second ends **1252** of the cable harnesses **1241**, **1242** and **1243** are each gathered lying side by side in a horizontal orientation as shown in FIGS. **6***a, b*, **8***a* to form a first bundle **1245***a*. In the embodiment depicted in FIG. **6***a, b*, the first cable harness bundle **1245***a* is secured using hook and loop straps **1401**. The cable harness bundles **1245***a, b, c, d* will have a total length between 45" and 90". The length of the cable harness may vary depending on the specific hardware component and port configuration. Thus, it may be understood that when the second ends **1252** of each of the cable harness bundles **1245** *a, b, c, d* are routed to the first side **1110***a* of the rack **1100** and the bundle **1245***a* bends at approximately a radiused 90° bend downward along the side rail **1110***a*. The first cable bundle **1245***a* joins with second, third and fourth cable bundles **1245** *b, c, d* to form a major cable bundle **1247** that runs vertically down the side rail **1110***a* toward the bottom of the rack **1100**. While FIG. **6***b* attempts to illustrate all visible individual cables, FIG. **6***a* is schematic with respect to the cables and a single line **1247** is representative of a bundle of cables.

[0076] Each of the second, third and fourth cable bundles **1245***b, c d* are formed in the same manner as discussed above. In other words, in the embodiment depicted in FIGS. **6***a, b* each cable bundle **1245***b, c d* includes three cable harness that each include eight individual cables terminated with individually channeled fiber connectors **1221-1228** connected to other areas on hardware blade component sides **1200***b, c* d. So in the embodiment depicted in FIGS. **6***a, b* each cable bundle **1245** will be made up of twenty-four individual cables. Each cable harness has its individual cables furcated to form the second end **1252** at furcation points **1253***b, c, d* (FIG. **6***b*). Because the length of each cable bundle **1245***a, b, c, d* (and each harness **1241-1243** therein) is progressively longer (as each component **1200***a, b, c, d* is progressively further from the patch panel **1300**) each of the multi-fiber connectors **1260** will be side-by-side.

[0077] Each of the second ends **1252** of the cable harnesses **1245***a, b, c, d* are routed downward along the side rail **1110***a* and may be secured with cable management. The major bundle **1247** makes a bend of approximately 90° to route each cable bundle **1245***a, b, c, d* to the front end **1310** of the patch panel **1300** for routing the bundles through the cable pathway openings **1320** at the front end **1310** of the patch panel housing **1300**. A Crimmins tool may be used to pull each group of multi-fiber connectors **1260** from the front end **1310** to the rear end **1312** of the patch panel housing **1300**.

[0078] In a preferred embodiment, the first cable bundle **1245***a* is routed through the first cable pathway opening **1320***a* and the multi-fiber connectors **1260** terminated on the first coupler plate **1341** positioned at the first side **1331** (FIG. **9***a*). Then the second end **1252** of the second cable bundle **1245***b* is routed through the second cable pathway opening **1320***b* and its multi-fiber connectors **1260** are terminated at the second coupler plate **1342** adjacent the primary position where the first cable harness bundle **1245***a* has its connectors **1260** terminated to coupler connector **1351-1353**. Then the second end **1252** of the third cable bundle **1245***c* is routed through the third cable pathway opening **1320***c* and its connectors **1260** mated to the third coupler plate **1343**. Finally, the second end **1252** of a fourth cable bundle **1245***d* is routed through the fourth cable pathway opening **1320***d* and its multi-fiber connectors **1260** are mated to the fourth coupler plate **1344**.

[0079] As depicted in FIG. **9***b*, it is preferable to remove the coupler plate **1341** from the rear end **1312** of the patch panel housing **1300** to attach the multi-fiber connectors **1260** to its corresponding coupler connector **1351-1358**. Once each of the connectors **1260** are mated to the coupler plate **1341** the plate is mounted to the rear end **1312** of the housing **1300** via snap fit fasteners **1380***a*, **1380***b* (FIG. **10***e*). According to the orientation of the preferred embodiment of the hardware blade components **1200** having twenty-four channels on a single side **1200***a*; the use of only four cable bundles **1245***a, b, c, d* are necessary coming from the four hardware blade components **1200***a, b, c, d*. In that instance, a cable bundle is routed through the first, second, third and fourth cable pathway openings **1320***a, b, c, d.*

[0080] However, it is to be understood that a hardware blade component **1200** and having more channels will require additional cable harnesses and cable bundles and in that instance there are additional cable pathway openings **1330** (FIGS. **6***a*, **9***a*) to accommodate additional multi-fiber connectors **1260** that are routed from the additional cable bundles. Also in a taller rack **1100**, there may be other hardware blade components mounted above the blade **1200***d*, so that the cable bundles from the upper most blades may also be routed to the first side rail **1110***a* and drop down vertically to join the major bundle **1247** and be routed through the cable pathway openings **1330** moving from right to left (as shown in FIG. **6***a*) and its connectors **1260** terminated on remaining coupler plates **1341-44** (FIG. **10**).

[0081] In assembling the cables to the rack **1100**, each of the cable bundles **1245***a, b, c, d* has a first radiused 90° bend **1391***a, b, c, d* when the first ends **1251** are routed from the front end **1215** of each of the hardware blade components and a second radiused 90° bend **1392***a-d* when the second end **1252** of each bundle is routed into the channel openings **1320** *a, b, c, d*. The routing of the second ends **1252** of the cable bundles from the front end **1310** to the rear end **1312** of the patch panel housing **1300** is done in a straight line, so that there are no bends in the cable bundle. Since the length of the second ends **1252** are carefully tailored to the size of the patch panel housing **1300** and with respect to the orientation on the rack with relation to each of the hardware blade components populated thereon, there is little slack and minimum bending of the cable bundles on the rack **1100**.

[0082] Also due to the structured orientation of the cabling bundles **1245** and harnesses **1241-1244** from the hardware components **1200** where first cable bundle **1245***a* is routed to the first cable pathway opening numbered "1" and the second cable bundle **1245***b* routed to the second cable pathway opening numbered "2" etc. to provide a sequential orientation, there is little slack in each of the cable harnesses **1241-1244** and cable bundles **1245***a, b, c, d* and which provides for an organized and orderly rack cabling system. The orderly and organized system as described above also allow for a more rapid assembly of the cables **1241-1244** and cable bundles **1245***a, b, c, d* to the rack system **1100**.

[0083] As well, due to the minimal bends of the cable bundles **1245***a, b, c, d* the fiber optic cables are well maintained, have increased longevity and maintain high performance. Finally, due to the organizational structure of the patch panel housing **1300** having each of the separated cable pathway openings **1320**, divider walls **1337** and the housings

orientation where the cable pathway openings **1320** are oriented at the front end **1310** being adjacent to the front end **1215** of the hardware blade component **1200***a, c* and terminating at the rear end **1312**, provides for a patch panel housing **1300** that takes up a minimal amount of space. For example, as depicted in FIG. **6***a*, it can be seen that the patch panel housing **1300** takes a two RU space.

[0084] It will be apparent to those skilled in the art that various modifications and variations can be made in locking mechanism of alternate embodiments of the invention without departing from the spirit or scope of the invention. Thus, it is intended that embodiments of the invention cover the modifications and variations of this invention provided within the scope of the appended claims and their equivalents.

What is claimed is:

1. A rack cabling system comprising:

a rack having mounted thereon a first hardware component and a patch panel housing mounted on the rack adjacent the first hardware component, the patch panel housing including a first end having cable pathway openings and a second end having connector elements mounted therein, the patch panel housing mounted in the rack so that its first end is aligned with a first end of the first hardware component;

the cable pathway openings arranged within the patch panel housing between a first side and second side of the housing, the patch panel having a first cable pathway opening located adjacent the first side of the housing and defining a primary position and a first connector element mounted on the second end adjacent the first side and the first connector element having a first position corresponding to the primary position of the first cable pathway opening and a second position adjacent the first position;

the first hardware component having a first cable harness extending therefrom, each harness including a group of fiber connectors terminated on a group of cables at a first end of the harness and a multi-fiber connector at an opposite second end of the harness, each hardware component having at least a first and second cable harness extending therefrom, the first hardware component having a first and second area for connecting the first end of each cable harness;

the first cable harness having its first end mounted to the first hardware component in the first area on the hardware component and the second end received in the primary position of the patch panel so that the first cable harness is routed with three bends or less of the cables from the first hardware component into the first cable pathway opening and extending without a bend through the patch panel housing to the second end so that the multi-fiber connector is terminated at the first connector element in the first position;

the second cable harness is routed with three bends or less of the cables from the second area of the hardware component into the cable pathway opening of the patch panel and extending without a bend through the patch panel housing to the second end so that the multi-fiber connector is terminated at the second position of the connector element off-set from the first position and the length of each of the cables comprising the second cable harness being longer than each of the cables comprising the first cable harness wherein a minimum amount of slack is provided in each of the first and second cable harnesses.

2. The rack cabling system of claim **1**, wherein the first end of the patch panel is located at a front of the rack on a side from which the first cable harness extends.

3. The rack cabling system of claim **2**, wherein the second end of the patch panel is located at a rear of the rack opposite the front of the rack.

4. The rack cabling system of claim **3**, wherein the connector element comprises a coupler plate and includes up to eight couplers on each plate and each coupler numbered sequentially beginning with 1 through 8.

5. The rack cabling system of claim **4**, wherein the second cable harness multi-fiber connector is terminated in the second position at a coupler numbered "2".

6. The rack cabling system of claim **1**, wherein each of the first and second cable harnesses including the first end having up to twelve individually channeled LC type connectors terminated on up to twelve individual cables forming the group of cables at the first end and each harnesses including the second end having up to twelve individual cables joined to form a multi-fiber cable terminated with an MTP type connector and the multi-fiber cable furcated to provide up to twelve individual cables at the first end of the harness.

7. The rack cabling system of claim **6**, wherein the LC type connector comprises an LC or mSFP-LC pro-slide connector.

8. The rack cabling system of claim **6**, wherein the first and second area of the hardware component each including up to twelve fiber optic connectors for mating with the six to twelve individually channeled LC type connectors at the first end of the cable harness.

9. The rack cabling system of claim **6**, wherein at least four cable harnesses are routed from each hardware component and each cable harness having a length of approximately 36", 42", **48"** and 54", respectively and the first end of each harness having up to twelve individual cables staggered by a difference in length of approximately ½" connector to connector with a tolerance range of ¼" to 1".

10. The rack cabling system of claim **1**, wherein the bend of the first and second cable harness comprises a change in direction of the second end of the harness of more than five degrees and any continuous arc of the cable comprising a single bend until the cable runs in a straight path for at least three inches and then changes direction to begin a second bend.

11. The rack cabling system of claim **1**, wherein the rack includes trunk cables attached to the connector elements on the patch panel housing and a horizontal trunk management bar attached to the rack for managing the trunk cables.

12. The rack cabling system of claim **1**, wherein the rack includes a second hardware component, each of the first and second hardware components being mounted in a vertical orientation within the rack.

13. The rack cabling system of claim **12**, wherein each of the first and second cable harnesses extend downward from the first hardware component and the second end of each cable harness forming approximately a radiused 90° bend in order to enter the front end of the patch panel housing so that the first and second cable harnesses are received in the first cable pathway opening numbered "1".

14. The rack cabling system of claim **1**, wherein the rack includes a second hardware component, each of the first and second hardware components being mounted in a horizontal orientation within the rack.

15. The rack cabling system of claim **14**, wherein each of the first and second cable harnesses extend sideways from the first hardware component toward a first side of the rack;

a third cable harness extends from the second hardware component sideways toward the first side of the rack, the third cable harness having a first and second end;

each of the first ends of the first, second and third cable harnesses forming approximately a radiused 90° bend in order to extend downward along the first side of the rack; and

the second end of each of the first, second and third cable harnesses forming approximately a radiused 90° bend in order to enter the front end of the patch panel housing so that the first and second cable harnesses are received in the first cable pathway opening numbered "1" and the third cable harness is received in a second cable pathway opening numbered "2".

16. The rack cabling system of claim **1**, wherein the first hardware component is one of a switch, router, director, data management tool and server.

17. A rack cabling system comprising:

a rack having mounted thereon a first hardware component and second hardware component, a patch panel housing mounted on the rack adjacent the first hardware component, the patch panel housing having a first end having cable pathway openings and a second end having connector elements mounted therein;

the cable pathway openings arranged within the patch panel housing between a first side and second side of the housing, the patch panel having a first cable pathway opening located adjacent the first side of the housing and defining a primary position and a first connector element mounted on the second end adjacent the first side and being in the primary position corresponding to the first cable pathway opening and the patch panel housing having a second cable pathway opening;

the first hardware component having a first cable harness bundle extending therefrom, the second hardware component having a second cable harness bundle extending therefrom, each of the first and second cable harness bundles having at least two harnesses each comprising a group of fiber connectors terminated on a group of cables at a first end and a multi-fiber connector at an opposite second end,

the first cable harness bundle having its first end mounted to the first hardware component and the second ends received in the primary position of the patch panel so that the first cable harness bundle is routed with three bends or less of the cables from the first hardware component into the first cable pathway opening and extending without a bend through the patch panel housing to the second end so that the multi-fiber connectors are terminated at the first connector element;

the second cable harness bundle is routed with three bends or less of the cables from the second hardware component into the second cable pathway opening offset from the primary position of the patch panel and extending without a bend through the patch panel housing to the second end so that the multi-fiber connectors are terminated at a second connector element off-set from the primary position and the length of each of the cables comprising the second cable harness bundle being longer than each of the cables comprising the first cable harness bundle wherein a minimum amount of slack is provided in each of the first and second cable harness bundles.

18. The rack cabling system of claim **17**, wherein the patch panel first end is at a front side of the rack on a side from which the cable harness extends and the first and second connector elements comprising coupler plates.

19. The rack cabling system of claim **18**, wherein each of the first and second cable harness bundles extend sideways from the first and second hardware component, respectively toward a first side of the rack and each of the first ends of the first and second cable harness bundles forming approximately a radiused 90° bend in order to extend downward along the first side of the rack and the second end of each of the first and second cable harness bundles forming approximately a radiused 90° bend in order to enter the front end of the patch panel housing so that the first cable harness bundle is received in the first cable pathway opening numbered "1" and the second cable harness bundle is received in a second cable pathway opening numbered "2".

20. The rack cabling system of claim **17**, wherein the first cable harness bundle comprises at least six individual cables having six individually channeled fiber connectors at a first end extending from a first area of the first hardware component and a second end from which the six individual cables are furcated; and

the second cable harness bundle comprises at least six individual cables having six individually channeled fiber connectors at a first end extending from a first area of the second hardware component and a second end from which the six individual cables are furcated.

21. The rack cabling system of claim **20**, wherein the first cable bundle further comprises at least eight individual cables having eight individually channeled fiber connectors at a first end extending from a second area of the first hardware component and a second end from which the eight individual cables are furcated; and

the second cable harness bundle further comprises at least eight individual cables having eight individually channeled fiber connectors at a first end extending from a second area of the second hardware component and a second end from which the eight individual cables are furcated.

22. A method of assembling cabling for rack of hardware components comprising the steps of:

assembling a rack having first and second hardware components;

preparing no more than a three rack unit (RU) space on the rack and mounting a patch panel housing thereto, the patch panel housing having a first end having a cable pathway opening and a second end having connector elements;

orienting the patch panel housing on the rack so that the first end is aligned with a first end of the first hardware component and a primary position of the cable pathway opening in accordance with the position of the first hardware component;

attaching a first end of a first cable harness to the first hardware component;

routing a second end of the first cable harness to the cable pathway opening of the patch panel housing with three or less bends of the first cable harness;

routing the second end of the first cable harness through the patch panel housing to the second end;

terminating the second end of the first cable harness at a first connector element;

attaching a first end of a second cable harness to the second hardware component;

routing a second end of the second cable harness to the cable pathway opening of the patch panel housing with three or less bends of the second cable harness;

routing the second end of the second cable harness through the patch panel housing to the second end in a position adjacent to the primary position; and

terminating the second end of the second cable harness at a second connector element.

23. The method of claim **22**, further comprising the steps of:

providing a patch panel housing first end that is located at a front of the rack and includes two sets of routing indicia for prioritizing placement of the first and second cable harnesses;

identifying the first set of routing indicia corresponding to a present orientation of the hardware component;

routing the first and second cable harnesses through the patch panel housing front end in the primary position according to one of the first and second routing indicia; and

receiving the first and second cable harnesses at first and second connector elements, each comprising a coupler plate having up to eight coupler connectors per plate.

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