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(54) **MODULAR ELECTRONIC ENCLOSURE WITH COOLING DESIGN**

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(57) **ABSTRACT**

An embodiment of a modular electronic enclosure is provided as including a chassis having a first portion defining a first compartment, and a second portion defining a second compartment. First and second replaceable units are replaceably received within the first and second compartments, respectively. The modular electronic enclosure also has a fan unit that is replaceably received within a compartment defined by the first portion or the second portion. The fan unit is configured to pull in cooling air through the first portion and exhaust pressurized cooling air through the second portion. A method of cooling a modular electronic enclosure defining first and second compartments is also provided.

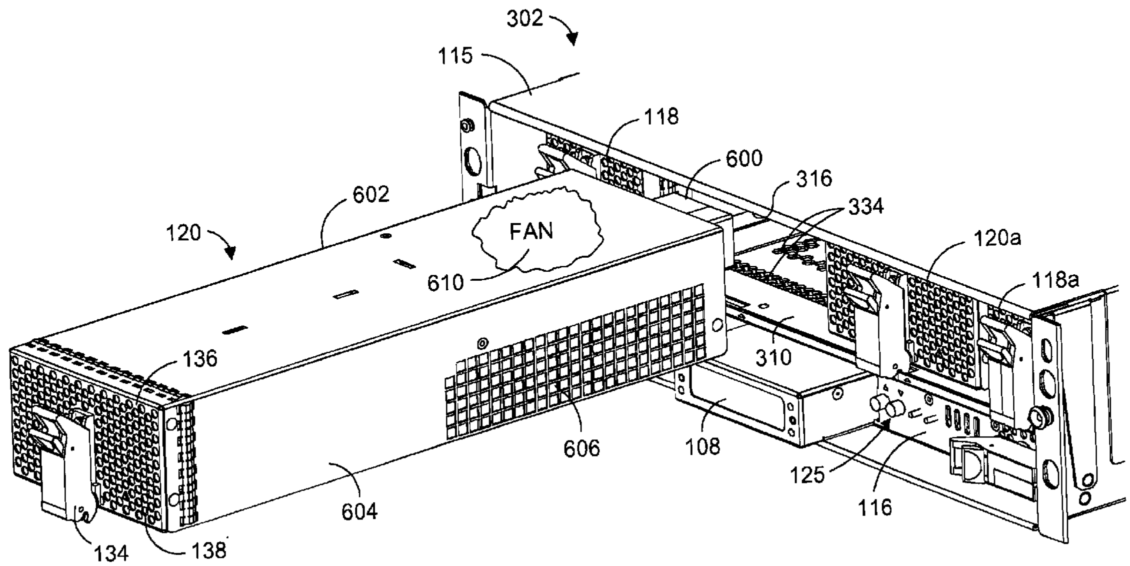
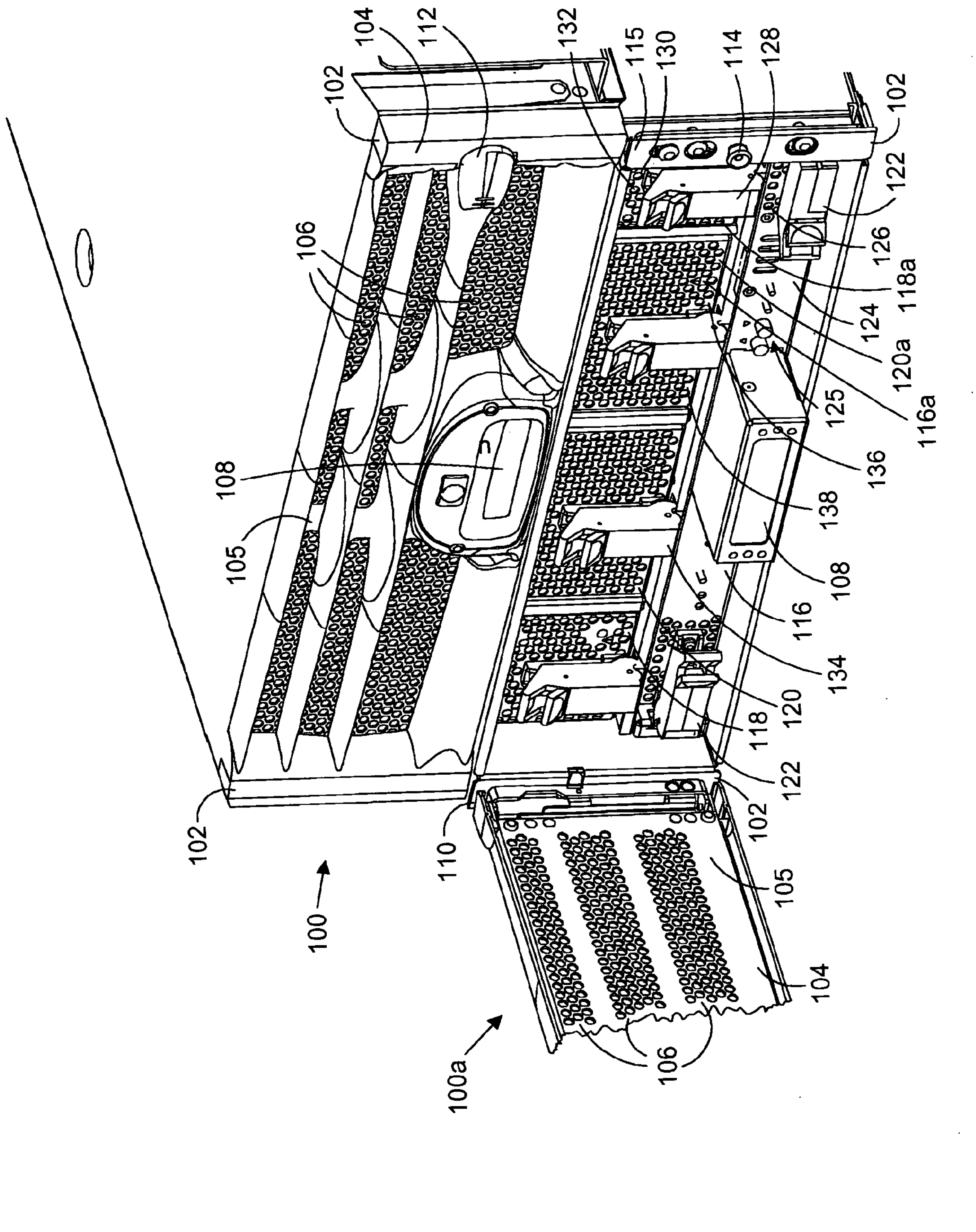


FIG. 1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100a
102
104
105
106
108
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116a
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118a
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130
132
134
136
138

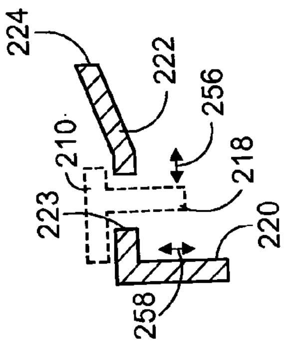

224
222
256
210
218
223
220
258

FIG. 2E

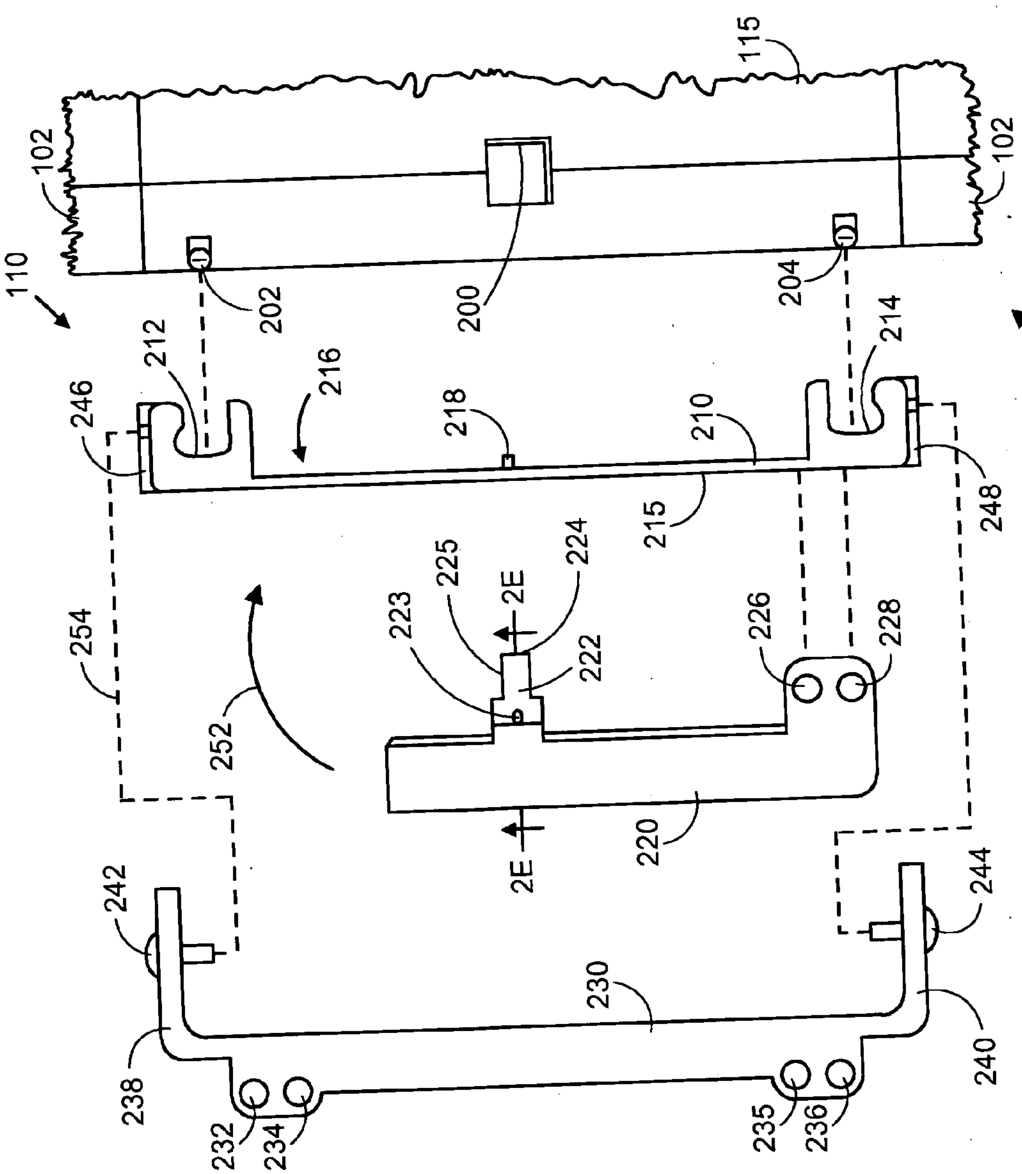

110
102
115
102
202
200
204
212
216
214
246
218
210
250
215
248
225
224
223
2E
222
226
228
254
252
220
2E
242
244
230
238
240
232
234
235
236

FIG. 2A

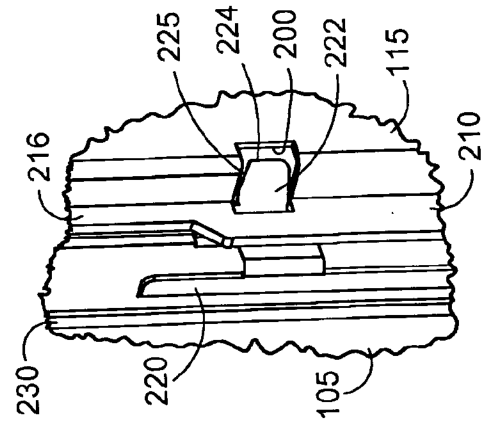


FIG. 2D

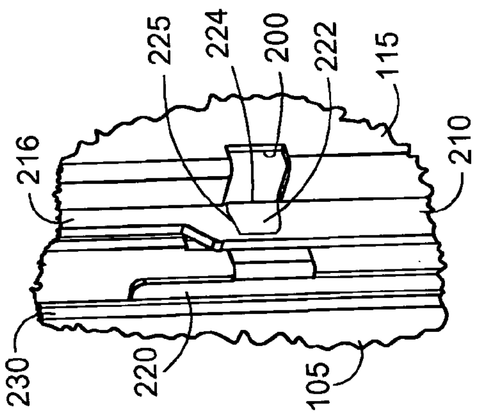


FIG. 2C

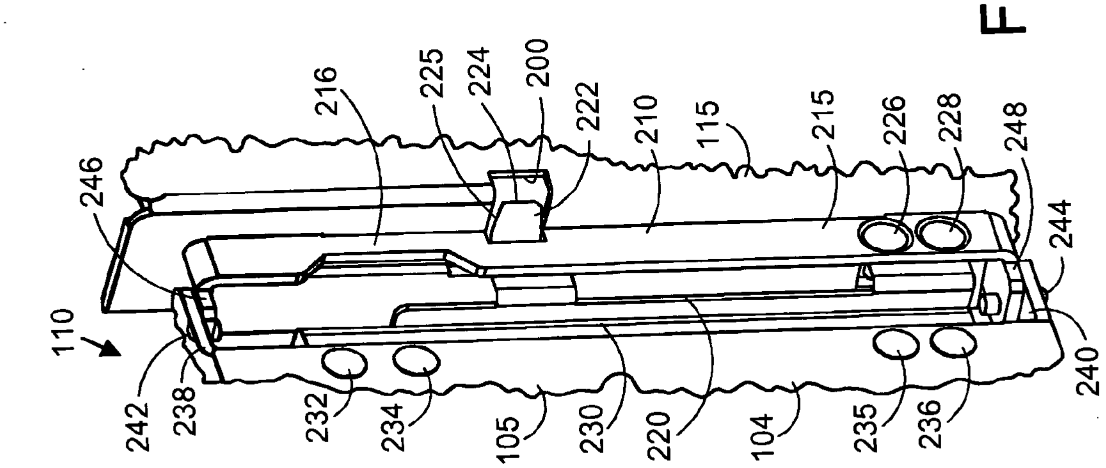


FIG. 2B

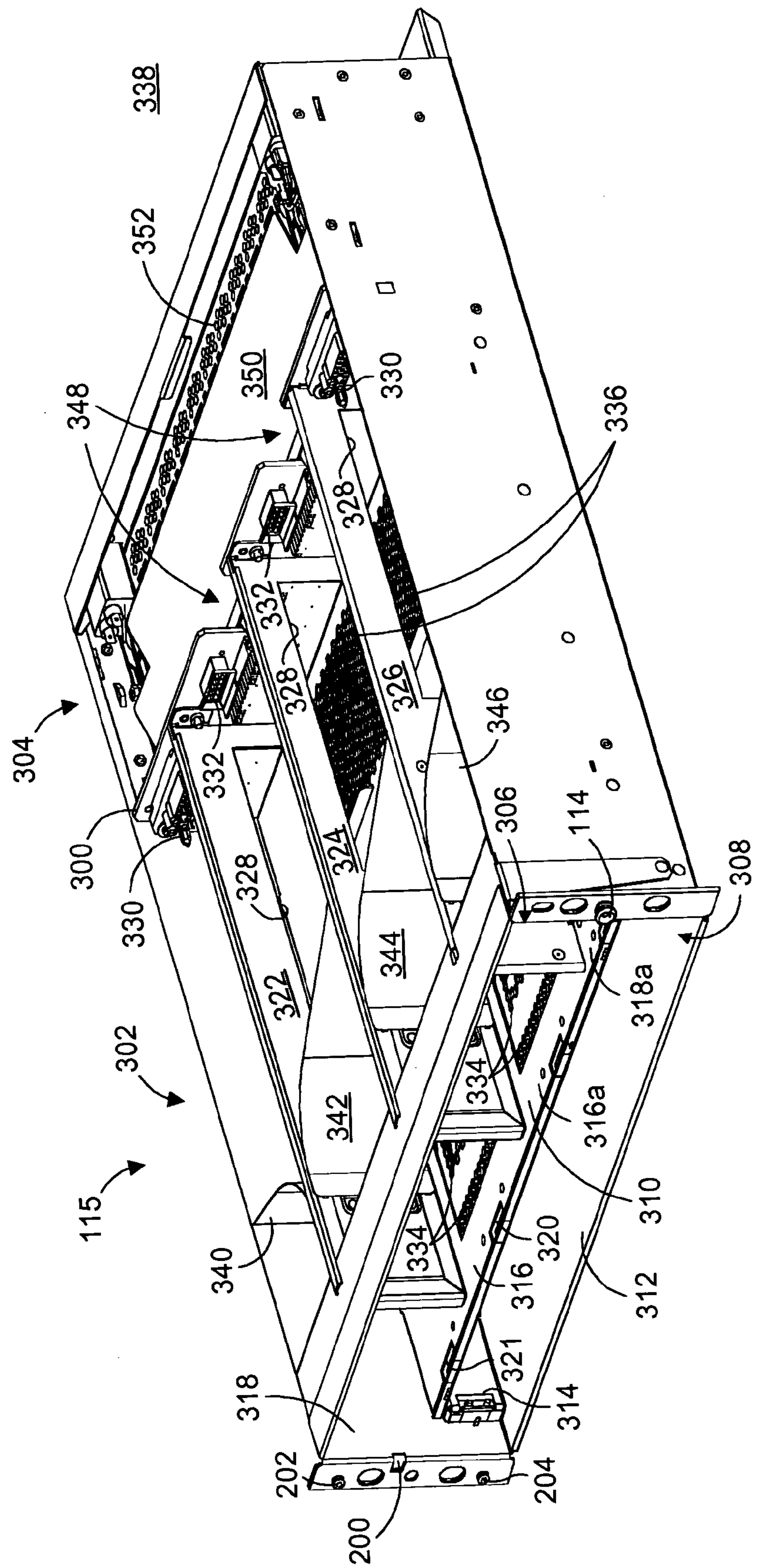
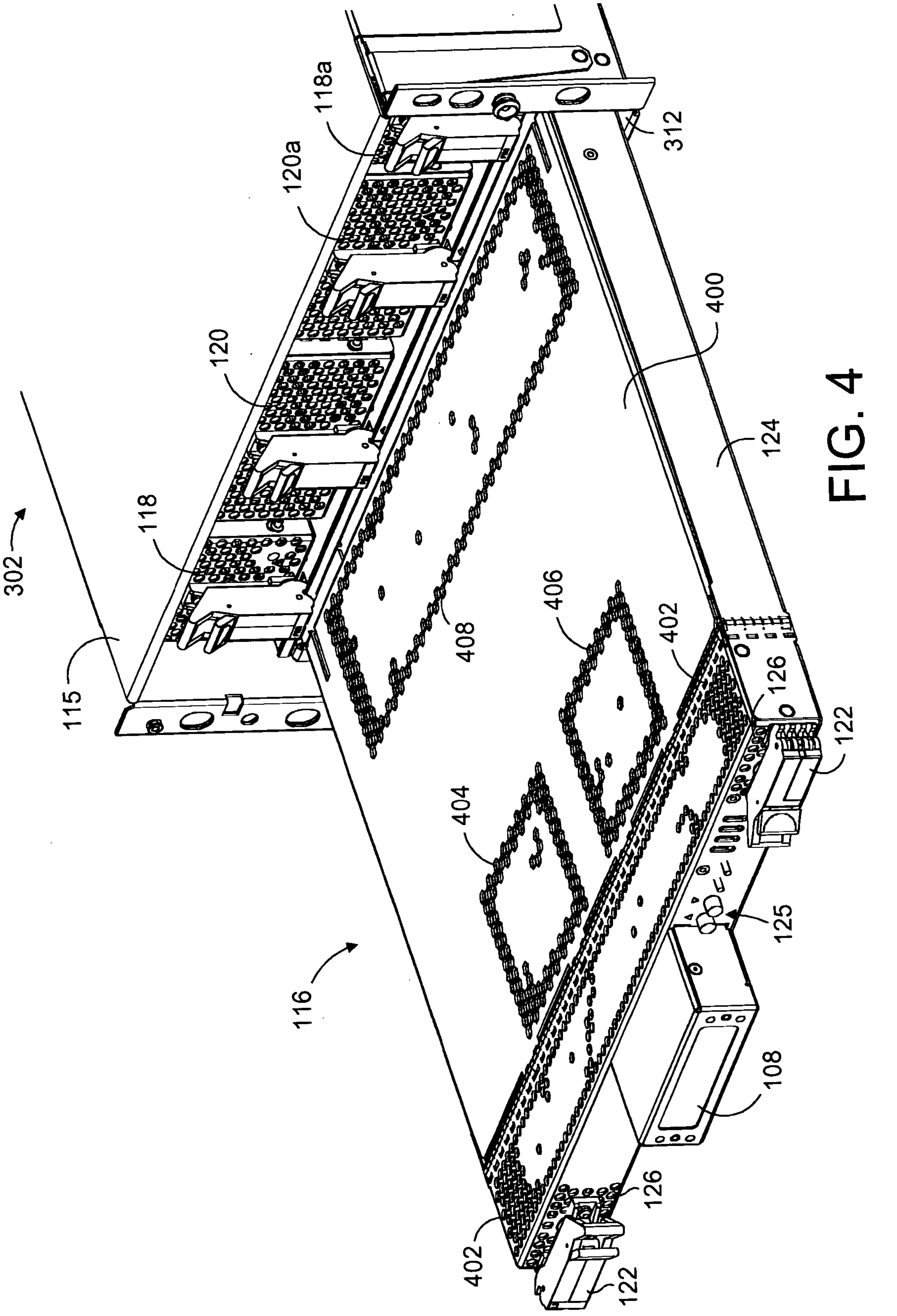
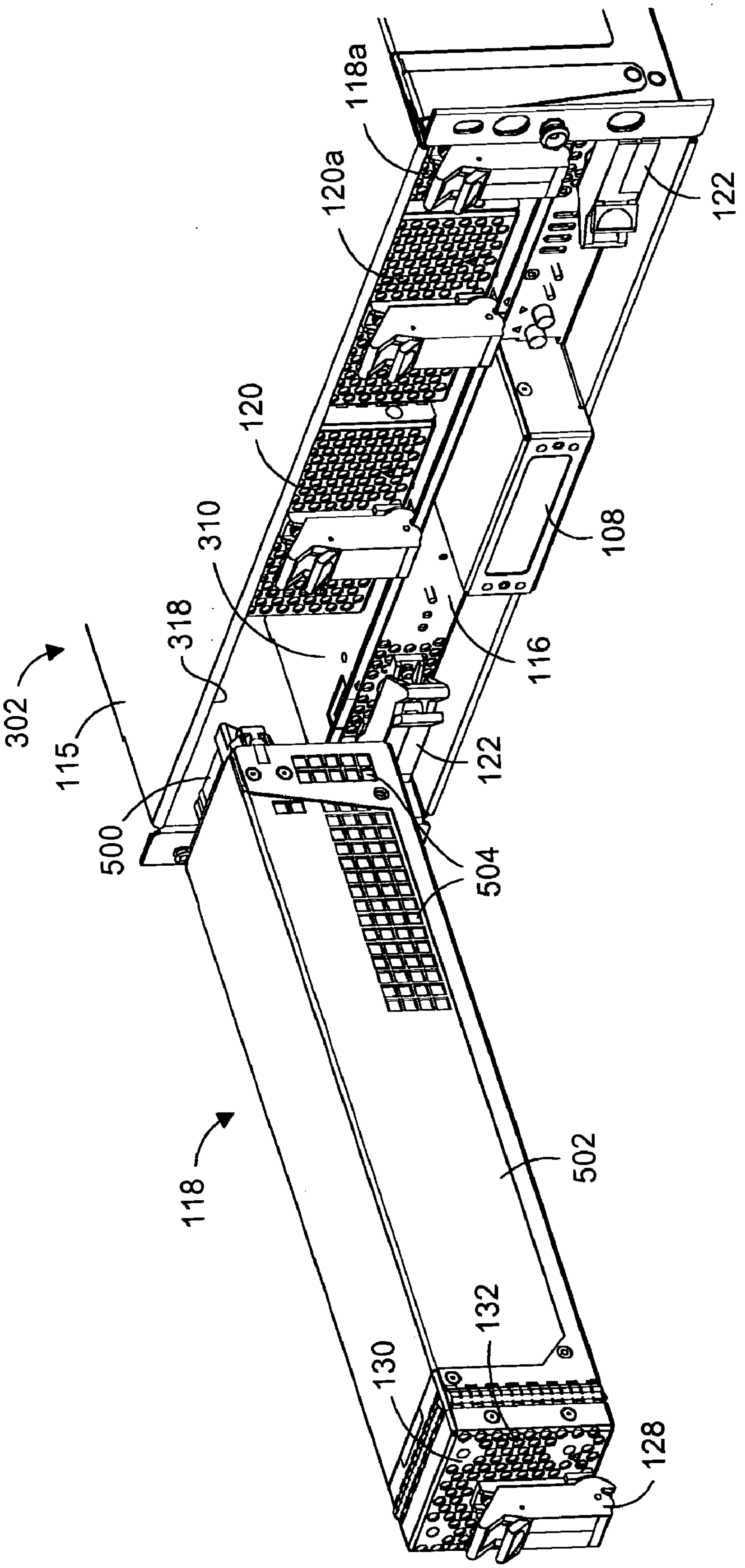

338
352
348
350
330
336
304
332
328
326
300
330
332
328
324
346
306
114
308
302
322
328
344
318a
115
342
334
316a
310
340
334
320
316
312
321
318
314
202
204
200

FIG. 3


302
115
118
120
120a
118a
312
408
400
406
402
404
124
126
122
125
116
108
FIG. 4



118a
120a
122
120
310
318
302
115
500
108
116
122
504
118
502
132
130
128

FIG. 5

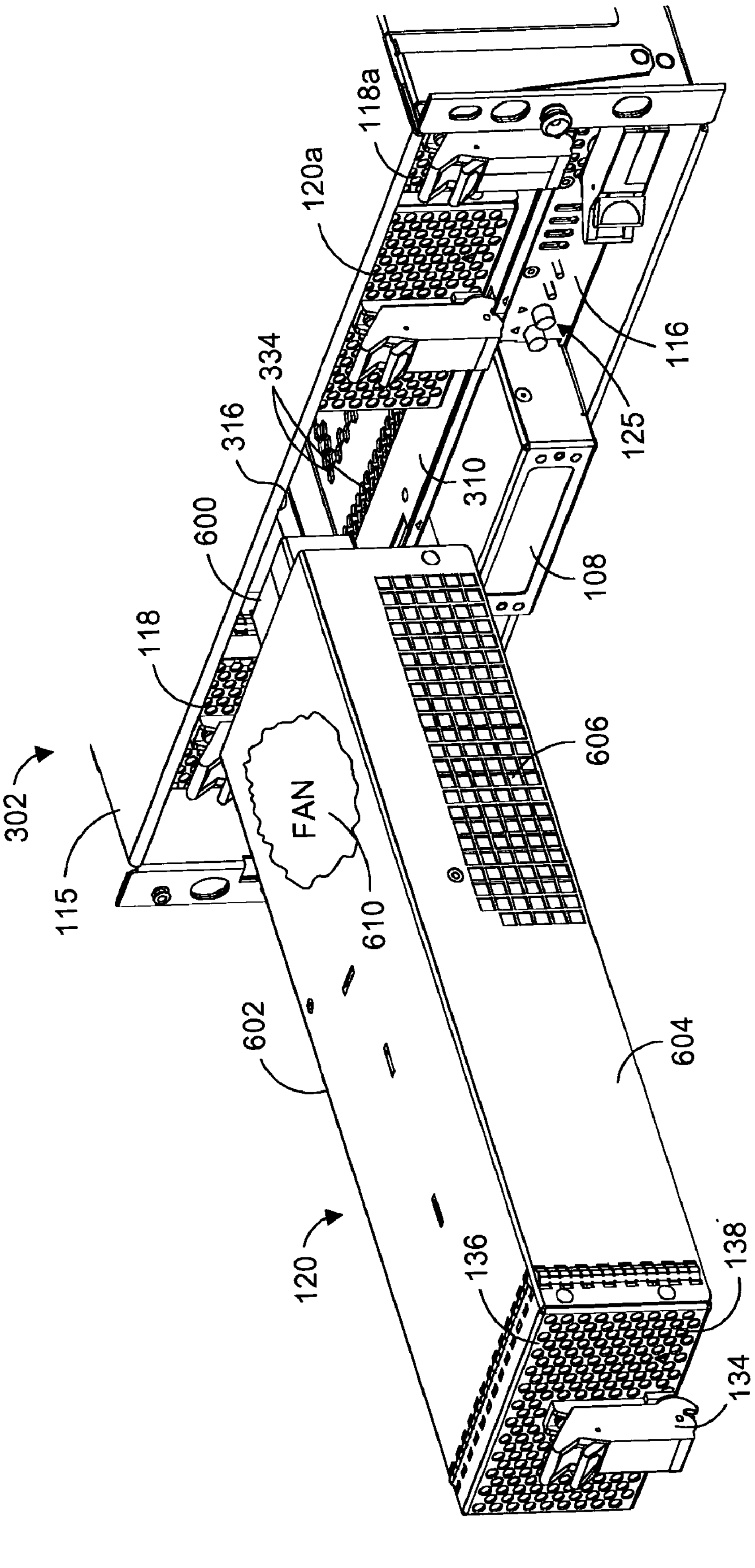

302
115
118
600
316
334
120a
118a
310
108
125
116
606
FAN
610
602
604
120
136
138
134

FIG. 6

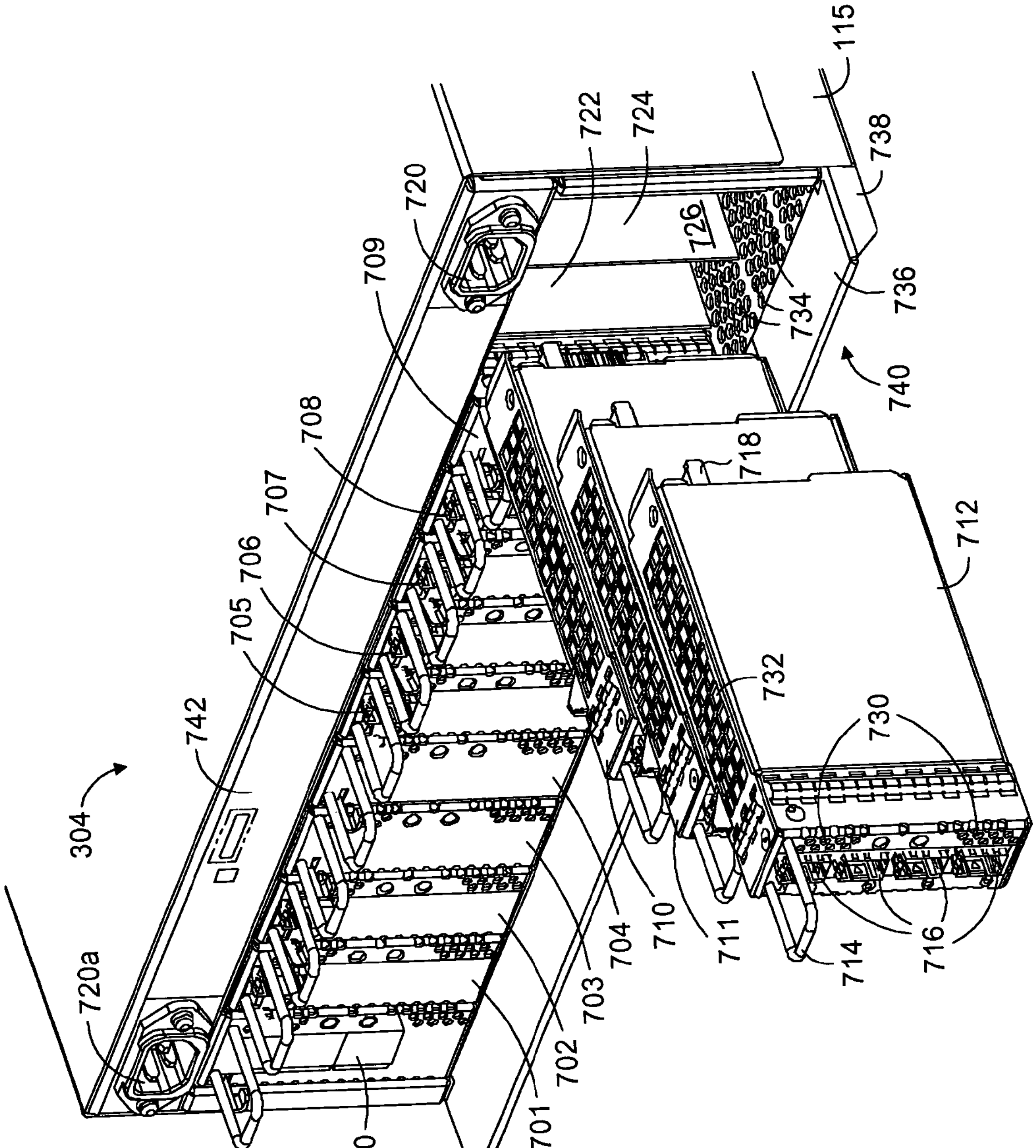
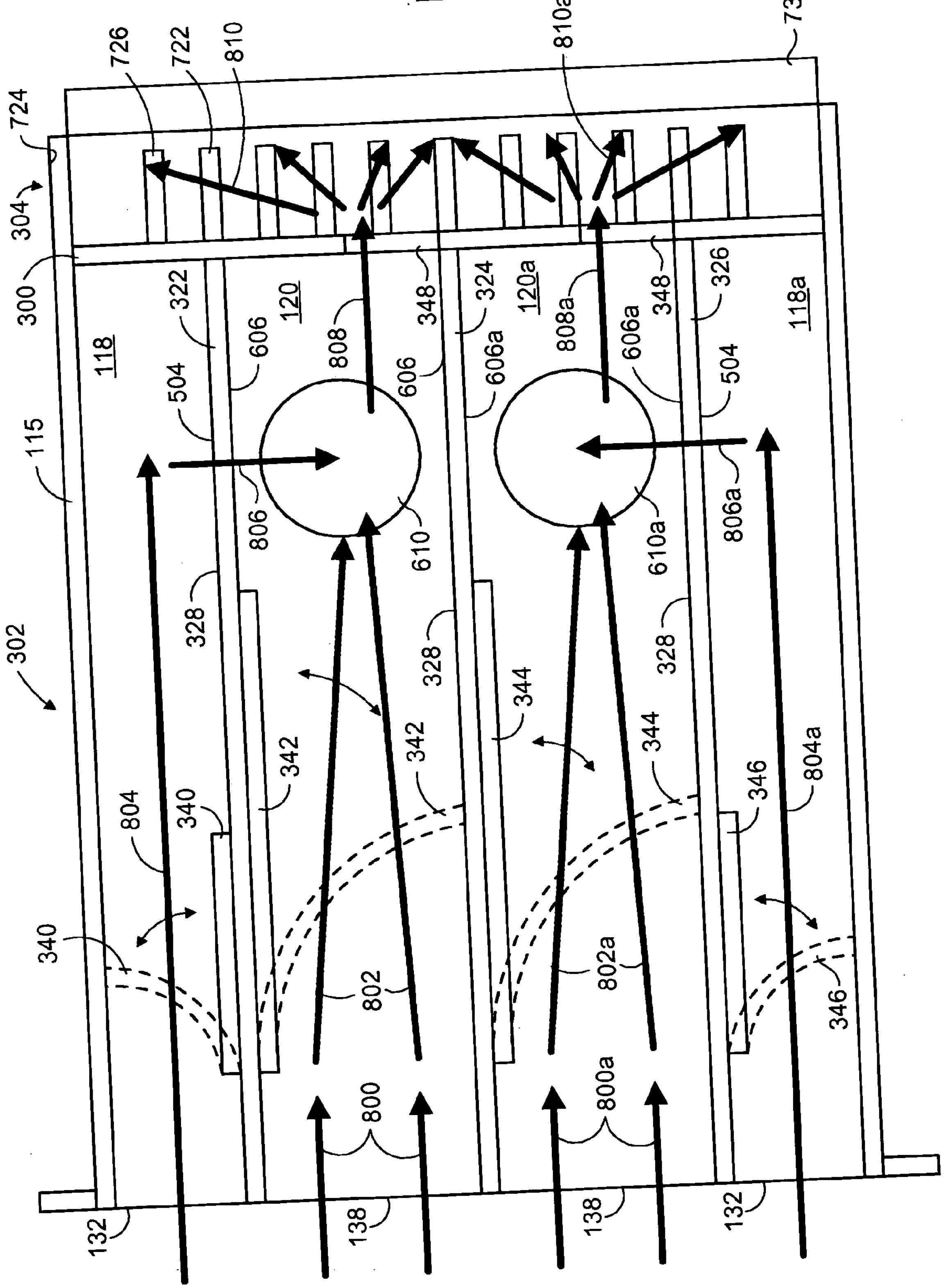

304
742
720a
700
701
702
703
704
705
706
707
708
709
710
711
714
716
730
732
712
718
740
734
736
738
726
724
722
720
115

FIG. 7

FIG. 8



724
726
722
810
810a
736
304
300
118
120
120a
118a
322
324
326
348
606
606a
504
808
808a
115
806
806a
610
610a
302
328
344
342
340
346
804
804a
802
802a
800
800a
138
132

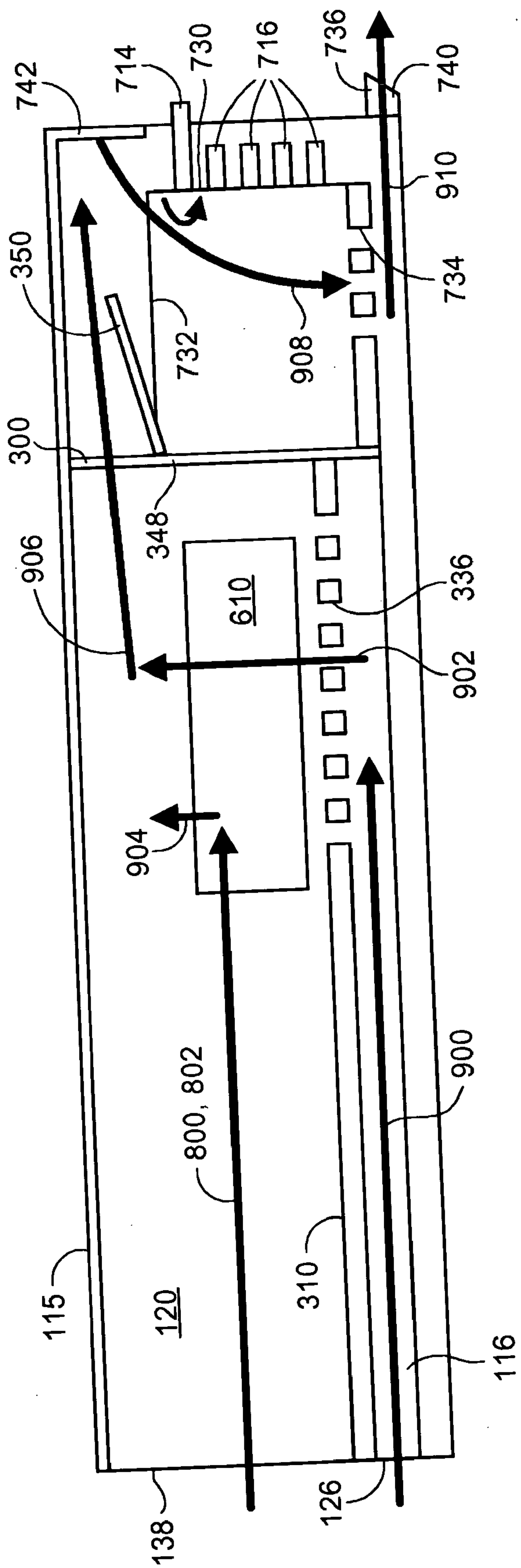

742
714
730
716
736
740
350
910
734
732
908
300
348
906
610
336
902
904
800, 802
900
310
115
120
116
126
138

FIG. 9

MODULAR ELECTRONIC ENCLOSURE WITH COOLING DESIGN

BACKGROUND

[0001] Earlier of electronic enclosures, such as those used in servers, were stacked one on top of the other in standard Electronic Industry Association (EIA) racks. These earlier enclosures carried various electronic components, such as a power supply, a logic board or "motherboard," input/output ports, and a fan unit, but these components were in cumbersome arrangements. For instance, to service the interior components, either a snap-on front plate or a conventionally hinged front door first had to be opened, or the entire enclosure taken from the rack and a top cover removed. Often the fan had to be removed before electronic components could even be accessed. This accessing operation was particularly difficult for servicing personnel, since if the unit was deactivated, replacement had to be accomplished within a short time span (e.g., ten minutes) so other components would not lose stored information. Also, the number and size of components housed within these earlier enclosures was often limited by the cooling capability of the enclosure. In some earlier front access enclosures, the ability to control fan airflow when changing components was limited by their air dam designs, which function to limit fan air in-take when a component is removed. These earlier air dams were either a hinged saloon door style, or a horizontally hinged door relying on gravity for closure, both of which inherently leak-in large quantities of air.

SUMMARY

[0002] An embodiment of a modular electronic enclosure is provided as including a chassis having a first portion defining a first compartment, and a second portion defining a second compartment. First and second replaceable units are replaceably received within the first and second compartments, respectively. The modular electronic enclosure also has a fan unit that is replaceably received within a compartment defined by the first portion or the second portion. The fan unit is configured to pull in cooling air through the first portion and exhaust pressurized cooling air through the second portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The present invention can be further understood by reference to the following description and attached drawings that illustrate the embodiment(s). Other features and advantages will be apparent from the following detailed description of the embodiment(s), taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

[0004] **FIG. 1** is a partially fragmented, front elevational view showing one embodiment of a modular electronic enclosure of the present invention mounted in an EIA rack for use, actually showing two enclosures, one with a front faceplate bezel closed, and the other with the bezel open;

[0005] **FIG. 2A-2E** show the bezel latching mechanism of **FIG. 1**, with:

[0006] **FIG. 2A** being an enlarged, exploded view,

[0007] **FIG. 2B** being an enlarged perspective view shown before attaching the bezel,

[0008] **FIG. 2C** being an enlarged detailed perspective view during attachment,

[0009] **FIG. 2D** being an enlarged detailed perspective view shown after attachment, and

[0010] **FIG. 2E** being an enlarged cross sectional view taken along lines **2E-2E** of **FIG. 2A**;

[0011] **FIG. 3** is a perspective view of a chassis of the enclosure of **FIG. 1**, with various replaceable units (CRU's) of electronics removed;

[0012] **FIG. 4** is a perspective view of a logic board or "motherboard" of the enclosure **FIG. 1**, shown partially removed from the chassis;

[0013] **FIG. 5** is a perspective view of a power unit of the enclosure **FIG. 1**, shown partially removed from the chassis;

[0014] **FIG. 6** is a perspective view of a fan unit of the enclosure **FIG. 1**, shown partially removed from the chassis;

[0015] **FIG. 7** is a perspective view of an input output unit of the enclosure **FIG. 1**, shown partially removed from the chassis;

[0016] **FIG. 8** is a top plan view showing a diagram of airflow through the enclosure of the **FIG. 1**; and

[0017] **FIG. 9** is a side elevational view showing a diagram of airflow through the enclosure of the **FIG. 1**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] In the following description of the invention, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration a specific example in which the invention may be practiced. It is to be understood that other embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

I. General Overview:

[0019] **FIG. 1** shows one embodiment of a modular electronic enclosure **100** mounted to a standard EIA rack for convenience, although other mounting systems may be employed. The enclosure **100** includes a front faceplate or bezel **104**, which is shown in a closed position. Also shown in **FIG. 1** is a modular electronic enclosure **100*a***, identical to enclosure **100** except that the bezel **104** is shown in an open position. Note the use herein of the an alpha designator (a) indicates different placement or position of a like-numbered component without the prime designator, unless otherwise noted. Bezel **104** includes a frame **105** and a series of air inlet apertures or inlet ports **106**. The bezel **104** may also include provisions for viewing a display **108**, which may provide identifying, status, or other information regarding components within the enclosure **100**.

[0020] The bezel **104** may be opened with a bezel latching mechanism **110**, described in further detail below, when a latch, such as spring-loaded latch **112** is activated. When closed, the latch **112** engages a latch post **114** projecting from a chassis **115** of enclosure **100**. Housed within chassis **115** are a variety of electrical components, in this embodiment, customer replaceable units (CRU's), such as a logic board or motherboard **116**, a pair of power units **118, 118*a***, and a pair of fan units **120, 120*a***. The motherboard **116** may be removably secured within chassis **115** by a pair of latches **122** supported by a frame **124** of motherboard **116**. The frame **124** may also support various input devices for the motherboard **116**, such as a pair of scrolling (up/down) buttons **125** which may be used to show and/or select different information on display **108**. The frame **124** defines a series of air inlet apertures or ports **126**, here shown arranged around the latches **122**, although other locations in the front portion of frame **124** may be more suitable in other implementations.

[**0021**] In a similar fashion, each of the power units **118**, **118***a* may be held in place by a latch **128** supported by a frame **130** of each power unit. Each power unit frame **130** defines a series of air inlet apertures or ports **132**. Each fan unit **120**, **120***a* may be held in place by a latch **134** supported by a frame **136** of each fan unit. Each fan unit frame **136** defines a series of air inlet apertures or ports **138**. Location of the inlet ports **132**, **138** are shown by way of example only, and may be placed in other arrangements in other implementations.

[**0022**] This completes the overview discussion of the front loading CRU's housed within the modular electronic enclosure **100**. Before moving on to other portions of the enclosure **100**, one embodiment of a bezel latch mechanism **110** will be discussed.

II. Bezel Latch Mechanism:

[**0023**] **FIGS. 2A-2E** show one embodiment of a bezel latch mechanism **110** used in enclosure **100** to attach the bezel **104** to the enclosure chassis **115**. First turning to **FIG. 2A**, the components will be discussed from right to left, that is starting from chassis **115** and moving outward toward the bezel **104**. The chassis **115** supports a latch lock engaging member, here shown as chassis defining a latch lock hole **200**. The chassis also supports two hinge posts **202** and **204** which project outwardly from the chassis. The latch mechanism **110** also has a chassis hinge mount **210** which defines two hinge posts slots **212** and **214** located to receive the hinge posts **202** and **204**, respectively. The chassis hinge mount **210** has a side wall **215**, as better seen in **FIG. 2B**. The mount **210** also defines a cut-down neck portion **216** and an alignment pin **218**.

[**0024**] The latch mechanism **110** includes an activation member, here illustrated as a leaf spring latch **220**. The spring latch **220** includes a latch finger **222** which defines an elongated alignment slot **223** that receives alignment pin **218**. The slot **223** is elongated along the longitudinal axis of finger **222** to allow the pin **218** to slide within slot **223**, as well as move partially out of slot **223**, during operation which allows the spring latch **220** to move relative to the chassis hinge mount **210**. The latch finger **222** also has a blunt end **224** and an upper ramped edge **225** leading down to the blunt end. Perhaps as better shown in **FIG. 2B**, the spring latch **220** is attached to the interior of side wall **215** of the chassis hinge mount **210** by a pair of rivets **226** and **228**, shown with their heads projecting from the latch spring in **FIG. 2A**.

[**0025**] Progressing on to the next component to the left, we see a bezel hinge mount **230** which attaches by rivets **232**, **234**, **236** and **238** to an interior wall of the bezel frame **105**, as shown in **FIG. 2B**. Mount **230** also includes a pair of hinge plates **238** and **240** which each define holes to receive hinge pins **242** and **244**, respectively. The chassis hinge mount **210** also has a pair of hinge pin flanges **246** and **248**, which each define holes therethrough to receive hinge pins **242** and **244**, respectively, as indicated by the dashed lines in **FIG. 2A**, and as best seen in **FIG. 2B**. The terms "hinge plate" and "hinge pin flange" may be considered as interchangeable terms, with the only differentiation herein being for the sake of clarifying the explanation as to which component is being referred to in a particular discussion.

[**0026**] **FIG. 2A** has several dashed lines and curved arrows which may need some explanation to give one the proper orientation of the components of the bezel latch mechanism **110**. To show the orientation of the chassis hinge mount posts slots **212**, **214** with respect to hinge posts **202** and **204**, respectively, curved arrow **250** indicates that mount **210** needs to be rotated 90 degrees. Similarly, curved arrow **252** indicates that given the position of mount **210** in **FIG. 2A**, the spring latch **220** needs to be rotated 90 degrees so rivets **226**, **228** may be inserted through side wall **215** of mount **210** before being received by the spring latch **220**. The dashed lines in **FIG. 2A** indicate the various components that match together, such as dashed line **254** which indicates hinge pin **242** is to be received by the hole defined by hinge pin flange **246**.

[**0027**] In the past, the front opening electronic enclosures used faceplates which were either, (1) hinged, or (2) of the snap-on variety. The hinged faceplates often took up necessary space in the service aisle during maintenance, where they could easily be bumped or damaged by service personnel. These hinged faceplates typically used a conventional house door type hinge, a gate hinge, a continuous hinge, or other permanently attached hinge, which prevented the faceplate from being removed if it was obstructing work or workers. The snap-on faceplates required complete removal before any of the internal components could be accessed even for a quick adjustment or check-up, such as to use the scrolling buttons **125** on motherboard **116**.

[**0028**] The bezel latch mechanism **110**, not only provides for a rapid hinged opening, but also for complete removal of the bezel **104** if desired. During normal operation, hinge posts **202**, **204** reside within an upper portion of slots **212**, **214**, respectively (see **FIG. 2A**). After opening the spring-loaded latch **112** (**FIG. 1**), the bezel **104** may be swung open to the position of **FIG. 2B** where the latch finger **222** has disengaged lock hole **200**, allowing service personnel to lift the bezel off of posts **202** and **204** (**FIG. 2A**) for removal from chassis **115**. Thus, through the use of bezel latch mechanism **110**, the bezel **104** may function as a hinged faceplate as well as a snap-off faceplate, depending upon the need at hand. Before moving on to a detailed explanation of the operation of the bezel latch mechanism **110**, a further explanation of the spring latch **220** with respect to **FIG. 2E** may be helpful.

[**0029**] For further clarification, **FIG. 2E** shows one embodiment of the cross sectional shape of latch finger **222**, with respect to the engagement of pin **218** and alignment hole **223**. The blunt end **224** of the latch finger **222** extends outwardly at an angle from the portion of finger **222** where slot **223** resides, allowing the latch finger to better engage the lock hole **200** in the illustrated embodiment. The elongated nature of alignment slot **223** allows the alignment pin **218** to move longitudinally within slot **223**, as indicated by arrow **256**. Furthermore, the length of pin **218** allows it to move inwardly and outwardly from slot **223**, as indicated by arrow **258** to facilitate flexing of the latch spring **220** during operation.

[**0030**] Referring briefly to **FIG. 2A**, to replace the bezel **104** after servicing, the post slots **212**, **214** first receive hinge posts **202**, **204** through their lower open mouths, and then as bezel **104** moves downwardly, perhaps under the force of gravity or under manual pressure, the posts come to rest within the upper portion of the slots, leaving the bezel pivotally attached to the chassis for hinged opening and closing. This reattachment operation is shown in **FIGS. 2B-2D**, with unattachment occurring the opposite order. In a beginning attachment phase shown in **FIG. 2B**, the posts **202**, **204** are entering the mouths of slots **212**, **214** (see **FIG. 2A**), respectively, and the latch finger **222** has not yet began to engage lock hole **200**. In a transitional phase shown in **FIG. 2C**, posts **202**, **204** are beginning to move upwardly along the vertical portion of slots **212**, **214** (**FIG. 2A**), while the ramped edge **225** of latch finger **222** is beginning to gently engage lock hole **200**.

[**0031**] A final, fully engaged state is shown in **FIG. 2D**, where posts **202**, **204** have come to rest in the top portion of slots **212**, **214** (see **FIG. 2A**), and the latch finger **222** is fully engaged within lock hole **200**. As the final stage of **FIG. 2D** arrives, the spring action of latch **220** is felt by a person replacing bezel **104** when finger **222** fully engages lock hole **200**, giving this person a positive tactile indication that hinge posts **202**, **204** (**FIG. 2A**) are in the proper position for swinging bezel **104** shut. Thus, the latch mechanism **110** provides a tactile response for service personnel when the bezel **104** has been snapped back into place for a hinged closing. Similarly upon opening, the disengagement of the latch finger **222** from lock hole **200** is also felt, giving the person a tactile response that bezel **104** is ready to be removed from posts **202** and **204** (see **FIG. 2A**).

III. Enclosure Chassis with Air Dams:

[**0032**] **FIG. 3** shows the chassis **115** of the illustrated embodiment of modular electronic enclosure **100** as including a midplane **300**, which divides the chassis into a front portion **302** and a rear portion **304**. The front portion **302** will be discussed first, followed by a discussion of airflow vents through chassis **115**. In this embodiment, the front portion **302** is divided into an upper portion **306** and a lower portion **308** by deck **310**. The lower portion **308** comprises a single compartment **312** which includes a pair of motherboard latch receptacles, one on the right side and the other on the left side, such as left latch receptacle **314** visible in the view of **FIG. 3**.

[**0033**] The upper portion **306** is divided into four compartments, here shown as adjacent fan compartments **316** and **316***a*, and flanking power compartments **318** and **318***a*. The fan compartments **316**, **316***a* each included a fan latch receptacle, such as receptacle **320** for left fan compartment **316**, while the power compartments **318**, **318***a* each include a power latch receptacle, such as receptacle **321** for the left power compartment **318**. Thus, the lower compartment latch receptacles **314** receive latches **122**, while the fan compartment latch receptacles **320** receive latches **134**, and the power compartment receptacles **321** receive latches **128** to removably secure the motherboard **116**, the fan units **120**, **120***a*, and the power units **118**, **118***a* in place.

[**0034**] The compartments **318**, **320**, **320***a* and **318***a* are each separated by dividers **322**, **324** and **326**, respectively. Each of the dividers **322-326** defines a window **328** therethrough to allow air to flow between adjacent compartments. At the rear of the power compartments **318** and **318***a* are electrical connectors **330** which engage mating electrical connectors (not shown) at the rear of each of the power units **118** and **118***a*, respectively. Similarly, at the rear of fan compartments **316**, **316***a* are electrical connectors **332** which engage mating electrical connectors (not shown) at the rear of each of the fan units **116** and **116***a*.

[**0035**] Before going into detailed description of airflow through the modular electronic enclosure **100**, the various components which contribute to the airflow design are described with respect to the components with which they are associated. The big deck **310** defines therethrough a series of vent holes **334** located toward front portion of each of the fan compartments **316**, **316***a*, and another series of fan vent holes **336** located toward the rear portion of the fan compartments. It is apparent that while groups of circular or rectangular fan vent holes are illustrated herein, the vents may also be arranged as one or more vents slots, or in other geometric patterns or configurations depending upon the particular implementation employed. Similarly, while the compartments **312**, **318**, **316**, **316***a* and **318***a* are shown as arranged into upper and lower portion **306**, **308** other compartment divisions may be made within chassis **115**, depending upon the desired implementation, while still employing the concepts described herein.

[**0036**] The chassis **115** includes four air dams **340**, **342**, **344** and **346**, located near the entrances to compartments **318**, **316**, **316***a* and **318***a*, respectively. Each of the illustrated air dams **340-346** are of a flexible metal spring material which acts as a flap, although in some embodiments a flexible plastic or other similar material may be more suitable. When the upper portion modules **318**, **316**, **316***a* and **318***a* are pulled out of the chassis **115**, the air dams **340-346** spring into their closed positions, as shown in **FIG. 3**, to prevent an airflow "short-circuit." The simple one-piece design of air dams **340-346** used in this thermal design is believed to be unique, and may be used in other applications, to prevent unwanted airflow through a passageway, such as in a vending machine beverage can-catcher, or other air barriers for refrigeration, heating or ventilation protection when an item needs to occasionally pass through the passageway.

[**0037**] As mentioned the Background section above, earlier air dams were typically of the double hinged saloon-door style, or a horizontally hinged, vertically hung door which was gravity operated, similar to many inside/outside doggie doors, but these earlier designs only prevented 85% of airflow therethrough. In the illustrated embodiment, the air dams **340-346** have shown in testing to be 95% efficient in preventing airflow therethrough when the fan and power units **118**, **116**, **116***a* and **118***a* are removed from compartments, **316**, **318**, **316***a* and **318***a*. While the illustrated air dam **340** swings open toward the right, and air dams **342-346** swing open toward the left, which is convenient for the illustrated embodiment, although it is apparent that left swinging or right swinging air dams may be substituted therefor.

[**0038**] The midplane **300** of chassis **115** also defines a pair of airflow channels **348**, located at the rear of each of the fan compartments **316**, **316***a* to allow airflow between the chassis front portion **302** and the chassis rear portion **304**. Near the front of the rear portion **304**, chassis **115** includes an air metering plate **350**, which is ramped upward from the bases of airflow channels **348** toward the rear of chassis **115**. As described in further detail below, the metering plate **350** may be replaced with metering plates of different sizes, orientations, and configurations to control airflow between the front and rear portions **302**, **304** to accommodate for various cooling capacities required by the components housed therein. Thus, the modular electronic enclosure **100** may be upgraded for larger heat loads by varying the size and configuration of metering plate **350**. The rear portion **304** of chassis **115** may define a series of vent holes **352** therein, to vent components housed within the chassis rear portion **304** (see **FIG. 7**), or alternatively, vent holes **352** may be defined by an upper portion of components housed within the rear portion **304** of chassis **115**. The overall airflow design of the modular electronic enclosure **100** will be discussed in more detail after describing the various hot-swappable modular components **116**, **118**, **120**, **120***a*, **118***a* housed therein.

IV. Hot-Swappable Modular Components:

[**0039**] **FIG. 4** shows the motherboard **116** removed from chassis **115**. The motherboard **116** includes an upper surface **400** of frame **124** which defines series of vent holes **402** therethrough toward the front thereof, and a series of vent holes **404**, **406** which reside under vent holes **344** beneath the fan compartments **316**, **316***a* (**FIG. 3**), respectively. The motherboard frame upper surface **400** also defines a series of vent holes **408** therethrough toward the rear of the motherboard **116**, which allow airflow from the motherboard through vent holes **336** of the fan compartments.

[**0040**] **FIG. 5** shows power module **118** as having an electrical connector **500** which mates with connector **330** when the power module **118** is inserted into the power unit compartment **318**. The power unit **118***a* is constructed a similar fashion. Each power unit frame **130** has an interior sidewall **502** which defines a series of vent holes **504** therethrough to facilitate airflow from the power units **118**, **118***a* toward the fan modules **120**, **120***a*, respectively.

[**0041**] **FIG. 6** shows one fan unit **120** as including an electrical connector **600** located toward the rear of the unit to engage electrical connector **332** when the fan unit is inserted into the fan compartment **316**. The fan unit **120***a* is constructed in a similar fashion. The frames **136** of the fan units **120**, **120***a* each have opposing side surfaces **602** and **604**, which each may define a series of vent holes **606** therethrough for airflow through windows **328** of dividers **322**-**326**. Each of the fan units **120** and **120***a* may include a ventilation member, such as fan **610**, the operation of which will be described in further detail below under the Airflow section.

[**0042**] Thus far, the CRU's residing within the front portion **302** of chassis **115** had been discussed. **FIG. 7** shows thirteen CRU's **700**-**712** residing within the chassis rear portion **304**, although it is apparent that in other implementations other modules may reside therein and be of different numbers and different configurations. Each CRU **700**-**712** has a handle **714** for inserting and extracting the unit from chassis **115**. Most of the CRU's are input/output units, each having four pairs of input/output receptacles **716** (shown only on CRU module **712**), such as those for receiving fiber-optic cables. In one embodiment, CRU's **703** and **704** are router interconnects, and CRU **700** is a maintenance port. Each of the CRU's **700**-**712** may include an electrical interconnect **718**, which mates with an electrical interconnect (not shown) the located underneath the air metering plate **350** along the rear surface of midplane **300**.

[**0043**] The chassis **115** also supports a pair of electrical power interconnects **720** and **720***a*, here shown located above CRU's **700** and **712**. The interior of the chassis rear portion **304** is divided into the thirteen compartments, such as compartments **722** and **724** which are separated by divider **726** to receive CRU's **711** and **712**, respectively. Each of the CRU's **700**-**712** has an exposed face which defines a series of vent holes **730** therethrough, and an upper surface which defines another group of vent holes **732** therethrough. The lower surface of each of the CRU's **700**-**712** may also define vent holes for airflow between the CRU's and chassis vent holes **734** defined by a floor **736** underneath each of the CRU compartments, such as compartments **722** and **724**. The floor **736** is preferably elevated by footing walls, such as wall **738**, to define an airflow passageway **740** underneath floor **736**. The chassis **115** also has a rear wall **742** located above CRU's **700**-**712**, which besides being a convenient location for mounting interconnects **720**, **720***a*, and displaying various manufacturing and certification indicia, also serves as an air deflection wall, as described in greater detail below with respect to **FIG. 9**.

[**0044**] The chassis **115** illustrates only one embodiment of a modular electronic enclosure, and the various components housed within upper and lower portions **306**, **308** of front portion **302** as well as the components housed within the rear portion **304** are merely shown by way of example, and other arrangements for the compartments, and placement of the midplane **300**, if used, may be employed. These modular components, as mentioned above, are known as customer replaceable units or CRU's, and may be replaced without disengaging power from modular electronic enclosure **100**. Even the dual fan units **120**, **120***a* may be replaced without de-energizing the electronic enclosure **100**, while one fan unit is replaced, the other continues to provide cooling. The same holds true for the dual power units **118**, **118***a*, one of which may be replaced while the other continues to power the CRU's remaining within enclosure **100**. Additionally, through the use of the compartment dividers **310**, **322**-**326** and **726**, the CRU's require no effort in alignment prior to inserting each module, such change-outs are speedily accomplished.

V. Airflow Cooling and the Metering Plate:

[**0045**] **FIG. 8** shows a top view of the airflow cooling design of the illustrated modular electronic enclosure **100**. Air entering through the air inlet ports **138** of fan units **120**, **120***a* is indicated by arrows **800**, **800***a*, with airflow through the majority the fan compartments toward fans **610**, **610***a* is indicated by arrows **802**, **802***a*, respectively. Air entering through the inlet ports **132** of power units **118**, **118***a* is indicated by arrows **804**, **804***a*, which then traverses through windows **328** of dividers **322** and **326** into fan units **610**, **610***a*. Pressurized air leaving fan units **610**, **610***a* is indicated by arrows **808**, **808***a* which passes through the airflow channels **348** of midplane **300** and across the air metering plate **350** (**FIG. 3**). The air metering plate **350** ramps upward toward the rear of the chassis, which results in pressurizing the air further, by constricting the airflow passageway. Arrows **810**, **810***a* show the airflow pattern across the metering plate **350** (omitted for clarity from the view of **FIG. 8**) in the chassis rear portion **304**.

[**0046**] The metering plate **350** is replaceable to allow for system upgrades which may impose larger heat loads on the enclosure **100**. For example, by increasing the size of metering plate **350**, the airflow streams **810**, **810***a* are further pressurized and air velocity is increased to move the heat away faster. In other embodiments, the ramp angle of the metering plate **350** may be varied, raising the ramp to increase velocity, and lowering the ramp to decrease air velocity. In other embodiments, the configuration of the trailing edge of ramp **350** may be varied, such as by adding scallops or cut-out areas to increase airflow across some of the CRU's **700-712** and decrease airflow across others.

[**0047**] **FIG. 9** shows the airflow passageways through the fan unit **120** and motherboard **116**, as arrows **800**, **802** and **900**, respectively. Warm air from the motherboard **116** passes upward through vent holes **336** in the deck **310**, and then into fan **610**. Arrow **904** shows pressurized air leaving fan **610**, which is then directed through channel **348**, as shown by arrow **906**, then over the metering plate **350** and into the chassis rear portion **304**. The chassis rear wall **742** deflects the airflow downwardly through vents **732** and into the interior of CRU's **700-712**. The warmed air may vent outwardly through the faceplates vents **730**, or downwardly through vents **734** in the floor **736**, to exit through the lower airflow passageway **740**.

[**0048**] This airflow design places the fans in the middle of the electronic enclosure to pull in cool air through the front CRU modules **316-320***a* and push pressurized air through the rear CRU modules **700-712** after which the warm air is vented to atmosphere. This unique airflow design facilitates the high-density packing of CRU's within chassis **115**, which is believed today the highest density available for fiber input/output interconnects **716**, here capable of carrying a large number of cables, while still maintaining a modular, hot swappable design for the CRU's. In the illustrated embodiment, the overall design is 5.25 inches tall, which is equivalent to three units (3U) high for electronic designers, while still fitting into the 19 inch wide EIA standard rack **102**. As mentioned above, the airflow flow concepts described herein may be easily adapted to other arrangements and configurations of CRU's, while still maintaining the hot swapping capability of the CRU's.

VI. CONCLUSION

[**0049**] Thus, a modular electronic enclosure **100** having a unique cooling design and useful in practicing a unique cooling method for controlling heat generated by various CRU's house therein. Every CRU may be removed or serviced without disrupting the airflow through the enclosure, including the fan modules **120** or **120***a*, in part because of the spring-loaded air dams **340-346** (shown open in solid lines, and closed in dashed lines in **FIG. 8**). The air dams **340-346** restrict airflow into the enclosure when a fan unit **120**, **120***a* or a power unit **118**, **118***a* is removed from chassis **115**. Additionally, this unique cooling design allows for a much higher density arrangement of the input/output CRU's **700-712** than currently available in other enclosures.

[**0050**] The modular hot swappable nature of the CRU's, allowing interchange without the need to power down the enclosure, also provides for replaceability from the front and rear of the enclosure, without requiring removal from the mounting racks **102** and without requiring removal of a top cover from the chassis. In this manner, the CRU's are quickly replaced, with interconnect alignment being facilitated by the compartment dividers **310**, **322-326** and **726**. Bezel latch mechanism **110** allows for a quick hinged opening of the bezel **104**, while also allowing the bezel **104** to be quickly removed and quickly replaced when desired. The tactile feedback provided by the spring latch **220** assists a person in determining when the post slots **212**, **214** are fully engaged on the hinge posts **202**, **204** when replacing the bezel.

[**0051**] The foregoing has described the principles, embodiments and modes of operation of the present invention. However, the invention should not be construed as being limited to the particular embodiments discussed. The above-described embodiments should be regarded as illustrative rather than restrictive, and it should be appreciated that variations may be made in those embodiments by workers skilled in the art without departing from the scope of the present invention as defined by the following claims.

1-29. (canceled)

30. A latch mechanism for an enclosure to removably attach a door to a pair of hinge posts supported by a frame, comprising:

a door hinge mount configured for attachment to the door;

a frame hinge mount defining a pair of the post slots configured to releasably receive the pair of hinge posts;

hinge pins pivotally attaching the door hinge mount to the frame hinge mount; and

a spring latch supported by the frame hinge mount and having a latch finger which engages a latch lock engaging member supported by the frame when the post slots have fully received the pair of hinge posts.

31. The latch mechanism of claim 30, wherein:

the pair of post slots are each defined with an open mouth, a hooked portion, and an upright portion joining the mouth with the hooked portion, with the pair of hinge posts entering and exiting the post slots through the mouth thereof, and resting within the hooked portion thereof when the post slots have fully received the pair of hinge posts; and

the latch finger has a ramped portion which engages a surface of the latch lock engaging member as the hinge posts move through the upright portion of the post slots.

32. The latch mechanism of claim 30, further comprising:

an alignment member supported by the frame hinge mount; and

wherein the latch finger defines an alignment slot which slidably receives the alignment member during pivoting of the door hinge mount relative to the frame hinge mount.

33. The latch mechanism of claim 30, wherein:

the pair of post slots are each defined with an open mouth, a hooked portion, and an upright portion joining the mouth with the hooked portion, with the pair of hinge posts entering and exiting the post slots through the mouth thereof, and resting within the hooked portion thereof when the post slots have fully received the pair of hinge posts;

the latch lock engaging member comprises a latch lock hole defined by the frame to have an upper surface;

the latch finger has a ramped portion which engages latch lock hole upper surface as the hinge posts move through the upright portion of the post slots;

an alignment member supported by the frame hinge mount; and

wherein the latch finger defines an alignment slot which slidably receives the alignment member during pivoting of the door hinge mount relative to the frame hinge mount.

34. An apparatus for selectively closing an enclosure defined in part by opposing first and second side walls and upper and lower walls, comprising:

an air dam of a flexible metal spring material having first and second opposing edges, and upper and lower edges configured to extend between said upper and lower walls; and

an attachment member which attaches said first edge to the first side wall;

wherein the air dam is biased into a closed position with said second edge engaging the second side wall, and wherein air dam is forced into an open position with said second edge engaging the first side wall when an item passes therethrough when moving through the compartment.

35. An apparatus according to claim 34, wherein the air dam is moved toward an interior of the compartment when moving from the closed position to the open position when said item enters the compartment.

36. An enclosure for slidably and replaceably receiving plural first and plural second replaceable units, comprising:

a chassis having opposing front and rear faces;

a midplane member having opposing front and rear surfaces supported by the chassis to define a front portion between the midplane member and the front face, and a rear portion between the midplane member and the rear face;

plural first electrical connectors supported by the midplane front surface to couple with mating electrical connectors of said plural first replaceable units when installed through the chassis front face; and

plural second electrical connectors supported by the midplane rear surface and to couple with mating electrical connectors of said plural second replaceable units when installed through the chassis rear face.

37. The enclosure of claim 36, further comprising a deck member located to divide the front portion into upper and lower portions which each receive some of said plural first replaceable units.

38. The enclosure of claim 36, further comprising a ventilation unit configured to pull cooling air through the front face and the first replaceable units, pressurize said cooling air, and exhaust said pressurize cooling air through the plural second replaceable units.

39. The modular electronic enclosure of claim 38, wherein:

the chassis defines plural separate compartments configured to slidably receive individual ones of the plural first and plural second replaceable units; and

the electronic enclosure further comprises separate air dams located within at least some of said plural separate compartments to inhibit entrance of cooling air therein when an associated replaceable unit is removed therefrom.

40. The modular electronic enclosure of claim 36, further comprising:

a bezel door configured to cover the chassis front face when in a closed state; and

a bezel latch mechanism configured to pivotally attach the bezel door to the chassis for movement between the closed state and an open state, with the latch mechanism also being configured for removably attaching the bezel door to the chassis in the open state;

wherein the bezel latch mechanism further comprises a spring latch configured to provide tactile feedback when the bezel door is reattached to the chassis for pivotal movement from the open state to the closed state.

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