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(54) STANDARD ANTENNA INTERFACE

STANDARDISIERTE ANTENNENSCHNITTSTELLE

INTERFACE D'ANTENNE STANDARD

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Description

[0001] This application is a continuation in part of and claims priority to U.S. Application Serial No. 14/137,059, filed December 20, 2013. This application also claims priority to the following U.S. Provisional Applications, pursuant to 35 U.S.C. § 120: U.S. Provisional Application Serial No. 61/907,259, filed 21 November 2013; U.S. Provisional Application Serial No. 61/863,739, filed 08 August 2013.

BACKGROUND

[0002] The present inventions relate generally to wireless communications. In particular, they relate to improvements in wireless base station antenna and radio deployments.

[0003] A traditional installation of a wireless radio network system mounted at the top of the tower consists of a remote radio head (RRH) and a separate antenna. These components are mounted in separate locations and are cabled together using jumper cables to pass the radio frequency (RF) signal between them. Such an installation decreases the performance of the radio network, creates complex and time consuming installations, and introduces opportunities for installation errors.

[0004] Current installations require multiple jumper cables and multiple mounting kits/hardware. This involves more installation time (approximately 12-15 hours per site). Jumper cables present RF losses and Passive Intermodulation products (PIM) performance issues. These issues degrade network performance, and add significant cost to the network operator to overcome. Jumper cables also require more weatherproofing, and additional capital expense and operating expense.

[0005] Since there is no common structure or installation method to mount the RRH and the antenna, it is up to the installation team to define the mounting method. This can result in installation errors, missing hardware, wrong cable lengths, and inadequate mounting hardware.

[0006] Once the antenna and RRH are mounted at the tower top, it is strictly up to the installer to cable and connect the components together correctly. The installer will need a schematic or wiring diagram to understand how such connections should be made. This introduces the possibility of installing cables at the wrong locations, improperly assembling connectors to the jumper cables, or not engaging them correctly.

[0007] Attempts to solve the limitations of the current system, typically involves integrating the radio modules of the RRH with the antenna into a single enclosure (Integrated or Active Antenna). Integrated antennas do not provide flexibility for the network operator to select different RRHs or Antennas from different suppliers. The radio network operator is limited to the supplier of the active or integrated antenna and the performance and price of that system. The Integrated antenna approach also restricts the ability of the operator to leverage supplier diversity for the antenna products, or for the RRH units. It also limits the availability of new beamwidth antennas, as well as multi-beam antennas. The operator is further challenged to stock spares of expensive combined units.

[0008] Antennas are passive components and have an inherently lower failure rate than do Remote Radio Heads. Typical antenna return rates are less than 0.1% annually, while RRH return rates range from 3% to 5% typically. Thus, integrating an antenna and RRH in a single unit on the tower would require antennas to be replaced at the same rate as RRH's, increasing operating expenses.

[0009] Additionally, current installations are not visibly appealing due to non-standard mounting configurations and the use of multiple jumper cables. Such installations do not have the appearance of a well thought out solution.

[0010] WO 2013/071206 A1 discloses a connector with a capacitively coupled connector interface for interconnection with a female portion. The connector has an annular groove, with a sidewall, open to an interface end of the female portion. A male portion is provided with a male outer conductor coupling surface at an interface end, covered by an outer conductor dielectric spacer. The male portion is retained with a range of radial movement, with respect to a longitudinal axis of the male portion, by a bias web of a float plate. The male outer conductor coupling surface is dimensioned to seat, spaced apart from the sidewall by the outer conductor dielectric spacer, within the annular groove, when the male portion and the female portion are in an interlocked position.

[0011] US 2010/079346 A1 describes an enclosure system for a radio board and an antenna circuit, having a downwardly opening, concave housing with an interior housing cavity, a base that fits across the bottom of the housing, and a mounting plate that mounts on the base and extends into the housing cavity. The radio board and antenna mount on the mounting plate. A transparent cable access door has spaced knockouts that allow routing of communication interface cables. Mounting bolts attached to the exterior of the housing allow mounting of a mounting bracket. The bottom of the base is flat for placement on a flat surface.

SUMMARY OF THE INVENTION

[0012] The present invention provides an RF interconnection module and a mount assembly as defined in the appended claims.

[0013] An RF interconnection module according to one aspect of the present disclosure includes a housing having a perimeter, a capacitive coupling at least partially disposed in the housing, and a float gasket disposed about the perimeter of the housing. When the housing is mounted in an opening, the float gasket is positioned between the housing and the opening. The float gasket may be made of an elastomer material, and may include

a first flange, a second flange and a middle portion. The first flange and the second flange may be operable to secure the float gasket in the opening, and the middle portion may include a plurality of outwardly extending ribs for movable securing the gasket in the opening.

[0014] The RF interconnection module may include a float plate disposed in the housing. The capacitive coupling may be movably disposed in the float plate so that the capacitive coupling may move with respect to the housing. The float plate may be made of an elastomer material. The float plate may include a plurality of flexibly fingers that define an aperture for receiving the capacitive coupling. The flexible fingers may operate to movably secure the capacitive coupling in the aperture.

[0015] In another aspect of the present disclosure, a mount assembly includes a bracket assembly attachable to a tower-mounted equipment and at least one jumper cable having at least one ohmic connector for connecting to the tower-mounted equipment and at least one capacitive connector. The capacitive connector may comprise an RF interconnection module mounted on the bracket assembly. The RF interconnection module may include a float gasket for movably mounting the RF interconnection module on the bracket assembly. The mount assembly may include at least one diplexer having a low friction car configured to engage a linear guided support member of a radio head mount. The bracket assembly may be adjustable to accommodate tower mounted equipment of various sizes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Figure 1 is a perspective view of a first example of an antenna interface which may comprise one or more devices according to the present invention.

Figure 2 is a side view of an antenna interface in accordance with the first example..

Figure 3 is an end view of a remote radio head adapted for use in the first example of the present invention.

Figure 4 is a side view of a remote radio head adapted for use in the first example of the present invention.

Figure 5 is a perspective view of a remote radio head connector according to the present invention that is adapted for use in the first example of the present invention.

Figure 6 is a perspective view of an antenna connector according to the present invention that is adapted for use in the first example of the present invention.

Figures 7a and 7b are perspective views illustrating certain details of connectors which may be used in connection with the first example of the present invention.

Figure 8 is a perspective view of a diplexer connector adapted for use in the first example of the present invention.

Figures 9a and 9b are perspective views of a second example of an antenna interface which may comprise one or more devices according to the present invention.

Figures 10a and 10b are side views of the standard antenna interface of the second example.

Figure 11 is a perspective view of a third example which may comprise one or more devices according to the present invention.

Figure 12 is a perspective view of a standard antenna interface according to the third example.

Figure 13 is a perspective view of the third example with additional components.

Figure 14 is a perspective view of the third example with additional components.

Figures 15a-15c illustrate a combination of features from the second and third examples.

Figures 16a-16b illustrate an antenna adapted for use in another example of the present invention.

Figures 17a-17c illustrate a remote radio head adapted for use in another example of the present invention.

Figure 18 is an exploded view of the RRH Connector illustrated in Figure 5.

Figure 19 is an exploded view of the RF Connector shown in Figure 6.

Figures 20 is a perspective view of an embodiment of a float gasket installed in an opening of a portion of a panel.

Figure 21 is a cross section of an embodiment of a float gasket.

Figures 22a-22b illustrate an embodiment of an adjustable mount assembly according to the present invention that is rear mounted to a remote radio head.

Figure 23a-23b illustrate an embodiment of an adjustable mount assembly according to the present invention that is side mounted to a remote radio head.

DESCRIPTION OF EXAMPLES OF THE INVENTION

[0017] A Standard Antenna Interface is described herein to overcome the limitations of a traditional RRH and antenna tower top installation. This disclosure creates a standard antenna interface that provides a reduced installation time, prevents the installer from directly touching/interfacing with the RF electrical path, creates a PIM free interface, and allows the network operator the flexibility to select any brand of antenna or RRH to install. This solution further enables the stocking of separate antennas and RRH's, thus reducing the cost of inventory. In addition, the higher failure rate RRH's can be replaced independently of the more reliable passive antennas.

[0018] The Standard Antenna Interface comprises of a standard interface structure, including antenna mounting brackets and RRH mounting structure, and a RF in-

terconnection module. The standard interface structure acts as the mounting medium for both the antenna and the RRH. Both the antenna and RRH are mounted to their respective universal mounting structure. One mounting structure will receive the antenna and, optionally, all necessary interconnects, where the other bracket or mounting structure will receive the RRH and, optionally necessary interconnects. In embodiments where the Standard Interface Structure does not include RF interconnects, such RF interconnects are made directly between the antenna and the RRH. Each entity will mount directly to the standard interface structure and can be removed independently from each other. Preferably, the Standard Antenna Interface allows antennas and radios from different manufacturers to be coupled together in the field without adding jumper cables and/or ohmic connections.

[0019] Referring to Figures 1 and 2, a first example of a Standard Antenna Interface 10 is disclosed. In this example, an Upper Tower Mount 12, and Middle Tower Mount 14 and a Lower Tower Mount 16 are mounted on a Mounting Pole 18. The Upper Tower Mount 12, and Middle Tower Mount 14 and a Lower Tower Mount 16 are configured to mechanically interface with a plurality of Remote Radio Heads 20 and an Antenna 22. Preferably, the Upper Tower Mount 12, and Middle Tower Mount 14 and a Lower Tower Mount 16 are configured to mechanically interface with a Diplexer 24 placed between a Remote Radio Head 20 and the Antenna 22.

[0020] The example illustrated in Figures land 2 allows for the installation of up to four Remote Radio Heads 20. In an alternative example (not illustrated), when one or two Remote Radio Heads 20 are desired, the Middle Tower Mount 14 may be omitted.

[0021] The Upper Tower Mount 12 and the Lower Tower Mount 16 each include a Linear Guided Support 26. In the illustrated example, the Linear Guided Supports 26 comprise tracks that are configured to receive a roller trolley. However, alternative track and low friction car slide structures are within the scope of this disclosure and may be substituted. In this example, the Upper Tower Mount 12 includes an Antenna Mount 28. An additional Antenna Mount 29 is included on the Mounting Pole 18. The Antenna 22 includes Brackets 30, which include slots to engage Antenna Mount 28 and Antenna Mount 29. Middle Tower Mount 14 includes two Linear Guided Supports 26. The Linear Guided Supports 26 are on the opposite side of the Mounting Pole 18 from the Antenna 22 and extend away from the Antenna 22.

[0022] Alternatively, the Lower Tower Mount 16 may be structurally the same as Upper Tower Mount 12, but is inverted when mounted. The Upper Tower Mount 12 and the Lower Tower Mount 16 each include an Antenna Mount 28 in this example.

[0023] Referring to Figure 3 and Figure 4, the Remote Radio Head 20 includes an Upper Low Friction Car 32 and a Lower Low Friction Car 34. The Upper Low Friction Car 32 and a Lower Low Friction Car 34 each engage a respective Linear Guided Support 26. For example, when a Remote Radio Head 20 is installed in a lower location on the Standard Interface, the Upper Low Friction Car 32 engages a Linear Guided Support 26 of the Middle Tower Mount 14 and the Lower Low Friction Car 34 engages the Linear Guided Support 26 of the Lower Tower Mount 16. In the illustrated example, the Upper Low Friction Car 32 and the Lower Low Friction Car 34 each comprise a wheeled trolley. However, alternative low friction non-wheeled cars are also contemplated and may be substituted for the wheeled trolleys.

[0024] Each Remote Radio Head 20 includes a RRH Connector 40. The Antenna 20 includes a plurality of integrated RF Interconnection Modules 44 designed to engage a respective mating RRH Connector 40. Alternatively, the RF Interconnection Module 44 may be located on the Standard Antenna Interface 10, and the Antenna 20 may be provided with a connector.

[0025] Once the Upper Low Friction Car 32 and the Lower Low Friction Car 34 are engaged in their respective Linear Guided Supports 26, the Remote Radio Head 20 may then slide into engagement with Antenna 22. Specifically, the RRH connector 40 is mated with its respective RF Interconnection Module 44. The Remote Radio Head 20 may mate directly with the antenna, or optionally, a Diplexer 24 may be included between two Remote Radio Heads 20 and the Antenna 22. The Remote Radio Head 20 may be locked into place with Lock 35.

[0026] When a Diplexer 24 is used, the Diplexer 24 will include two sets of RF Interconnection Modules 44 facing the Remote Radio Heads 20. The Diplexer 24 also includes one RRH Connector 40 facing the Antenna 22. The Antenna 22 may be configured to have a single RF Interconnection Module 44 facing the Diplexer 24. The Diplexer 24 includes a pair of Upper Low Friction Cars 32 and a pair of Lower Low Friction Cars 34. In addition to Remote Radio Head 20 and Diplexer 24, additional types of tower-mountable equipment, such as filters, may be accommodated by the Standard Antenna Interface 10.

[0027] An assembly may comprise as few as one antenna and one Remote Radio Head 20. However, as illustrated in the figures, each Linear Guided Support 26 may include two channels to accept two Remote Radio Heads 20, and there may be more than one pair of Linear Guided Supports 26 for each Antenna 22. In the illustrated examples, there may be four Remote Radio Heads 20 coupled to the Antenna 22.

[0028] The example of Figures 1-4 enable straight-in, linear engagement of the RF connectors. This allows for an improved design of blind-matable, capacitively coupled RF connectors to be employed. An example of such a long-engagement is illustrated in Figures 5 and 6.

[0029] As illustrated in Figures 5 and 6, RF Interconnection Module 44 and RRH Connector 40 may comprise a blind mate connector of coaxial construction. In one example, the RF Interconnection Module 44 may include includes a central conductor extension having a generally Cylindrical Post 60 and an Outer Conductor Extension

62. The Cylindrical Post 60 may be covered by a dielectric layer, such as one formed of a polymeric shrink sleeve. The RRH Connector 40 may include a Central Conductor Extension 64 that is adapted to receive the Cylindrical Post 60 of the RF Interconnection Module 44, and an Outer Conductor Extension 66 configured to fit within the Outer Conductor Extension 62. A dielectric layer overlies the Outer Conductor Extension 66. The dielectric layers prevent an ohmic connection between the conductor extensions and ensure that the coupling is capacitive, reducing the possibility of Passive Intermodulation (PIM).

[0030] The RF Interconnection Module 44 may include a float plate to improve alignment of capacitive, blind mate connectors. Referring to Figures 7a and 7b, portions of an Interconnection Module 44 including a Float Plate 70 are illustrated. The float plate 70 may receive blind mated coaxial connectors within each opening; four such interconnections, designated at 72 illustrated in Figures 7a and 7b. The float plate 70 is typically mounted to a rigid structure, such as a back of an antenna, that includes openings that align with the openings in the float plate 70. The openings in the rigid structure are sufficiently large that they do not interfere with flexure of the fingers 76 normal to the main body panel 78. Exemplary environments in which float plates may be employed with blind-matable connectors are discussed in U.S. Patent Publication No. 2013/0065415 to Van Swearingen et al..

[0031] As can be understood with reference to Figures 7a and 7b, as a connector 80 is inserted into the float plate 70, the fingers 76 can flex to help to compensate for any misalignment of the connector 80 relative to its mating connector 82. Such misalignment is not uncommon due to minor tolerance differences in the sizes of the connectors 80, 82 and their components.

[0032] While a rolling, straight-in engagement is advantageous, another example employs a pivoting, axially guided engagement. Referring to Figures 9a, 9b, 10a and 10b, the Standard Antenna Interface 110 mounts away from the pole or the wall and houses the Antenna 122 and Remote Radio Head 120 on one side of the pole. In this example, the Standard Antenna Interface 110 is constructed out of formed sheet metal. However, the Standard Antenna Interface 110 may also be constructed out of metal rectangular tubing. As in the example above, an RF Interconnection Module 144 is integrated into Antenna 122 (Fig. 10a).

[0033] Referring to Figures 10a and 10b, a Remote Radio Head may be connected to the Standard Antenna Interface 110. The Remote Radio Head 120 includes mounting a hooked Mounting Bracket 127 and a slotted Mounting Bracket 128. The Standard Antenna Interface 110 includes Pins 129, which comprise axially guided support structure. The hooked Mounting Bracket 127 and a slotted Mounting Bracket 128 engage the Pins 129 of the Standard Antenna Interface (Fig. 9a), and allow the Remote Radio Head 120 to rotate into engagement (Fig. 9b). In another example, The Standard Antenna Interface 110 may be configured receive two or more Remote Radio Heads 120. The Antenna 122 also has a hooked Mounting Bracket 127 (not illustrated) and a slotted Mounting Bracket 128 that engages Pins 129 and allows Antenna 122 to be rotated into engagement in a similar manner.

[0034] The Remote Radio Head 120 may be installed and/or removed from the Standard Antenna Interface 110 without moving the Antenna 122 (10a). Similarly, the Antenna 122 may be installed and/or removed from the Standard Antenna Interface 110 without moving the Remote Radio Head 120 (10b). In another example, the hooked Mounting Bracket 127 and the slotted Mounting Bracket 128 may be replaced with a single piece mounting bracket. The linear guided support structure and the axially guided support structure may also be used in combination. For example, an antenna may be mounted using the axially guided support structure, such as Pins 129 and corresponding Hooked Mounting Bracket 127, and tower mountable equipment may be installed using Linearly Guided Supports 26 and Low Friction Cars 32, 34.

[0035] Referring to Figures 11 and 12, a perspective view of an additional example is illustrated. In this example, the Standard Antenna Interface 210 accommodates an Antenna 222 and up to four RRH Remote Radio Heads 220. In this example, the Standard Antenna Interface 210 is mounted to a pole. The Standard Antenna Interface 210 includes Cross Members 212, 214, and 216, and a Vertical Member 217.

[0036] Referring to Figure 12, the Standard Antenna Interface 210 includes Mounting Points 228 for the Antenna 222 and RF Interconnection Modules 244. Referring to Figure 13, an Antenna 222 mounted to the Standard Antenna Interface 210. Mounting Brackets 229 for receiving Remote Radio Heads 120 are also installed on the Standard Antenna Interface 210 in an upper position. Float Plates 270 may be included on the Mounting Brackets 229. Additionally, an optional Diplexer 224 is mounted on the Standard Antenna Interface 210. Figure 14 continues the example of Figure 13, with the inclusion of Mounting Brackets 229 being installed on the Diplexer 224. The Remote Radio Heads 220 may be mounted on the Diplexer 224 in the same way that they would be mounted directly to the Standard Antenna Interface 210. The Mounting Brackets 224 include an RF Interconnection Module 244, which interfaces with Antenna Connector 242 and connectors on the Remote Radio Head (not illustrated).

[0037] The installation of the Diplexer 224 on the lower mounting brackets is just one example; a Diplexer 224 may be included on the upper mounting brackets, the lower mounting brackets, both mounting brackets, or omitted altogether. This flexibility in optionally including a diplexer is an advantage of this example.

[0038] The RF Interconnection Module 244 comprises a blind mate RF connector system that provides 7/16 DIN type RF performance in a blind mate approach for fast and robust component interfacing. The RF Interconnection Module 244 may include capacitively coupled inter-

faces and/or connectors such as those described in U.S. Patent Application Nos. 13/672,965, 13/673,084 and 13/673,373, which were filed on November 9, 2012.

[0039] Referring to figure 15, an example of a Standard Antenna Interface 310 including an RF Interconnection Module 344 is illustrated. RRH Connector 340 of Remote Radio Head 320 engages one side of the RF Interconnection Module 344, and Antenna Connector 320 of Antenna 322 engages the other side of the RF Interconnection Module 344.

[0040] Referring to Figures 16a-16b and 17a-17c, examples of an Antenna 422 and a Remote Radio Head 420 including RF Interconnection Module 444 and RRH Connector 440 are illustrated. Figure 16b illustrates RF jumper cables 452 connected from a bottom of an Antenna 422 to an RF interconnector module 444. Similarly, Figure 17c illustrates RF jumper cables 454 connected from an RRH 420 to a RRH Connector 440. Jumper cables 452 and 454 may include metal-to-metal ohmic connectors on the one hand for attachment to the RRH 420 or antenna 440 and capacitive connectors on the other hand for attachment to the RRH Connector 440 or RF Interconnection Module 444. In these examples, installation of the RF Interconnection Module 444 and RRH Connector 440 occurs prior to traveling to the deployment site so that the harness and all jumper cabling 452 and 454 (in Figures 16b and 17c) can be tested for RF path integrity and concealed behind a covers 450 and 456 (in Figures 16b, 17b and 17c). Such concealment prevents an installer from touching or otherwise interfacing with this RF path and may provide an aesthetically pleasing look.

[0041] Figure 18 is an exploded view of the RRH Connector 40 illustrated in Figure 5. Figure 19 is an exploded view of the RF Connector 44 shown in Figure 6. The RRH Connector 40 comprises a connector housing 90, capacitive connectors 64, a float plate 70 (see Figures 7a and 7b), and a float assembly comprising float shells 84 and 88 and a float gasket 86. The float gasket 86 may be an elastomeric material. Float shell 84 may include a first flange 85a and a second flange 85b (also shown in Figure 19) adapted to engage float shell 88. Similarly, float shell 88 may include a first flange 89a and a second flange 89b (also shown in Figure 18) adapted to engage float shell 84. When assembled, flanges 85a, 85b, 89a, and 89b operate to secure float gasket 86 in a space between the float shells 84 and 88 that is dimensioned to be about the thickness of the float gasket 86. The float plate 70 allows the capacitive connectors 64 to move with respect to the connector housing 90, such as by the flexure of fingers 76 as described above with respect to Figures 7a and 7b. The float gasket 86 allows the connector housing 90 to move with respect to a surface on which the RF connector 40 is mounted, as described below with respect to Figures 20, 21, 22a, 22b. 23a and 23b.

[0042] Similarly, the RF Connector 44 comprises a connector housing 94, capacitive connectors 62, a float plate 70 (see Figures 7a and 7b), and a float assembly comprising float shells 84 and 88 and a float gasket 86. Again, the float plate 70 allows the capacitive connectors 62 to move with respect to the connector housing 94, and the float gasket 86 allows the connector housing 90 to move with respect to a surface on which the RF connector 40 is mounted. The connector housings 90 and 94 may include corresponding bevels 92 and 96 to facilitate alignment of the housings 90 and 94 and their associated capacitive connectors 64 and 62.

[0043] Referring to Figures 20 and 21, one embodiment of a float gasket 86 is illustrated in more detail. Figure 20 is a perspective view of a float gasket 86 installed in an opening of a portion of a panel. The float gasket 86 includes a first flange portion 81a and a second flange portion 81b (see Figure 19) separated by a middle portion 83. Figure 21 is a cross section of the float gasket 86 to illustrate a first flange 81a and ribs 87. First and second flanges 81a and 81b are dimensioned to be larger than an opening in which the float gasket 86 is to be installed. The middle portion 83 includes a plurality of outer ribs 87. The ribs 87 extend outwardly from the middle portion 83 and are dimensioned to engage an inner periphery of the hole in which the float gasket 86 is mounted. The float gasket 86 and/or ribs 87 may be compressed slightly, which allows the connector shell to "float" within the opening on the surface to which the RRH connector 40 or RF connector 44 is mounted. In practice, a float gasket 86 is installed in an opening, float shells 84 and 88 are installed around the float gasket 86, a float plate 70 and capacitive connectors 64 or 62 are installed, and finally the connector housing 90 or 94 is installed.

[0044] Figures 22a, 22b, 23a and 23b illustrate an embodiment of an adjustable mount assembly 500 that may be side mounted or rear mounted to a RRH 20. In Figures 22a and 22b, the mount assembly 500 is rear mounted to a RRH 20. The mount assembly 500 includes a first bracket 502 and a second bracket 504. The first bracket 502 includes a first set of adjustable slots 512a, 512b, 512c and 512d. The first set of slots 512a, 512b, 512c and 512d may be dimensioned to receive hardware (such as screws) for securing the mount assembly 500 to the RRH 20 and also serve to fix the relative positions of brackets 502 and 504. By loosening and/or tightening the hardware, the relative positions of the brackets 502 and 504 may be adjusted to accommodate RRHs 40 of various size. Bracket 504 includes an opening 541 for receiving an RRH connector 40, such as the RRH connector shown in Figure 18. The RRH connector 40 may be cabled to the RRH 20 by jumper cables 544. Jumper cables 554 may include metal-to-metal ohmic connectors on the one hand for attachment to the RRH 20 and capacitive connectors on the other hand for attachment to the RRH Connector 40. Bracket 504 also may include an Upper Low Friction Car 32 and/or a Lower Low Friction Car 34 that operate as described above with respect to Figures 3 and 4.

[0045] Figures 23a and 23b show the mount assembly 500 side mounted to a RRH 20. As illustrated, the first

bracket 502 includes a second set of adjustable slots 514a, 514b and 514c for receiving mount posts 515a, 515b and 515c. Mount posts 515a, 515b and 515c may be, for example, threaded posts that can be used with appropriate hardware to secure the relative positions of brackets 502 and 504. Even if the assembly 500 is rear mounted to a RRH 20, mount posts 515a, 515b and 515c may help to align brackets 502 and 504 during assembly. Brackets 502 and 504 may also include a set of mounting points, such as apertures 516a, 516b and 516c for receiving hardware for side mounting the assembly 500 to the RRH 20. While Figures 22a, 22b, 23a and 23b illustrate an embodiment of an adjustable mount assembly 500 that may be side mounted or rear mounted to a RRH 20, mount assembly 500 may be modified to provide only side mounting, only rear mounting, or other functionality contemplated herein.

[0046] In practice, brackets 502 and 504, jumper cables 554, and RRH Connector 40 (including, for example, float gasket 86, float shells 84 and 88, float plate 70, capacitive connectors 66, and/or connector housing 90) may be assembled/mounted to an RRH 20 and/or fully tested offsite, such as an in a factory setting. This enables all ohmic connections (metal-to-metal) to be done in a controlled environment such as a the factory and performance tested before shipping a completed assembly to the field. In the field, the only RF connections that need to be made are the capacitive, which are more reliable and less likely to induce PIM.

[0047] The present disclosure is not limited to remote radio heads and antennas. Universal mounting brackets may also be used to mount additional items of tower-mountable equipment.

[0048] In another example, the standard interface structure mounts directly to the pole and allows the RRH and the antenna to straddle the pole. The standard interface structure includes an RF interconnection module, which is moved off to the side so it avoids the pole when the RRH and antenna are engaged. The RRH and Antenna mount directly to the standard interface structure, and each may be removed independently.

[0049] In another example, instead of mounting to a pole, the Standard Antenna Interface may replace a pole in a tower installation. In this example, the structure may comprise rectangular tubing or round tubing with an extended pipe tubing at both ends. The RF interconnect mates inside the center structure and is concealed within the structure when the antenna and RRH are installed.

[0050] In another example, additional functionality is added to the standard antenna interface by way of RF filtering and/or amplification. Additional modules, such as a tower mount amplifiers (TMA) or RF filters, may be added within the standard interface structure. These modules will contain an RF interconnection module on one or both sides, enabling it to directly connect to the antenna or RRH. The modules may be removable separate entities, or permanently embedded into the standard interface enclosure.

Claims

1. An RF interconnection module (40, 44) comprising:

a connector housing (90, 94);
a capacitive coupling (62, 64) at least partially disposed in the connector housing (90, 94);
a float gasket (86) comprising a middle portion (83) and first and second flanges (81a, 81b), wherein the middle portion (83) is configured to engage with an inner periphery of an opening into which the float gasket (86) is to be installed, wherein the first and second flanges (81a, 81b) are dimensioned to be larger than the opening in which the float gasket (86) is to be installed, and wherein, when the connector housing (90, 94) is mounted, one of the first and second flanges (81a, 81b) of the float gasket (86) is positioned between the connector housing (90, 94) and a surface that includes the opening; and
a first float shell (84) and a second float shell (88) each configured to engage a respective flange (81a, 81b) of the float gasket (86),
wherein the float gasket (86) is configured to allow the connector housing (90, 94) to move with respect to the surface that includes the opening.

2. The RF interconnection module (40, 44) of claim 1, wherein the middle portion (83) includes a plurality of outwardly extending ribs (87) for movably securing the float gasket (86) in the opening.

3. The RF interconnection module (40, 44) of claim 1, further comprising:

a float plate (70) disposed in the connector housing (90, 94),
wherein the capacitive coupling (62, 64) is movably disposed in the float plate (70) so that the capacitive coupling (62, 64) may move with respect to the connector housing (90, 94).

4. The RF interconnection module (40, 44) of claim 3, wherein the float plate (70) includes a plurality of flexible fingers (76) that define an aperture for receiving the capacitive coupling (62, 64), the flexible fingers (76) movably securing the capacitive coupling (62, 64) in the aperture.

5. A mount assembly (500) comprising:

a bracket assembly (502, 504) attachable to a tower-mounted equipment (20); and
at least one jumper cable (544, 554) having at least one ohmic connector for connecting to the tower-mounted equipment (20) and at least one capacitive connector, wherein
the at least one capacitive connector comprises

an RF interconnection module (40) according to claim 1, the RF interconnection module (40) being mounted on the bracket assembly (504).

6. The mount assembly (500) of claim 5, wherein the float gasket (86) movably mounts the RF interconnection module (40) on the bracket assembly (504).

7. The mount assembly (500) of claim 5, further comprising at least one diplexer (24) having a low friction car (32, 34) configured to engage a linear guided support member (26) of a radio head mount (20).

8. The RF interconnection module (40, 44) of claim 1, wherein the first float shell (84) and the second float shell (88) each comprises a pair of flanges (85a, 85b, 89a, 89b) operable to secure the float gasket (86) in a space between the first float shell (84) and the second float shell (88).

Patentansprüche

1. HF-Anschlussmodul (40, 44) umfassend:

ein Verbindergehäuse (90, 94);
eine kapazitive Kopplung (62, 64), die zumindest teilweise in dem Verbindergehäuse (90, 94) angeordnet ist;
eine schwimmende Dichtung (86) umfassend einen mittleren Abschnitt (83) und erste und zweite Flansche (81a, 81b), wobei der mittlere Abschnitt (83) ausgestaltet ist, mit einem inneren Umfang einer Öffnung in Eingriff zu kommen, in die die schwimmende Dichtung (86) eingebaut werden soll, wobei die ersten und zweiten Flansche (81a, 81b) größer als die Öffnung, in die die schwimmende Dichtung (86) eingebaut werden soll, dimensioniert sind, und wobei, wenn das Verbindergehäuse (90, 94) montiert ist, einer der ersten und zweiten Flansche (81a, 81b) der schwimmenden Dichtung (86) zwischen dem Verbindergehäuse (90, 94) und einer Fläche, die die Öffnung aufweist, positioniert ist; und
eine erste schwimmende Verblendung (84) und eine zweite schwimmende Verblendung (88), die jeweils ausgestaltet sind, mit einem jeweiligen Flansch (81a, 81b) der schwimmenden Dichtung (86) in Eingriff zu kommen,
wobei die schwimmende Dichtung (86) ausgestaltet ist, dem Verbindergehäuse (90, 94) zu ermöglichen, sich in Bezug auf die Fläche, die die Öffnung aufweist, zu bewegen.

2. HF-Anschlussmodul (40, 44) nach Anspruch 1, wobei der mittlere Abschnitt (83) eine Mehrzahl von sich nach außen erstreckenden Rippen (87) zum beweglichen Sichern der schwimmenden Dichtung (86) in der Öffnung aufweist.

3. HF-Anschlussmodul (40, 44) nach Anspruch 1, ferner umfassend:

eine schwimmende Platte (70), die in dem Verbindergehäuse (90, 94) angeordnet ist,
wobei die kapazitive Kopplung (62, 64) beweglich in der schwimmenden Platte (70) derart angeordnet ist, dass sich die kapazitive Kopplung (62, 64) in Bezug auf das Verbindergehäuse (90, 94) bewegen kann.

4. HF-Anschlussmodul (40, 44) nach Anspruch 3, wobei die schwimmende Platte (70) eine Mehrzahl von flexiblen Fingern (76) aufweist, die eine Öffnung zum Aufnehmen der kapazitiven Kopplung (62, 64) definieren, wobei die flexiblen Finger (76) die kapazitive Kopplung (62, 64) beweglich in der Öffnung sichern.

5. Montageanordnung (500), umfassend:

eine Halterungsanordnung (502, 504), die an einer an einem Masten montierten Ausrüstung (20) anbringbar ist; und
mindestens ein Überbrückungskabel (544, 554) mit mindestens einem ohmschen Verbinder zum Verbinden mit der an einem Masten montierten Ausrüstung (20) und mindestens einem kapazitiven Verbinder,
wobei
der mindestens eine kapazitive Verbinder ein HF-Anschlussmodul (40) nach Anspruch 1 umfasst, wobei das HF-Anschlussmodul (40) an der Halterungsanordnung (504) montiert ist.

6. Montageanordnung (500) nach Anspruch 5, wobei die schwimmende Dichtung (86) das HF-Anschlussmodul (40) beweglich an der Halterungsanordnung (504) montiert.

7. Montageanordnung (500) nach Anspruch 5, ferner umfassend mindestens eine Frequenzweiche (24) mit einem reibungsarmen Schlitten (32, 34), der ausgestaltet ist, mit einem linear geführten Trägerelement (26) einer Funkkopfhalterung (20) in Eingriff zu kommen.

8. HF-Anschlussmodul (40, 44) nach Anspruch 1, wobei die erste schwimmende Verblendung (84) und die zweite schwimmende Verblendung (88) jeweils ein Paar von Flanschen (85a, 85b, 89a, 89b) umfasst, die zum Sichern der schwimmenden Dichtung (86) in einem Raum zwischen der ersten schwimmenden Verblendung (84) und der zweiten schwimmenden Verblendung (88) anwendbar sind.

Revendications

1. Module d'interconnexion RF (40, 44) comprenant :

un boîtier de connecteur (90, 94) ;
un couplage capacitif (62, 64) disposé au moins partiellement dans le boîtier de connecteur (90, 94) ;
un joint libre (86) comprenant une partie centrale (83) et des première et deuxième flasques (81a, 81b), la partie centrale (83) étant configurée pour entrer en prise avec une périphérie interne d'une ouverture dans laquelle le joint libre (86) doit être installé, les première et deuxième flasques (81a, 81b) étant dimensionnées pour être plus grandes que l'ouverture dans laquelle le joint libre (86) doit être installé, et quand le boîtier de connecteur (90, 94) est monté, une des première et deuxième flasques (81a, 81b) du joint libre (86) étant positionnée entre le boîtier de connecteur (90, 94) et une surface qui comporte l'ouverture ; et
une première coque libre (84) et une deuxième coque libre (88) configurées chacune pour entrer en prise avec une flasque respective (81a, 81b) du joint libre (86),
dans lequel le joint libre (86) est configuré pour permettre au boîtier de connecteur (90, 94) de se déplacer par rapport à la surface qui comporte l'ouverture.

2. Module d'interconnexion RF (40, 44) selon la revendication 1, dans lequel la partie centrale (83) comporte une pluralité de nervures s'étendant vers l'extérieur (87) destinées à fixer de façon mobile le joint libre (86) dans l'ouverture.

3. Module d'interconnexion RF (40, 44) selon la revendication 1, comprenant en outre :

une plaque libre (70) disposée dans le boîtier de connecteur (90, 94),
dans lequel le couplage capacitif (62, 64) est disposé de façon mobile dans la plaque libre (70) de telle sorte que le couplage capacitif (62, 64) peut se déplacer par rapport au boîtier de connecteur (90, 94).

4. Module d'interconnexion RF (40, 44) selon la revendication 3, dans lequel la plaque libre (70) comporte une pluralité de doigts souples (76) qui définissent une ouverture destinée à recevoir le couplage capacitif (62, 64), les doigts souples (76) fixant de façon mobile le couplage capacitif (62, 64) dans l'ouverture.

5. Ensemble support (500) comprenant :

un ensemble console (502, 504) fixable à un équipement monté sur tour (20) ; et
au moins un câble d'accouplement (544, 554) ayant au moins un connecteur ohmique destiné à se raccorder à l'équipement monté sur tour (20) et au moins un connecteur capacitif,
dans lequel l'au moins un connecteur capacitif comprend un module d'interconnexion RF (40) selon la revendication 1, le module d'interconnexion RF (40) étant monté sur l'ensemble console (504).

6. Ensemble support (500) selon la revendication 5, dans lequel le joint libre (86) monte de façon mobile le module d'interconnexion RF (40) sur l'ensemble console (504) .

7. Ensemble support (500) selon la revendication 5, comprenant en outre au moins un diplexeur (24) ayant un chariot à faible frottement (32, 34) configuré pour entrer en prise avec un élément de support guidé linéaire (26) d'un support de tête radio (20).

8. Module d'interconnexion RF (40, 44) selon la revendication 1, dans lequel la première coque libre (84) et la deuxième coque libre (88) comprennent chacune une paire de rebords (85a, 85b, 89a, 89b) utilisables pour fixer le joint libre (86) dans un espace entre la première coque libre (84) et la deuxième coque libre (88).

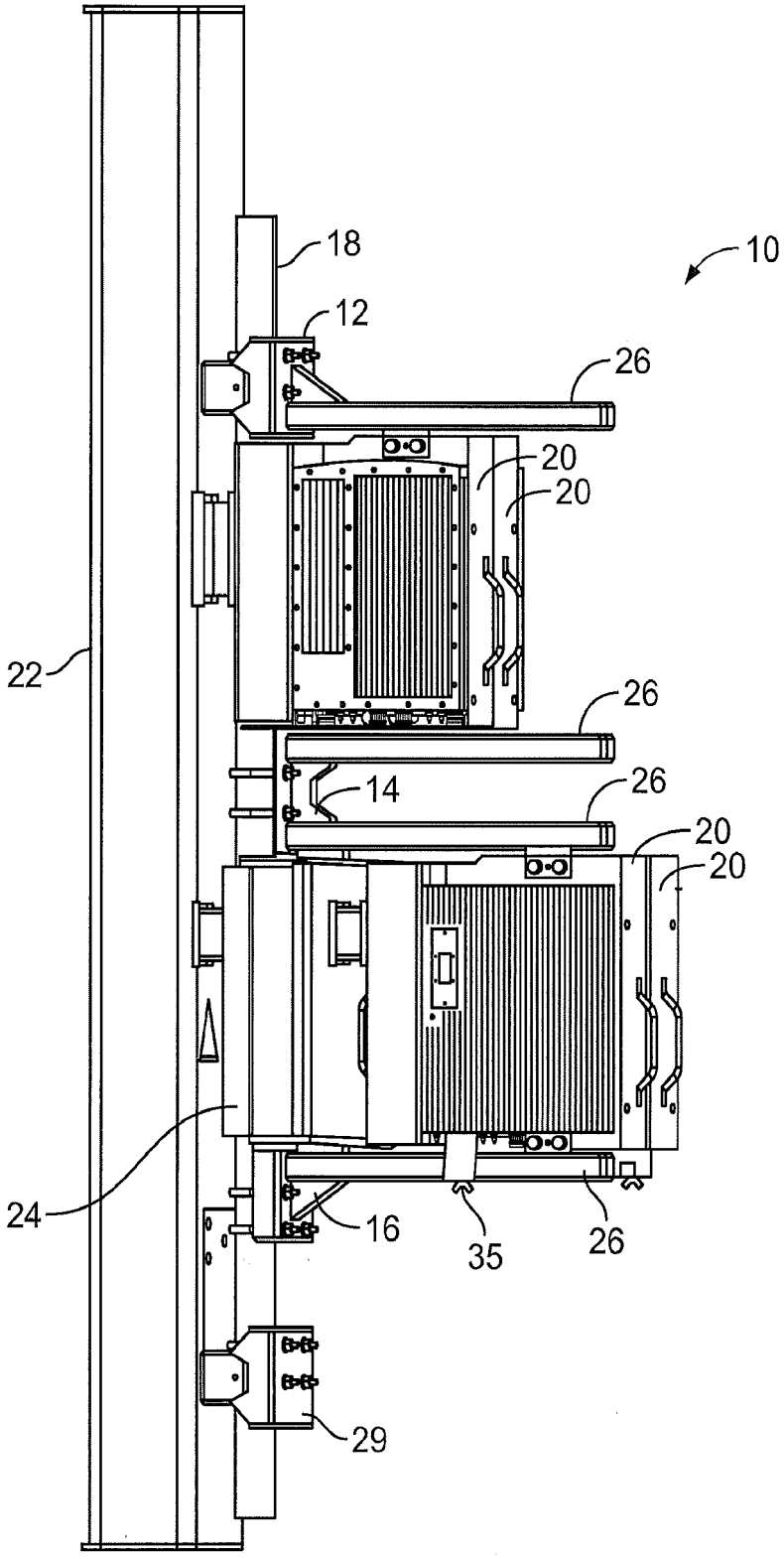

FIG. 1

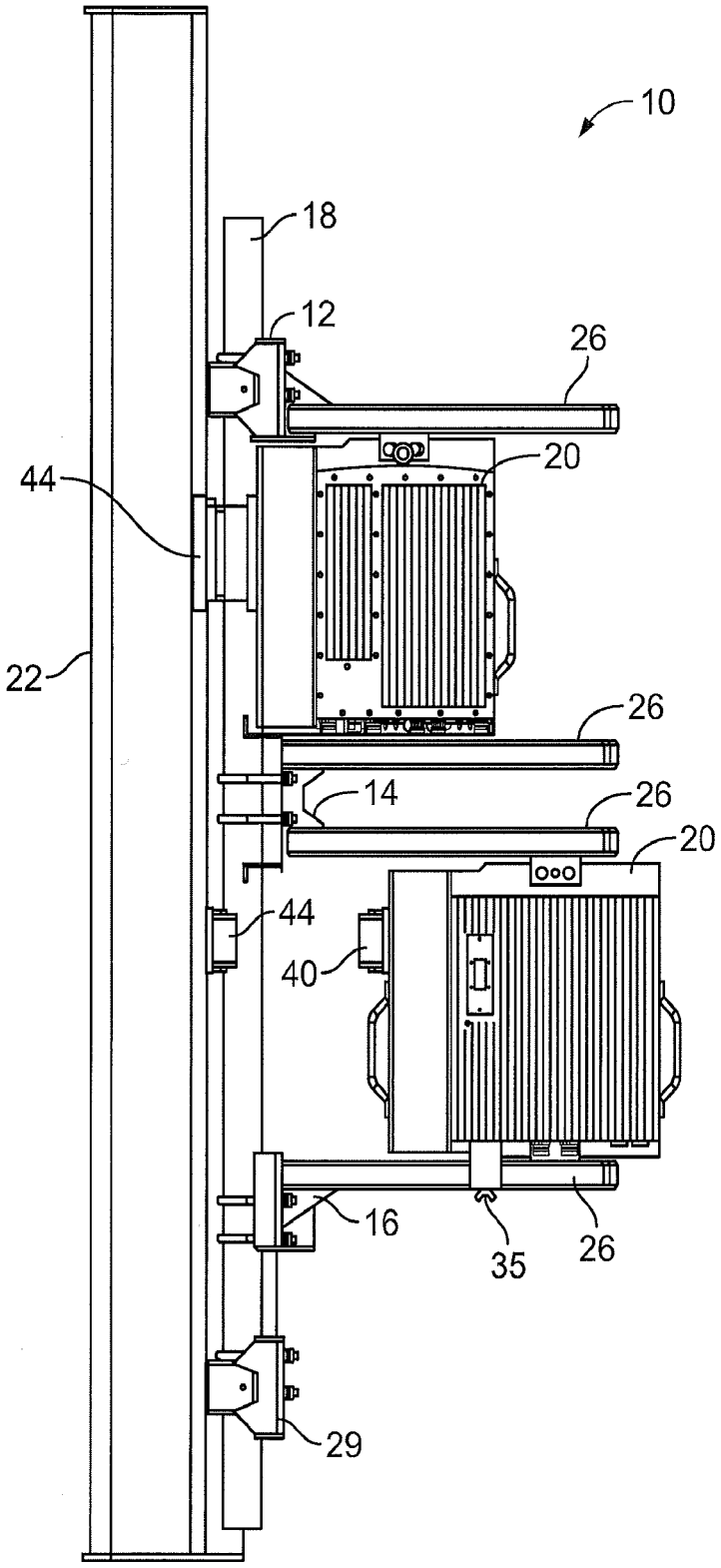

FIG. 2

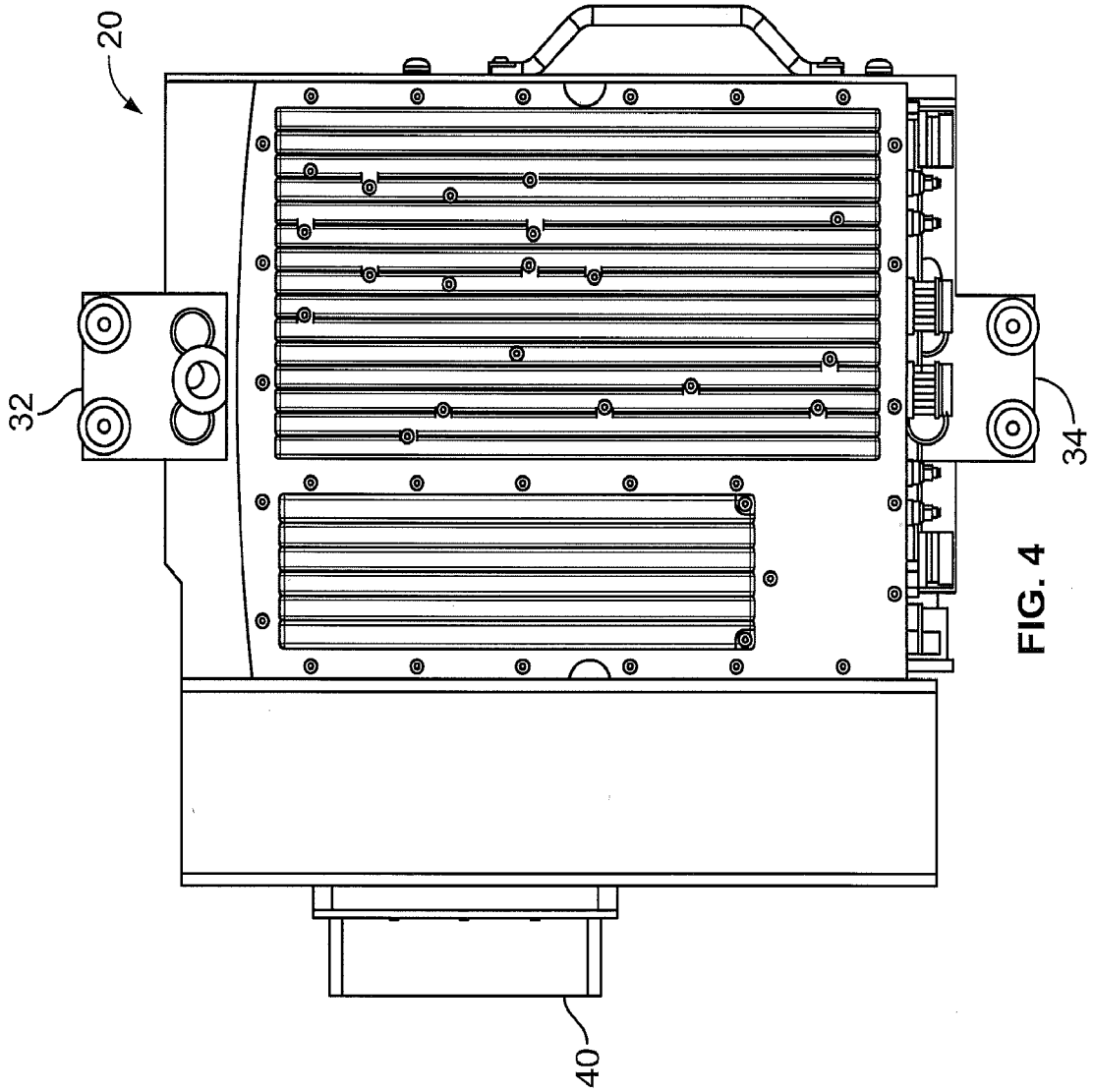

FIG. 4

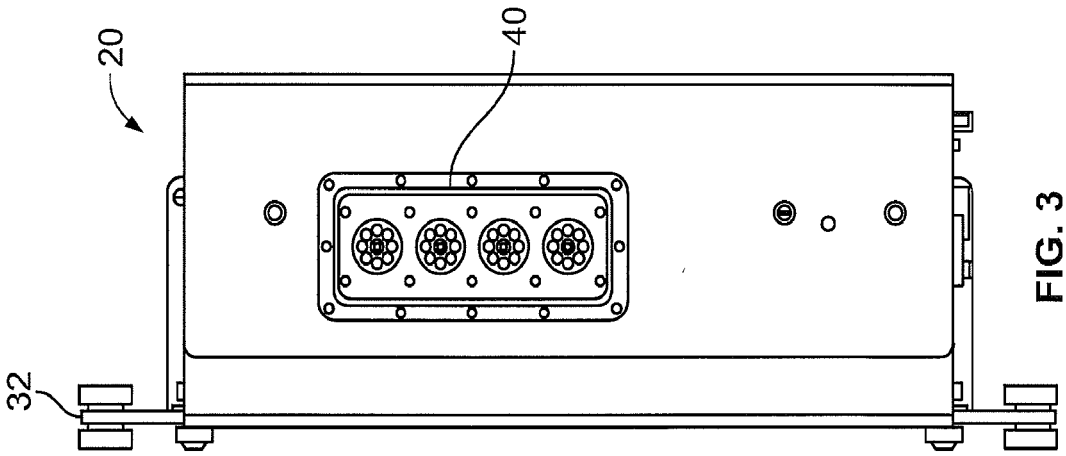

FIG. 3

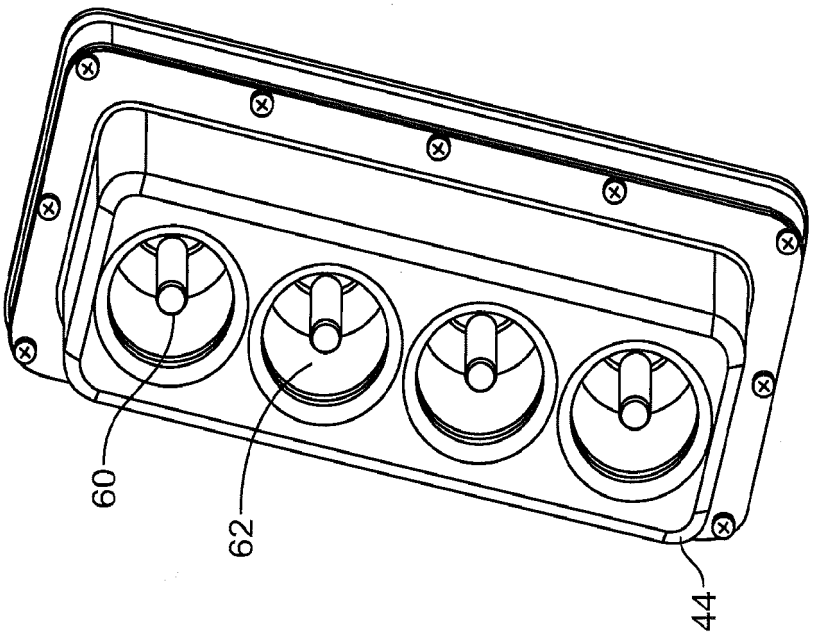

FIG. 6

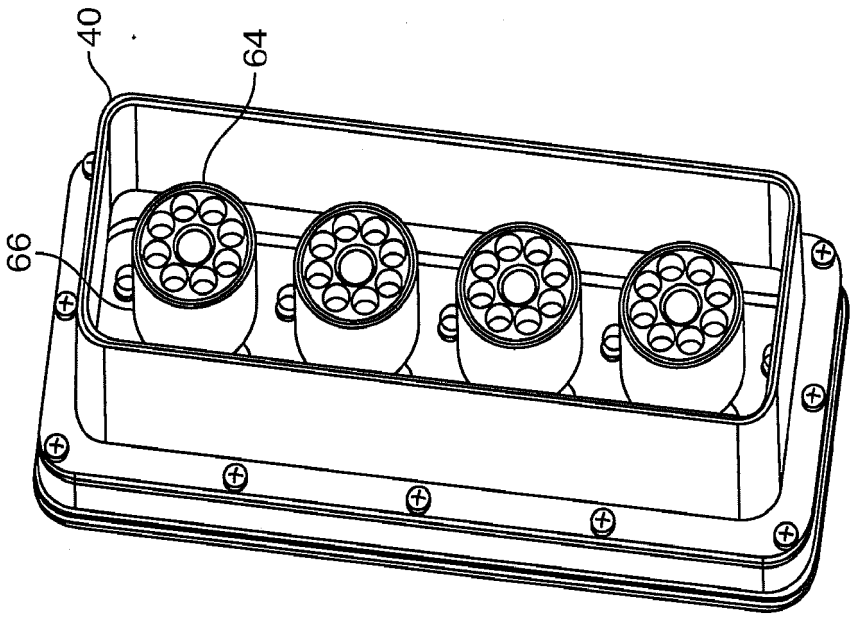

FIG. 5

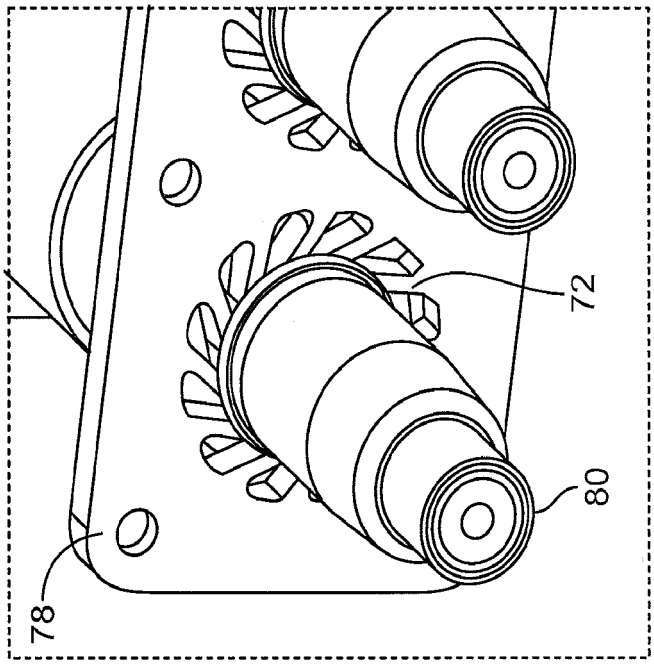

FIG. 7B

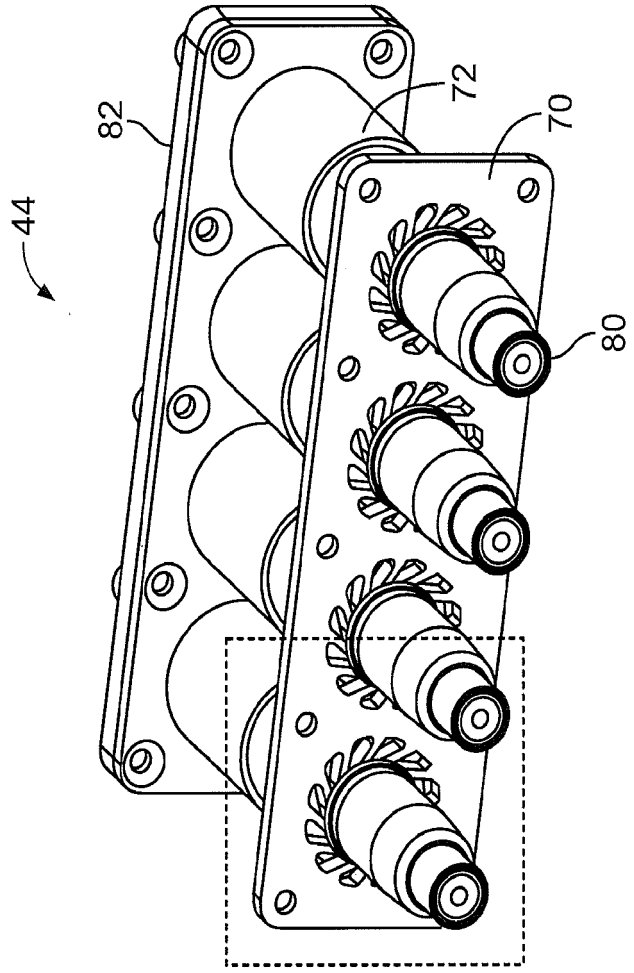

FIG. 7A

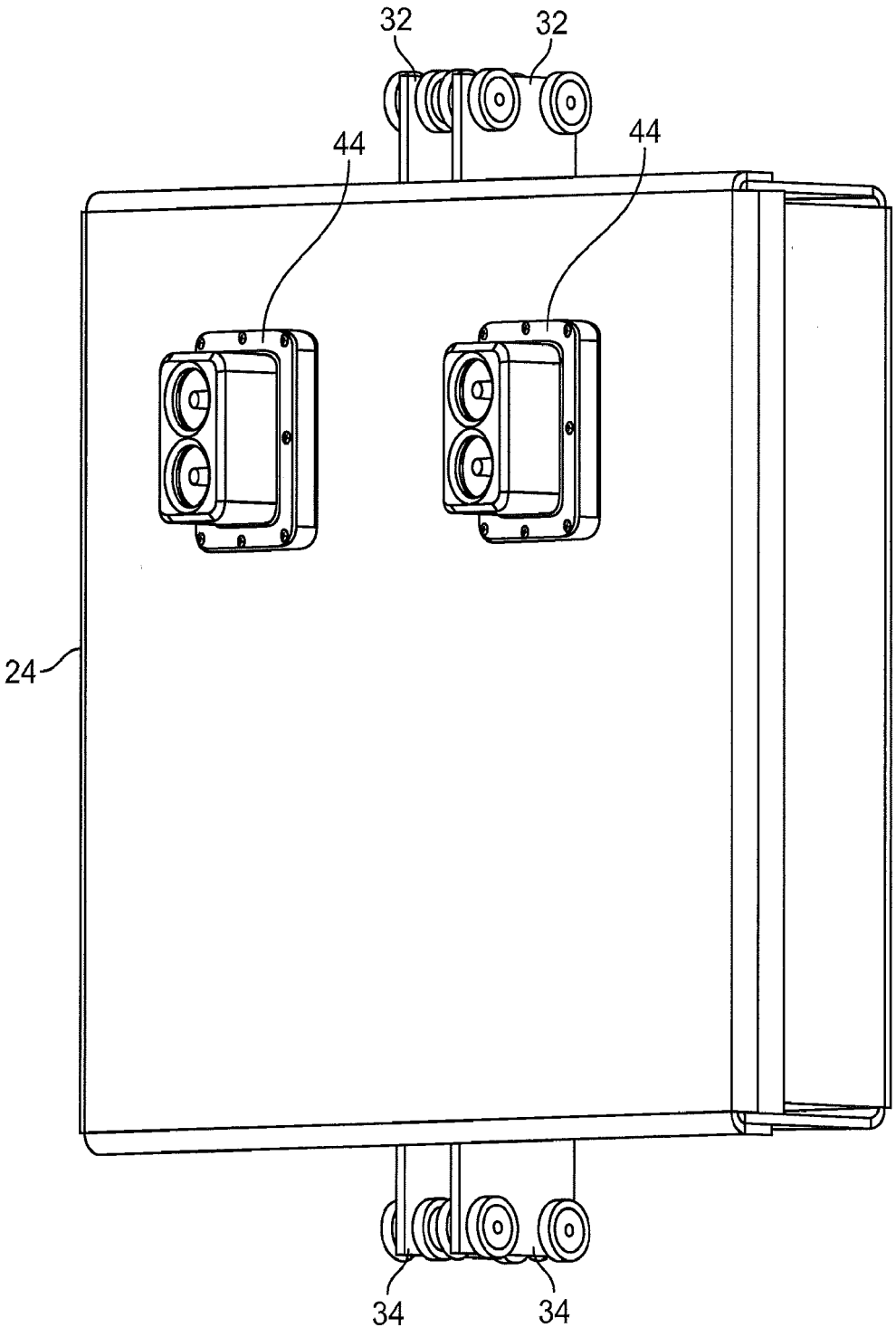

FIG. 8

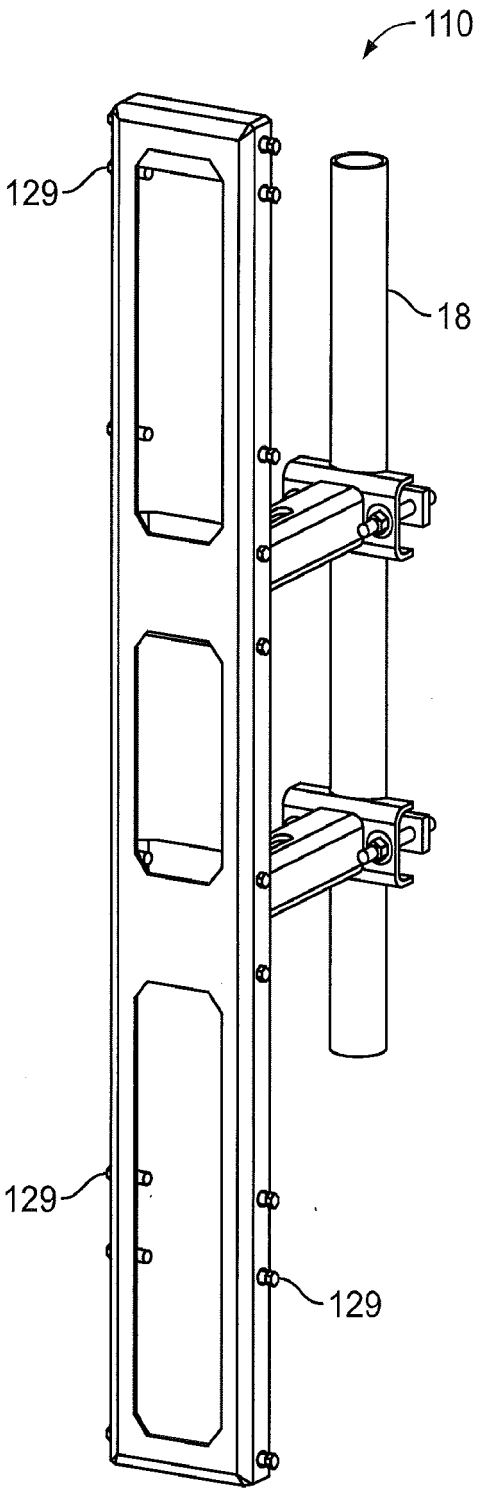

FIG. 9A

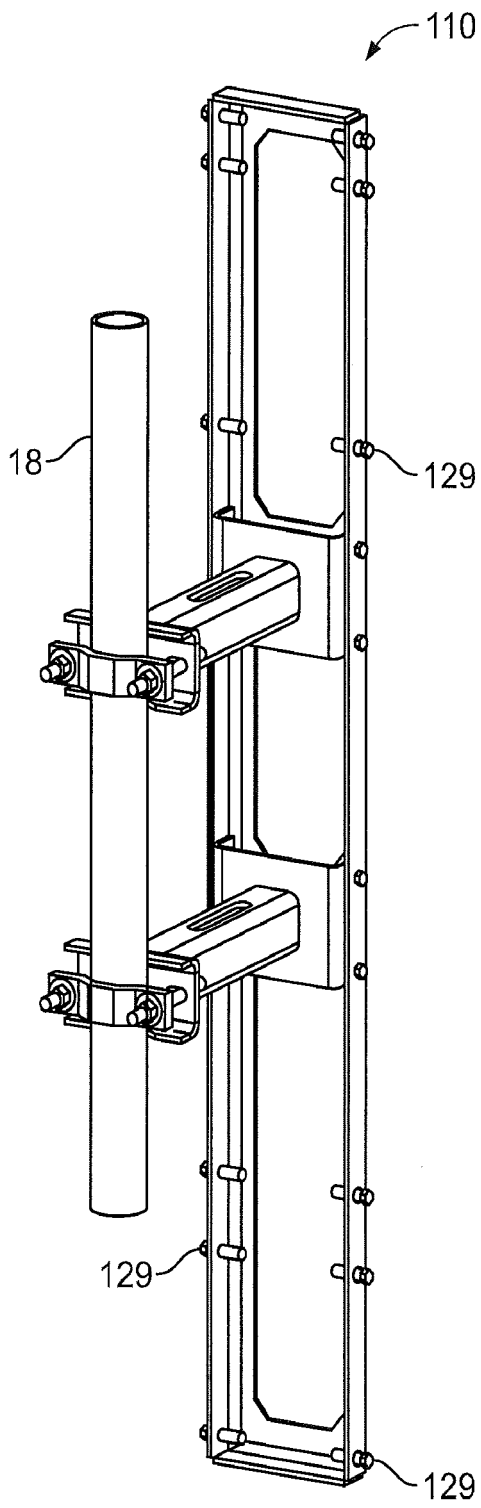

FIG. 9B

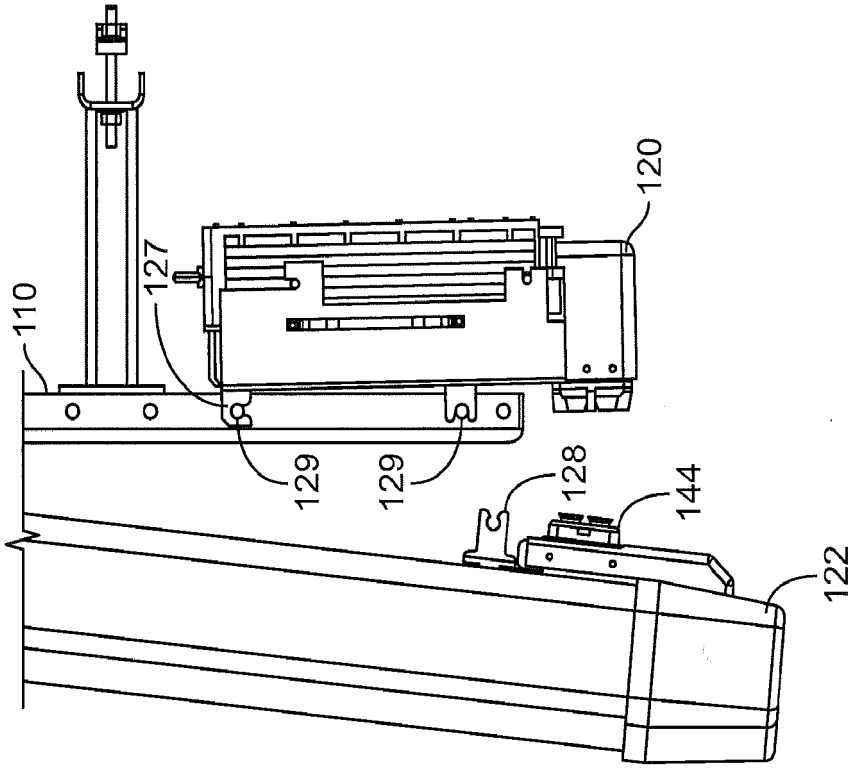

FIG. 10B

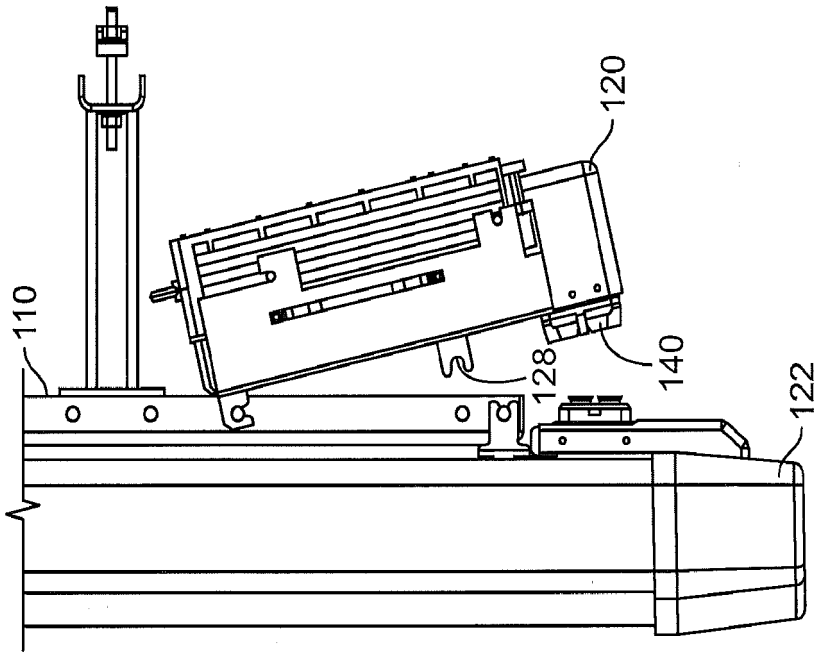

FIG. 10A

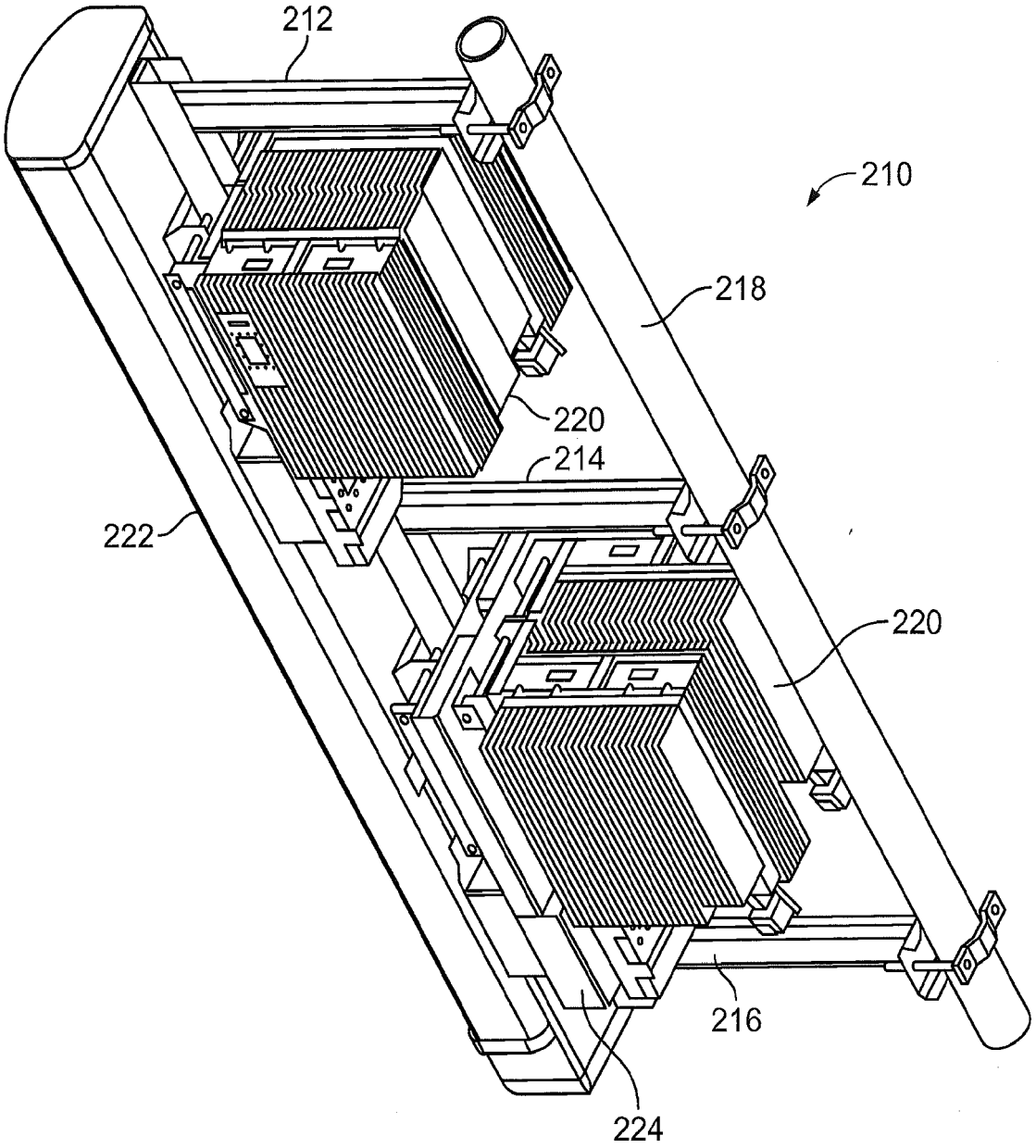

FIG. 11

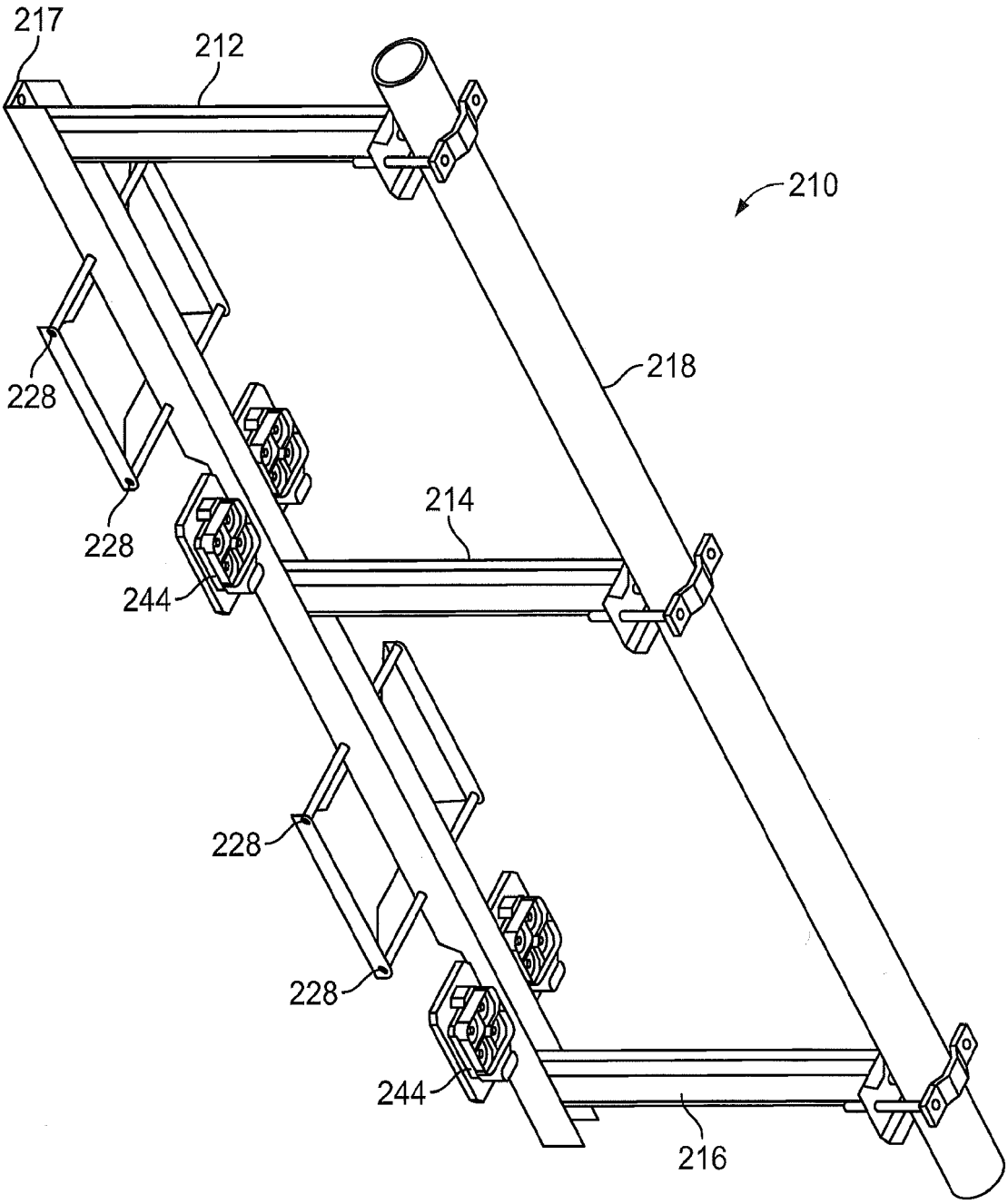

FIG. 12

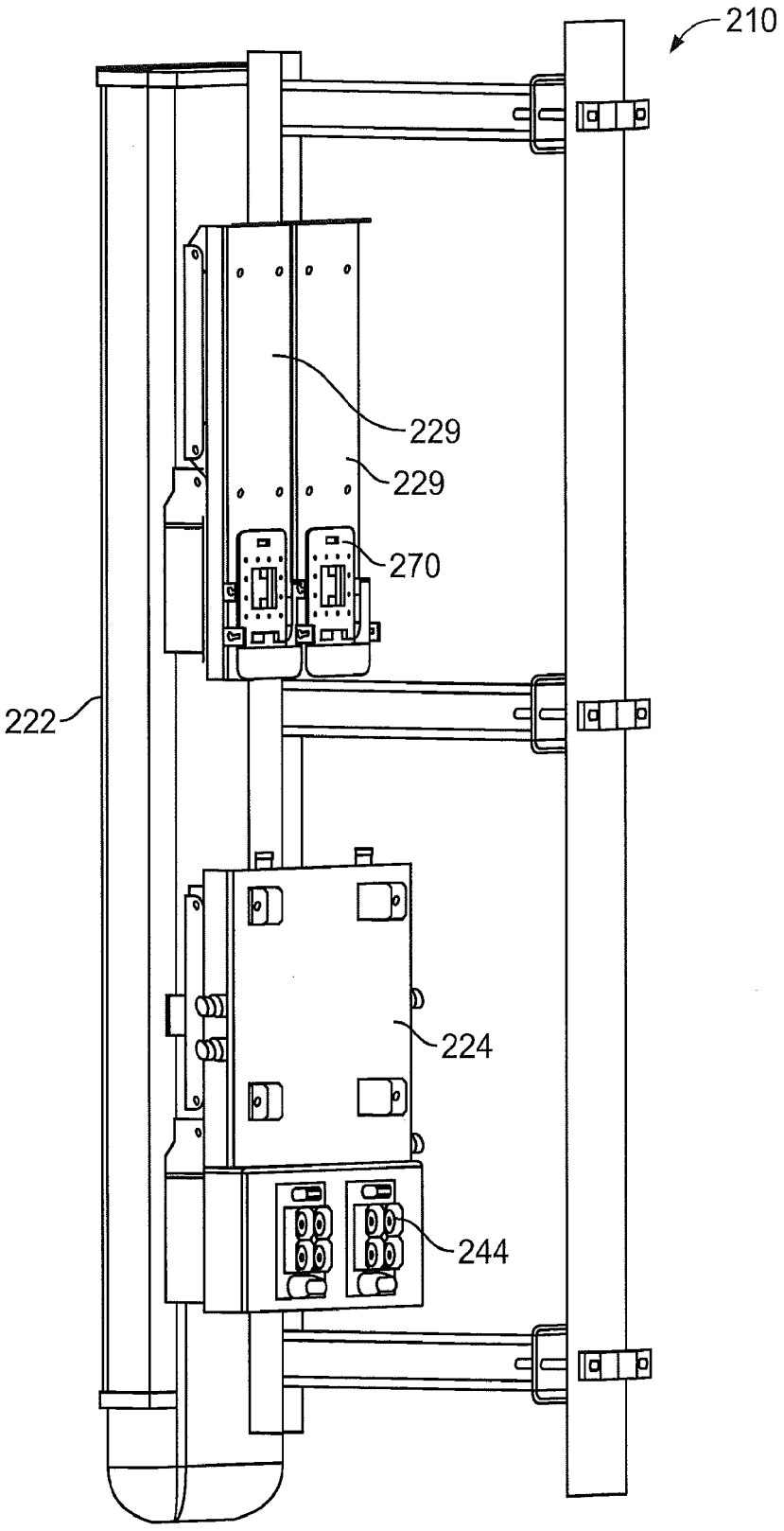

FIG. 13

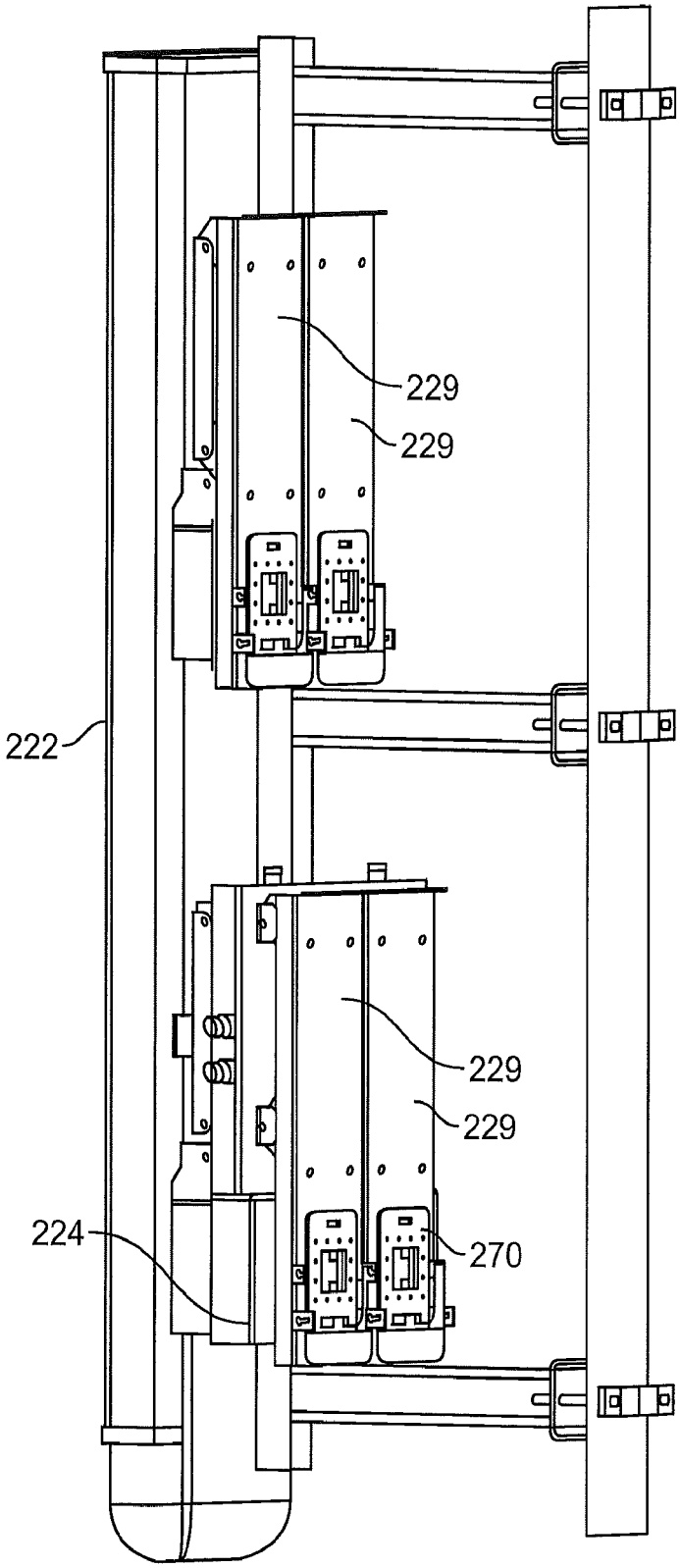

FIG. 14

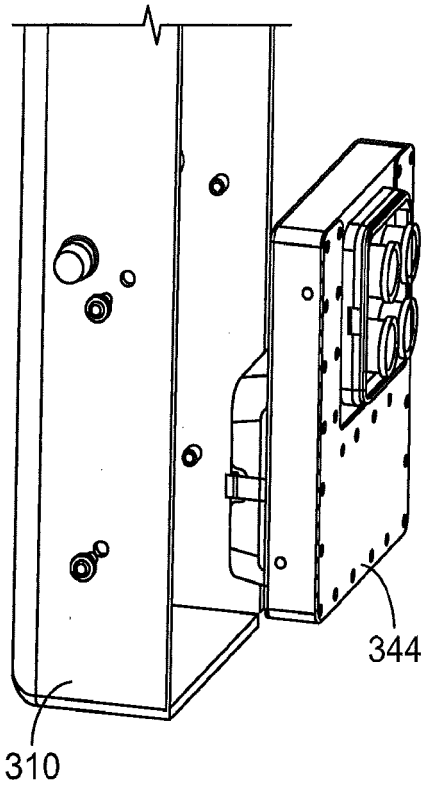

FIG. 15A

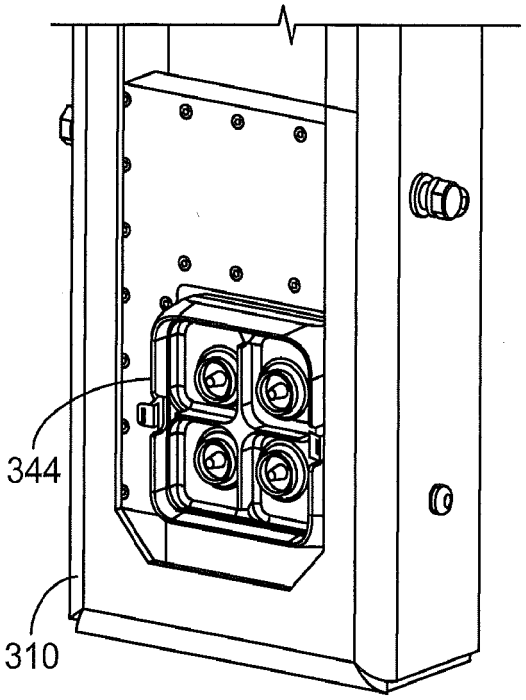

FIG. 15B

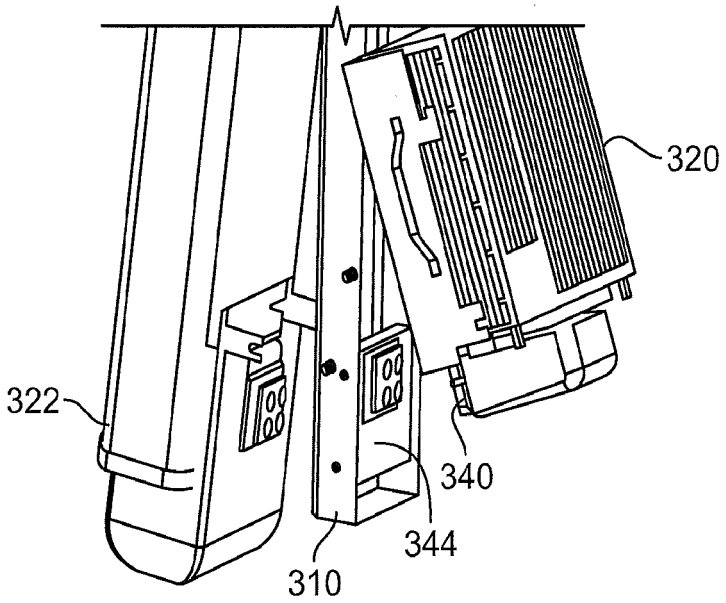

FIG. 15C

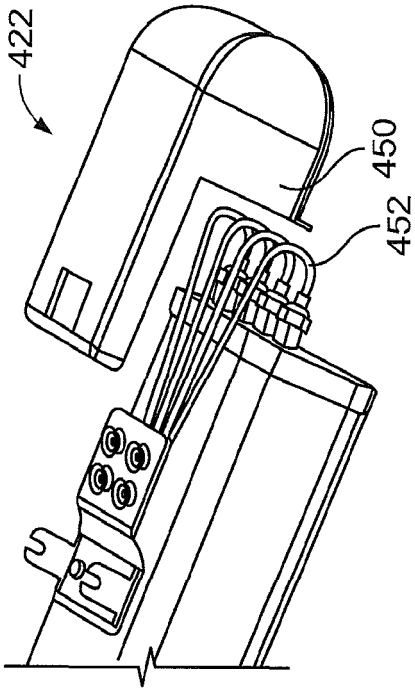

FIG. 16B

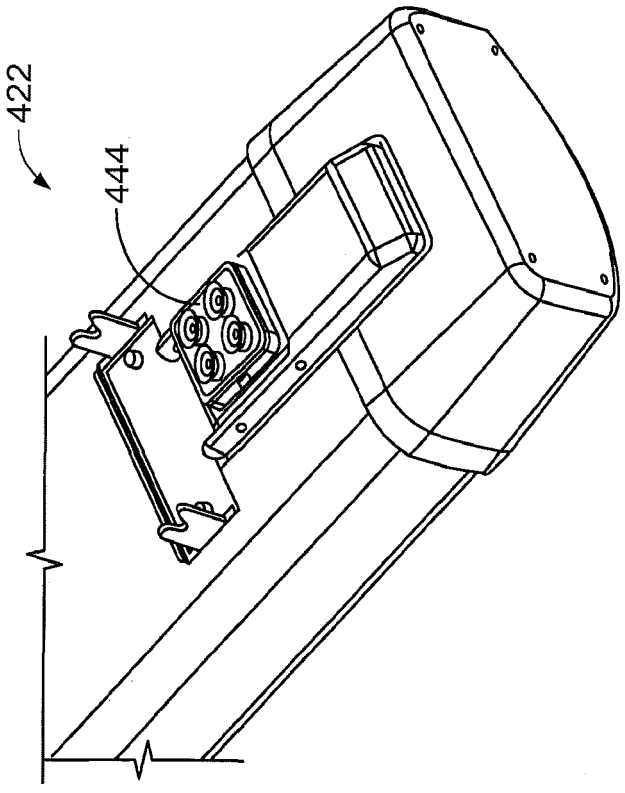

FIG. 16A

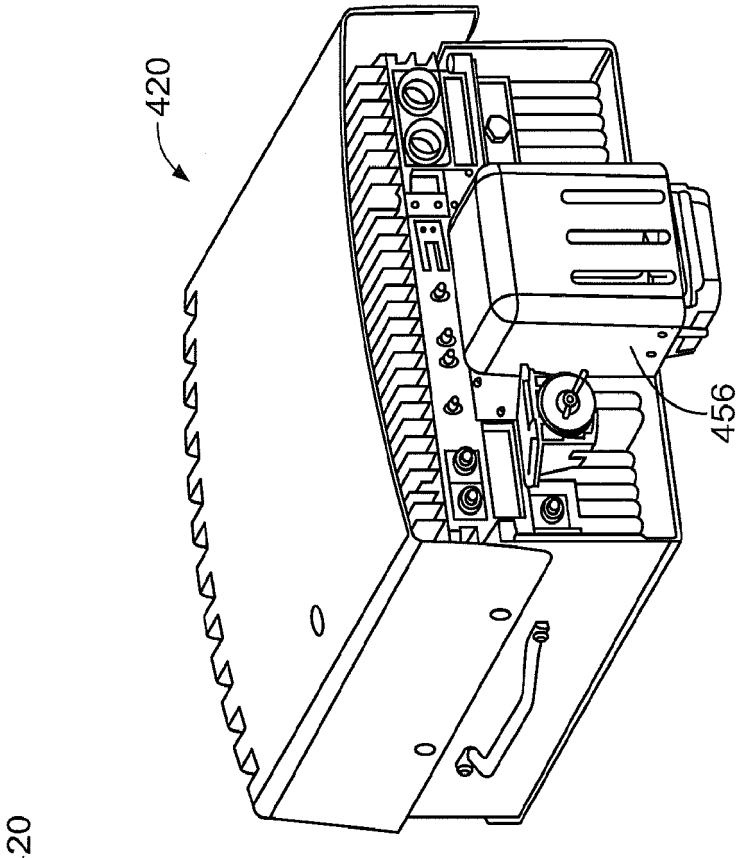

FIG. 17b

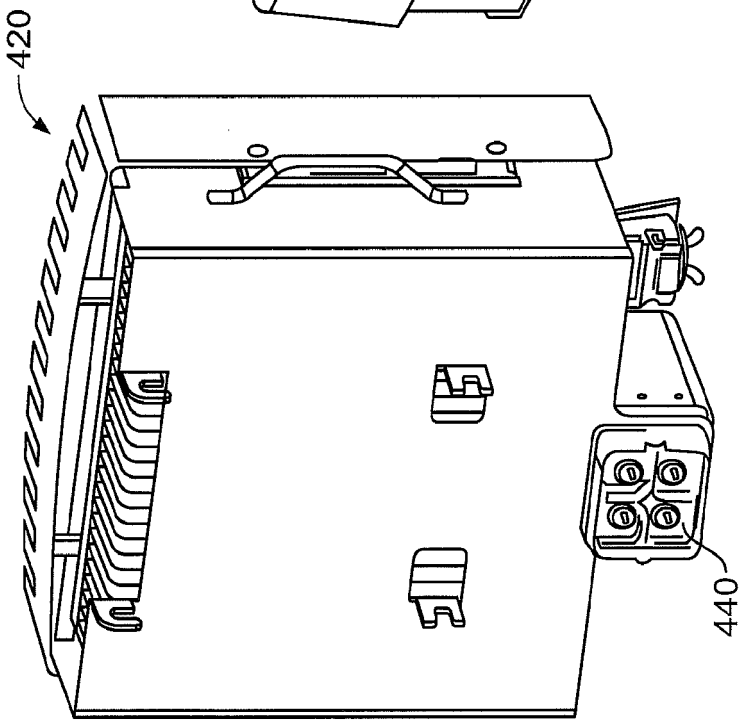

FIG. 17a

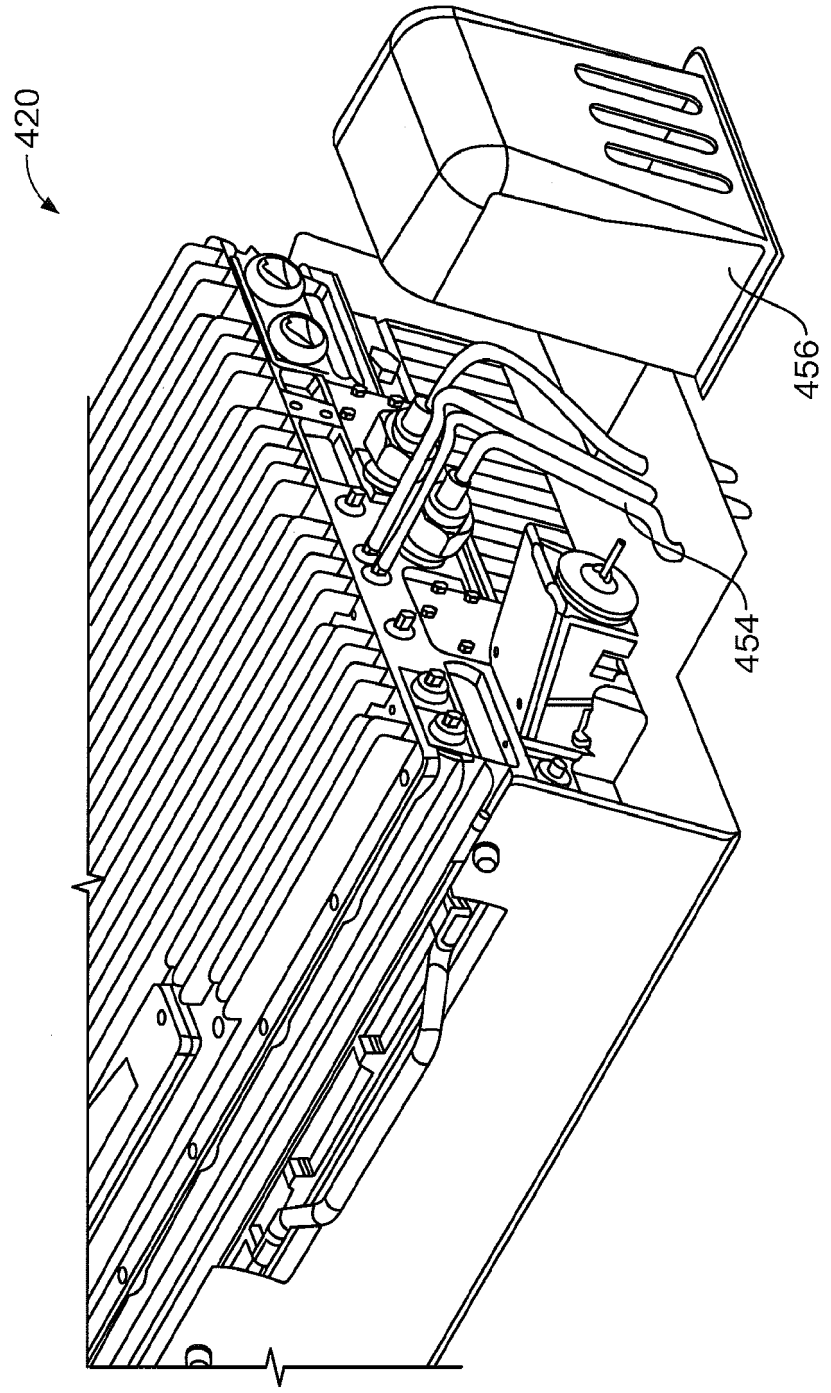

FIG. 17c

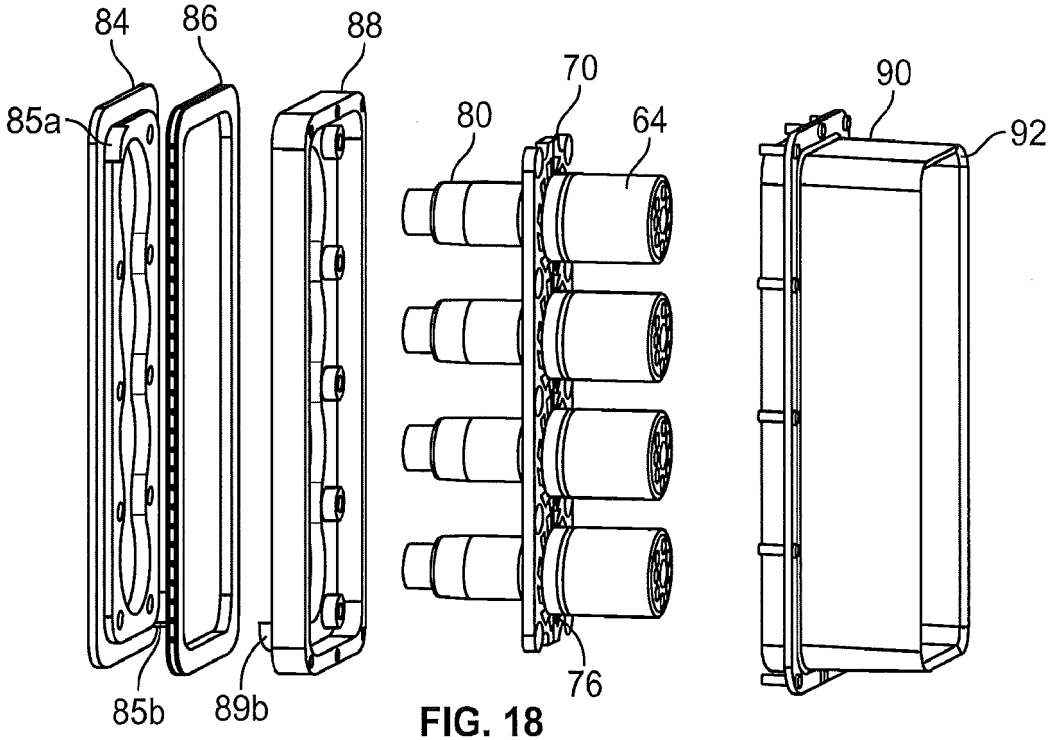
84
86
88
85a
70
80
64
90
92
85b
89b
76

FIG. 18

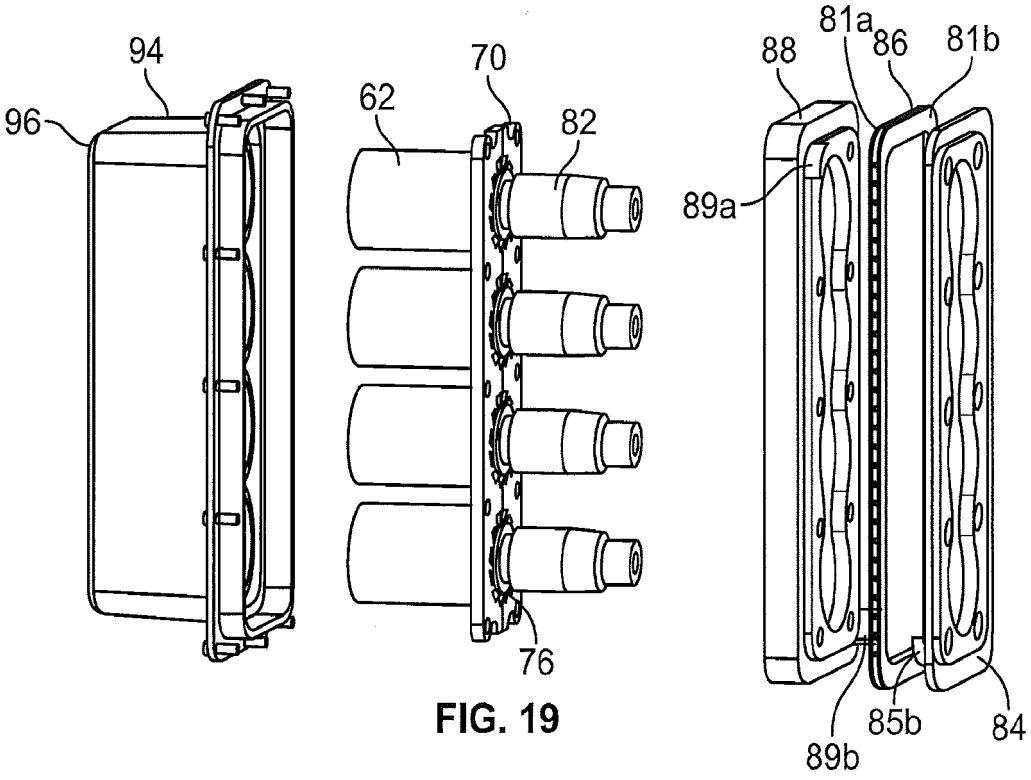
94
96
70
62
82
81a
88
86
81b
89a
76
85b
84
89b

FIG. 19

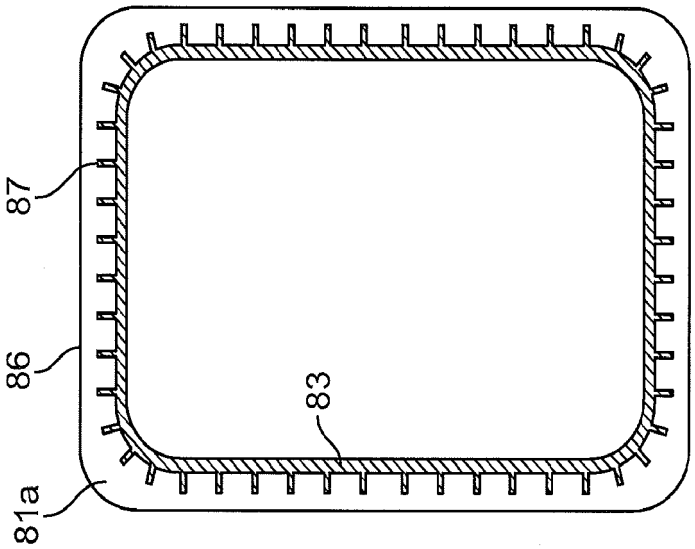

FIG. 21

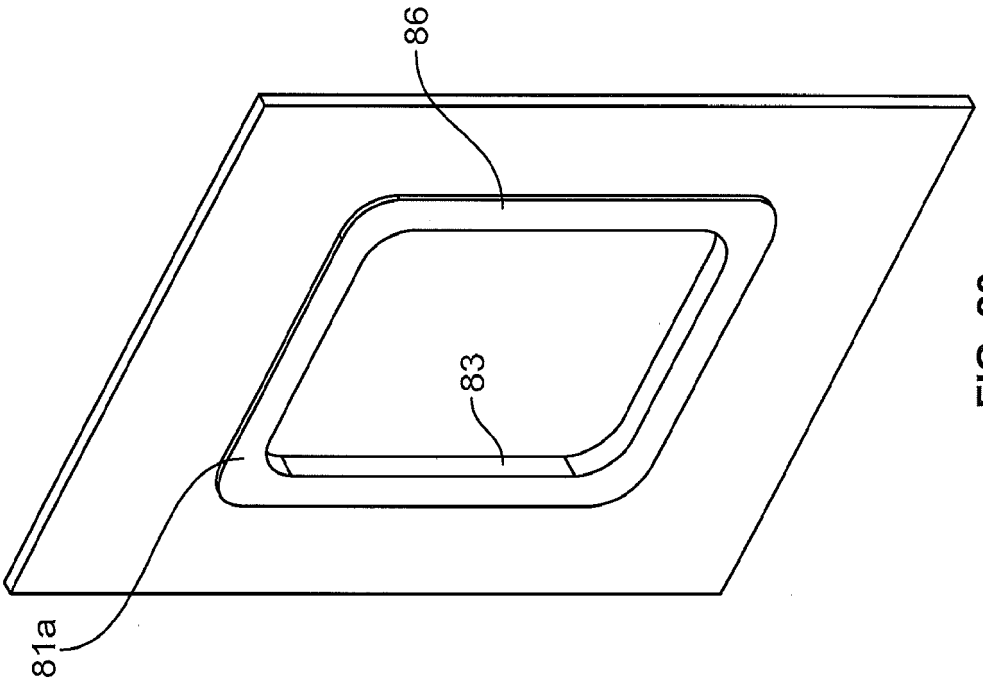

FIG. 20

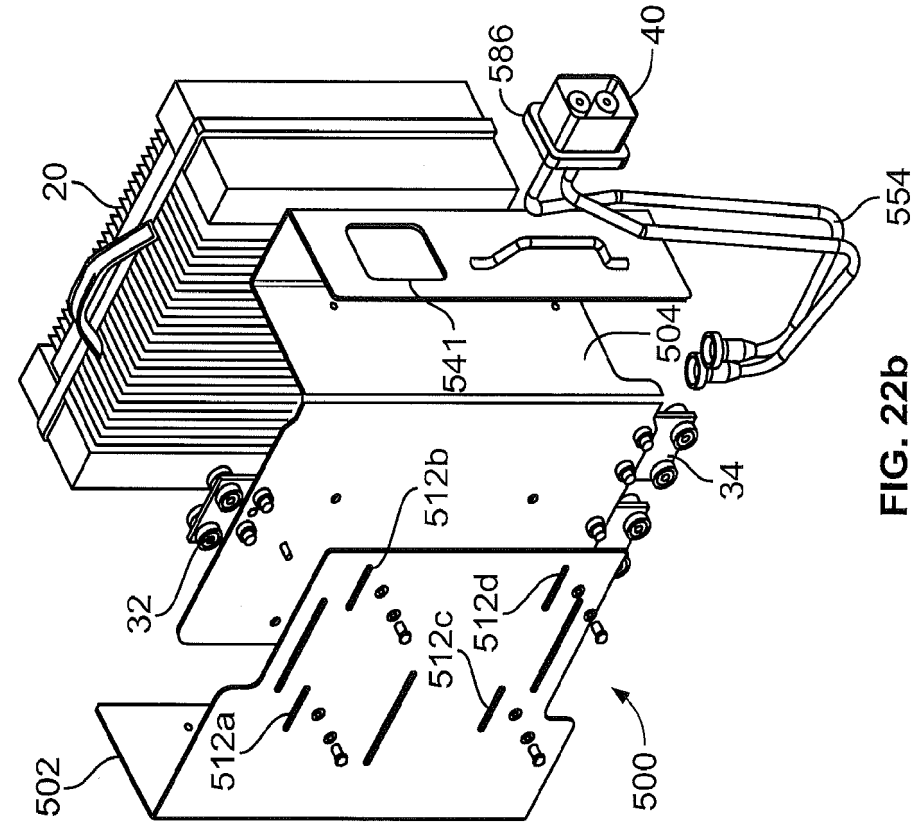

FIG. 22b

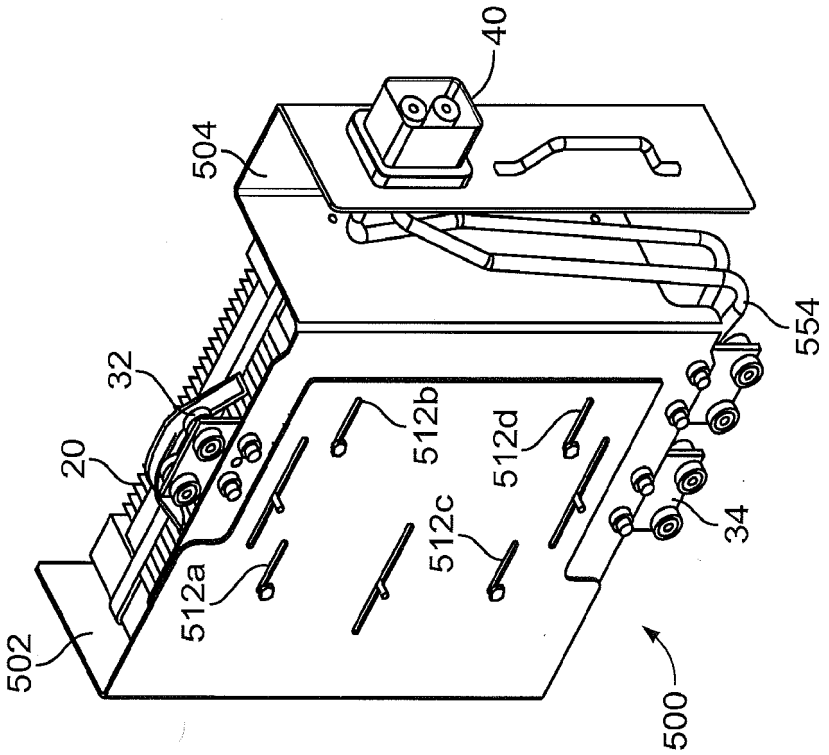

FIG. 22a

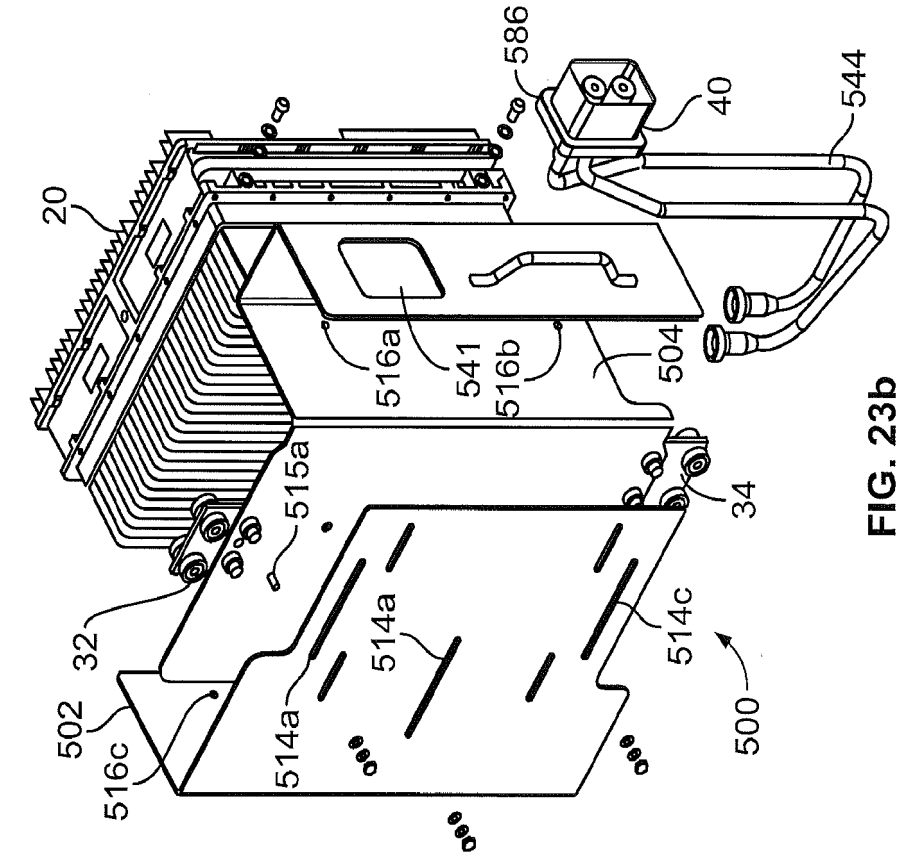

FIG. 23b

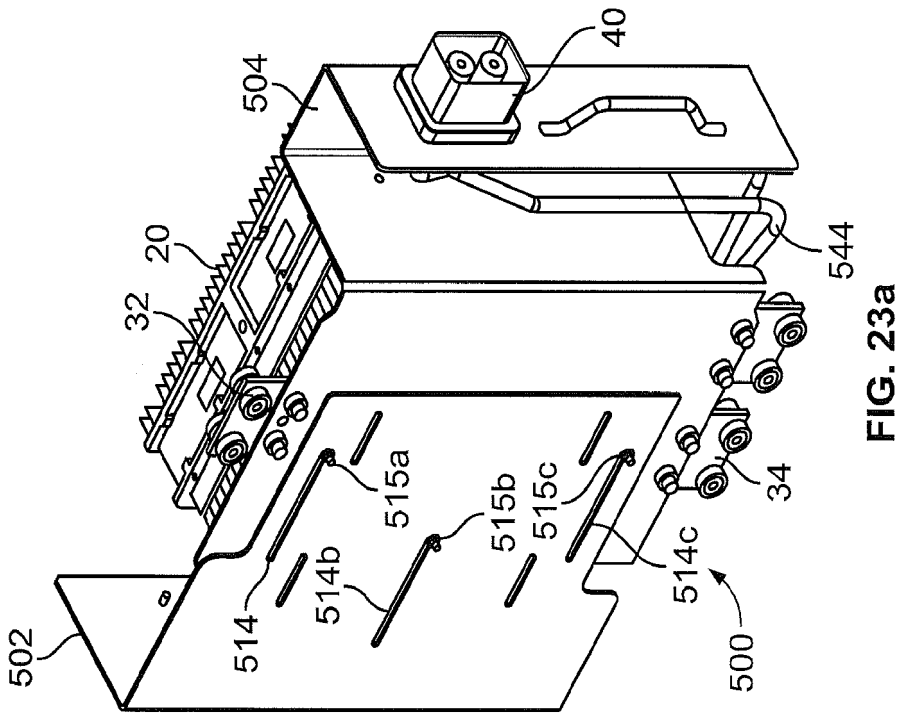

FIG. 23a

REFERENCES CITED IN THE DESCRIPTION

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