



(51) International Patent Classification:

H01Q 1/24 (2006.01) *H01R* 13/514 (2006.01)
H04W 88/08 (2009.01) *H01R* 13/627 (2006.01)

(21) International Application Number:

PCT/US2016/013232

(22) International Filing Date:

13 January 2016 (13.01.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/102,873 13 January 2015 (13.01.2015) US

(71) Applicant: COMMSCOPE TECHNOLOGIES LLC
[US/US]; 1100 Commscope Place, SE, Hickory, NC 28602 (US).

(72) Inventors: DICKERSON, Calvin, J.; 2412 Glenbrook Meadows Drive, Garland, TX 75040 (US). TRAN, Duy, Khanh; 7002 Stafford Drive, Rowlett, TX 75089-2146 (US). BONCZYK, Michael, F.; 909 North Church Street, Anna, TX 75409 (US). OREM, John, W.; 4 Heritage Circle, Allen, TX 75002 (US). BRADLEY, Eddie, Ray; 1360 Hamilton Green, Allen, TX 75013 (US).

(74) Agents: AYERS, D. Randal et al.; Myers Bigel & Sibley, P.A., P.O. Box 37428, Raleigh, North Carolina 27627 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: STANDARD ANTENNA INTERFACE CONNECTOR ASSEMBLY

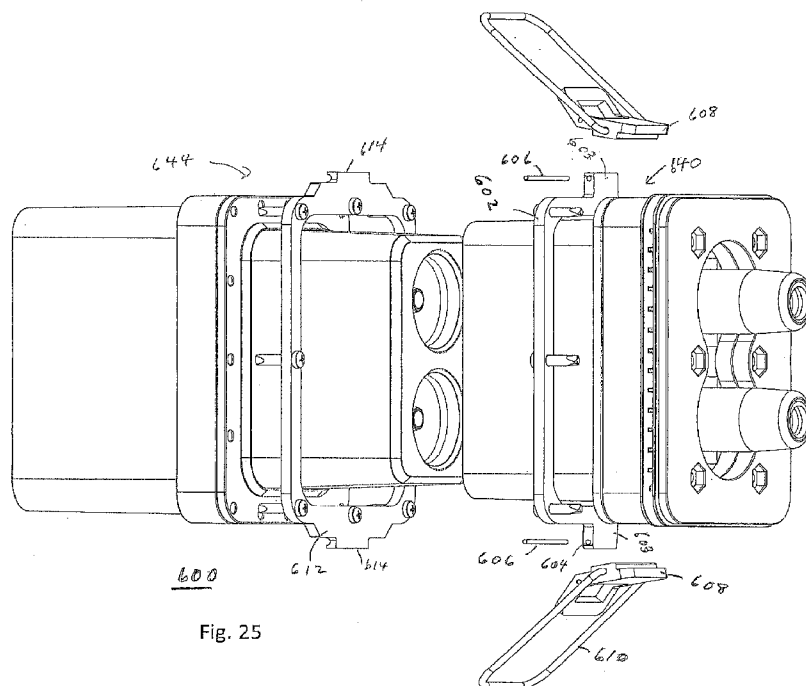


Fig. 25

(57) Abstract: A standard RF connector assembly for wireless communications antenna system. The RF connector assembly includes a first connector housing incorporating an RF connector, the housing including a first latch plate attached to the housing and has at least two toggle mounts. A toggle is attached to each toggle mount and each toggle includes a metal band pivotably attached to the toggle. A second connector housing incorporating a second RF connector includes a second latch plate attached to the second housing and has at least two tabs configured to be engaged by the metal bands to secure the first and second housing into latched engagement with each other.

WO 2016/115240 A1



Published:

— *with international search report (Art. 21(3))*

STANDARD ANTENNA INTERFACE CONNECTOR ASSEMBLY

This application is a continuation in part of and claims priority to U.S. Application Serial No. 14/321,310, filed July 1, 2014; U.S. Provisional Application Serial No. 62/102,873, filed January 13, 2015. The disclosure of these applications are incorporated by reference.

BACKGROUND

[0001] The present inventions relate generally to wireless communications. In particular, they relate to improvements in wireless base station antenna and radio deployments.

[0002] 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.

[0003] 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.

[0004] 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.

[0005] 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. In addition, once connected connectors may partially or fully disengage due to vibrations, thermal cycling, etc. Thus, reliable, secure latching of the connections is desirable.

[0006] Solutions have been proposed to solve the limitations of the current system. For example, U.S. Application Serial No. 14/137,059 (which is incorporated by reference) describes a Standard Interface having a linear engagement structure and capacitive RF connectors. U.S. Application Serial No. 14/321,310 (which is incorporated by reference) describes improvements to the capacitive connector blocks and adapter kits for adapting existing tower-mounted equipment to be used with a Standard Interface. While such solutions are marked improvements over conventional remote radio head installations, some applications may require greater reliability of the RF signal path. The RF connector latch assembly described herein may be combined with any of the embodiments of the incorporated patent applications to provide improved reliability.

SUMMARY OF THE INVENTION

[0007] An RF connector assembly according to one aspect of the invention includes a first connector housing having a first RF connector disposed within the housing and a first latch plate attached to the housing having at least two toggle mounts and a respective toggle attached to each respective toggle mount and each respective toggle including a band pivotally attached to

the toggle. A second connector housing includes a second RF connector disposed within the housing and configured to mate with the first RF connector. A second latch plate is attached to the second connector housing and includes at least two tabs configured to be engaged by the bands to secure the first and second connector housing in latched engagement with each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a perspective view of a first example of the present invention.

[0009] Figure 2 is a side view of another aspect according to the first example of the present invention.

[00010] Figure 3 is an end view of a remote radio head adapted for use in the first example of the present invention.

[00011] Figure 4 is a side view of a remote radio head adapted for use in the first example of the present invention.

[00012] Figure 5 is a perspective view of a remote radio head connector adapted for use in the first example of the present invention.

[00013] Figure 6 is a perspective view of an antenna connector adapted for use in the first example of the present invention.

[00014] 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.

[00015] Figure 8 is a perspective view of a diplexer connector adapted for use in the first example of the present invention.

[00016] Figures 9a and 9b are perspective views of a standard antenna interface according to a second example of the present invention.

[00017] Figures 10a and 10b are side views of the standard antenna interface of the second example.

[00018] Figure 11 is a perspective view of a third example of the present invention.

[00019] Figure 12 is a perspective view of a standard antenna interface according to the third example of the present invention.

[00020] Figure 13 is a perspective view of the third example of the present invention with additional components.

[00021] Figure 14 is a perspective view of the third example of the present invention with additional components.

[00022] Figures 15a-15c illustrate a combination of features from the second and third examples of the present invention.

[00023] Figures 16a-16b illustrate an antenna adapted for use in another example of the present invention.

[00024] Figures 17a-17c illustrate a remote radio head adapted for use in another example of the present invention.

[00025] Figure 18 is an exploded view of the RRH Connector illustrated in Figure 5.

[00026] Figure 19 is an exploded view of the RF Connector shown in Figure 6.

[00027] Figures 20 is a perspective view of an embodiment of a float gasket installed in an opening of a portion of a panel.

[00028] Figure 21 is a cross section of an embodiment of a float gasket.

[00029] Figures 22a-22b illustrate an embodiment of an adjustable mount assembly that is rear mounted to a remote radio head.

[00030] Figure 23a-23b illustrate an embodiment of an adjustable mount assembly that is side mounted to a remote radio head.

[00031] Figure 24 is a perspective view of a blind mate capacitive RF connector with a latch mechanism according to the present invention.

[00032] Figure 25 is an exploded view of a blind mate capacitive RF connector with a latch mechanism according to the present invention.

[00033] Figure 26 is a side view of a blind mate capacitive RF connector with a latch mechanism according to the present invention.

[00034] Figure 27 is an end view of a blind mate capacitive RF connector with a latch mechanism according to the present invention.

DESCRIPTION OF EXAMPLES OF THE INVENTION

[00035] The present invention is described herein with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will convey the scope of the invention to those skilled in the art.

[00036] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or

addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[00037] Many different embodiments are disclosed herein, in connection with the description and the drawings. It will be understood that it would be unduly repetitious and obfuscating to literally describe and illustrate every combination and subcombination of these embodiments. Accordingly, the present specification, including the drawings, shall be construed to constitute a complete written description of all combinations and sub combinations of the embodiments described herein, and of the manner and process of making and using them, and shall support claims to any such combination or subcombination.

[00038] A Standard Antenna Interface is described herein to overcome the limitations of a traditional RRH and antenna tower top installation. This invention creates a standard antenna interface with a connector latching mechanism that provides a reduced installation time, allows the installer to avoid directly touching/interfacing with the RF electrical path, and creates a PIM free interface. An RF connector latch is provided to improve reliability of the RF signal path.

[00039] The Standard Antenna Interface comprises of a standard interface structure, including antenna mounting brackets and RRH mounting structure, and a RF interconnection 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.

[00040] 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.

[00041] The example illustrated in Figures 1 and 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.

[00042] 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 invention 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, as shown.

[00043] 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.

[00044] 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.

[00045] 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.

[00046] 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.

[00047] When a Diplexer 24 is used, the Diplexer 24 will include two sets of RF Interconnection Modules 44 facing the Remote Radio Heads 20 (See Fig. 8). 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 may include a pair of Upper Low Friction Cars 32 and a pair of Lower Low Friction Cars 34 such as shown in Fig. 8. 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.

[00048] 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.

[00049] 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 an engagement is illustrated in Figures 5 and 6.

[00050] 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 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).

[00051] 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 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., the disclosure of which is hereby incorporated herein by reference in its entirety.

[00052] As can be understood with reference to Figures 7a and 7b, as a connector 80 is inserted into the float plate 70, the fingers 72 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.

[00053] 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).

[00054] 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.

[00055] 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.

[00056] 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.

[00057] 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).

[00058] 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.

[00059] 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 interfaces 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, and the disclosures of which are incorporated by reference.

[00060] Referring to Figures 15a, 15b, and 15c, 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.

[00061] 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.

[00062] 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.

[00063] 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.

[00064] 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.

[00065] 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.

[00066] 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.

[00067] 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 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.

[00068] The present invention is not limited to remote radio heads and antennas. Universal mounting brackets may also be used to mount additional items of tower-mountable equipment.

[00069] 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.

[00070] 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.

[00071] 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.

[00072] Referring to Figures 24-27, an improved blind mate RF connector 600 suitable for the standard antenna interface with a latching structure is illustrated. Referring to Figure 25, a first latch plate 602 is included on a first RF connector 640. The first latch plate 602 includes toggle mounts 603 each with an aperture 604 for inserting a pin 606. Toggles 608 are attached to the first latch plate 602 with pins 606 inserted through the aperture 604. Each toggle 608 also has a band 610, for example, composed of metal or other strong material.

[00073] A second latch plate 612 is included on the second blind mate RF connector 644. The second latch plate 612 includes tabs 614 configured to be engaged by the metal bands 610. The first and second plates 602, 612 are assembled to their respective connector housing with screws.

[00074] The metal band 610 is allowed to pivot on one end and latch the other end when under tension. When the first and second blind mate RF connectors 602, 612 are engaged, the metal band 610 may be hooked on the tab 614 and the toggle 608 may be rotated to the secured position. The toggle 608 rotates past 180 degrees to maintain latch tension. Such latches may be incorporated into any of the blind mate RF connectors illustrated in Figures 1-8, 10-19, and 22-23.

[00075] The latch structure prevents the blind mate RF connectors 640, 644 from disengaging during operation. This includes thermal cycling, vibration and other environmental effects.

[00076] An advantage of the present invention over known connector locking structures is that engagement force is distributed over two latches, improving reliability of the connection. Also, the latches may be disengaged one at a time, and, once disengaged, the latches do not have to be manipulated any further while the blind mate RF connectors are separated. This is

particularly desirable when separating the blind mate RF connectors involves sliding potentially heavy equipment on a cellular base station tower.

[00077] Although embodiments of the present invention have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense and it is intended that the invention be limited only to the extent required by the appended claims and the applicable rules of law.

[00078] The Abstract of the Disclosure is provided to comply with 37 C.F.R. §1.72(b), requiring an abstract that will allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, it can be seen that various features are grouped together in a single embodiment for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter may lie in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

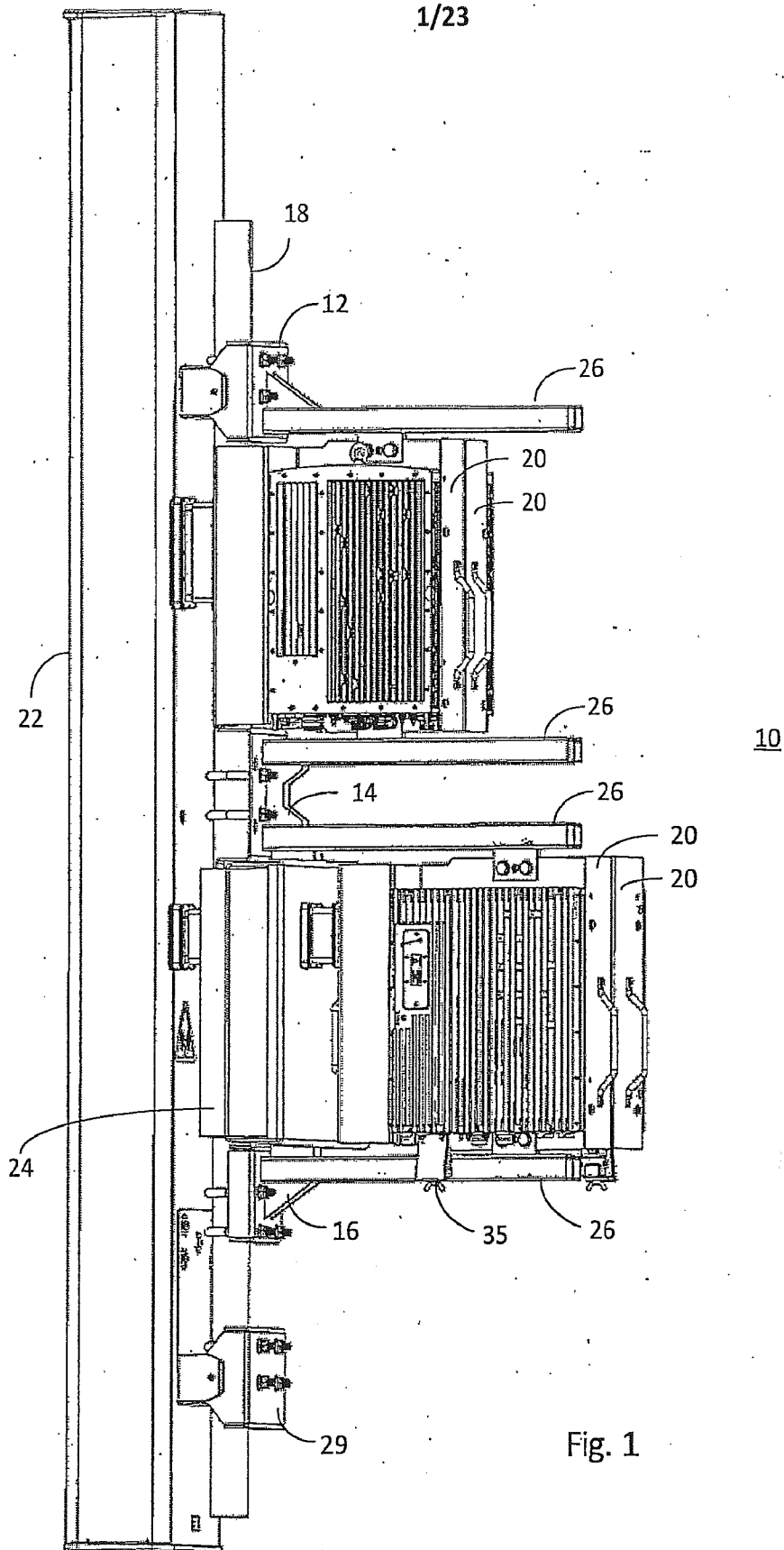
What is claimed is:

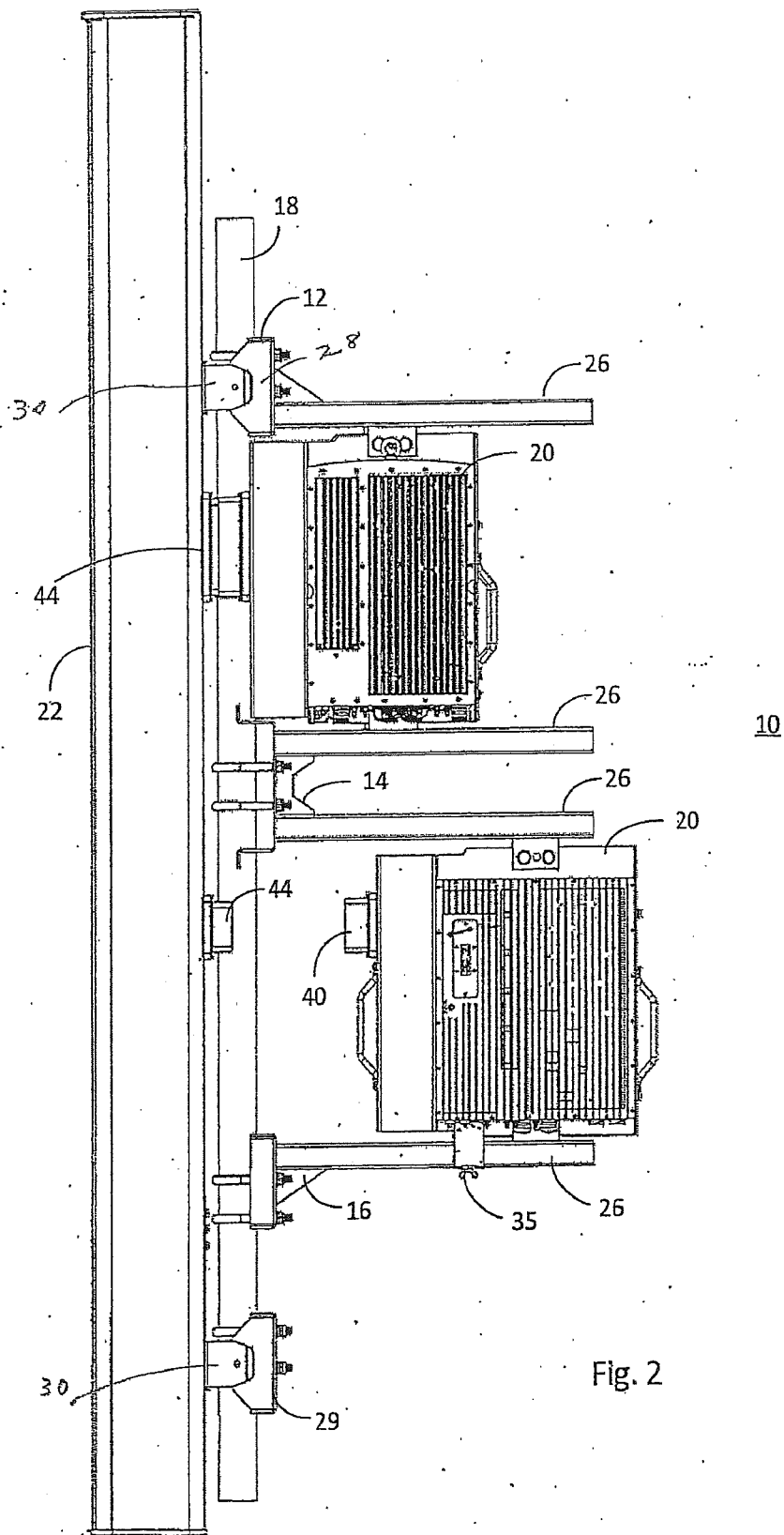
1. An RF connector assembly comprising:
 - a first connector housing including a first RF connector disposed within the housing;
 - a first latch plate, attached to the first housing, having at least two toggle mounts;
 - a toggle attached to each toggle mount and each toggle including a band pivotable attached to the toggle;
 - a second connector housing including a second RF connector disposed within the housing and configured to mate with the first RF connector; and
 - a second latch plate attached to the second housing, the second latch plate including at least two tabs configured to be engaged by the bands, to secure the first and second connector housings in latched engagement with each other.
2. The RF connector assembly of claim 1 wherein each respective toggle is attached to a respective toggle mount of the first latch plate by a pin inserted into an aperture in each respective toggle mount.
3. The RF connector assembly of claim 2 wherein the bands are metal bands.
4. The RF connector assembly of claim 2 wherein each metal band is configured to pivot on one end of the toggle and each respective metal band is configured to securely engage a respective tab of the second latch plate under tension to latch the first and second housings into engagement when the toggles are rotated to a secure position.
5. The RF connector assembly of claim 4 wherein the toggles rotate more than 180° to maintain latch tension.
6. The RF connector assembly of claim 4 wherein one of the connector housings is incorporated into an antenna and antenna mountable equipment incorporate the other

connector housing for engagement between the antenna and the antenna mountable equipment.

7. The RF connector assembly of claim 5 wherein RF connectors comprise a capacitive coupling.
8. The RF connector assembly of claim 5 wherein the RF connectors are blind-mate connectors.
9. The RF connector assembly of claim 7 further comprising a float plate disposed in at least one of the connector housings such that the capacitive coupling is movably disposed in the float plate.
10. The RF connector assembly of claim 8 wherein the blind-mate connectors are coaxial.
11. The RF connector assembly of claim 9 wherein the float plate is mounted to the back of an antenna.
12. The RF connector assembly of claim 1 wherein the first and second connector housings employ an pivoting, axially guided engagement.
13. The RF connector assembly of claim 9 further comprises a float assembly having a float gasket attached at least one of the connector housings to allow the at least one housing to move with respect to a surface on which the at least one housing is mounted.

1/23





3/23

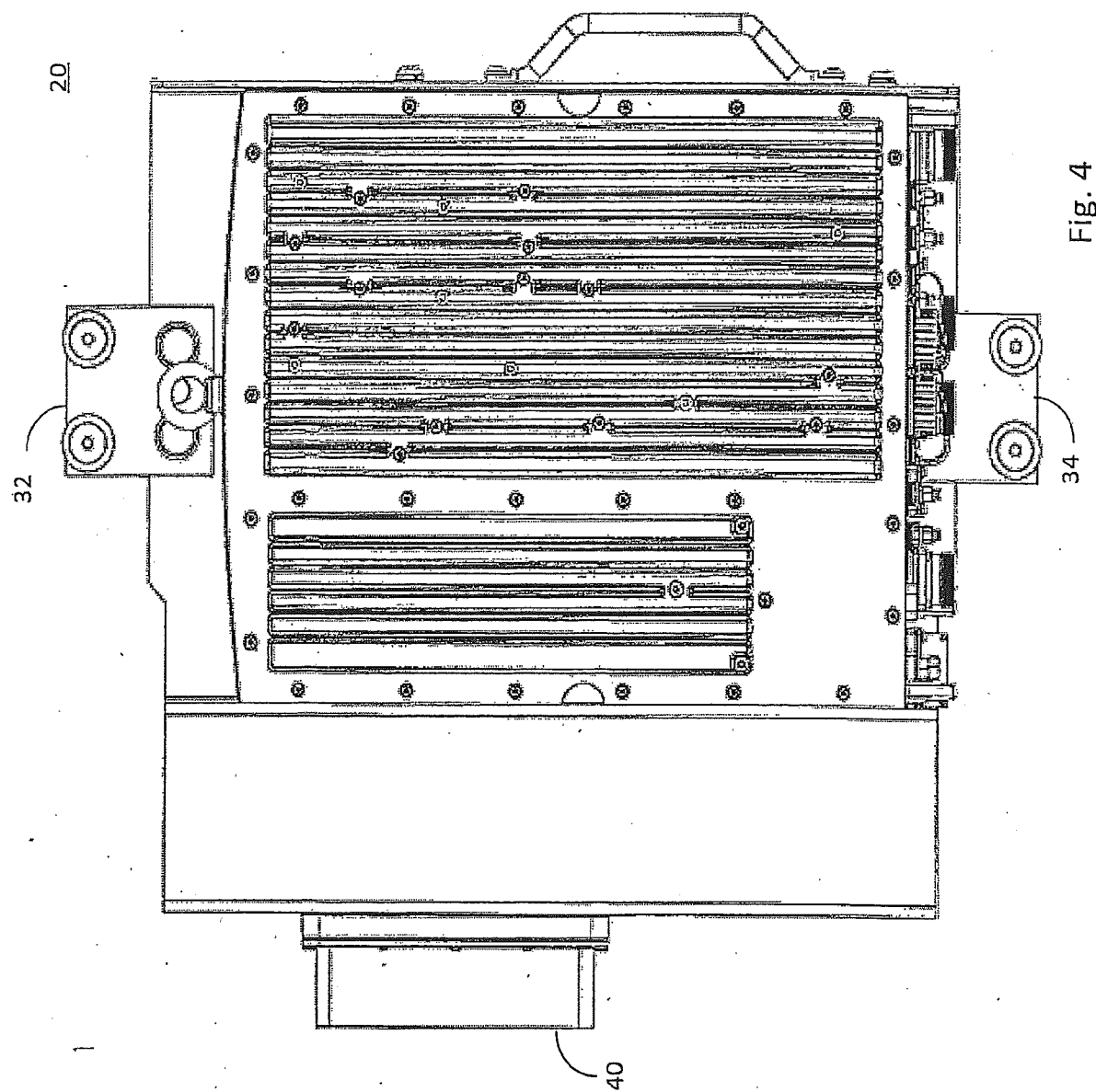


Fig. 4

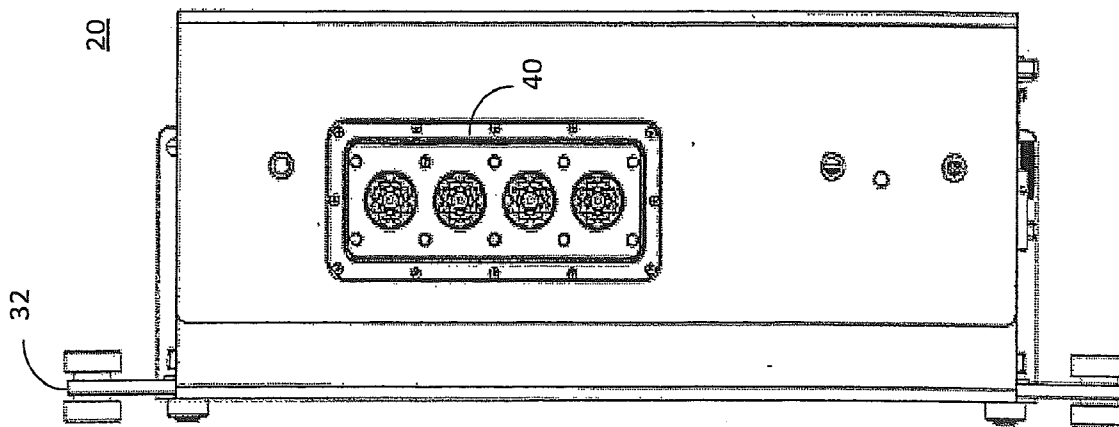


Fig. 3

4/23

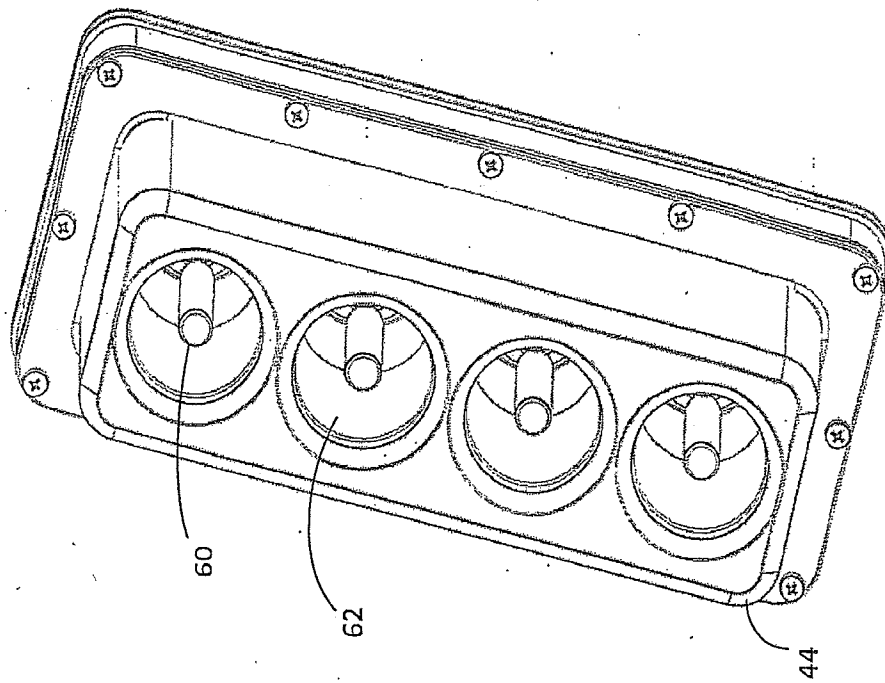


Fig. 6

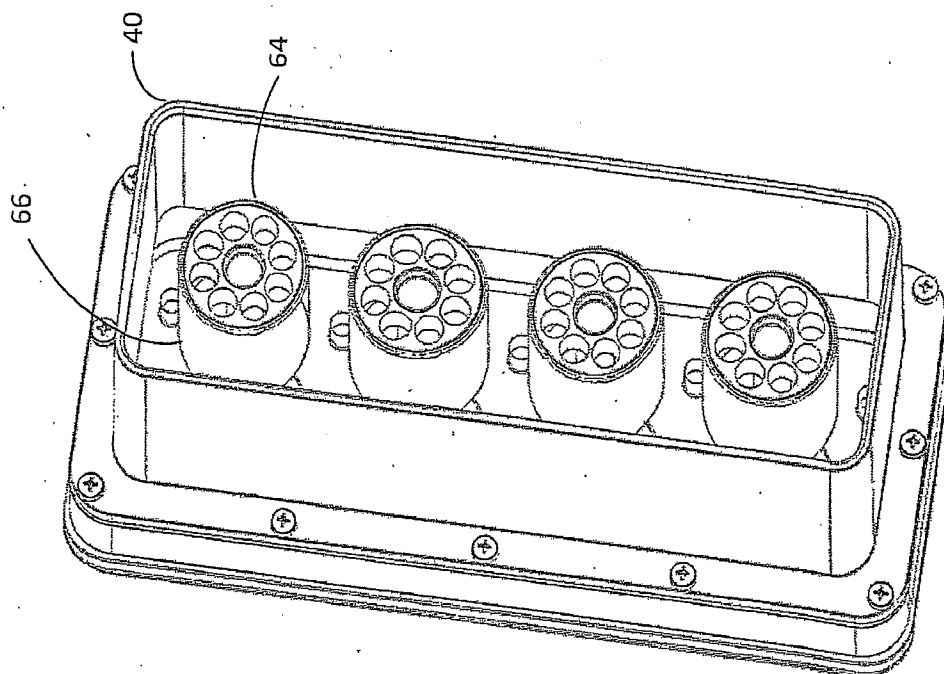


Fig. 5

5/23

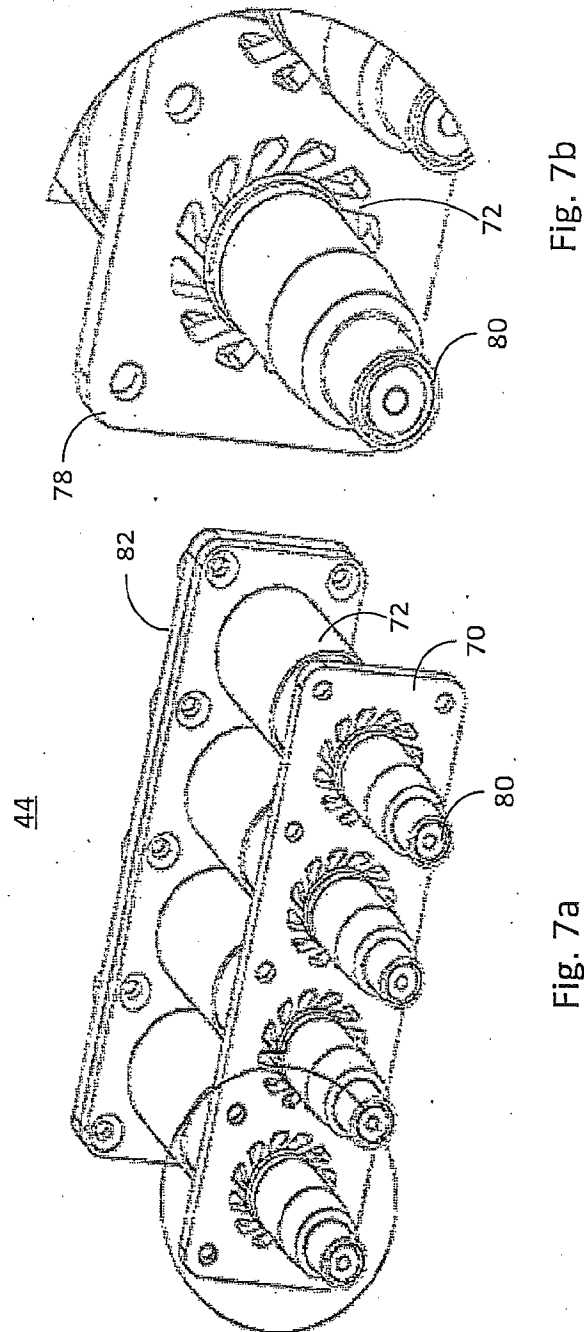


Fig. 7b

Fig. 7a

6/23

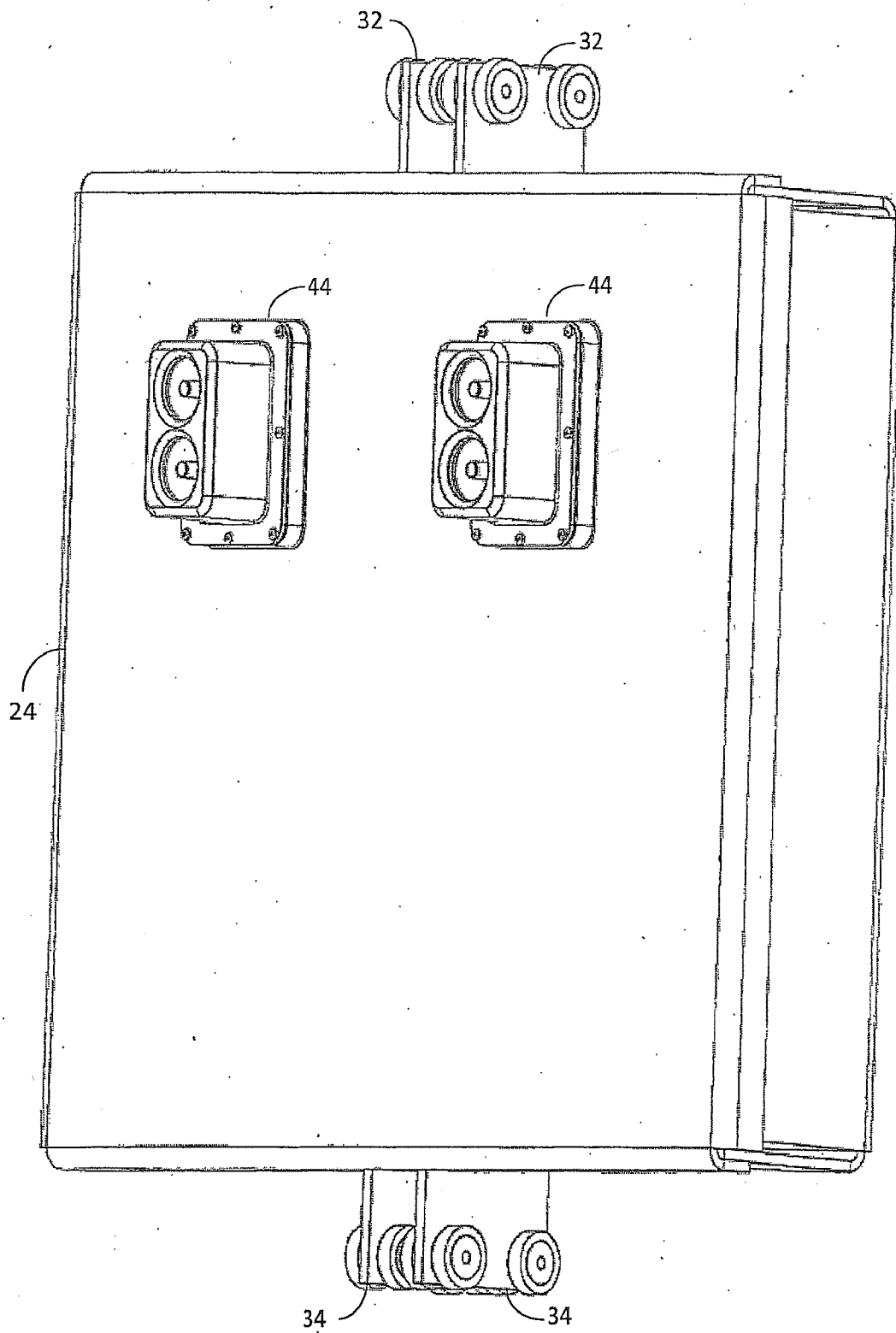


Fig. 8

7/23

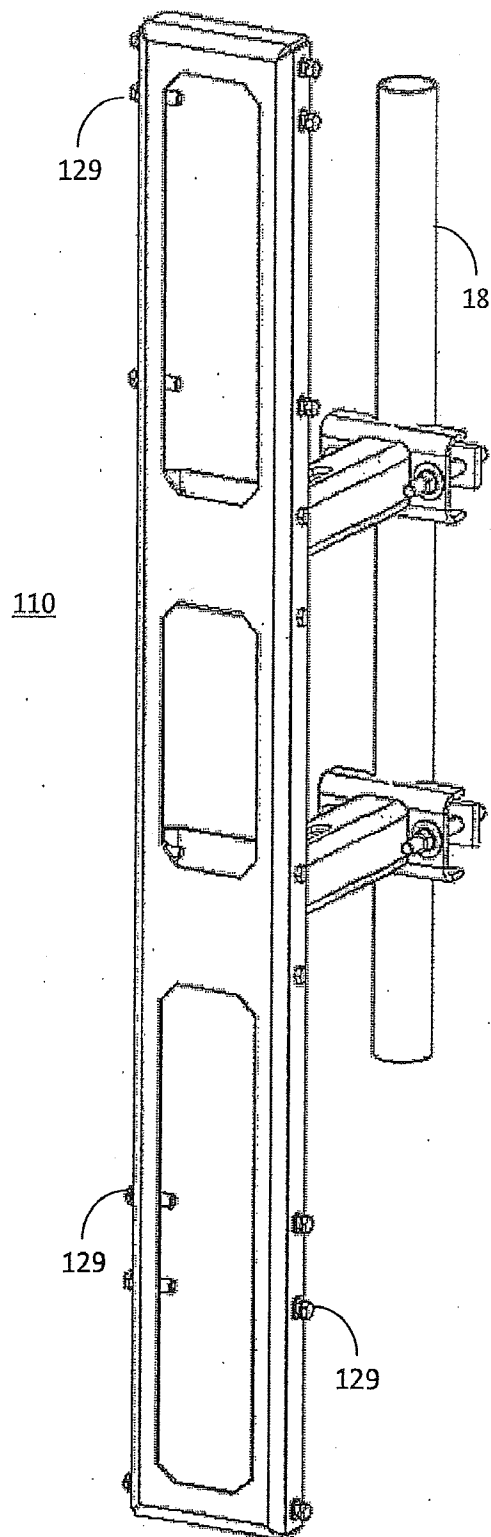


Fig. 9a

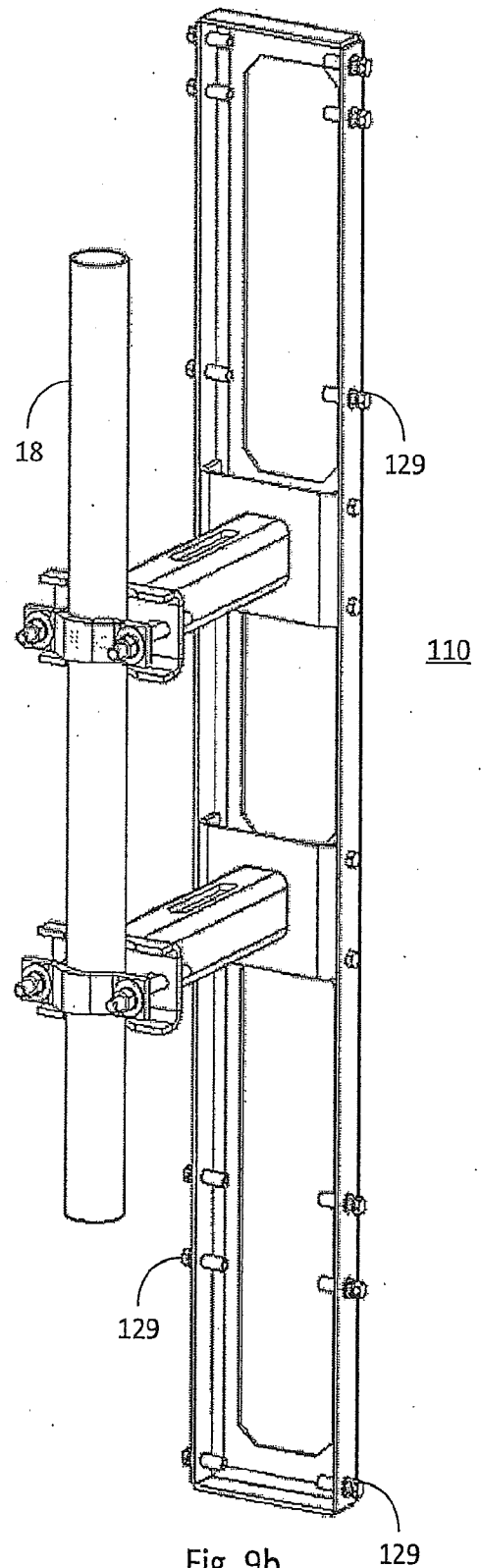


Fig. 9b

8/23

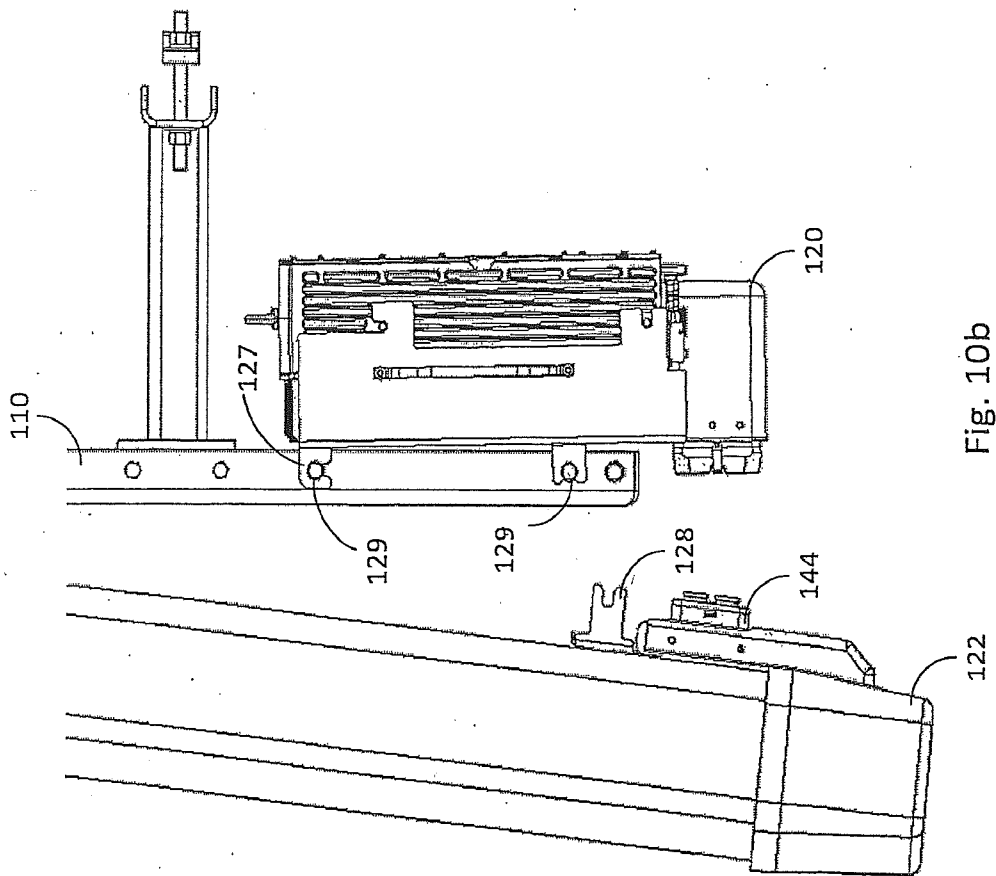


Fig. 10b

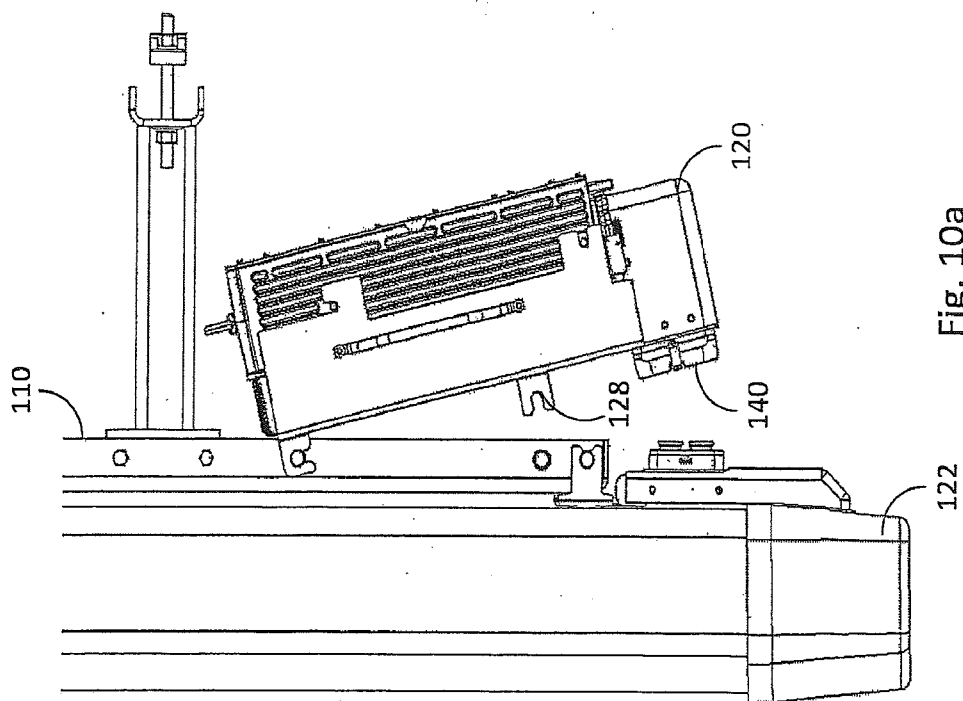


Fig. 10a

9/23

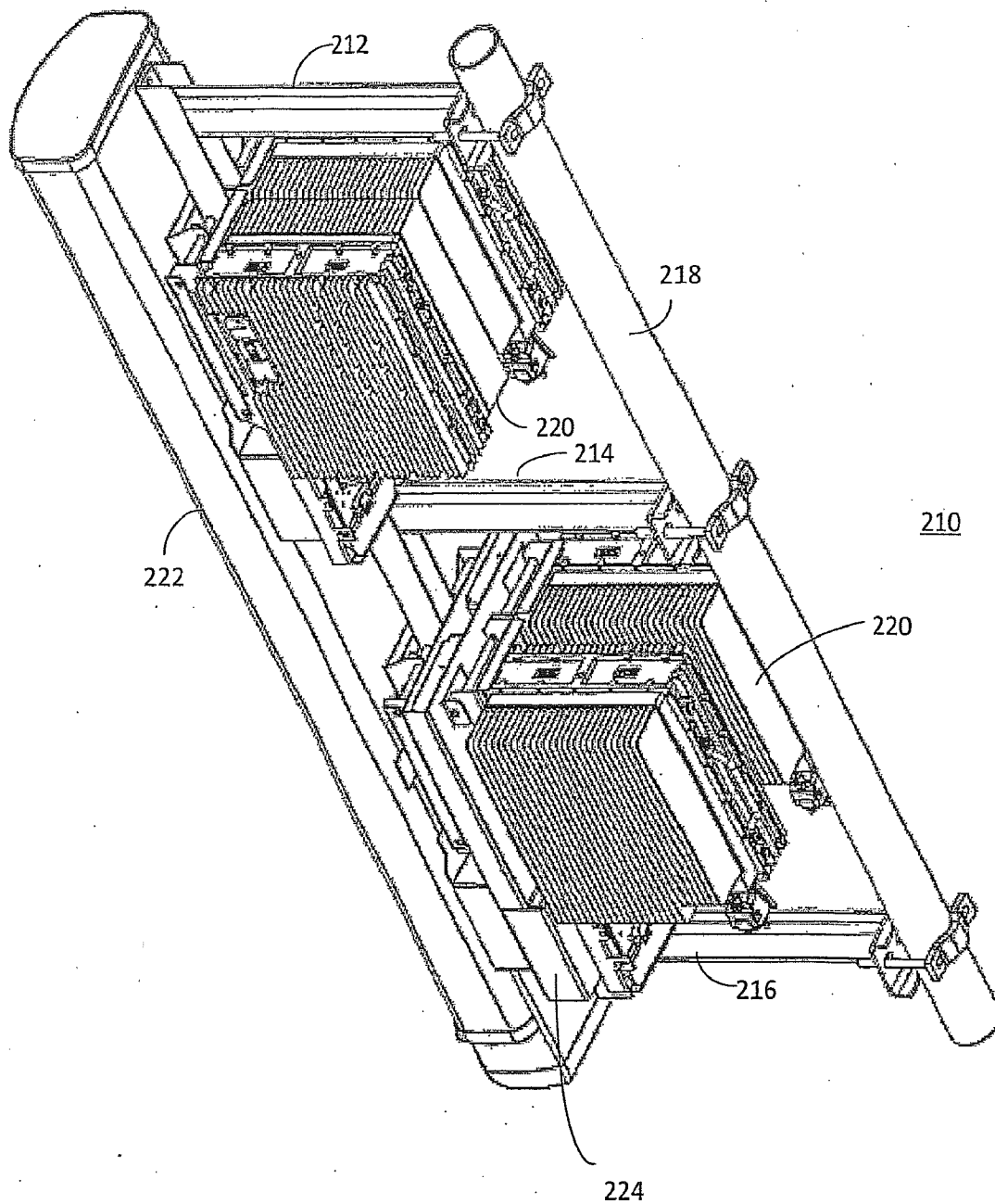


Fig. 11

10/23

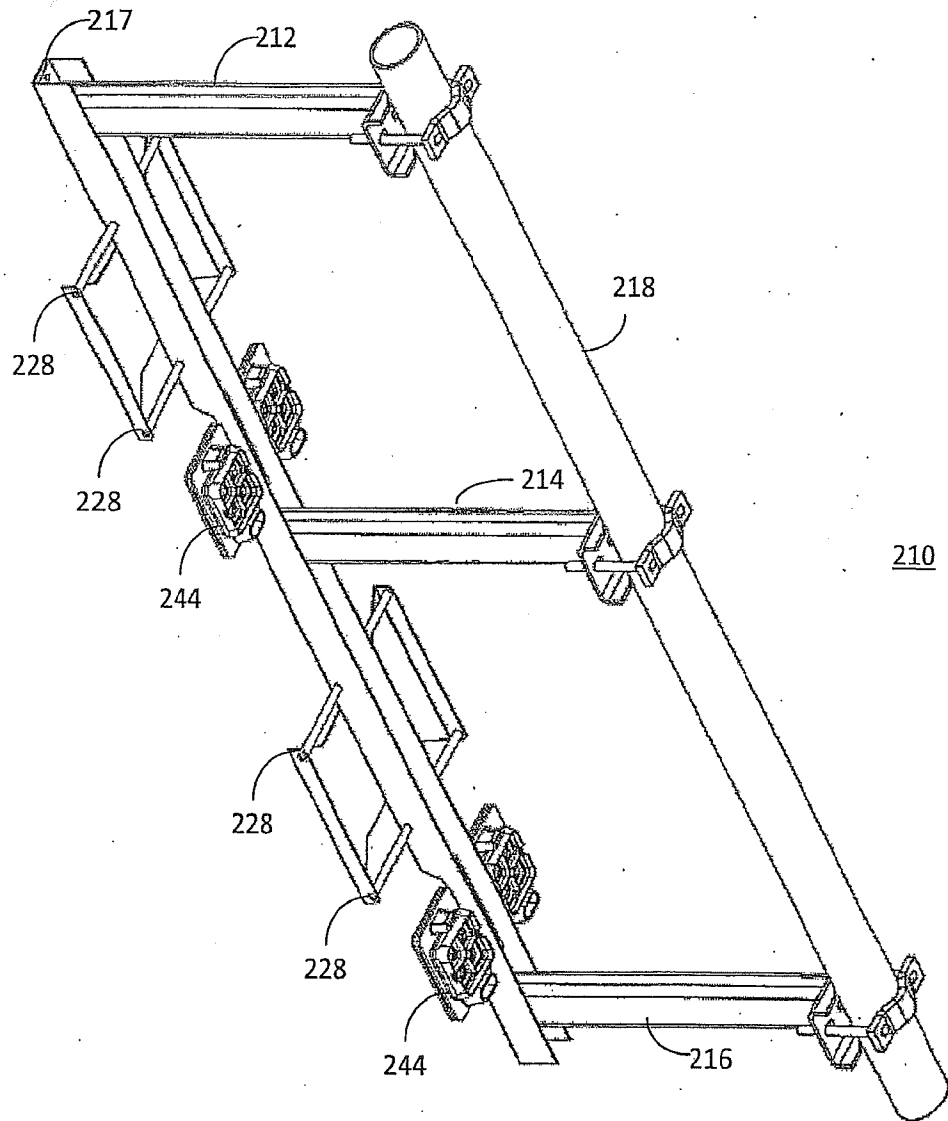


Fig. 12

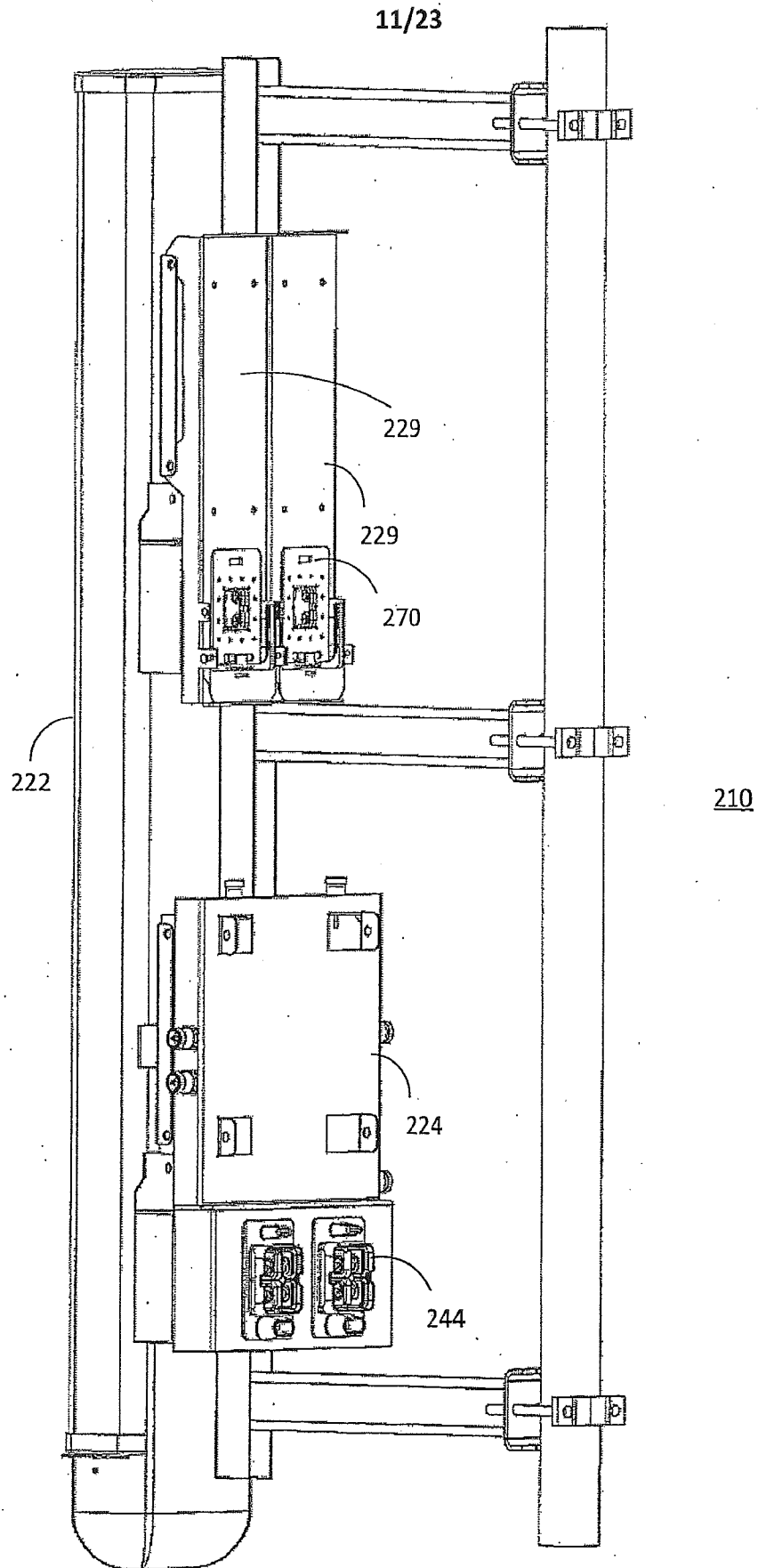


Fig. 13

12/23

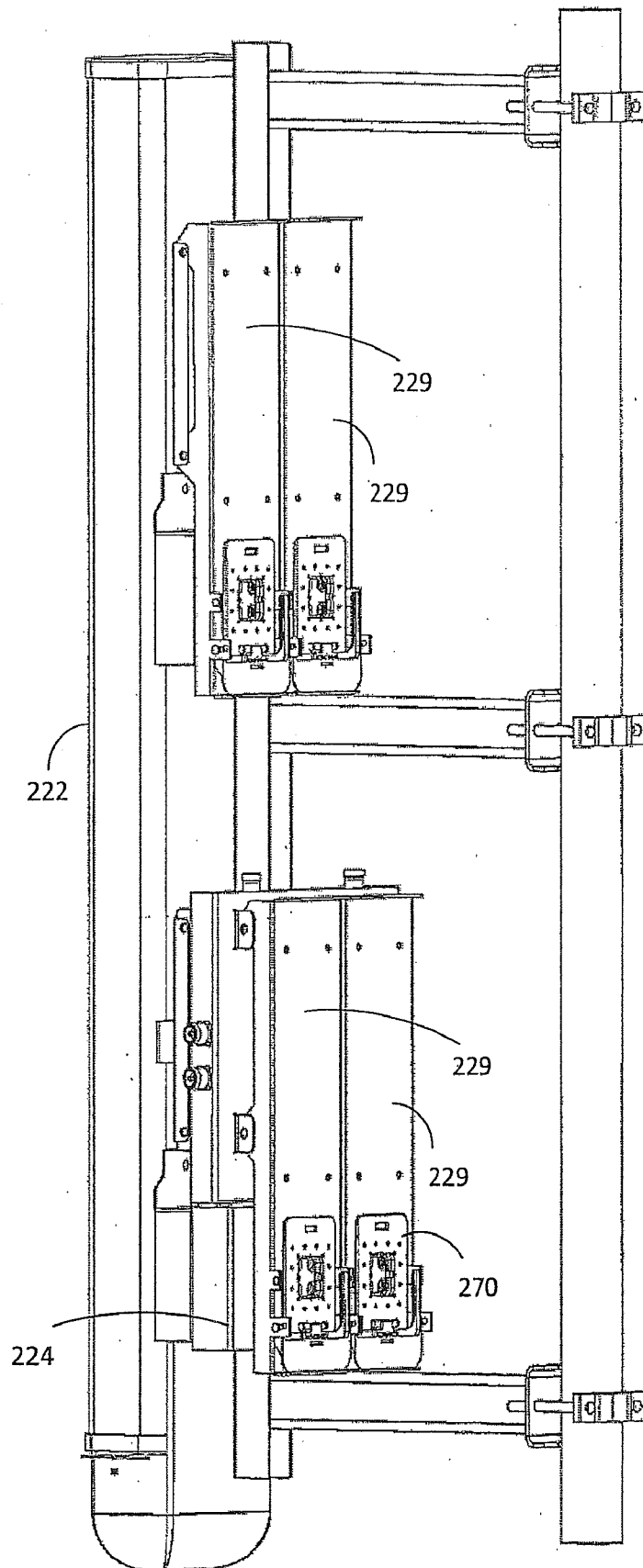


Fig. 14

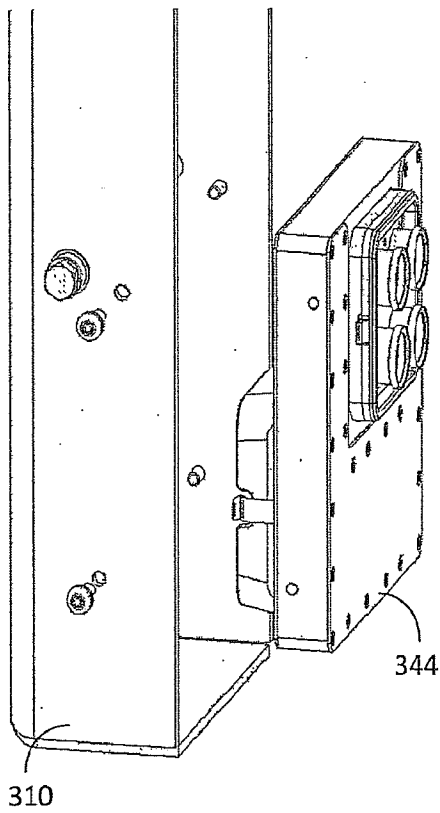


Fig. 15a

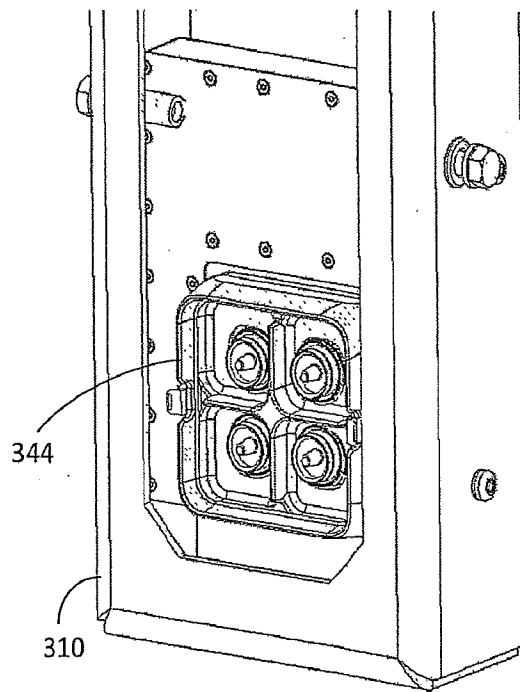


Fig. 15b

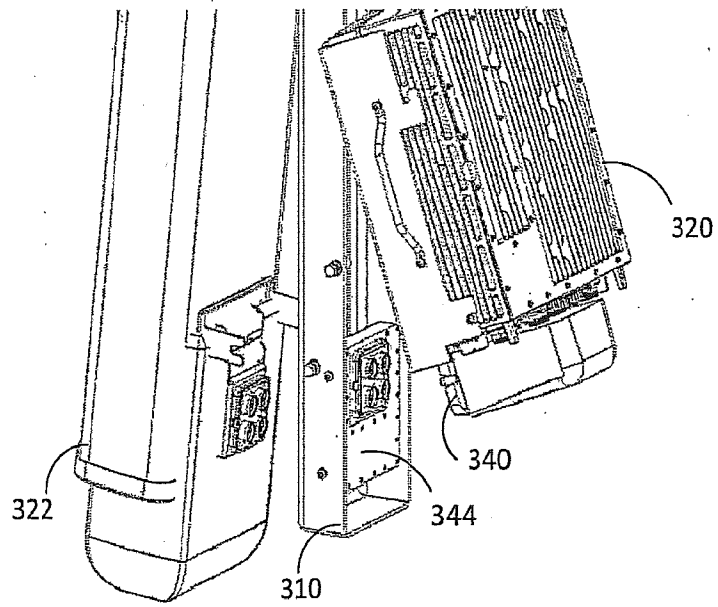


Fig. 15c

14/23

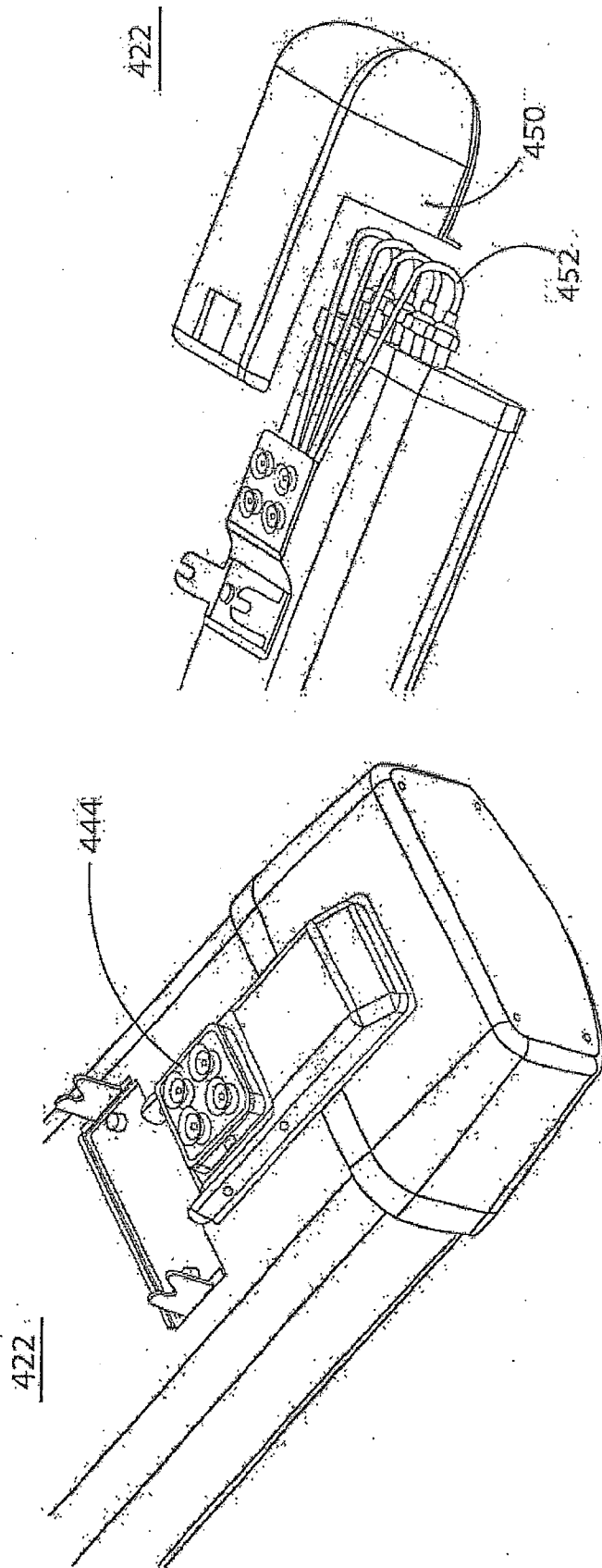


Figure 16b

Figure 16a

15/23

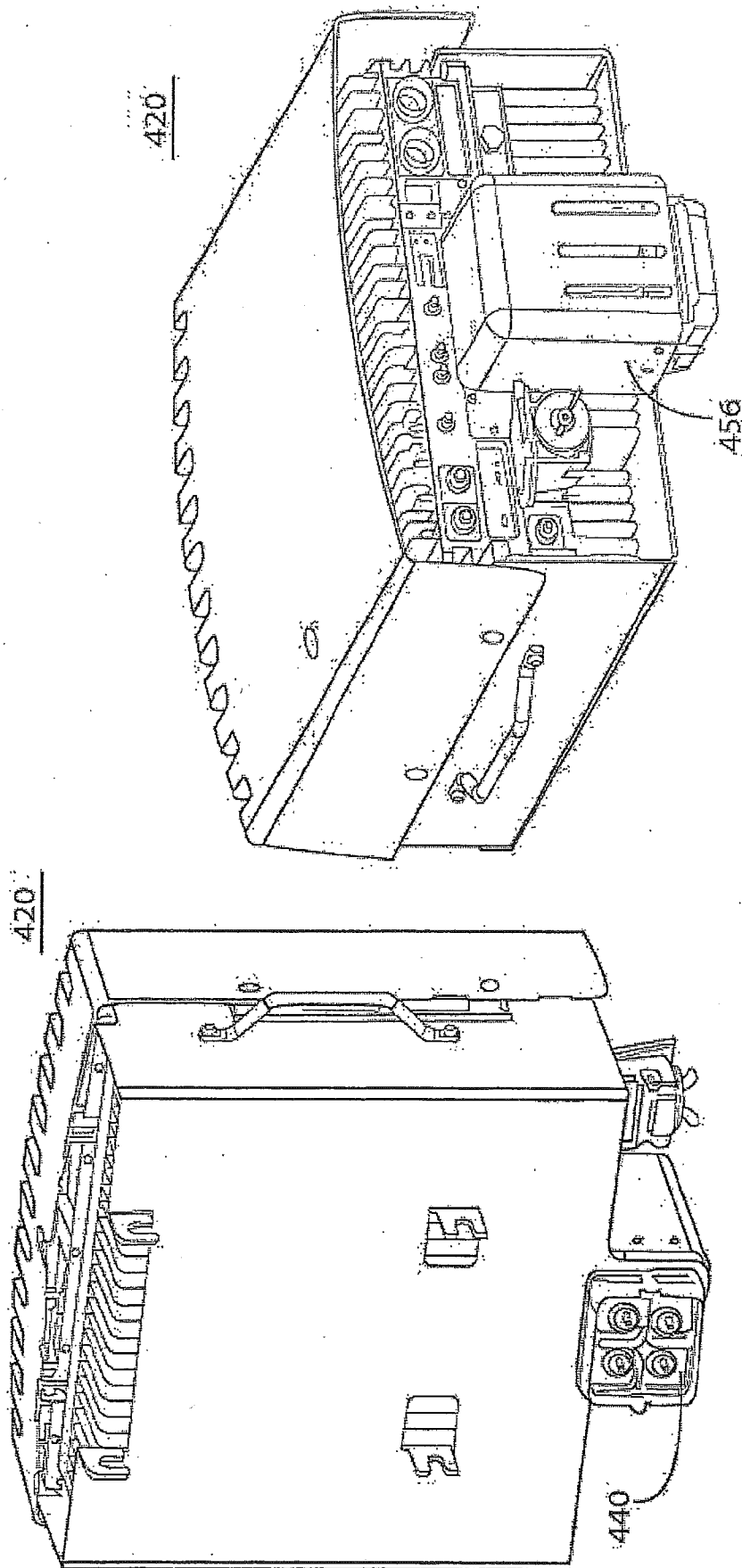


Figure 17b

Figure 17a

16/23

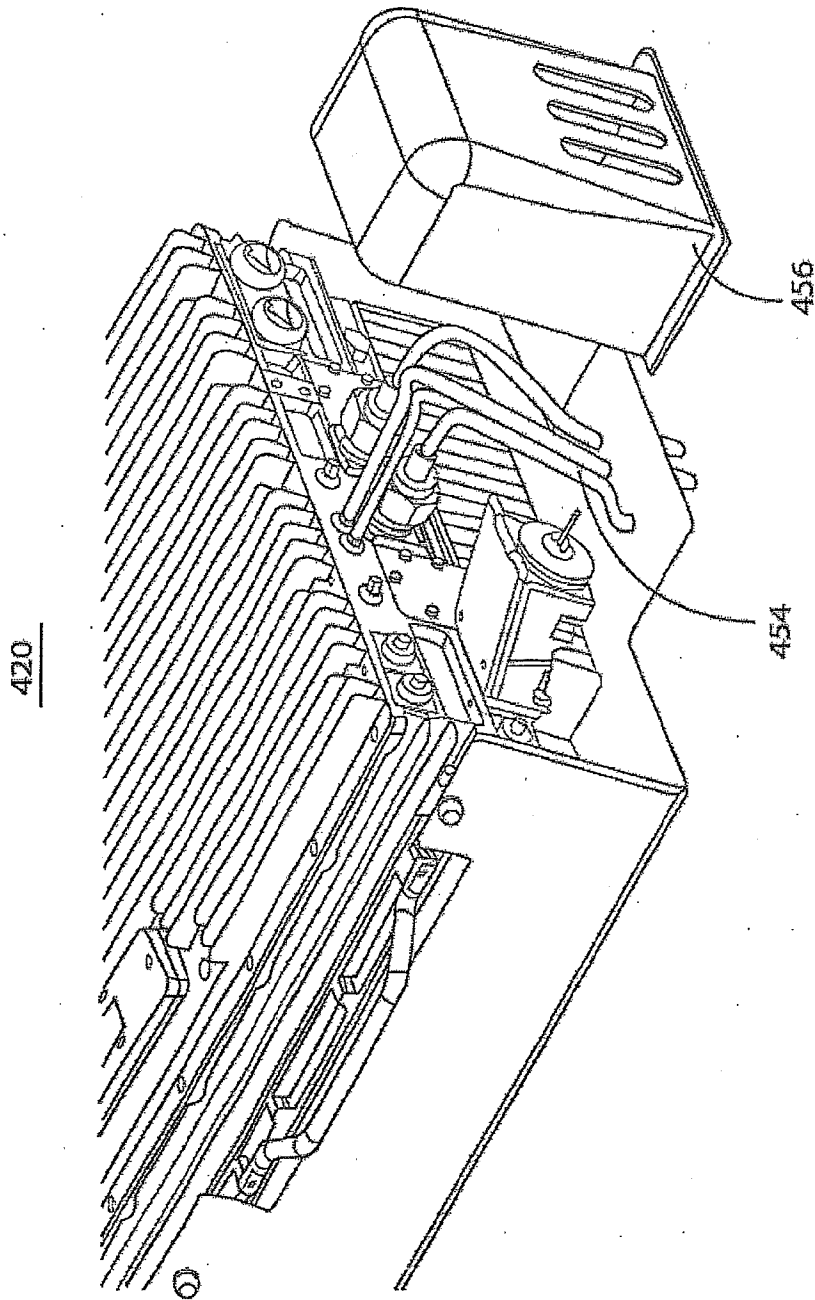


Figure 17c

17/23

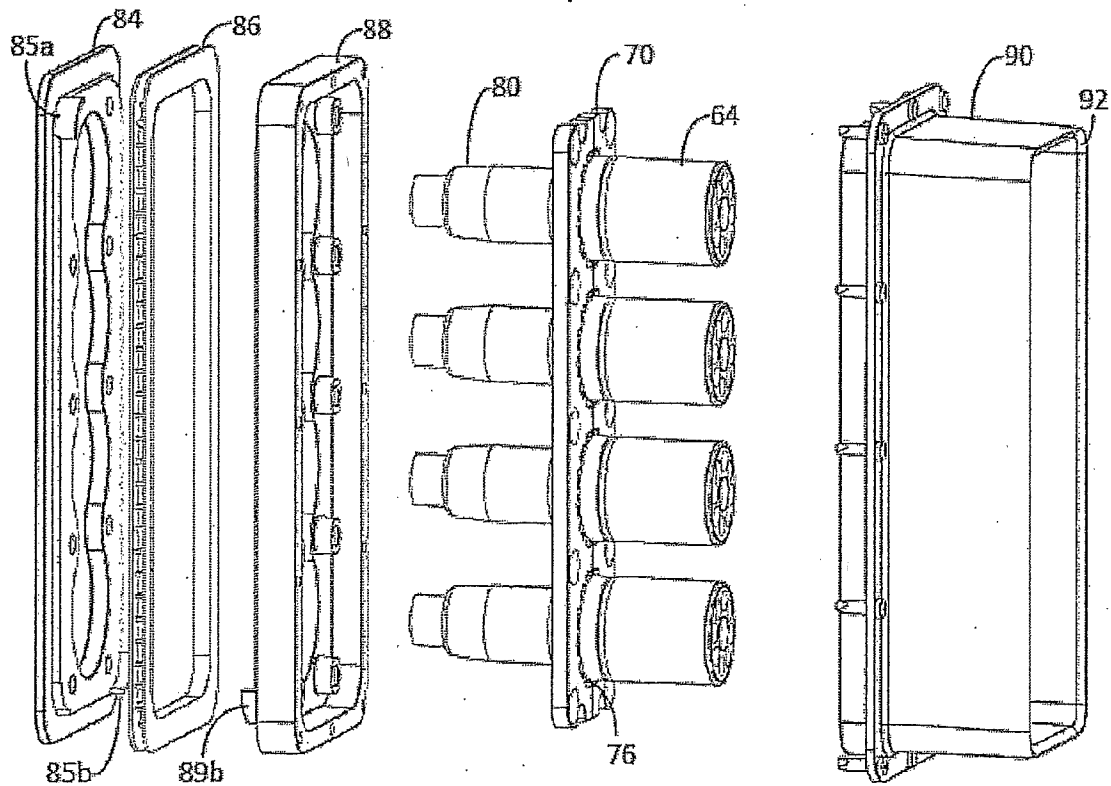


Fig. 18

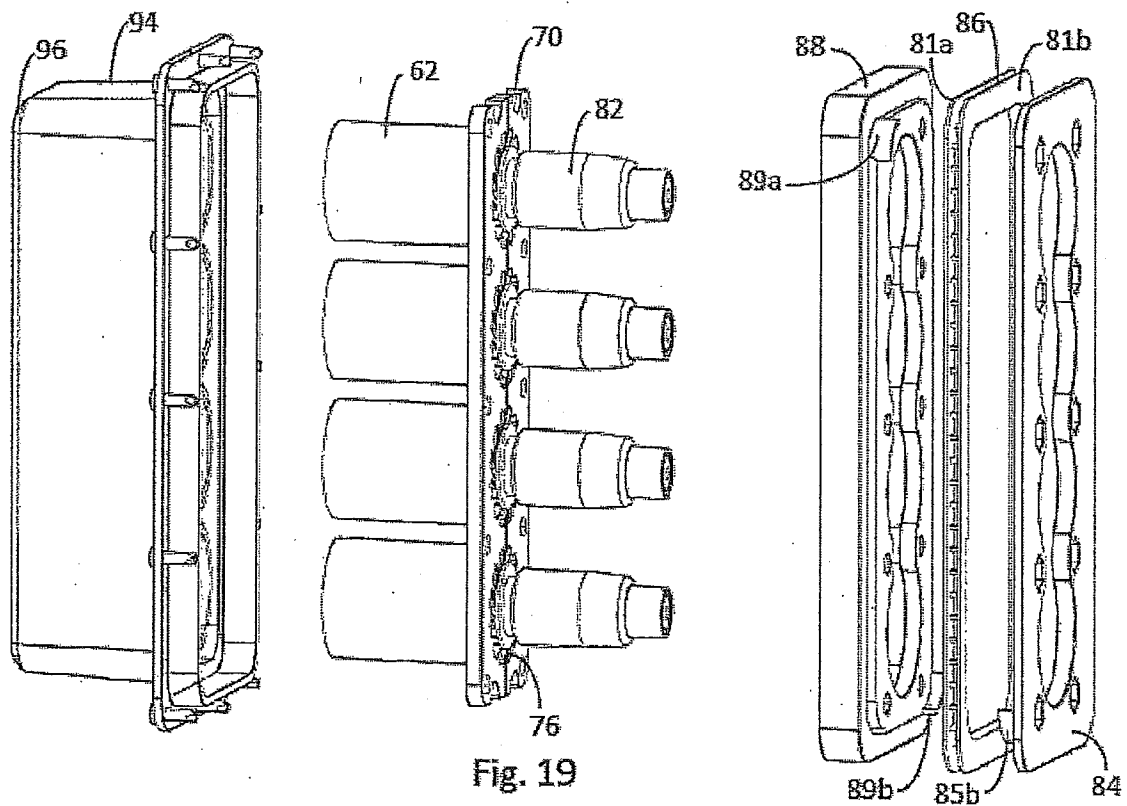


Fig. 19

18/23

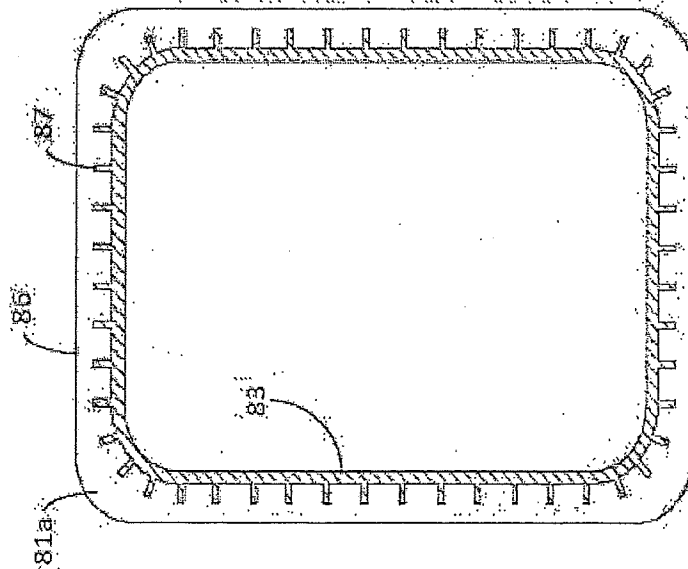


Fig. 21

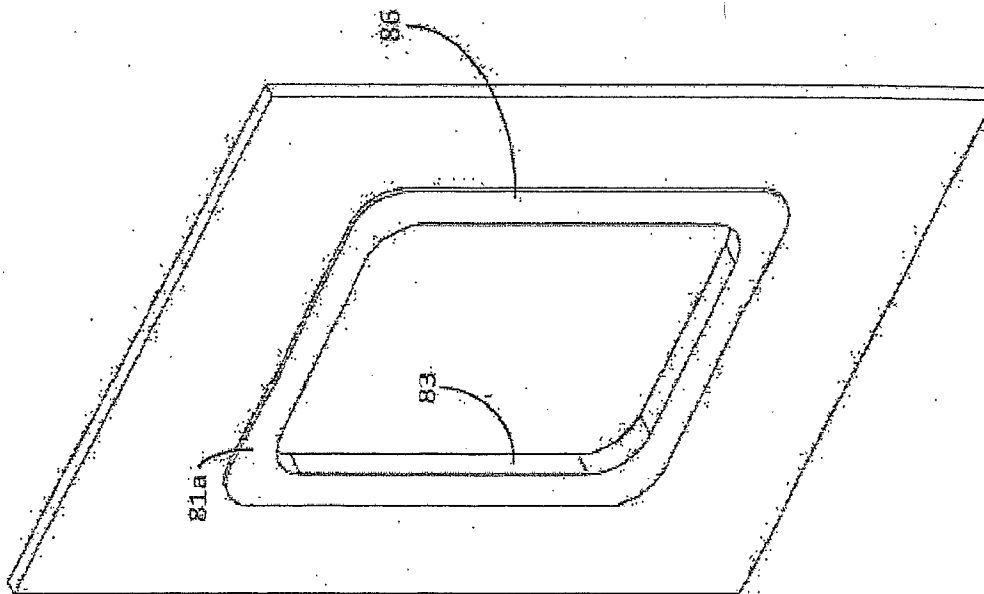


Fig. 20

19/23

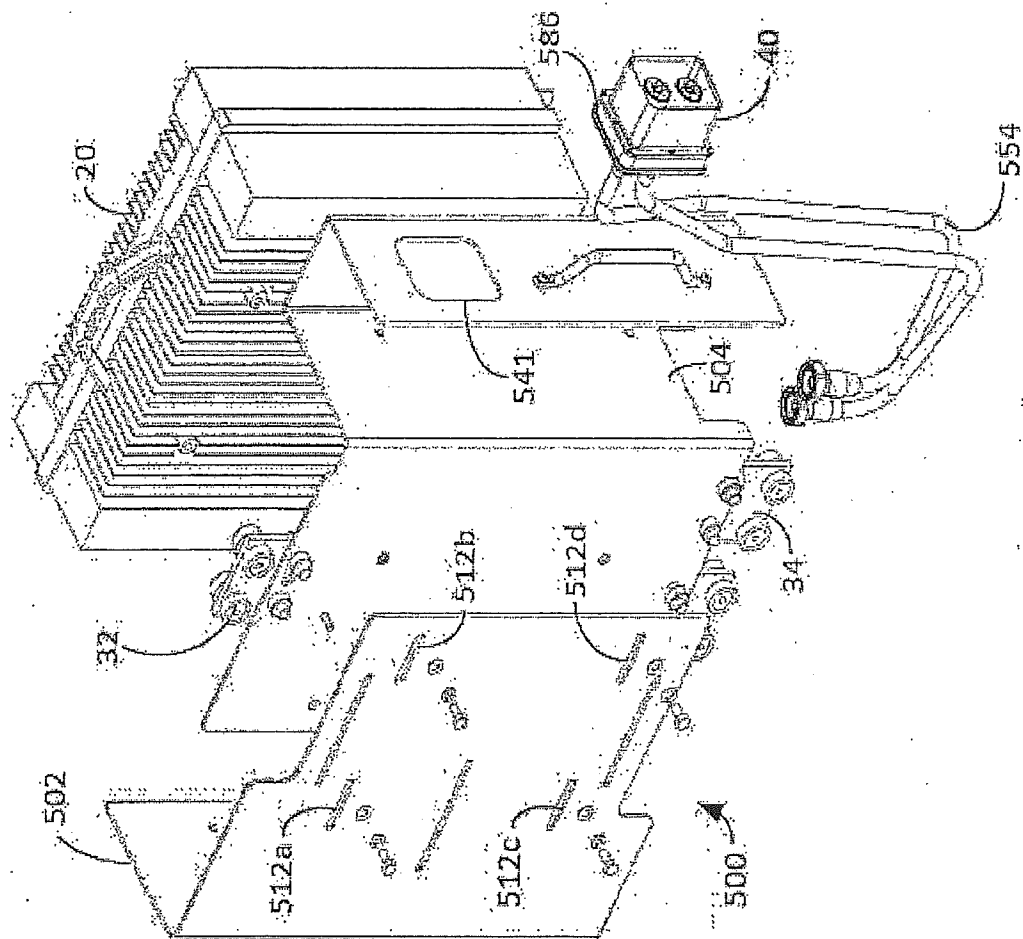


Fig. 22b

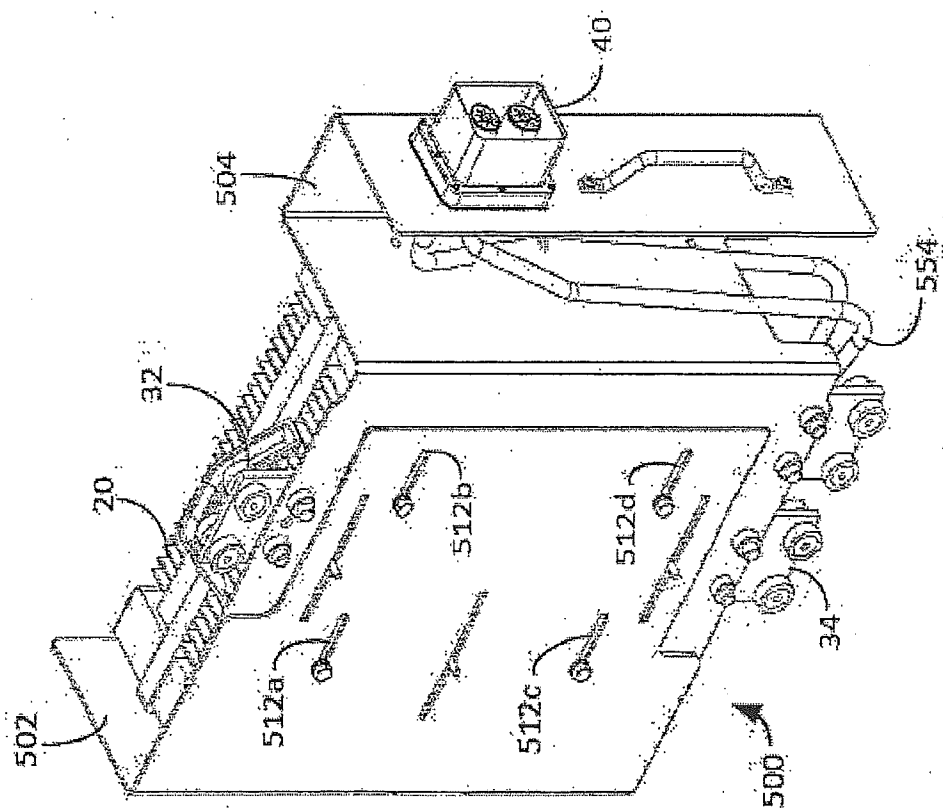


Fig. 22a

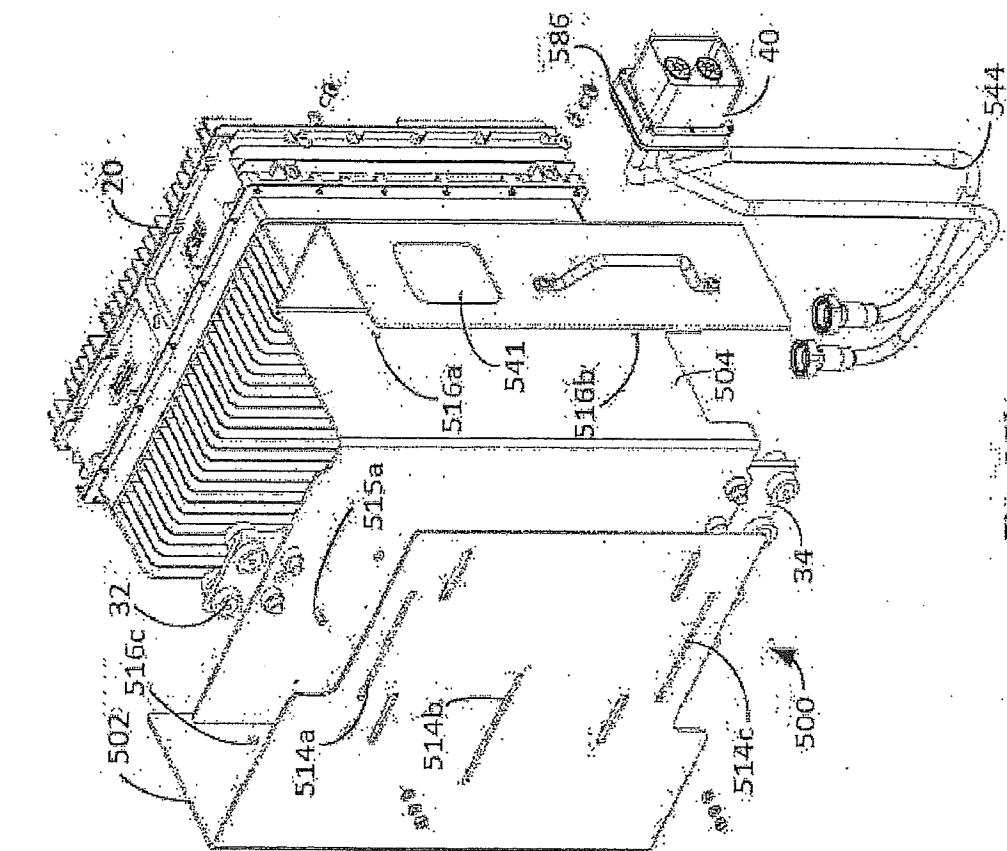


Fig. 23b

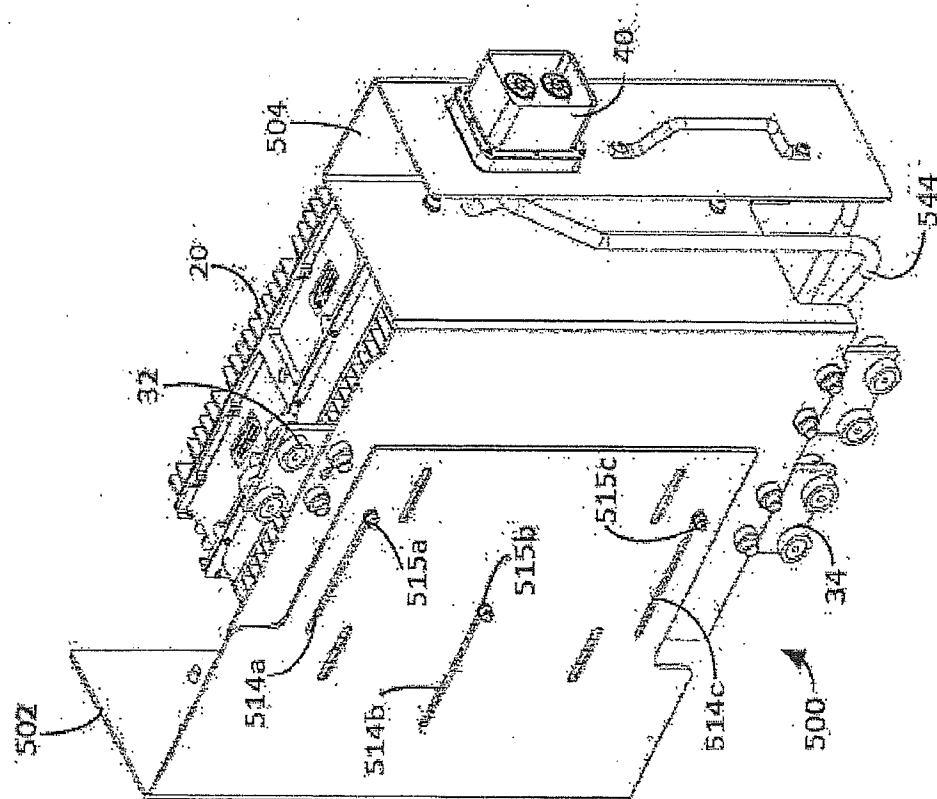


Fig. 23a

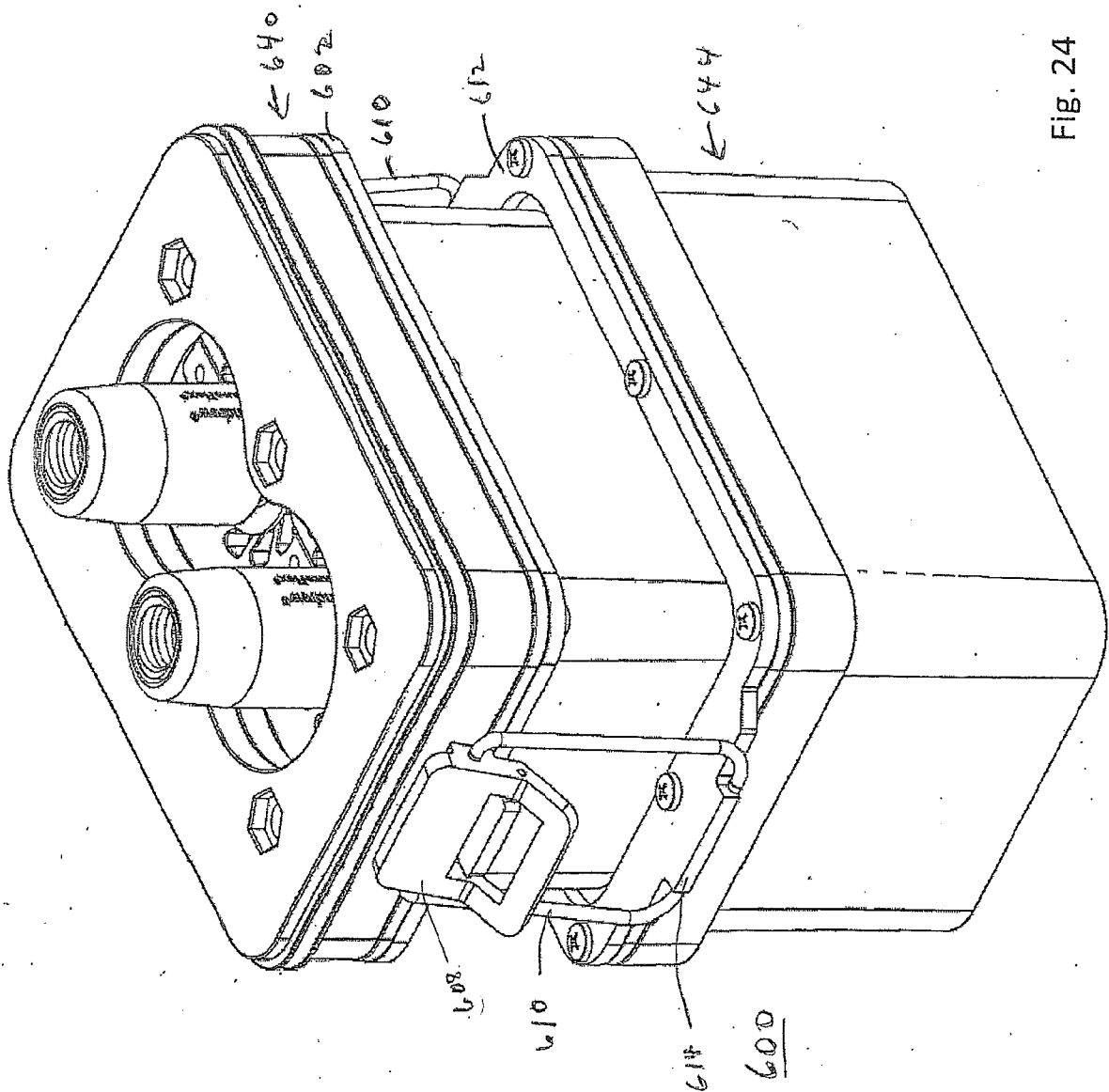
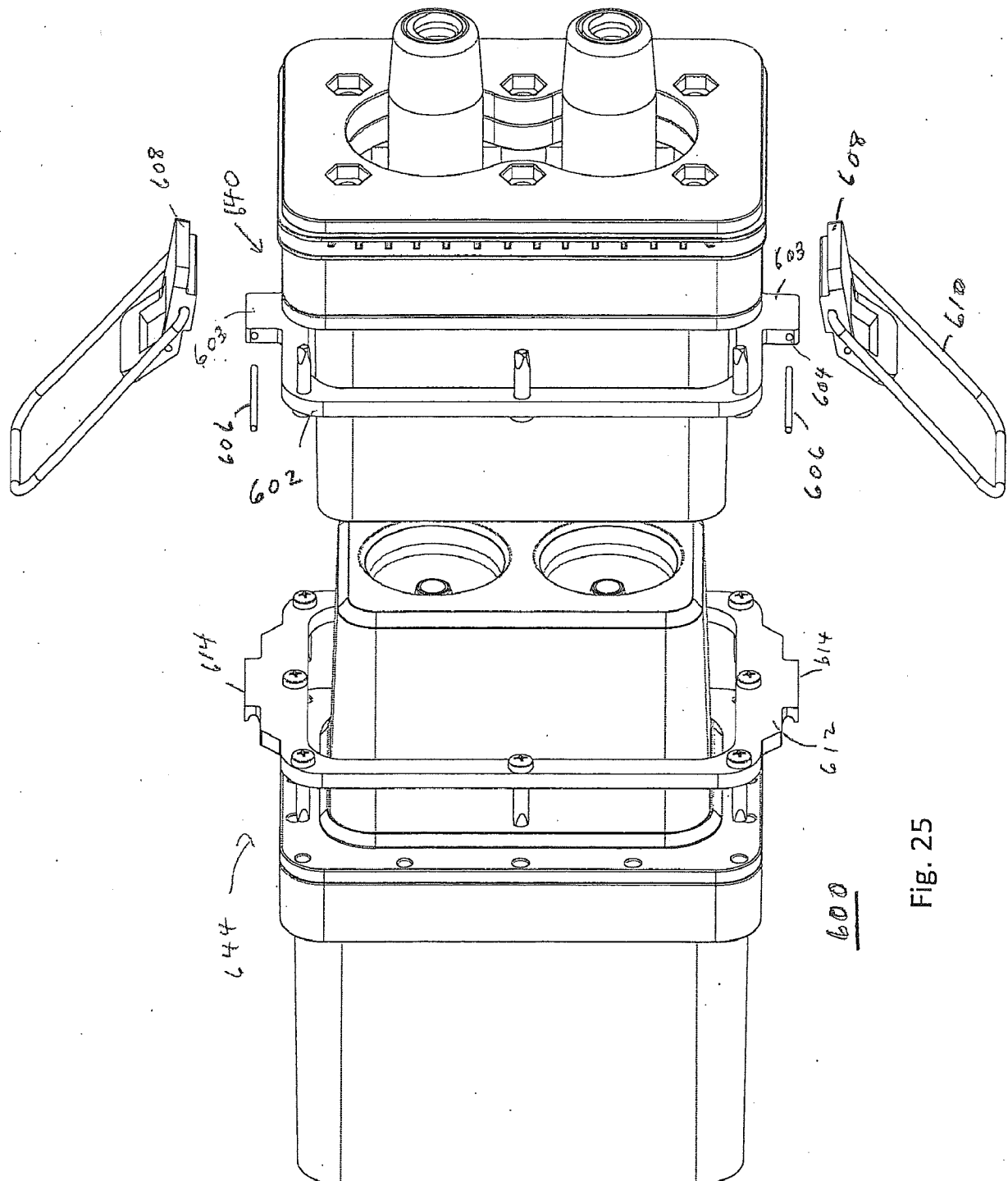


Fig. 24

22/23



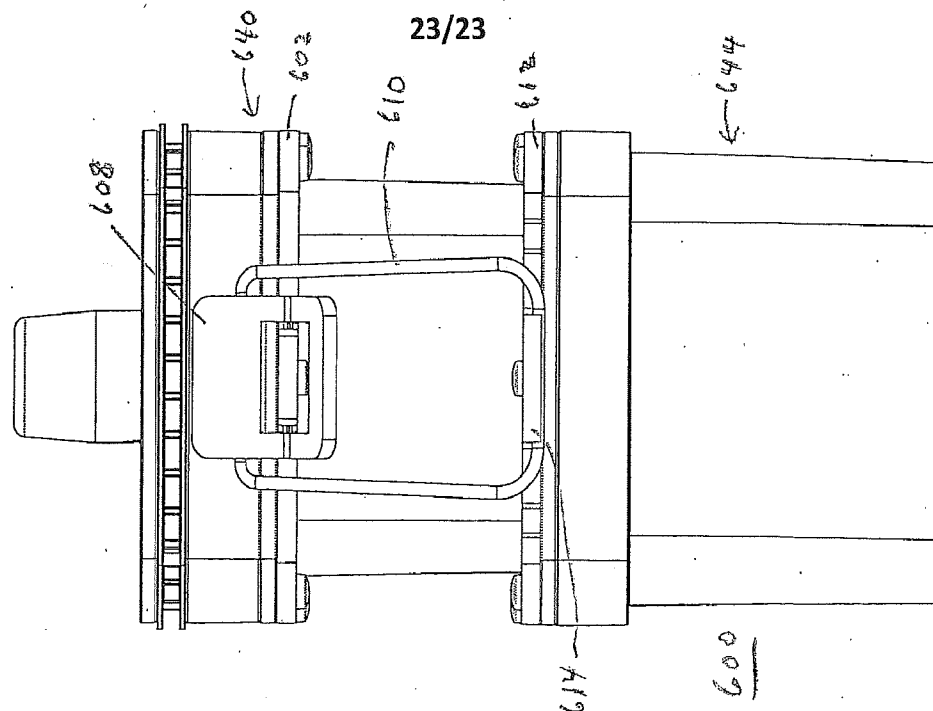


Fig. 26

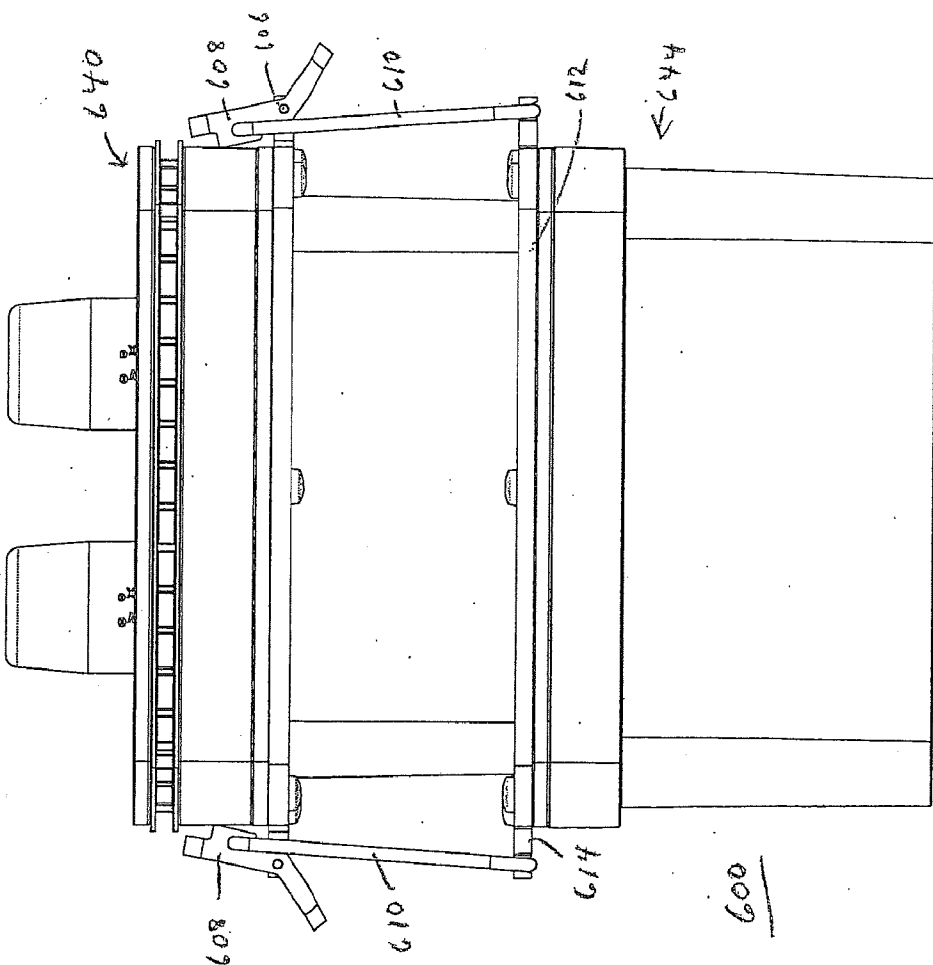


Fig. 27

23/23

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/013232

A. CLASSIFICATION OF SUBJECT MATTER INV. H01Q1/24 H04W88/08 H01R13/514 H01R13/627 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) H01Q H04W H01R		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014/315408 A1 (COLAPIETRO JULIAN R [US] ET AL) 23 October 2014 (2014-10-23) paragraph [0048] - paragraph [0050]; figures 5-7, 10, 15, 18, 19 paragraphs [0052], [0053], [0058], [0060], [0061] -----	1-13
A	GB 2 421 364 A (LIANG TEI CO LTD [TW]) 21 June 2006 (2006-06-21) page 1, line 3 - page 2, line 4 page 3, line 24 - page 6, line 14; figures 2-10 ----- -/--	1-13
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 16 March 2016		Date of mailing of the international search report 24/03/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Patrovsky, Andreas

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/013232

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SEL: "240-Kanal-UKW-Sprechfunkgerät FuG 7b - Bedienungsanleitung und Kurzbeschreibung", 31 December 1972 (1972-12-31), XP055258494, Retrieved from the Internet: URL:http://www.moba-paffenholz.de/klaus-paffenholz.de/docs/bos-funk/testbilder/sel-7b-manual.pdf [retrieved on 2016-03-15] pages 8-14; figures 1, 2, 4, 5 -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/013232

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2014315408 A1	23-10-2014	US 2014315408 A1	23-10-2014
		US 2016043515 A1	11-02-2016

GB 2421364 A	21-06-2006	NONE	
