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(71) Applicant: **COMMSCOPE TECHNOLOGIES LLC** [US/US]; 1100 CommScope Place SE, Hickory, North Carolina 28602 (US).

(72) Inventors: **HENDRIX, Walter**; 2101 Sky Ridge Creek, Richardson, Texas 75082 (US). **NOEL, James**; 7285 Moss Ridge Road, Parker, Texas 75002 (US). **PAULUS, Michael**; 4605 Cedar Springs Road, #307, Dallas, Texas 75219 (US).

(74) Agent: **CANNON, James, R.**; Myers Bigel, P.A., PO Box 37428, Raleigh, North Carolina 27627 (US).

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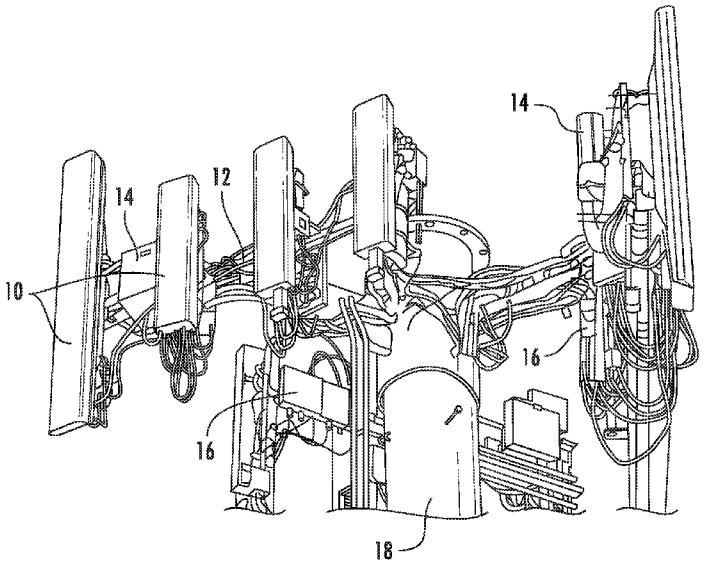

FIG. 1

(57) Abstract: A module for a communications cell site includes: a mounting frame; a remote radio unit (RRU) mounted to the frame; a radio frequency (RF) signal conditioning unit mounted to the frame; and a cover mounted to the frame that covers the RRU and the RF signal conditioning unit.

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[Continued on next page]

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INTEGRATED CELL SITE SECTOR MODULE

Field of the Invention

[0001] The present application claims priority from and the benefit of U.S. Provisional Patent Application No. 62/435,100, filed December 16, 2016, the disclosure of which is hereby incorporated herein in its entirety.

Field of the Invention

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

Background

[0003] One known wireless radio network system that may be mounted at the top of the tower comprises a remote radio unit (RRU) and a separate antenna. These components are mounted in separate locations and are then cabled together using jumper cables to pass radio frequency (RF) signals between them. An exemplary installation is shown in **FIG. 1**, wherein multiple antennas **10** are mounted on mounts **12**, with RRUs **14** also mounted on the mounts **12**. The mounts **12** are mounted on a tower **18**. Such an installation, when done on site, may involve complex and time consuming installations, and may introduce opportunities for installation errors. For example, current installations typically require multiple jumper cables and multiple mounting kits/hardware. This involves substantial installation time (approximately 12-15 hours per site). In addition, doing this installation at the site outdoors in variable temperature and humidity conditions can adversely affect interconnect quality and overall system performance.

[0004] Also, many installations include an RF combiner, RF diplexer, and/or RF filter (shown at **16** in **FIGS. 1** and **2**) mounted near each RRU **14**. These are collectively referred to herein as "RF signal conditioning units", and serve to condition signals being transmitted between each RRU **14** and its corresponding antenna **10**. Of course, interconnection of the RF signal conditioning unit **16** with the other components introduces further opportunity for errors in installation.

Summary

[0005] As a first aspect, embodiments of the invention are directed to a module for a communications cell site. The module comprises: a mounting frame; a remote radio unit (RRU) mounted to the frame; a radio frequency (RF) signal conditioning unit mounted to the frame; and a cover mounted to the frame that covers the RRU and the RF signal conditioning unit.

[0006] As a second aspect, embodiments of the invention are directed to a module for a communications cell site comprising: a mounting frame; two remote radio units (RRUs) mounted to the frame; two radio frequency (RF) signal conditioning units mounted to the frame; and first and second covers mounted to the frame that cover the RRUs and the RF signal conditioning units.

[0007] As a third aspect, embodiments of the invention are directed to

Brief Description of the Figures

[0008] **FIG. 1** is a bottom perspective view of a cell site with antennas, RRUs and RF signal conditioning units mounted on an antenna mount atop a tower.

[0009] **FIG. 2** is a perspective view of an exemplary RRU as shown in **FIG. 1**.

[0010] **FIG. 3** is a perspective view of an exemplary RF signal conditioning unit as shown in **FIG. 1**.

[0011] **FIG. 4** is a front perspective view of a module for a cell site that includes an RRU and an RF signal conditioning unit in a single unit.

[0012] **FIG. 5** is a top view of the module of **FIG. 4**.

[0013] **FIG. 6** is a front perspective view of the module of **FIG. 4** with one of the covers removed and the RRUs shown schematically.

[0014] **FIG. 7** is a rear perspective view of the module of **FIG. 4** with both of the covers removed and the RRUs shown schematically.

[0015] **FIG. 8** is a side view of the module of **FIG. 4** with both of the covers removed.

[0016] **FIG. 9** is a top view of the module of **FIG. 4** with both of the covers removed.

[0017] **FIG.10** is a rear perspective view of the frame of the module of **FIG. 4**.

Detailed Description

[0018] The present invention now is described more fully hereinafter 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 fully convey the scope of the invention to those skilled in the art.

[0019] Like numbers refer to like elements throughout. In the figures, the thickness of certain lines, layers, components, elements or features may be exaggerated for clarity. Broken lines illustrate optional features or operations unless specified otherwise.

[0020] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the specification and relevant art and should not be interpreted in an idealized or overly formal sense unless expressly so defined herein. Well-known functions or constructions may not be described in detail for brevity and/or clarity.

[0021] 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. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. As used herein, phrases such as "between X and Y" and "between about X and Y" should be interpreted to include X and Y. As used herein, phrases such as "between about X and Y" mean "between about X and about Y." As used herein, phrases such as "from about X to Y" mean "from about X to about Y."

[0022] It will be understood that when an element is referred to as being "on", "attached" to, "connected" to, "coupled" with, "contacting", etc., another element, it can be directly on, attached to, connected to, coupled with or contacting the other element or intervening elements may also be present. In contrast, when an element is referred to as being, for example, "directly on", "directly attached" to, "directly connected" to, "directly coupled" with or "directly contacting" another element, there are no intervening elements present. It will also be appreciated by those of skill in the art that references to a structure or feature that is disposed "adjacent" another feature may have portions that overlap or underlie the adjacent feature.

[0023] Spatially relative terms, such as "under", "below", "lower", "over", "upper", "lateral", "left", "right" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is inverted, elements described as "under" or "beneath" other elements or features would then be oriented "over" the other elements or features. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the descriptors of relative spatial relationships used herein interpreted accordingly.

[0024] Referring now to the figures, a telecommunications module, designated broadly at **100**, is shown in **FIGS. 4-10**. The module includes a frame **102**, two covers **104**, **105**, two RRUs **106, 108**, and two RF signal conditioning units **110, 112**. These components are described in greater detail below.

[0025] Referring to **FIG. 10**, the frame **102** includes two vertical members **120**, a lower member **122**, and an upper member **124** that generally define an open rectangle. The vertical members **120** are channels with C-shaped cross-sections. The lower and upper members **122, 124** have generally square cross-sections.

[0026] The upper surface of the upper member **124** includes bumps or nubs **124a** that project slightly upwardly. The lower surface of the lower member **122** has similar bumps or numb (not shown). These bumps or nubs **124a** provide mounting locations for the covers **104, 105**.

[0027] The members **120, 122, 124** include a number of mounting locations that can facilitate the mounting of different models of RRUs (such as the RRUs **106, 108**) and RF signal conditioning units (such as the RF signal conditioning units **110, 112**). In the illustrated embodiment, the mounting locations include clip nuts **121** clipped onto the members over holes in the members (not shown) that receive mounting screws. However, those of skill in this art will recognize that the RRUs **106, 108** and RF signal conditioning units **110, 112** may be mounted on the frame **102** in a variety of different ways.

[0028] Still referring to **FIG. 10**, each of the lower and upper members **122, 124** projects slightly from one of the vertical members **120**. A mounting flange **128** is attached to the projecting end of each of the lower and upper members **122, 124**. A clamp **130** with two U-bolts **132** is attached to each mounting flange **128**. The U-bolts **132** can be employed to attach the frame **102** to a vertical member of a mounting structure such as a mount **12** shown in **FIG. 1**.

[0029] Also, a lifting eye **136** is attached to the upper member **124**. The lifting eye **136** can enable the module **100** to be lifted by a crane or the like from the ground to the top of a tower for mounting.

[0030] The frame **102** may be formed of a number of suitable materials. Typically, the frame **102** comprises a metallic material, such as aluminum.

[0031] Referring to **FIGS. 6-8**, the RRUs **106, 108** are mounted to the frame **102**. Mounting of the RRUs **106, 108** may be carried out in any suitable manner; in the illustrated embodiment, the RRUs **106, 108** are mounted to adapter plates **107, 109** that are in turn mounted to the frame **102.** In the illustrated embodiment, the adapter plates **107, 109** are mounted to the frame **102** via screws or bolts inserted into the clip nuts **121** in the frame **102**.

[0032] The RRUs **106, 108** may be of any variety, including FHFB and FRIS. In some embodiments, including the illustrated embodiment, the RRUs **106, 108** have external electrical ports **117, 119** that extend from the lower surfaces thereof (see **FIGS. 7** and **8**).

[0033] Referring still to **FIGS. 6-8**, the RF signal conditioning units **110, 112** are mounted to one side of a mounting panel **126**. The mounting panel **126** is then mounted to the frame **102** via

screws inserted into the clip nuts **121**. The RF signal conditioning units **110, 112** may be any that are known to be suitable for use in antenna towers and, as noted above, may include RF filters, RF combiners and RF diplexers.

[0034] It can be seen in **FIGS. 6** and **8** that the RF signal conditioning units **110, 112** have external electrical ports **160** that extend upwardly (i.e., toward the RRUs **106, 108**). This arrangement of ports can facilitate the interconnection of jumper cables between the ports **117, 119** of the RRUs **106, 108** and the ports **160** of the RF signal conditioning units **110, 112**. The RF signal conditioning units **110, 112** also have external ports **162** (see **FIG.** 7) that face downwardly (i.e., away from the RRUs **106, 108**); these ports **162** connect with jumper cables that connect with adjacently-mounted antennas.

[0035] As can be seen in **FIGS. 4** and **5**, the covers **104, 105** (which are mirror images of each other) are generally rectangular. Each cover **104, 105** has a main panel **141**, a floor **142**, two side walls **143**, and a ceiling **144**. Each cover **104, 105** includes two perforated regions **146, 147** in its main panel **141, 151**, and a perforated region **148** in its ceiling **144, 154**.

[0036] The covers **104, 105** may also have cutout areas that enable components of the frame to extend outside of the covers **104, 105** (e.g., the lower and upper members **122, 124** extend to present the mounting flanges **128**) and/or to provide routing paths for cables (e.g., jumper cables routed between the RF signal conditioning units **110, 112** and the antenna).

[0037] The covers **104, 105** may be attached to the frame **102** in any suitable manner (e.g., via screws or bolts, clips, an interference fit, or the like). In the illustrated embodiment, the covers **104, 105** overlie the frame **102** and are held in place by the bumps or nubs **124a**. The covers **104, 105** are typically formed of a metallic material such as aluminum.

[0038] As can be seen in **FIGS. 8** and **9**, the RRUs **106, 108** shown therein have vertical fins **106a, 108a**, which encourage heat flow in a vertical direction. Thus, air entering the cover **104** through either of the perforated regions **146, 147** is encouraged to flow upwardly by the fins **106a** and to exit through the perforated region **148**. This defined air flow path can passively dissipate heat that may build up within the cover **104** due to RRU operation. The perforated regions in the cover **105** may similarly define an air flow path for its adjacent RRU.

[0039] It should be noted that the module discussed above may provide several benefits over prior arrangements. Providing a subset of components mounted on the top of a tower can enable

these components to be connected and tested prior to installation on the tower, which can both simplify installation and enhance reliability. The perforated regions in the covers can provide cooling to the RRUs and RF signal conditioning components through free convection. The arrangement of the RRUs and the RF signal conditioning components within the enclosure can facilitate repair and replacement, as can the attachment of the covers. Also, the use of mounting plates and adapter plates can greatly simplify replacement of the RRUs and the RF signal conditioning units; the RRUs and RF conditioning units (which may be configured differently than the units they are replacing) can be mounted on the mounting/adapter plates on the ground, and the adapter/mounting plates can be quickly and easily mounted on the frame atop the tower. Because the frame and the covers create a single module, the resulting structure may have a more appealing appearance than multiple components mounted on a tower; moreover, the single module can reduce tower leasing costs by being classified as a single unit rather than as a number of disparate components.

[0040] The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

That Which is Claimed is:

1. A module for a communications cell site, comprising:

a mounting frame;

a remote radio unit (RRU) mounted to the frame;

a radio frequency (RF) signal conditioning unit mounted to the frame; and

a cover mounted to the frame that covers the RRU and the RF signal conditioning unit.

2. The module defined in Claim 1, wherein the RRU is a first RRU and the RF signal conditioning unit is a first RF signal conditioning unit, and further comprising a second RRU and a second RF signal conditioning unit mounted to the frame.

3. The module defined in Claim 1 or Claim 2, wherein the cover includes first and second perforated regions located to guide air flow over the RRU.

4. The module defined in any of Claims 1-3, wherein the RF signal conditioning unit is mounted below the RRU.

5. The module defined in Claim 4, wherein the RRU has a plurality of electrical ports on a lower surface thereof, and the RF signal conditioning unit has a plurality of electrical ports on an upper surface thereof.

6. The module defined in Claim 5, further comprising a jumper cable that interconnects one of the plurality of electrical ports on the RRU and one of the plurality of electrical ports on the RF signal conditioning unit.

7. The module defined in any of Claims 1-6, wherein the RRU is mounted to an adapter plate that is in turn mounted to the frame.

8. The module defined in any of Claims 1-7, mounted on an antenna mount on an antenna tower.

9. The module defined in any of Claims 1-8, wherein the RF signal conditioning unit is electrically connected to an antenna.

10. A module for a communications cell site, comprising:

a mounting frame;

two remote radio units (RRUs) mounted to the frame;

two radio frequency (RF) signal conditioning units mounted to the frame; and

first and second covers mounted to the frame that cover the RRUs and the RF signal conditioning units.

11. The module defined in Claim 10, wherein each cover includes first and second perforated regions located to guide air flow over the RRUs.

12. The module defined in Claim 10 or Claim 11, wherein the RF signal conditioning units are mounted below the RRUs.

13. The module defined in Claim 12, wherein each RRU has a plurality of electrical ports on a lower surface thereof, and each RF signal conditioning unit has a plurality of electrical ports on an upper surface thereof.

14. The module defined in Claim 13, further comprising a jumper cable that interconnects one of the plurality of electrical ports on each RRU and one of the plurality of electrical ports on each RF signal conditioning unit.

15. The module defined in any of Claims 10-14, wherein each of the RRUs is mounted to a respective adapter plate that is in turn mounted to the frame.

16. The module defined in any of Claims 10-15, mounted on an antenna mount on an antenna tower.

17. The module defined in any of Claims 10-16, wherein each RF signal conditioning unit is electrically connected to an antenna.

18. A module for a communications cell site, comprising:

a mounting frame;

a remote radio unit (RRU) mounted to the frame having a plurality of ports;

a radio frequency (RF) signal conditioning unit mounted to the frame having a plurality of ports;

a jumper cable that interconnects one of the plurality of electrical ports on the RRU and one of the plurality of electrical ports on the RF signal conditioning unit; and

a cover mounted to the frame that covers the RRU and the RF signal conditioning unit.

19. The module defined in Claim 18, wherein the cover includes first and second perforated regions located to guide air flow over the RRU.

20. The module defined in Claim 18 or Claim 19, wherein the RRU is mounted to an adapter plate that is in turn mounted to the frame.

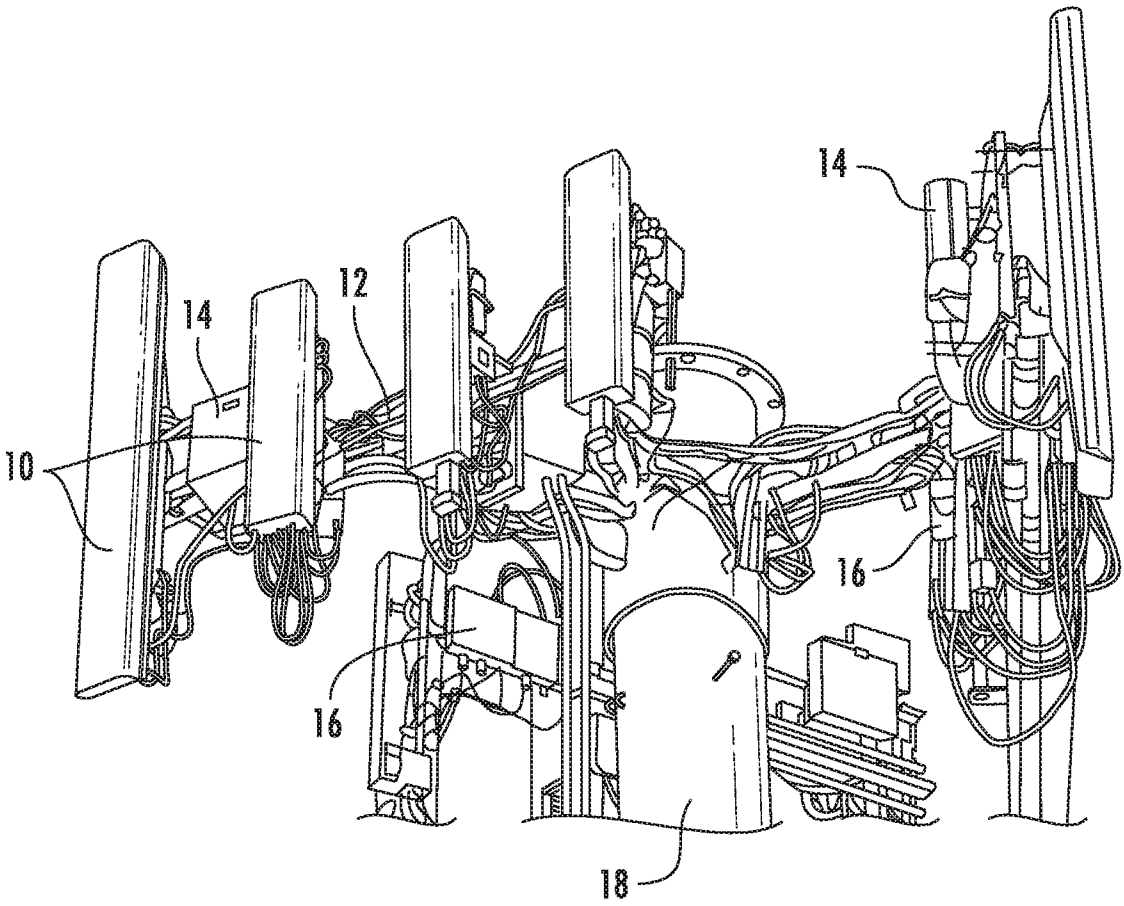

FIG. 1

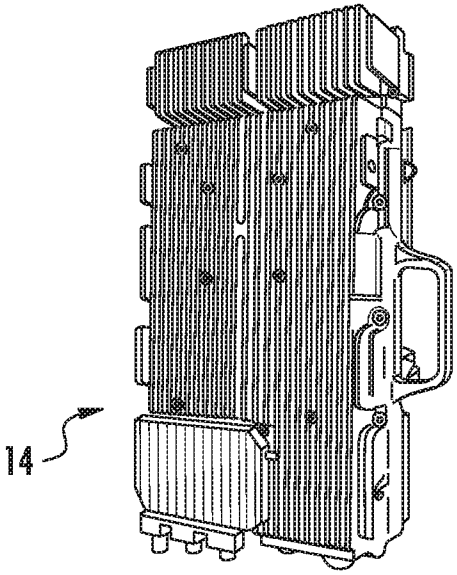

FIG. 2

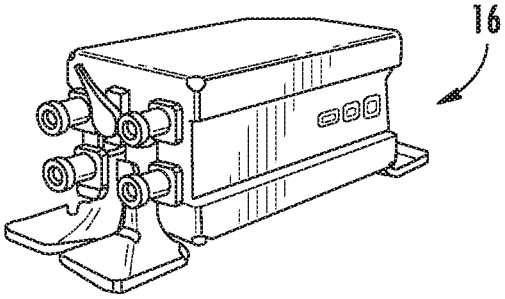

FIG. 3

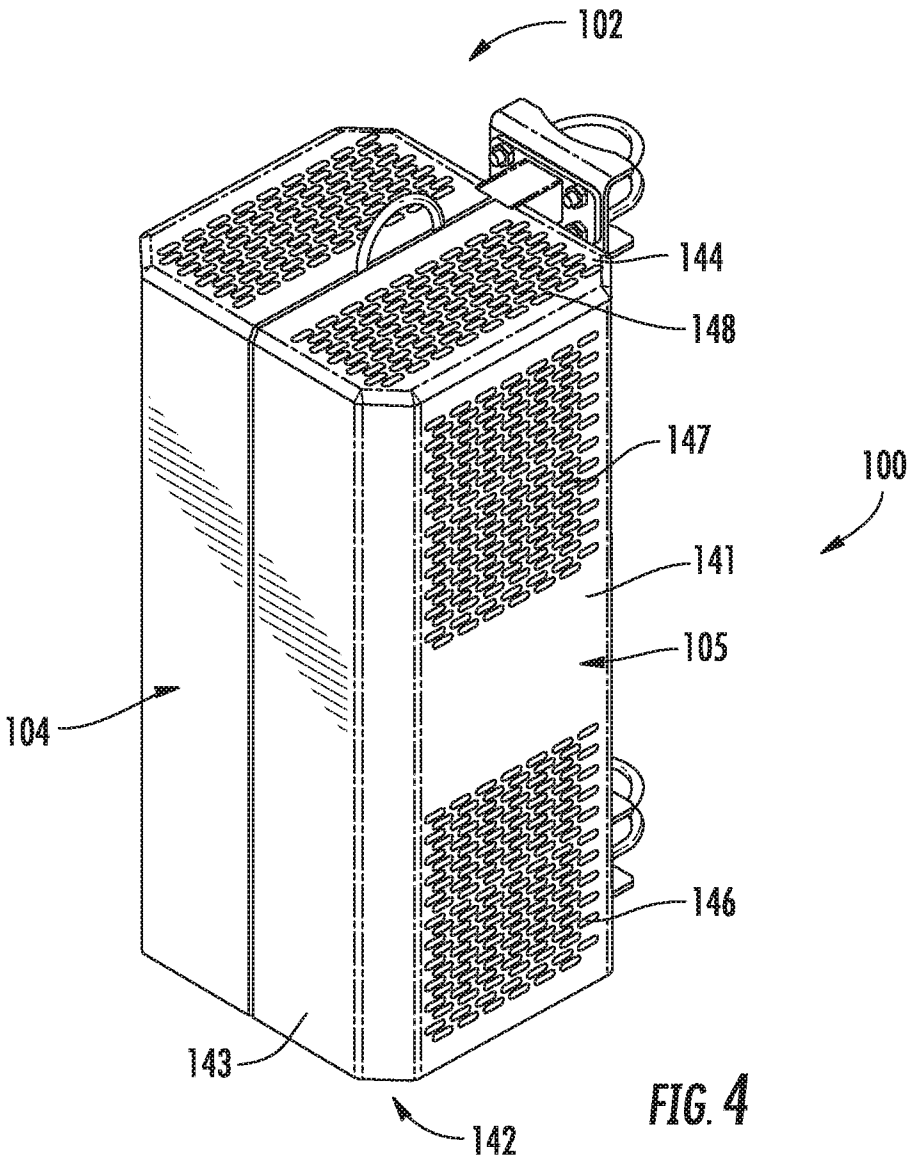

FIG. 4

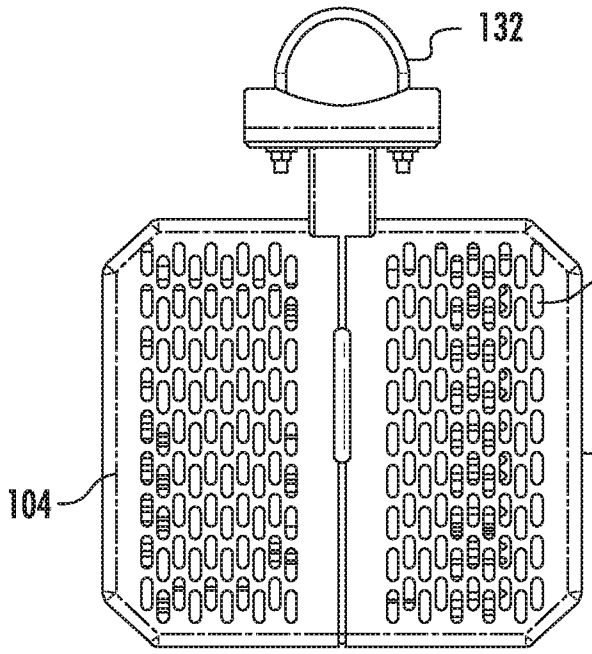

FIG. 5

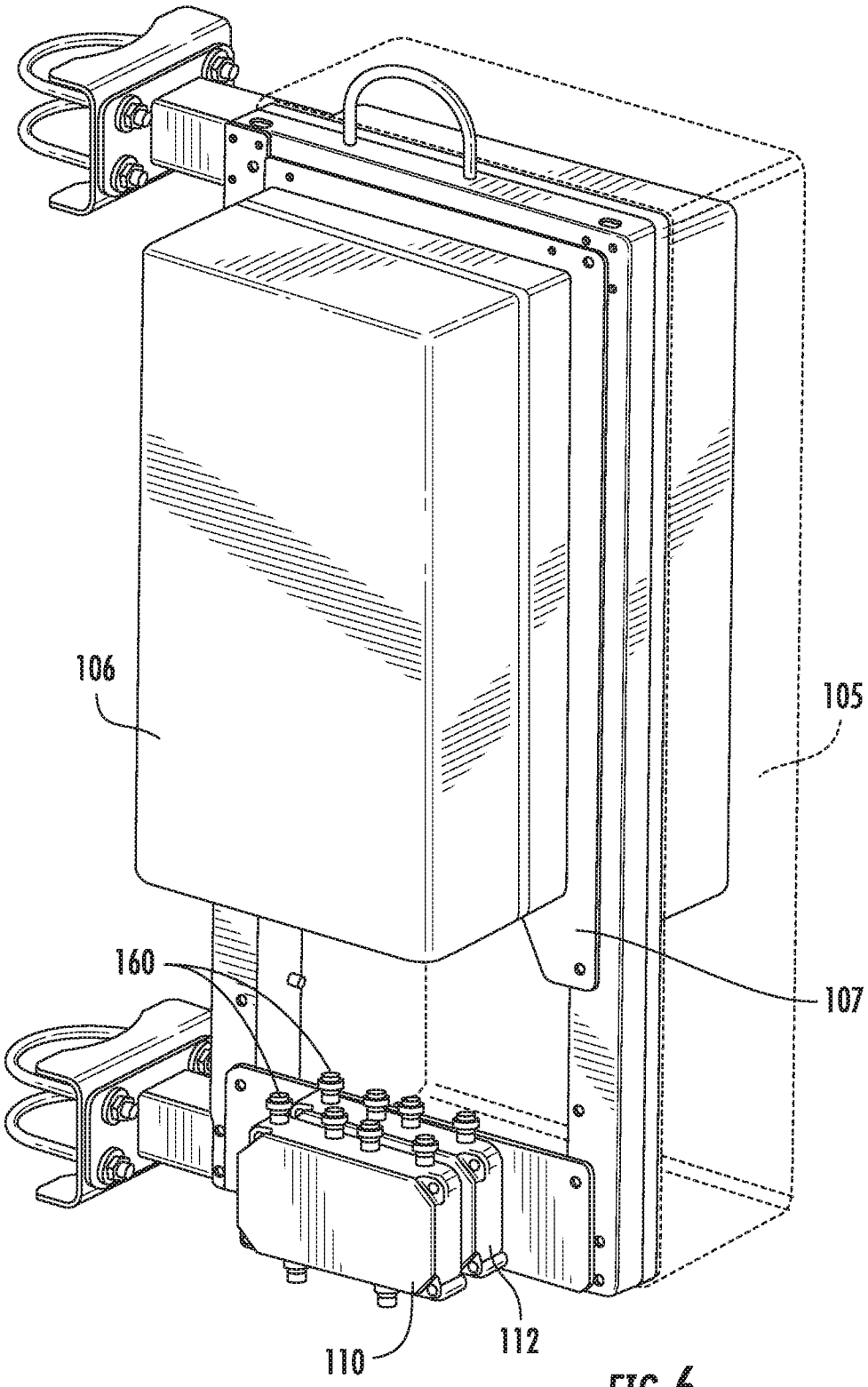

FIG. 6

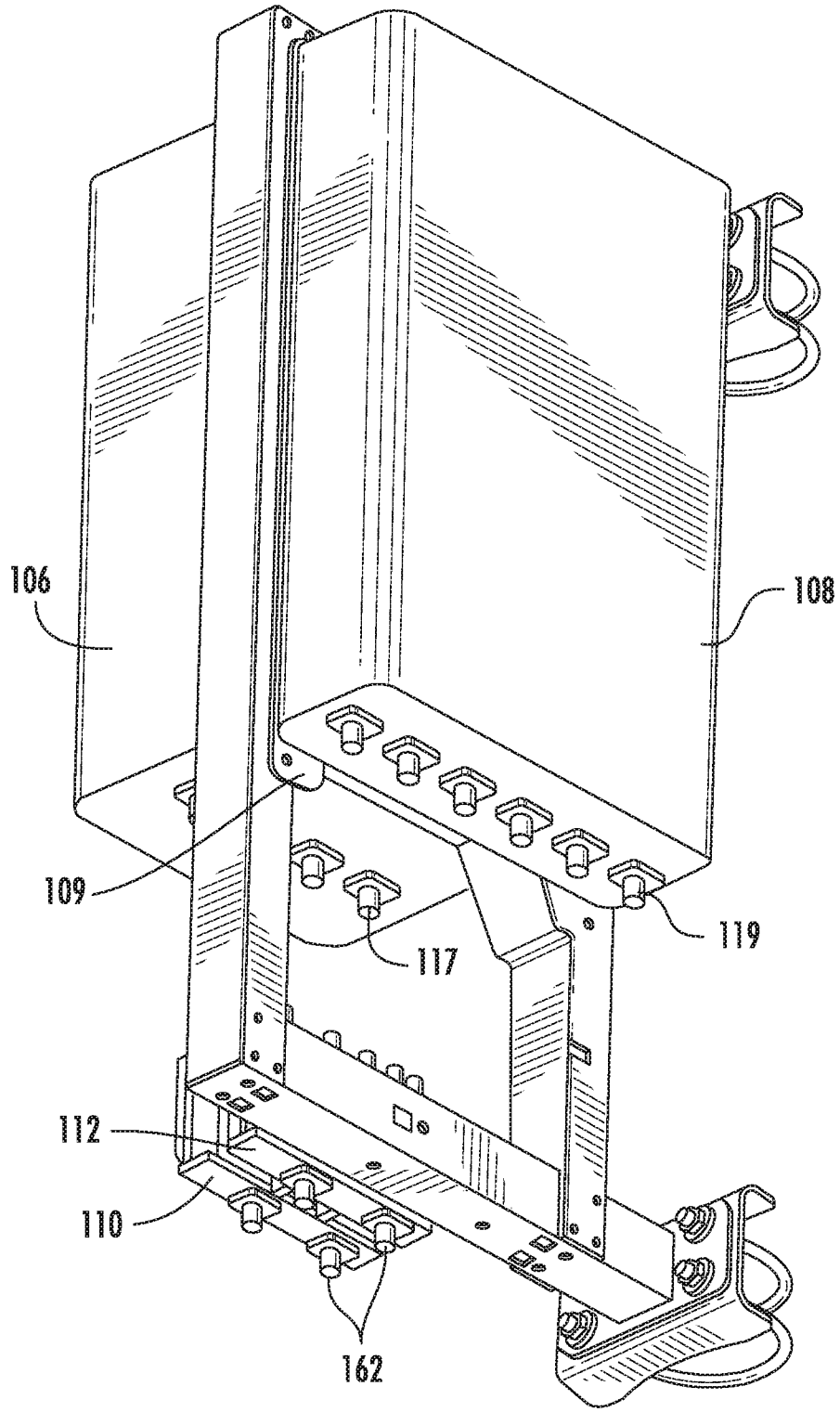

FIG. 7

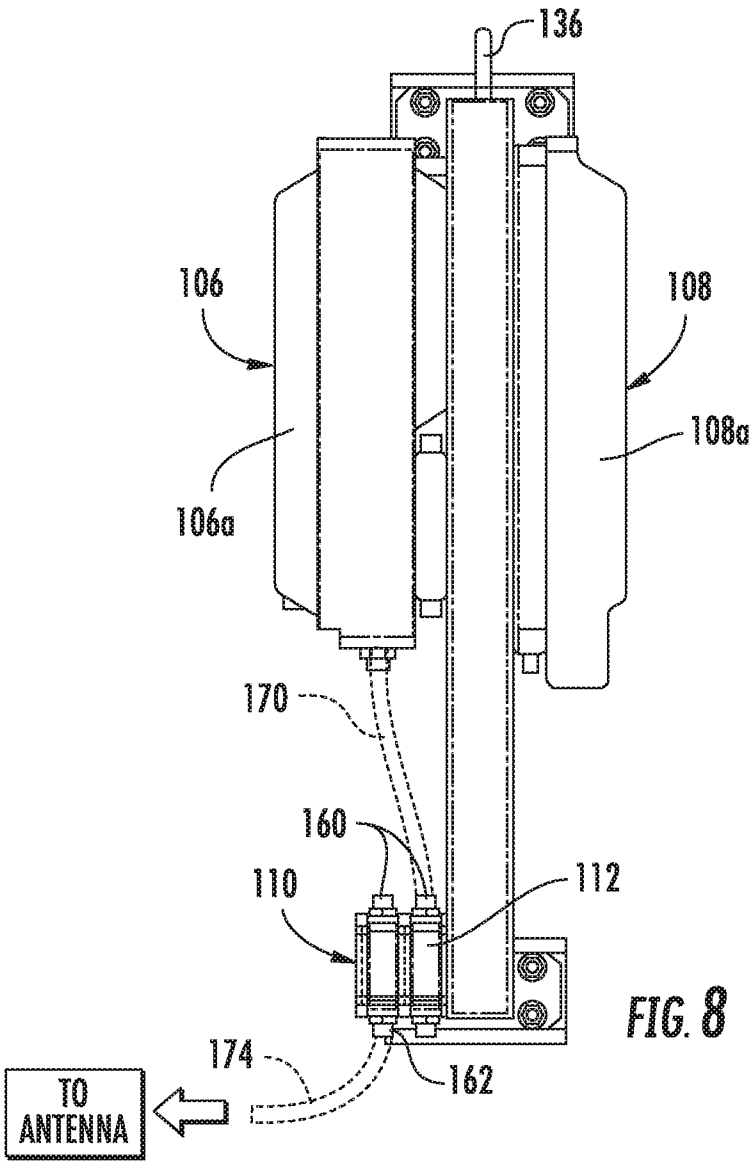
136
106
108
108a
106a
170
160
110
112
174
162
TO ANTENNA

FIG. 8

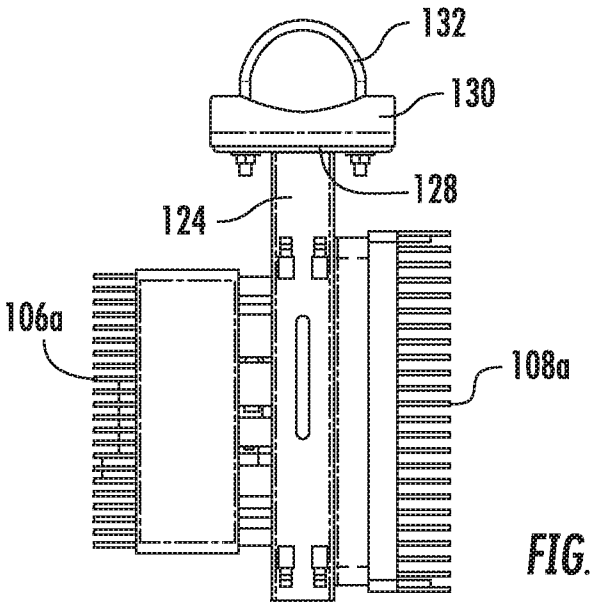
132
130
128
124
106a
108a

FIG. 9

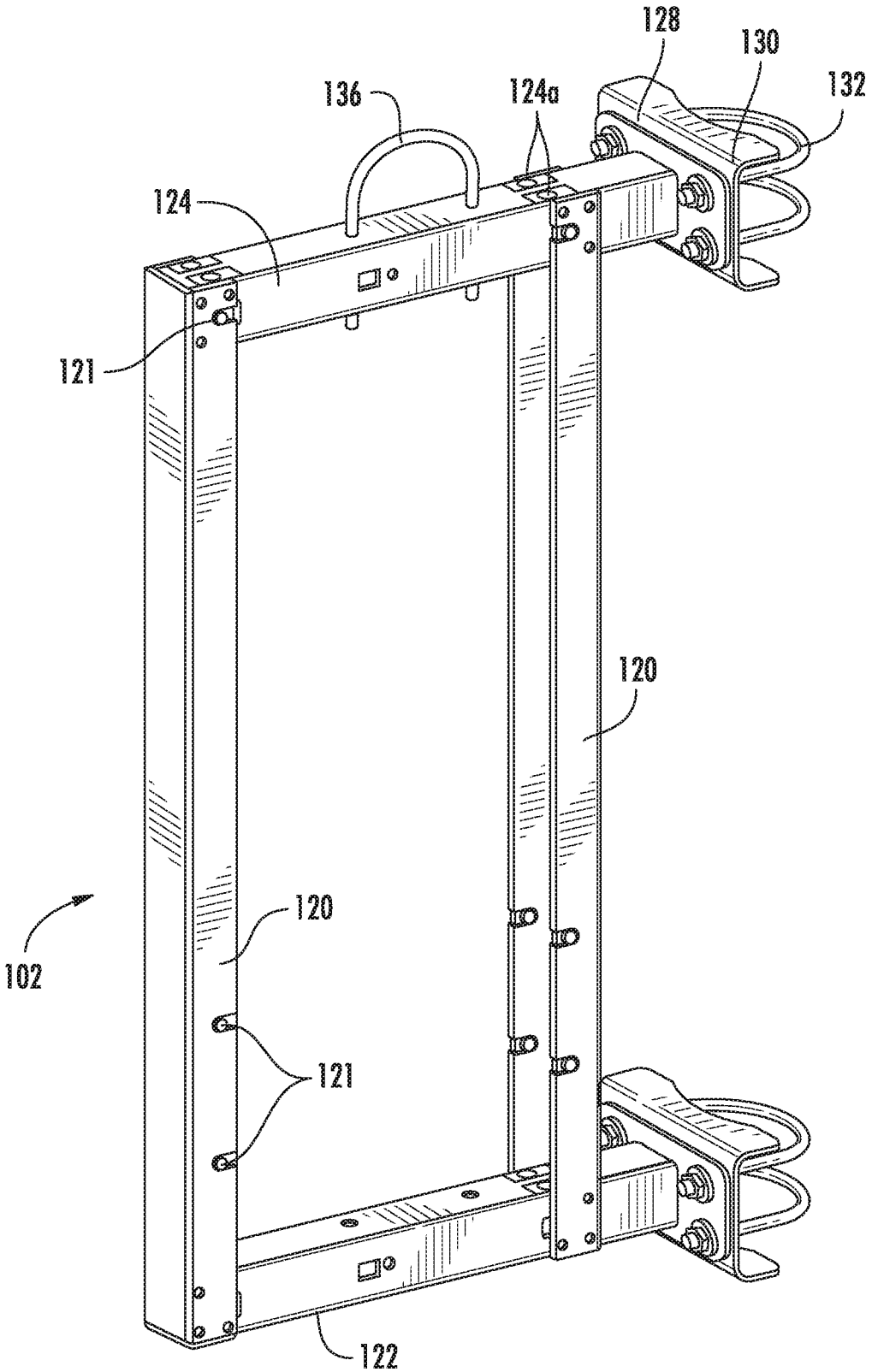

FIG. 10