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(54) **Title:** CABLE SUPPORT BRACKETS

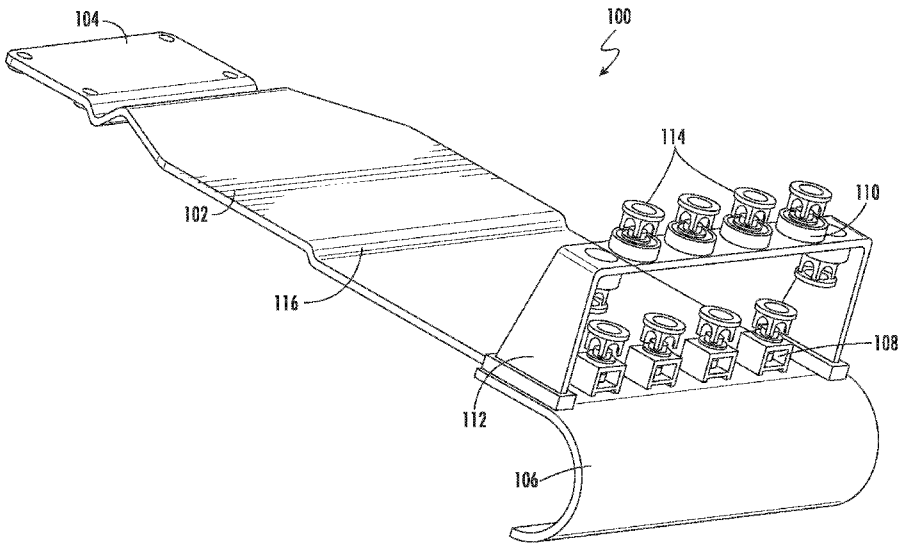


FIG. 1

(57) **Abstract:** The present disclosure describes a cable support bracket. The cable support bracket may include a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base. The cable support bracket may further include a bridge removably attached to the base, the bridge having a plurality of apertures, each bridge aperture configured to receive a respective cable hanger; and a second plurality of cable hangers, each cable hanger secured in a respective aperture in the bridge. Antenna assemblies and methods for organizing coaxial cable connections at a base station antenna are also provided.

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CABLE SUPPORT BRACKETS

RELATED APPLICATION

[0001] The present application claims priority from and the benefit of U.S. Provisional Patent Application No. 62/791,104, filed January 11, 2019, the disclosure of which is hereby incorporated herein by reference in full.

FIELD

[0002] The present invention is directed generally toward telecommunications equipment, and more particularly, support brackets for coaxial cable connections with an antenna.

BACKGROUND

[0003] With increased demand for more wireless communication, the number of radio and antenna units that a tower traditionally supports has increased and is expected to continue to increase. New towers will need to be designed to support greater numbers of antenna and radio units, while existing towers are retrofitted to support more units, and effort is made to fully utilize space available on the towers.

[0004] When mounting antennas to towers or other structures, the cables attaching the radio to the antenna typically protrude from the bottom of the antenna for some unsupported length. It is typically desirable to secure these cables to maintain a sense of organization and to prevent swaying in the wind. A system of cable support brackets is commonly used to hold these cables in place. Those support systems usually also mount to the same mounting structure to which the antenna is mounted (*e.g.*, an individual pole of an antenna mount or a monopole).

[0005] Areas near cellular antennas (*i.e.*, within 1λ, or one wavelength) can be (relatively) high radio frequency (RF) energy environments. Conductive items in these areas, such as hangers, brackets and other hardware, can generate undesirable passive intermodulation (PIM). Typical examples of potential PIM-generating conditions include the combination of steel-on-steel contact (between two or more components), plus low contact pressure and/or relative movement between the steel components at the joint. As such, it may be desirable to provide solutions near an antenna with reduced (or eliminated) likelihood of PIM generation.

SUMMARY

[0006] A first aspect of the present invention is directed to a cable support bracket. The cable support bracket may comprise a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base.

[0007] Another aspect of the present invention is directed to a cable support bracket. The cable support bracket may comprise a base configured to be mounted to an antenna and configured to receive and secure a first plurality of cable hangers; a bridge removably attached to the base, the bridge configured to receive and secure a second plurality of cable hangers; and a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base.

[0008] Another aspect of the present invention is directed to an antenna assembly. The antenna assembly may comprise an antenna; and a cable support bracket, the cable support bracket comprising: a base configured to be mounted to the antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base, wherein the cable support bracket is mounted to the antenna.

[0009] Another aspect of the present invention is directed to an antenna assembly in combination with a plurality of cables. The antenna assembly may comprise an antenna; and a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base, wherein the cable support bracket is mounted to the antenna, and wherein at least one of the plurality of cables is secured within at least one of the plurality of cable hangers.

[0010] Another aspect of the present invention is directed to a method for organizing coaxial cable connections at a base station antenna. The method may comprise providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer surface, wherein the cable guide is

coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base; mounting the cable support bracket to an antenna having a plurality of connection ports such that each cable hanger aligns with a respective connection port; connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and securing each coaxial cable to a respective cable hanger.

[0011] Another aspect of the present invention is directed to a method for organizing coaxial cable connections at a base station antenna. The method may comprise providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna and configured to receive and secure a first plurality of cable hangers; a bridge removably attached to the base, the bridge configured to receive and secure a second plurality of cable hangers; and a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; mounting the cable support bracket to an antenna having a plurality of connection ports such that each cable hanger aligns with a respective connection port; connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and securing each coaxial cable to a respective cable hanger.

[0012] It is noted that aspects of the invention described with respect to one embodiment, may be incorporated in a different embodiment although not specifically described relative thereto. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination. Applicant reserves the right to change any originally filed claim and/or file any new claim accordingly, including the right to be able to amend any originally filed claim to depend from and/or incorporate any feature of any other claim or claims although not originally claimed in that manner. These and other objects and/or aspects of the present invention are explained in detail in the specification set forth below. Further features, advantages and details of the present invention will be appreciated by those of ordinary skill in the art from a reading of the figures and the detailed description of the preferred embodiments that follow, such description being merely illustrative of the present invention.

BRIEF DESCRIPTION OF THE FIGURES

[0013] **FIG. 1** is a side perspective view of a cable support bracket according to embodiments of the present invention.

[0014] **FIG. 2** is a side perspective exploded view of the cable support bracket of **FIG. 1**.

[0015] **FIG. 3** is a front perspective view of a cable support bracket according to alternative embodiments of the present invention.

[0016] **FIG. 4** is a side perspective view of the cable support bracket of **FIG. 1** attached to an antenna to form an antenna assembly.

[0017] **FIG. 5** is a rear perspective view of the antenna assembly of **FIG. 4**.

[0018] **FIG. 6** is a bottom view of the antenna assembly of **FIG. 4**.

[0019] **FIG. 7** is a front view of the antenna assembly of **FIG. 4**.

[0020] **FIG. 8** is a rear view of the antenna assembly of **FIG. 4**.

[0021] **FIG. 9** is a side view of the cable support bracket of **FIG. 1**.

[0022] **FIG. 10** is a side perspective view of the antenna assembly utilizing the cable support bracket of **FIG. 3** in combination with coaxial cables according to embodiments of the present invention.

[0023] **FIG. 11** is a side perspective view of the antenna assembly and cables of **FIG. 10**.

[0024] **FIG. 12** is a bottom view of the antenna assembly and cables of **FIG. 10**.

[0025] **FIG. 13** is a side perspective view of a cable support bracket according to alternative embodiments of the present invention.

DETAILED DESCRIPTION

[0026] 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.

[0027] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown.

[0028] In the figures, certain layers, components or features may be exaggerated for clarity, and broken lines illustrate optional features or operations unless specified otherwise. 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.

[0029] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements,

components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention. The sequence of operations (or steps) is not limited to the order presented in the claims or figures unless specifically indicated otherwise.

[0030] 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.

[0031] 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. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0032] 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."

[0033] Embodiments of the present invention are directed to cable support brackets and assemblies which may greatly reduce passive intermodulation (PIM) and provide for easy identification of coaxial cables connected to an antenna. In some embodiments, a cable support bracket of the present invention may provide optimized and predetermined coaxial support locations for coaxial cable connections at a base station antenna. In some embodiments, a cable support bracket of the present invention may mitigate PIM caused by bends in a coaxial cable that are that are too close to the connector body. In some

embodiments, a cable support bracket of the present invention may provide an integrated cable bend radius guide that helps maintain the minimum bend radius requirements of a coaxial cable. In some embodiments, a cable support bracket of the present invention may be fabricated from a non-conductive polymer-based material which may help to mitigate PIM. In some embodiments, a cable support bracket of the present invention may provide for easy identification of organized coaxial cables attached to an antenna. In some embodiments, a cable support bracket of the present invention may be integrated into an existing antenna structure or as a separate accessory. In some embodiments, a cable support bracket of the present invention may be integrated for use with polymer-based cable hangers. In some embodiments, a cable support bracket of the present invention may be slotted or provided with holes to help reduce exposure to wind drag.

[0034] Referring now to the figures, a cable support bracket **100** according to some embodiments of the present invention is illustrated in **FIGS. 1-13**. As will be discussed in further detail below, the cable support bracket **100** of the present invention may comprise a base **102** and a cable guide **106**. In some embodiment, the base **102** of the cable support bracket **100** may be configured to receive and secure a plurality of cable hangers **114**. In some embodiments, the cable support bracket **100** may further comprise a bridge **112**.

[0035] Referring to **FIGS. 1-3**, the cable support bracket **100** of the present invention comprises a base **102**. In some embodiments, the base **102** is configured to be mounted to an antenna **150** (*see, e.g.*, **FIG. 5**). In some embodiments, the base **102** may comprise a mounting plate **104** to assist in mounting the cable support bracket **100** to the antenna **150**. The mounting plate **104** may be coupled to or integral with the base **102**. In some embodiments, the base **102** (and/or mounting plate **104**) may be configured such that it can be secured to a pre-existing mounting bracket **154** on an antenna **150** (*see, e.g.*, **FIG. 5**). In some embodiments, the antenna **150** is a base station antenna. Other methods may be employed to secure or provide additional support to a bracket **100** being mounted to an antenna **150**, such as, for example, elastomeric bands, adhesives, or the like.

[0036] In some embodiments, the cable support bracket **100** is formed of a non-metallic and/or polymeric material. For example, in some embodiments, the cable support bracket **100** comprises acetal, nylon, polypropylene, polyvinyl chloride, and/or fiberglass. In some embodiments, the base **102** of the cable support bracket **100** may comprise one or more ridges **116**. The ridge(s) **116** may provide additional structural support and/or stiffness to the cable support bracket **100** when the bracket **100** is mounted to an antenna **150**.

[0037] Still referring to **FIGS. 1-3**, in some embodiments, the cable support bracket **100** further comprises a plurality of cable hangers **114**. For example, the cable support bracket **100** may comprise 1, 2, 3, 4 or more cable hangers **114**. As discussed below, typically the number of cable hangers **114** is equal to the number of connection ports **152** at the bottom **150b** of an antenna **150**. For example, as shown in **FIGS. 1-3**, in some embodiments, the cable support bracket **100** may comprise ten (10) cable hangers **114**.

[0038] Each cable hanger **114** is configured to hold and secure a respective coaxial cable **250** when the cable **250** is connected to an antenna **150** (*see, e.g.*, **FIGS. 10-12**). In some embodiments, the cable hangers **114** may be attached to the base **102** of the cable support bracket **100**. For example, in some embodiments, the base **102** may comprise a plurality of apertures **107**. Each aperture **107** may be configured to receive and secure a respective cable hanger **114** to the base **102** (*see, e.g.*, **FIG. 5**). In some embodiments, the apertures **107** have a diameter in the range of 0.5 inches to 1 inch. For example, in some embodiments, the apertures **107** have a nominal diameter of 0.75 inches. In some embodiments, the cable hangers **114** have a height ($\mathbf{H_{ch}}$) in a range of about 0.5 inches to about 1.5 inches (*see, e.g.*, **FIG. 9**). Exemplary types of cable hangers **114** that may be used with a cable support bracket **100** of the present invention include, but are not limited to, SSH-114-1 and SSH-1014-1 available from CommScope, Inc. (Joliet, Illinois). *See also, e.g.*, United States Patent Application Publication No. 2018/0045336 to Vaccaro, which is incorporated herein by reference in its entirety.

[0039] In some embodiments, the base **102** of the cable support bracket **100** may comprise a plurality of base support platforms **108**. Each base support platform **108** may be configured to receive and secure a cable hanger **114**. In some embodiments, each aperture **107** may configured to receive and secure a respective base support platform **108** to the base **102**. For example, in some embodiments, the base support platforms **108** may be attached to the base **102** of the cable support bracket **100** via the apertures **107** and each cable hanger **114** is attached to a respective base support platform **108**. Exemplary types of base support platforms **108** that may be used with a cable support bracket **100** of the present invention include, but are not limited to, SA-1C-1F and SA-1TR available from CommScope, Inc. (Joliet, Illinois). As discussed in further detail below, the base support platforms **108** assist with aligning each of the cable hangers **114** with a respective connection port **152** located at the bottom **150b** of an antenna **150** (*see, e.g.*, **FIG. 6**).

[0040] In some embodiments, the plurality of base support platforms **108** are formed of a non-metallic and/or polymeric material, such as, for example, nylon, acetal, polypropylene,

or polyethylene. In some embodiments, each base standoff platform **108** has a height (H_{b1}) in a range of about 0.5 inches to about 1.5 inches. The height (H_{b1}) of the base standoff platform **108** has the potential of being increased depending on the antenna type and connector locations on the antenna.

[0041] As mentioned above, the cable support bracket **100** further comprises a cable guide **106**. The cable guide (or cable bend radius guide) **106** may be coupled to or integral with the base **102** of the bracket **100** and extends outwardly from one end of the base **102**. In some embodiments, the base **102** and the cable guide **106** may be a unitary member. The cable guide **106** may have a generally arced outer profile (*see also, e.g.*, **FIG. 9**). For example, in some embodiments, the cable guide **106** has a radius (**R**) of about 2 inches or greater, and may extend over an arc distance of at least 90 degrees, and in some cases, at least 120 degrees. Coaxial cables **250** have minimum bend radius requirements. Bends in a coaxial cable **250** may damage the cable and/or cause unwanted passive intermodulation (PIM). The cable guide **106** of the present invention helps to maintain the minimum bend radius requirements of a coaxial cable **250** when the cable **250** is connected to an antenna **150**, thereby helping to reduce unwanted PIM near the antenna **150** (*see, e.g.*, **FIGS. 10-12**).

[0042] The cable support bracket **100** of the present invention has a length (**L**) and a width (**W**). The length (**L**) and width (**W**) of the bracket **100** may vary depending on the type of antenna **150** that the bracket **100** is being mounted and/or the number of connection ports **152** at the bottom **150b** of the antenna **150** (*see, e.g.*, **FIG. 8**). For example, in some embodiments, the cable support bracket **100** has a length (**L**) in a range of about 20 inches to about 30 inches and a width (**W**) in a range of about 10 inches to about 36 inches. In some embodiments, the cable guide **106** may have greater width (**W**) than the base **102** of the cable support bracket **100** (*see, e.g.*, **FIG. 7** and **FIG. 8**). In some embodiments, the bracket **100** of the present invention may be sized to fit an antenna **150** having two (2) connection ports **152** to an antenna **150** having fifty (50) or more connection ports **152**.

[0043] Still referring to **FIGS. 1-3**, in some embodiments, the cable support bracket **100** may further comprise a bridge **112**. The bridge **112** may be removably attached to the base **102**. For example, as shown in **FIG. 2**, the bridge **112** may comprise one or more latching members **118**. The base **102** of the bracket **100** may comprise slots **120** configured to receive the latching members **118** of the bridge **112**. When inserted into the slots **120**, the latching members **118** secure the bridge **112** to the base **102**. In some embodiments, the bridge **112** may be integral with the base **102**, such that the bridge **112** and the base **102** comprise a unitary member.

[0044] As shown in **FIGS. 1-3**, the bridge **112** may comprise a plurality of bridge standoff platforms **110**. The bridge standoff platforms **110** may be coupled to or integral with the bridge **112**. Each bridge standoff platform **110** has a height ($\mathbf{H_{b2}}$) and is configured to receive a cable hanger **114** (*see also, e.g.*, **FIG. 9**). In some embodiments, a cable hanger **114** is secured in a respective bridge standoff platform **110**. In some embodiments, each bridge standoff platform **110** has a height ($\mathbf{H_{b2}}$) in a range of about 0.5 inches to about 1.5 inches. The height ($\mathbf{H_{b2}}$) of the bridge standoff platform **110** has the potential of being increased based on antenna connector layouts. Similar to the base **102**, in some embodiments, the bridge **112** may comprise a plurality of apertures **109** configured to receive and secure a respective cable hanger **114** to the bridge **102** (*see, e.g.*, **FIG. 3**).

[0045] In some embodiments, the height ($\mathbf{H_{b2}}$) of each bridge standoff platform **110** may be adjustable to allow the proper alignment of a cable hanger **114** with a connection port **152** of an antenna **150**. For example, in some embodiments, each bridge standoff platform **110** may comprise threads where turning the platform **110** clockwise or counterclockwise will raise or lower the platform **110** to a desirable height ($\mathbf{H_{b2}}$) above the top of the bridge **112**.

[0046] In some embodiments, the bridge **112** is attached to the base **102** such that the bridge standoff platforms **110** (and cable hangers **114** attached to the bridge standoff platforms **110**) reside above the base standoff platforms **108** (and the cable hangers **114** attached to the base standoff platforms **108**). For example, as shown in **FIGS. 1-4** and **FIGS. 10-12**, the cable hangers **114** attached to the bridge **112** reside directly above the cable hangers **114** attached to the base **102**.

[0047] The bridge **112** should have a sufficient height ($\mathbf{H_b}$) such that the cable hangers **114** attached to the bridge **112** align with an upper row of connection ports **152**. The bridge **112** should also have a sufficient height ($\mathbf{H_b}$) above the cable hangers **114** secured to the base **102** (or in a base standoff platform **108**) such that the bridge **112** does not contact the cable hangers **114** secured to the base **102** (or base standoff platforms **108**). A sufficient height ($\mathbf{H_b}$) of the bridge **112** also allows for enough space for easy installation and identification of coaxial cables **250** by a technician (*see also, e.g.*, **FIG. 12**). For example, in some embodiments, the bridge **112** has a height ($\mathbf{H_b}$) relative to the base **102** in the range of about 3 inches to about 6 inches. The height ($\mathbf{H_b}$) of the bridge **112** can vary based on antenna design and has the potential to be increased based on the type of antenna.

[0048] In some embodiments, the height ($\mathbf{H_b}$) of the bridge **112** may be adjustable. For example, in some embodiments, each side of the bridge **112** may comprise a telescoping member that allows the bridge **112** to be raised and lowered to a desirable height ($\mathbf{H_b}$).

[0049] In some embodiments, in place of the base support platforms **108** and/or the bridge **112**, one or more cable hangers **114** may be stacked on top of one another to align one or more cable hangers **114** with one or more connection ports **152**. For example, three cable hangers **114** may be stacked on top of one another such that the bottom and top cable hangers **114** in the stack each align with a respective connection port **152**.

[0050] Referring to **FIG. 3**, in some embodiments, the base **102** of the cable support bracket **100** may further comprise slots (or holes) **122**. The slots **122** may be included to reduce the exposure area of the cable support bracket **100**, thereby mitigating wind drag on the cable support bracket **100**. The slots **122** may vary in number, shape and/or size.

[0051] Referring now to **FIGS. 4-8**, an antenna assembly **200** according to some embodiments of the present invention is illustrated. As shown in **FIGS. 4-8**, a cable support bracket **100** as described herein is mounted to an antenna **150**. The base **102** of the cable support bracket **100** is secured to the antenna **150** by a mounting plate **104** (*see, e.g.*, **FIG. 5**). The mounting plate **104** is configured such that it can be secured to a pre-existing mounting bracket **154** on the antenna **150**.

[0052] Referring to **FIG. 6**, the cable support bracket **100** aligns the cable hangers **114** with the connection ports **152** of the antenna **150**. Aligning the cable hangers **114** with the connection ports **152** helps to prevent or reduce bending the coaxial cables **250** when secured within the cable hangers **114**. Thus, the cable support bracket **100** helps to mitigate PIM caused by bends of the coaxial cable that are that are too close to the connector body that terminates the cable. In some embodiments, the cable support bracket **100** may be color-coded to match with the connection ports **152** of an antenna **150** allowing for easy installation and organization of the cables **250** by a technician (*see also, e.g.*, **FIGS. 10-12**).

[0053] As shown in **FIG. 6**, the cable support bracket **100** has ten cable hangers **114** to match the ten connection ports **152** of the antenna **150** (*see, e.g.*, four cable hangers **114** are attached to the base **102** and six cable hangers **114** are attached to the bridge **112**). Note that two of the cable hangers **114** are attached to the bottom of the bridge **112** in order to properly align with two of the connection ports **152** on the antenna **150**. The arrangement of cable hangers **114** on the base **102** and/or bridge **112** may vary depending on how the connection ports **152** are arranged on an antenna **150**. The cable support brackets **100** of the present invention can be modified to match different arrangements of connection ports **152** on different antennas **150**.

[0054] As stated above, it is undesirable to bend a coaxial cable **250** close to its connection with an antenna **150**. Bending a coaxial cable **250** too close to the connection port **152** may

damage the coaxial cable **250** and/or may be a source of unwanted PIM. Industry standards for support before the first bend of a coaxial cable **250** vary from operator to operator. For example, typical industry standards provide that coaxial cables **250** should not bend within six inches from the connection port **152**. As shown in **FIG. 7** and **FIG. 8** (*see also*, **FIGS. 10-12**), the cable support bracket **100** of the present invention is attached to an antenna **150** such that the cable guide **106** and cable hangers **114** are a sufficient distance (**D**) from the bottom **150b** (and connection ports **152**) of the antenna **150**. Note that it is also desirable that the cable hangers **114** (and cable guide **106**) are not too far from the bottom **150b** and connection ports **152** of the antenna **150**. The farther away the cable hangers **114** are from the connection ports **152**, the greater the length of cable **250** extending between the connection ports **152** and cable hangers **114** that is exposed to wind. This could lead to damage to and/or loosening of the connection between the cables **250** and the antenna **150**, and/or can add to the wind load of the antenna assembly **200**. In some embodiments, the cable hangers **114** and/or cable guide **106** are at distance from the bottom **150b** of an antenna **150** in a range of about 9 inches to about 13 inches.

[0055] Referring now to **FIGS. 10-12**, illustrated is an antenna assembly **200**, in combination with a plurality of coaxial cables **250**, according to embodiments of the present invention. Each of the cables **250** are connected to a respective connection port **152** located at the bottom **150b** of an antenna **150**. The cable support bracket **100** of the present invention aligns the cable hangers **114** with the connection ports **152** to provide optimized and predetermined coaxial support for the coaxial cable connections at the antenna **150**. The cable support bracket **100** helps keep the coaxial cables **250** straight near the connection ports **152**. Reducing bends in the coaxial cables **250** that are too close to the connector body help to mitigate PIM. The cable guide **106** helps to maintain the minimum bend radius requirements of the coaxial cables **250**, thereby also helping to reduce unwanted PIM near the antenna **150**. As shown in **FIG. 12**, the cable support bracket **100** of the present invention may provide for easy identification of organized coaxial cables **250** attached to the antenna **150**.

[0056] Referring to **FIG. 13**, a cable support bracket **300** according to alternative embodiments of the present invention is illustrated. In some embodiments, the cable support bracket **300** may comprise a shroud **220**. In some embodiments, the shroud **220** may be coupled to or integral with the base **102** and have one or more walls **220w**. The walls **220w** of the shroud **220** may be configured to receive and secure a plurality of cable hangers **114**. The cable support bracket **300** is configured to align the cable hangers **114** with the

connection ports **152** of the antenna **150.** For example, in some embodiments, a plurality of cable hangers **114** may be secured to an interior of one or more walls **220w** of the shroud **220**. As shown in **FIG. 13**, the cable hangers **114** may be attached to and hang down from the interior of a top wall **220w** of the shroud **220** such that the cable hangers **114** may align with an upper row of connection ports **152.**

[0057] In some embodiments, the shroud **220** may be configured to meet or overlap with the lower edge of the antenna **150** to cover cable connections at the bottom **150b** of the antenna **150**. The shroud **220** may also have a length such that the shroud covers the length of cable **250** extending between the connection ports **152** at the bottom **150b** of an antenna **150** and the cable hangers **114**, thereby protecting the cables **250** (and cable connection(s) to the antenna **150**) from harsh environmental conditions (*e.g.*, wind, rain, snow, etc.). In some embodiments, the shroud **220** may be configured to fit around the radome of an antenna **150** (or in some embodiments may be integral with the radome) and may assist in mounting the cable support bracket **300** to the antenna **150** or may be used as additional support when the bracket **100** is mounted to an antenna **150**.

[0058] Methods for organizing coaxial cable connections at a base station antenna are also provided. In some embodiments, a method may comprise providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna, the base comprising a plurality of base standoff platforms, each standoff platform configured to receive a cable hanger; a cable guide having a generally arced outer surface, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective base standoff platform; mounting the cable support bracket to an antenna having a plurality of connection ports such that each cable hanger aligns with a respective connection port; connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and securing each coaxial cable to a respective cable hanger.

[0059] In some embodiments, the method may comprise providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna and configured to receive and secure a first plurality of cable hangers; a bridge removably attached to the base, the bridge configured to receive and secure a second plurality of cable hangers; and a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; mounting the cable support bracket to an antenna having a plurality of connection ports such

that each cable hanger aligns with a respective connection port; connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and securing each coaxial cable to a respective cable hanger

[0060] 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 cable support bracket, the bracket comprising:

a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger;

a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and

a plurality of cable hangers, each cable hanger secured in a respective aperture in the base.

2. The cable support bracket of Claim 1, wherein the base comprises a plurality of base standoff platforms, each standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective base standoff platform.

3. The cable support bracket of any one of Claims 1 or 2, the bracket further comprising:

a bridge removably attached to the base, the bridge comprising a plurality of apertures, each bridge aperture configured to receive a respective cable hanger; and

a second plurality of cable hangers, each cable hanger secured in a respective aperture in the bridge.

4. The cable support bracket of Claim 3, wherein the bridge comprises a plurality of bridge standoff platforms, each bridge standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective bridge standoff platform.

5. A cable support bracket, the bracket comprising:

a base configured to be mounted to an antenna and configured to receive and secure a first plurality of cable hangers;

a bridge removably attached to the base, the bridge configured to receive and secure a second plurality of cable hangers; and

a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base.

6. The cable support bracket of Claim 5, the bracket further comprising:

a plurality of base standoff platforms coupled to the base, each base standoff platform configured to receive and secure a respective cable hanger; and

a plurality of bridge standoff platforms coupled to the bridge, each bridge standoff platform configured to receive and secure a respective cable hanger.

7. The cable support bracket of any one of the preceding claims, in combination with a plurality of cables, wherein at least one of the cables is secured within at least one of the plurality of cable hangers.

8. The cable support bracket of any one of the preceding claims, wherein the plurality of cables is coaxial cables.

9. The cable support bracket of any one of the preceding claims, wherein the base further comprises at least one support ridge.

10. The cable support bracket of any one of the preceding claims, wherein the bracket is formed of a non-metallic material.

11. The cable support bracket of Claim 10, wherein the non-metallic material comprises acetal, nylon, polypropylene, polyvinyl chloride, and/or fiberglass.

12. The cable support bracket of any one of the preceding claims, wherein the cable guide has a radius of about 2 inches or greater.

13. The cable support bracket of any one of the preceding claims, wherein the base further comprises slots or holes.

14. The cable support bracket of any one of the preceding claims, wherein the bracket has a length in the range of about 20 inches to about 30 inches and a width in the range of about 10 inches to about 36 inches.

15. The cable support bracket of any one of the preceding claims, wherein the bridge has a height in the range of about 3 inches to about 6 inches.

16. The cable support bracket of any one of the preceding claims, wherein the bracket is mounted to an antenna.

17. The cable support bracket of Claim 16, wherein the antenna is a base station antenna.

18. An antenna assembly, the assembly comprising:

an antenna; and

a cable support bracket, the cable support bracket comprising:

a base configured to be mounted to the antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger;

a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and

a plurality of cable hangers, each cable hanger secured in a respective aperture in the base,

wherein the cable support bracket is mounted to the antenna.

19. The antenna assembly of Claim 18, wherein the base comprises a plurality of base standoff platforms, each standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective base standoff platform.

20. The antenna assembly of any one of Claims 18 or 19, wherein the cable support bracket of the assembly further comprises a bridge removably attached to the base, the bridge comprising a plurality of apertures, each bridge aperture configured to receive a respective cable hanger; and a second plurality of cable hangers, each cable hanger secured in a respective aperture in the bridge.

21. The antenna assembly of Claim 20, wherein the bridge comprises a plurality of bridge standoff platforms, each bridge standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective bridge standoff platform.

22. The antenna assembly of any one of Claims 18-21, in combination with a plurality of cables, wherein at least one of the cables is secured within at least one of the plurality of cable hangers.

23. The antenna assembly of Claim 22, wherein the plurality of cables is coaxial cables.

24. The antenna assembly of any one of Claims 18-23, wherein the base further comprises at least one support ridge.

25. The antenna assembly of any one of Claims 18-24, wherein the bracket is formed of a non-metallic material.

26. The antenna assembly of Claim 25, wherein the non-metallic material comprises acetal, nylon, polypropylene, polyvinyl chloride, and/or fiberglass.

27. The antenna assembly of any one of Claims 18-26, wherein the cable guide has a radius of about 2 inches or greater.

28. The antenna assembly of any one of Claims 18-27, wherein the base further comprises slots or holes.

29. An antenna assembly, in combination with a plurality of cables, the assembly comprising:

an antenna; and

a cable support bracket, the support bracket comprising:

a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger;

a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and

a plurality of cable hangers, each cable hanger secured in a respective aperture in the base,

wherein the cable support bracket is mounted to the antenna, and

wherein at least one of the plurality of cables is secured within at least one of the plurality of cable hangers.

30. The cable support bracket of Claim 29, wherein the base comprises a plurality of base standoff platforms, each standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective base standoff platform.

31. The cable support bracket of any one of Claims 29 or 30, the bracket further comprising:

a bridge removably attached to the base, the bridge comprising a plurality of apertures, each bridge aperture configured to receive a respective cable hanger; and

a second plurality of cable hangers, each cable hanger secured in a respective aperture in the bridge.

32. The cable support bracket of Claim 31, wherein the bridge comprises a plurality of bridge standoff platforms, each bridge standoff platform configured to receive a cable hanger, wherein a cable hanger is secured in a respective bridge standoff platform.

33. The antenna assembly of any one of Claims 29-32, wherein the plurality of cables is coaxial cables.

34. The antenna assembly of any one of Claims 29-33, wherein the base further comprises at least one support ridge.

35. The antenna assembly of any one of Claims 29-34, wherein the bracket is formed of a non-metallic material.

36. The antenna assembly of Claim 35, wherein the non-metallic material comprises acetal, nylon, polypropylene, polyvinyl chloride, and/or fiberglass.

37. The antenna assembly of any one of Claims 29-36, wherein the cable guide has a radius of about 2 inches or greater.

38. The antenna assembly of any one of Claims 29-37, wherein the base further comprises slots or holes.

39. A method for organizing coaxial cable connections at a base station antenna, the method comprising:

providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna, the base comprising a plurality of apertures, each aperture configured to receive a cable hanger; a cable guide having a generally arced outer surface, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base; and a plurality of cable hangers, each cable hanger secured in a respective aperture in the base;

mounting the cable support bracket to an antenna having a plurality of connection ports such that each cable hanger aligns with a respective connection port;

connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and

securing each coaxial cable to a respective cable hanger.

40. A method for organizing coaxial cable connections at a base station antenna, the method comprising:

providing a cable support bracket, the support bracket comprising: a base configured to be mounted to an antenna and configured to receive and secure a first plurality of cable hangers; a bridge removably attached to the base, the bridge configured to receive and secure a second plurality of cable hangers; and a cable guide having a generally arced outer profile, wherein the cable guide is coupled to or integral with the base and extends outwardly from one end of the base;

mounting the cable support bracket to an antenna having a plurality of connection ports such that each cable hanger aligns with a respective connection port;

connecting a plurality of coaxial cables to the plurality of connection ports, wherein each coaxial cable is connected to a respective connection port; and

securing each coaxial cable to a respective cable hanger.

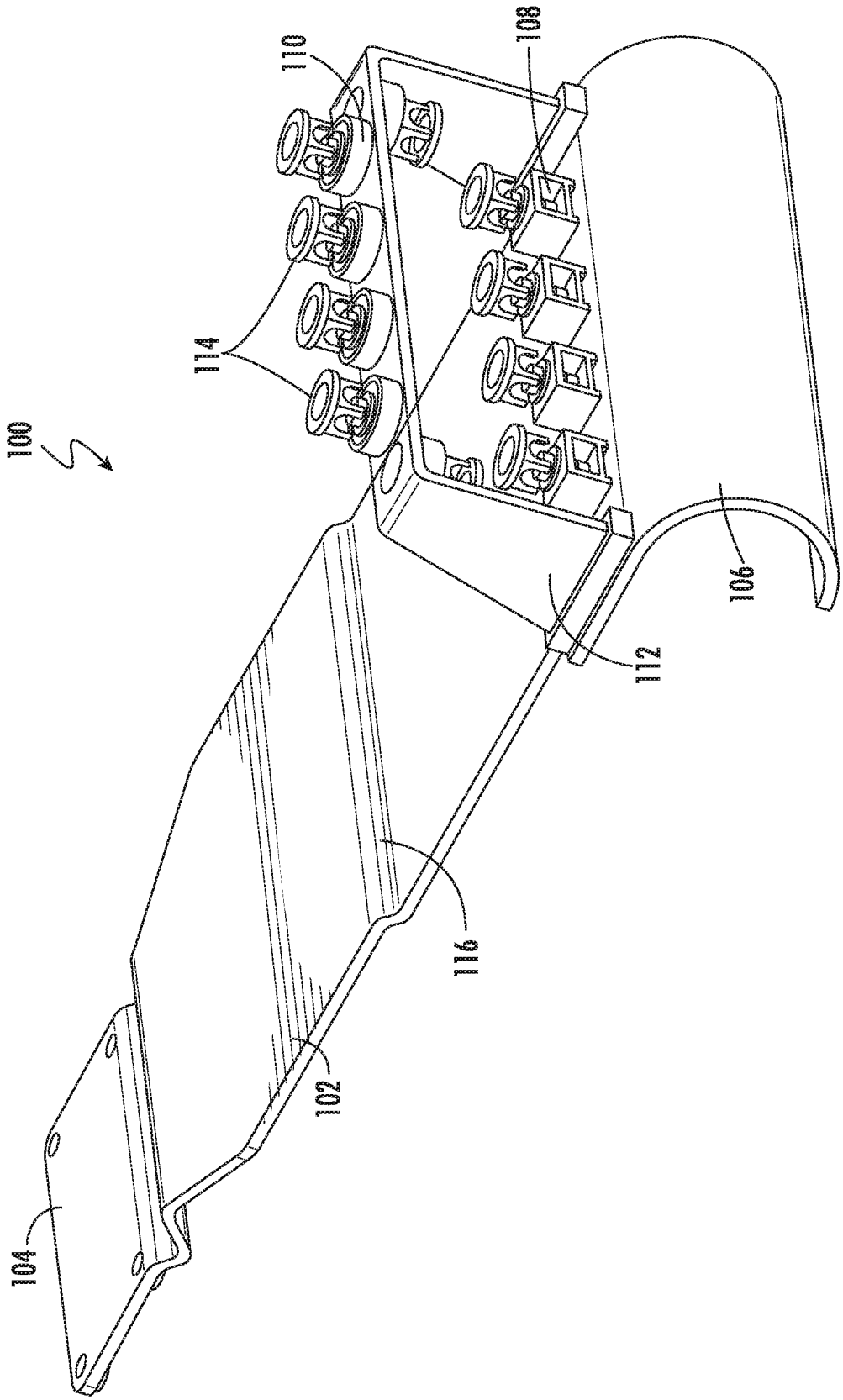


FIG. 1

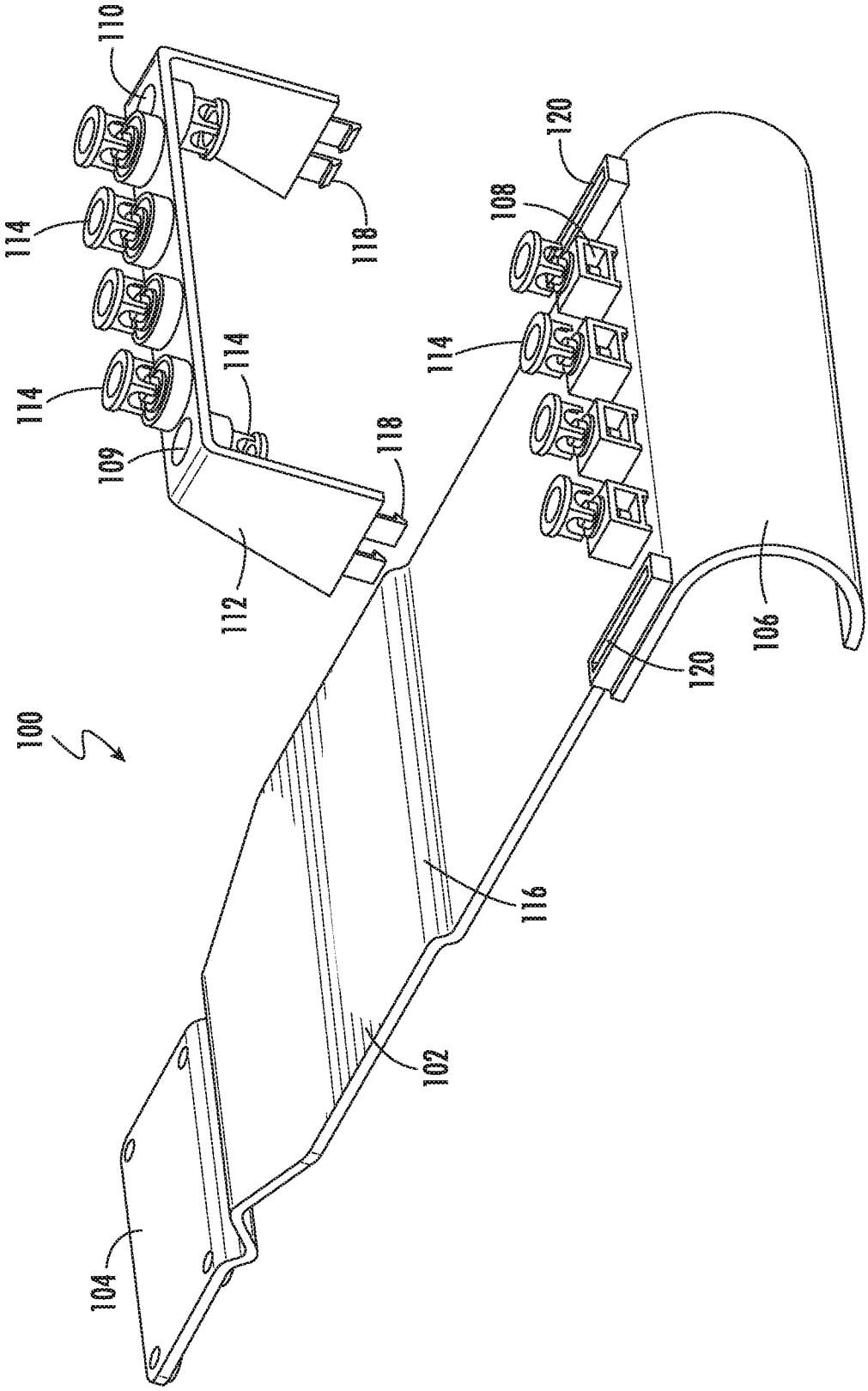

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FIG. 2

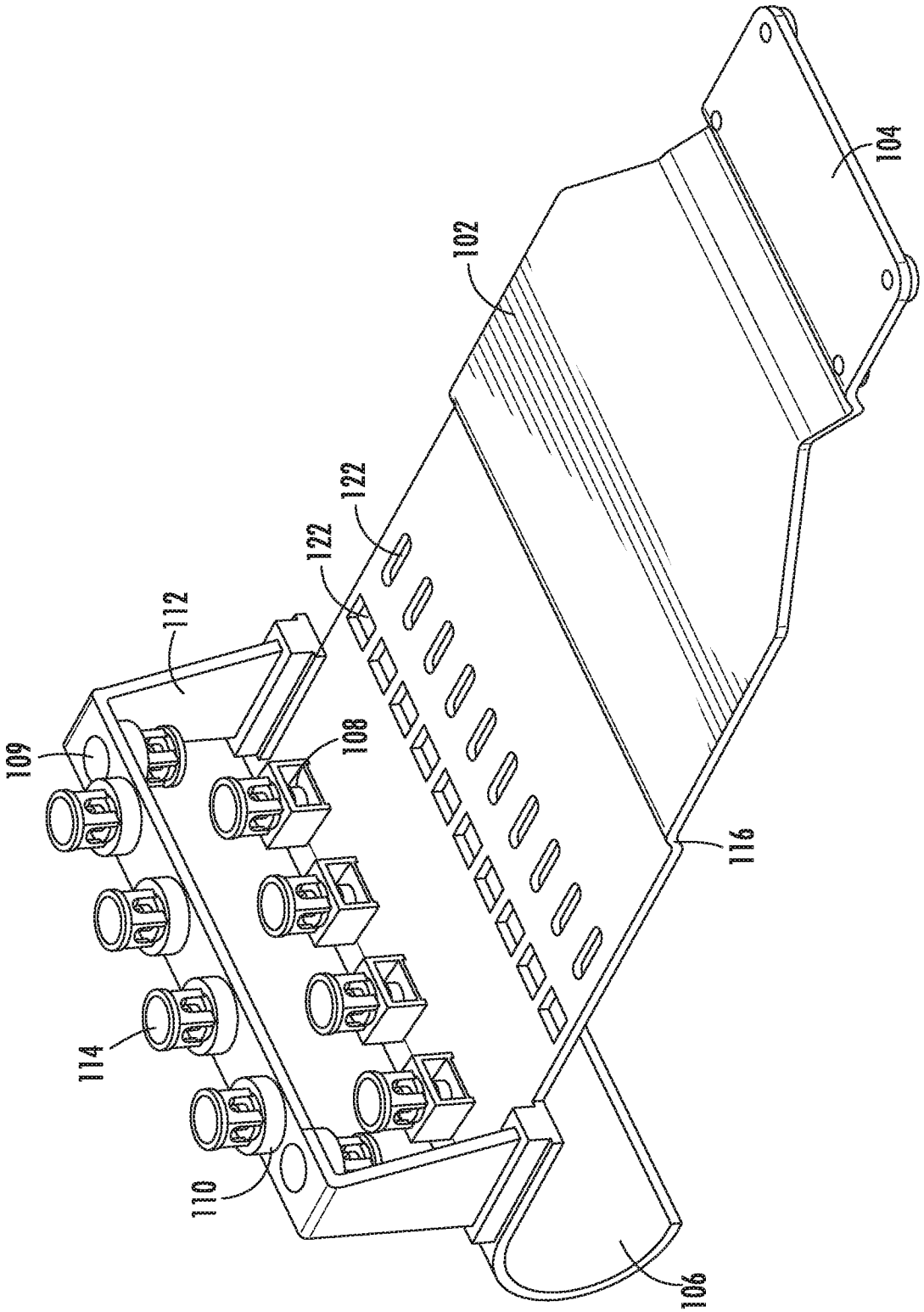


FIG. 3

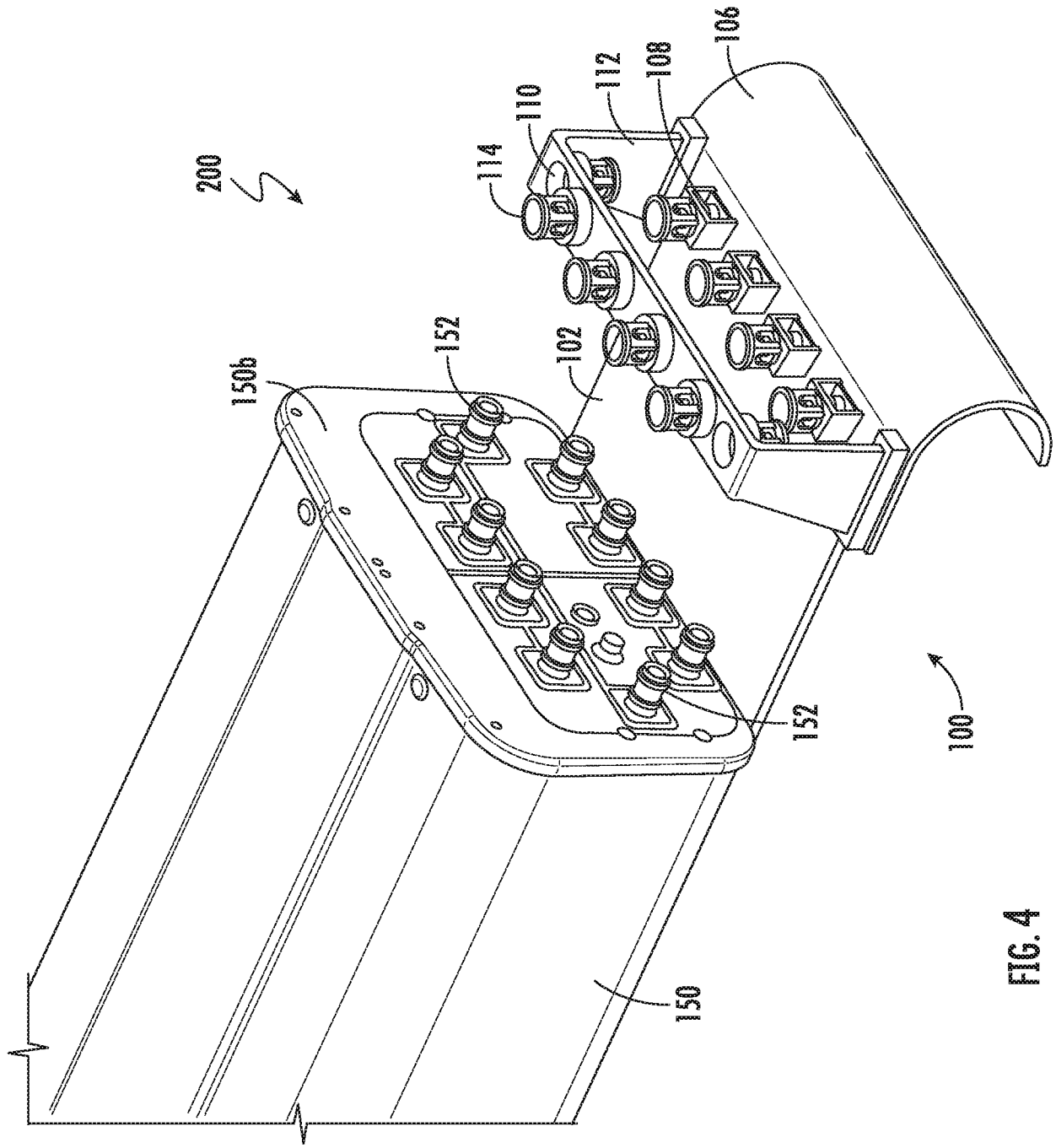


FIG. 4

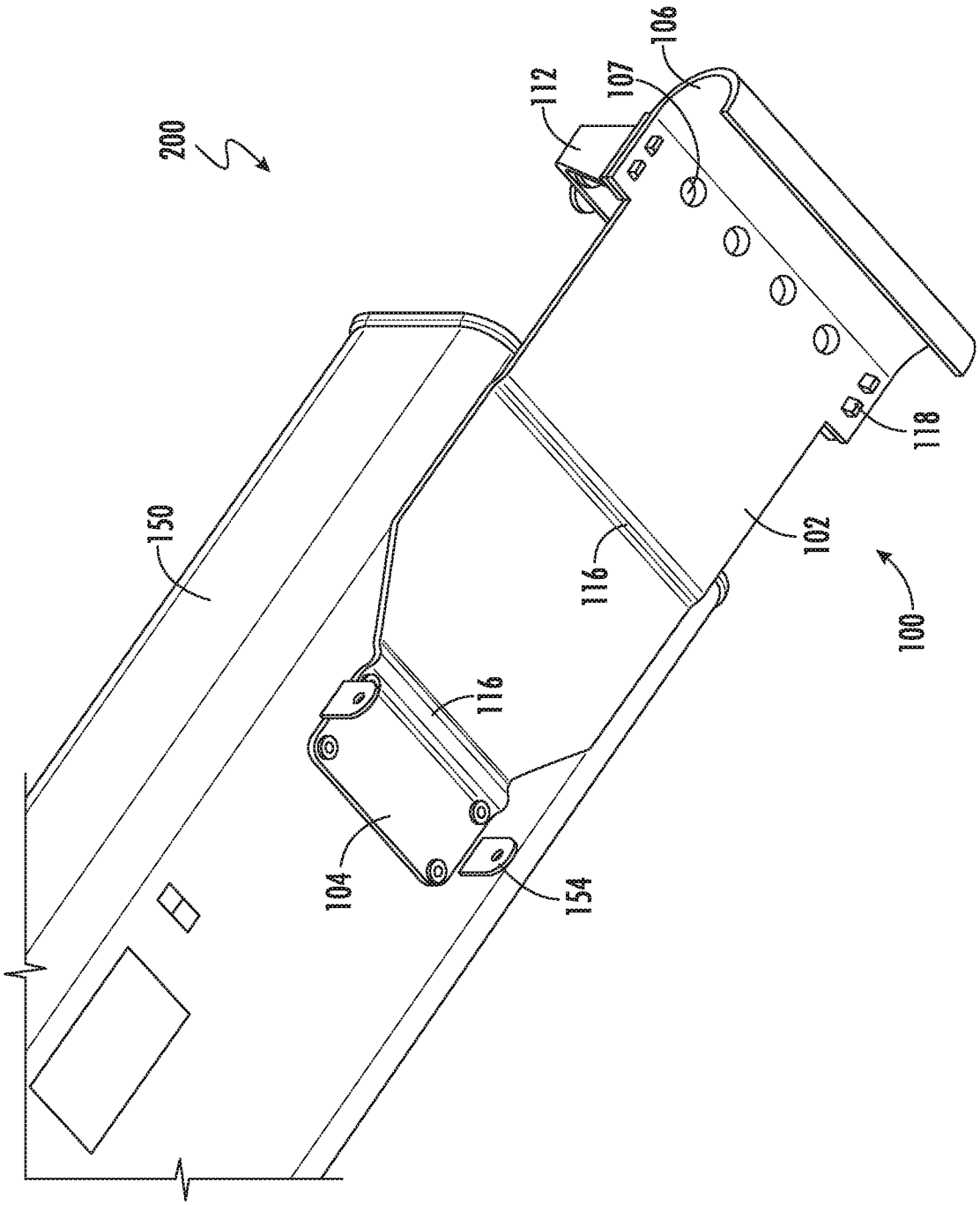


FIG. 5

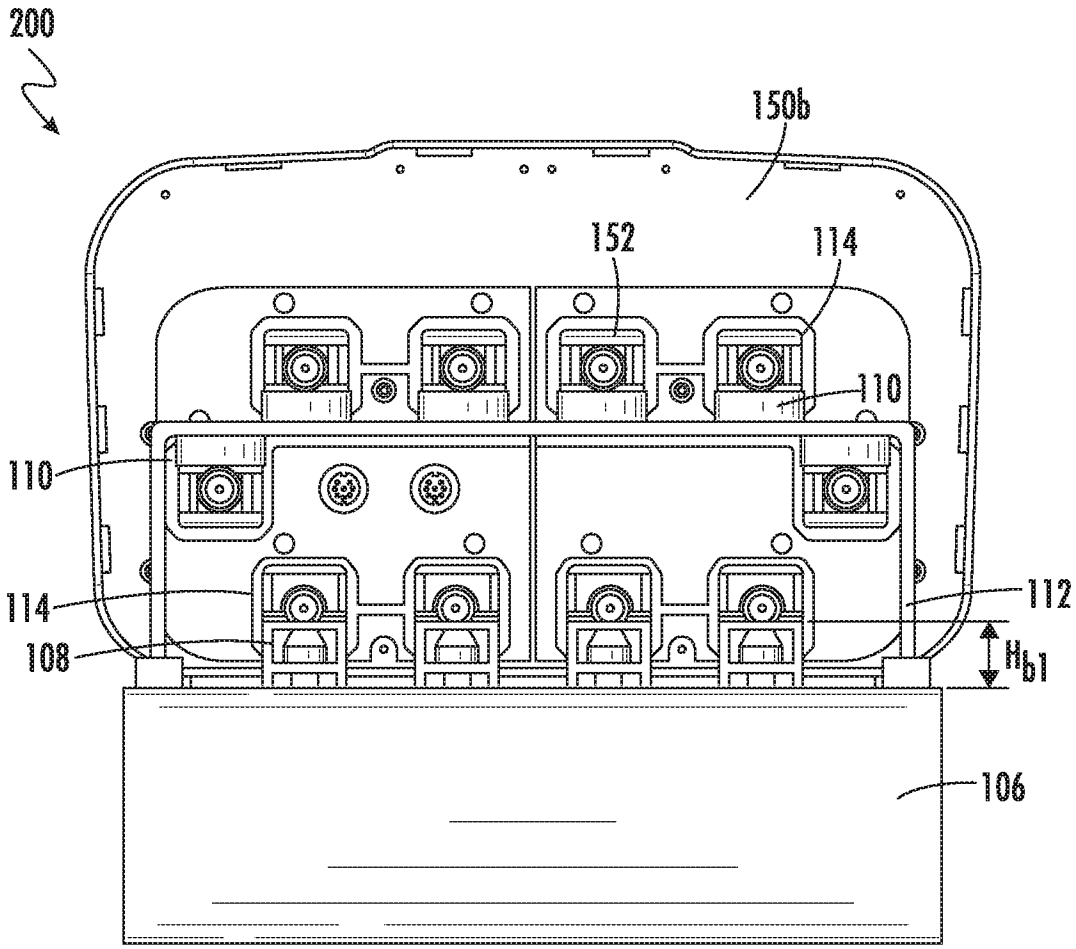


FIG. 6

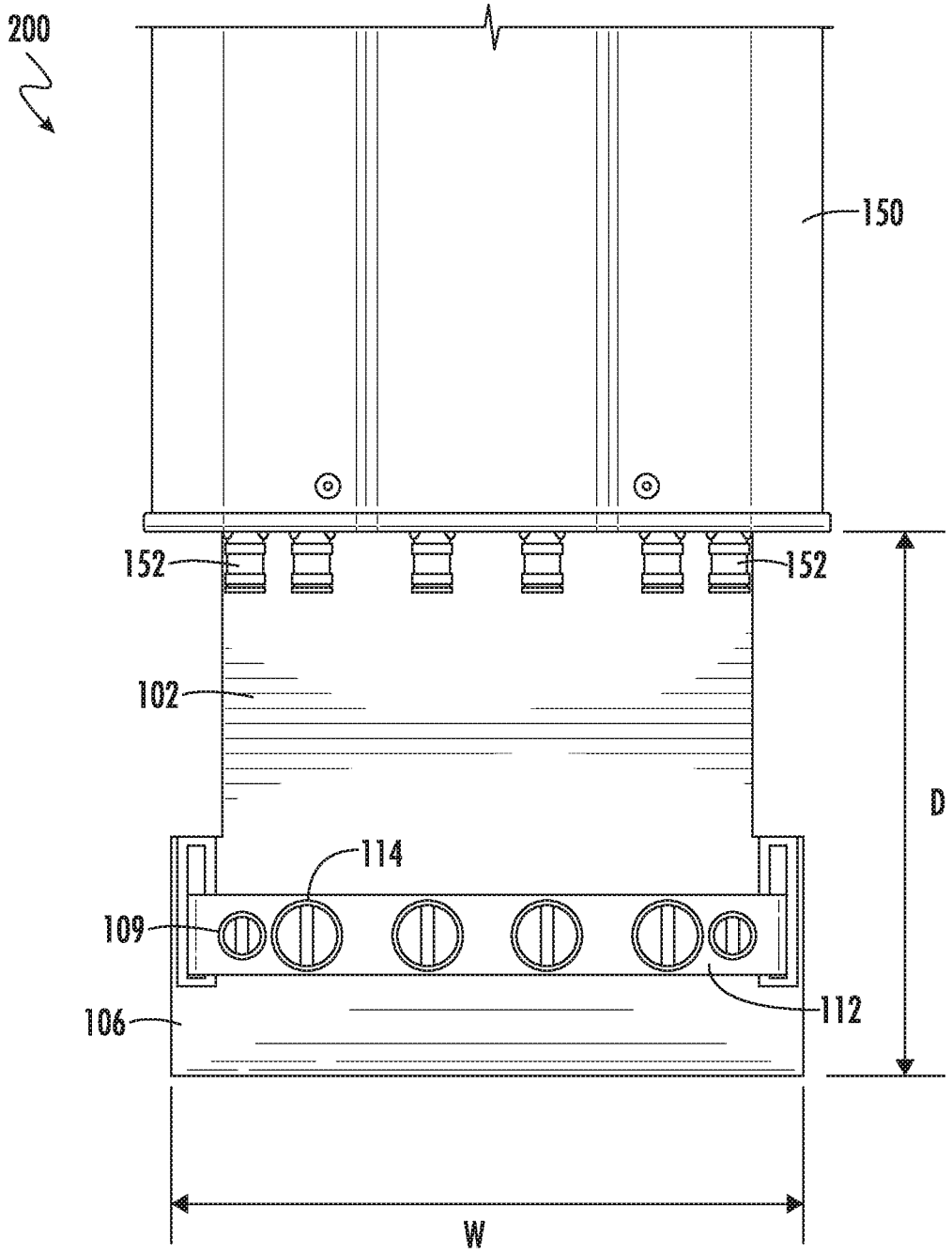


FIG. 7

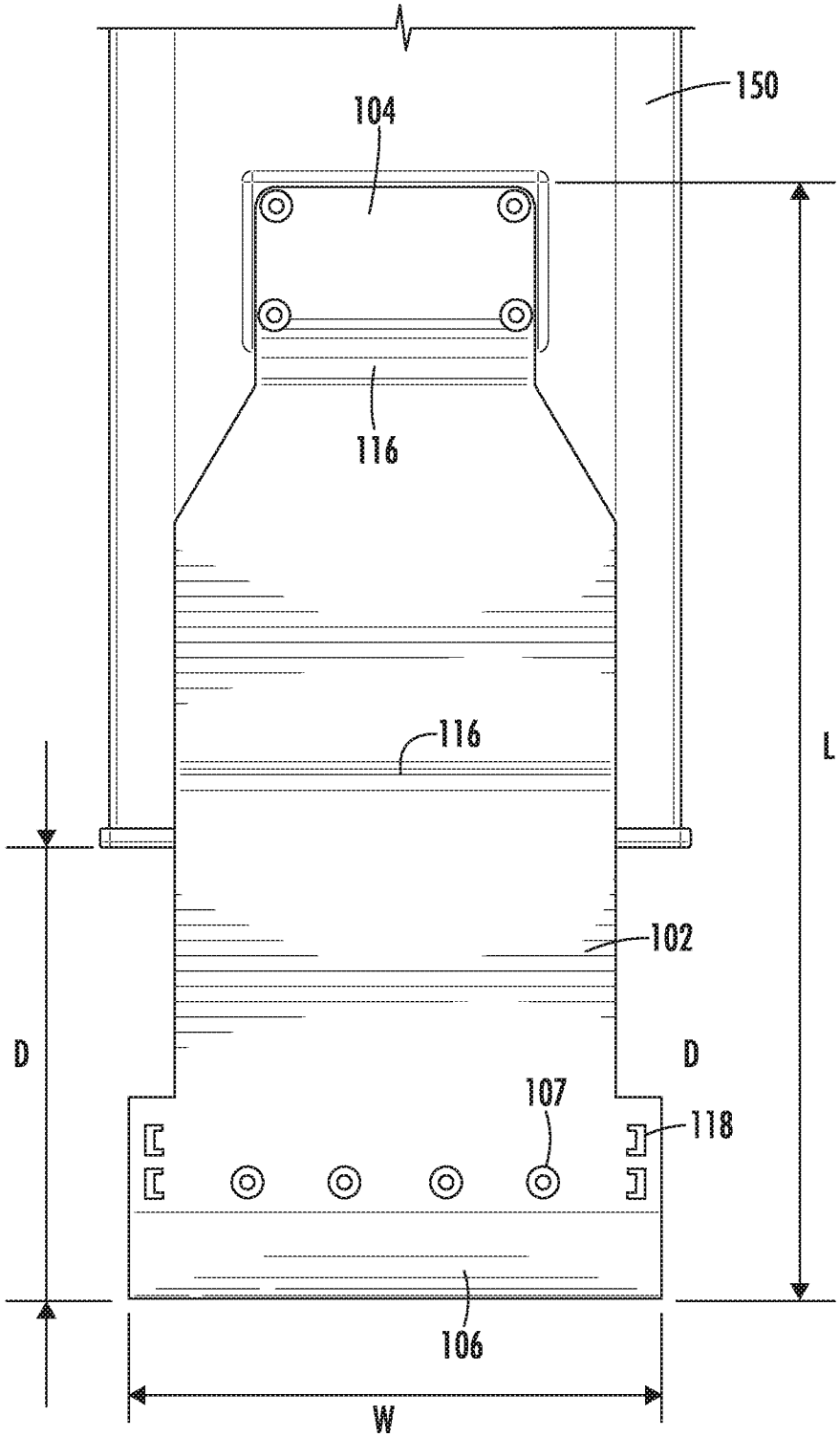


FIG. 8

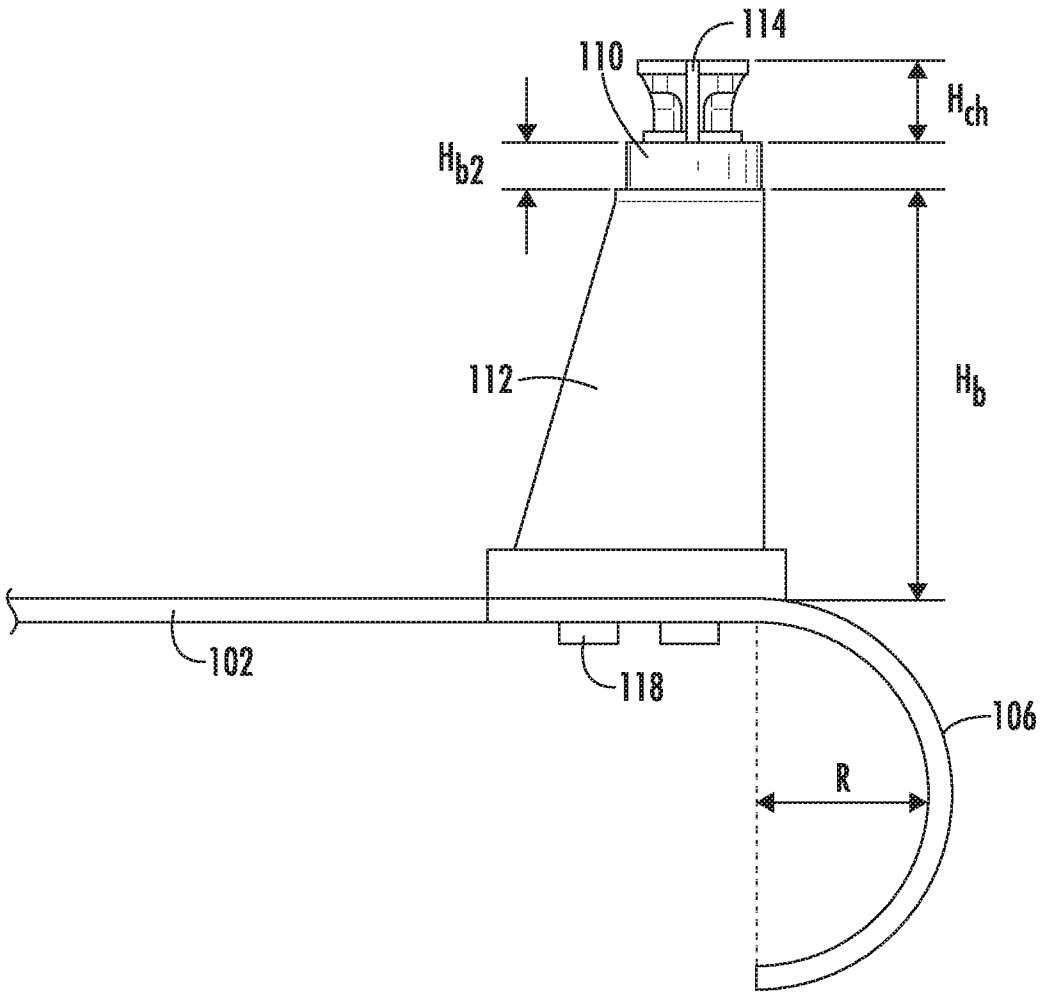


FIG. 9

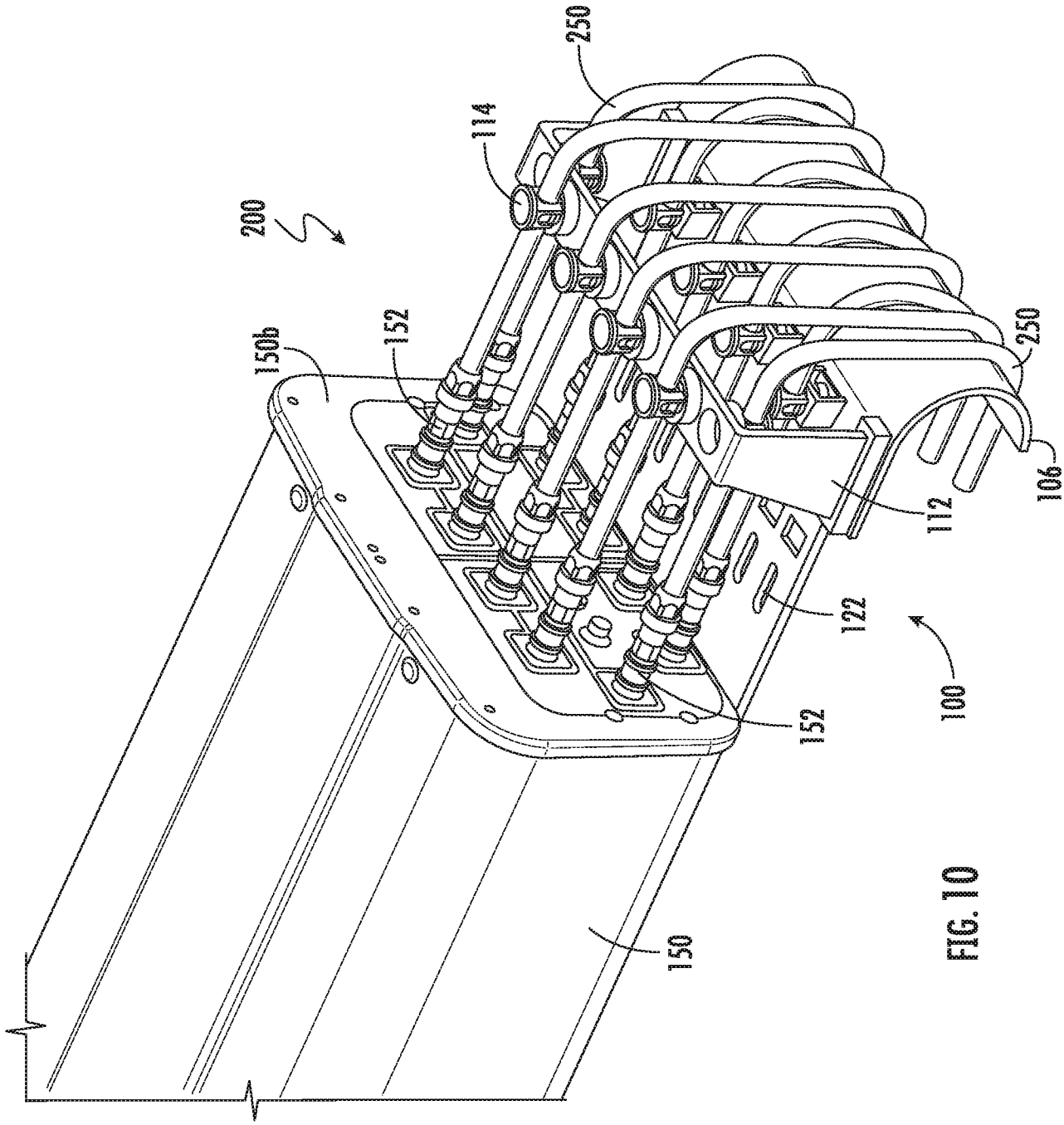


FIG. 10

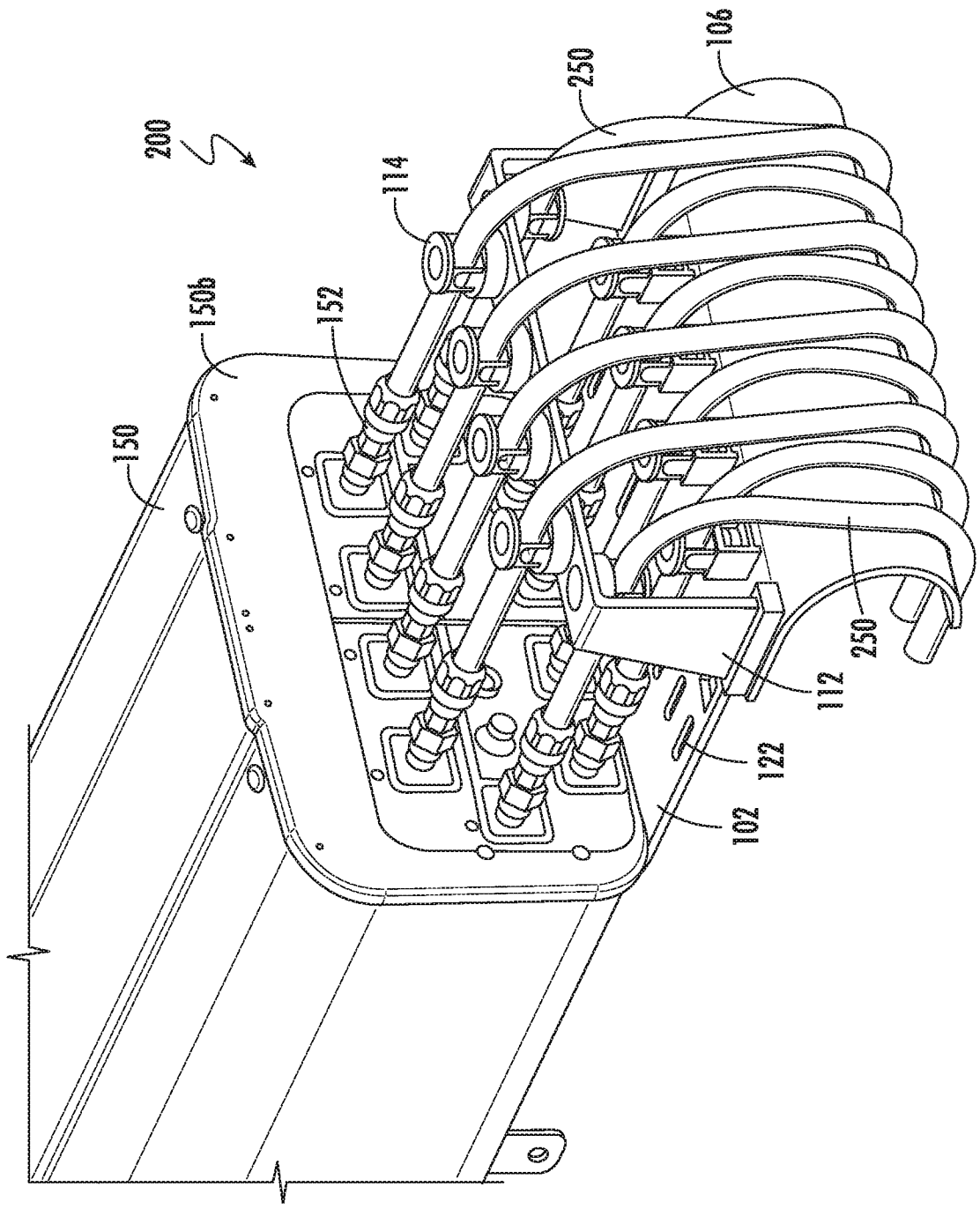


FIG. 11

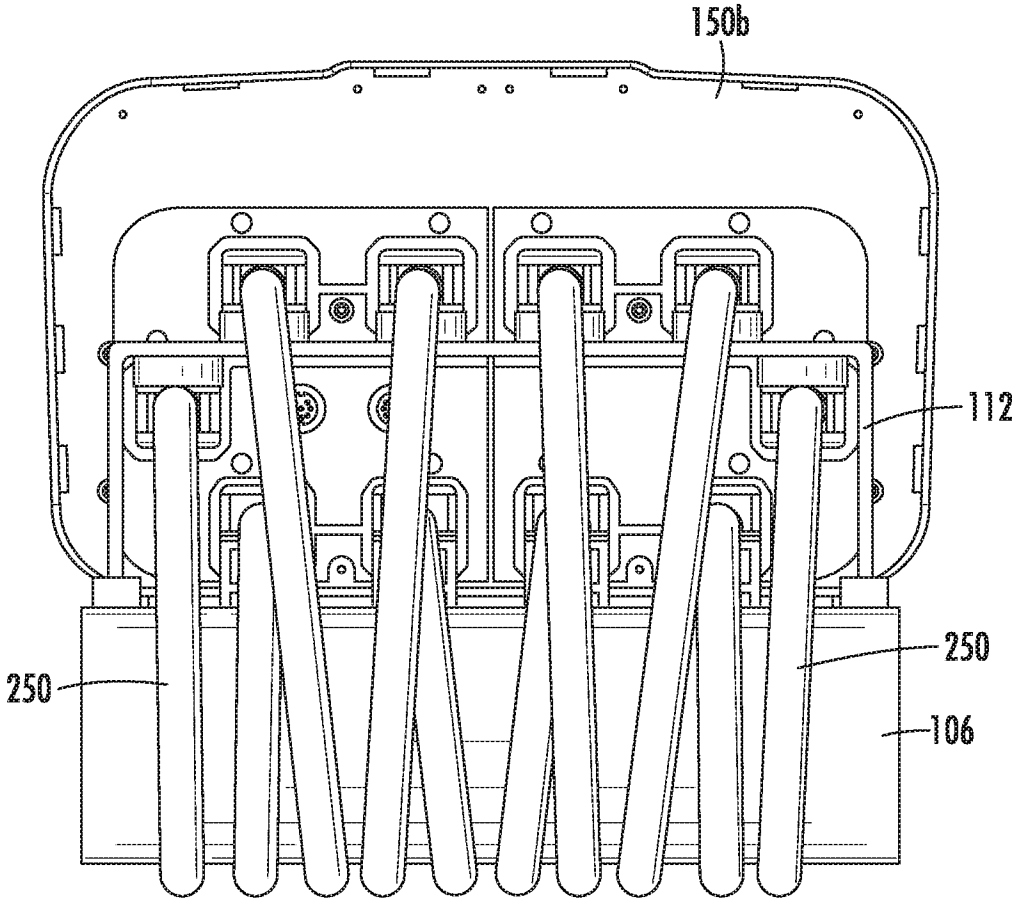


FIG. 12

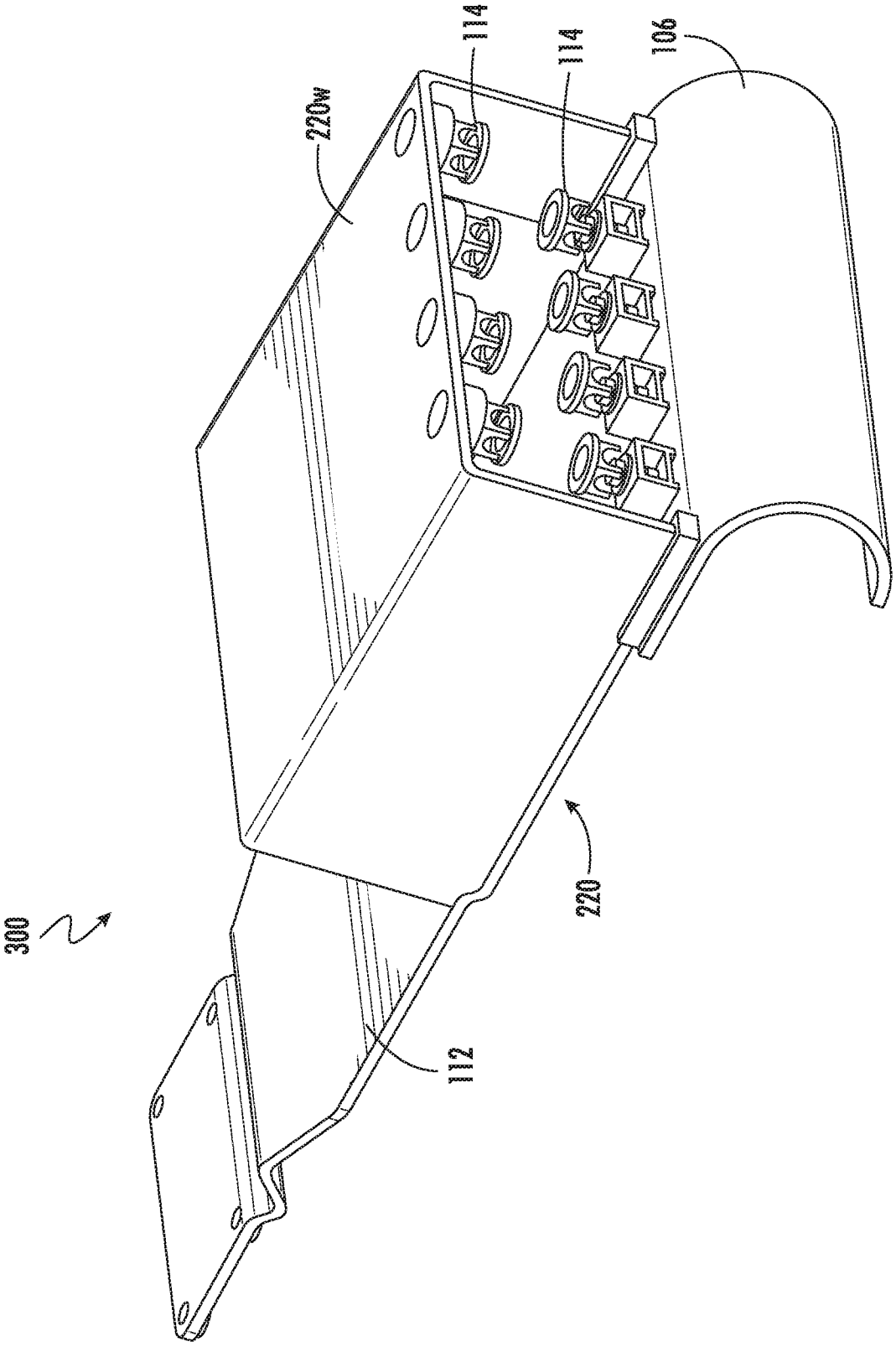


FIG. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/012864

A. CLASSIFICATION OF SUBJECT MATTER

H02G 3/02(2006.01)i, H01Q 1/12(2006.01)i

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)
H02G 3/02; B41J 29/00; F16L 3/02; H01Q 1/50; H01R 4/46; H02B 1/20; H02G 11/00; H02G 3/30; H05K 7/00; H01Q 1/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: cable, support, antenna, guide, hanger, aperture

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2010-255760 A (THREE M INNOVATIVE PROPERTIES CO.) 11 November 2010 See paragraphs [0016]-[0017] and figures 1-2.	1,18,29,39
A		2-6,19-21,30-32,40
Y	CN 202797276 U (SUZHOU DAFU COMM TECHNOLOGY CO., LTD.)13 March 2013 See claim 1 and figure 2.	1,18,29,39
Y	JP 2004-073000 A (ORTHO CLINICAL DIAGNOSTICS INC.) 04 March 2004 See paragraphs [0021]-[0030] and figures 2-3.	1,18,29,39
A	JP 6116518 B2 (FUJITSU FRONTECH LTD.) 19 April 2017 See claim 1 and figure 1.	1-6,18-21,29-32 ,39-40
A	KR 10-0772839 B1 (ELSCOM CO., LTD.) 02 November 2007 See paragraphs [0024]-[0033] and figure 4.	1-6,18-21,29-32 ,39-40

☐ 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
"D" document cited by the applicant in the international application
"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	Date of mailing of the international search report
07 May 2020 (07.05.2020)	**07 May 2020 (07.05.2020)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea
Facsimile No. +82-42-481-8578

Authorized officer
JANG, Gijeong
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2020/012864

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 11,17,23,26,36
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claims 11, 17, 23, 26, 36 are considered to be unclear in that they refer to one of the claims which do not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 7-10, 12-16, 22, 24-25, 27-28, 33-35, 37-38
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2020/012864

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2010-255760 A	11/11/2010	None	
CN 202797276 U	13/03/2013	None	
JP 2004-073000 A	04/03/2004	CA 2437438 A1	08/02/2004
		EP 1388919 A2	11/02/2004
		EP 1388919 A3	09/02/2005
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JP 6116518 B2	19/04/2017	JP 2015-211605 A	24/11/2015
KR 10-0772839 B1	02/11/2007	None	