



(51) International Patent Classification:

G02B 6/44 (2006.01) H02G 15/115 (2006.01)
H02G 15/117 (2006.01)

(21) International Application Number:

PCT/US2017/052133

(22) International Filing Date:

19 September 2017 (19.09.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/399,600 26 September 2016 (26.09.2016) US

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

(72) Inventor: WANG, Chi-Ming; 732 S. Financial Place, Apt. 219, Chicago, Illinois 60605 (US).

(74) Agent: CANON, James, R.; Myers Bigel, P.A., PO 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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, 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).

Published:

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

(54) Title: BREAKOUT ENCLOSURE FOR TRANSITIONING FROM TRUNK CABLE TO JUMPER CABLE

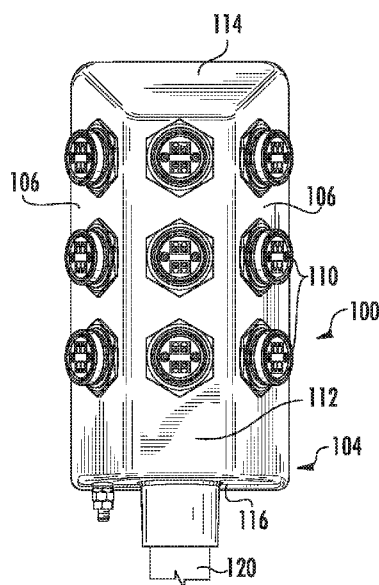


FIG. 1

(57) Abstract: An assembly for breaking out a trunk cable includes: a base having a generally flat surface adapted for mounting to a mounting surface; a shell having a front wall, two side walls extending from opposite sides of the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity; a plurality of connectors mounted to each of the side walls; a trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors; and at least one bus bar mounted to the shell within the cavity, at least one of the power conductors and at least one of the connectors in electrical connection with the bus bar.



BREAKOUT ENCLOSURE FOR TRANSITIONING FROM TRUNK CABLE TO JUMPER CABLE

Related Application

[0001] The present application claims priority from and the benefit of U.S. Provisional Patent Application No. 62/399,600, filed September 26, 2016, the disclosure of which is hereby incorporated herein in its entirety.

Field of the Invention

[0002] The present invention relates generally to power and signal distribution, and more particularly to distribution from hybrid cables.

Background

[0003] Latest developments in technology for delivering power and data in wireless infrastructure use hybrid cables, wherein the term “hybrid cable” is intended to mean a cable that includes both power conductors and one or more fiber optic cords or cables. An exemplary hybrid cable is the HFF cable, available from CommScope, Inc. (Joliet, Illinois). Unlike RF-based systems, a single hybrid trunk cable can be used to power multiple sectors, thereby eliminating multiple runs of RF cable. However, in order to use a single hybrid trunk cable, at

some point the trunk cable must transition to jumper cables. Typically, these are distributed inside an enclosure that transitions the trunk conductor gauge to the jumper conductor gauge and connects the optical fibers in the trunk to the optical fibers in the jumper cables. Currently, transitions are achieved by making connections inside the enclosure, requiring it to be opened, cables to be fed/mated to the enclosure, and power and fiber connections to be made, all in the field (e.g., on the top of cell sites near a remote radio unit (RRU)). This practice can create many issues for installers, including time, safety, connection errors (such as loose power connections and/or poor fiber cleaning), and more opportunity for connector damage.

[0004] In co-assigned and co-pending U.S. Patent Application Serial No. 14/448,269, filed July 31, 2014, the disclosure of which is hereby incorporated herein in its entirety, devices are described that provide a solution to some of the issues described above. The devices discussed therein comprise an enclosure having mixed media connectors in one or two walls to receive jumper cables. A hybrid fiber-power trunk cable is routed to the bottom wall of the enclosure, then is routed within the enclosure to the mixed media connectors. The trunk cable is either attached to the enclosure via a trunk cable connector, which is then connected with the mixed media connectors, or is routed through a cable gland in the bottom wall of the enclosure and connected with the mixed media connectors. Co-assigned and co-pending U.S. Patent Application No. 15/071,620, filed March 16, 2016 (also incorporated herein by reference in its entirety), discusses a number of embodiments of enclosures, some of which have side walls for mounting mixed media connectors that form a triangular or trapezoidal cross-section.

Summary

[0005] As a first aspect, embodiments of the invention are directed to an assembly for breaking out a trunk cable, comprising: a base having a generally flat surface adapted for mounting to a mounting surface; a shell having a front wall, two side walls extending from opposite sides of the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity; a plurality of connectors mounted to each of the side walls; a trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors; and at least one bus bar mounted to the shell within the cavity. At least one

of the power conductors and at least one of the connectors are in electrical connection with the bus bar.

[0006] As a second aspect, embodiments of the invention are directed to an assembly for breaking out a trunk cable comprising: a base having a generally flat surface adapted for mounting to a mounting surface; a shell having a front wall, two side walls extending from opposite sides of the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity; a plurality of connectors mounted to each of the side walls; a trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors; and a platform configured for mounting of components (such as an OVP unit) residing in the cavity.

[0007] As a third aspect, embodiments of the invention are directed to an assembly for breaking out a trunk cable comprising: a base having a generally flat surface adapted for mounting to a mounting surface; a shell having a front wall, two side walls extending from opposite sides of and flaring outwardly from the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity; a plurality of connectors mounted to each of the side walls; a hybrid trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors and a plurality of optical fibers; and two bus bars mounted to the shell within the cavity. Each of the bus bars is positioned adjacent a free edge of a respective side wall. At least one of the power conductors and at least one of the connectors are in electrical connection with each bus bar.

Brief Description of the Figures

[0008] FIG. 1 is a perspective view of an exemplary enclosure according to embodiments of the present invention.

[0009] FIG. 2 is a section view of the enclosure of FIG. 1 with the conductors and optical fibers removed for clarity.

[0010] FIG. 3 is a top view of the shell of the enclosure of FIG. 1, with the terminals, optical fibers and conductors removed for clarity.

[0011] FIG. 4 is a top view of the shell of FIG. 3, with the optical fibers and conductors removed for clarity.

[0012] FIG. 5 is a top view of the shell of FIG. 3 with the conductors and optical fibers present.

[0013] FIG. 6 is a top view of the shell of FIG. 3 with a platform included.

Detailed Description

[0014] The present invention is described with reference to the accompanying drawings, in which certain 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 that are pictured and described 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. It will also be appreciated that the embodiments disclosed herein can be combined in any way and/or combination to provide many additional embodiments.

[0015] Unless otherwise defined, all technical and scientific terms that are used in this disclosure have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The terminology used in the below description is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used in this disclosure, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will also be understood that when an element (e.g., an assembly, a housing, a cable, etc.) is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

[0016] Referring now to the figures, a breakout enclosure for distributing power and fiber from a hybrid trunk cable is shown in FIG. 1 and designated broadly at 100. The enclosure has a base 102 (FIG. 2) and a shell 104 that mate to form the hollow enclosure 100. The shell 104 includes side walls 106, a front wall 112, a top wall 114 and a bottom wall 116 through which a cable 120 is routed. The shell 104 is generally trapezoidal in cross-section, with the side walls 106 flaring outwardly from the front wall 112 (this arrangement may provide a reduced wind loading). Mixed media/hybrid connectors 110 are mounted on the side walls 106 and the front

wall 112. The base 102 is generally flat and is configured for attachment to a pole or other mounting apparatus after the enclosure 100 is pulled up to a desired location on an antenna tower.

[0017] The enclosure 100 illustrated therein is exemplary only; other enclosures, including those shown in U.S. Patent Application No. 15/071,620, *supra*, may be suitable. Exemplary materials for the enclosure 100 include thermoplastics. In some embodiments, the pieces of the enclosure may be formed by injection molding.

[0018] It will also be apparent to those of skill in this art that the enclosure may include different numbers of connectors. For example, enclosures including six connectors (in both 3x2 and 2x3 arrangements), eight connectors (in a 2x4 arrangement), and twelve connectors (in a 3x4 arrangement) may also be employed. In the 2x3 and 2x4 arrangements, the enclosure may include only an short arced front wall (without any connectors mounted thereon), which can save space and provide less wind resistance.

[0019] Referring now to FIGS. 2-5, the interior of the enclosure 100 is shown therein. Referring first to FIG. 3, the interior side of the shell 104 is shown. As can be seen therein, holes 122 are present in the side walls 106 to provide mounting locations for the connectors 110. Holes 124 are also present in the front wall 112 to provide mounting locations for connectors 110.

[0020] Two copper bus bars 130 are mounted near the free edges of the side walls 106 and extend parallel to the length of the shell 104. The bus bars 130 are mounted in supports 132 extending from each side wall 106 that capture the ends of the bus bars 130. In the illustrated embodiment, the bus bars 130 are further secured with screws (not shown) inserted into bosses 134 in the supports 132. Typically, one bus bar 130 may be used to provide power (often -48V) in parallel, and the other bus bar 130 may be used to provide the return path in parallel (more commonly the return path is arranged in parallel).

[0021] The bus bars 130 are positioned to be connected with power conductors of the hybrid cable 120 and to the connectors 110; such connections may be formed by welding, clamps, sockets or the like. In the illustrated embodiment, terminals 131 are mounted in electrical contact with the bus bars 130 and are employed to interconnect various components via the bus bars 130 (see FIGS. 2 and 4). For example, in the illustrated embodiment, fifteen terminals 131

are mounted on each bus bar 130: five of the terminals 131 are connected with conductors 120a from the hybrid trunk cable 120 (see FIG. 5); nine of the terminals 131 are connected via a conductor 120b with a respective hybrid connector 110 (FIG. 5); and one terminal 131 is attached via a conductor (not shown) to an overvoltage protection unit (OVP unit) (not shown in FIGS. 2-6).

[0022] Those skilled in this art will appreciate that different numbers of terminals 131 may be employed, and that the terminals 131 may be omitted entirely if the conductors are interconnected via other means. For example, the conductors 120, 120a, 120b may be welded, soldered, or spliced to the bus bars 130 to achieve electrical interconnection.

[0023] As can be seen in FIG. 5, the bus bars 130 are positioned within the cavity of the enclosure 100 to avoid interfering with or impeding routing of the conductors 120 and/or the fibers 123 of the cable 120 and additional conductors 120a, 120b traveling within the enclosure 100. In particular, the positioning of the bus bars 130 adjacent the free edges of the side walls 106 of the wider end of the shell 104 can provide additional space for the routing of conductors 120a, 120b and/or optical fibers 123, and for manipulating conductors/fibers during assembly. Moreover, such positioning can provide additional space for the coiling and bending of optical fibers 123 near the narrower portion of the shell 104 near the front wall 112 to satisfy minimum bend radius requirements that the optical fibers 123 may have. Also, the positioning of the bus bars 130 can provide space for additional components of the enclosure 100, such as an OVP unit or circuit breaker.

[0024] Those skilled in this art will appreciate that other arrangements of bus bars may be employed. For example, rather than one bus bar 130 being included per side, two, three or more bus bars may be included. As an example, two or three bus bars may be mounted in the enclosure collinearly, such that the separate bus bars extend essentially the same length within the enclosure as the bus bars 130 discussed above. The separate bus bars may be of the same length or different lengths as desired. Such arrangements may be particularly suitable for larger enclosures (e.g., 3x4 configurations) to enable power to be managed more precisely. For example, multiple bus bars can be used to accommodate different system configurations (all parallel, some parallel/some single, given numbers of sets of parallel conductors, etc.). Also, this connection method may be employed in lieu of butt splicing, even without creating any parallel

connections, because it may offer the advantage of stabilizing the conductors in a desired location, rather than being free-floating like butt splices. In some instances the positions of the conductors may assist in maintaining the fibers in position. Additionally, multiple bus bars may be used to create a single parallel portion (e.g., the return portion) while leaving other portions (e.g., the -48V) as individual circuits.

[0025] Also, in some embodiments, it may be advantageous to arrange the bus bars to extend across the width, rather than along the length, of the shell of the enclosure. In such an arrangement, the bus bars would (as described above) typically be mounted across the wider edges of the shell, with the optical fibers residing in the narrower portion of the shell as discussed above. It may also be advantageous to include multiple bus bars on the same side of the enclosure in different vertical locations (e.g., the bus bars may be stacked, staggered and/or tiered relative to each other).

[0026] Referring now to FIG. 6, a platform 140 is located at the end of the shell 104 adjacent the top wall 114. The platform 140 is mounted to the shell 104 with four bosses 142 (see FIG. 4). The platform 140 can enable the addition of components such as an OVP unit 146 and/or a circuit breaker. Cutouts 144 are included in the sides of the platform 140 to provide space for the routing of conductors 120a, 120b and optical fibers 123 to and from components mounted on or near the platform 140 to the connectors 110.

[0027] 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. An assembly for breaking out a trunk cable, comprising:
 - a base having a generally flat surface adapted for mounting to a mounting surface;
 - a shell having a front wall, two side walls extending from opposite sides of the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity;
 - a plurality of connectors mounted to each of the side walls;
 - a trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors; and
 - at least one bus bar mounted to the shell within the cavity, at least one of the power conductors and at least one of the connectors in electrical connection with the bus bar.
2. The assembly defined in Claim 1, wherein the at least one bus bar is two bus bars.
3. The assembly defined in Claim 2, wherein each bus bar is positioned adjacent a free edge of a respective side wall.
4. The assembly defined in any of Claims 1-3, further comprising terminals mounted on the at least one bus bar.
5. The assembly defined in Claim 4, wherein the power conductors of the trunk cable are connected to the terminals, and wherein conductors are routed between the terminals and the connectors.
6. The assembly defined in any of Claims 1-5, wherein the trunk cable is a hybrid trunk cable that includes a plurality of optical fibers.
7. The assembly defined in Claim 6, wherein the optical fibers reside adjacent the front wall.

8. The assembly defined in any of Claims 1-7, wherein the shell is configured such that the side walls flare outwardly from the front wall.

9. The assembly defined in any of Claims 1-8, wherein the at least one bus bar is at least two bus bars on each side of the enclosure.

10. An assembly for breaking out a trunk cable, comprising:
a base having a generally flat surface adapted for mounting to a mounting surface;
a shell having a front wall, two side walls extending from opposite sides of the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity;
a plurality of connectors mounted to each of the side walls;
a trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors; and
a platform configured for mounting of components residing in the cavity.

11. The assembly defined in Claim 10, wherein the platform is positioned adjacent the end wall opposed to the end wall through which the trunk cable is routed.

12. The assembly defined in Claim 10 or Claim 11, wherein the platform includes cutaway areas for routing of conductors.

13. The assembly defined in any of Claims 10-12, further comprising an overvoltage protection unit mounted on the platform.

14. The assembly defined in any of Claims 10-13, further comprising two bus bars mounted to the shell within the cavity, the power conductors and the connectors in electrical connection with the bus bars.

15. The assembly defined in Claim 14, wherein each bus bar is positioned adjacent a free edge of a respective side wall.

16. The assembly defined in Claim 14 or Claim 15, further comprising terminals mounted on the bus bars.

17. The assembly defined in Claim 16, wherein the power conductors of the trunk cable are connected to the terminals, and wherein conductors are routed between the terminals and the connectors.

18. The assembly defined in any of Claims 10-17, wherein the trunk cable is a hybrid trunk cable that includes a plurality of optical fibers.

19. The assembly defined in Claim 18, wherein the optical fibers reside adjacent the front wall.

20. An assembly for breaking out a trunk cable, comprising:
a base having a generally flat surface adapted for mounting to a mounting surface;
a shell having a front wall, two side walls extending from opposite sides of and flaring outwardly from the front wall, and two opposed end walls, the side walls of the shell mounted to the base to form a cavity;
a plurality of connectors mounted to each of the side walls;
a hybrid trunk cable routed into the cavity through one of the end walls, the trunk cable comprising a plurality of power conductors and a plurality of optical fibers; and
two bus bars mounted to the shell within the cavity, each of the bus bars positioned adjacent a free edge of a respective side wall, at least one of the power conductors and at least one of the connectors in electrical connection with each bus bar.

1/3

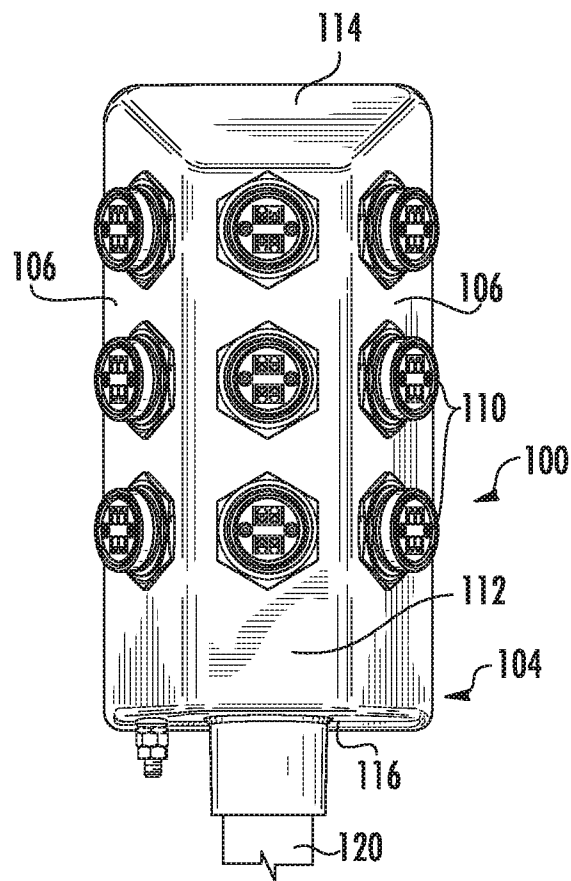


FIG. 1

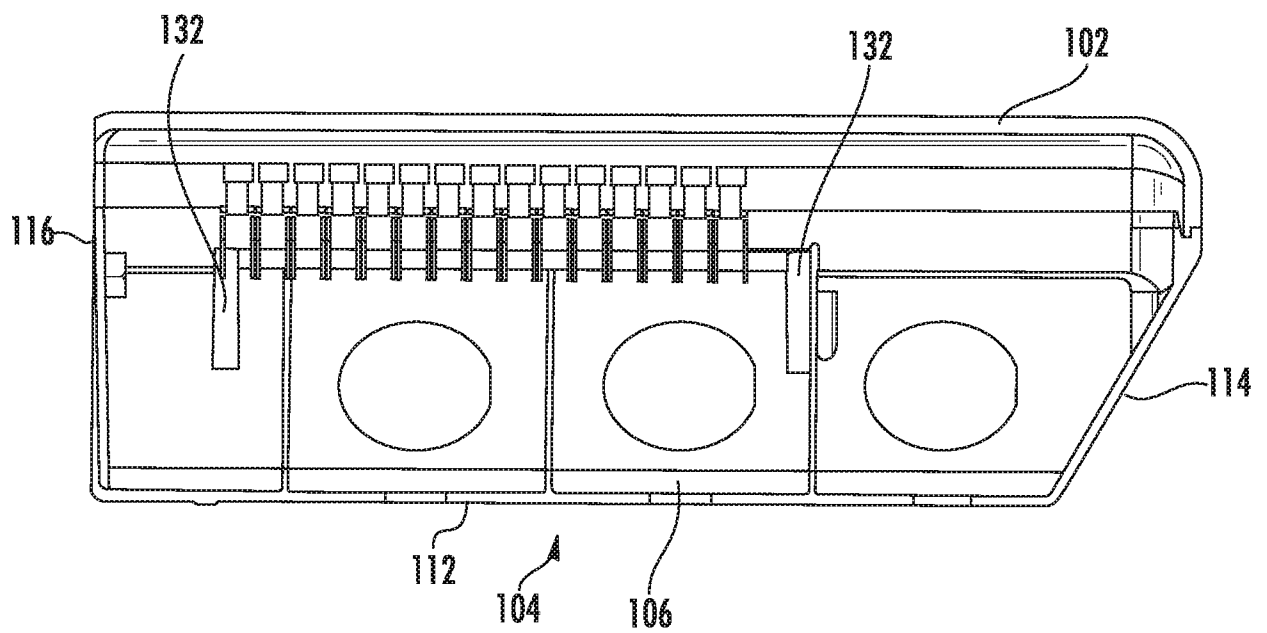


FIG. 2

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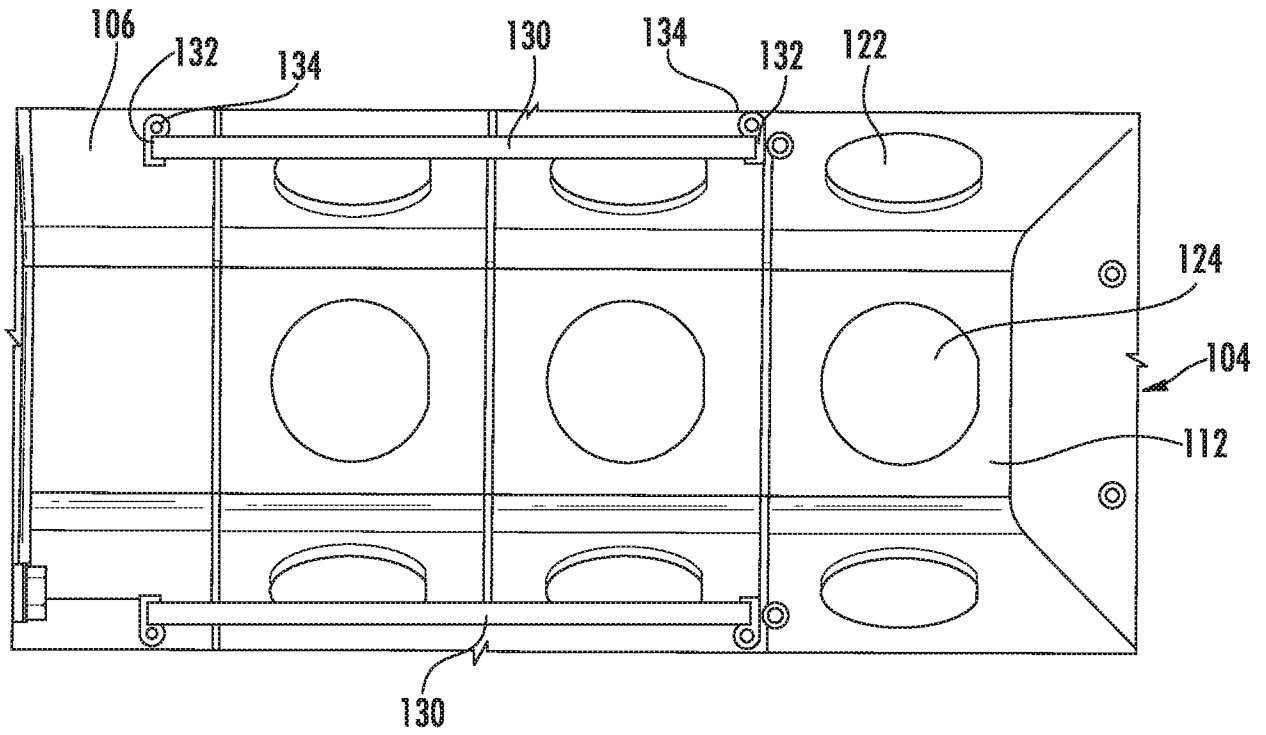


FIG. 3

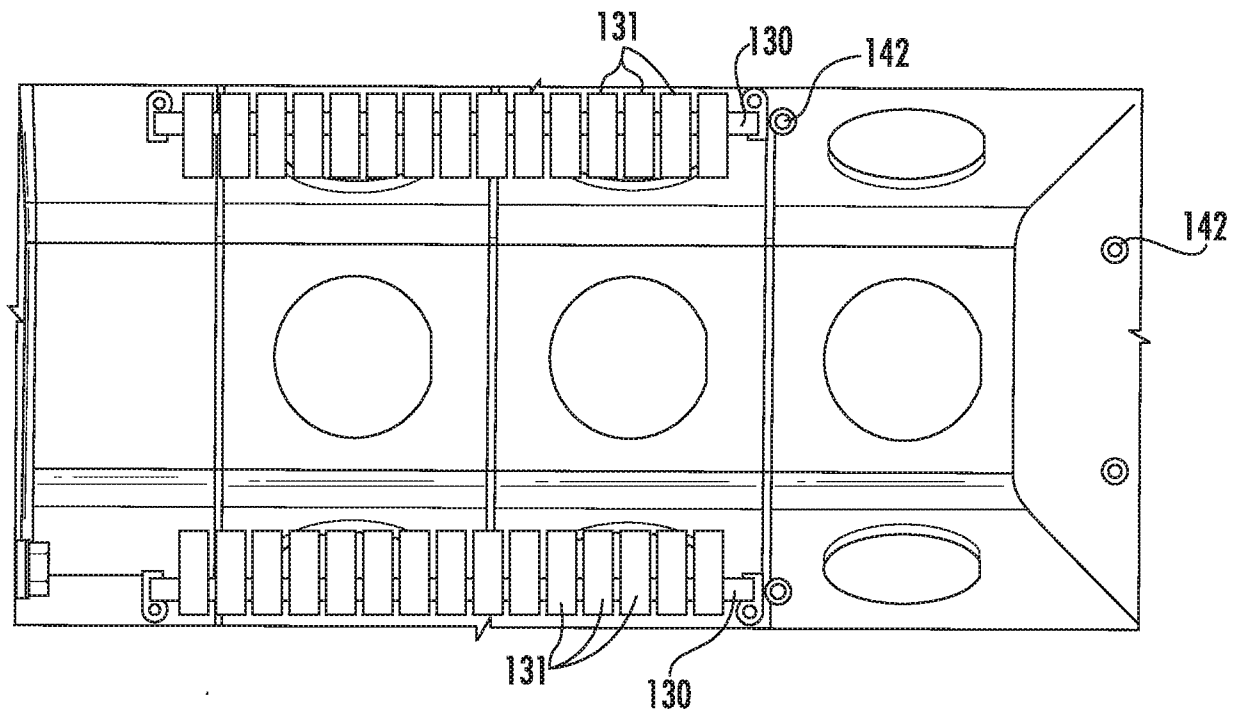


FIG. 4

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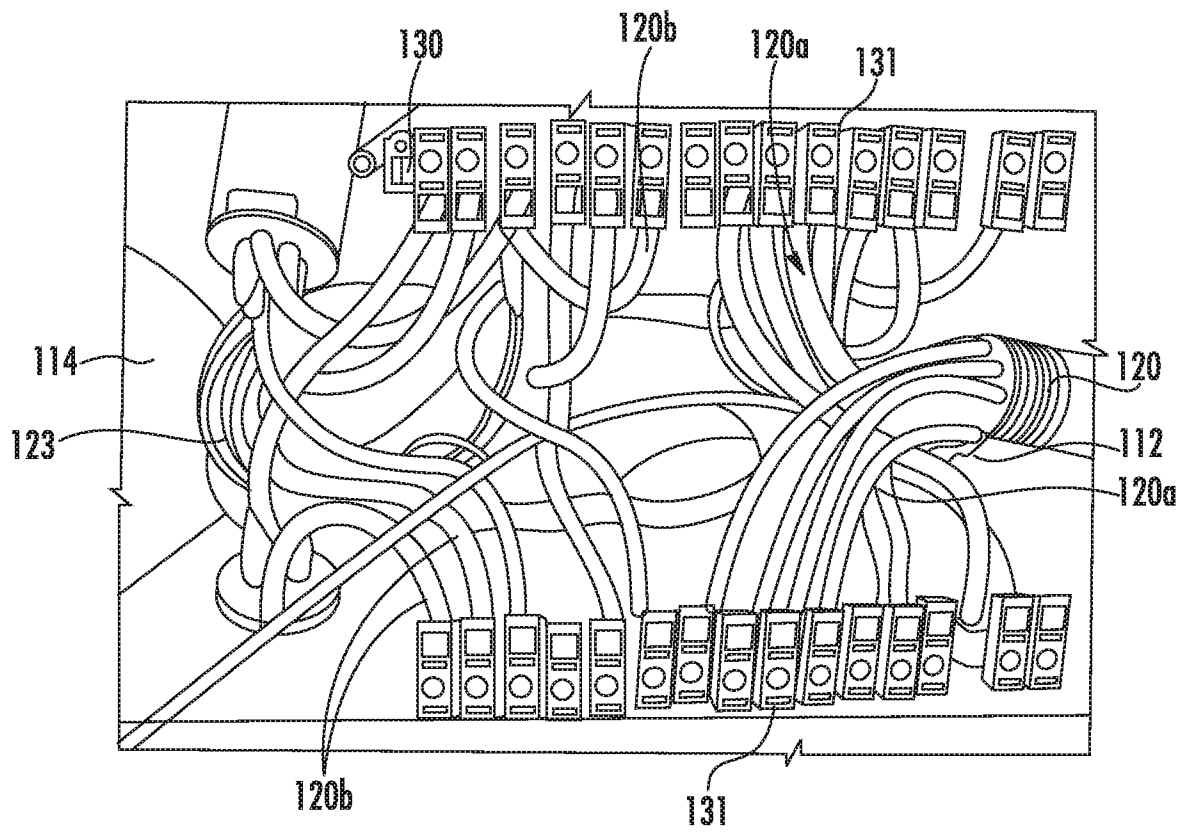


FIG. 5

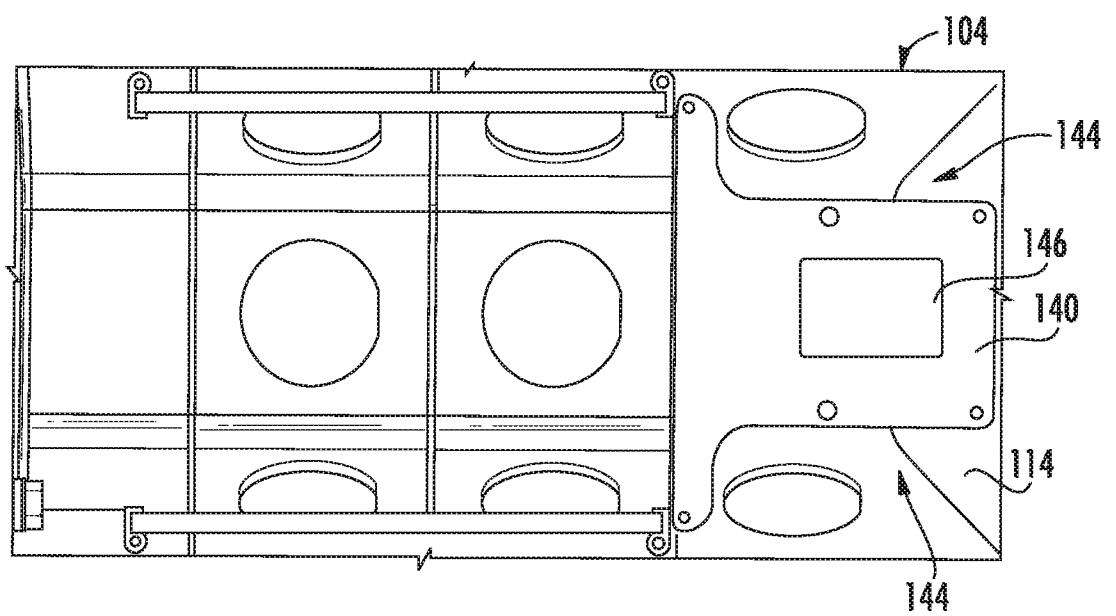


FIG. 6

INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US2017/052133**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.: 7,15,17,19
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 7, 15, 17, 19 refer to claim which does not comply with PCT Rule 6.4(a). Therefore, claims 7, 15, 17, 19 do not meet the requirements of PCT Article 6.
3. ☒ Claims Nos.: 6,8,9,13,14,16,18
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 additional 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.

A. CLASSIFICATION OF SUBJECT MATTER**G02B 6/44(2006.01)i, H02G 15/117(2006.01)i, H02G 15/115(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)

G02B 6/44; H02G 3/22; H01B 9/00; H02G 3/18; G02B 6/40; H01R 13/639; G02B 6/46; H05K 1/02; H01R 13/518; H01B 7/30; H02G 15/117; H02G 15/115

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: trunk cable, shell, connectors, bus bar, side wall

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016-0276817 A1 (COMMSCOPE TECHNOLOGIES LLC.) 22 September 2016 See claim 1 and figures 1-3.	10-12
Y		1-5, 20
Y	US 7893567 B1 (DEROS et al.) 22 February 2011 See column 15, lines 55-62, column 16, lines 4-8 and figures 15-17.	1-5, 20
A	US 2015-0270637 A1 (COMMSCOPE TECHNOLOGIES LLC.) 24 September 2015 See paragraphs [0034]-[0038] and figures 1-2.	1-5, 10-12, 20
A	KR 10-2015-0006712 A (SAMSUNG ELECTRONICS CO., LTD.) 19 January 2015 See claim 1 and figure 1.	1-5, 10-12, 20
A	US 5202538 A (SKIRPAN) 13 April 1993 See column 12, lines 12-25 and figure 6b.	1-5, 10-12, 20



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

11 January 2018 (11.01.2018)

Date of mailing of the international search report

11 January 2018 (11.01.2018)

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

KANG, Sung Chul

Telephone No. +82-42-481-8405



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/052133

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016-0276817 A1	22/09/2016	US 9742176 B2 WO 2016-149337 A1	22/08/2017 22/09/2016
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