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

(72) Inventors: RUDENICK, Paula; 425 Hillside Drive, Apt # 102, Jordan, Minnesota 55352 (US). CAMPBELL, Brent; 4724 14th Ave S, Minneapolis, Minnesota 55407 (US). SOLHED, James J.; 10554 170th Street West, Lakeville, Minnesota 55044 (US). SAND, Duane R.; 9724 State Highway 24 N.W., Annandale, Minnesota 55302 (US).

(74) Agent: KOWALCHYK, Katherine M.; Merchant & Gould P.C., P.O. Box 2903, Minneapolis, Minnesota 55402-0903 (US).

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[Continued on nextpage]

(54) Title: FIBER OPTIC CABLE SLACK MANAGEMENT MODULE

(57) Abstract: A fiber optic cable slack management module includes a base defining a first cable management spool, an outer face of which is configured to contact cables when cables are pulled away from the base and a second cable management spool, within which the first cable management spool is located. An inner face of the second cable management spool is configured to contact cables when cables are in a relaxed, non-pulled state. The fiber optic cable slack management module defines a cable exit adjacent the first cable management spool and defined at least partially by the inner face of the second cable management spool, the cable exit defined by a channel positioned between the first and second cable management spools.

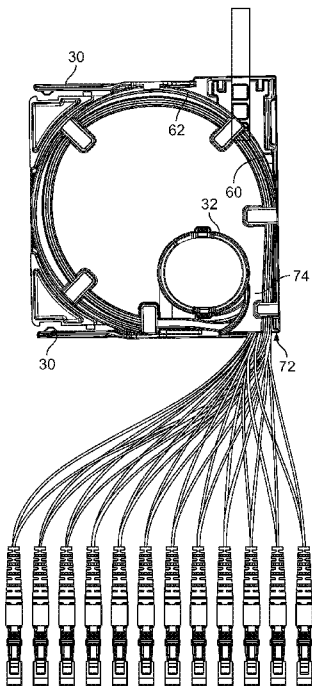
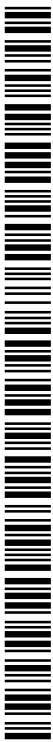


FIG. 11



SM, TR, OAPI, BF, BI, CF, CG, CL, CM, GA, GN, GQ,  
GW, KM, ML, MR, NE, SN, TD, TG;

**Published:**

**Declarations under Rule 4.17:**

— *of inventorship (Rule 4.17(iv))*

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

## **FIBER OPTIC CABLE SLACK MANAGEMENT MODULE**

### **Cross Reference to Related Application**

5                   This application is being filed on December 7, 2015 as a PCT International Patent Application and claims the benefit of U.S. Patent Application Serial No. 62/090,203, filed on December 10, 2014, the disclosure of which is incorporated herein by reference in its entirety.

### **Field**

10                   The present invention relates to apparatus and methods for termination and storage of optical fiber cables, such as distribution cables.

### **Background**

                    With respect to termination and storage of optical fibers including distribution fibers, various concerns exist. One concern is providing high density to minimize needed space. In the case of outside plant enclosures, a reduced size for the enclosures and the internal structures is preferred.

15                   A further concern related to termination and storage of optical fiber cables is the ease of access to the cables and the terminations. Such ease of use is desired during assembly, during installation in the field, and later when changes or modifications to the system are desired requiring adding or removing terminations, or when cleaning and checking the terminations.

20                   A further concern in the area of termination and storage of optical fiber cables includes protecting the optical fiber from damage from excess bending below the minimum bend radius of the cable. Such protection of the fibers is desired during assembly and installation, and later when individual terminations and cables are accessed for cleaning or modification.

                    Further improvements in these areas are desired.

### **Summary**

30                   The present disclosure relates to a fiber optic cable slack storage/management module for managing slack associated with fiber terminations in a

distribution chassis or frame. The cable slack module includes a base defining a first cable management spool, an outer face of which is configured to contact cables when cables are pulled away from the base, and a second cable management spool, within which the first cable management spool is located. An inner face of the second cable management spool is configured to contact cables when cables are in a relaxed, non-pulled state. The fiber optic cable slack management module defines a cable exit adjacent the first cable management spool and defined at least partially by the inner face of the second cable management spool, the cable exit defined by a channel positioned between the first and second cable management spools.

A further aspect of the present disclosure relates to a fiber optic telecommunications system comprising a telecommunications chassis including at least one movable adapter module mounted to the chassis and at least one cable slack management module mounted to the chassis adjacent the at least one adapter module, the cable slack management module configured to manage cables extending from fiber optic connectors coupled to adapters of the adapter module. The at least one cable slack management module includes a base defining a first cable management spool, an outer face of which is configured to contact cables when cables are pulled away from the base, and a second cable management spool, within which the first cable management spool is located. An inner face of the second cable management spool is configured to contact cables when cables are in a relaxed, non-pulled state. The fiber optic cable slack management module defines a cable exit adjacent the first cable management spool and defined at least partially by the inner face of the second cable management spool, the cable exit defined by a channel positioned between the first and second cable management spools.

A variety of additional inventive aspects will be set forth in the description that follows. The inventive aspects can relate to individual features and combinations of features. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the broad inventive concepts upon which the embodiments disclosed herein are based.

### **Brief Description of the Drawings**

FIG. 1 is a front perspective view of a telecommunications chassis including a plurality of cable slack management modules having inventive aspects in accordance with the present disclosure mounted thereon;

FIG. 2 is a rear perspective view of the chassis of FIG. 1;

FIG. 3 illustrates the chassis of FIG. 1 with one of the cable slack management modules and a sliding adapter module of the chassis exploded off the chassis;

FIG. 4 is a side view of the chassis of FIGS. 1-3 illustrating the cable slack management modules mounted in a stacked configuration;

FIG. 5 is a front perspective view of one of the cable slack management modules shown in isolation;

FIG. 6 is a rear perspective view of the cable slack management module of FIG. 5;

FIG. 7 is a top view of the cable slack management module of FIG. 5;

FIG. 8 is a bottom view of the cable slack management module of FIG. 5;

FIG. 9 is a side view of the cable slack management module of FIG. 5;

FIG. 10 illustrates the cable slack management module of FIG. 5 with the upper cover removed to show the internal features;

FIG. 11 illustrates the cable slack management module of FIG. 10 from a top view;

FIG. 12 illustrates the cable slack management module of FIG. 5 in an exploded configuration;

FIG. 13 illustrates the cable slack management module being used as a direct pass-through distribution module without the storage of extra cable slack;

FIG. 14 illustrates the cable slack management module with only one of the trays of the module being used to store extra cable slack;

FIG. 15 illustrates the cable slack management module with both of the trays of the module being used to store extra cable slack;

FIG. 16 illustrates the cable slack management module of FIG. 15 in a fully assembled configuration with the upper cover mounted thereon, wherein the output fibers are shown as being directed to sliding adapter modules; and

FIG. 17 illustrates the cable slack management module of FIG. 16 from a top view.

### **Detailed Description**

Referring now to FIGS. 1-17, a fiber optic cable slack management/storage module 10 having inventive aspects in accordance with the present disclosure is illustrated. In FIGS. 1-4, a plurality of the cable slack management modules 10 is

illustrated as mounted on a telecommunications fixture 12 (i.e., frame, chassis) in a stacked arrangement. The cable slack management modules 10 are mounted adjacent sliding adapter modules 14. The cable slack management modules 10 are configured to manage the cabling 16 (or cable slack) extending from connectors 18 coupled to the adapter modules 14.

As will be described in further detail, the cabled fibers 16 terminated by the connectors 18 coupled to the sliding adapter modules 14 are input into the cable slack management module 10 via an optical device 20 (e.g., a fan-out in the depicted embodiment). The configuration of the cable slack management module 10 allows extra cable slack 16 to be stored therewithin such that the extra cable slack 16 can be used when the sliding adapter modules 14 are moved outwardly from the telecommunications fixture 12, without violating minimum bending requirements.

Referring now to FIGS. 5-17, where one of the cable slack management modules 10 is illustrated in isolation, each cable slack management module 10 includes a base 22 with a bottom wall 24 and vertically extending peripheral walls 26. The base 22 defines a fan-out pocket 25 for receiving the fan-out 20 with a snap-fit interlock. The fan-out pocket 25 is defined partially by the bottom wall 24. The fan-out pocket 25 and the fan-out 20 define the fiber input portion 28 of the cable slack management module 10.

As shown in FIGS. 7, 8, 11, and 17, portions of the front and rear peripheral walls 26 of the base 22 define flexible cantilever arms 30 for providing a snap-fit interlock with the telecommunications fixture 12.

The base 22 defines a first spool 32 extending upwardly from the bottom wall 24 of the base 22. As will be described in further detail hereafter, the first spool 32 is one of the structures that provide the minimum bend radius protection for the cables 16 within the cable slack management module 10.

As shown in FIGS. 5-17, each cable slack management module 10 also defines a pair of cable storage trays 34. The trays 34 are mounted in a stacked arrangement onto the base 22 and define a lower tray 34a and an upper tray 34b. Cables 16 enter the individual trays 34 via a ramp 36 defined by each tray 34. After the fibers 16 are input into the cable slack management module 10 via the fan-out 20, half of the separated and cabled fibers 16 enter the lower tray 34a via the ramp 36 of the lower tray 34a and half of the separated and cabled fibers 16 enter the upper tray 34b via the ramp 36 of the upper tray 34b.

In the given embodiment of the cable slack management module 10, the upper tray 34b (the floor 38 thereof) forms the cover 40 of the lower tray 34a. The upper tray 34b defines a separate removable cover 42. The trays 34 are mounted via a snap-fit interlock to the base 22. As shown in FIGS. 5, 6, 10, 12, and 13-16, a flexible portion 44 of both the front peripheral wall 26 and the rear peripheral wall 26 of the base 22 defines notches 46 for receiving tabs 48 extending outwardly from the trays 34 for keeping the trays 34 mounted within the base 22.

The removable cover 42 of the upper tray 34b is also held in place by an inwardly extending tab 50 of the flexible portion 44 of the rear peripheral wall 26 and flexible cantilever arms 52 defined by the first spool 32. In certain embodiments, the cover 42 used with the upper tray 34b may be provided with a handle 54 to facilitate mounting and removal (see FIGS. 5-7).

Each of the upper and lower trays 34 defines an opening 56 through which the first spool 32 extends. Thus, the first spool 32 extends all the way from the bottom wall 24 to the cover 42 of the upper tray 34b.

Each tray 34 also includes a curved peripheral wall 58, the inner face 60 of which defines a second spool 62. The second spool 62 defined by each tray 34 cooperates with the first spool 32 in keeping the cable slack 16 stored and managed without violating minimum bend radius requirements.

The second spool 62 (i.e., the inner face 60 of the curved peripheral wall 58 of each tray 34) is configured to contact the cables 16 within the tray 34 when the cables 16 are in a relaxed state (when the sliding adapter modules 14 are in a non-extended position). An outer face 64 of the first spool 32 is configured to contact the cables 16 within the tray 34 when the cables 16 are pulled (when the sliding adapter modules 14 are moved to an extended position).

The combination of the first spool 32 and the second spool 62 provides the cables 16 with bend radius protection both in a relaxed state and in a pulled, tensioned state.

Each tray 34 also defines a plurality of cable retention fingers 66 extending inwardly from the peripheral wall 58. The cable retention fingers 66 facilitate initial assembly of the cable slack management module 10 as the cables 16 are being lead from the fan-out 20, up the ramps 36 and into the trays 34. In order to provide unobstructed movement of the cables 16 within the trays 34, however, the cable retention fingers 66 fit within notches 68 defined by the cover 42 for the upper tray 34b and notches 70 defined

by the floor 38 of the upper tray 34b for the lower tray 34a. In this manner, a smooth, flush ceiling is created for each of the trays 34 and the cables 16 can move without any obstruction.

5 The cable exit portion 72 of the cable slack management module 10 is defined adjacent the first spool 32 and at least partially by the inner face 60 of the peripheral wall 58 of each tray 34 (i.e., the second spool 62), where the cable exit 72 is generally defined by a channel 74 positioned between the first and second spools 32, 62 as can be seen in FIGS. 10, 11, and 14-16. The cable exit portion 72 is generally aligned with the fiber input portion 28 of the cable slack management module 10 when viewing  
10 the module 10 in a front to back direction.

Thus, the optical fibers 16 enter the cable slack management module 10 via the fan-out 20 at a first common plane 76. The separated and cabled fibers 16 are then directed to multiple levels defined by the trays 34 via the ramps 36. The cables 16 are looped once around the trays 34 and exit the cable slack management module 10 via the  
15 cable exit channel 74. It should be noted that in the depicted embodiment, half of the cabled fibers 16 coming from the fan-out 20 are directed into the lower tray 34a and half are directed into the upper tray 34b.

The cables 16 exiting the cable slack management module 10 are terminated with fiber optic connectors 18 that are coupled to the adapters 17 of the sliding  
20 adapter modules 14.

Although shown with LC format connectors 18, in other embodiments, the cables 16 output from the cable slack management module 10 may be terminated with other types or footprints of connectors 18 such as SC or LX.5, such connectors 18 leading to adapter modules 14 having adapters 17 with matching footprints.

25 Examples of sliding adapter modules 14 that are usable with the cable slack management module 10 of the present disclosure are shown and described in further detail in U.S. Patent Application Ser. No. 62/040,314, filed August 21, 2014, now PCT Application No. PCT/US20 15/046392, filed August 21, 2015, both titled "High Density Adapter Carrier Pack;" and U.S. Patent Nos. 6,591,051 and 9,075,203, each of which is  
30 incorporated herein by reference in its entirety.

Now referring to FIGS. 13-17, even though the cable slack management module 10 has been described as being used as a cable slack storage/management device, the cable management module 10 can be set up to be used as a simple distribution or a fan-out module where fibers 16 entering the module 10 are output in a pass-through



configuration, wherein one or more of the trays 34 are not used for carrying coiled cables 16.

For example, FIG 13 illustrates the cable management module 10 set up to output the cabled fibers 16 directly from the module 10 without storing any extra slack 16. Fibers 16 are input via the fan-out 20 and are output via an opening 78 at a front side of the base 22 that is at the same plane 76 as the fan-out 20.

FIG. 14 illustrates a set-up where only one of the trays 34 (e.g., the lower tray 34a) is used for storing cable slack 16. As shown in the depicted example, one of the sliding adapter modules 14 receives connectorized cables 16 that account for slack and the other of the sliding adapter modules 14 receives connectorized cables 16 directly from the module 10 without any cable slack.

FIG. 15 illustrates the version of the cable slack management module 10 discussed previously, where both of the trays 34 are being used for storing/managing cable slack 16, where one of the sliding adapter modules 14 receives connectorized cables 16 output from the lower tray 34a at a first level and the other sliding adapter module 14 receives connectorized cables 16 output from the upper tray 34b at a second level, wherein both of the levels are above the input plane 76 defined by the fan-out 20.

FIGS. 16-17 illustrate the module set-up of FIG. 15 with the upper cover 42 applied.

In the depicted embodiment, the cable slack management module 10 is designed to manage twenty-four 900 $\mu$ m fibers that are input into the module 10 through a twenty-four fiber fan-out 20. As illustrated, the twenty-four fibers may be split into two groups of twelve fibers before exiting the module 10, wherein each group of twelve fibers may be lead to oppositely moving sliding adapter modules 14 (as shown in FIGS. 13-17) or adjacent stacked adapter modules 14 that move in the same direction. The cable slack management module 10 provides multiple set-up options.

The chassis 12 depicted in FIGS. 1-4 is a 288-fiber chassis, with twenty-four sliding adapter modules 14 (i.e., two sets of twelve oppositely moving adapter modules 14), each adapter module 14 including twelve adapter ports. The fiber counts can be varied depending upon the desired density at both the input side (different fan-out devices) or at the output side.

Although in the foregoing description, terms such as "top," "bottom," "front," "back," "right," "left," "upper," and "lower" may have been used for ease of description and illustration, no restriction is intended by such use of the terms. The

devices described herein can be used in any orientation, depending upon the desired application.

Having described the preferred aspects and embodiments of the present disclosure, modifications and equivalents of the disclosed concepts may readily occur to one skilled in the art. However, it is intended that such modifications and equivalents be included within the scope of the claims which are appended hereto.

## CLAIMS:

1. A fiber optic cable slack management module comprising:  
a base defining a first cable management spool, an outer face of which is configured to contact cables when cables are pulled away from the base;  
a second cable management spool, within which the first cable management spool is located, wherein an inner face of the second cable management spool is configured to contact cables when cables are in a relaxed, non-pulled state,  
wherein the fiber optic cable slack management module defines a cable exit adjacent the first cable management spool and defined at least partially by the inner face of the second cable management spool, the cable exit defined by a channel positioned between the first and second cable management spools.
2. A fiber optic cable slack management module according to claim 1, further comprising a plurality of removable trays mounted to the base in a stacked configuration, each of the trays configured for managing cables, wherein an outer peripheral wall of each tray defines the second cable management spool.
3. A fiber optic cable slack management module according to claim 2, wherein fibers entering the base along a common plane are directed to multiple different levels provided by the trays via ramps.
4. A fiber optic cable slack management module according to claim 2, further comprising two of the trays.
5. A fiber optic cable slack management module according to claim 1, wherein an input for the cable slack management module is defined by a fiber optic fan-out.
6. A fiber optic cable slack management module according to claim 5, wherein the input is defined at a rear of the base and the cable exit is defined at a front of the base, wherein the input and the cable exit are generally aligned along a right to left direction.

7. A fiber optic cable slack management module according to claim 2, wherein each tray defines a smooth, flush ceiling so as to allow unobstructed movement of the cables between the relaxed, non-pulled state and a pulled state.
8. A fiber optic cable slack management module according to claim 7, wherein each tray defines cable retention fingers extending inwardly from the outer peripheral wall, the retention fingers fitting within notches defined by a cover for each tray so as to define the smooth, flush ceiling.
9. A fiber optic cable slack management module according to claim 8, wherein the cover for at least one of the trays is defined by a floor of an adjacent upper tray.
10. A fiber optic cable slack management module according to claim 1, further comprising snap-fit features for removably mounting to a telecommunications fixture.
11. A fiber optic telecommunications system comprising:
  - a telecommunications chassis including at least one movable adapter module mounted to the chassis;
  - at least one cable slack management module mounted to the chassis adjacent the at least one adapter module, the cable slack management module configured to manage cables extending from fiber optic connectors coupled to adapters of the adapter module, the at least one cable slack management module comprising:
    - a base defining a first cable management spool, an outer face of which is configured to contact cables when cables are pulled away from the base;
    - a second cable management spool, within which the first cable management spool is located, wherein an inner face of the second cable management spool is configured to contact cables when cables are in a relaxed, non-pulled state, wherein the fiber optic cable slack management module defines a cable exit adjacent the first cable management spool and defined at least partially by the inner face of the second cable management spool, the cable exit defined by a channel positioned between the first and second cable management spools.

12. A fiber optic telecommunications system according to claim 11, further comprising a plurality of the cable slack management modules mounted to the chassis in a stacked arrangement.
13. A fiber optic telecommunications system according to claim 11, wherein the chassis includes one cable slack management module for every two movable adapter modules.
14. A fiber optic telecommunications system according to claim 11, wherein the at least one movable adapter module includes LC format fiber optic adapters.
15. A fiber optic telecommunications system according to claim 11, wherein an input for the cable slack management module is defined by a fiber optic fan-out that separates ribbonized fibers into individual cabled fibers leading to the fiber optic connectors coupled to the adapters of the adapter module.
16. A fiber optic telecommunications system according to claim 11, wherein the cable slack management module includes a plurality of removable trays mounted to the base in a stacked configuration, each of the trays configured for managing cables, wherein an outer peripheral wall of each tray defines the second cable management spool.
17. A fiber optic telecommunications system according to claim 16, wherein fibers entering the base along a common plane are directed to multiple different levels provided by the trays via ramps.
18. A fiber optic telecommunications system according claim 16, wherein each cable slack management module includes two of the trays.
19. A fiber optic telecommunications system according to claim 16, wherein each tray defines a smooth, flush ceiling so as to allow unobstructed movement of the cables between the relaxed, non-pulled state and a pulled state.

20. A fiber optic telecommunications system according to claim 19, wherein each tray defines cable retention fingers extending inwardly from the outer peripheral wall, the retention fingers fitting within notches defined by a cover for each tray so as to define the smooth, flush ceiling.

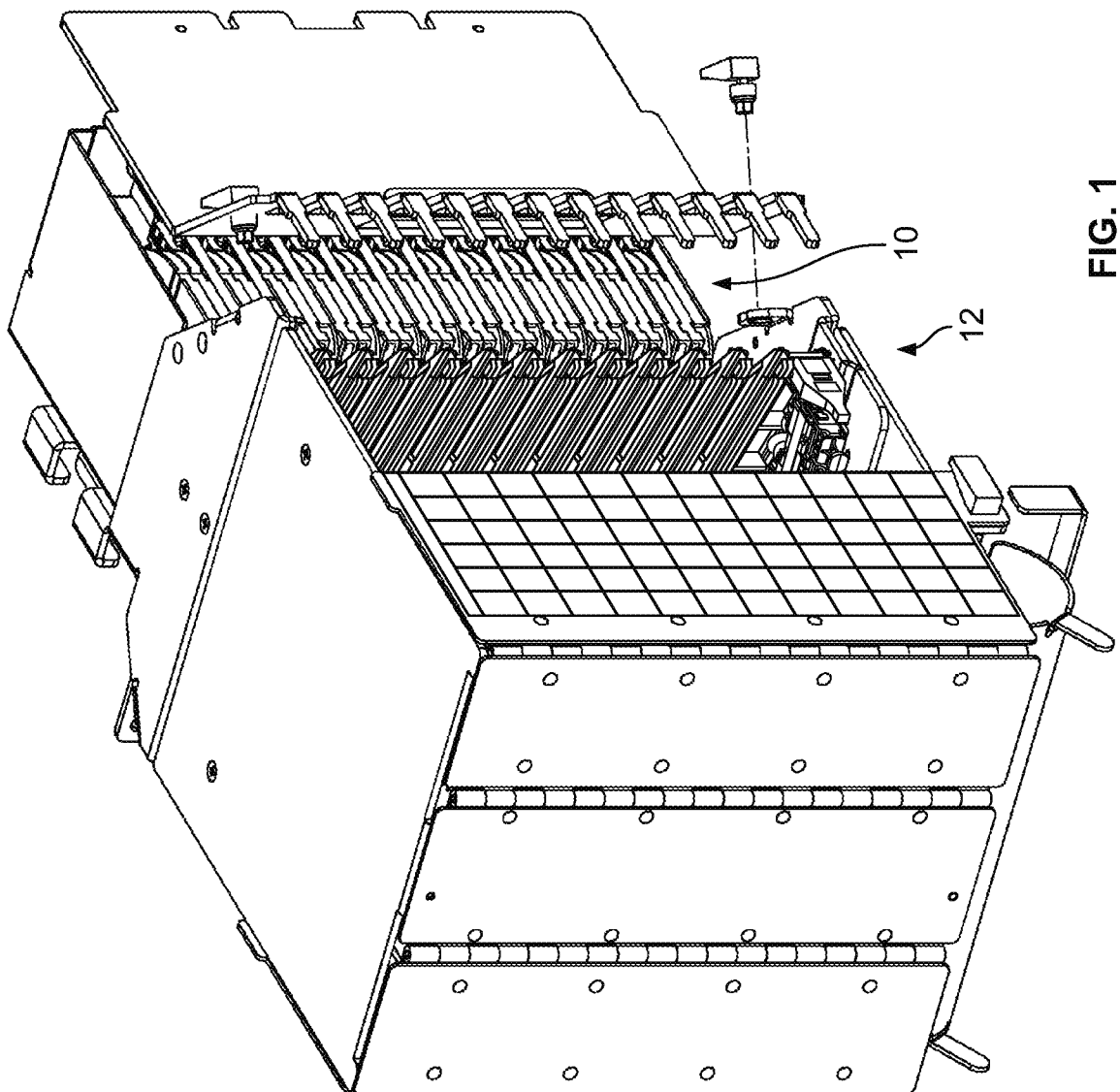
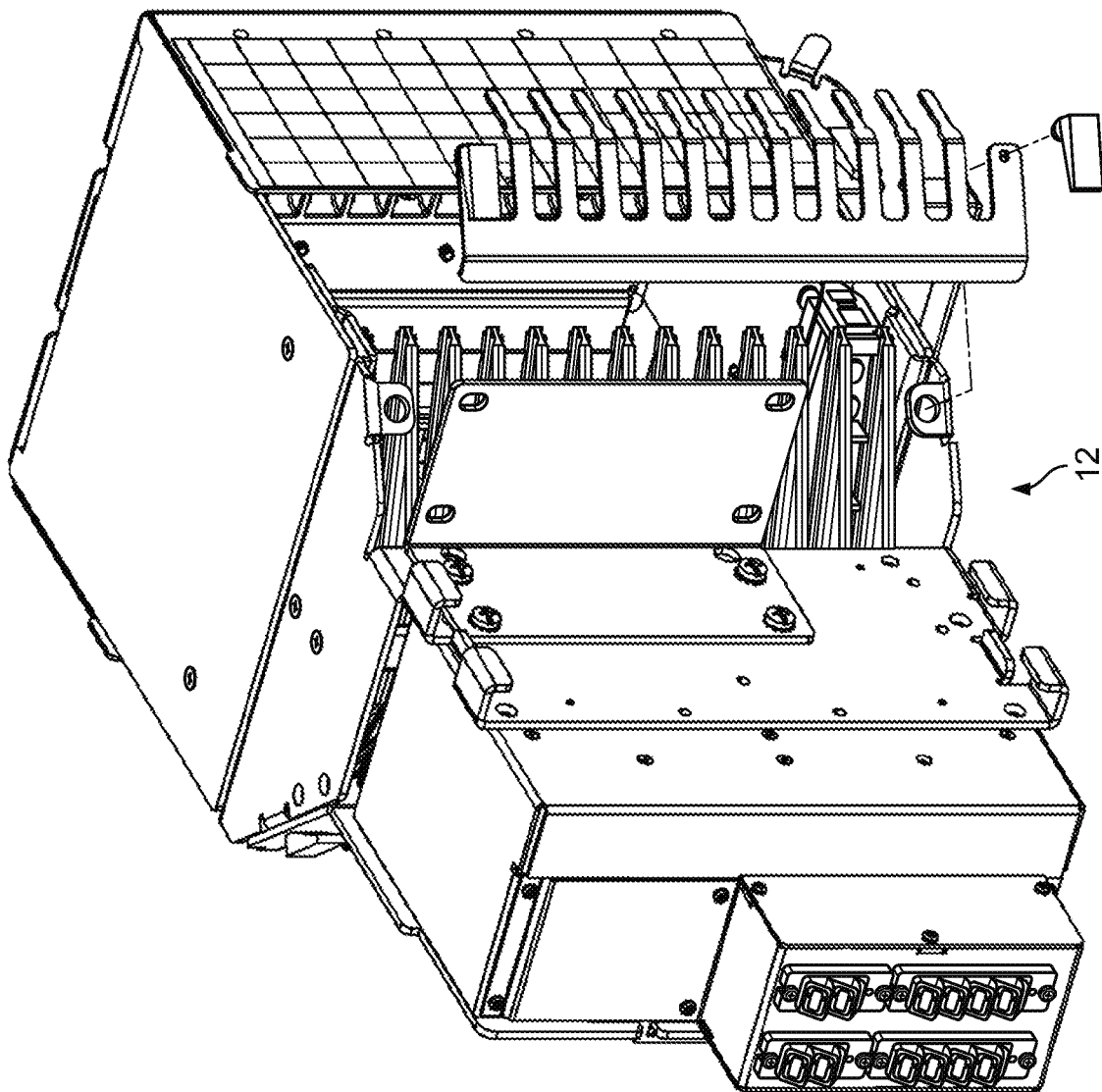


FIG. 1

FIG. 2





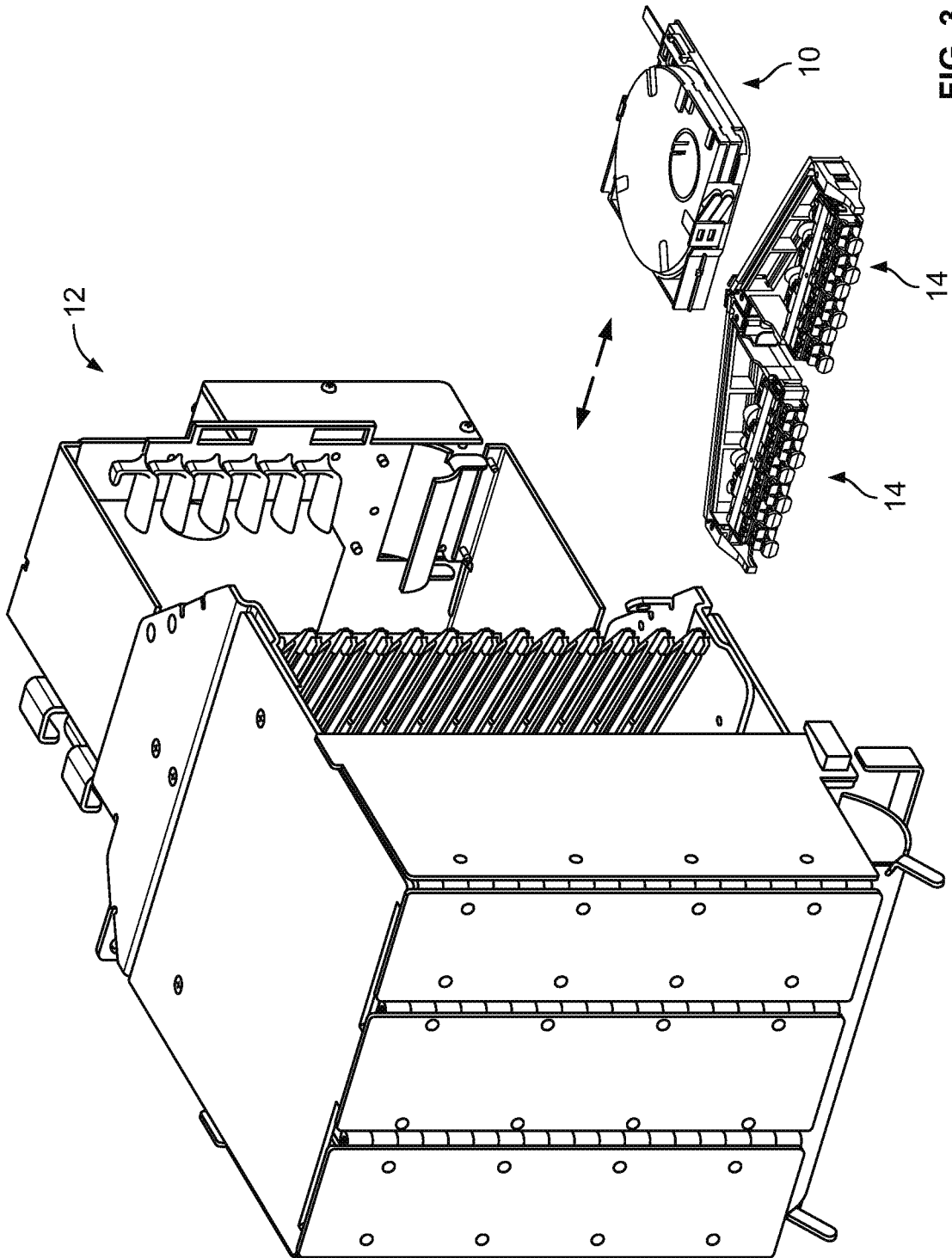
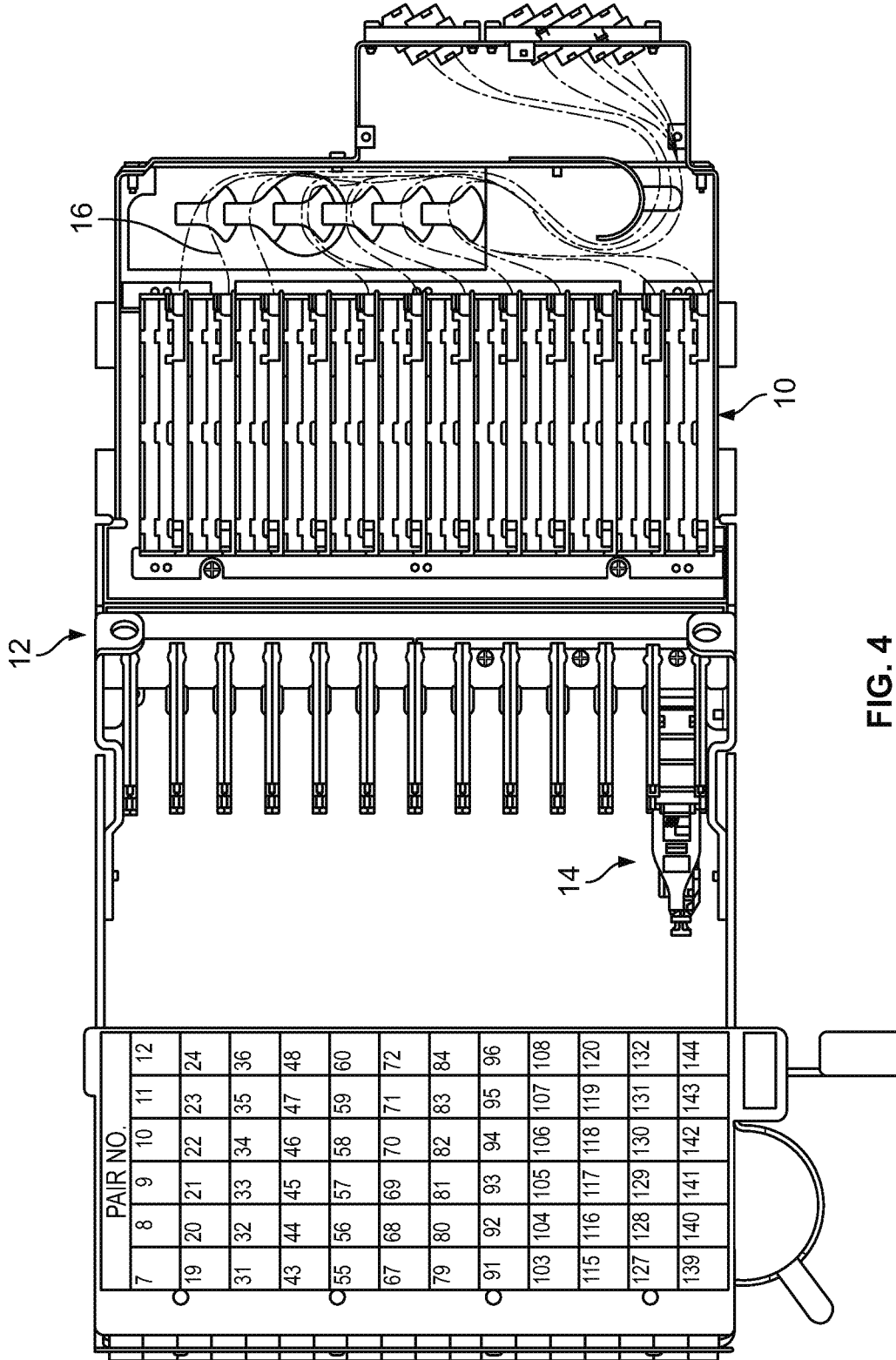


FIG. 3



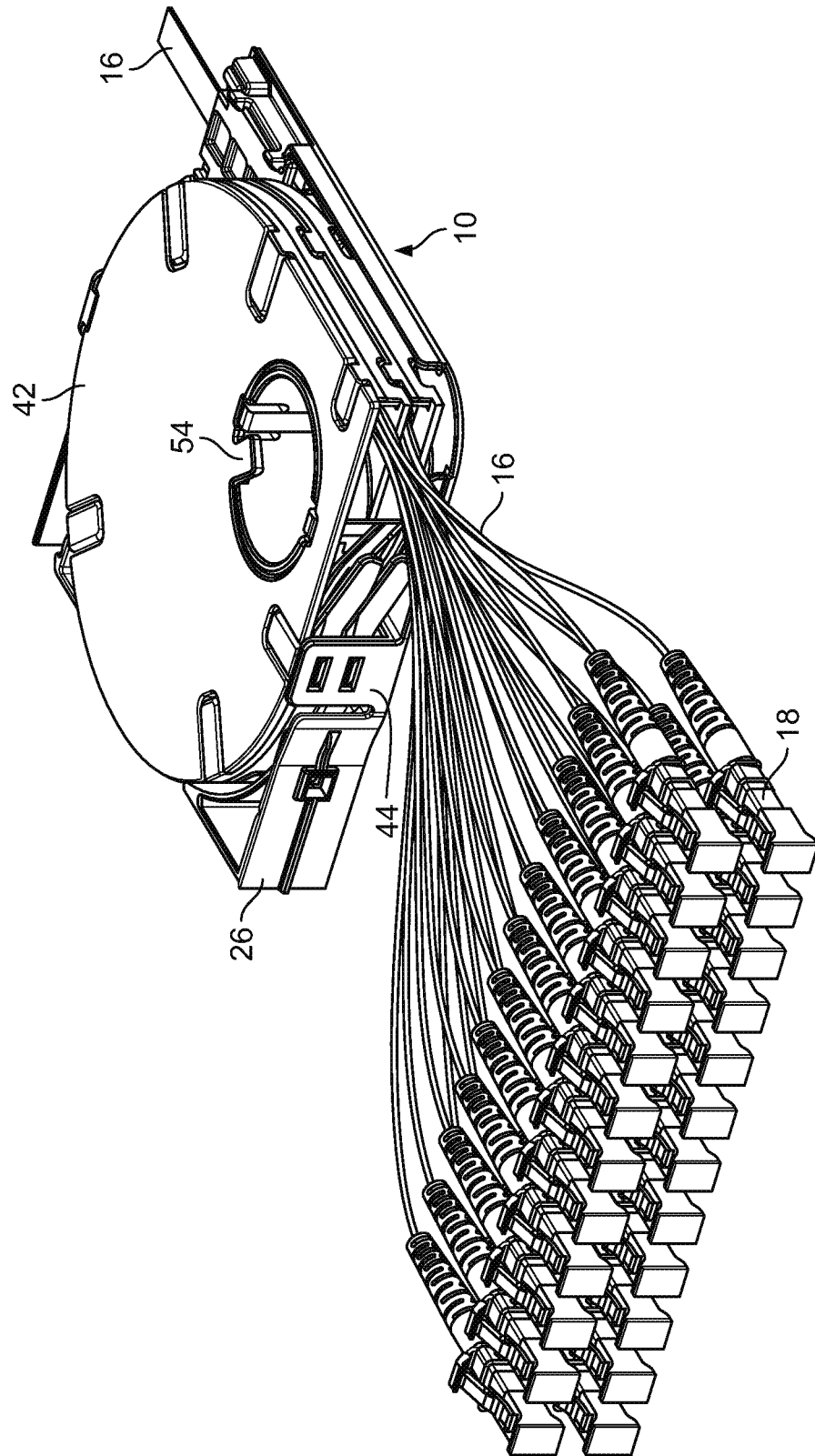


FIG. 5

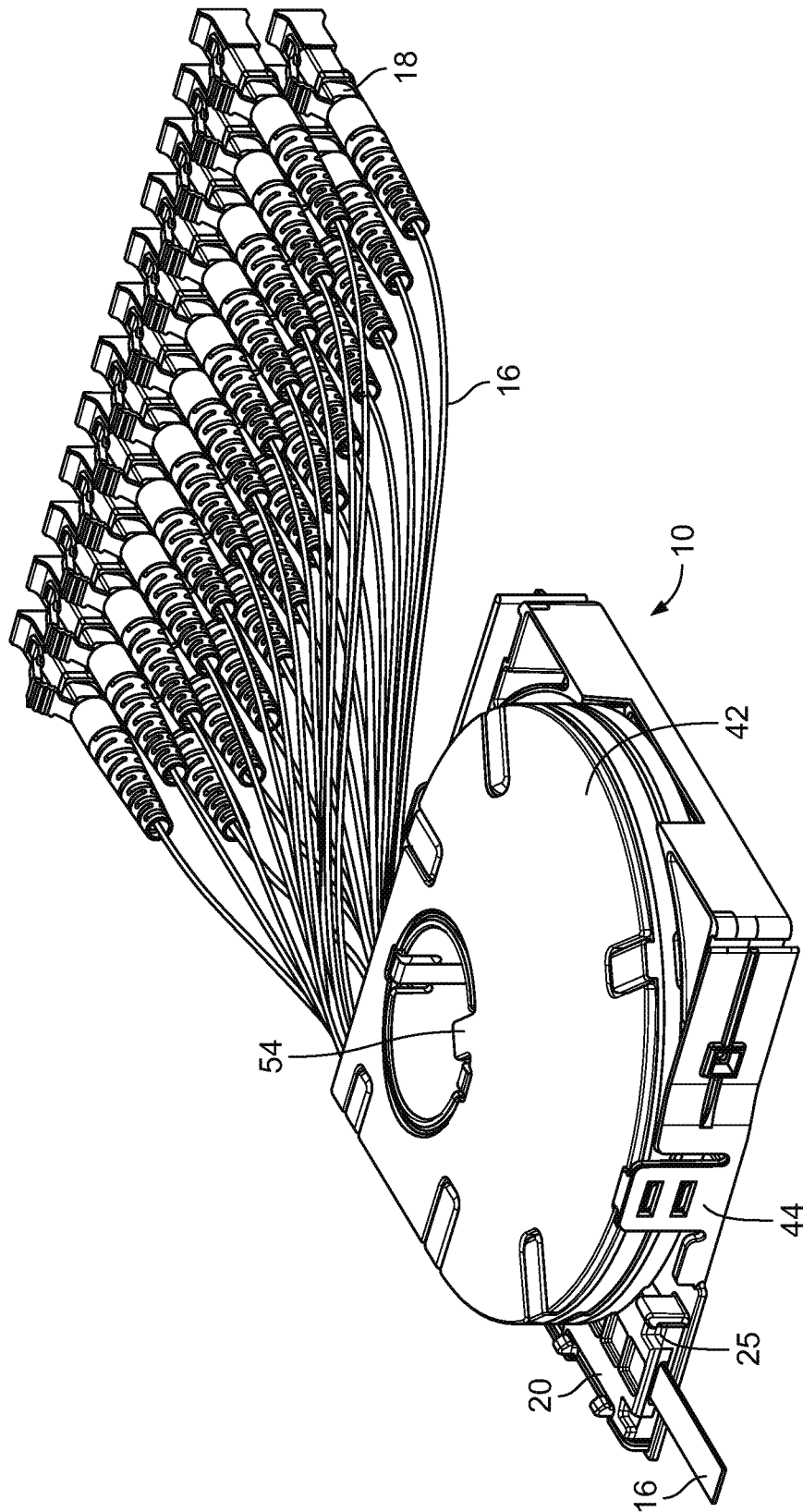


FIG. 6

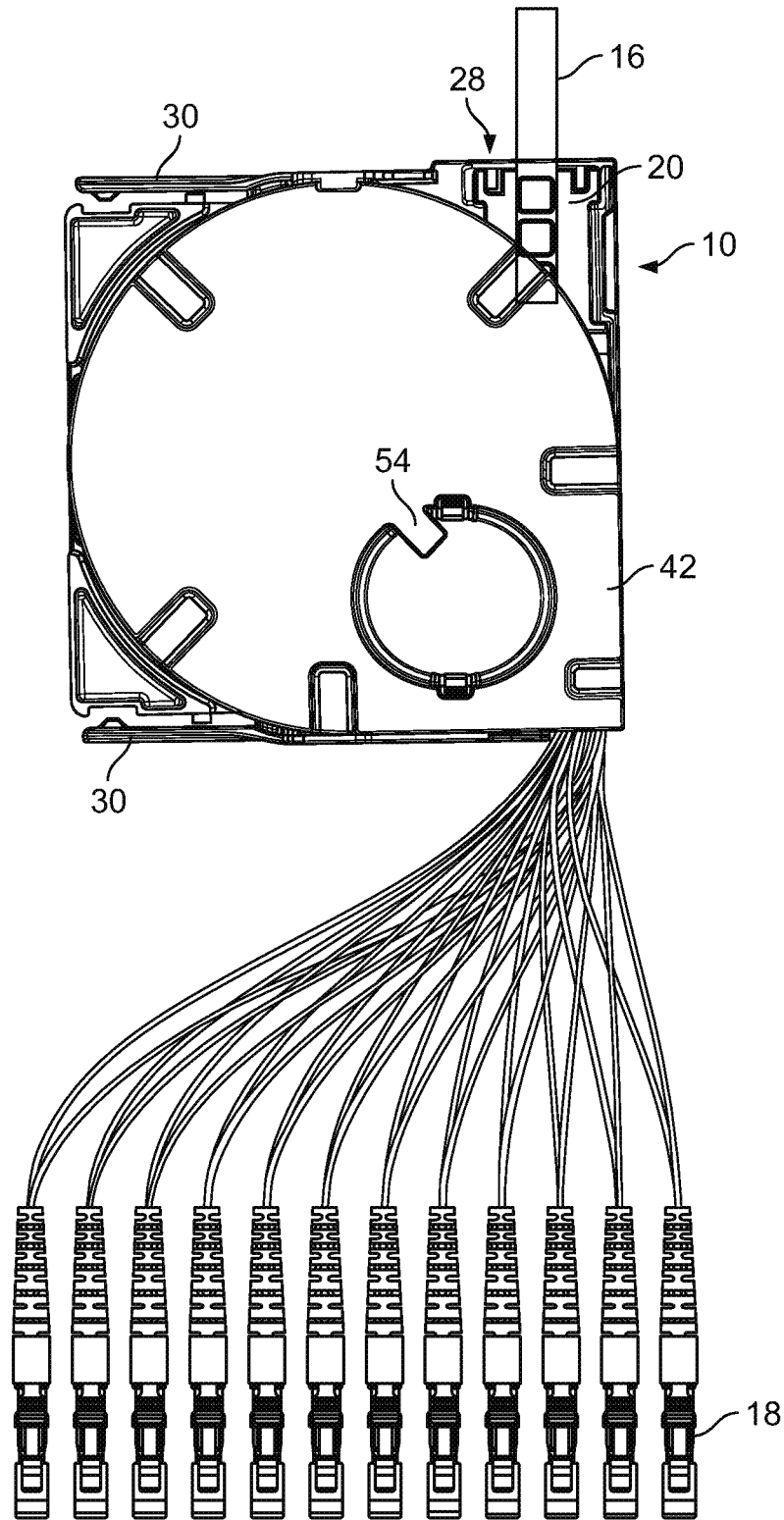


FIG. 7

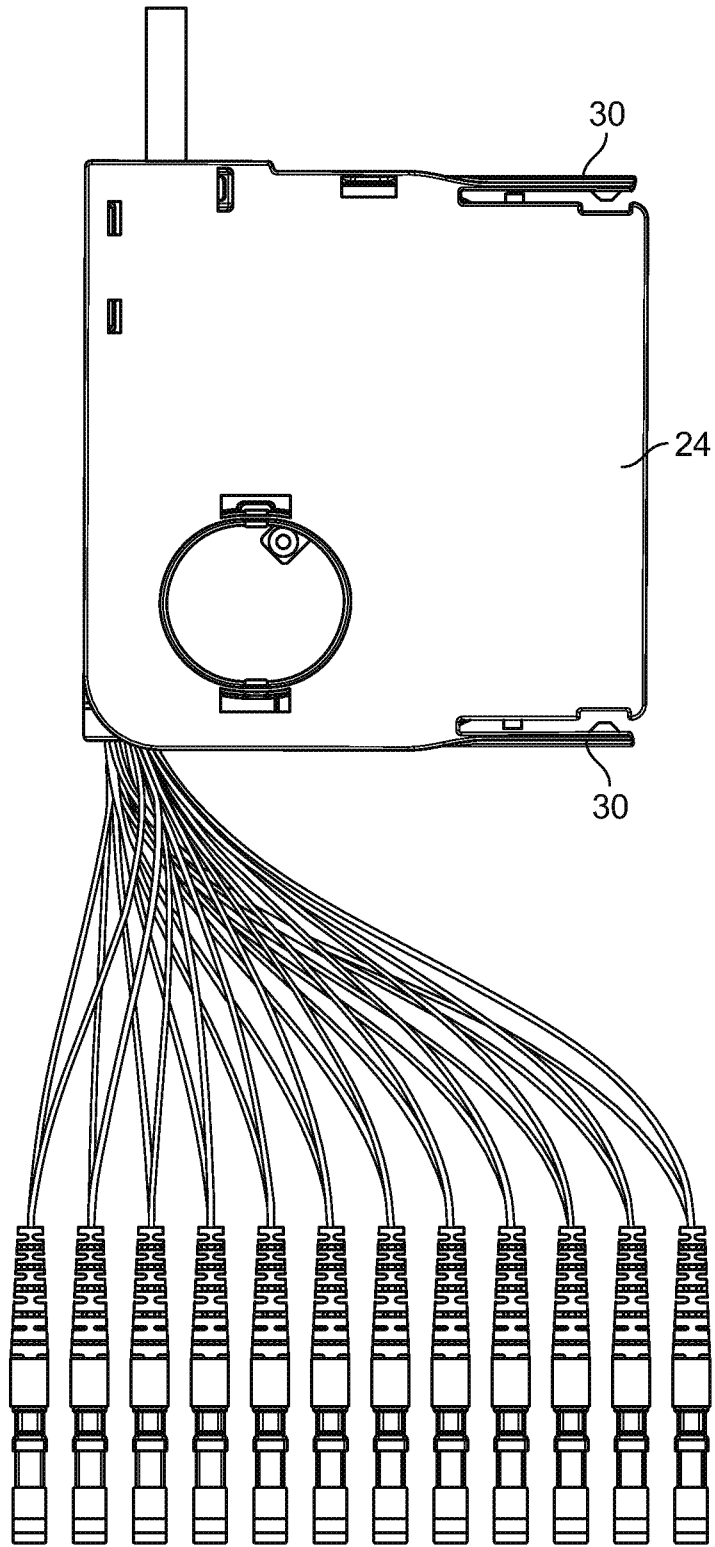


FIG. 8

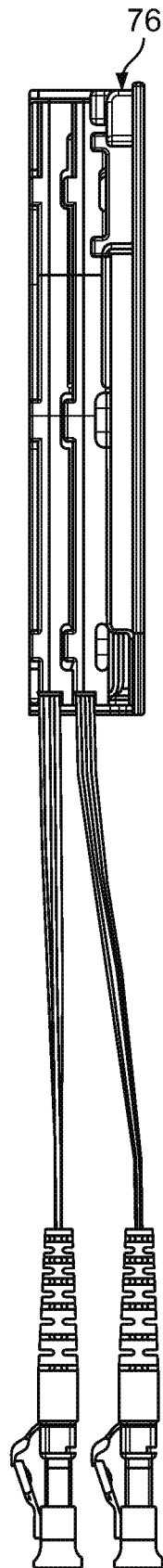


FIG. 9

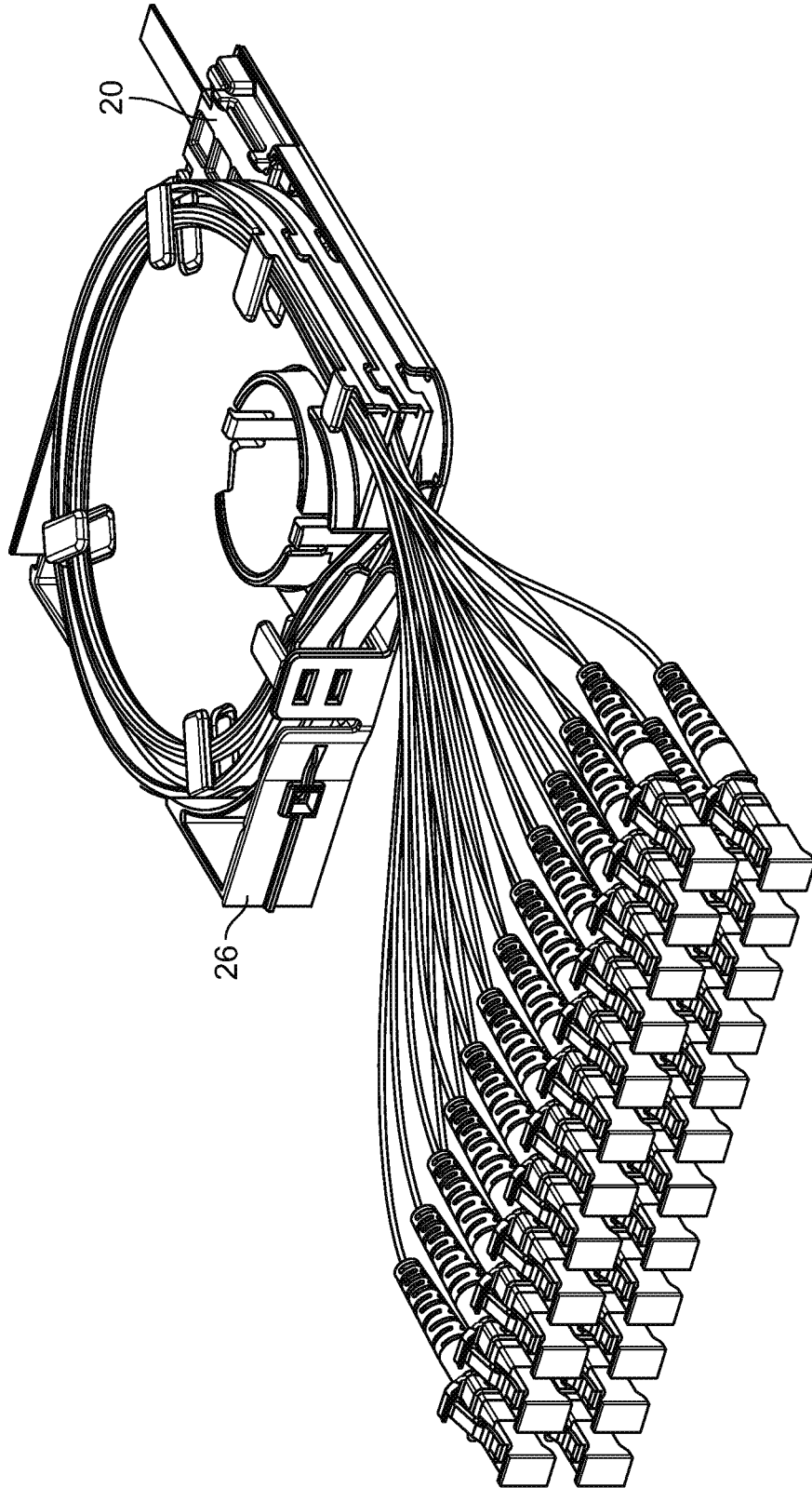


FIG. 10



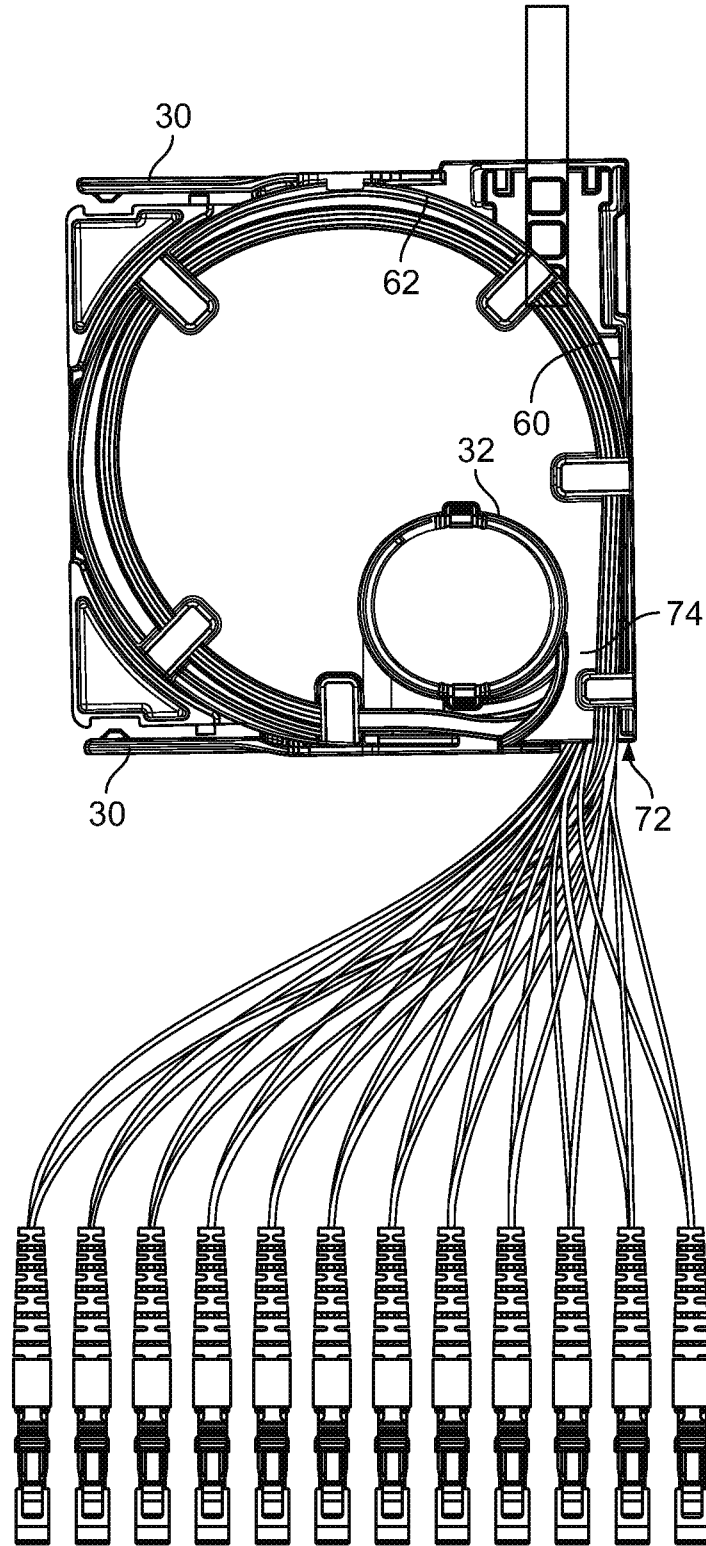


FIG. 11

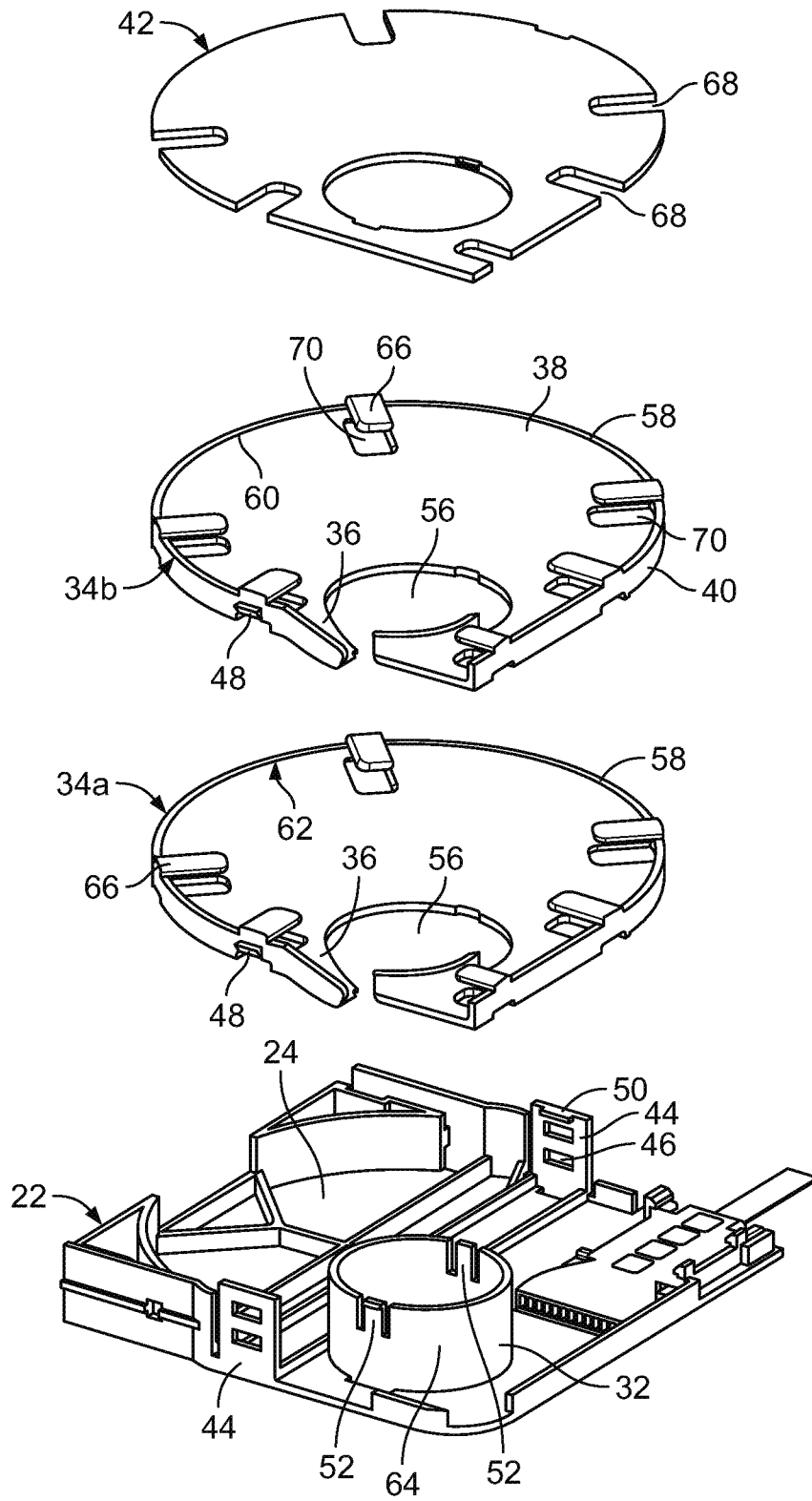


FIG. 12

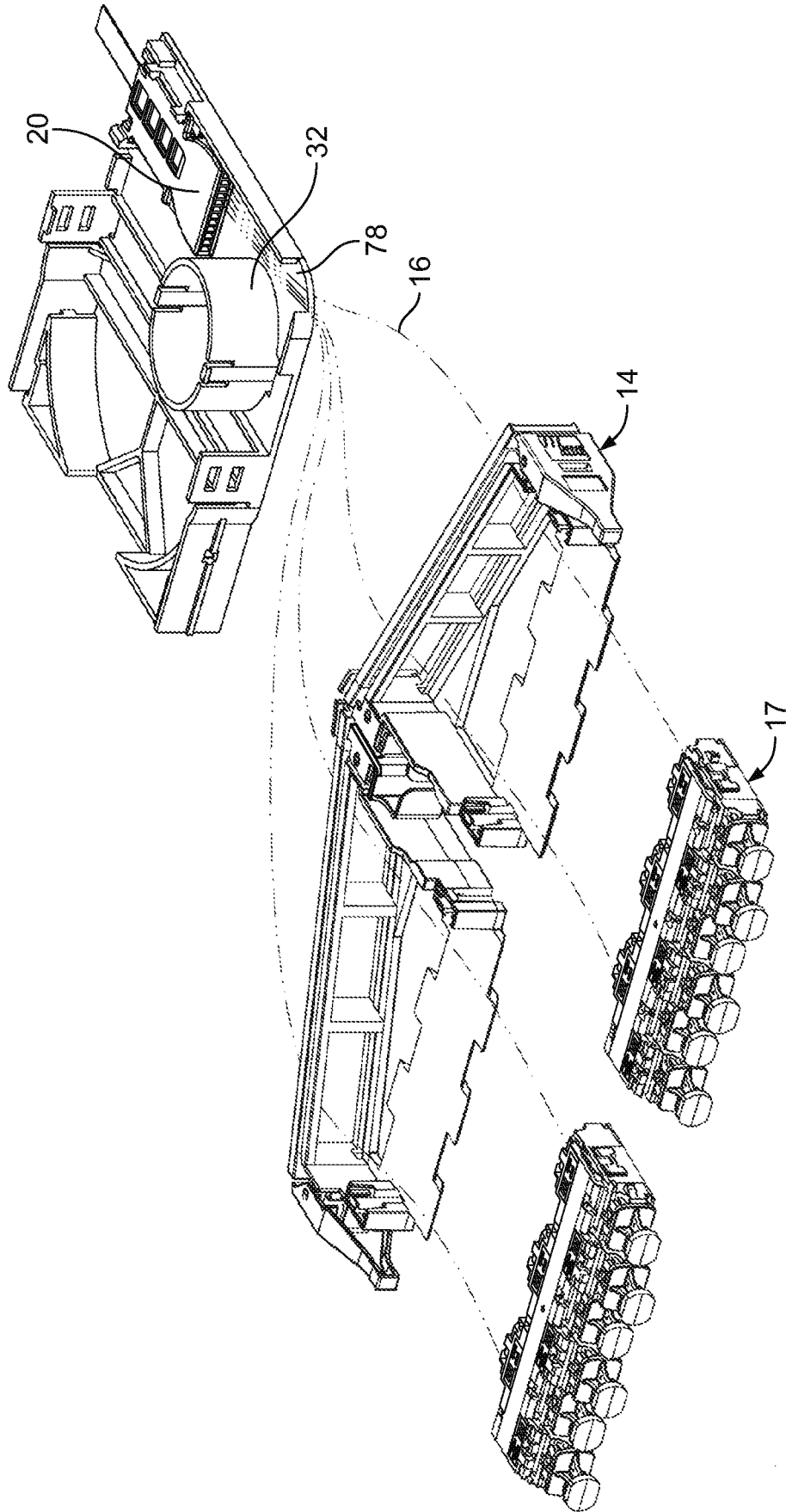


FIG. 13

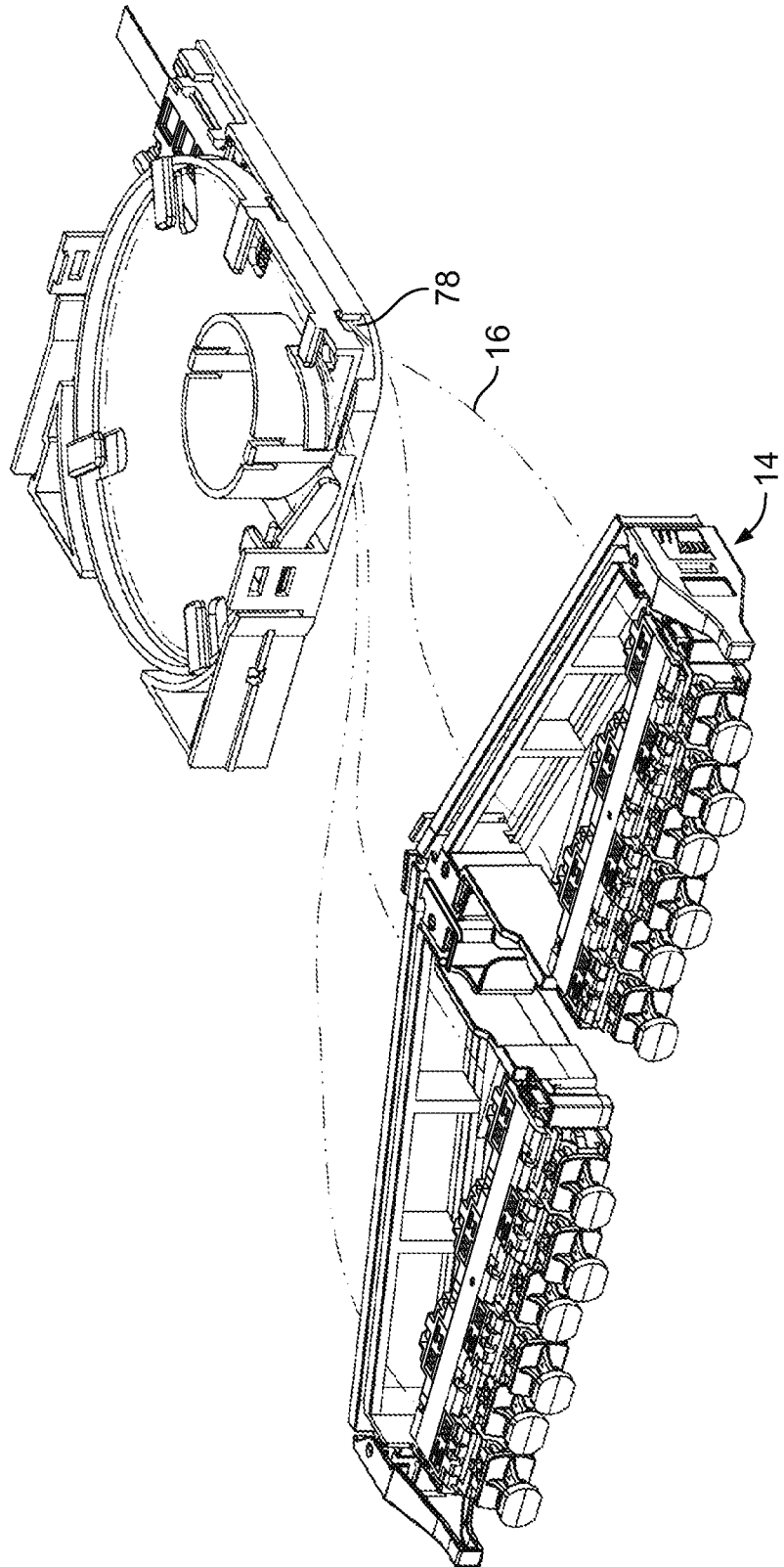


FIG. 14

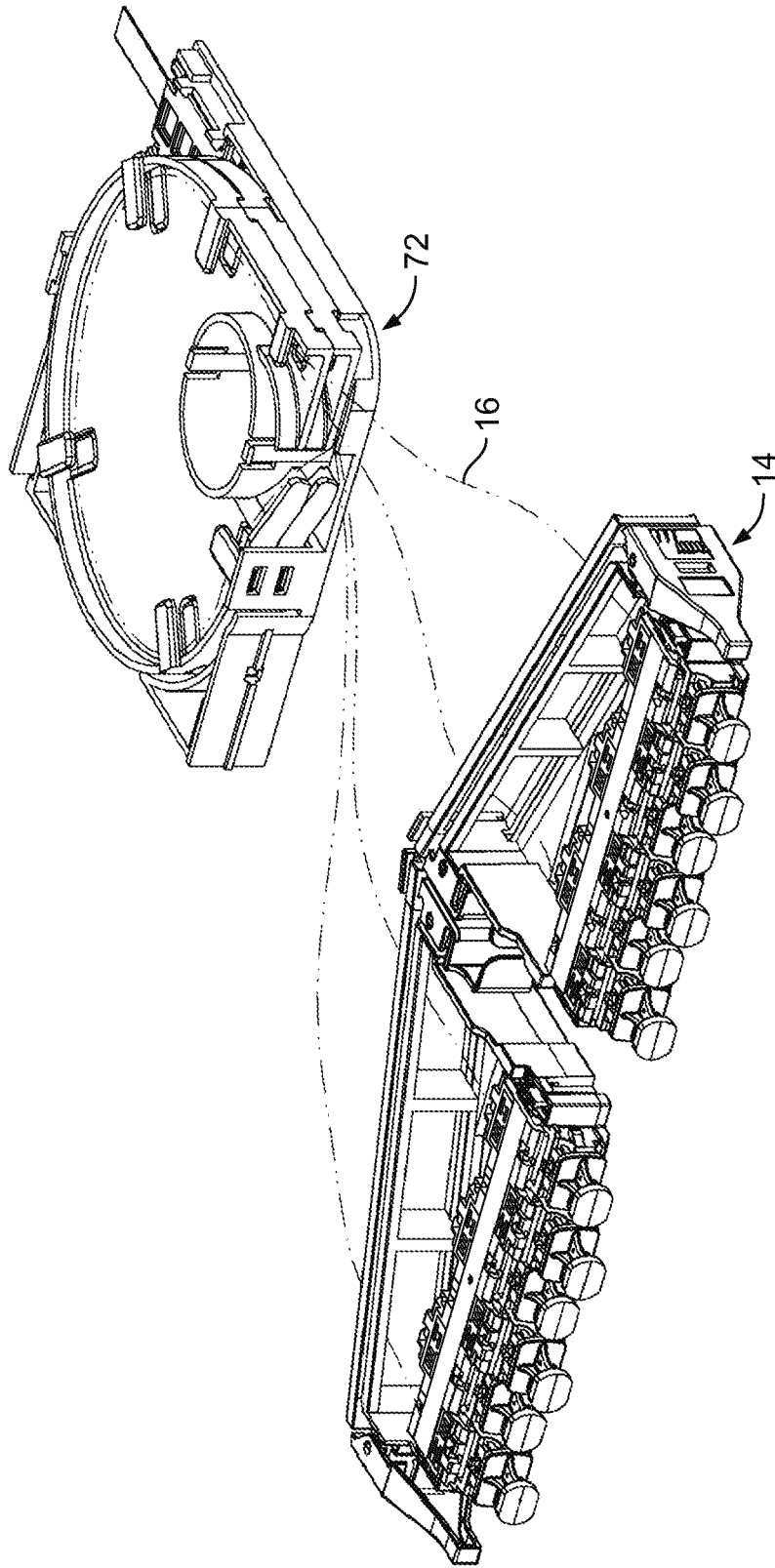


FIG. 15

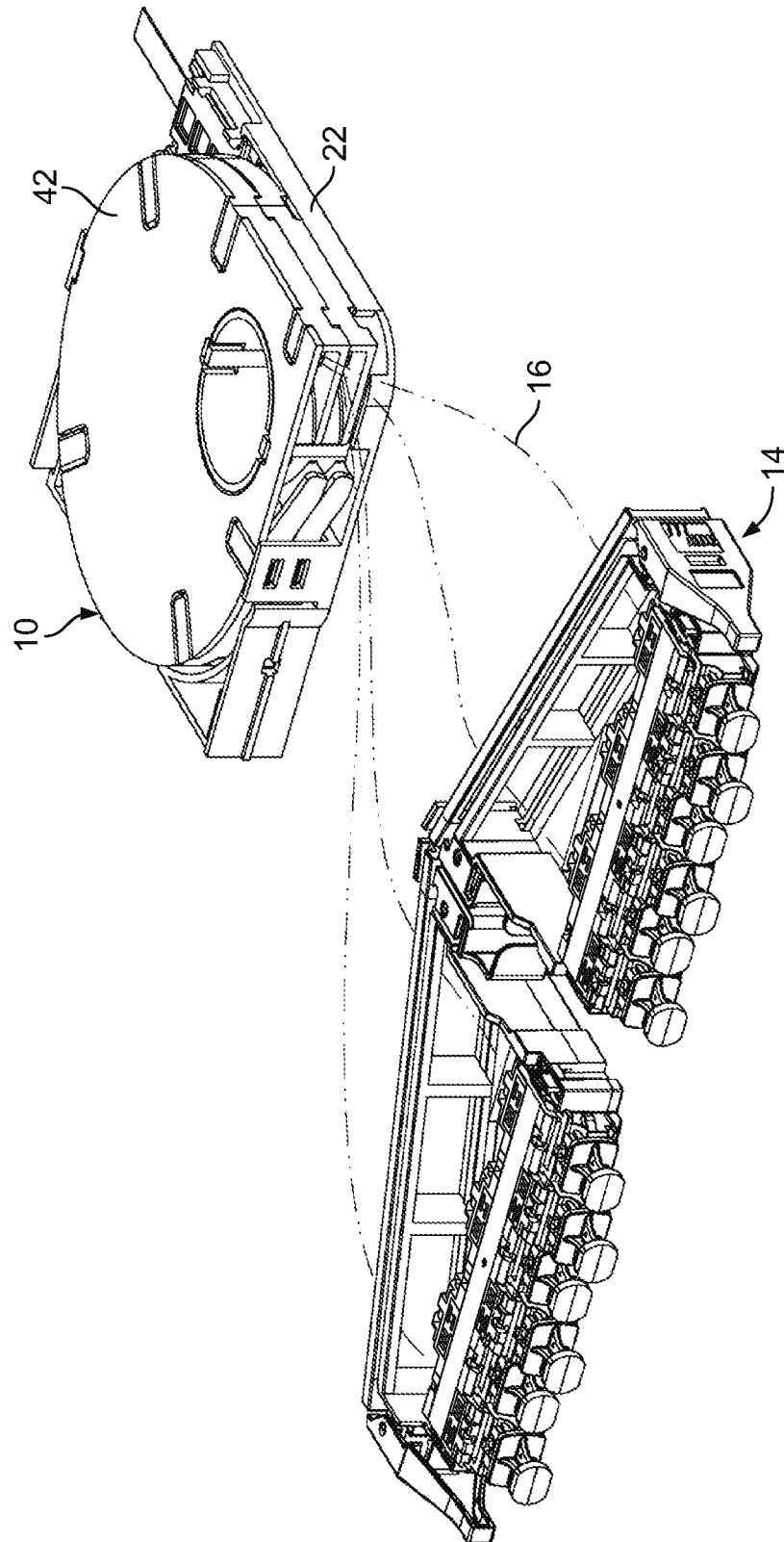


FIG. 16

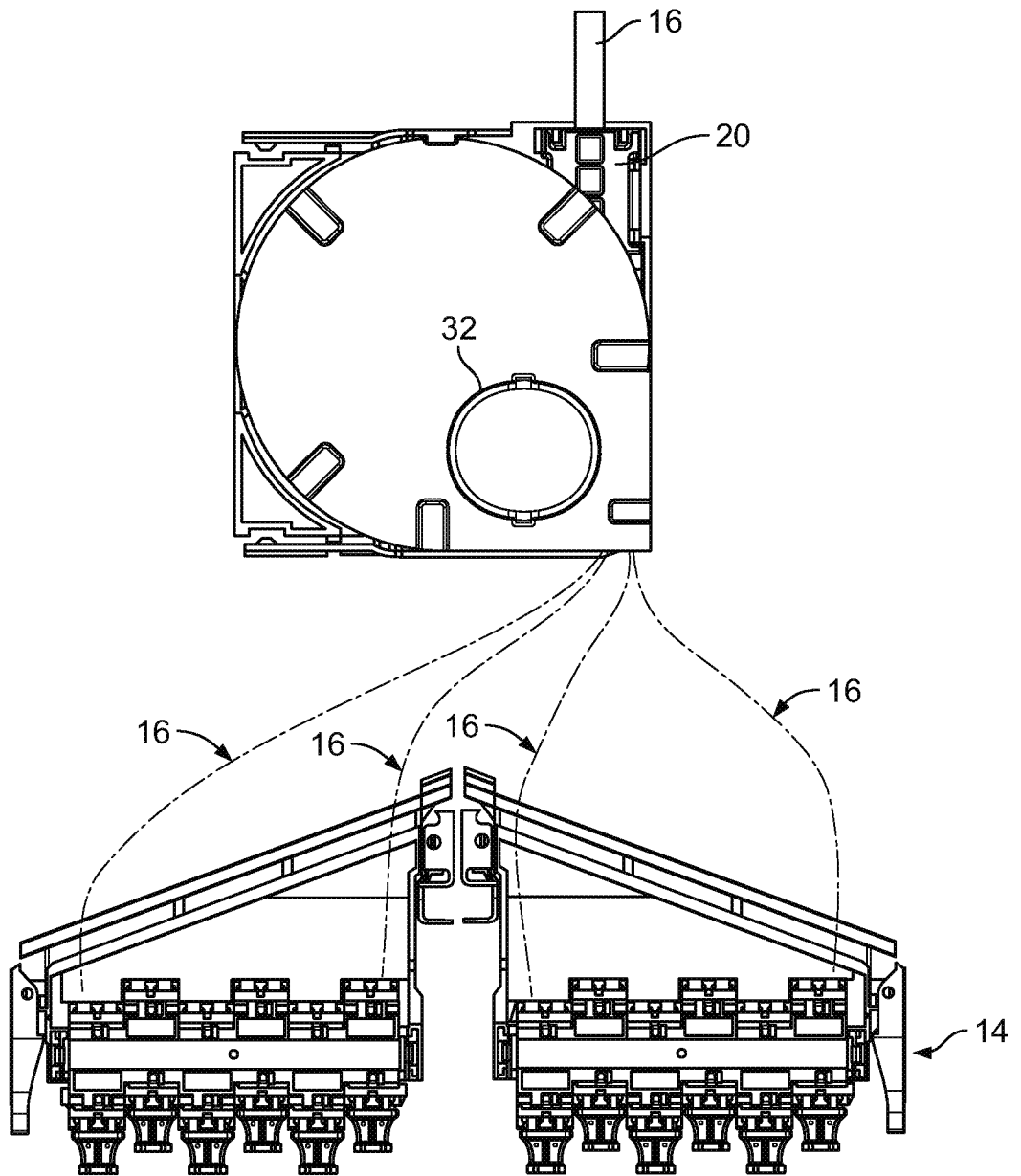


FIG. 17

**A. CLASSIFICATION OF SUBJECT MATTER****G02B 6/44(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; F16L 3/02; G02B 6/46; H01R 13/72; G02B 6/00

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) &amp; Keywords: spool, cable, slack, pull, connector, tray

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category <sup>1</sup>	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0259602 AI (ADC TELECOMMUNICATIONS INC.) 18 September 2014 See paragraphs [0021H0027] , [0032H0034] , [0040] - [0044] , [0047H0048] , [0052] ; claims 1-3 , 7; and figures 1, 3-4 , 6.	1-20
Y	US 2011-0268414 AI (GIRAUD et al.) 03 November 2011 See paragraph [0053] , [0064] , [0070] ; and figures 13, 17.	1-20
A	US 2010-0322579 AI (COOKE et al.) 23 December 2010 See paragraphs [0052]- [0055] ; claim V, and figure 12.	1-20
A	US 2007-0036506 AI (KEWITSCH) 15 February 2007 See paragraphs [0036] - [0039] ; claim V, and figures 1A-2B.	1-20
A	KR 10-2010-0027636 A (SK BROADBAND CO., LTD. et al.) 11 March 2010 See paragraphs [0013]- [0017] ; claim V, and figures 3-5 .	1-20

**I** 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

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**04 April 2016 (04.04.2016)**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





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Information on patent family members

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