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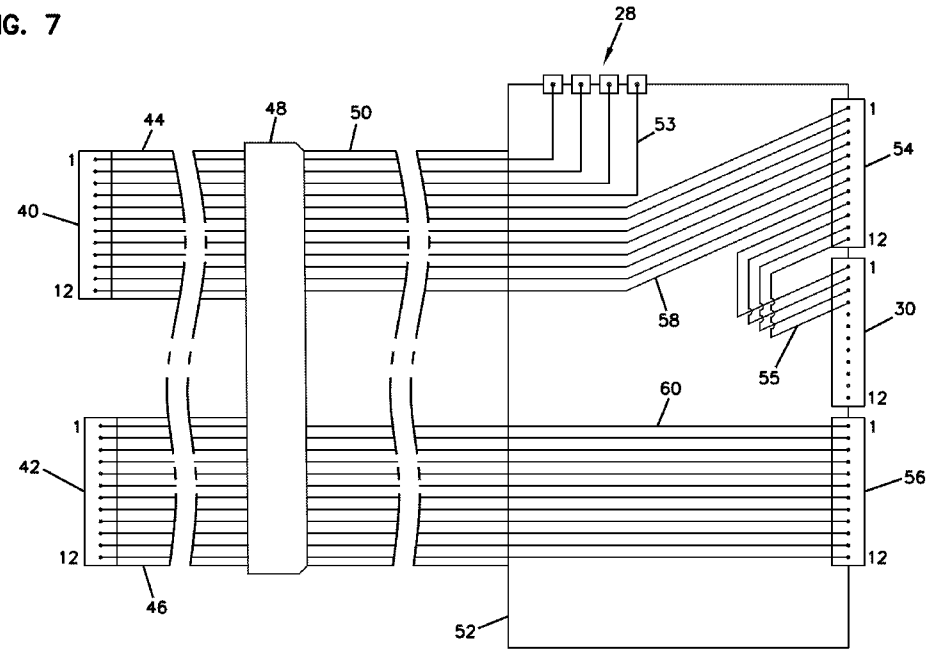
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(54) **Title:** FIBER OPTIC NETWORK ARCHITECTURE WITH PARALLEL INDEXED AND NON-INDEXED FIBER PATHS

FIG. 7



(57) **Abstract:** The present disclosure relates to a fiber optic network including a plurality of fiber distribution components daisy chained together to form a chain of fiber distribution components, the chain of fiber distribution components having a first set of optical fiber paths that are indexed along a length of the chain and a second set of optical fiber paths that are not indexed along a length of the chain.

WO 2018/085397 A1

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FIBER OPTIC NETWORK ARCHITECTURE WITH PARALLEL INDEXED AND NON-INDEXED FIBER PATHS

Cross-Reference to Related Application

This application is being filed on November 1, 2017 as a PCT International Patent Application and claims the benefit of U.S. Patent Application Serial No. 62/416,691, filed on November 2, 2016, the disclosure of which is incorporated herein by reference in its entirety.

Technical Field

The present disclosure relates generally to fiber optic communications networks. More particularly, the present disclosure relates to network architectures for fiber optic communications networks.

Background

Optical networks are becoming increasingly more prevalent in part because service providers want to deliver high bandwidth communication capabilities to customers. There is a need for advanced fiber optic network architectures for more effectively and efficiently extending fiber optic networks to an ever increasing number of customers.

Summary

Aspects of the present disclosure relate to a fiber optic network architecture including a plurality of fiber distribution components daisy chained together to form a chain of fiber distribution components. The chain of fiber distribution components has a first set of optical fiber paths that are indexed along a length of the chain and a second set of optical fiber paths that are not indexed along a length of the chain.

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

Brief Description of the Drawings

Figure 1 illustrates a fiber optic network architecture having a plurality of fiber distribution components daisy chained together to form a chain of fiber distribution components, chain of fiber distribution components has a first set of optical fiber paths that are indexed along a length of the chain and a second set of optical fiber paths that are not indexed along a length of the chain;

Figure 2 shows the fiber optic architecture of Figure 1 with an indexing terminal coupled to the non-indexed set of optical fiber paths;

Figure 3 shows the fiber optic network architecture of Figure 1 with two indexing terminals coupled to the non-indexed set of optical fiber paths;

Figure 4 illustrates the fiber optic network architecture of Figure 1 with three custom, non-indexing terminals coupled to the non-indexing set of optical fiber paths;

Figure 5 illustrates the fiber optic network architecture of Figure 1 with three indexing terminals coupled to the non-indexing set of optical fiber paths;

Figure 6 illustrates the fiber optic network architecture of Figure 1 with two indexing terminals coupled directly to the non-indexing optical fiber paths and a third terminal optically connected to certain ones of the non-indexed optical fiber paths via reverse indexing paths of the chain;

Figure 7 schematically depicts one of the daisy chained fiber distribution components of the fiber optic network architecture of Figure 1;

Figure 8 illustrates an example splitter terminal adapted to be optically coupled to one of the drop ports of the chain of fiber distribution components;

Figure 9 illustrates an example configuration for an indexing terminal adapted to be coupled to a plurality of the non-indexed optical fiber paths of the chain of Figure 1;

Figure 10 illustrates a custom terminal adapted to be optically coupled to selected optical fiber paths of the non-indexed optical fiber paths of the daisy chain of the fiber optic network of Figure 1;

Figure 11 illustrates another custom terminal adapted to be coupled to selected optical fiber paths of the non-indexed fiber paths of the daisy chain of the fiber optic network of Figure 1;

Figure 12 illustrates still another custom terminal adapted to be optically coupled to selected optical fiber paths of the non-indexed fiber paths of the daisy chain of the fiber optic network of Figure 1;

Figure 13 illustrates an example loop-back apparatus for use with the network architecture of Figure 1, the loop-back apparatus has patching capabilities;

Figure 14 shows another loop-back apparatus adapted for use with the network architecture of Figure 1;

Figure 15 illustrates still another loop-back apparatus adapted for use with the network architecture of Figure 1;

Figure 16 illustrates a further loop-back apparatus adapted for use with the network architecture of Figure 1; and

Figure 17 illustrates still another loop-back apparatus adapted for use with the network architecture of Figure 1.

Detailed Description

As used herein, a ruggedized fiber optic connector is a fiber optic connector that more robustly designed than a traditional indoor fiber optic connector such as an SC style fiber optic connector or an LC style fiber optic connector. Ruggedized fiber optic connectors are typically suitable for outdoor use. Ruggedized fiber optic connectors can include single-fiber fiber optic connectors and multi-fiber fiber optic connectors. Ruggedized multi-fiber optic connectors can be referred to as HMFOC connectors (e.g., hardened multi-fiber fiber optic connectors). Certain ruggedized fiber optic connectors in accordance with the principles of the present disclosure are designed to be capable of withstanding pull-out loads greater than 25lbs. or greater than 50lbs. when secured to corresponding ruggedized fiber optic connectors or when secured within corresponding ruggedized fiber optic connector ports. Certain ruggedized fiber optic connectors in accordance with the principles of the present disclosure can include rotatable (i.e., twist-to-lock) coupling element (i.e., couplers, fasteners, sleeves, collars, retainers, etc.) for securing the ruggedized connectors within their corresponding connector ports or for securing the ruggedized connectors to corresponding ruggedized connectors. Example rotatable coupling elements include threaded elements (e.g., threaded nuts, threaded sleeves, etc.) and bayonet-style elements. Certain ruggedized connectors may also include snap-fit coupling elements and sliding lock clips that function as coupling elements. Ruggedized fiber optic connectors in accordance with the principles of the present

disclosure can also include seals for sealing with their respective connector ports or for sealing between respective ruggedized male and female fiber optic connectors when such fiber optic connectors are coupled together.

As used herein, demateable fiber optic connection locations often include ferrules supporting optical fibers. The ferrules can include single-fiber ferrules (e.g., cylindrical ferrules such as LC or SC ferrules) for supporting optical fibers corresponding to single-fiber optical connectors. Multi-fiber demateable fiber optic connection locations within the principles of the present disclosure can also include multi-fiber ferrules for supporting a plurality of optical fibers. Example multi-fiber fiber optic ferrules include 12 fiber ferrules such as MPO ferrules which support optical fibers in a sequence such as in a row. It will be appreciated that multi-fiber ferrules can support different numbers of optical fibers such as two fibers, four fibers, eight fibers, twelve fibers, twenty-four fibers, thirty-six fibers, forty-eight fibers or more fibers. In certain examples, the optical fibers can be arranged sequentially one row, two rows or more than two rows. In other examples, ferrule-less demateable fiber optic connection structures can be used. Example ferrule-less demateable fiber optic connection locations are disclosed by PCT Publication No. WO 2016/043922, which is hereby incorporated by reference in its entirety.

Aspects of the present disclosure also relate to using indexing components to extend a fiber optic network outwardly from a field-installed factory manufactured break-out cable. A typical indexing component includes first and second demateable multi-fiber connection locations. Each of the demateable multi-fiber connection locations can include a plurality of optical fiber positions arranged in a sequence. In a preferred example, the optical fibers at the demateable fiber optic connection locations are retained in a particular fiber position sequence by a ferrule. In certain examples, the ferrule can include a two-fiber ferrule, an eight-fiber ferule, a twelve fiber MPO ferrule, a twenty-four fiber ferrule or other ferrules. While ferrules are preferred, ferrule-less systems are also contemplated. Within the indexing component, indexing optical fibers are routed from the first demateable multi-fiber connection location to the second demateable multi-fiber connection location in an indexed configuration. The indexed optical fibers are indexed such that first ends of the optical fibers at the first demateable multi-fiber connection location are at different sequential fiber positions compared to second ends of the optical fibers at the second demateable multi-fiber connection location. Within the indexing component one or more of the sequential fiber positions of the first multi-fiber demateable fiber optic location are not optically connected to any of the sequential fiber positions of

the second demateable multi-fiber fiber optic connection location, but instead are optically connected to one or more drop locations by one or more drop optical fibers. The one or more drop locations can each include demateable fiber optic connections for interfacing with additional cables (e.g., drop cables) and components (e.g., terminals such as multi-service terminals, splitter terminals, wavelength division mulit-plexer (WDM) terminals, etc.). Similarly, one or more of the sequential fiber positions of the second demateable multi-fiber connection location are not optically connected to any of the sequential fiber positions of the first demateable multi-fiber connection location, but instead are optically coupled to one or more one or more drop locations by one or more drop optical fibers. The one or more drop locations can each include demateable fiber optic connections for interfacing with additional cables (e.g., drop cables) and components (e.g., terminals such as multi-service terminals, splitter terminals, wavelength division mulit-plexer (WDM) terminals, etc.).

The drop fiber or fibers routed from the first demateable multi-fiber connection location can be referred to as forward drop fiber or forward drop fibers and the drop fiber or fibers routed from the second demateable multi-fiber connection location can be referred to as a reverse drop fiber or reverse drop fibers. It will be appreciated that it is preferred to include forward and reverse drop route fibers, but in certain examples only a forward drop fiber or only a reverse drop fiber may be provided. In certain examples, the forward and/or reverse drop fibers can be routed to single-fiber demateable connection locations. In other examples, where a plurality of forward and/or reverse drop fibers are provided, the drop fibers can be routed to multi-fiber demateable fiber optic connection locations or to a plurality of separate single-fiber demateable fiber optic connection locations. In still other examples, forward and/or reverse drop optical fibers can be routed to optical splitters that split the optical liners into a plurality of optical lines that can be routed to individual demateable fiber optic connection locations or to one or more multi-fiber demateable fiber optic connection locations. The demateable fiber optic connection locations can be ruggedized or non-ruggedized. Additionally, the demateable fiber optic connection locations can be provided as male or female fiber optical connectors terminating the end of tether cables, or as demateable fiber optic connection locations incorporated within ports of a terminal housing adapted for receiving fiber optic connectors. Example configurations for ruggedized single-fiber fiber optic ports/adapters as well as ruggedized single-fiber fiber optic connectors are disclosed by US Patent No. 7,744,288, which is hereby incorporated by reference in its entirety. Example multi-fiber

connection locations with hardened multi-fiber fiber optic connectors are disclosed by International Application No. PCT/US2014/039377, which is hereby incorporated by reference. Example indexing configurations and indexing components are disclosed by US Patent No. 9,348,096, which is hereby incorporated by reference in its entirety.

Indexing components in accordance with the principles of the present disclosure can include housings defining fiber optic connection ports incorporating dematerable single fiber and/or multi-fiber connection locations. In other examples, indexing components in accordance with principles of the present disclosure can include more cable-based constructions having fan-outs configured to fan out optical fibers from a main cable to a plurality of cables or tethers with the cables being terminated at their ends by male or female dematerable multi-fiber connection locations.

Figure 1 illustrates a fiber optic network architecture 20 in accordance with the principles of the present disclosure. The fiber optic network architecture 20 includes a plurality of fiber distribution components 22a-22f daisy chained together to form a chain of fiber distribution components. The chain of fiber distribution components can include a first set of optical fiber paths 24 that are indexed along a length of the chain and a second set of optical fiber paths 26 that are not indexed along a length of the chain. In certain examples, first and second sets of optical fiber paths each include 12 optical fiber paths. In certain examples, the first set of optical fiber paths is indexed in a forward direction and a reverse direction. In certain examples, the first set of optical fiber paths includes forward drop locations 28 dropped from the forward direction and reverse drop locations 30 dropped from the reverse direction. Terminals such as splitter terminals 32 are shown coupled to the forward drop locations 28. The splitter terminals 32 can include a passive optical power splitters 34 that splits optical signals and route such optical signals to ruggedized dematerable fiber optic connection locations 36. An example splitter terminal 32 is shown at Figure 8.

Figure 7 shows an example fiber distribution component 22a that can be used to form the chain of fiber distribution components. It will be appreciated that the fiber distribution components 22a-22f can have the same basic configuration except for the number of optical fibers dropped in the forward direction to forward drop locations 28. It will be appreciated that the forward and reverse drop locations 28, 30 can each include ruggedized dematerable fiber optic connection locations which may be single fiber connection locations or multi-fiber connection locations.

Referring to Figure 7, the distribution component 22a includes a first multi-fiber demateable fiber optic connection location 40 including a first plurality of sequential fiber positions and a second multi-fiber demateable fiber optic connection location 42 including a second plurality of sequential fiber positions. In one example, the first and second multi-fiber demateable fiber optic connection locations can be formed by ruggedized multi-fiber optic connectors mounted at the ends of tethers 44, 46 directed outwardly from a fanout 48. A main cable 50 can be routed from the fanout 48 to a terminal housing 52. The terminal housing 52 can include a third multi-fiber demateable fiber optic connection location 54 including a third plurality of sequential fiber positions and a fourth multi-fiber demateable fiber optic connection location 56 including a fourth plurality of sequential fiber positions. The third and fourth multi-fiber demateable fiber optic connection locations 54, 56 can be provided as ruggedized fiber optic adapters or ports provided on the terminal housing 52. A plurality of indexing fibers 58 are indexed between the sequential fiber positions of the first and third multi-fiber demateable fiber optic connection locations 40, 54. The indexing fibers 58 can be routed from the first multi-fiber demateable fiber optic connection location 40 through the first tether 44 and the main cable 50 to the terminal housing 52. Within the terminal housing 52, the indexing fibers 58 can be routed to the third multi-fiber demateable fiber optic connection location 54 in an indexed configuration which shifts the sequential fiber positions as comparted to at the first connection location 40.

The fiber distribution component 22a can also include a plurality of non-indexing fibers 60 routed between the sequential fiber positions of the second multi-fiber demateable fiber optic connection location 42 and the fourth multi-fiber demateable fiber optic connection location 56. The non-indexing fibers 60 are not indexed so that the fibers remain connected to the same sequential positions at both the second and fourth multi-fiber demateable fiber optic connection locations 42, 56. The non-indexing fibers 60 can be routed from the second multi-fiber demateable fiber optic connection location 42 through the second tether 46 and the main cable 50 to the terminal housing 52. Within the terminal housing, the non-indexing fibers 60 are routed to the fourth multi-fiber demateable fiber optic connection location 56.

The fiber distribution component 22a also includes at least one forward drop location 28 optically coupled to at least one of the first sequential fiber positions of the first multi-fiber demateable fiber optic connection location 40 by forward drop fibers 53. The forward drop locations 28 of Figure 7 are shown as four separate single fiber

demateable fiber optic connection locations. In other examples, other numbers of forward drop locations can be provided. The forward drop locations can be single fiber drop locations or multi-fiber drop locations. By way of example, the fiber distribution components 22b, 22d and 22f each include only one forward drop location 28, the fiber distribution component 22c has three forward drop locations 28 and the fiber drop components 22e has two forward drop locations 28.

The fiber distribution component 22a also includes a reverse drop location 30 optically coupled to at least one of the sequential fiber positions of the third multi-fiber demateable fiber optic connection location 54 by reverse drop fibers 55. As depicted, the reverse drop location 30 is provided by a multi-fiber demateable fiber optic connection location and four optical fibers 55 are shown dropped in the reverse direction. In other examples, more or fewer than four optical fibers may be dropped. In other examples, the reverse drop locations 30 may include one or more single fiber demateable fiber optic connection locations.

In the daisy chain of Figure 1, the first dematable multi-fiber connection location 40 of a given one of the fiber distribution components 22 couples to the third dematable multi-fiber fiber optic connection location 54 of the immediately upstream one of the fiber distribution components 22 in the chain, and the second dematable multi-fiber fiber optic connection location 42 of the given fiber distribution component 22 couples to the fourth dematable multi-fiber fiber optic connection location 56 of the immediately upstream fiber distribution component 22 in the chain. In this way, the fiber distribution components 22a-22f are daisy chained together with the indexed fiber optic pathways passing through the first and third dematable multi-fiber fiber optic connection locations 40, 54 and the non-indexed fiber optic pathways passing through the second and fourth dematable multi-fiber fiber optic connection locations 42, 56.

Figure 2 shows an indexing terminal 70 coupled to the second set of non-indexed optical fiber paths 26. The indexing terminal 70 is shown coupled to the fiber distribution component 22c. As shown at Figure 9, the indexing terminal 70 includes a first dematable multi-fiber fiber optic connection location 72, a second dematable multi-fiber fiber optic connection location 74, and a third dematable multi-fiber fiber optic connection location 76. Indexing fibers 78 couple positions 5-12 of the first dematable multi-fiber fiber optic connection location 72 to positions 1-8 of the second dematable multi-fiber fiber optic connection location 74. Drop fibers 80 optically couple positions 1-

4 of the first demateable multi-fiber fiber optic connection location 72 to the third demateable multi-fiber fiber optic connection location 76.

When the indexing terminal 70 is integrated with the fiber optic network architecture 20, the first demateable multi-fiber fiber optic connection location 72 couples to the fourth demateable multi-fiber fiber optic connection location 56 of one of the distribution components 22, and the second demateable multi-fiber fiber optic connection location 42 of an immediately downstream one of the fiber distributions components 22 couples to the second demateable multi-fiber fiber optic connection location 74 of the indexing terminal 70.

Figure 3 shows an example where two of the indexing terminals 70 have been integrated with the fiber optic network architecture 20 to provide further fiber optic connection locations.

Figure 4 shows an example where unique or customized terminals 90a-90c are integrated with the fiber optic network architecture 20. The terminals 90a-90c do not include indexing functionality. Each of the terminals is adapted to access or select a certain set of the non-indexed set of optical fibers that run through the chain of fiber distribution components. Terminal 90a provides access to fibers 1-4, terminal 90b provides access to fibers 5-8, and terminal 90c provides access to fibers 9-12. The un-accessed fibers are passed on through the daisy chain without being indexed. For example, in terminal 90a, fibers 5-12 are passed on. In terminal 90b, fibers 1-4 and 9-12 are passed on. For terminal 90c, fibers 1-8 are passed on. In the terminals 90a-90c, a first demateable multi-fiber fiber optic connection location 92 can couple to the fourth demateable multi-fiber fiber optic connection location 56 of a corresponding one of the fiber distribution components 22, and a second demateable multi-fiber fiber optic connection location 94 can be optically coupled to the second demateable multi-fiber fiber optic connection location 42 of a fiber distribution component 22 located immediately downstream in the chain. Fibers 95 are non-indexing fibers and extend between the connection locations 92, 94 without altering the fiber sequencing. Thus, fibers 95 are positioned at the same sequential positions at each of the connection locations 92, 94. Drop fibers 97 are routed from certain sequential fiber positions of the first connection location 92 to a demateable drop connection location 99.

Figure 5 is an example of the fiber optic network architecture 20 of Figure 1 with three of the indexing terminals 70 integrated with the network architecture. In the

example of Figure 5, if terminal 70a is added after terminals 70b, 70c, a signal loss will occur at terminals 70b, 70c at the time terminal 70a is installed.

Figure 6 shows an example where a loop-back device 100 is used to loop-back signals from the non-indexed optical fiber paths (e.g., corresponding to connection location 42, 56 to the reverse indexed fibers (corresponding to drop locations 30) so that a signal can be provided to the indexing terminal 70a without interrupting service to terminals 70b and 70c. In the example of Figure 6, the terminal 70a is coupled to the reverse drop location 30 of the fiber distribution component 22a. The loop-back device 100 can have patching capability as shown at Figure 13. For example, the device 100 can include fiber optic adapters 101 (for mechanically and optically coupling two fiber optic connectors) that may be arranged in a patch panel or other arrangement so that unused optical fibers corresponding to the non-indexed optical fibers of the chain of fiber distribution components can be optically connected to specific reverse drop locations 30 in the chain. Connectorized patch cables 103 can be used to provide optical coupling to selected reverse optical paths.

The loop-back device 100 can include a first dematerable multi-fiber fiber optic connection location 100 that optically connects to the second dematerable multi-fiber fiber optic connection location 74 of the indexing terminal 70c and a second dematerable multi-fiber fiber optic connection location 104 that optically connects to the third dematerable multi-fiber fiber optic connection location 54 of the fiber distribution component 22f. The first connection location 72 of the indexing terminal 70c couples to the connection location 56 of the distribution terminal 22f. By optically coupling signal paths from the connection location 56 of the component 22f to positions 1-4 of the connection location 104 (and thus positions 1-4 of the connection location 54) via a loopback device, the accessed signal paths are connected to the four reverse drop fibers 55 of the component 22a. By optically coupling signal paths from the connection location 56 of the component 22f to positions 5-8 of the connection location 104 (and thus positions 5-8 of the connection location 54), the accessed signal paths are connected to the reverse drop locations 30 of the components 22b and 22c. By optically coupling signal paths from the connection location 56 of the component 22f to positions 9-12 of the connection location 104 (and thus positions 9-12 of the connection location 540 , the accessed signal paths are connected to the reverse drop locations 30 of the components 22d, 22e and 22f. Thus, the patch cords and patching arrangement allows the reverse drop output location to be specifically selected.

Figures 14-17 show other loop-back configurations that allow different fiber positions to be looped back to the reversed indexed fibers. The loop back configurations include patch cables 200a-200d having different fiber position switching arrangements. The cables 200a-200d can be coupled between the connection location 74 of the terminal 70c and the connection location 54 of the component 22f. The cables each provide a different sequential fiber position shift between opposite connectorized ends of the patch cables. By selecting the cable with the suitable fiber shift arrangement and by connecting the selected cable between the connection locations 74, 54, desired reverse drop locations can be activated (e.g., provide with live signals) based on the fiber shift arrangement selected. Cables having fiber shifts other than those depicted can also be used.

Various modifications and alterations of this disclosure will become apparent to those skilled in the art without departing from the scope and spirit of this disclosure, and it should be understood that the scope of this disclosure is not to be unduly limited to the illustrative examples set forth herein.

What is claimed is:

1. A fiber optic network comprising:

a plurality of fiber distribution components daisy chained together to form a chain of fiber distribution components, the chain of fiber distribution components having a first set of optical fiber paths that are indexed along a length of the chain and a second set of optical fiber paths that are not indexed along a length of the chain.

2. The fiber optic network of claim 1, wherein the first and second sets of fiber paths each include 12 fiber paths.

3. The fiber optic network of any of claims 1-2, wherein the first set of fiber paths is indexed in a forward direction and a reverse direction, wherein the first set of fiber paths includes forward drop locations dropped from the forward direction and reverse drop locations dropped from the reverse direction, and wherein a loop-back device is used to optically connect optical fiber paths from the second set of optical fiber path to the reverse drop locations.

4. The fiber optic network of claim 3, wherein the loop-back device includes patching capabilities for coupling the optical fiber paths from the second set of optical fiber paths to selected ones of the reverse drop locations.

5. The fiber optic network of claim 3, further comprising a plurality of terminals each coupled to the forward drop location of one of the fiber distribution components.

6. The fiber optic network of claim 5, wherein each terminal houses a passive optical splitter that splits optical signals received from the respective forward drop location and routes such split optical signals to ruggedized dematerable fiber optic connection locations.

7. The fiber optic network of any of claims 3-6, wherein the forward and reverse drop locations each include ruggedized dematerable fiber optic connection locations.

8. The fiber optic network of any of claims 3-7, wherein at least one of the forward drop locations is a single fiber connection location.

9. The fiber optic network of any of claims 3-7, wherein at least one of the forward drop locations is a multi-fiber connection location.

10. The fiber optic network of any of claims 1-9, wherein each fiber distribution component includes a plurality of indexing fibers indexed between multi-fiber demateable fiber optic connection locations.

11. The fiber optic network of any of claims 1-10, wherein each fiber distribution component also includes plurality of non-indexing fibers routed between other multi-fiber demateable fiber optic connection locations.

12. A fiber distribution component comprising:

a first multi-fiber demateable fiber optic connection location including a first plurality of sequential fiber positions;

a second multi-fiber demateable fiber optic connection location including a second plurality of sequential fiber positions;

a third multi-fiber demateable fiber optic connection location including a third plurality of sequential fiber positions;

a fourth multi-fiber demateable fiber optic connection location including a fourth plurality of sequential fiber positions;

a plurality of indexing fibers indexed between the first and third pluralities of sequential fiber positions; and

a plurality of non-indexing fibers routed between the second and fourth pluralities of sequential fiber positions; and

at least one of the sequential fiber positions of the first plurality of sequential fiber positions being optically coupled to a drop location of the indexing component, the drop location including a demateable fiber optic connection interface.

13. The distribution device of claim 12, further comprising at least one of the third sequential fiber positions being routed to a demateable reverse drop location.

14. The distribution device of claim 13, wherein the demateable reverse drop location is provided by a multi-fiber demateable fiber optic connection location.

15. The distribution device of claim 13, wherein the demateable reverse drop location is provided by one or more single-fiber demateable fiber optic connection locations.

16. The distribution device of any of claims 12-15, wherein the first and second demateable fiber optic connection locations are respectively provided at the end of first and second tethers routed from a cable fan-out, wherein the third and fourth demateable fiber optic connection locations are provided on a terminal, wherein the drop location is provided at the terminal, and wherein a main cable is routed from the cable fan-out to the terminal.

17. The distribution device of claim 16, wherein the first and second multi-fiber demateable fiber optic connection locations are formed by ruggedized multi-fiber optic connectors mounted at the ends of the first and second tethers.

18. The distribution device of claim 16, wherein the third and fourth multi-fiber demateable fiber optic connection locations include ruggedized fiber optic adapter ports provided on a housing of the terminal

19. The distribution device of any of claims 12-18, wherein the drop location is one of a plurality of forward drop locations, each forward drop location being optically coupled to a respective one of the sequential fiber positions of the first plurality of sequential fiber positions.

20. The distribution device of claim 19, wherein each forward drop location including a respective demateable fiber optic connection interface.

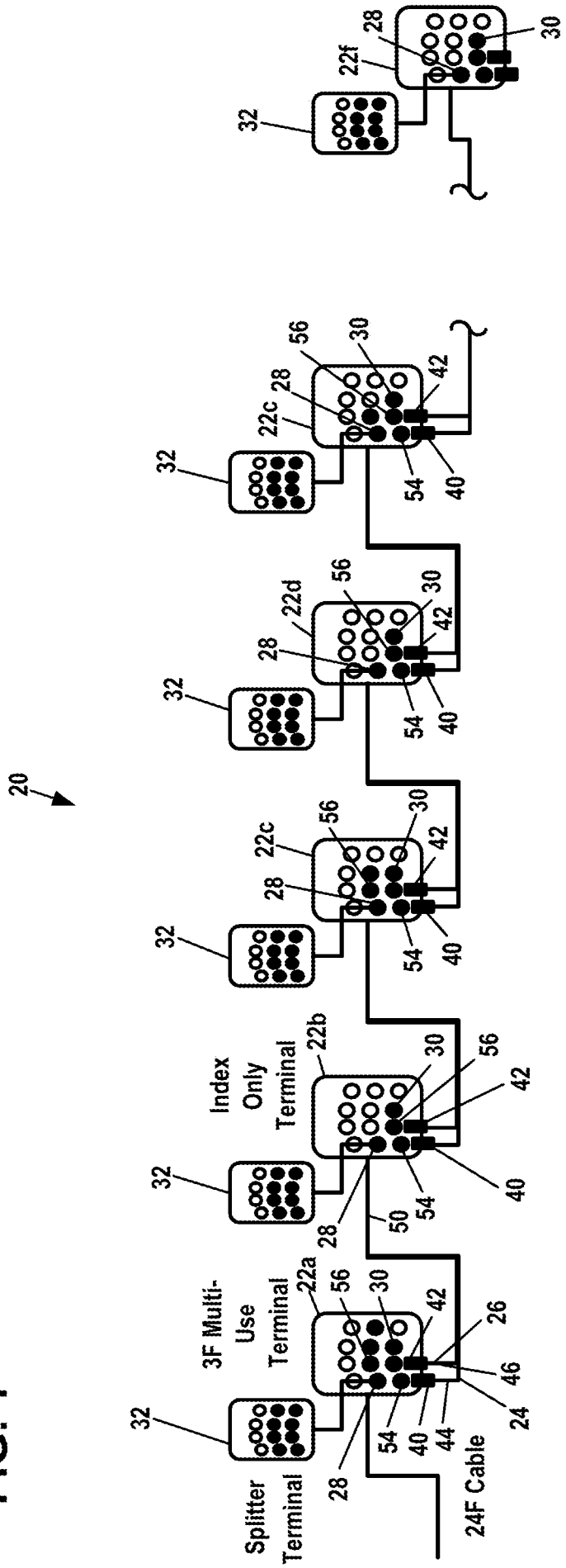

20
Splitter Terminal
3F Multi-Use Terminal
Index Only Terminal
24F Cable
22a
22b
22c
22d
22f
24
26
28
30
32
40
42
44
46
50
54
56

FIG. 1

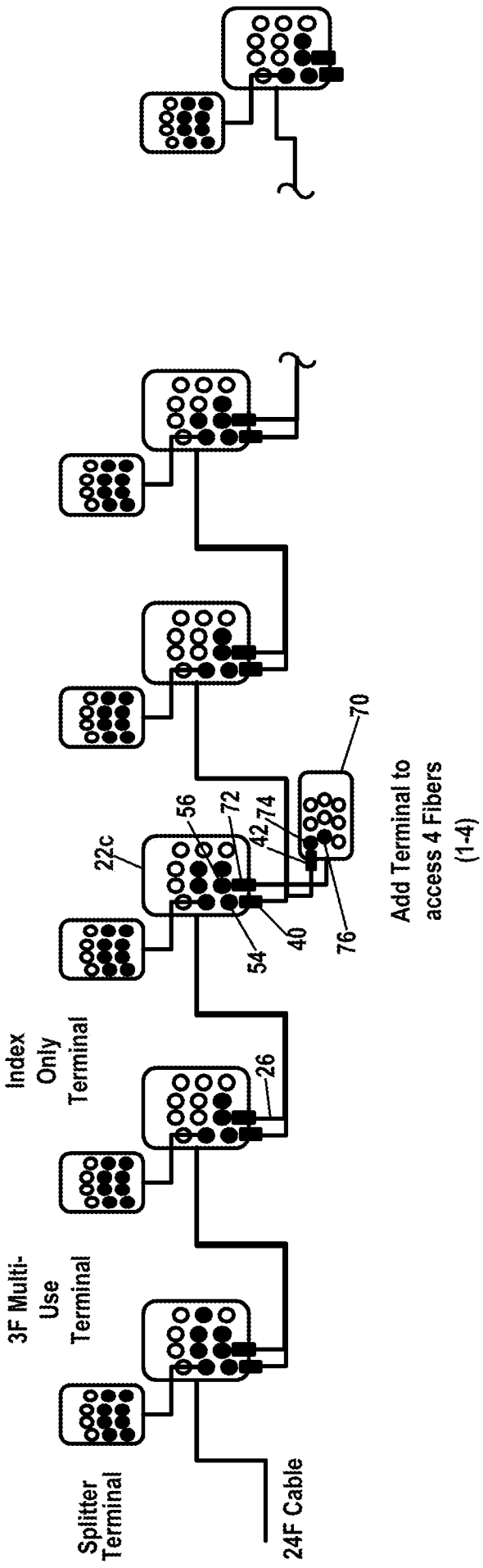
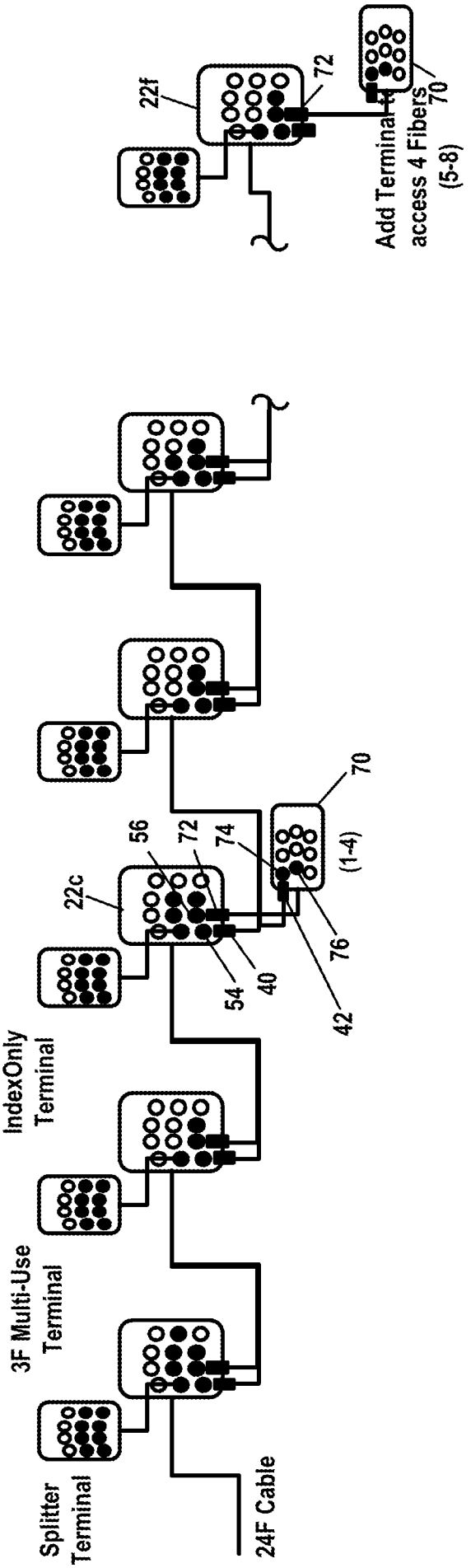

Splitter Terminal
3F Multi-Use Terminal
Index Only Terminal
24F Cable
22c
26
54
56
72
42
74
40
76
70
Add Terminal to access 4 Fibers (1-4)

FIG. 2

FIG. 3


Splitter Terminal
24F Cable
3F Multi-Use Terminal
IndexOnly Terminal
22c
56
72
74
70
(1-4)
54
40
42
76
22f
72
70
Add Terminal to access 4 Fibers (5-8)

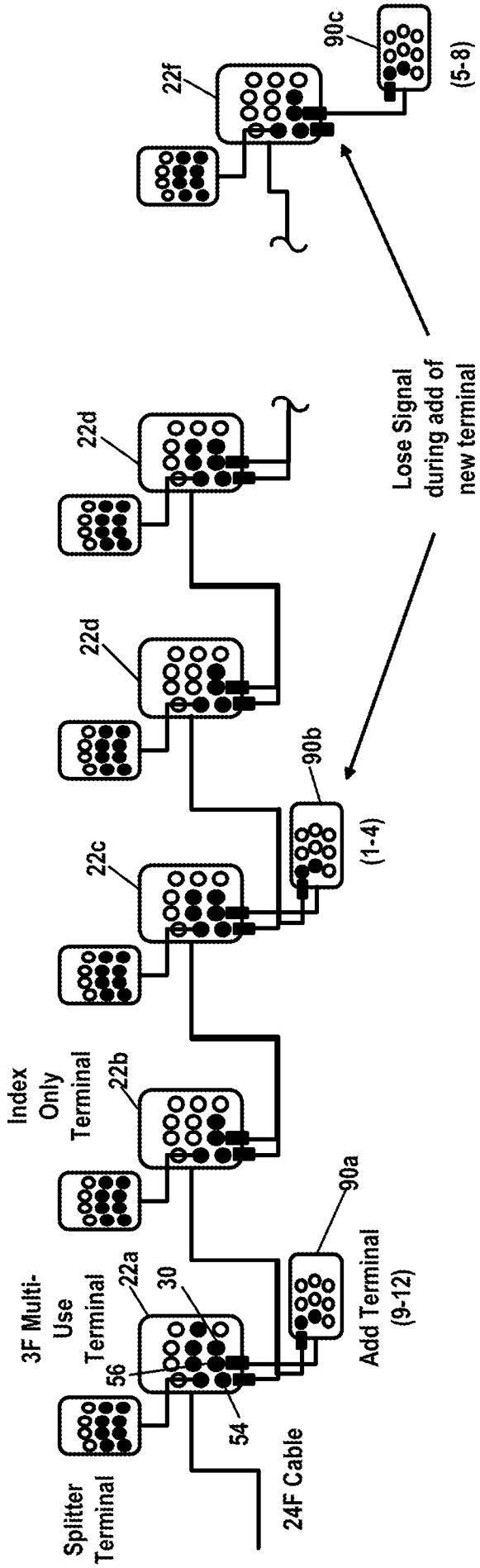

Splitter Terminal
24F Cable
3F Multi-Use Terminal
22a
30
56
54
Index Only Terminal
22b
22c
22d
22d
22d
22f
90a
Add Terminal (9-12)
90b
(1-4)
90c
(5-8)
Lose Signal during add of new terminal

FIG. 4

FIG. 5

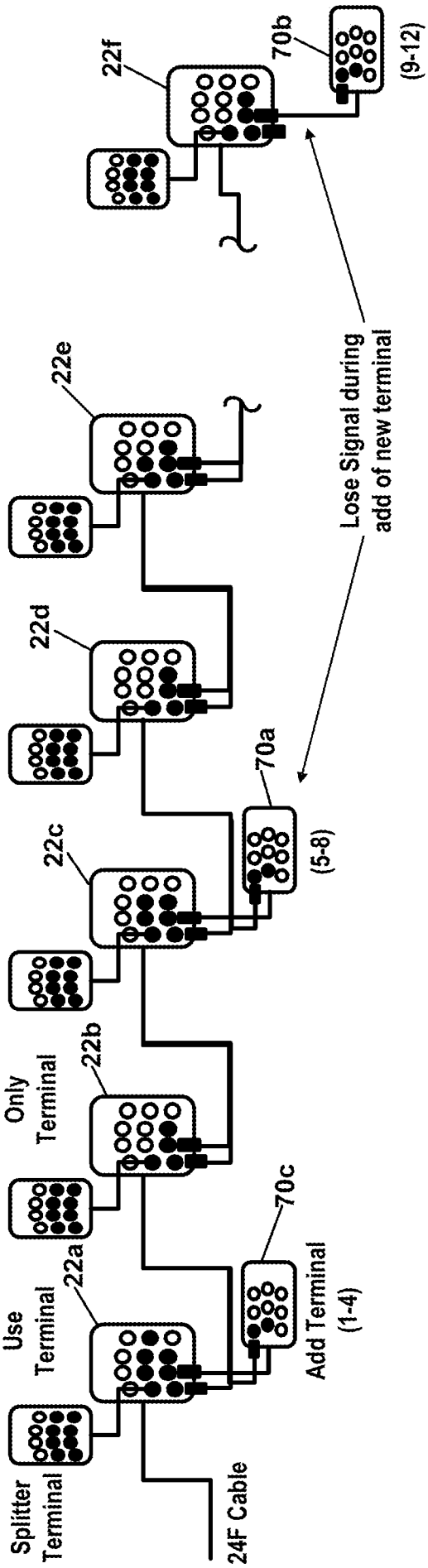
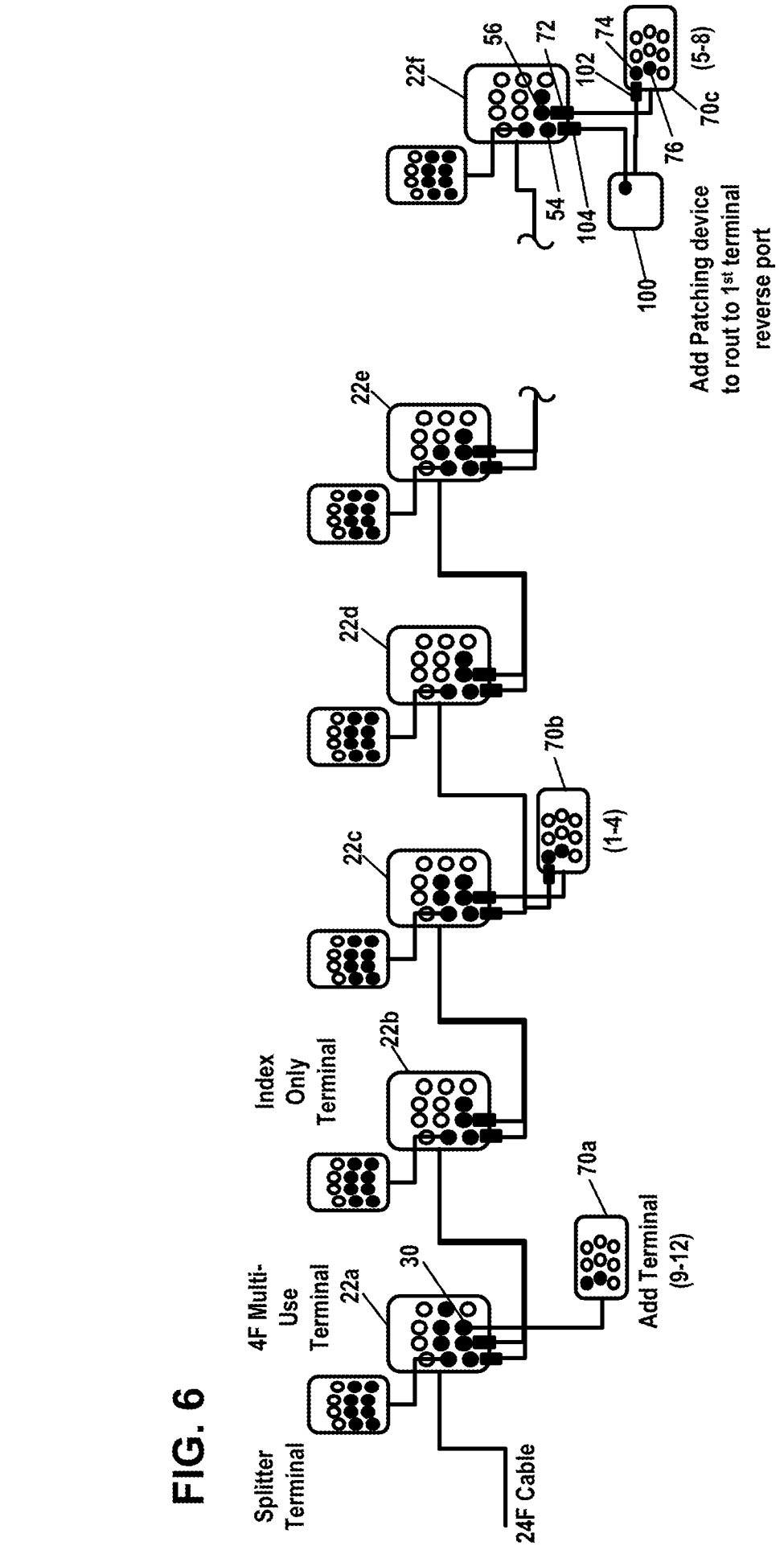

Splitter Terminal
24F Cable
3F Multi-Use Terminal
22a
Index Only Terminal
22b
22c
22d
22e
22f
70a
(5-8)
70b
(9-12)
70c
Add Terminal (1-4)
Lose Signal during add of new terminal

FIG. 6


Splitter Terminal
24F Cable
4F Multi-Use Terminal
22a
30
Index Only Terminal
22b
22c
22d
22e
22f
70a
Add Terminal (9-12)
70b
(1-4)
70c
(5-8)
54
56
72
74
76
100
102
104
Add Patching device to rout to 1st terminal reverse port

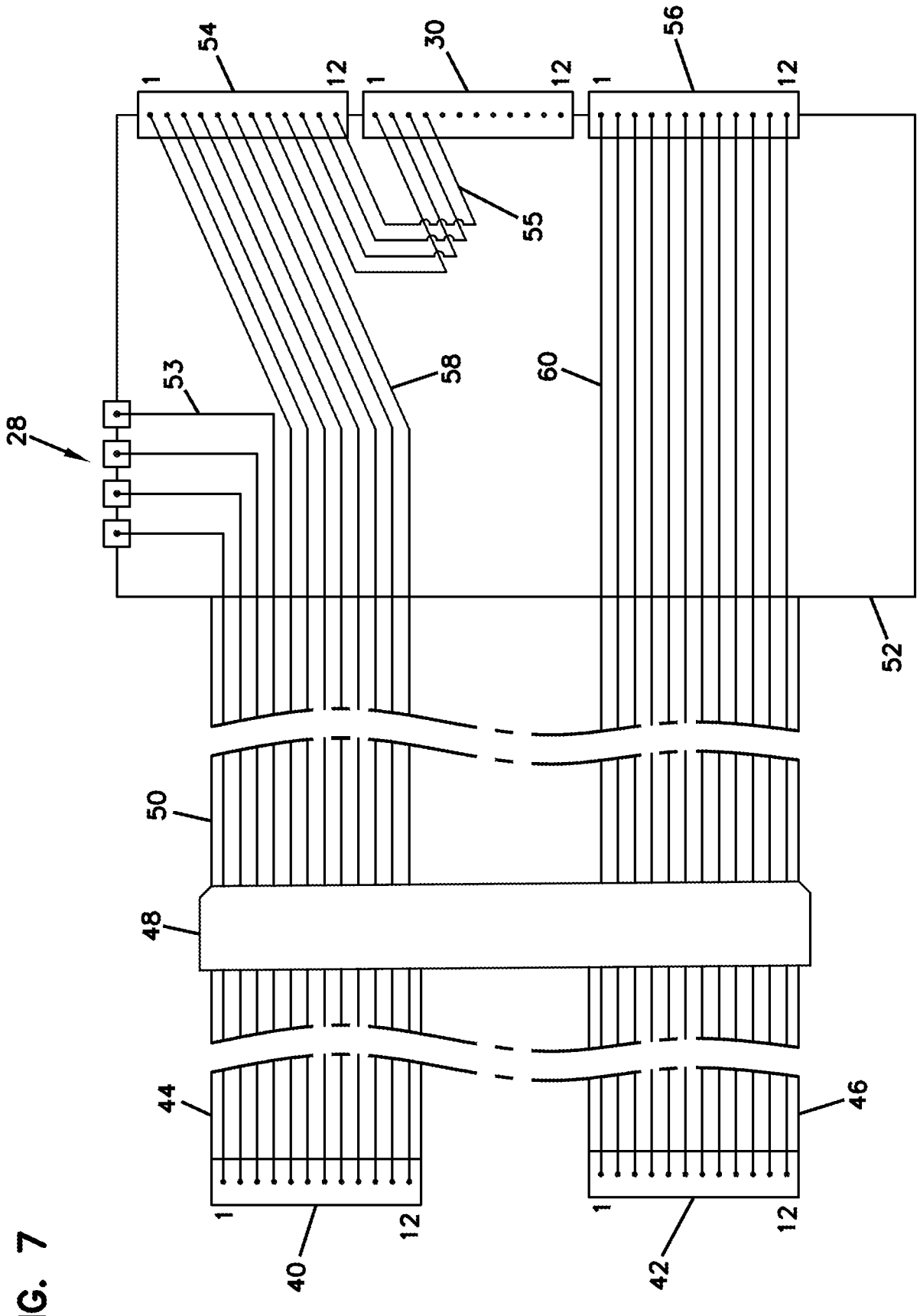


FIG. 7

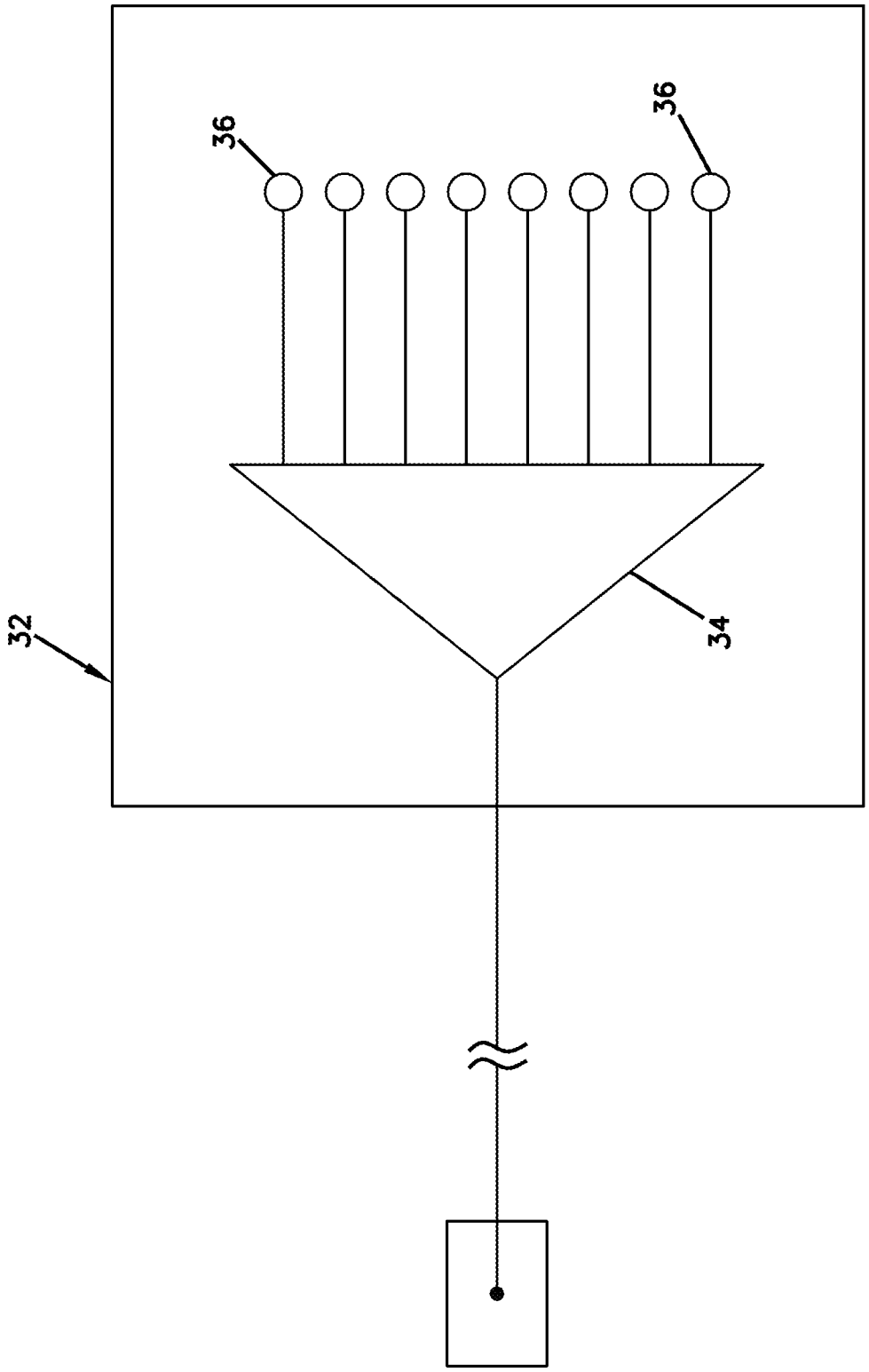


FIG. 8

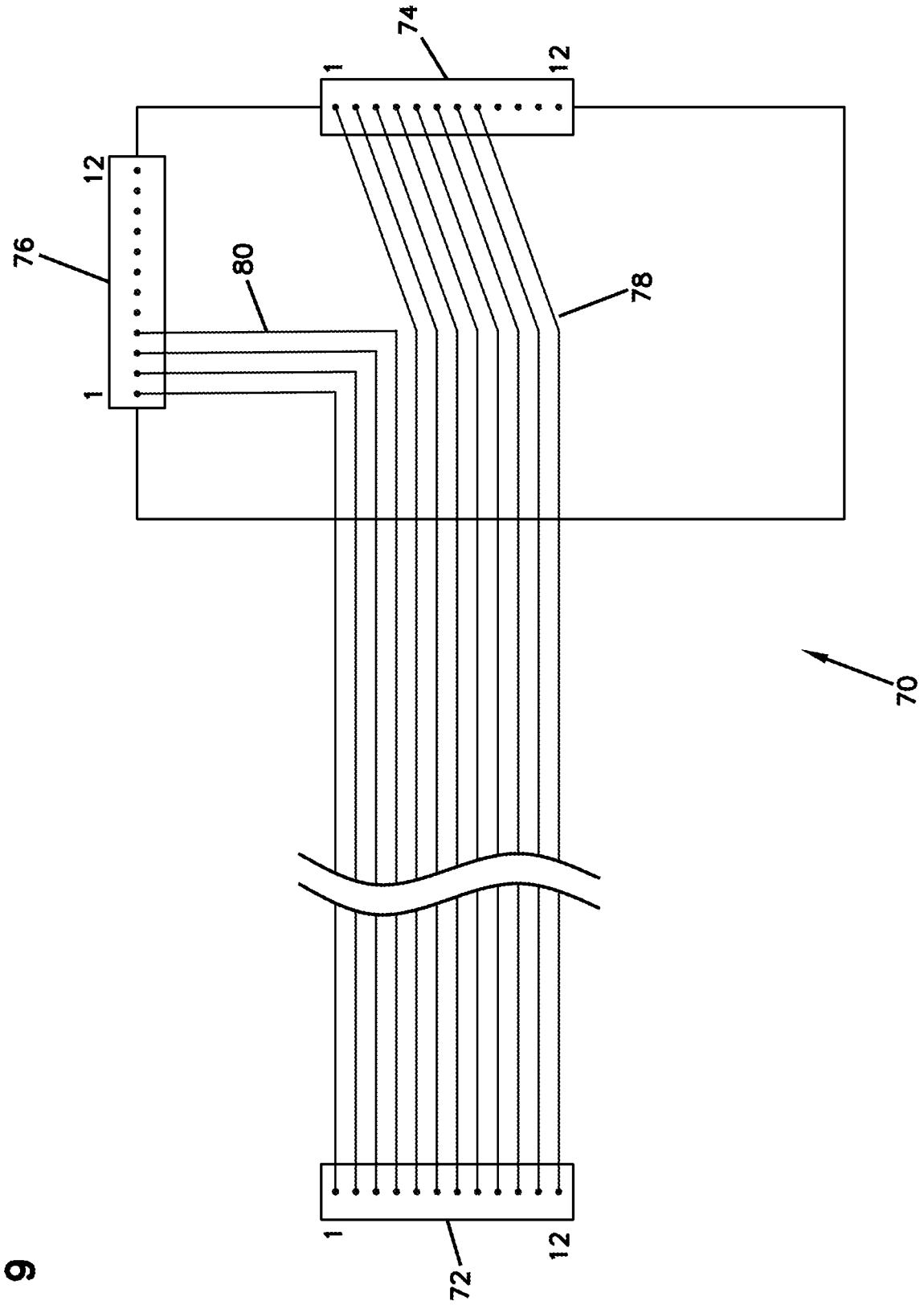


FIG. 9

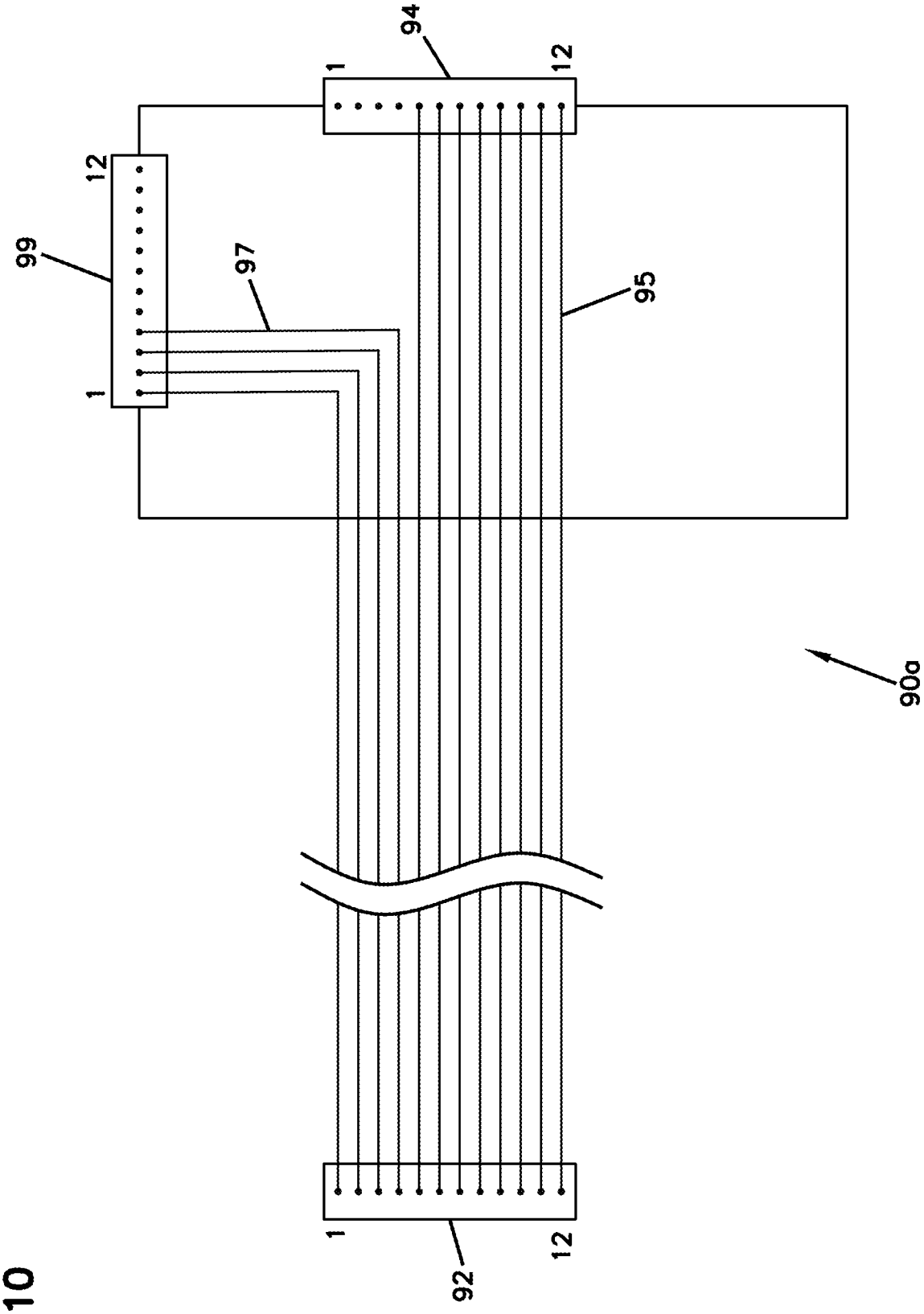


FIG. 10

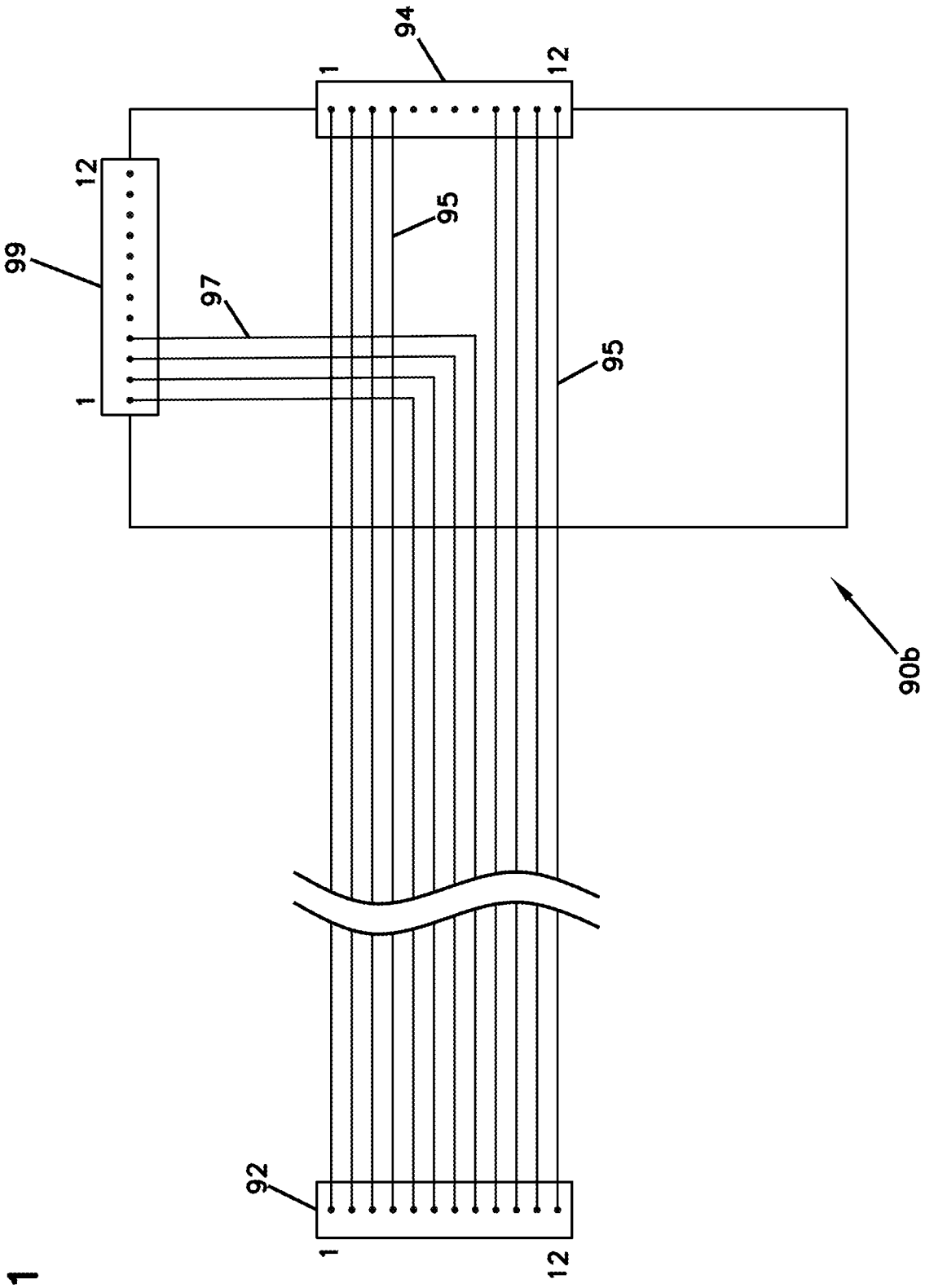


FIG. 11

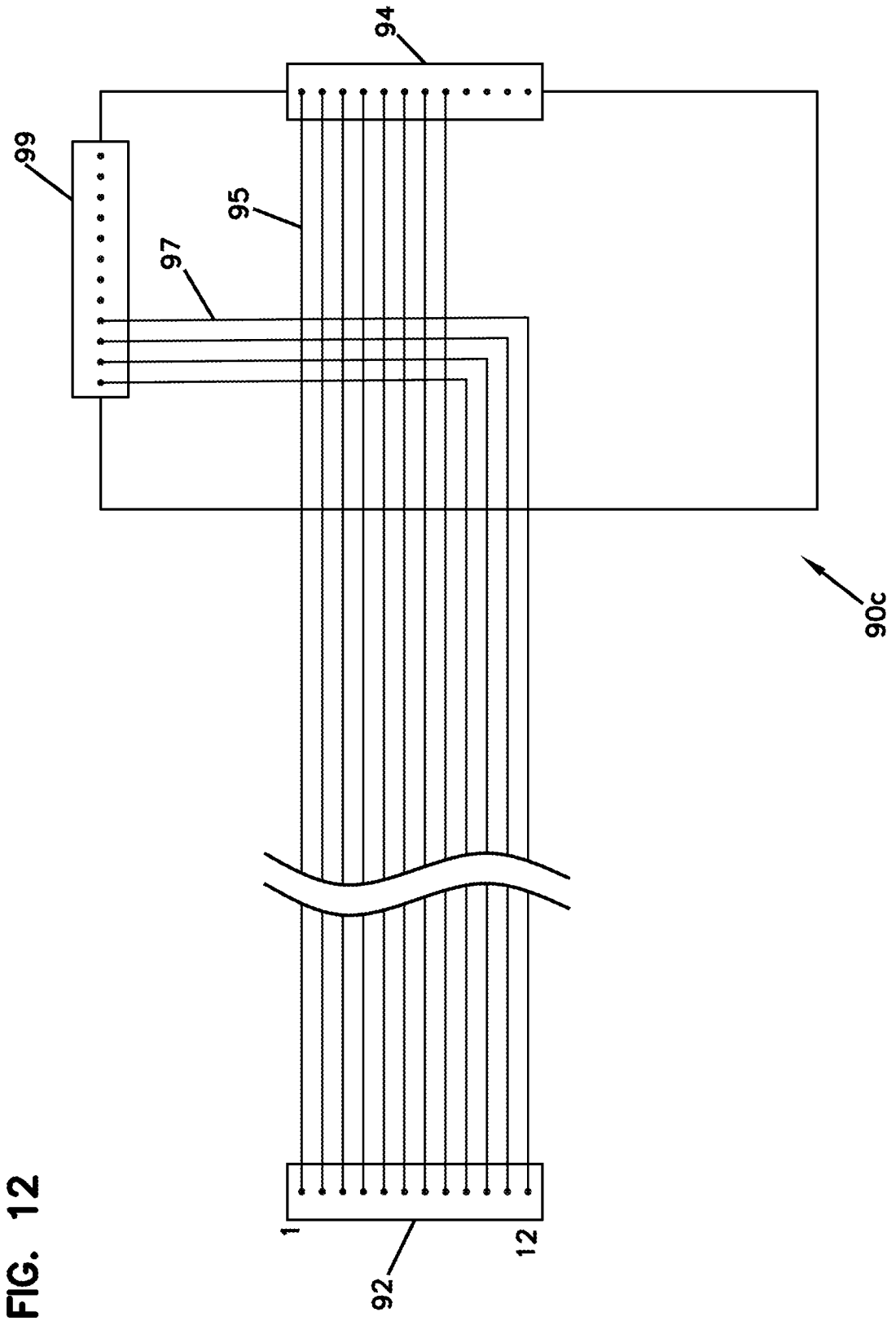


FIG. 12

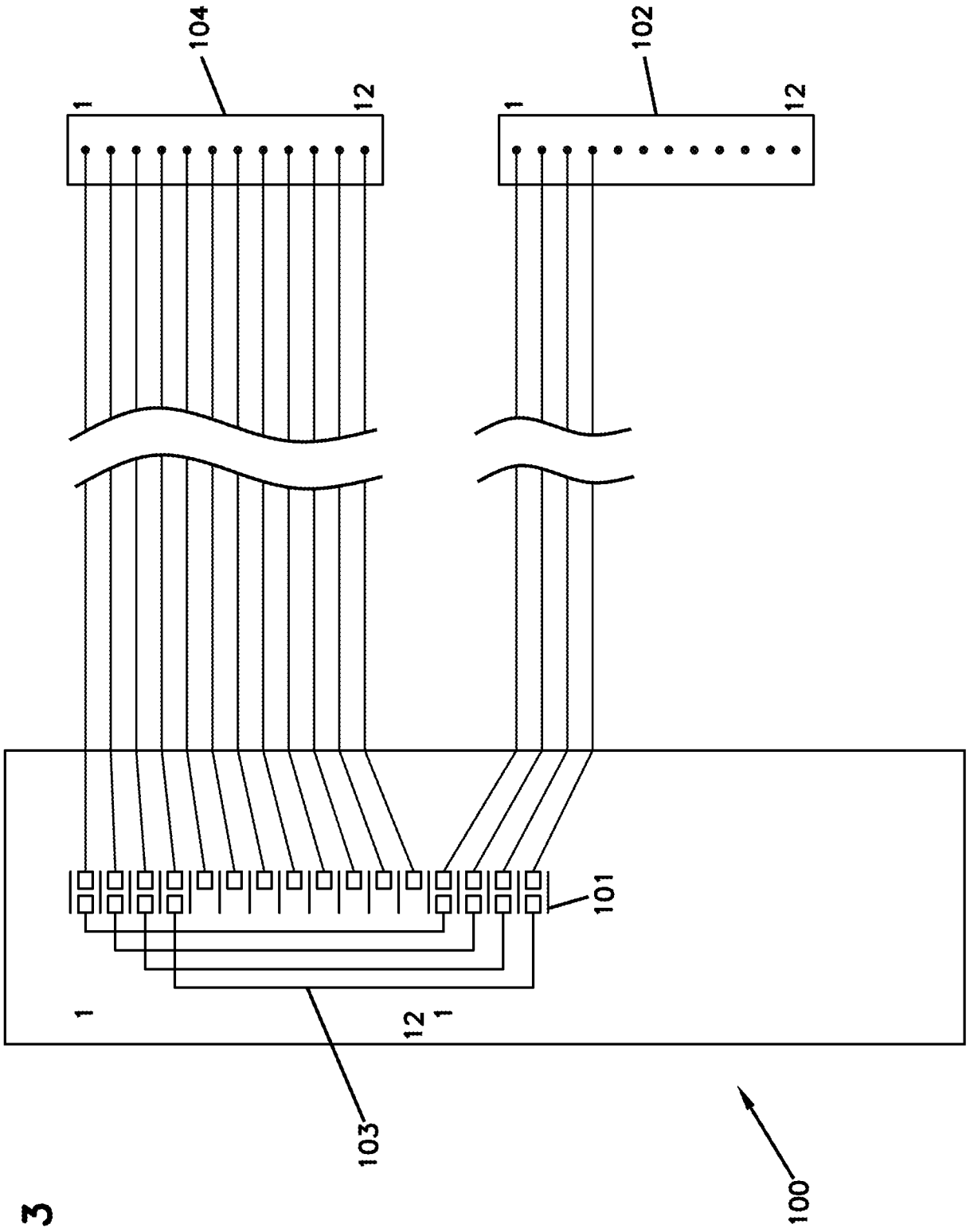


FIG. 13

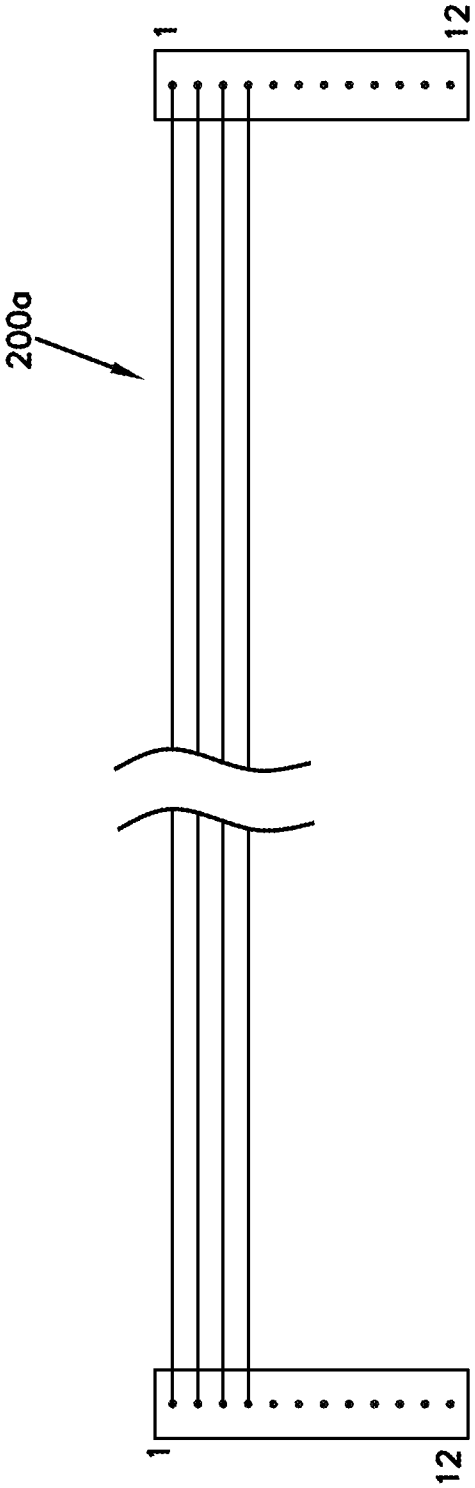


FIG. 14

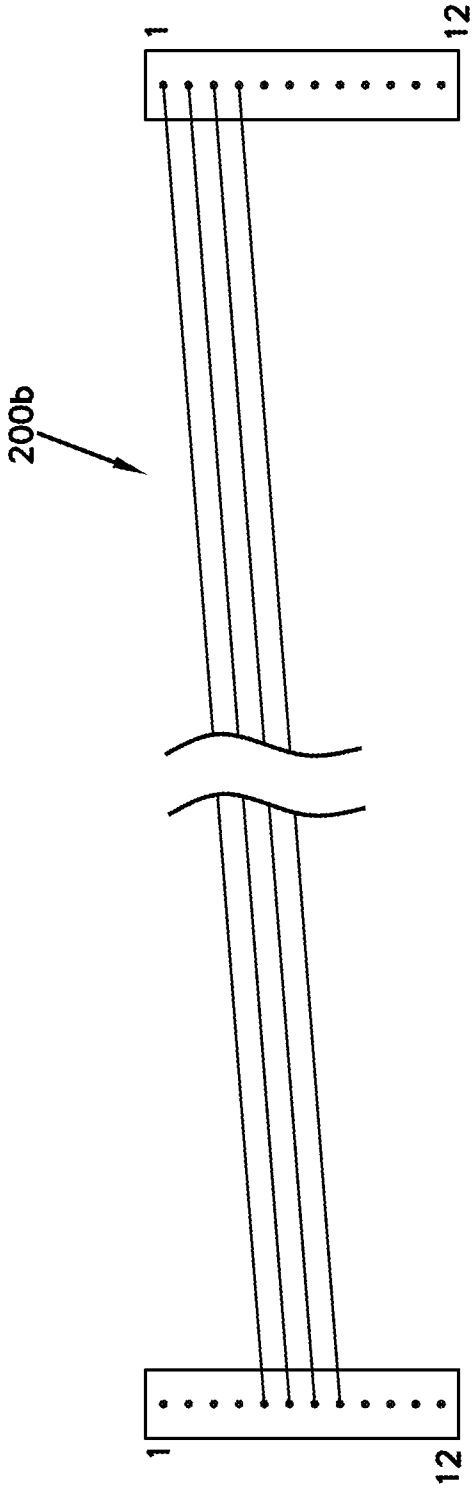


FIG. 15

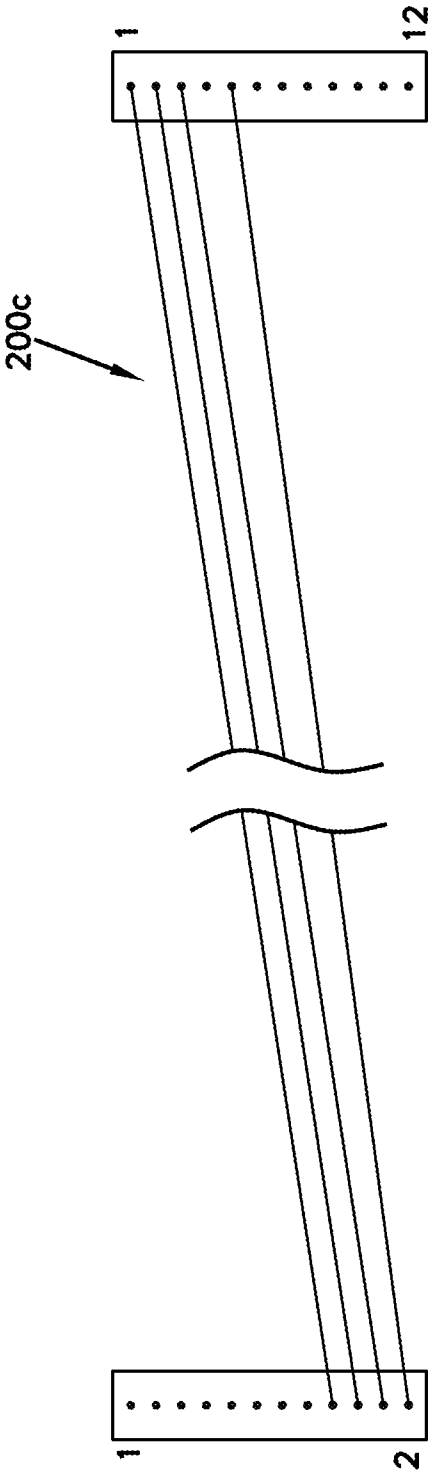


FIG. 16

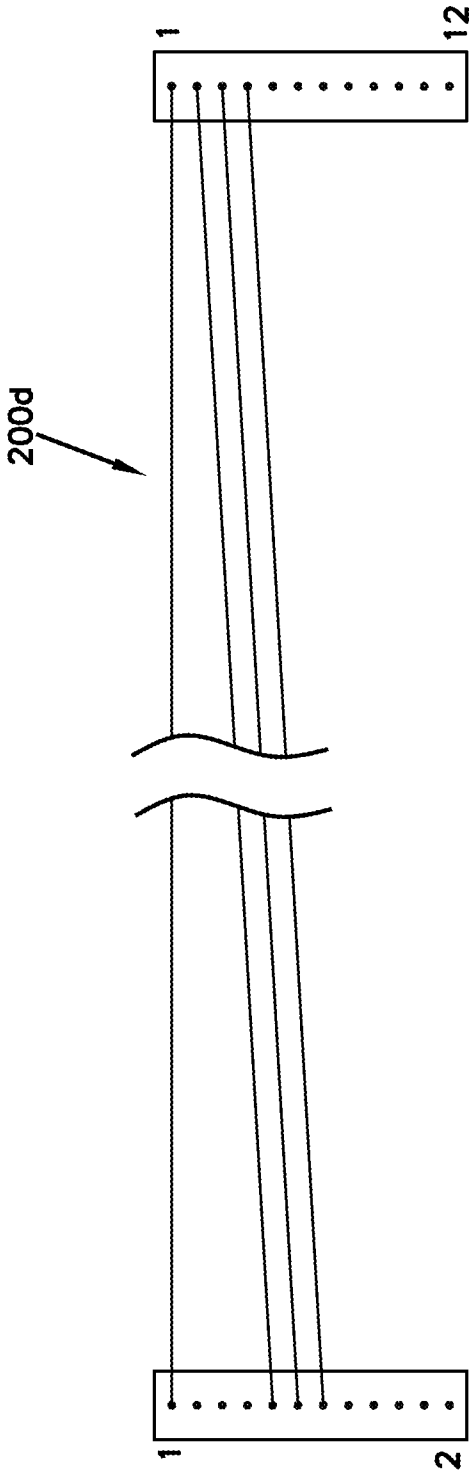


FIG. 17

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 23167136WOU1	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. **PCT/US2017/059528**	International filing date *(day/month/year)* **01 November 2017 (01.11.2017)**	(Earliest) Priority Date *(day/month/year)* 02 November 2016 (02.11.2016)
Applicant **COMMSCOPE TECHNOLOGIES LLC**		

This International search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of **5** sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of :
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☒ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the drawings,
   a. the figure of the **drawings** to be published with the abstract is Figure No. **7**
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/059528

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.: 20
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:
Claim 20 is not clear because it refers to claim 19 which do not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 7-11,19
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

International application No.
PCT/US2017/059528

A. CLASSIFICATION OF SUBJECT MATTER

G02B 6/44(2006.01)i, G02B 6/26(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; G02B 6/24; G02B 6/26; H04J 14/02; G02B 6/38; H04B 10/27; G02B 6/46

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: fiber, optic, distribution, chain, loop-back

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2015-0378112 A1 (ADC TELECOMMUNICATIONS, INC.) 31 December 2015 See paragraphs [0045], [0052]-[0060]; and figures 1-4.	1-2,12,16-18
A		3-6,13-15
Y	US 2010-0092129 A1 (CONNER) 15 April 2010 See paragraphs [0059]-[0060]; and figure 3.	1-2,12,16-18
A	US 2014-0294390 A1 (BADINELLI) 02 October 2014 See figures 3-4.	1-6,12-18
A	US 2014-0161402 A1 (CUNNINGHAM) 12 June 2014 See figures 1-2.	1-6,12-18
A	US 2013-0034336 A1 (CASSELL et al.) 07 February 2013 See figure 1.	1-6,12-18

☐ 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	Date of mailing of the international search report
20 February 2018 (20.02.2018)	**21 February 2018 (21.02.2018)**

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
Kim, Yeonkyung
Telephone No. +82-42-481-3325

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/059528

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015-0378112 A1	31/12/2015	EP 3161536 A1	03/05/2017
		EP 3161536 A4	03/01/2018
		US 9766414 B2	19/09/2017
		WO 2015-200826 A1	30/12/2015
US 2010-0092129 A1	15/04/2010	AU 2009-201534 A1	29/04/2010
		AU 2009-201534 B2	26/08/2010
		AU 2009-201623 A1	29/04/2010
		AU 2009-201624 A1	07/10/2010
		AU 2009-201624 B2	24/03/2011
		AU 2009-201625 A1	29/04/2010
		AU 2009-201625 B2	07/04/2011
		AU 2009-201626 A1	29/04/2010
		AU 2010-213701 A1	01/09/2011
		AU 2011-201172 A1	07/04/2011
		AU 2011-201287 A1	07/04/2011
		AU 2015-203506 A1	16/07/2015
		AU 2015-268676 A1	07/01/2016
		AU 2015-268676 B2	31/08/2017
		AU 2015-268676 B9	28/09/2017
		CA 2740152 A1	22/04/2010
		CA 2740154 A1	22/04/2010
		CA 2740154 C	23/05/2017
		CA 2740157 A1	22/04/2010
		CA 2740161 A1	22/04/2010
		CA 2740164 A1	22/04/2010
		CA 2751027 A1	19/08/2010
		CN 102209925 A	05/10/2011
		CN 102210112 A	05/10/2011
		CN 102210112 B	25/11/2015
		CN 102210113 A	05/10/2011
		CN 102210113 B	18/05/2016
		CN 102210114 A	05/10/2011
		CN 102210114 B	02/03/2016
		CN 102210115 A	05/10/2011
		CN 102334057 A	25/01/2012
		CN 102334057 B	18/06/2014
		CN 107065087 A	18/08/2017
		EP 2350724 A1	03/08/2011
		EP 2353232 A1	10/08/2011
		EP 2353232 B1	16/11/2016
		EP 2353233 A1	10/08/2011
		EP 2353233 B1	22/01/2014
		EP 2353234 A1	10/08/2011
		EP 2353235 A1	10/08/2011
		EP 2353235 B1	14/12/2016
		EP 2396687 A1	21/12/2011
		ES 2456355 T3	22/04/2014
		ES 2613882 T3	26/05/2017

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2017/059528

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		ES 2617135 T3	15/06/2017
		PL 2353235 T3	31/07/2017
		PT 2353235 T	07/02/2017
		US 2010-0092133 A1	15/04/2010
		US 2010-0092146 A1	15/04/2010
		US 2010-0092169 A1	15/04/2010
		US 2010-0092171 A1	15/04/2010
		US 2011-0293277 A1	01/12/2011
		US 8249450 B2	21/08/2012
		US 8737837 B2	27/05/2014
		US 9188759 B2	17/11/2015
		US 9207421 B2	08/12/2015
		WO 2010-044967 A1	22/04/2010
		WO 2010-044973 A1	22/04/2010
		WO 2010-044975 A1	22/04/2010
		WO 2010-044976 A1	22/04/2010
		WO 2010-044979 A1	22/04/2010
		WO 2010-093794 A1	19/08/2010
US 2014-0294390 A1	02/10/2014	US 2011-0241881 A1	06/10/2011
		US 2017-078043 A1	16/03/2017
		US 9490929 B2	08/11/2016
US 2014-0161402 A1	12/06/2014	US 9091835 B2	28/07/2015
		WO 2014-088986 A1	12/06/2014
US 2013-0034336 A1	07/02/2013	AU 2011-227326 A1	06/09/2012
		AU 2015-234391 A1	29/10/2015
		CA 2789702 A1	22/09/2011
		CA 2789702 C	12/09/2017
		CN 102792205 A	21/11/2012
		CN 102792205 B	16/03/2016
		EP 2548069 A1	23/01/2013
		US 9547144 B2	17/01/2017
		WO 2011-116081 A1	22/09/2011