

# US Patent & Trademark Office

## Patent Public Search | Text View

---

United States Patent	12386125
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Chang; Jimmy Jun Fu et al.

---

### Optical fiber connector with changeable gender

---

#### Abstract

A multi-fiber, fiber optic connector is interchangeable between a male connector and a female connector by including a pin retainer having a releasable retention device configured to lock the pins in place within the retainer. The retention device may be opened, for example, with a release tool, to free the retention pins for removal of the pins. A method for switching a connector between a male connector configuration and a female connector configuration may be possible as a result of the releasable retention configuration.

---

**Inventors:** Chang; Jimmy Jun Fu (Sturbridge, MA), Takano; Kazuyoshi (Tokyo, JP)

**Applicant:** Senko Advanced Components, Inc. (Hudson, MA)

**Family ID:** 1000008747710

**Assignee:** Senko Advanced Components, Inc. (Hudson, MA)

**Appl. No.:** 18/431896

**Filed:** February 02, 2024

#### Prior Publication Data

Document Identifier	Publication Date
US 20240176080 A1	May. 30, 2024

#### Related U.S. Application Data

continuation parent-doc US 18170498 20230216 US 11892688 child-doc US 18431896  
continuation parent-doc US 17195137 20210308 US 11585988 20230221 child-doc US 18170498  
continuation parent-doc US 16784993 20200207 ABANDONED child-doc US 17195137  
continuation parent-doc US 16453115 20190626 US 11073662 20210727 child-doc US 16784993  
continuation parent-doc US 15958227 20180420 US 10409009 20190910 child-doc US 16453115

**Publication Classification**

**Int. Cl.:** G02B6/38 (20060101)

**U.S. Cl.:**

CPC      **G02B6/3882** (20130101); **G02B6/3825** (20130101); **G02B6/3826** (20130101);  
            **G02B6/3885** (20130101);

**Field of Classification Search**

**CPC:**     G02B (6/3882); G02B (6/3825); G02B (6/3826); G02B (6/3885)

---

**References Cited**

**U.S. PATENT DOCUMENTS**

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2163201	12/1938	Kalencik	N/A	N/A
2538296	12/1950	Crocker	N/A	N/A
2624776	12/1952	Price	N/A	N/A
3025486	12/1961	Falconer	N/A	N/A
3721945	12/1972	Hults	N/A	N/A
3733576	12/1972	Cooper	N/A	N/A
4296999	12/1980	Mead	N/A	N/A
4327964	12/1981	Haesley et al.	N/A	N/A
4356360	12/1981	Volz	N/A	N/A
4478473	12/1983	Frear	N/A	N/A
4626052	12/1985	Rumble	N/A	N/A
4762388	12/1987	Tanaka et al.	N/A	N/A
4764129	12/1987	Jones et al.	N/A	N/A
4840451	12/1988	Sampson et al.	N/A	N/A
4872736	12/1988	Myers et al.	N/A	N/A
4979792	12/1989	Weber et al.	N/A	N/A
5041025	12/1990	Haitmanek	N/A	N/A
D323143	12/1991	Ohkura et al.	N/A	N/A
5210934	12/1992	Lenzi et al.	N/A	N/A
5212752	12/1992	Stephenson et al.	N/A	N/A
5265181	12/1992	Chang	N/A	N/A
5289554	12/1993	Cubukciyan et al.	N/A	N/A
5317663	12/1993	Beard et al.	N/A	N/A
5335301	12/1993	Newman et al.	N/A	N/A
5348487	12/1993	Marazzi et al.	N/A	N/A
5444806	12/1994	DeMarchi et al.	N/A	N/A
5481634	12/1995	Anderson et al.	N/A	N/A
5506922	12/1995	Grois et al.	N/A	N/A
5521997	12/1995	Rovenolt et al.	N/A	N/A

5570445	12/1995	Chou et al.	N/A	N/A
5588079	12/1995	Tanabe et al.	N/A	N/A
5684903	12/1996	Kyomasu et al.	N/A	N/A
5687268	12/1996	Stephenson et al.	N/A	N/A
5781681	12/1997	Manning	N/A	N/A
5791921	12/1997	Lee	N/A	N/A
5937130	12/1998	Amberg et al.	N/A	N/A
5956444	12/1998	Duda et al.	N/A	N/A
5971626	12/1998	Knodell et al.	N/A	N/A
6041155	12/1999	Anderson et al.	N/A	N/A
6049040	12/1999	Biles et al.	N/A	N/A
6085003	12/1999	Knight	N/A	N/A
6134370	12/1999	Childers et al.	N/A	N/A
6178283	12/2000	Weigel	N/A	N/A
RE37080	12/2000	Stephenson et al.	N/A	N/A
6200040	12/2000	Edwards et al.	N/A	N/A
6206577	12/2000	Hall, III et al.	N/A	N/A
6206581	12/2000	Driscoll et al.	N/A	N/A
6227717	12/2000	Ott et al.	N/A	N/A
6238104	12/2000	Yamakawa et al.	N/A	N/A
6247849	12/2000	Liu	N/A	N/A
6419504	12/2001	Nelson	N/A	N/A
6461054	12/2001	Iwase	N/A	N/A
6464408	12/2001	Nolan	N/A	N/A
6471412	12/2001	Belenkiy et al.	N/A	N/A
6478472	12/2001	Anderson et al.	N/A	N/A
6530696	12/2002	Ueda	N/A	N/A
6551117	12/2002	Poplawski et al.	N/A	N/A
6579014	12/2002	Melton et al.	N/A	N/A
6634801	12/2002	Waldron et al.	N/A	N/A
6648520	12/2002	McDonald et al.	N/A	N/A
6669377	12/2002	Barnes et al.	N/A	N/A
6682228	12/2003	Rathnam et al.	N/A	N/A
6685362	12/2003	Burkholder et al.	N/A	N/A
6695486	12/2003	Falkenberg	N/A	N/A
6854894	12/2004	Yunker et al.	N/A	N/A
6872039	12/2004	Baus et al.	N/A	N/A
6923666	12/2004	Liao	N/A	N/A
6935789	12/2004	Gross, III et al.	N/A	N/A
7036993	12/2005	Luther	N/A	N/A
7091421	12/2005	Kukita et al.	N/A	N/A
7090406	12/2005	Melton et al.	N/A	N/A
7090407	12/2005	Melton et al.	N/A	N/A
7111990	12/2005	Melton et al.	N/A	N/A
7113679	12/2005	Melton et al.	N/A	N/A
7121850	12/2005	Yeh	N/A	N/A
D533504	12/2005	Lee	N/A	N/A
D534124	12/2005	Taguchi	N/A	N/A
7077576	12/2005	Luther et al.	N/A	N/A
7150567	12/2005	Luther et al.	N/A	N/A

7153041	12/2005	Mine et al.	N/A	N/A
7198409	12/2006	Smith et al.	N/A	N/A
7207724	12/2006	Gurreri	N/A	N/A
D543146	12/2006	Chen et al.	N/A	N/A
7258493	12/2006	Milette	N/A	N/A
7264402	12/2006	Theuerkom	N/A	N/A
7281859	12/2006	Mudd et al.	N/A	N/A
D558675	12/2007	Chien et al.	N/A	N/A
7315682	12/2007	En Lin et al.	N/A	N/A
7325976	12/2007	Gurreri et al.	N/A	N/A
7325980	12/2007	Pepe	N/A	N/A
7329137	12/2007	Martin et al.	N/A	N/A
7331718	12/2007	Yazaki et al.	N/A	N/A
7354291	12/2007	Caveney et al.	N/A	N/A
7371082	12/2007	Zimmel et al.	N/A	N/A
7387447	12/2007	Mudd et al.	N/A	N/A
7390203	12/2007	Murano et al.	N/A	N/A
D572661	12/2007	En Lin et al.	N/A	N/A
7431604	12/2007	Waters et al.	N/A	N/A
7463803	12/2007	Cody et al.	N/A	N/A
7465180	12/2007	Kusuda et al.	N/A	N/A
7510335	12/2008	Bing et al.	N/A	N/A
7513695	12/2008	Lin et al.	N/A	N/A
7540666	12/2008	Luther	N/A	N/A
7561775	12/2008	Lin et al.	N/A	N/A
7591595	12/2008	Lu et al.	N/A	N/A
7594766	12/2008	Sasser et al.	N/A	N/A
7641398	12/2009	O'Riorden et al.	N/A	N/A
7670177	12/2009	Myer et al.	N/A	N/A
7695199	12/2009	Teo et al.	N/A	N/A
7695316	12/2009	Sun	N/A	N/A
7699533	12/2009	Milette	N/A	N/A
7785019	12/2009	Lewallen	N/A	N/A
7824113	12/2009	Wong et al.	N/A	N/A
7837395	12/2009	Lin et al.	N/A	N/A
D641708	12/2010	Yamauchi	N/A	N/A
8157578	12/2011	Lee	N/A	N/A
8186890	12/2011	Lu	N/A	N/A
8192091	12/2011	Hsu et al.	N/A	N/A
8202009	12/2011	Lin et al.	N/A	N/A
8251733	12/2011	Wu	N/A	N/A
8267595	12/2011	Lin et al.	N/A	N/A
8270796	12/2011	Nhep	N/A	N/A
8277237	12/2011	Cherish	N/A	N/A
8408815	12/2012	Lin et al.	N/A	N/A
8465317	12/2012	Gniadek et al.	N/A	N/A
8534928	12/2012	Cooke	N/A	N/A
8622634	12/2013	Arnold	N/A	N/A
8651749	12/2013	Junior et al.	N/A	N/A
8678670	12/2013	Takahashi	N/A	N/A

8757893	12/2013	Isenhour et al.	N/A	N/A
8768125	12/2013	Beatty et al.	N/A	N/A
9046660	12/2014	Good et al.	N/A	N/A
9411101	12/2015	Takahashi et al.	N/A	N/A
9684139	12/2016	Chang et al.	N/A	N/A
9778425	12/2016	Nguyen et al.	N/A	N/A
9798094	12/2016	Kuffel	N/A	N/A
9829645	12/2016	Good	N/A	N/A
9977199	12/2017	Jimmy et al.	N/A	N/A
10725249	12/2019	Higley et al.	N/A	N/A
2002/0110333	12/2001	Yang	N/A	N/A
2002/0191919	12/2001	Nolan	N/A	N/A
2003/0053787	12/2002	Lee	N/A	N/A
2004/0052473	12/2003	Seo et al.	N/A	N/A
2004/0136657	12/2003	Ngo	N/A	N/A
2004/0141693	12/2003	Szilagyi et al.	N/A	N/A
2004/0152354	12/2003	Luther et al.	N/A	N/A
2004/0161958	12/2003	Togami et al.	N/A	N/A
2004/0234209	12/2003	Cox et al.	N/A	N/A
2005/0111796	12/2004	Matasek et al.	N/A	N/A
2005/0141817	12/2004	Yazaki et al.	N/A	N/A
2006/0067628	12/2005	Suzuki et al.	N/A	N/A
2006/0089049	12/2005	Sedor	N/A	N/A
2006/0127025	12/2005	Haberman	N/A	N/A
2006/0269194	12/2005	Luther et al.	N/A	N/A
2006/0274411	12/2005	Yamauchi	N/A	N/A
2007/0025665	12/2006	Dean et al.	N/A	N/A
2007/0028409	12/2006	Yamada	N/A	N/A
2007/0079854	12/2006	You	N/A	N/A
2007/0098329	12/2006	Shimoji et al.	N/A	N/A
2007/0149062	12/2006	Long et al.	N/A	N/A
2007/0230874	12/2006	Lin	N/A	N/A
2007/0232115	12/2006	Burke et al.	N/A	N/A
2007/0243749	12/2006	Wu	N/A	N/A
2008/0008430	12/2007	Kewitsch	N/A	N/A
2008/0044137	12/2007	Luther et al.	N/A	N/A
2008/0069501	12/2007	Mudd et al.	N/A	N/A
2008/0101757	12/2007	Lin et al.	N/A	N/A
2008/0226237	12/2007	O'Riorden et al.	N/A	N/A
2008/0267566	12/2007	En Lin	N/A	N/A
2009/0022457	12/2008	de Jong et al.	N/A	N/A
2009/0028507	12/2008	Jones et al.	N/A	N/A
2009/0196555	12/2008	Lin et al.	N/A	N/A
2009/0214162	12/2008	O'Riorden et al.	N/A	N/A
2009/0220197	12/2008	Gniadek et al.	N/A	N/A
2010/0034502	12/2009	Lu et al.	N/A	N/A
2010/0092136	12/2009	Nhep	N/A	N/A
2010/0247041	12/2009	Szilagyi	N/A	N/A
2010/0322561	12/2009	Lin et al.	N/A	N/A
2011/0044588	12/2010	Larson et al.	N/A	N/A

2011/0131801	12/2010	Nelson et al.	N/A	N/A
2011/0177710	12/2010	Tobey	N/A	N/A
2012/0099822	12/2011	Kuffel et al.	N/A	N/A
2012/0189260	12/2011	Kowalczyk et al.	N/A	N/A
2012/0269485	12/2011	Haley et al.	N/A	N/A
2012/0301080	12/2011	Gniadek	N/A	N/A
2013/0071067	12/2012	Lin	N/A	N/A
2013/0089995	12/2012	Gniadek et al.	N/A	N/A
2013/0094816	12/2012	Lin et al.	N/A	N/A
2013/0121653	12/2012	Shitama et al.	N/A	N/A
2013/0170797	12/2012	Ott	N/A	N/A
2013/0183012	12/2012	Cabanne Lopez et al.	N/A	N/A
2013/0216185	12/2012	Klavuhn	385/60	G02B 6/3882
2013/0259429	12/2012	Czosnowski et al.	N/A	N/A
2013/0315539	12/2012	Koreeda et al.	N/A	N/A
2013/0322825	12/2012	Cooke et al.	N/A	N/A
2014/0016901	12/2013	Lambourn et al.	N/A	N/A
2014/0023322	12/2013	Gniadek	N/A	N/A
2014/0023326	12/2013	Anderson et al.	N/A	N/A
2014/0050446	12/2013	Chang	N/A	N/A
2014/0133808	12/2013	Hill et al.	N/A	N/A
2014/0154913	12/2013	Ho	N/A	N/A
2014/0226946	12/2013	Cooke et al.	N/A	N/A
2014/0334780	12/2013	Nguyen et al.	N/A	N/A
2014/0348477	12/2013	Chang	N/A	N/A
2015/0003785	12/2014	Raven et al.	N/A	N/A
2015/0378113	12/2014	Good et al.	N/A	N/A
2018/0364421	12/2017	Chang et al.	N/A	N/A
2019/0384017	12/2018	Lu	N/A	N/A

# **FOREIGN PATENT DOCUMENTS**

<b>Patent No.</b>	<b>Application Date</b>	<b>Country</b>	<b>CPC</b>
2495693	12/2003	CA	N/A
2836038	12/2005	CN	N/A
201383588	12/2009	CN	N/A
202600189	12/2011	CN	N/A
202006011910	12/2006	DE	N/A
102006019335	12/2006	DE	N/A
1074868	12/2000	EP	N/A
1211537	12/2001	EP	N/A
1245980	12/2001	EP	N/A
1566674	12/2004	EP	N/A
2111240	12/1982	GB	N/A
S63229416	12/1987	JP	N/A
3363479	12/1993	JP	N/A
2003014983	12/2002	JP	N/A
2009229545	12/2008	JP	N/A
2009276493	12/2008	JP	N/A
20110009902	12/2010	KR	N/A

200821653	12/2007	TW	N/A
2001/79904	12/2000	WO	N/A
2004/027485	12/2003	WO	N/A
2008/112986	12/2007	WO	N/A
2009/135787	12/2008	WO	N/A
2010/024851	12/2009	WO	N/A
2012/136702	12/2011	WO	N/A
2012/162385	12/2011	WO	N/A
2013038204	12/2012	WO	N/A
2014/028527	12/2013	WO	N/A
2014/182351	12/2013	WO	N/A
2015/191024	12/2014	WO	N/A
2016053851	12/2015	WO	N/A
2016/148741	12/2015	WO	N/A

## OTHER PUBLICATIONS

Non-Final Office Action received for U.S. Appl. No. 16/453,115 dated Jul. 24, 2020, 27 pages.  
cited by applicant

Notice of Allowance received for U.S. Appl. No. 16/453,115 dated Oct. 3, 2019, 26 pages. cited by  
applicant

European Search Report and Written Opinion dated Mar. 3, 2015 for EP 14187661. cited by  
applicant

European Search Report and Written Opinion dated Feb. 19, 2015 for EP 14168005. cited by  
applicant

“Fiber Optic Connectors and Assemblies Catalog” 2009, Huber & Suhner Fiber Optics, Herisau,  
Switzerland, [www.nubersuhner.com](http://www.nubersuhner.com). cited by applicant

“Fiber Optic Interconnect Solutions, Tactical Fiber Optical Connectors, Cables and Termini” 2006,  
Glenair, Inc., Glendale, California, [www.mps-electronics.de](http://www.mps-electronics.de). cited by applicant

Fiber Optic Products Catalog Nov. 2007, Tyco Electronics Corporation, Harrisburg, Pennsylvania,  
[www.ampnetconnect.com](http://www.ampnetconnect.com). cited by applicant

International Search Report and Written Opinion dated Apr. 27, 2012 for PCT/US2011/058799.  
cited by applicant

International Search Report and Written Opinion dated Aug. 27, 2012 for PCT/US2012/039126.  
cited by applicant

International Search Report and Written Opinion dated Jan. 16, 2014 for PCT/US2013/54784. cited  
by applicant

International Search Report and Written Opinion dated Oct. 9, 2014 for PCT/US2014/041500. cited  
by applicant

International Search Report and Written Opinion dated May 14, 2014 for PCT/US2014/012137.  
cited by applicant

International Search Report and Written Opinion dated Aug. 21, 2008 for PCT/US2008/057023.  
cited by applicant

International Preliminary Report on Patentability dated Aug. 22, 2016 from related International  
Application No. PCTUS2015/059458, International Filing Date Nov. 6, 2015. cited by applicant

International Search Report {ISR) W02008112986 Sep. 15, 2009. cited by applicant

ISR W020140285271SR Feb. 20, 2014. cited by applicant

ISR W02015US57610ISR Jan. 21, 2016. cited by applicant

Ex Parte ReExamination, Application No. 90/020, 125, dated Apr. 15, 2019, p. 31. cited by  
applicant

International Search Report and Written Opinion dated Mar. 30, 2016 from corresponding

International Application No. PCT /US15/65479, International Filing Date Dec. 14, 2015. cited by applicant

International Preliminary Report on Patentability dated Dec. 14, 2017, from related International Application No. PCT/US15/65479, International Filing Date Dec. 14, 2015. cited by applicant

Non-Final Office Action from related U.S. Appl. No. 14/725,514, filed May 29, 2015, dated Jun. 30, 2016, 10 pages. cited by applicant

Non-Final Office Action from related U.S. Appl. No. 15/626,430 dated Jul. 28, 2017, 10 pages. cited by applicant

International Search Report, Application No. 15/894,501.4, pp. 8, dated Dec. 3, 2018. cited by applicant

Jones, et al., U.S. Appl. No. 62/058, 188, filed Oct. 1, 2014, entitled: Fiber Optic Connector and Pin Change Method for the Same. cited by applicant

Chang et al., Request for Ex Parte Reexamination of U.S. Pat. No. 9,977,199, dated Dec. 7, 2018, entitled: Optical Fiber Connector With Changeable Gender. cited by applicant

Non-Final Office Action received for U.S. Appl. No. 16/784,993 dated Oct. 6, 2020, 12 pages. cited by applicant

Non-Final Office Action received for U.S. Appl. No. 15/958,227 dated Oct. 1, 2018, 14 pages. cited by applicant

---

*Primary Examiner:* Bedtelyon; John

---

## **Background/Summary**

CROSS-REFERENCE TO RELATED APPLICATION (1) This application a continuation of U.S. patent application Ser. No. 18/170,498 filed on Feb. 16, 2023, which is a continuation of U.S. patent application Ser. No. 17/195,137 filed on Mar. 8, 2021 and now U.S. Pat. No. 11,585,988 granted on 02/21/2023, which is a continuation of U.S. patent application Ser. No. 16/784,993 filed on Feb. 7, 2020, a continuation of U.S. patent application Ser. No. 16/453,115 filed on Jun. 26, 2019 and now U.S. Pat. No. 11,073,662 granted on 07/27/2021, a continuation of U.S. patent application Ser. No. 15/958,227, filed Apr. 20, 2018 and now U.S. Pat. No. 10,409,009 granted on Sep. 10, 2019, which is a continuation of U.S. patent application Ser. No. 15/626,430 filed on Jun. 19, 2017 and is now U.S. Pat. No. 9,977,199 issued on May 22, 2018, which is continuation of U.S. patent application Ser. No. 14/725,514, filed May 29, 2015, now U.S. Pat. No. 9,684,139 issued on Jun. 20, 2017, all of which are incorporated herein by reference in its entirety.

## **BACKGROUND**

(1) Demand for bandwidth by enterprises and individual consumers continues to experience exponential growth. To meet this demand efficiently and economically, data centers have to achieve ultra-high density cabling with low loss budgets. Fiber optics have become the standard cabling medium used by data centers to meet the growing needs for data volume and transmission speeds.

(2) Individual optical fibers are extremely small. For example, even with protective coatings, optical fibers may be only about 250 microns in diameter (only about 4 times the diameter of a human hair). As such, hundreds of fibers can be installed in cables that will take up relatively little space. For connections between cables, however, the fibers are terminated with connectors. Multiple fibers may be arranged within a single connector. For example, multi-fiber connectors such as those using multi-fiber push-on/pull-off (MPO) technology may contain and connect 12 or 24 fibers. Connectors, such as MPO type connectors, generally include a housing portion that contains a ferrule that terminates the ends of the fibers. Ferrules are generally used to retain the



ends of the optical fibers for connecting the optical fibers. One type of optical ferrule that may be used with MPO type connectors is an MT (Mechanically Transferable) ferrule.

(3) Typically, MPO connectors are joined together to connect the optical transmission path of one fiber optic cable to another fiber optic cable or device, and the connection may be made by inserting the MPO connectors in an MPO adapter. An adapter generally includes a housing, or portion of a housing, having at least one port which is configured to receive and hold a connector to facilitate the optical connection of the connector ferrule with the ferrule of another connector or other device. Adapters may be used to facilitate connections contained within a chassis. The term “chassis” as used herein broadly refers to a containment structure for housing electrical components or switching components.

(4) MT (Mechanically Transferable) ferrules are optical ferrules which are standardized according to JIS C 5981, IEC 61754-5 and the like. The MT ferrules get pushed together within the adapter to optically connect the ferrules by means of a so-called PC (Physical Contact) connection, wherein the optical fibers in one ferrule contact the optical fibers in the other ferrule and get compressed together to provide an optical connection. Optical transmission performance between the optical fibers is strongly dependent on connecting conditions such as axis alignment and inclination of the optical fibers, and gaps between the opposing optical fibers.

(5) MT ferrules generally use at least two guide pins for high-accuracy alignment of the optical fibers in the mating ferrules. An MT ferrule body may include at least two guide pin holes on the end surface of the ferrule for receiving the guide pins therein. For a pair of mating connectors, one of the ferrule bodies of a first connector may be provided with guide pins in the guide pin holes (generally called the ‘male’ connector), and the other ferrule body of a second connector may have only the guide pin holes (generally called the ‘female’ connector). As such, a highly accurate mating of the connectors may be achieved when the guide pins of the male connector are disposed within the guide pin holes of the female connector.

(6) The gender, male or female, designation of a connector may often be typically predisposed during manufacturing of the connector, wherein connectors may be manufactured to be either male or female. Such connectors may be pre-installed on cable ends, and care must be taken so that the cables are all installed in the proper direction so that mating of male and female ends may be possible. Alternatively, for on-site installation, a connector may be assembled onto a cable end, and during assembly the installer may install pins or a pin component into a ferrule body to provide a male connector, or alternatively, leave such pieces absent to provide a female connector.

(7) For installations wherein the gender may accidentally end up being incorrect, or installations where the gender may need to be changed for one reason or another, such as a renovation or installation of a gender specific component, the gender of typical connectors is not changeable, or only changeable after disassembly and reassembly in the opposite designation. As such, for predetermined gender connectors, an entire connector may need to be removed and essentially scrapped, for replacement by an opposite gender connector, or for connectors requiring disassembly and reassembly, much time may be wasted in the re-gendering process.

(8) Therefore, there remains a need for multi-fiber, fiber optic connectors that have the flexibility of easily changing the gender of the connector on site.

## SUMMARY

(9) A multi-fiber, fiber optic connector may include removable guide pins for changing the gender of the connector. The connector may be configured to releasably retain the guide pins therein. The guide pins may be insertable into the connector to convert the connector from a female connector to a male connector. Once inserted, the guide pins may be retained, or locked in place with a retention configuration. To convert from male to female, the retention configuration may be opened to release the guide pins, and the guide pins may be removed from the connector.

(10) In an embodiment, a multi-fiber fiber optic connector interconvertible between a male connector and a female connector, includes a ferrule comprising a plurality of optical fibers

supported therein and terminating at a first end of the ferrule for alignment with optical fibers of an additional device, at least two spaced apart passages disposed along at least a portion of the ferrule and configured for receiving alignment pins therein, a pin retainer configured for releasably retaining the alignment pins in a the connector when the alignment pins are disposed in the passages, and a housing disposed around the pin retainer and at least a portion of the ferrule. The pin retainer includes a portion for engaging each alignment pin to retain the alignment pins in the connector for a male configuration, wherein the portion for engaging is selectively releasable from the alignment pins for removal of the alignment pins for a female configuration.

(11) In an embodiment a pin retainer for a fiber optic connector includes a body portion for being disposed with a ferrule in the connector, an at least one selectively displaceable locking member configured for locking an alignment pin with the body portion, wherein the selectively displaceable locking member has a first position for engaging an alignment pin to lock an alignment pin with the body portion, and a second position displaced from the first position for release of an alignment pin locked with the body portion.

(12) In an embodiment a method for interconversion of a fiber optic connector between a male configuration with at least one alignment pin, and a female configuration with at least one passage for receiving an alignment pin is provided. The connector includes at least one selectively displaceable locking member for locking at least one alignment pin therein, and the method includes, for converting a female configuration to a male configuration, slidably inserting at least one alignment pin into engagement with the selectively displaceable locking member to lock the alignment pin into the connector, and for converting a male configuration to a female configuration, releasing the selectively displaceable locking member from the alignment pin, and slidably removing the alignment pin from the connector.

---

## Description

### BRIEF DESCRIPTION OF THE FIGURES

(1) FIGS. 1A and 1B depict male and female configurations of an MPO connector according to an embodiment.

(2) FIG. 2 depicts an MPO adapter as generally used for mating MPO connectors of FIGS. 1A and 1B.

(3) FIG. 3 is an exploded view of a male connector according to an embodiment.

(4) FIG. 4 is a perspective view of a ferrule and a pin retainer according to an embodiment.

(5) FIGS. 5A and 5B are front and rear exploded perspective views of the ferrule and the pin retainer of FIG. 4.

(6) FIG. 6 is a perspective view of a pin retainer and guide pins according to an embodiment.

(7) FIGS. 7A-7D are top, side, front and rear face views of a pin retainer according to an embodiment.

(8) FIGS. 8A-8D provide top, side and sectional views of a pin retained with a pin retainer according to an embodiment.

(9) FIG. 9 depicts a perspective view of a male connector with its outer housing pulled back to show the release slots according to an embodiment.

(10) FIG. 10 provides a side view of the inner housing showing the release slots according to an embodiment.

(11) FIG. 11 is a detailed view of the release slots shown in FIG. 10 according to an embodiment.

(12) FIG. 12 shows a tool and placement thereof relative to the release slots according to an embodiment.

(13) FIGS. 13A-13B are side and sectional views of the embodiment of FIG. 12 according to an embodiment.

- (14) FIGS. **14A** and **14B** are sectional views showing use of a tool to release the pins according to an embodiment.
- (15) FIGS. **15A** and **15B** show an alternative tool configuration according to an embodiment.
- (16) FIGS. **16A-16D** show an alternative configuration of a pin retainer according to an embodiment.
- (17) FIGS. **17A-17D** show an alternative configuration of a pin retainer according to an embodiment.

(18) FIGS. **18A-18B** show a one-piece housing and pin retainer according to an embodiment.

DETAILED DESCRIPTION

(19) As used herein, the term “optical fiber” is intended to apply to all types of single mode and multi-mode light waveguides, including one or more bare optical fibers, coated optical fibers, loose-tube optical fibers, tight-buffered optical fibers, ribbonized optical fibers, bend performance optical fibers, bend insensitive optical fibers, nanostructured optical fibers or any other expedient for transmitting light signals. A multi-fiber optic cable includes a plurality of the optical fibers. Such cables have a variety of names depending on their particular usage, and may be considered as “trunk cables” or “trunks” when connected to fiber optic modules used to form connections to jumper cables using a select polarity.

(20) For connection of cables together or with other fiber optic devices, the terminal ends of a cable may include a male connector **10** or female connector **12** as represented in FIGS. **1A** and **1B**, respectively, or in exploded view of FIG. **3**. A connector **10**, **12** may include an inner housing structure **14** configured to interact with and connect with an adapter **15** as represented in FIG. **2**. An adapter **15**, in a simple form, may include two aligned ports **18a**, **18b** for aligning fiber optic connectors **10**, **12** therein to align and connect optical fibers **16** end-to-end. For proper alignment, the connectors to be aligned generally include one male connector **10** and one female connector **12**. The male connector **10** generally includes at least two guide/alignment pins **20** that fit into the guide/alignment holes **22** of the female connector **12**, thereby essentially ensuring proper alignment of the optical fibers **16** of the two connectors when mated end to end. As described herein, the connectors **10**, **12** and adapters **15** may be considered multi-fiber connectors and multi-fiber adapters.

(21) While the following description is directed towards MPO adapters and MPO connectors with MT optical ferrules, the embodiments described may be applicable to other adapters, connectors and ferrule types as well. An embodiment of an MPO connector **10**, **12** may include a ferrule **24** that may be a multi-fiber ferrule as shown at a first end of the connector. In addition, the connector **10** may have attached thereto, a fiber optic cable **26** and cable boot **28** that may extend from a second end of the connector.

(22) An adapter **15** may include a first end **30a** having a first port **18a** for receiving the ferrule end of an optical fiber connector **10**, **12** therein, and may include a second end **30b** having an additional port **18b** (not visible) for receiving an additional optical fiber connector, or other type of fiber optic device therein.

(23) For retention of an MPO connector **10** within each of the ports **18a**, **18b**, the ports may be provided internally with a connector clip that may be formed by the two resilient tabs **32a**, **32b**. The tabs **32a**, **32b** may be configured to be displaceable outwardly for insertion and removal of a connector **10**, **12** into or out of the ports **18a**, **18b**, and may return to essentially their original position to engage and retain a connector in the ports. Adapters **15** may be configured to be mounted on a chassis panel, and may include mounting flanges **34a**, **34b** to mount the adapter via screws, for example.

(24) A connector **10**, **12** may include an inner housing **14** that may surround the ferrule **24**. A connector **10**, **12** may also include a displaceable outer housing member **36** that may be slidably disposed about the inner housing **14** adjacent the second end of the connector **10**, **12**. To provide for a pre-determined alignment of the fiber optic cables within the adapter **15**, the inner housing **14**

may include an alignment key **38** that is configured to fit within keying slot **40** of the adapter. Inner housing **14** may slide into port **18a** (for example) until tabs **32a**, **32b** engage into slots **42** of the inner housing **14**. The outer housing **36** may be moved towards the second end to allow the tabs **32a**, **32b** to engage into slots **42**, and to retain the tabs in the slots, the outer housing **36** may be slid back towards the first end and over the tabs within the port **18a**. The outer housing **36** may be biased towards the first end via springs **44**, as shown for example in FIG. 3, or alternative types of biasing devices.

(25) A male connector **10** is depicted in exploded view in FIG. 3. In an embodiment as shown, the ferrule **24**, as part of a terminal cable assembly **50**, may fit within the inner housing **14**. The assembly **50** may also include a guide pin retainer **52** (described in more detail below), a terminal housing **54** to which the cable **26** attaches via the terminal post **56**. A biasing member, such as a spring **58** may be disposed between the terminal housing **54** and the pin retainer **52** to bias the ferrule **24** forwardly within the inner housing **14**. Such biasing provides a biased mating of ferrule ends and optical fibers **16** when connectors **10**, **12** are mated in an adapter **15** to thereby hold the mated ferrule ends and optical fibers in contact with one another.

(26) A fiber optic cable **26** as shown in FIGS. 1A, 1B may be retained with the terminal post **56** by means of a crimp sleeve **60**, or other type of detainment connector. A connector such as sleeve **60** may be crimped to the terminal post **56** as well as to a cable sheathing of the cable **26** to thereby prevent the cable from being pulled away from the terminal housing **54**.

(27) A more detailed view of the ferrule **24** and pin retainer **52** are represented in FIGS. 4, 5A and 5B. As represented, the ferrule **24** may include at least two pin receiving holes or passages **22** that extend through the body of the ferrule. Guide pins **20** may be attached with the pin retainer **52**, and may be slidably inserted into the holes **22** from the rear end of the ferrule **24** to provide a male ferrule assembly as represented in FIG. 4, for a male connector **10** as represented in FIG. 1A. For a female connector **12**, as represented in FIG. 1B, the pin retainer **52** may be used alone, without the attached guide pins **20**, thereby leaving the holes **22** open for mating with guide pins of a male connector **10**.

(28) In an embodiment as represented in FIG. 6 and FIGS. 7A-7D, the pin retainer **52** may be configured so that the guide pins **20** may be insertable into, and removable from the pin retainer. For each guide pin **20**, the pin retainer may include a pin retention configuration, which may include a clip formed from a pair of opposed arms **70a**, **70b**. The arms **70a**, **70b** may define a retention space **72** therebetween into which a guide pin **20** may be disposed. The retention space may be cylindrical and may have a diameter (d.sub.1) that corresponds with a reduced diameter notch **20b** formed in the guide pin **20**. The notch **20b** may have a diameter (d.sub.2) that is less than the diameter (d.sub.3) of the guide pin **20** at least adjacent each side of the notch.

(29) The arms **70a**, **70b** may be configured to have a degree of resilience sufficient to allow the arms to move away from one another by an amount sufficient to allow a guide pin **20** to be inserted between the arms, and once the guide pin is inserted, have the arms return to their original position to retain the guide pin in place.

(30) As represented by the dashed line in FIG. 6, a guide pin **20** may be laterally inserted into the retention space **72**. The arms **70a**, **70b** may define a tapered groove **74** that has a first width (w.sub.1) at the exterior lateral side of the pin retainer **52**, and tapers to a second width (w.sub.2) adjacent the retention space **72**. The first width (w.sub.1) may be greater than the diameter (d.sub.2) of the pin **20** in the notch **20b**, and the second width (w.sub.2) may be less than the diameter (d.sub.2) of the pin in the notch, and the diameter (d.sub.2) of the pin in the notch **20b** may correspond essentially to the diameter (d.sub.1) of the retention space **72**. As the pin **20** is laterally inserted into the groove **74**, the pin will move into the groove and first engage the arms **70a**, **70b**. The pin **20** may then be pressed further inward, displacing the arms **70a**, **70b** away from one another until the pin passes between the arms and moves into the retention space **72**, at which point, the arms may return towards their original position and retain the pin therebetween, with the

pin notch **20b**, disposed in, and retained within the retention space.

(31) Alternatively, a guide pin **20** may be inserted axially into the retention space **72** between the arms **70a**, **70b**. A tapered end **20a** of the guide pin **20** may be tapered so that, as the guide pin is moved axially into the retention space **72**, the tapered end **20a** forces the arms **70a**, **70b** apart to the point wherein the guide pin may fit therebetween. The guide pin may then be further inserted until the notch **20b** is disposed between the arms **70a**, **70b**, wherein the arms may return towards their original position and retain the pin therebetween.

(32) Both axial ends of the notch **20b** may be defined by a radial (orthogonal) edge **75a** or **75b**, extending from the reduced diameter (d.sub.2) of the notch to the diameter (d.sub.3) of the pin **20**. As such, axial movement of the pin **20** out of the retention space may be prevented. For axial or lateral removal of the pin **20**, the arms **70a**, **70b** need to be forced apart, as discussed further below, to create an opening of a size sufficient to allow the pin to pass therethrough. If, in an embodiment, the edge **75b** were instead tapered from the reduced diameter (d.sub.2) of the notch **20b** to the diameter (d.sub.3) of the pin **20**, in a direction the tapered end **20a**, application of an axial pulling force to the pin may allow for the pin to be axially withdrawn from the pin retainer **52** as the taper would slide between the arms **70a**, **70b** and open the arms as the pin was withdrawn. However, to prevent tampering, or unauthorized removal of the pins **20**, a preferred embodiment requires the use of a tool, as discussed below with reference to FIGS. **12**, **13A**, **13B**, **14A** and **14B**, for example, to force open the retaining arms **70a**, **70b**.

(33) FIGS. **8A-8D** provide top and side views, as well as sectional views of a pin **20** retained with a pin retainer **52**. FIG. **8C** depicts a longitudinal section through the pin **20** and pin retainer **52** of an embodiment as represented in FIG. **8A**. As shown, the pin **20** may be axially retained within the pin retainer **52**. FIG. **8D** depicts a transverse section through the pin **20** and pin retainer **52** of an embodiment as represented in FIG. **8B**. As shown, the pin **20** may be laterally retained within the pin retainer **52**.

(34) As represented in FIG. **9**, to provide a fiber optic connector that may be changed from male (with pins **20**) to female (without pins **20**) access to release the pins may be provided via passages **80** that may be provided in the sides of the inner housing **14**. In an embodiment as shown, the passages **80** may be provided within the slots **42**. As represented in FIG. **9**, in comparison to the view provided by FIG. **1A**, the outer housing **36** may be moved rearwardly away from the front end of the connector to expose the slots **42** and passages **80**. The passages **80** (refer to FIG. **10**) may be configured to provide access to the arms **70a**, **70b** (refer to FIG. **11**) through the walls of the inner housing **14**.

(35) The passages **80** may be configured to accommodate a release tool **82** as depicted in FIGS. **12-13B**. In an embodiment, the release tool **82** may be configured to include at least two nibs **84a**, **84b** that fit through the passages **80**, one on each side of the inner housing **14**, so that, when forced inwardly through the passages, push the arms **70a**, **70b** apart by an amount sufficient to release the pins **20** from the pin retainer **52**. FIG. **13B** depicts a general positioning of a release tool **82** and nibs **84a**, **84b** relative to a connector **10** with the outer housing **36** displaced rearwardly for removal of the pins **20**.

(36) For clarity, FIGS. **14A** and **14B** reproduce only the pin retainer **52**, pins **20**, and a portion of the release tool **82** of FIG. **13B**. As shown in FIGS. **14A** and **14B**, the tool nibs **84a**, **84b** may be aligned with the tapered groove **74** between the arms **70a**, **70b**. In an embodiment, the tool arms **82a**, **82b** may be squeezed towards one another to move the nibs **84a**, **84b** into the tapered groove **74** and between the arms **70a**, **70b** to displace the arms away from one another and away from the pins **20** as represented in FIG. **14B**. After the arms **70a**, **70b** are sufficiently displaced, the pins **20** may be removed from the pin retainer **52** and from the connector **10** to change the connector from a male connector **10** (FIG. **1A**) to a female connector **12** (FIG. **1B**).

(37) Referring to FIG. **6**, **8B**, **8C**, **10** or **11**, alternatively, a female connector **12** may be converted to a male connector **10** by inserting the tapered ends **20a** of the pins **20** into the guide/alignment holes

22, and pushing the pins inwardly into the pin retainer 52. Because of the tapered configuration of the ends 20a of the pins 20, the tapered ends 20a may force the retainer arms 70a, 70b apart to make it possible for the pins to enter between the arms. When the pin notch 20b passes into the retention space 72 between the arms, the arms may return to their original position to lock the pins in place. If desired, to facilitate insertion of the pins 20 into the pin retainer 52 the release tool 82 could be used to open the arms 70a, 70b thereby making it possible to insert the pins with less force on the pins.

(38) An alternative embodiment of a release tool 90 is depicted in FIGS. 15A and 15B. As shown, the release tool 90 may be more compact while maintaining nibs 90a, 90b in a configuration appropriate for entering the passages 80. While two variants of a release tool are shown, other configurations within the general skill of the artisan may also be provided. In an embodiment (not shown directly, but a variant of which is provided below) a separate tool may not be needed if the inner housing 14 was configured with release tabs that are integral with the housing and include nibs that project partially into the tapered groove 74. A user may then simply squeeze the sides of the connector at the corresponding tabs to press the nibs further in the groove 74 to displace the arms 70a, 70b.

(39) An alternative embodiment of a pin retainer 152 and associated release tool 182 are represented in FIGS. 16A-16D. Instead of having lateral tapered grooves 74 like the embodiment of pin retainer 52, the retainer may be configured to include tapered grooves 174 that extend from a top or bottom surface of the retainer. Arms 170a may be displaceable laterally away from a central core 175. In essentially the same manner as previously discussed with reference to the earlier embodiments, the pins 20 may be retained within the retainer 152, but between displaceable arms 170a and the central core 175. For converting a female connector to a male connector, the pins 20, because of the tapered ends 20a, may be pushed into the retainer 152 so that as the tapered ends are pushed between the arms 170a and the central core 175, the arms may be forced away from the central core.

(40) To convert from a male connector to a female connector, a release tool, such as tool 182 may be used to force the arms 170a laterally away from the central core 175 to open the retainer and provide clearance for the pins 20 to be released from the retainer. In an embodiment (not shown), the tool 182 may be a separate tool carried by the user, and the inner housing 114 may include a corresponding opening, openings 115 for accommodating the tool so that the nibs 190a, 190b may be inserted through the housing to displace the arms 170a.

(41) In an alternative embodiment, as shown in FIGS. 16C and 16D, the tool 182 may be separate from the housings and retainer, but included as a component of the connector 111. As represented in FIG. 16B, the tool 182 may include a body portion 183 from which the nibs 190a, 190b project. The tool 182 may include projecting hooks 191 that extend laterally away from the nibs 190a, 190b and body portion 183, such that the body portion may define a first length (L.sub.1) and the hooks define a second length (L.sub.2) that is greater than the first length (L.sub.1). The inner housing 114 may include an opening 115 that accommodates the body portion 183. The opening 115 may have a width that is essentially the same as, or slightly greater than a width of the body portion 183, and a length (L.sub.3) that is essentially the same as or slightly greater than the length (L.sub.1), but less than the length (L.sub.2). With such a configuration of the tool 182, the hooks 191 will not fit through the opening 115 so that the tool 182 is retained within the inner housing 114. The tool body portion 183 may have flexibility and resiliency to allow the tool 182 to be bent for insertion through the opening. For example, a first side with nibs 190a may be inserted through the opening 115, the tool can be bent to reduce the length (L.sub.3) to fit through the opening, and the second end with nibs 190b may be inserted into place wherein the tool may then return to its original configuration as shown.

(42) Application of an inward pressure on the body portion 183 may force the nibs 190a, 190b inwardly into the tapered grooves 174 to press arms 170a, 170a outwardly away from the central

core **175**, thereby providing clearance between the pins **20** and the arms to allow the pins to be removed in a similar manner as to that shown and discussed with reference to FIG. **14B**. While not shown in the drawings, the outer housing **36**, when in its forward position (shown displaced rearwardly in FIG. **16C**), may completely cover, or alternatively cover a substantial portion of the tool body portion **183** and opening **115** to prevent an accidental force on the body portion from releasing the pins **20**.

(43) An alternative configuration of a pin retainer **252** is represented in FIGS. **17A-17D**. In an embodiment, a U-shaped retention clip **283** may include J-shaped hooks **271a**, **271b** at the ends of arms **270a**, **270b**. The J-shaped hooks **271a**, **271b** may be configured to curl into, or fit into the pin notches **20b** so that, when disposed in the notches, the pins **20** will be held within the pin retainer **252**. FIG. **17C** represents a top view looking down at a J-hook **271b** and pin **20** from the top of the configuration of FIG. **17B**. The pin retainer **252** may include resilient spring arms **253a**, **253b** configured to apply pressure to the J-hooks **271a**, **271b** to retain the J-hooks in the notches **20b**. With reference to FIG. **17B**, resilient spring arms **253a**, **253b**, may apply a downward pressure on J-hooks **271a**, **271b** to hold the J-hooks in the notches **20b** (shown in cross-section).

(44) Referring to FIG. **17A**, to release pins **20**, an upward force against the spring arms **253a**, **253b** may be applied to the clip **283** so that arms **270a**, **270b** move the J-hooks **271a**, **271b** upwardly and out of the notches **20b**. This will free the pins **20** so that the pins may be removed from the pin retainer **252**. Upon removal of the pins **20**, the spring arms **270a**, **270b** may return to their original position pushing the J-hooks **271a**, **271b** downwardly. As for previous embodiments, to insert pins **20** into the retainer **252**, the tapered ends **20a** may be inserted in and forced under the J-hooks **271a**, **271b** to move the J-hooks upwardly against the force of spring arms **253a**, **253b** until the notches **20b** are aligned with the J-hooks, at which time the J-hooks will be forced downwardly into the notches under the force of the spring arms.

(45) As shown in cross-section in FIG. **17D**, the inner housing **214** may include an opening **215** for access (which could resemble the opening **115** as shown in FIG. **16C**) to press inwardly on the clip **283**. While not shown in the drawings, the outer housing **36**, when in its forward position may completely cover, or alternatively cover a substantial portion of, the clip **283** and opening **215** to prevent an accidental force on the body portion from releasing the pins **20**.

(46) In an alternative embodiment, spring arms **253a**, **253b** could be configured to fit into the notches **20b** to engage with the pins **20** and retain the pins in the retainer **252** instead of the J-hooks. A U-shaped, or alternative configuration tool (not shown), for example a U-shaped tool essentially resembling the clip **283**, but without the J-hooks may be configured to release the pins **20**. The tool may be separate from the connector housing, or included as a part of the connector housing, and may be configured to be pushed into the housing to engage the spring arms **253a**, **253b** and move the spring arms away from and out of the notches **20b** to release the pins **20**.

(47) As represented in FIGS. **18A** and **18B**, a pin retainer **352** may be configured integral with the inner housing **324** to form a one-piece housing unit (compared with the configuration of FIG. **4**). In an embodiment, the arms **370a**, **370b** may be configured similar to arms **70a**, **70b** as previously discussed, for example with reference to FIG. **6**. Arms **370a**, **370b** may define a tapered notch **374** therebetween, and a tool, such as tool **82** (FIG. **12**) may be used to open the arms for release of pins **20**.

(48) Various parts, components or configurations described with respect to any one embodiment above may also be adapted to any others of the embodiments provided.

(49) This disclosure is not limited to the particular systems, devices and methods described, as these may vary. The terminology used in the description is for the purpose of describing the particular versions or embodiments only, and is not intended to limit the scope.

(50) In the above detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description,

drawings, and claims are not meant to be limiting. Other embodiments may be used, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

(51) The present disclosure is not to be limited in terms of the particular embodiments described in this application, which are intended as illustrations of various aspects. Many modifications and variations can be made without departing from its spirit and scope, as will be apparent to those skilled in the art. Functionally equivalent methods and apparatuses within the scope of the disclosure, in addition to those enumerated herein, will be apparent to those skilled in the art from the foregoing descriptions. Such modifications and variations are intended to fall within the scope of the appended claims. The present disclosure is to be limited only by the terms of the appended claims, along with the full scope of equivalents to which such claims are entitled. It is to be understood that this disclosure is not limited to particular methods, reagents, compounds, compositions or biological systems, which can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular embodiments only, and is not intended to be limiting.

(52) As used in this document, the singular forms “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise. Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art. Nothing in this disclosure is to be construed as an admission that the embodiments described in this disclosure are not entitled to antedate such disclosure by virtue of prior invention. As used in this document, the term “comprising” means “including, but not limited to.”

(53) While various compositions, methods, and devices are described in terms of “comprising” various components or steps (interpreted as meaning “including, but not limited to”), the compositions, methods, and devices can also “consist essentially of” or “consist of” the various components and steps, and such terminology should be interpreted as defining essentially closed-member groups.

(54) With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

(55) It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as “open” terms (e.g., the term “including” should be interpreted as “including but not limited to,” the term “having” should be interpreted as “having at least,” the term “includes” should be interpreted as “includes but is not limited to,” etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases “at least one” and “one or more” to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles “a” or “an” limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases “one or more” or “at least one” and indefinite articles such as “a” or “an” (e.g., “a” and/or “an” should be interpreted to mean “at least one” or “one or more”); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g., the



bare recitation of “two recitations,” without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to “at least one of A, B, and C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., “a system having at least one of A, B, and C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to “at least one of A, B, or C, etc.” is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., “a system having at least one of A, B, or C” would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase “A or B” will be understood to include the possibilities of “A” or “B” or “A and B.”

(56) In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

(57) As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as “up to,” “at least,” and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

(58) Various of the above-disclosed and other features and functions, or alternatives thereof, may be combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations or improvements therein may be subsequently made by those skilled in the art, each of which is also intended to be encompassed by the disclosed embodiments.

## Claims

1. A multi-fiber fiber optic connector configured to be converted between a female connector configuration and a male connector configuration by releasing or connecting notched guide pins, each notched guide pin including a retention notch, the multi-fiber fiber optic connector comprising: a housing having a front end portion and a rear end portion spaced apart along a longitudinal axis; a ferrule disposed in the housing for terminating a plurality of optical fibers, the ferrule having a front end portion and a rear end portion spaced apart along a longitudinal axis, the ferrule comprising first and second guide pin passages extending longitudinally from the rear end portion through the front end portion, the first and second guide pin passages being spaced apart along a fiber alignment axis, the ferrule configured to hold a plurality of optical fibers in one or more rows parallel to the fiber alignment axis, the ferrule being configured to accept one of the notched guide pins in each of the first and second guide pin passages such that the retention notch is rearward of the rear end portion of the ferrule; and a pin keeper disposed in the housing rearward of the rear end portion of the ferrule, the pin keeper comprising a retention clip having an operating

shape, the retention clip being movable in relation to the ferrule between a retaining position and a release position without deflection of the retaining clip from its operating shape during movement of the retention clip between the retaining position and the release position, wherein when the retention clip is in the retaining position, the retention clip is configured to move into the retention notches of the notched guide pins received in the first and second guide pin passages for retaining the notched guide pins in the first and second guide pin passages, wherein when the retention clip is in the release position, the retention clip disengages from the retention notches of notched guide pins received in the first and second guide pin passages for releasing the guide pins from the first and second guide pin passages; and wherein the multi-fiber fiber optic connector is configured so that the retention clip is resiliently biased toward the retaining position.

2. The multi-fiber fiber optic connector as set forth in claim 1, further comprising a spring configured to apply pressure to the retention clip to resiliently bias the retention clip toward the retaining position.

3. The multi-fiber fiber optic connector as set forth in claim 1, wherein the housing is an inner housing, the multi-fiber optic connector further comprising an outer housing disposed on the inner housing for movement relative to the inner housing between a forward position and a rear position.

4. The multi-fiber fiber optic connector as set forth in claim 3, wherein the inner housing comprises an access opening operatively aligned with the retention clip such that the retention clip can be moved from the retaining position to the release position.

5. The multi-fiber fiber optic connector as set forth in claim 4, wherein the outer housing is configured to cover the access opening in the forward position and expose the access opening in the rear position.

6. The multi-fiber fiber optic connector as set forth in claim 1, wherein the pin keeper further comprises a front body portion between the retention clip and the ferrule.

7. The multi-fiber fiber optic connector as set forth in claim 6, wherein the retention clip is a separate piece from the front body portion.

8. The multi-fiber fiber optic connector as set forth in claim 7, wherein the front body portion defines first and second guide pin openings through which notched guide pins extend rearward to the retention clip.

9. The multi-fiber fiber optic connector as set forth in claim 7, wherein the retention clip is displaceable in relation to the front body portion between the retaining position and the release position.

10. A multi-fiber fiber optic connector configured to be converted between a female connector configuration and a male connector configuration by releasing or connecting notched guide pins, each notched guide pin including a retention notch, the multi-fiber fiber optic connector comprising: an housing having a front end portion and a rear end portion spaced apart along a longitudinal axis; a ferrule disposed in the housing for terminating a plurality of optical fibers, the ferrule having a front end portion and a rear end portion spaced apart along a longitudinal axis, the ferrule comprising first and second guide pin passages extending longitudinally from the rear end portion through the front end portion, the first and second guide pin passages being spaced apart along a fiber alignment axis, the ferrule configured to hold a plurality of optical fibers in one or more rows parallel to the fiber alignment axis, the ferrule being configured to accept one of the notched guide pins in each of the first and second guide pin passages such that the retention notch is rearward of the rear end portion of the ferrule; a pin keeper disposed in the housing rearward of the rear end portion of the ferrule, the pin keeper comprising a retention clip defining a first opening and a second opening larger than the first opening, the retention clip further defining a throat, the first and second openings communicating with each other through the throat, the pin keeper being adjustable for moving the retention clip between a retaining position and a release position by moving the entire retention clip relative to the ferrule such that the notched guide pin passes through the throat from the first opening to the second opening in a direction transverse to

the alignment axis as the retention clip moves from the retaining position to the release position; wherein when the retention clip is in the retaining position, the retention clip is configured to move into the retention notches of the notched guide pins received in the first and second guide pin passages for retaining the notched guide pins in the first and second guide pin passages; and wherein when the retention clip is in the release position, the retention clip disengages from the retention notches of notched guide pins received in the first and second guide pin passages for releasing the guide pins from the first and second guide pin passages.

11. The multi-fiber fiber optic connector as set forth in claim 10, wherein the retention clip has a first arm having a curved end portion configured for selectively engaging the retention notch of a notched guide pin received in the first guide pin passage and a second arm having a curved end portion configured for selectively engaging the retention notch of a notched guide pin received in the second guide pin passage.

12. The multi-fiber optic connector as set forth in claim 11, wherein the clip is shaped and arranged such that the curved end portions of the first and second arms move conjointly in relation to the ferrule as the clip is moved.

13. The multi-fiber fiber optic connector of claim 12, wherein the curved end portions of the first and second arms define concave edges configured to face toward the notched guide pins, the concave edge of the first arm facing toward the fiber alignment axis.

14. The multi-fiber optic connector as set forth in claim 11, wherein the curved end portion of the first arm defines a curved hook.

15. The multi-fiber fiber optic connector as set forth in claim 10, wherein the multi-fiber fiber optic connector is configured so that the retention clip is resiliently biased toward the retaining position.

16. A multi-fiber fiber optic connector configured to be converted between a female connector configuration and a male connector configuration by releasing or connecting notched guide pins, each notched guide pin including a retention notch, the multi-fiber fiber optic connector comprising: a housing having a front end portion and a rear end portion spaced apart along a longitudinal axis; a ferrule disposed in the housing for terminating a plurality of optical fibers, the ferrule having a front end portion and a rear end portion spaced apart along a longitudinal axis, the ferrule comprising first and second guide pin passages extending longitudinally from the rear end portion through the front end portion, the first and second guide pin passages being spaced apart along a fiber alignment axis, the ferrule configured to hold a plurality of optical fibers in one or more rows parallel to the fiber alignment axis, the ferrule being configured to accept one of the notched guide pins in each of the first and second guide pin passages such that the retention notch is rearward of the rear end portion of the ferrule; a pin keeper disposed in the housing rearward of the rear end portion of the ferrule, the pin keeper comprising a front body portion, a rear body portion, and a retention clip being disposed between front body portion and the rear body portion, the front body portion configured to pass the notched guide pins received in the first and second guide pin passages to the retention clip, the rear body portion defining a space for receiving rear end portions of notched guide pins retained by the retention clip, the retention clip being formed from a separate piece of material than the front body portion and the rear body portion, the retention clip being movable in relation to the ferrule between a retaining position and a release position; wherein when the retention clip is in the retaining position, the retention clip is configured to move into the retention notches of the notched guide pins received in the first and second guide pin passages for retaining the notched guide pins in the first and second guide pin passages; and wherein when the retention clip is in the release position, the retention clip disengages from the retention notches of notched guide pins received in the first and second guide pin passages for releasing the guide pins from the first and second guide pin passages.

17. The multi-fiber optic connector as set forth in claim 16, wherein the multi-fiber optic connector is configured to resiliently bias the retention clip toward the retaining position.

18. The multi-fiber fiber optic connector as set forth in claim 17, wherein the retention clip is

configured to move between the retaining position and the release position substantially without deforming.

19. A multi-fiber fiber optic connector configured to be converted between a female connector configuration and a male connector configuration by releasing or connecting notched guide pins, each notched guide pin including a retention notch, the multi-fiber fiber optic connector comprising: an housing having a front end portion and a rear end portion spaced apart along a longitudinal axis; a ferrule disposed in the housing for terminating a plurality of optical fibers, the ferrule having a front end portion and a rear end portion spaced apart along a longitudinal axis, the ferrule comprising first and second guide pin passages extending longitudinally from the rear end portion through the front end portion, the first and second guide pin passages being spaced apart along a fiber alignment axis, the ferrule configured to hold a plurality of optical fibers in one or more rows parallel to the fiber alignment axis, the ferrule being configured to accept one of the notched guide pins in each of the first and second guide pin passages; a retention clip disposed in the housing, the retention clip defining a first opening and a second opening larger than the first opening, the retention clip further defining a throat, the first and second openings communicating with each other through the throat, the retention clip being movable with respect to the ferrule between a retaining position and a release position by moving the entire retention clip relative to the ferrule such that the notched guide pin passes in a direction transverse to the alignment axis through the throat from the first opening to the second opening as the retention clip moves from the retaining position to the release position; wherein when the retention clip is in the retaining position, the retention clip is configured to move into the retention notches of the notched guide pins received in the first and second guide pin passages for retaining the notched guide pins in the first and second guide pin passages; and wherein when the retention clip is in the release position, the retention clip disengages from the retention notches of notched guide pins received in the first and second guide pin passages for releasing the guide pins from the first and second guide pin passages.

20. The multi-fiber fiber optic connector as set forth in claim 19 wherein the retention clip has an external perimeter and axial projections of the first and second guide pin passages remain within the external perimeter of the in the retaining position and in the release position.

21. The multi-fiber fiber optic connector as set forth in claim 20, wherein the retention clip is configured to move between the retaining position and the release position substantially without deforming.

22. The multi-fiber fiber optic connector as set forth in claim 20, wherein the retention clip comprises a single piece of material configured to simultaneously engage into the retention notches of the two notched guide pins received in the first and second guide pin passages in the retaining position.

23. The multi-fiber fiber optic connector as set forth in claim 22, the retention clip defining a pair of first openings spaced apart along the lateral axis, a pair of second openings larger than the first openings spaced apart along the lateral axis, and a pair of throats spaced apart along the lateral axis, wherein each first opening communicates with a respective second opening through a respective throat, wherein the retention clip is sized and arranged so that: when the retention clip is in the retaining position, the first and second guide pin passages are aligned vertically and laterally with the pair of first openings such that the notched guide pins received in the first and second guide pin passages are seated in the pair of first openings; when the retention clip is in the release position, the first and second guide pin passages are aligned vertically and laterally with the pair of second openings; and as the retention clip moves from the retaining position to the release position, the notched guide pins received in the first and second guide pin passages pass from the pair of first openings to the pair of second openings through the pair of throats.

24. A multi-fiber fiber optic connector configured to be converted between a female connector configuration and a male connector configuration by releasing or connecting notched guide pins,

each notched guide pin including a retention notch, the multi-fiber fiber optic connector comprising: an inner housing having a front end portion and a rear end portion spaced apart along a longitudinal axis, the inner housing having opposite first and second side walls spaced apart along a lateral axis perpendicular to the longitudinal axis, and a top wall and a bottom wall spaced apart along a vertical axis perpendicular to the lateral axis, the inner housing having an access opening for facilitating gender change; a ferrule disposed in the inner housing for terminating a plurality of optical fibers, the ferrule having a front end portion and a rear end portion spaced apart along a longitudinal axis, the ferrule comprising first and second guide pin passages extending longitudinally from the rear end portion through the front end portion, the first and second guide pin passages being spaced apart along a fiber alignment axis parallel to the lateral axis, the ferrule configured to hold a plurality of optical fibers in one or more rows parallel to the fiber alignment axis, the ferrule being configured to accept one of the notched guide pins in each of the first and second guide pin passages such that the retention notch is rearward of the rear end portion of the ferrule; a retention clip disposed in the inner housing rearward of the rear end portion of the ferrule, the retention clip adjustable via the access opening for moving the retention clip between a retaining position and a release position by displacing the entire retention clip relative to the ferrule in a plane transverse to the longitudinal axis; wherein when the retention clip is in the retaining position, the retention clip is configured to engage into the retention notches of the notched guide pins received in the first and second guide pin passages for retaining the notched guide pins in the first and second guide pin passages; and wherein when the retention clip is in the release position, the retention clip disengages from the retention notches of notched guide pins received in the first and second guide pin passages for releasing the guide pins from the first and second guide pin passages.

25. The multi-fiber fiber optic connector as set forth in claim 24, wherein the retention clip has a first curved surface configured for selectively engaging the retention notch of a notched guide pin received in the first guide pin passage and a second curved surface configured for selectively engaging the retention notch of a notched guide pin received in the second guide pin passage.

26. The multi-fiber optic connector as set forth in claim 25, wherein the first and second curved surfaces move conjointly in relation to the ferrule as the retention clip is displaced in the plane transverse to the longitudinal axis.

27. The multi-fiber fiber optic connector of claim 25, wherein the first curved surface and the second curved surface face in a vertical direction.

---