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(54) Title: OPTICAL FIBER CONNECTOR WITH CHANGEABLE POLARITY

(57) Abstract: A multi-fiber, fiber optic connector may include a reversible keying arrangement for determining the orientation for plugging the connector into an adapter to thereby allow for a change in polarity of the connection to be made on site. The connector housing may be configured to engage with a removable key that may be engaged with the housing in at least two different locations to provide the plug-in orientation, or the housing may have slidably displaceable keys movable between multiple positions on the housing.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G02B 6/38, G02B 6/36, G02B 6/40, H01R 13/02 (2016.01)

CPC - G02B6/38, G02B6/36, G02B6/3825, G02B6/40, H01R13/02, G02B6/3885, G02B6/3831

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)
IPC (8) G02B 6/38, G02B 6/36, G02B 6/40, H01R 13/02 (2016.01)
CPC: G02B6/38, G02B6/36, G02B6/3825, G02B6/40, H01R13/02, G02B6/3885, G02B6/3831

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC (8) G02B 6/38, G02B 6/36, G02B 6/40, H01R 13/02, H01R 13/24 (2016.01)
CPC: G02B6/38, G02B6/36, G02B6/3825, G02B6/3840, G02B6/40, H01R13/02, H01R13/24, G02B6/3869, G02B6/3885, G02B6/3831 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase: Google Patents, Google Scholar; Google Web; Search terms used: Fiber optics multiple polarity key removable slidable connector cable first second polarity snap-in twist fastener key two connector adapter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 2013/02/2825 A1 (Cooke et al.) 05 December 2013 (05.12.2013), entire document, especially Fig. 1A, 1B, 1C, 2, 3A, 4, 5A, 6A, 7A, 9A, 9B; para[0025]; para[0029]; para[0032]; para[0044]; para[0033]; para[0034];</td>
<td>1, 13-14</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,521,997 A (Rovenolt et al.) 28 May 1996 (28.05.1996), entire document, especially Fig. 1, 3, 4, 6; col 3, ln 1-3; col 3, ln 5-6; col 4, ln 62-65; col 3, ln 10-12;</td>
<td>15</td>
</tr>
<tr>
<td>A</td>
<td>US 8,636,424 B2 (Kurfel et al.) 28 January 2014 (28.01.2014), entire document, especially Fig. 13, 14, 16; col 7, ln 43-46; col 7, ln 61-63; col 7, ln 47-51; col 7, ln 52-55;</td>
<td>2-12</td>
</tr>
<tr>
<td>A</td>
<td>US 5,335,301 A (Newman et al.) 02 August 1994 (02.08.1994), entire document</td>
<td>1-15</td>
</tr>
<tr>
<td>A</td>
<td>US 5,265,181 A (Chang) 23 November 1993 (23.11.1993), entire description</td>
<td>1-15</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

* 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
"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
"Z" document member of the same patent family

Date of the actual completion of the international search
23 June 2016

Date of mailing of the international search report
22 AUG 2016

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Form PCT/ISA/210 (second sheet) (January 2015)
**INTERNATIONAL SEARCH REPORT**

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.:  
   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:

3. Claims Nos.:  
   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:  
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-15 directed to a multi-fiber optic connector with a removable key.

Group II: Claim 16 directed to a method of switching the polarity configuration between a multi-fiber optic connector and adapter using multiple movably displaceable keys.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

— Continued in supplemental box —

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

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of 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.: 1-15

*Uemark 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.

Form PCT/ISA/210 (continuation of first sheet (2)) (January 2015)
SPECIAL TECHNICAL FEATURES

The invention of Group II includes the special technical features of a method of switching the polarity configuration between a multi-fiber optic connector and adapter, wherein the connector comprises at least first and second movably displaceable keys along the housing between a first position and second position, and when the first key is in the first position, the second key is in the second position and providing a first polarity; wherein the method also includes slingly displacing the first or second key from its first or second position to the alternate position to change the polarity, not required by the claims of Group I.

COMMON TECHNICAL FEATURES

The inventions of Groups I-II share the technical features of a multi-fiber fiber optic connector comprising: a ferrule having a plurality of optical fibers supported therein; a housing disposed around at least a portion of the ferrule, the housing comprising: a first end for being inserted into a fiber optic adapter, a second end disposed opposite the first end, and at least a first wall portion extending from the first end towards the second end and a second wall portion opposite the first wall portion and extending from the first end towards the second end, wherein each of the first wall portion and the second wall portion have an internal surface disposed towards the ferrule and an external surface disposed outwardly away from the ferrule, and the housing defining a longitudinal axis in a direction from the first end to the second end, a transverse axis orthogonal to the longitudinal axis, and a vertical centerline through the first and second wall portions; and a key configured to be removably attached to either: the first wall portion to define a first keyed configuration for insertion of the first end into the adapter in only a first orientation to define a first polarity with respect to the adapter, or the second wall portion to define a second keyed configuration for insertion of the first end into the adapter in only a second orientation to define a second polarity with respect to the adapter, wherein the second polarity is opposite to the first polarity, wherein the key comprises: a first end configured for engaging with the housing adjacent the first housing end to prevent movement of the first key end with respect to the housing in at least a direction laterally away from the housing when removably attached to either the first wall portion or the second wall portion; and a second end disposed longitudinally away from the first end and configured for being removably attached to the housing at a second location of the housing spaced longitudinally from the first end of the housing towards the second end of the housing to prevent movement of the key with respect to the housing in at least a longitudinal direction along the housing when removably attached to either the first wall portion or the second wall portion. Specifically, Groups I and II are related as an apparatus (Group I) and methods for using the apparatus (Group II). The apparatus is known in prior art as shown in US 2013/0322825 A1 to Cooke et al., (hereinafter 'Cooke'). Therefore, Groups I and II lack unity since the shared technical features do not represent a contribution over Cooke:
INTERNATIONAL SEARCH REPORT

INTERNATIONAL APPLICATION No.
PCT/US 15/59458
— Continuation supplemental box for Box No. ...
... they do not share a same or corresponding special technical feature.

Regarding claim 1. Cooke discloses a multi-fiber fiber optic connector (20, Fig. 1A, 2; para[0025]), 'a connector includes the structure (assembly) mounted upon the end of a multi-fiber fiber optic cable'; para[0028], 'an example connector 20') comprising: a ferrule (30, Fig. 1A, 2; para[0029], 'a multi-fiber ferrule ("ferrule") 30') having a plurality of optical fibers supported therein (Fig. 1A, 2; para[0029] - see how the ferrule 30 is referred to as a multi-fiber ferrule 30'); a housing (46, Fig. 1A, 1C, 2; para[0029], 'an inner housing 46') disposed around at least a portion of the ferrule (34, Fig. 1A, 1C, 2; para[0029], 'an inner housing 46 positioned about ferrule 30 around the ferrule outside portion 34), the housing comprising: a first end (62, Fig. 1A - see front/first end 62; para[0032], 'inner housing 46 includes a front end 62') for being inserted into a fiber optic adapter (200, Fig. 7A, 9A - see adapter 200, and see how the first end 62 of the connector 20 is for being inserted into the adapter 200; para[0044], 'an adapter 200 configured to matingly engage MTP connector 20'), a second end (64, Fig. 1A - see back/second end 64; para[0032], 'a back end 64') disposed opposite the first end (Fig. 1A - see how the first end 62 and the second back end 64 are opposite), and at least a first wall portion (66T, Fig. 1A, 1C; para[0032], 'a top side 66T') extending from the first end towards the second end (Fig. 1A - see how the first/top wall portion 66T extends from the front/first end 62 to the second/back end 64) and a second wall portion (66B, Fig. 1B; para[0032], 'a bottom side 66B') opposite the first wall portion and extending from the first end towards the second end (Fig. 1A, 1B, 1C - see how the second wall portion 66B is opposite the first wall portion 66T and how it extends from the first end 62 to the second end 64), wherein each of the first wall portion and the second wall portion have an internal surface (Fig. 1A, 1B, 1C - see internal surface for first and second wall portions 66T and 66B) disposed towards the ferrule (Fig. 1C - see how the internal surfaces of the first and second wall portions 66T and 66B are disposed towards the ferrule 30) and an external surface (Fig. 1A, 1B, 1C - see external surface for first and second wall portions 66T and 66B) disposed outwardly away from the ferrule (Fig. 1C - see how the external surfaces of the first and second wall portions 66T and 66B are disposed outwardly away from the ferrule 30), and the housing defining a longitudinal axis (A1, Fig. 1A; para[0032], 'the connector axis A1') in a direction from the first end to the second end (Fig. 1A - see how the longitudinal axis A1 is in the direction from the first end 62 to the second end 64), a transverse axis (Fig. 1A - see transverse axis that runs perpendicularly to the longitudinal axis through the connector 20) orthogonal to the longitudinal axis (Fig. 1A - see transverse axis that is orthogonal to the longitudinal axis A1), and a vertical centerline (Fig. 1C - see vertical centerline disposed directly in the center of ferrule 30) through the first and second wall portions (Fig. 1C - see vertical centerline that runs directly through the middle of ferrule 30 from the first wall portion 66T to the second wall portion 66B); and a key (100, Fig. 2, 3A; para[0033], 'a polarity key 100') configured to be removably attached to either: the first wall portion (66T, Fig. 4 - see how the key 100 is removably attachable to the first wall portion 66T in the top recess 70T; para[0035], 'polarity key 100 is configured to be removably secured within top recess 70T') to define a first keyed configuration (Fig. 4 - see first keyed configuration where key 100 is disposed in the top first wall portion 66T; para[0042], 'with reference to FIGS. 4 and 6, MTP connector 20 includes first and second polarity keying configurations, depending in which recess polarity key 100 resides') for insertion of the first end into the adapter in only a first orientation to define a first polarity with respect to the adapter (Fig. 9A - see how the connector 20 can only be inserted with the top side 66T facing upward; para[0045], 'because MTP connector 20 has a switchable polarity key 100, a field technician can manage the polarity of the connection between the MTP connector and adapter 200'), or the second wall portion (66B, Fig. 6 - see how the key 100 is removably attachable to the second wall portion 66B in the bottom recess 70B; para[0035], 'polarity key 100 is configured to be removably secured within top recess 70B or bottom recess 70B') to define a second keyed configuration (Fig. 6 - see second keyed configuration where key 100 is disposed in the bottom second wall portion 66B for insertion of the first end into the adapter in only a second orientation to define a second polarity with respect to the adapter (Fig. 9B - see how the connector 20 can only be inserted with the bottom side 66B facing upward), wherein the second polarity is opposite to the first polarity (Fig. 4, 6, 9A, 9B - see how the first polarity orientation shown in Fig. 4 and 9A is opposite the second polarity orientation shown in Fig. 6 and 9B), wherein the key (100, Fig. 2, 3A) comprises: a first end (102, Fig. 3A - see first front end 102; para[0034], 'polarity key 100 has a front end 102, a back end 104') configured for engaging with the housing adjacent the first housing end (Fig. 1C, 2 - see how the first end 102 engages the housing 46 adjacent the first end 62 via the slot/recess 70T; para[0034], 'a polarity key 100 in the process of being inserted into top recess 70T') to prevent movement of the first key end with respect to the housing in at least a direction laterally away from the housing when removably attached to either the first wall portion or the second wall portion (Fig. 2, 4, 5A - see how the movement is prevented in a lateral direction when the front end 102 of the key 100 is removably attached to the front end 62 of the housing 46 since the key 100 is partially disposed in the recess 70T, and see how the key 100 is then secured at the front end 102 via lip 72T, further limiting any movement); and a second end (104, Fig. 3A - see second back end 104; para[0034], 'polarity key 100 has a front end 102, a back end 104') disposed longitudinally away from the first and configured for being removably attached to the housing at a second location of the housing (Fig. 2, 3A - see how the second end 104 is disposed longitudinally away from the first end 62 and is removably attached to the housing 46 at a second location near the second end 64) spaced longitudinally from the first end of the housing towards the second end of the housing (Fig. 2 - see how the second end 104 is configured for engaging the housing 46 adjacent to the second housing end 64 longitudinally spaced from the first end 62 of housing 46) to prevent movement of the key with respect to the housing in at least a longitudinal direction along the housing when removably attached to either the first wall portion or the second wall portion (Fig. 2, 4, 5A - see how the second end 104 of the key 100 engages the housing 46 adjacent to the second end 64, and how it prevents movement in a direction longitudinally away from the housing 46 when removably attached to either the first or second wall portions 66T or 66B by using securing feature 124).

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical feature that would otherwise unify the groups.

Therefore, Groups I-11 lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.

Form PCT/ISA/210 (extra sheet) (January 2015)