

intended to be a final action, will be governed by the requirements of 37 CFR 1.116 after final rejection and by 37 CFR 41.33 after appeal, which will be strictly enforced.

Notification of Concurrent Proceedings

The patent owner is reminded of the continuing responsibility under 37 CFR 1.565(a) to apprise the Office of any litigation activity, or other prior or concurrent proceeding, involving the '565 patent throughout the course of this reexamination proceeding. Likewise, if present, the third party requester is also reminded of the ability to similarly apprise the Office of any such activity or proceeding throughout the course of this reexamination proceeding. See MPEP §§ 2207, 2282 and 2286.

The requester cites to the following references:

U.S. Pat. No. 7,113,680 to Hurley et al. ("Hurley")

U.S. Pat. Pub. 2001/0029814 to Tiano ("Tiano")

U.S. Pat. No. 6,545,222 to Yokokawa et al. ("Yokokawa")

U.S. Pat. No. 5,524,938 to Sides, III et al. ("Sides")

U.S. Pat. No. 4,091,843 to Mikes et al. ("Mikes")

U.S. Pat. No. 5,212,755 to Holmberg ("Holmberg")

U.S. Pat. No. 5,268,983 to Tatarka et al. ("Tatarka")

U.S. Pat. Pub. 2002/0085820 to Gaillard et al. ("Gaillard")

U.S. Pat. No. 3,326,583 to Guarnaschelli ("Guarnaschelli")

U.S. Pat. No. 6,236,790 to Okada et al. ("Okada")

The request indicates that the requester considers:

- (1) Claims 1, 4-5, 13 and 24 are unpatentable over Hurley.
- (2) Claims 1, 4-5, 7, 8, 11, 13, 18, 20 and 23-24 are unpatentable over Hurley in view of Tiano, further in view of Yokokawa, and further in view of Sides.
- (3) Claims 2, 3, 12, 18, 20 and 23 are unpatentable over Hurley in view of Mikes.
- (4) Claims 6 and 9 are unpatentable over Hurley in view of Okada.
- (5) Claims 7-8 are unpatentable over Hurley in view of Holmberg.
- (6) Claim 10 is unpatentable over Hurley in view of Gaillard.
- (7) Claim 22 is unpatentable over Hurley in view of Tatarka.
- (8) Claims 16-17 are unpatentable over Hurley in view of Mikes, and further in view of Guarnaschelli.
- (9) Claims 14-15 are unpatentable over Hurley in view of Tatarka, and further in view of Guarnaschelli.
- (10) Claim 19 is unpatentable over Hurley in view of Mikes, and further in view of Tatarka, and further in view of Yokokawa.
- (11) Claim 21 unpatentable over Hurley in view of Guarnaschelli.

U.S. Patent No. 7,113,680 to Hurley

The Hurley reference is a new teaching, not previously considered nor addressed in the prior examination of the patent or a final holding of invalidity by the Federal Courts.

The Hurley reference raises an SNQ with respect to at least claim 1.

Claim 1 requires, *inter alia*, "A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube having an outer sealing surface and a tear cord between the inside diameter of said jacket and the outer surface of the tube..."

Fig. 4 of Hurley teaches a device comprising a separation layer 52, a protective jacket 50, and a tear cord (ripcord 54) positioned between the separation layer 52 and jacket 50. Hurley further teaches that separation layer 52 "can be formed from by [sic] an armor layer, for example, ***a metal or dielectric layer that may be formed from one or more pieces***" (col. 10, lines 47-50), which appears to suggest that separation layer 52 may be a one-piece, smooth, solid wall metal tube. The references considered during the prior examination do not disclose a jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube having an outer sealing surface and a tear cord between the inside diameter of said jacket and the outer surface of the tube. Thus, there is a substantial likelihood that a reasonable examiner would consider these teachings important in deciding whether or not at least claim 1 is patentable.

Accordingly, Hurley raises an SNQ as to at least claim 1 (and claims which depend therefrom), which has not been decided in a previous examination of the '565 patent.

It is further noted that each of the remaining independent claims 2, 3, 10, 12, 14, 18 and 21 each include some derivation of the basic "jacketed metal tube with a tear cord between the jacket and the tube" structure. Thus, it is agreed that Hurley appears to be a reasonably relevant reference upon which to base a patentability inquiry for all of claims 1-24 of the '565 patent. Thus, the examiner agrees to reexamine claim 1-24 in view of Hurley and the nine secondary references listed above, and will consider the specific combinations of references proposed by the requester at the time of the first Office action on the merits

Additionally, since both jacketed metal tubes (e.g. with the jacket being applied for abrasion control, corrosion control and/or thermal insulation) and ripcords (e.g. for conveniently ripping open insulation without the use sharp tools) existed in the prior art well before the filing date of the '565 patent, patentability of claims 1-24 will likely be assessed in view of one or more "basic" jacketed tube references (e.g. U.S. Pat. No. 4,345,363 to Leuchs et al) in combination with one or more "basic" ripcord references (e.g. U.S. Pat. No. 4,041,237 to Stine et al) at the time of the first Office action on the merits.

Conclusion

For the reasons given above, each of the references cited by the requester raises a substantial new question of patentability with respect to the subject patent. Accordingly, claims 1-24 of the subject patent will be reexamined.

Application/Control Number: 90/020,065
Art Unit: 3993

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All correspondence relating to this *ex parte* reexamination proceeding should be directed as follows:

By U.S. Postal Service Mail to:

Mail Stop *Ex Parte* Reexam
ATTN: Central Reexamination Unit
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

By FAX to: (571) 273-9900
Central Reexamination Unit

By hand to: Customer Service Window
Randolph Building
401 Dulany St.
Alexandria, VA 22314

By EFS-Web:

Registered users of EFS-Web may alternatively submit such correspondence via the electronic filing system EFS-Web, at

<https://efs.uspto.gov/efile/myportal/efs-registered>

EFS-Web offers the benefit of quick submission to the particular area of the Office that needs to act on the correspondence. Also, EFS-Web submissions are "soft scanned" (i.e., electronically uploaded) directly into the official file for the reexamination proceeding, which offers parties the opportunity to review the content of their submissions after the "soft scanning" process is complete.

Any inquiry concerning this communication or earlier communications from the Reexamination Legal Advisor or Examiner, or as to the status of this proceeding, should be directed to the Central Reexamination Unit at telephone number (571) 272-7705.

Other useful telephone numbers:
Reexamination Practice

(571) 272-7703

Application/Control Number: 90/020,065

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Art Unit: 3993

Reexamination Facsimile Transmission No.

(571) 273-9900

/David O. Reip/
Patent Reexamination Specialist
Central Reexamination Unit
(571) 272-4702

Conferee __/JGF/____

Conferee __/EDL/____

Order Granting / Denying Request For Ex Parte Reexamination	Control No.	Patent Under Reexamination
	90/020,065	7581565
	Examiner	Art Unit
	DAVID O. REIP	3993

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

The request for *ex parte* reexamination filed 24 December 2013 has been considered and a determination has been made. An identification of the claims, the references relied upon, and the rationale supporting the determination are attached.

Attachments: a) ☐ PTO-892, b) ☒ PTO/SB/08, c) ☐ Other: _____

1. ☒ The request for *ex parte* reexamination is GRANTED.

RESPONSE TIMES ARE SET AS FOLLOWS:

For Patent Owner's Statement (Optional): TWO MONTHS from the mailing date of this communication (37 CFR 1.530 (b)). **EXTENSIONS OF TIME ARE GOVERNED BY 37 CFR 1.550(c).**

For Requester's Reply (optional): TWO MONTHS from the **date of service** of any timely filed Patent Owner's Statement (37 CFR 1.535). **NO EXTENSION OF THIS TIME PERIOD IS PERMITTED.** If Patent Owner does not file a timely statement under 37 CFR 1.530(b), then no reply by requester is permitted.

2. ☐ The request for *ex parte* reexamination is DENIED.

This decision is not appealable (35 U.S.C. 303(c)). Requester may seek review by petition to the Commissioner under 37 CFR 1.181 within ONE MONTH from the mailing date of this communication (37 CFR 1.515(c)). **EXTENSION OF TIME TO FILE SUCH A PETITION UNDER 37 CFR 1.181 ARE AVAILABLE ONLY BY PETITION TO SUSPEND OR WAIVE THE REGULATIONS UNDER 37 CFR 1.183.**

In due course, a refund under 37 CFR 1.26 (c) will be made to requester:

a) ☐ by Treasury check or,

b) ☐ by credit to Deposit Account No. _____, or

c) ☐ by credit to a credit card account, unless otherwise notified (35 U.S.C. 303(c)).

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cc:Requester (if third party requester)

U.S. Patent and Trademark Office
PTOL-471 (Rev. 08-06)

Office Action in *Ex Parte* Reexamination

Part of Paper No. 20140224

Search Notes 	Application/Control No.		Applicant(s)/Patent under Reexamination	
	90/020,065		7581565	
	Examiner		Art Unit	
	DAVID O. REIP		3993	

SEARCHED			
Class	Subclass	Date	Examiner

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
patent file reviewed	2/17/2014	DOR

Receipt date: 12/24/2013

90020065 - GAU: 3993

Doc code: IDS

Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)

Approved for use through 07/31/2012. OMB 0651-0031

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		12178246
	Filing Date		2008-07-23
	First Named Inventor	TORRANCE	
	Art Unit	3754	
	Examiner Name	Brinson, Patrick F.	
	Attorney Docket Number	SURP 13.01 REEXAM	

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	7113680	B2	2006-09-26	Hurley et al	
	2	6545222	B2	2003-04-08	Yokokawa et al	
	3	5524937		1996-06-11	Sides, III et al	
	4	4091843		1978-05-30	Mikes et al	
	5	5212755		1993-05-18	Holmberg	
	6	5268983		1993-12-07	Tatarka et al	
	7	3326583		1967-06-20	Guarnaschelli	
	8	6236790	B1	2001-05-22	Okada et al	
If you wish to add additional U.S. Patent citation information please click the Add button.						

EFS Web 2.1.17

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /DR/

HUATONG EXHIBIT 1006

Page 249 of 413

Receipt date: 12/24/2013

90020065 - GAU: 3993

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	12178246
Filing Date	2008-07-23
First Named Inventor	TORRANCE
Art Unit	3754
Examiner Name	Brinson, Patrick F.
Attorney Docket Number	SURP 13.01 REEXAM

U.S. PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	20010029814	A1	2001-10-18	Tiano	
	2	20020085820	A1	2002-07-04	Gaillard et al	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							☐

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NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/David Reip/	Date Considered	02/25/2014
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Receipt date: 12/24/2013

90020065 - GAU: 3993

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	12178246
Filing Date	2008-07-23
First Named Inventor	TORRANCE
Art Unit	3754
Examiner Name	Brinson, Patrick F.
Attorney Docket Number	SURP 13.01 REEXAM

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
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REEXAM CONTROL NUMBER	FILING OR 371 (c) DATE	PATENT NUMBER
90/020,065	12/24/2013	7581565

26328
LAW OFFICE OF DAVID MCEWING
P.O. BOX 70410
HOUSTON, TX 77270

**CONFIRMATION NO. 1470
REEXAM ASSIGNMENT NOTICE**



Date Mailed: 02/04/2014

NOTICE OF ASSIGNMENT OF REEXAMINATION REQUEST

The above-identified request for reexamination has been assigned to Art Unit 3993. All future correspondence to the proceeding should be identified by the control number listed above and directed to the assigned Art Unit.

A copy of this Notice is being sent to the latest attorney or agent of record in the patent file or to all owners of record. (See 37 CFR 1.33(c)). If the addressee is not, or does not represent, the current owner, he or she is required to forward all communications regarding this proceeding to the current owner(s). An attorney or agent receiving this communication who does not represent the current owner(s) may wish to seek to withdraw pursuant to 37 CFR 1.36 in order to avoid receiving future communications. If the address of the current owner(s) is unknown, this communication should be returned within the request to withdraw pursuant to Section 1.36.

NOTICE OF USPTO EX PARTE REEXAMINATION PATENT OWNER STATEMENT WAIVER PROGRAM

The USPTO has implemented a pilot program where, after a reexamination proceeding has been granted a filing date and before the examiner begins his or her review, the patent owner may orally waive the right to file a patent owner's statement. See *"Pilot Program for Waiver of Patent Owner's Statement in Ex Parte Reexamination Proceedings,"* 75 FR 47269 (August 5, 2010). One goal of the pilot program is to reduce the pendency of reexamination proceedings and improve the efficiency of the reexamination process.

Ordinarily when ex parte reexamination is ordered, the USPTO must wait until after the receipt of the patent owner's statement and the third party requester's reply, or after the expiration of the time period for filing the statement and reply (a period that can be as long as 5 to 6 months), before mailing a first determination of patentability. The USPTO's first determination of patentability is usually a first Office action on the merits or a Notice of Intent to Issue Reexamination Certificate (NIRC).

Under the pilot program, the patent owner's oral waiver allows the USPTO to act on the first determination of patentability immediately after determining that reexamination will be ordered, and in a suitable case issue the reexamination order and the first determination of patentability (which could be a NIRC if the claims under reexamination are confirmed) at the same time.

Benefits to the Patent Owner for participating in this pilot program include reduction in pendency.

To participate in this pilot program, Patent Owners may contact the USPTO's Central Reexamination Unit (CRU) at 571-272-7705. The USPTO will make the oral waiver of record in the reexamination file in an interview summary and a copy will be mailed to the patent owner and any third party requester.

cc: Third Party Requester(if any)
HAYNES, SOLOWAY PC
175 CANAL STREET
MANCHESTER, NH 03101

/rbell/

Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900



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United States Patent and Trademark Office
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REEXAM CONTROL NUMBER	FILING OR 371 (c) DATE	PATENT NUMBER
90/020,065	12/24/2013	7581565

HAYNES, SOLOWAY PC
175 CANAL STREET
MANCHESTER, NH 03101

**CONFIRMATION NO. 1470
REEXAMINATION REQUEST
NOTICE**



Date Mailed: 02/04/2014

NOTICE OF REEXAMINATION REQUEST FILING DATE

(Third Party Requester)

Requester is hereby notified that the filing date of the request for reexamination is 12/24/2013, the date that the filing requirements of 37 CFR § 1.510 were received.

A decision on the request for reexamination will be mailed within three months from the filing date of the request for reexamination. (See 37 CFR 1.515(a)).

A copy of the Notice is being sent to the person identified by the requester as the patent owner. Further patent owner correspondence will be the latest attorney or agent of record in the patent file. (See 37 CFR 1.33). Any paper filed should include a reference to the present request for reexamination (by Reexamination Control Number).

cc: Patent Owner
26328
LAW OFFICE OF DAVID MCEWING
P.O. BOX 70410
HOUSTON, TX 77270

/rbell/

Legal Instruments Examiner
Central Reexamination Unit 571-272-7705; FAX No. 571-273-9900

Litigation Search Report CRU 3999

Reexam Control No.

90/020,065

To: Unassigned New Request
Location: Central Reexam Unit
Art Unit: 3993
Date: 2/4/14

From: Monica A. Graves
Location: CRU 3999, MDE 4B31
Phone: (571) 272-7253

monica.graves@uspto.gov

Case Serial Number: 90/020,065

Search Notes

Litigation search for U.S. Patent Number – 7,581,565

No Litigation Found

(See Attached)

- 1) I performed a KeyCite Search in Westlaw, which retrieves all history on the patent including any litigation.
- 2) I performed a search on the patent in Lexis CourtLink for any open dockets or closed cases.
- 3) I performed a search in Lexis in the Federal Courts and Administrative Materials databases for any cases found.
- 4) I performed a search in Lexis in the IP Journal and Periodicals database for any articles on the patent.
- 5) I performed a search in Lexis in the news databases for any articles about the patent or any articles about litigation on this patent.



Date of Printing: Feb 04, 2014

KEYCITE

US PAT 7581565 TEAR CORD FOR JACKETED TUBE, (Sep 01, 2009)

History

Direct History

=> **1 TEAR CORD FOR JACKETED TUBE, US PAT 7581565, 2009 WL 2756635 (U.S. PTO Utility Sep 01, 2009)**

Patent Family

- 2 JACKETED METAL TUBE FOR USE IN E.G. HYDROCARBON PRODUCTION DOWNHOLE WELL BORE, HAS TEAR CORD PULLED BACK TO CREATE SLIT IN PROTECTIVE JACKET AND ALLOWING JACKET TO BE SEPARATED FROM TUBE THAT CONVEYS HYDRAULIC FLUID AND CHEMICALS, Derwent World Patents Legal 2009-N11053
- 3 METAL TUBE USED IN HYDROCARBON PRODUCTION DOWN HOLE ENVIRONMENT COMPRISES ENCAPSULATING PROTECTIVE JACKET AROUND SOLID WALL METAL TUBE AND MULTIPLE TEAR CORDS BETWEEN JACKET AND TUBE WHERE PANEL OF JACKET IS REMOVED AFTER PULLING THE CORDS, Derwent World Patents Legal 2010-B16666+

Prior Art (Coverage Begins 1976)

- C** 4 BUFFER TUBES WITH IMPROVED FLEXIBILITY, US PAT 7346257 Assignee: Superior Essex Communications, LP, (U.S. PTO Utility 2008)
- C** 5 CABLE OR CABLE COMPONENT COATED WITH A WATER SWELLABLE MATERIAL, US PAT APP 20030178222 (U.S. PTO Application 2003)
- C** 6 CABLE WITH DUAL LAYER JACKET, US PAT 7276664 Assignee: Belden Technologies, Inc., (U.S. PTO Utility 2007)
- C** 7 CABLE WITH DUAL LAYER JACKET, US PAT 6441308 Assignee: Cable Design Technologies, Inc., (U.S. PTO Utility 2002)
- C** 8 CABLE WITH WIRE FOR SLITTING A PROTECTIVE SHEATH AND PROCESS OF MANUFACTURING SAME, US PAT 4237337 Assignee: Telefonaktiebolaget L M Ericsson, (U.S. PTO Utility 1980)
- C** 9 COMPOSITE FIBER OPTIC AND ELECTRICAL CABLE AND ASSOCIATED FABRICATION METHOD, US PAT 5651081 Assignee: CommScope, Inc., (U.S. PTO Utility 1997)
- C** 10 COMPOSITE FIBER OPTIC AND ELECTRICAL CABLE AND ASSOCIATED FABRICATION METHOD, US PAT 5469523 Assignee: CommScope, Inc., (U.S. PTO Utility 1997)

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- 1995)
- C** 11 ELECTRIC CONDUCTOR ADAPTED FOR USE IN PROCESS INSTRUMENTATION, US PAT 4041237Assignee: Samuel Moore & Company, (U.S. PTO Utility 1977)
 - C** 12 ELECTRICAL CABLE, US PAT 5481068Assignee: Raychem Limited, (U.S. PTO Utility 1996)
 - C** 13 INSULATED CABLE WITH WIRE FOR SLITTING A PROTECTIVE SHEATH, US PAT 3748371Assignee: TELEFONAKTIEBOLAGET LM ERICSSON, (U.S. PTO Utility 1973)
 - C** 14 MULTIPLE PARALLEL CONDUCTOR, US PAT 5962945Assignee: Alcatel, (U.S. PTO Utility 1999)
 - C** 15 OPTICAL FIBRE CABLES, US PAT 4707074Assignee: Telephone Cables Limited, (U.S. PTO Utility 1987)
 - C** 16 POLYPROPYLENE-POLYETHYLENE COPOLYMER BUFFER TUBES FOR OPTICAL FIBER CABLES AND METHOD FOR MAKING THE SAME, US PAT 5574816Assignee: Alcatel NA Cable Sytems, Inc., (U.S. PTO Utility 1996)
 - C** 17 RESHEATHABLE CABLE ARMOR, US PAT 6541706Assignee: Schlumberger Technology Corporation, (U.S. PTO Utility 2003)
 - C** 18 ROBUST FIBER OPTIC CABLES, US PAT 6249629Assignee: Siecor Operations, LLC, (U.S. PTO Utility 2001)
 - C** 19 STRENGTHENED BUFFERED OPTICAL FIBER, US PAT 4893893Assignee: American Telephone and Telegraph Co.,; AT&T Technologies, Inc., (U.S. PTO Utility 1990)
 - C** 20 SYSTEM AND METHOD FOR IMPROVING CONNECTIVITY OF MULTIPLE PARALLEL CONNECTORS, US PAT APP 20040245010 (U.S. PTO Application 2004)
 - C** 21 WATER-BLOCKED TELECOMMUNICATIONS CABLES, AND WATER-BLOCKING YARNS USEFULLY EMPLOYED IN SAME, US PAT 6500541Assignee: Fil-Tech, Inc., (U.S. PTO Utility 2002)
 - C** 22 WIRE AND CABLE, US PAT 4096346Assignee: Samuel Moore and Company, (U.S. PTO Utility 1978)

90/020,065

Search Result List							
Patent	Class	Subclass	Description	Court	Docket Number	Filed	Date Retrieved

Total number of results: 0

Search Title	Patent Search 7581565 2/4/2014
Patent Number	7581565
Client Matter Code	t swann

178246 (12) 7581565 September 1, 2009

UNITED STATES PATENT AND TRADEMARK OFFICE GRANTED PATENT

7581565

Get Drawing Sheet 1 of 5
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Link to Claims Section

September 1, 2009

Tear cord for jacketed tube

INVENTOR: Torrance, Roy - 3607 Freshmeadows, Houston, Texas, United States of America (US), 77063, United States of America () ; James, Jody - 2620 Sleepy Hollow, Pearland, Texas, United States of America (US), 77581, United States of America ()

APPL-NO: 178246 (12)

FILED-DATE: July 23, 2008

GRANTED-DATE: September 1, 2009

PRIORITY: July 23, 2008 - 12178246, United States of America (US)

ASSIGNEE-AT-ISSUE:

TORRANCE ROY

JAMES JODY

LEGAL-REP: McEwing, David

PUB-TYPE: September 1, 2009 - Patent without a pre-grant publication (B1)

PUB-COUNTRY: United States of America (US)

LEGAL-STATUS:

April 15, 2013 - MAINTENANCE FEE REMINDER MAILED

April 29, 2013 - FEE PAYMENT

April 29, 2013 - SURCHARGE FOR LATE PAYMENT

April 15, 2013 - Maintenance Fee Reminder Mailed.

April 29, 2013 - Payment of Maintenance Fee, 4th Yr, Small Entity.

April 29, 2013 - Surcharge for late Payment, Small Entity.

FILING-LANG: English (EN) (ENG)

PUB-LANG: English (EN) (ENG)

US-MAIN-CL: 138#110

US-ADDL-CL: 138#127, 138#131, 138#139, 138#149, 174#102.R

CL: 138, 174

SEARCH-FLD: 138#110, 138#149, 138#114, 138#116, 138#139, 138#131, 138#133, 138#127, 385#109, 385#108, 385#110, 174#102.R, 174#36

IPC-MAIN-CL: [8] F16L 011#00 (20060101) Advanced Inventive 20090901 (A F I B H US)

PRIM-EXMR: Brinson, Patrick F

REF-CITED:

3748371, July 24, 1973, Krook et al., United States of America (US)
4041237, August 9, 1977, Stine et al., United States of America (US)
4096346, June 20, 1978, Stine et al., United States of America (US)
4237337, December 2, 1980, Serrander, United States of America (US)
4707074, November 17, 1987, Heywood, United States of America (US)
4893893, January 16, 1990, Claxton et al., United States of America (US)
5469523, November 21, 1995, Blew et al., United States of America (US)
5481068, January 2, 1996, Norden, United States of America (US)
5574816, November 12, 1996, Yang et al., United States of America (US)
5651081, July 22, 1997, Blew et al., United States of America (US)
5962945, October 5, 1999, Krenzer et al., United States of America (US)
6249629, June 19, 2001, Bringuier, United States of America (US), 385#113
6441308, August 27, 2002, Dagnon, United States of America (US)
6500541, December 31, 2002, Schoeck, United States of America (US)
6541706, April 1, 2003, McLeon, United States of America (US)
7276664, October 2, 2007, Gagnon, United States of America (US)
7346257, March 18, 2008, Mumm et al., United States of America (US), 385#141
20030178222, September 25, 2003, Moore et al., United States of America (US), 174#120.R
20040245010, December 9, 2004, Bankes et al., United States of America (US)

CORE TERMS: tube, jacket, tubing, cord, tear, protective, wire, compression, disclosure, installed, fitting, cable, jacketed, fluid, steel, bore, fiber optic, downhole, encapsulating, electrical, chemicals, layer, blade, hermetically, hydrocarbon, ethylene, pertains, sealing, housing, fiber

ENGLISH-ABST:

The disclosure pertains to installing a tear cord between a metal tube and a protective jacket. The jacketed tubes may be used in a hydrocarbon production downhole well bore. The tubes may be used to furnish hydraulic fluid or chemicals into the well bore. The contents may be pressurized or under vacuum. The jacketed tubes are hermetically sealed. The tubes, which may be 1 inch in diameter, are joined using compression fittings. Tear cords are used to facilitate removal of the protective jacket without damage to the tube surface thereby facilitating the placement of compression fittings and maintaining the integrity of the tube wall.

NO-OF-CLAIMS: 24

EXMPL-CLAIM: 1

NO-OF-FIGURES: 5

NO-DRWNG-PP: 5

SUMMARY:

BACKGROUND TO THE DISCLOSURE

[0001]1. Field of Use

[0002]The disclosure pertains to tubes used in hydrocarbon production down hole environments.

[0003]2. Related Art

[0004]Tear cords incorporated with electrical wires and fiber optic cables are known. See for example U.S. Pat. No. 5,469,523.

SUMMARY OF DISCLOSURE

[0005]The disclosure pertains to installing a tear cord between a solid wall metal tube (hereinafter "tube") and a protective jacket. The jacketed tubes may be used in a hydrocarbon production downhole well bore or in gas or water injector downhole well bores.

DRWDESC:

SUMMARY OF DRAWINGS

[0006]The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate preferred embodiments of the invention. These drawings, together with the general description of the invention given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

[0007]FIG. 1 illustrates a single tube with a protective jacket and tear cord.

[0008]FIG. 2 illustrates two tubes within a protective jacket.

[0009]FIG. 3 illustrates 3 tubes of two separate diameters. The two smaller diameter tubes have two separate jackets over an inner wire or fiber.

[0010]FIG. 4 illustrates a tear cord helically wound on a tube.

[0011]FIG. 5 illustrates a cable comprising twisted steel bumpers or stand protecting a jacketed tube with tear cords.

DETDESC:

DETAILED DESCRIPTION OF DISCLOSURE

[0012]The disclosure pertains to a tear cord used to conveniently and safely remove a protective jacket surrounding a solid wall metal tube. The combined jacket and tube may be used in downhole applications related to the production of hydrocarbons. This includes gas or water injector downhole well bores.

[0013]Referencing FIG. 1, the tubes **1** are jacketed in one or more layers **2** of hard thermoplastic rubber or similar toughened and inert material to protect the tube and contents from the heat and corrosive environment of a well bore. The jacket also provides protection during installation and other events that may occur during operation of the well. The tubing may be placed inside the well casing and outside the production pipe. The jacketed tubes may

be spoolable.

[0014]The protective jackets are difficult and dangerous to cut or slit with a knife blade. This can also result in the outer tube sealing surface being nicked or gouged. Other methods use specialized tools such as an Encapsulation Stripping Tool manufactured by Tube Tec of Stonehaven, UK. The tool comprises rotating knife blades enclosed within a housing. The blades are mechanically controlled to not contact the metal tube. The tool may be manually operated or powered with air. Another tool for removing encapsulating protective jackets is manufactured by AnTech of Exeter, UK. Both Tube Tec and AnTech supply tools with stands and hand cranks and are promoted as reducing injury to the operator stripping the encapsulation jacket.

[0015]The tube may comprise steel alloys such as but not limited to stainless steel, incoloy (an alloy comprising nickel-iron-chromium), duplex alloy, carbon steel, or galvanized carbon steel.

[0016]The tubing may vary in diameter from [one eighth] inch to in excess of 1 inch. The tube wall thickness may be between 0.016 inch (or smaller) to 0.083 inch. The tubing walls are smooth and solid. The tubing has an annular or duct-like structure **30** as illustrated in FIG. 1.

[0017]The tubing may be used to convey chemicals and hydraulic fluids. Examples of chemicals conveyed through the tubing include water based glycol mixture during the initial drilling phase. During the well production phase, hydrates and asphaltines are pumped to reduce paraffin build up. Other chemicals include low dosage hydrate inhibitors, methanol ethylene glycol, ethanol and propanol.

[0018]The contents of the tubing may be under pressure or vacuum. The tubing may also contain an electrical power, electronic data transmission or fiber optic lines.

[0019]The sealing surface of the tubing is of prime importance, i.e., the wall of the tubing is to be free from nicks and gouges. This type of damage can result from use of a knife or other sharp edge instrument to cut away the protective jacket. In addition, this work is frequently performed on the floor of a drill rig. There are stringent safety standards imposed in this work environment making use of a knife or other open blade tools problematic.

[0020]The outer surface of the tube is required to be free from nicks and gouges since the tube connections can be made using compression fittings. If a nick or gouge extends into the surface deeper than the compression achieved by the ferrule of the compression fitting, a leak pathway is created. Such a defect may result in the fitting being over tightened, resulting in further deformation of the tubing. For example, the tubing may pass through an equipment housing. The connection of the tubing with the housing will utilize a compression fitting. Deformation of the tubing surface may compromise the seal of the compression fitting intended to block fluids or contaminants from entering the housing even if the tubing wall is not breached.

[0021]Gouges and nicks may also penetrate the tube wall. For example, if the tube is conveying hydraulic fluid, there will be a pressure loss. If the tubing is conveying chemicals, there will be likely contamination of the product or well completion fluid.

[0022]In some applications, the encapsulating protective jacket needs to be cut away from the tubing metal surface to allow a connection to be made in the tubing. The tubing will be required to be hermetically sealed and requires the insertion of ferrules or sleeves as part of the mechanical connection hardware in direct contact with the metal tube surface. Therefore the integrity of the tubing diameter and good uniform sealing surface is important in making a hermetically sealed connection.

[0023]The proper handling and use of correct tools to remove the encapsulating jacket are important. Typically 6 to 12 inches of the jacket may be removed. However, on occasion, significantly greater lengths are removed, e.g., lengths in excess of 100 feet.

[0024]The encapsulating protective jacket may comprise polyamide (nylon) polyethylene, polypropylene, ethylene chlorotrifluoroethylene (Halar), engineering thermoplastic vulcanates (ETPV) or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene (Santoprene). It may also comprise perfluoroalkoxy (Teflon PFA), polyvinylidene fluoride (PVDF) or fluorinated ethylene propylene (Teflon FEP) Polyetheretherketone (PEEK), or similar material.

[0025]For these and other reasons, this disclosure teaches use of a tear cord placed between the tube and the protective jacket. This allows the worker to pull back the tear cord and thereby create a slit in the jacket. With the jacket split to the desired length, i.e. for placement of a compression fitting, the worker can manually pull away the jacket. The jacket material that has been pulled off can be cut off using scissors, side cutter pliers, or other tools not containing an open blade.

[0026]Some tubing may be protected in an individual jacket and a group of such tubes then encased into a single outer jacket. This group may comprise 2 to 5 individual tubes. The group of tubes may be protected by multiple jackets. The tubes may be of differing diameter. This outer jacket may be flat, i.e., the tubes are stacked one on top of the other, thereby minimizing the width that will be taken up in a well bore. (See for example FIG. 3.) Special tooling may be installed with the well casing or on the outer surface of the production tubing to create channels or pathways holding the tubing cable.

[0027]Referencing FIG. 1, the disclosure teaches placing a tear cord **3** adjacent to the tube **1** under the protective jacket **2**. Referencing FIG. 3, in one embodiment at least one tear cord **13**, **14**, **15** is placed between the outer flat jacket **12** and each individual tube **9**, **10**, **11**.

[0028]The tear cord (sometimes referred to as a rip cord), can be oriented along longitudinal axis of the tube or wound in a helical pattern around the tube. This helical winding pattern is illustrated in FIG. 4 and may be particularly useful for cable consisting of a single tube with a protective jacket. FIG. 4 illustrates the encapsulating protective jacket **42** surrounding the tube **43** and the tear cord **44** between the tube and the jacket. The helical pattern facilitates removal of the jacket. The angled slit created in the jacket provides an edge that can easily be pulled from the end around and away from the tubing.

[0029]The tear cord can be a metal wire or other strong material such as Kevlar, a poly-aramid synthetic fiber. A Kevlar fiber is advantageous since the multiple fiber strands compress flat against the tubing or inner jacket, thereby not distorting the circumference of the outer jacket.

[0030]An advantage of a metal wire used as a tear cord is that the wire can be heated, thereby softening the jacket material to facilitate tearing the wire through the softened jacket. It will be appreciated that the jacket material needs to plasticize so that it can be sheared with the wire at a temperature below the melting point of the metal wire. This method may advantageously use an inner jacket to shield the tubing from heat.

[0031]In another embodiment, the tear cord is installed between the tube(s) and the protective jacket in selected locations in contrast to continuously along the length of the cable. This saves the cost and weight of materials that are not needed. For example, a tear cord may be installed in the first 100 feet and last 100 feet of a length of cable installed in between the well casing and the production tubing. The manufacturing process could mark the outside of the protective jacket to indicate the presence of a tear cord. This could be as simple as a painted line.

[0032]The use of hermetically sealing compression fittings allows the interior of the tube to maintain a positive atmosphere and thereby retard the infiltration of contaminants or fluid. Such contaminants or fluid may interfere with the signal or conductivity of a fiber optic or electrical wire.

[0033]FIG. 1 illustrates a single tube **1** with a protective jacket. The jacket **2** is illustrated. Also

illustrated is the tear cord **3** which is installed between the jacket and the tube.

[0034]FIG. 2 illustrates a pair of tubes **4, 5** encased by a single jacket **6**. There are two tear cords **7, 8**. Each tear cord is associated with a single tube.

[0035]FIG. 3 illustrates a 3 tube flat pack. The tubes **9, 10, 11**, are encased in a rectangular jacket **12**. There are individual tear cords **13, 14, 15** installed between each tube **9, 10, 11** and the surrounding jacket **12**. One tube **11** is protected by two separate jackets **12, 23**. In this embodiment, separate tear cords **15, 22** are installed for each jacket layer.

[0036]Continuing with FIG. 3, the inner coverings within the smaller diameter tubes **9, 10** can provide mechanical support **16** and the innermost layer providing electrical insulation **18** for the wire or fiber optic cable **20, 21**. These additional layers may be, for example, foam, or polyethylene or polypropylene. As indicated, the inner fiber may be a fiber optic cable or it may be a wire carrying electrical power or a data transmission line.

[0037]FIG. 4 illustrates a single tube **43** with a tear cord **44** wound helically beneath a protective jacket **42**. It will be appreciated that the helically wound embodiment would work with other tube and jacketing configurations, including the double tube configuration illustrated in FIG. 2 and the triple tube configuration of FIG. 3.

[0038]FIG. 5 illustrates 2 jacketed tubes **33, 34** combined with two strands of steel rope or strand **31, 32**. The steel rope may be dimensioned to provide protection to the tube against crushing forces as well as weight support of the tube in a vertical downhole environment. Also illustrated are tear cords **38, 39, 40, 41** installed adjacent to the tube and to each steel rope. Also illustrated one tube **34** containing a wire or fiber optic cable surrounded by insulation **36** and structural support **35**. It will be appreciated that both layers, installed inside the tube, may act as insulators.

[0039]In addition, this specification is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the manner of carrying out the invention. It is to be understood that the forms of the invention herein shown and described are to be taken as the presently preferred embodiments. As already stated, various changes may be made in the shape, size and arrangement of components or adjustments made in the steps of the method without departing from the scope of this invention. For example, equivalent elements may be substituted for those illustrated and described herein and certain features of the invention may be utilized independently of the use of other features, all as would be apparent to one skilled in the art after having the benefit of this description of the invention.

[0040]While specific embodiments have been illustrated and described, numerous modifications are possible without departing from the spirit of the invention, and the scope of protection is only limited by the scope of the accompanying claims.

ENGLISH-CLAIMS:

Return to Top of Patent

The invention claimed is:

1. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube having an outer sealing surface and a tear cord between the inside diameter of said jacket and the outer surface of said tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

2. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube, wherein the tube conveys hydraulic fluid, and a tear cord located between the

inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

3. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube, wherein the tube conveys chemicals, and a tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

4. The tube of claim 1 wherein the jacket comprises polyamide, polyethylene, ethylene chlorotrifluoroethylene or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene.

5. The tube of claim 1 wherein the jacket comprises engineered thermoplastic vulcanates, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.

6. The tube of claim 1 further comprising a tear cord made of poly-aramid fiber.

7. The tube of claim 1 wherein the solid wall metal tube comprises incoloy, stainless steel, carbon steel, or galvanized carbon steel.

8. The tube of claim 1 further comprising a second inner jacket surrounding the tube wherein the second jacket is located between the outer surface of the tube and the inner diameter of the first jacket.

9. The tube of claim 1 further comprising a tear cord made of metal.

10. A jacketed metal tube wherein a first protective jacket surrounding a smooth solid wall metal tube, and a tear cord is helically wound around the tube and the tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

11. The tube of claim 1 further comprising a tear cord placed at a selected location on a length of the tube.

12. A jacketed metal tube comprising one or more steel ropes within one or more protective jackets surrounding a smooth solid wall tube and a tear cord is positioned next to each steel rope and tube wherein the rope has the same axis of orientation as the tube and is positioned adjacent to the tube within the jacket whereby each tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the steel rope and metal tube without damage to the metal tube surface.

13. The tube of claim 1 further comprising a jacket of one or more materials of a group consisting of polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride and fluorinated ethylene propylene wherein the material is extruded onto the tube without radiation curing.

14. An encapsulated cable comprising a first protective jacket surrounding a plurality of solid wall metal tubes, and a plurality of tear cords with one tear cord located between the outside surface of each said tube and the inside diameter of said jacket whereby each tear cord is oriented longitudinally along the length of a tube, each tube further comprising smooth walls with sealing surfaces for attachment of compression fittings for performance in a negative or positive internal pressure environment and whereby the tear cord can be pulled back to create a slit in the protective jacket to allow the protective jacket to be separated from one or more

metal tubes without damage to a metal tube sealing surface.

15. The cable of claim 14 further comprising at least one tube containing a fiber optic cable, electrical wire or data communication cable.

16. The cable of claim 14 further comprising at least one tube suitable for installation of compression fittings to convey hydraulic fluid.

17. The cable of claim 14 further comprising at least one tube suitable for installation of compression fittings to convey chemicals.

18. A method of conveying liquids into a well bore comprising:

- -
 - i. placing a tear cord adjacent to an outer sealing surface of a first spoolable, smooth, solid wall metal tube;
- -
 - ii. placing a protective jacket around the metal tube and the tear cord; and
- -
 - iii. pulling the tear cord back to create a slit in the protective jacket to allow the protective jacket to be separated from the metal tube without damage to a metal tube surface.

19. The method of claim 18 further comprising placing a second tear cord adjacent to the outer diameter of the protective jacket and covering the first jacket with a second jacket.

20. The method of claim 18 further comprising placing the tear cord on the outer surface of the tube at a selected location.

21. A cable comprising a first encapsulating protective jacket surrounding at least one solid wall metal tube, and at least one tear cord between the said tube and the jacket whereby the tear cord can be pulled back to create a slit in the protective jacket to allow the protective jacket to be separated from one or more metal tubes without damage to a metal tube surface and the cable further comprising at least one compression fitting.

22. The tube of claim 8 further comprising a second inner jacket surrounding the tube and said second jacket positioned between the first protective jacket and said metal tube, and a first tear cord positioned between the inner diameter of the first jacket and the outer diameter of the second jacket and a second tear cord positioned between the inner diameter of the second jacket and the outer surface of the metal tube.

23. The method of claim 18 further comprising jacketing the metal tube and tear cord with polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.

24. The jacketed metal tube of claim 1 further comprising a fiber optic cable, electrical wire or data communication cable.

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LENGTH: 272 words

HEADLINE: PTO (Patent and Trademark Office) Litigation Center Report - January 6, 2014

BYLINE: Sterne, Kessler, Goldstein Fox P.L.L.C.

BODY:

Jan 09, 2014 (National Law Review:<http://www.natlawreview.com> Delivered by Newstex)
PTO Litigation Center[1]
Listed below are all new filings before PTAB of requests for inter partes review (IPR) and covered business methods review (CBM). Also listed are any newly-posted requests for ex parte reexamination at the USPTO. This listing is current as of 9:45 AM on Monday, January 6, 2014.

New IPR Requests

Trial Number - IPR2014-00319

Filing Date - 1/3/2014

Patent # - 7,177,798(different grounds from IPR2014-00320)

Title - NATURAL LANGUAGE INTERFACE USING CONSTRAINED INTERMEDIATE DICTIONARY OF RESULTS

Assignee - DYNAMIC ADVANCES, LLC

Petitioner - Apple Inc.

Status - Pending

Tech Center - 2600

Trial Number - IPR2014-00320

Filing Date - 1/3/2014

Patent # - 7,177,798 (different grounds from IPR2014-00319)

Title - NATURAL LANGUAGE INTERFACE USING CONSTRAINED INTERMEDIATE DICTIONARY OF RESULTS

Assignee - DYNAMIC ADVANCES, LLC

Petitioner - Apple Inc.

Status - Pending

Tech Center - 2600

Trial Number - IPR2014-00321

Filing Date - 1/3/2014

Patent # - 7,806,896

Title - KNEE ARTHROPLASTY METHOD

Assignee - BONUTTI SKELETAL INNOVATIONS LLC

Petitioner - ZIMMER HOLDINGS, INC.

Status - Pending

Tech Center - 3700

New CBM Review Requests

There have been no new requests for CBM review since the last report.

Newly-Posted Reexam Requests

Control # - 90/020,065

Date - 12/24/2013

Patent # - **7,581,565**

Inventor - TORRANCE, Roy et al.

Assignee - TORRANCE, Roy et al.

Title - TEAR CORD FOR JACKETED TUBE

Co-pending Litigation - No co-pending litigation provided.

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[1]: <http://www.natlawreview.com/author/pto-litigation-center>

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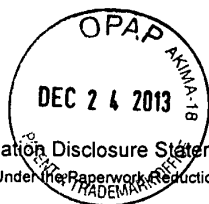
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		12178246
	Filing Date		2008-07-23
	First Named Inventor	TORRANCE	
	Art Unit	3754	
	Examiner Name	Brinson, Patrick F.	
	Attorney Docket Number	SURP 13.01 REEXAM	

U.S.PATENTS						
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear
	1	7113680	B2	2006-09-26	Hurley et al	
	2	6545222	B2	2003-04-08	Yokokawa et al	
	3	5524937		1996-06-11	Sides, III et al	
	4	4091843		1978-05-30	Mikes et al	
	5	5212755		1993-05-18	Holmberg	
	6	5268983		1993-12-07	Tatarka et al	
	7	3326583		1967-06-20	Guarnaschelli	
	8	6236790	B1	2001-05-22	Okada et al	
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	1	20010029814	A1	2001-10-18	Tiano		
	2	20020085820	A1	2002-07-04	Gaillard et al		
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(Not for submission under 37 CFR 1.99)

Application Number	12178246
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Attorney Docket Number	SURP 13.01 REEXAM

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	Filing Date	2008-07-23
	First Named Inventor	TORRANCE
	Art Unit	3754
	Examiner Name	Brinson, Patrick F.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.



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(12) **United States Patent**
Torrance et al.

(10) **Patent No.:** **US 7,581,565 B1**
(45) **Date of Patent:** **Sep. 1, 2009**

(54) **TEAR CORD FOR JACKETED TUBE**

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(*) Notice: Subject to any disclaimer, the term of this
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U.S.C. 154(b) by 0 days.

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(22) Filed: **Jul. 23, 2008**

(51) Int. Cl.
F16L 11/00 (2006.01)

(52) U.S. Cl. **138/110; 138/149; 138/139;**
138/131; 138/127; 174/102 R

(58) **Field of Classification Search** **138/110,**
138/149, 114, 116, 139, 131, 133, 127; 385/109,
385/108, 110; 174/102 R, 36
See application file for complete search history.

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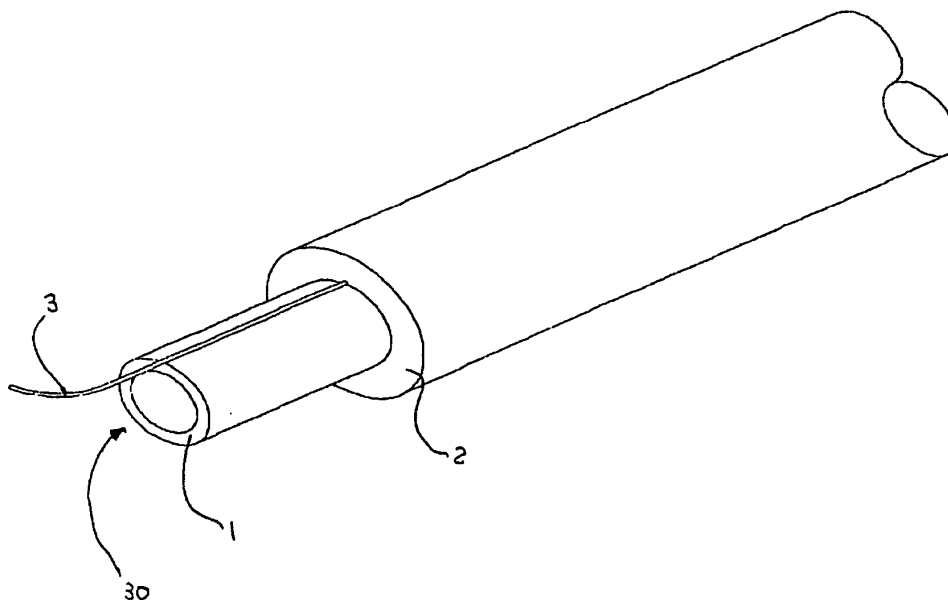
Primary Examiner—Patrick F Brinson

(74) *Attorney, Agent, or Firm*—David McEwing

(57) **ABSTRACT**

The disclosure pertains to installing a tear cord between a metal tube and a protective jacket. The jacketed tubes may be used in a hydrocarbon production downhole well bore. The tubes may be used to furnish hydraulic fluid or chemicals into the well bore. The contents may be pressurized or under vacuum. The jacketed tubes are hermetically sealed. The tubes, which may be 1 inch in diameter, are joined using compression fittings. Tear cords are used to facilitate removal of the protective jacket without damage to the tube surface thereby facilitating the placement of compression fittings and maintaining the integrity of the tube wall.

24 Claims, 5 Drawing Sheets



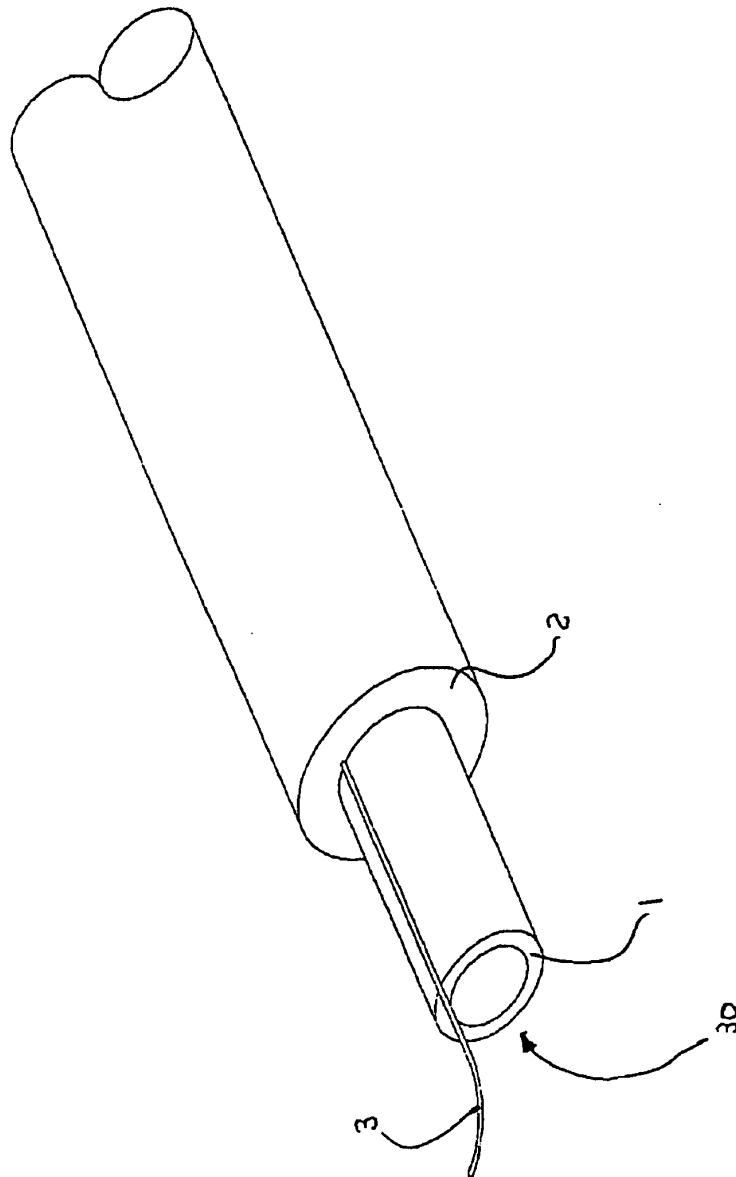


Figure 1

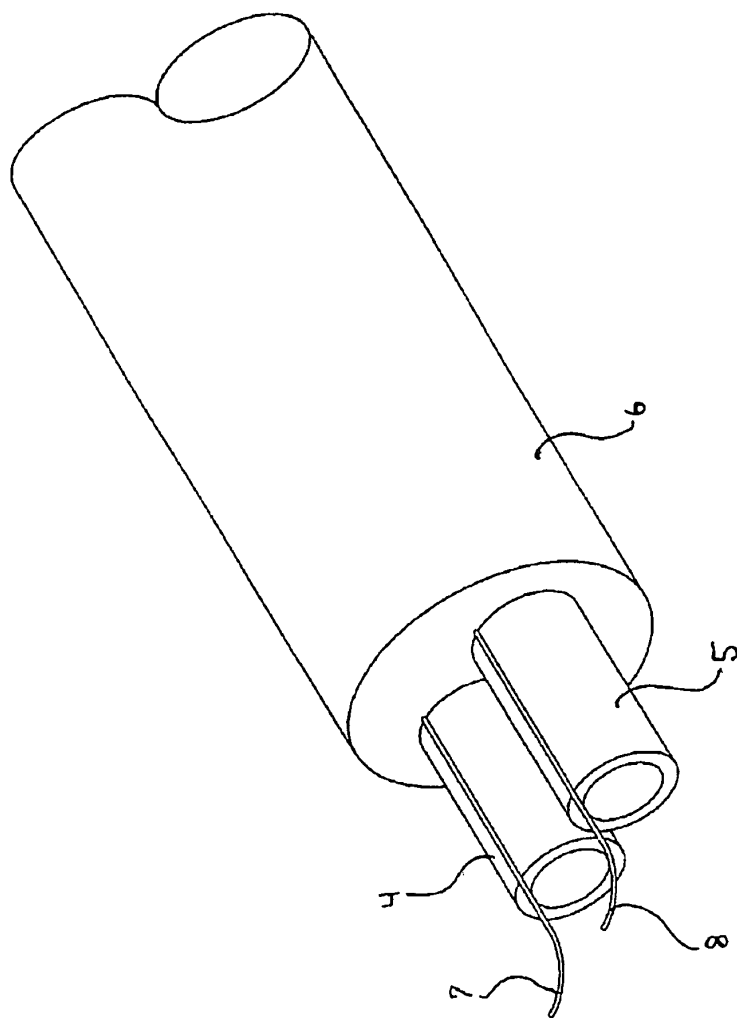


Figure 2

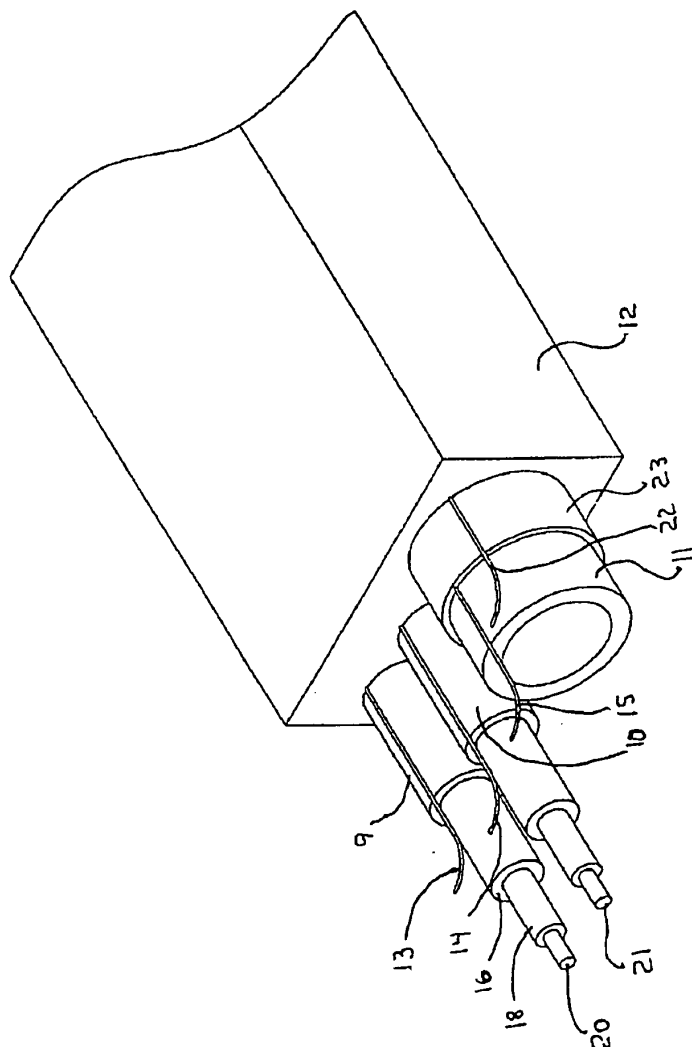


Figure 3

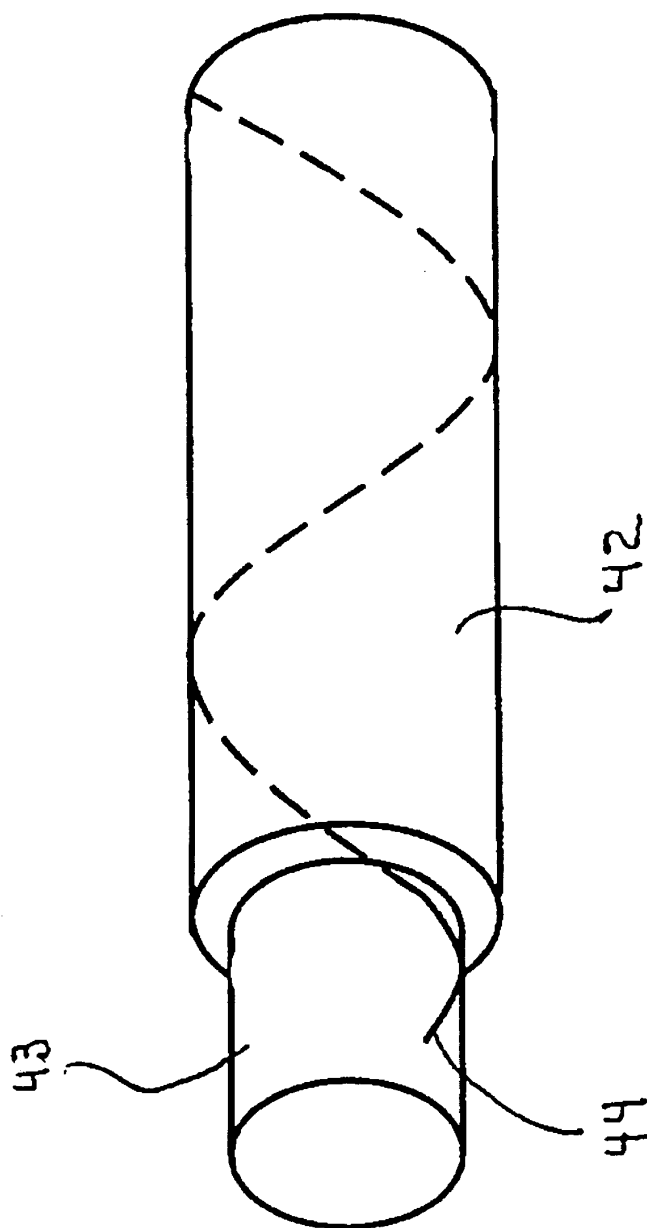


Figure 4

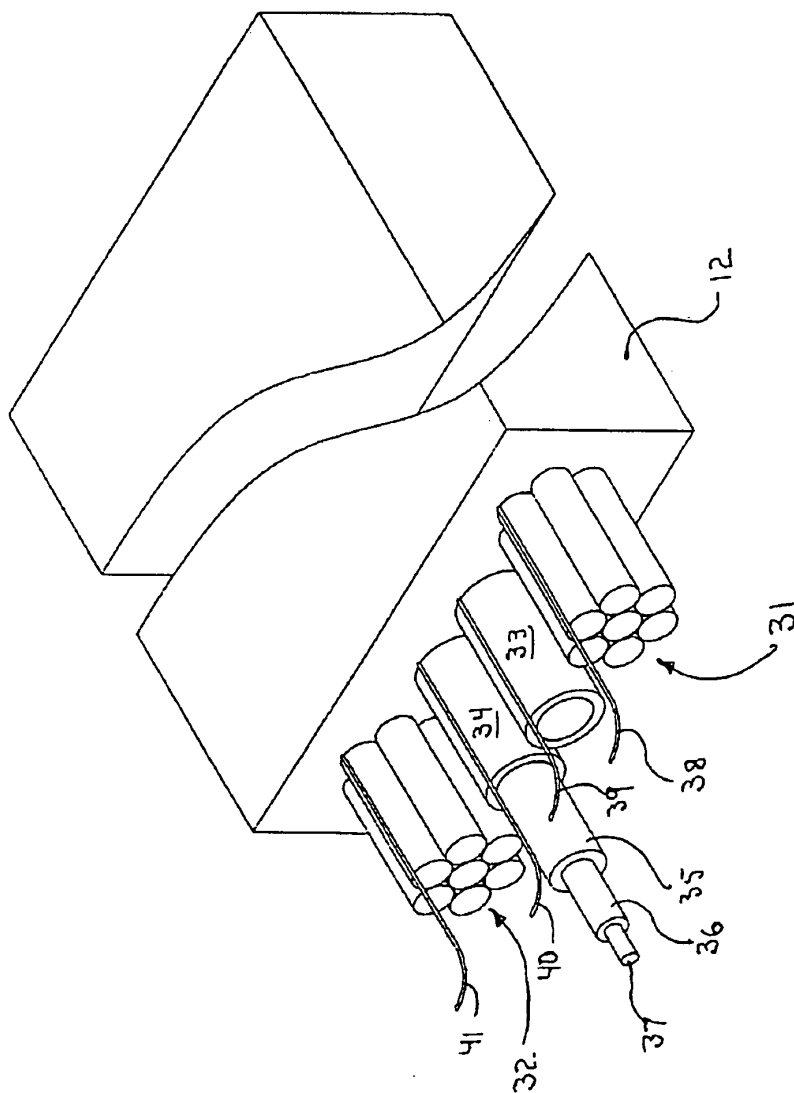


Figure 5

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TEAR CORD FOR JACKETED TUBE**BACKGROUND TO THE DISCLOSURE****1. Field of Use**

The disclosure pertains to tubes used in hydrocarbon production down hole environments.

2. Related Art

Tear cords incorporated with electrical wires and fiber optic cables are known. See for example U.S. Pat. No. 5,469,523.

SUMMARY OF DISCLOSURE

The disclosure pertains to installing a tear cord between a solid wall metal tube (hereinafter "tube") and a protective jacket. The jacketed tubes may be used in a hydrocarbon production downhole well bore or in gas or water injector downhole well bores.

SUMMARY OF DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate preferred embodiments of the invention. These drawings, together with the general description of the invention given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 illustrates a single tube with a protective jacket and tear cord.

FIG. 2 illustrates two tubes within a protective jacket.

FIG. 3 illustrates 3 tubes of two separate diameters. The two smaller diameter tubes have two separate jackets over an inner wire or fiber.

FIG. 4 illustrates a tear cord helically wound on a tube.

FIG. 5 illustrates a cable comprising twisted steel bumpers or stand protecting a jacketed tube with tear cords.

DETAILED DESCRIPTION OF DISCLOSURE

The disclosure pertains to a tear cord used to conveniently and safely remove a protective jacket surrounding a solid wall metal tube. The combined jacket and tube may be used in downhole applications related to the production of hydrocarbons. This includes gas or water injector downhole well bores.

Referencing FIG. 1, the tubes 1 are jacketed in one or more layers 2 of hard thermoplastic rubber or similar toughened and inert material to protect the tube and contents from the heat and corrosive environment of a well bore. The jacket also provides protection during installation and other events that may occur during operation of the well. The tubing may be placed inside the well casing and outside the production pipe. The jacketed tubes may be spoolable.

The protective jackets are difficult and dangerous to cut or slit with a knife blade. This can also result in the outer tube sealing surface being nicked or gouged. Other methods use specialized tools such as an Encapsulation Stripping Tool manufactured by Tube Tec of Stonehaven, UK. The tool comprises rotating knife blades enclosed within a housing. The blades are mechanically controlled to not contact the metal tube. The tool may be manually operated or powered with air. Another tool for removing encapsulating protective jackets is manufactured by AnTech of Exeter, UK. Both Tube Tec and AnTech supply tools with stands and hand cranks and are promoted as reducing injury to the operator stripping the encapsulation jacket.

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The tube may comprise steel alloys such as but not limited to stainless steel, incoloy (an alloy comprising nickel-iron-chromium), duplex alloy, carbon steel, or galvanized carbon steel.

The tubing may vary in diameter from 1/8 inch to in excess of 1 inch. The tube wall thickness may be between 0.016 inch (or smaller) to 0.083 inch. The tubing walls are smooth and solid. The tubing has an annular or duct-like structure 30 as illustrated in FIG. 1.

The tubing may be used to convey chemicals and hydraulic fluids. Examples of chemicals conveyed through the tubing include water based glycol mixture during the initial drilling phase. During the well production phase, hydrates and asphaltines are pumped to reduce paraffin build up. Other chemicals include low dosage hydrate inhibitors, methanol ethylene glycol, ethanol and propanol.

The contents of the tubing may be under pressure or vacuum. The tubing may also contain an electrical power, electronic data transmission or fiber optic lines.

The sealing surface of the tubing is of prime importance, i.e., the wall of the tubing is to be free from nicks and gouges. This type of damage can result from use of a knife or other sharp edge instrument to cut away the protective jacket. In addition, this work is frequently performed on the floor of a drill rig. There are stringent safety standards imposed in this work environment making use of a knife or other open blade tools problematic.

The outer surface of the tube is required to be free from nicks and gouges since the tube connections can be made using compression fittings. If a nick or gouge extends into the surface deeper than the compression achieved by the ferrule of the compression fitting, a leak pathway is created. Such a defect may result in the fitting being over tightened, resulting in further deformation of the tubing. For example, the tubing may pass through an equipment housing. The connection of the tubing with the housing will utilize a compression fitting. Deformation of the tubing surface may compromise the seal of the compression fitting intended to block fluids or contaminants from entering the housing even if the tubing wall is not breached.

Gouges and nicks may also penetrate the tube wall. For example, if the tube is conveying hydraulic fluid, there will be a pressure loss. If the tubing is conveying chemicals, there will be likely contamination of the product or well completion fluid.

In some applications, the encapsulating protective jacket needs to be cut away from the tubing metal surface to allow a connection to be made in the tubing. The tubing will be required to be hermetically sealed and requires the insertion of ferrules or sleeves as part of the mechanical connection hardware in direct contact with the metal tube surface. Therefore the integrity of the tubing diameter and good uniform sealing surface is important in making a hermetically sealed connection.

The proper handling and use of correct tools to remove the encapsulating jacket are important. Typically 6 to 12 inches of the jacket may be removed. However, on occasion, significantly greater lengths are removed, e.g., lengths in excess of 100 feet.

The encapsulating protective jacket may comprise polyamide (nylon) polyethylene, polypropylene, ethylene chlorotrifluoroethylene (Halar), engineering thermoplastic vulcanates (ETPV) or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene (Santoprene). It may also comprise perfluoroalkoxy (Te-

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flon PFA), polyvinylidene fluoride (PVDF) or fluorinated ethylene propylene (Teflon FEP) Polyetheretherketone (PEEK), or similar material.

For these and other reasons, this disclosure teaches use of a tear cord placed between the tube and the protective jacket. This allows the worker to pull back the tear cord and thereby create a slit in the jacket. With the jacket split to the desired length, i.e. for placement of a compression fitting, the worker can manually pull away the jacket. The jacket material that has been pulled off can be cut off using scissors, side cutter pliers, or other tools not containing an open blade.

Some tubing may be protected in an individual jacket and a group of such tubes then encased into a single outer jacket. This group may comprise 2 to 5 individual tubes. The group of tubes may be protected by multiple jackets. The tubes may be of differing diameter. This outer jacket may be flat, i.e., the tubes are stacked one on top of the other, thereby minimizing the width that will be taken up in a well bore. (See for example FIG. 3.) Special tooling may be installed with the well casing or on the outer surface of the production tubing to create channels or pathways holding the tubing cable.

Referencing FIG. 1, the disclosure teaches placing a tear cord 3 adjacent to the tube 1 under the protective jacket 2. Referencing FIG. 3, in one embodiment at least one tear cord 13, 14, 15 is placed between the outer flat jacket 12 and each individual tube 9, 10, 11.

The tear cord (sometimes referred to as a rip cord), can be oriented along longitudinal axis of the tube or wound in a helical pattern around the tube. This helical winding pattern is illustrated in FIG. 4 and may be particularly useful for cable consisting of a single tube with a protective jacket. FIG. 4 illustrates the encapsulating protective jacket 42 surrounding the tube 43 and the tear cord 44 between the tube and the jacket. The helical pattern facilitates removal of the jacket. The angled slit created in the jacket provides an edge that can easily be pulled from the end around and away from the tubing.

The tear cord can be a metal wire or other strong material such as Kevlar, a poly-aramid synthetic fiber. A Kevlar fiber is advantageous since the multiple fiber strands compress flat against the tubing or inner jacket, thereby not distorting the circumference of the outer jacket.

An advantage of a metal wire used as a tear cord is that the wire can be heated, thereby softening the jacket material to facilitate tearing the wire through the softened jacket. It will be appreciated that the jacket material needs to plasticize so that it can be sheared with the wire at a temperature below the melting point of the metal wire. This method may advantageously use an inner jacket to shield the tubing from heat.

In another embodiment, the tear cord is installed between the tube(s) and the protective jacket in selected locations in contrast to continuously along the length of the cable. This saves the cost and weight of materials that are not needed. For example, a tear cord may be installed in the first 100 feet and last 100 feet of a length of cable installed in between the well casing and the production tubing. The manufacturing process could mark the outside of the protective jacket to indicate the presence of a tear cord. This could be as simple as a painted line.

The use of hermetically sealing compression fittings allows the interior of the tube to maintain a positive atmosphere and thereby retard the infiltration of contaminants or fluid. Such contaminants or fluid may interfere with the signal or conductivity of a fiber optic or electrical wire.

FIG. 1 illustrates a single tube 1 with a protective jacket. The jacket 2 is illustrated. Also illustrated is the tear cord 3 which is installed between the jacket and the tube.

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FIG. 2 illustrates a pair of tubes 4, 5 encased by a single jacket 6. There are two tear cords 7, 8. Each tear cord is associated with a single tube.

FIG. 3 illustrates a 3 tube flat pack. The tubes 9, 10, 11, are encased in a rectangular jacket 12. There are individual tear cords 13, 14, 15 installed between each tube 9, 10, 11 and the surrounding jacket 12. One tube 11 is protected by two separate jackets 12, 23. In this embodiment, separate tear cords 15, 22 are installed for each jacket layer.

Continuing with FIG. 3, the inner coverings within the smaller diameter tubes 9, 10 can provide mechanical support 16 and the innermost layer providing electrical insulation 18 for the wire or fiber optic cable 20, 21. These additional layers may be, for example, foam, or polyethylene or polypropylene. As indicated, the inner fiber may be a fiber optic cable or it may be a wire carrying electrical power or a data transmission line.

FIG. 4 illustrates a single tube 43 with a tear cord 44 wound helically beneath a protective jacket 42. It will be appreciated that the helically wound embodiment would work with other tube and jacketing configurations, including the double tube configuration illustrated in FIG. 2 and the triple tube configuration of FIG. 3.

FIG. 5 illustrates 2 jacketed tubes 33, 34 combined with two strands of steel rope or strand 31, 32. The steel rope may be dimensioned to provide protection to the tube against crushing forces as well as weight support of the tube in a vertical downhole environment. Also illustrated are tear cords 38, 39, 40, 41 installed adjacent to the tube and to each steel rope. Also illustrated one tube 34 containing a wire or fiber optic cable surrounded by insulation 36 and structural support 35. It will be appreciated that both layers, installed inside the tube, may act as insulators.

In addition, this specification is to be construed as illustrative only and is for the purpose of teaching those skilled in the art the manner of carrying out the invention. It is to be understood that the forms of the invention herein shown and described are to be taken as the presently preferred embodiments. As already stated, various changes may be made in the shape, size and arrangement of components or adjustments made in the steps of the method without departing from the scope of this invention. For example, equivalent elements may be substituted for those illustrated and described herein and certain features of the invention may be utilized independently of the use of other features, all as would be apparent to one skilled in the art after having the benefit of this description of the invention.

While specific embodiments have been illustrated and described, numerous modifications are possible without departing from the spirit of the invention, and the scope of protection is only limited by the scope of the accompanying claims.

The invention claimed is:

1. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube having an outer sealing surface and a tear cord between the inside diameter of said jacket and the outer surface of said tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

2. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube, wherein the tube conveys hydraulic fluid, and a tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a

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slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

3. A jacketed metal tube comprising a first protective jacket surrounding a smooth solid wall metal tube, wherein the tube conveys chemicals, and a tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

4. The tube of claim 1 wherein the jacket comprises polyamide, polyethylene, ethylene chlorotrifluoroethylene or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene.

5. The tube of claim 1 wherein the jacket comprises engineered thermoplastic vulcanates, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.

6. The tube of claim 1 further comprising a tear cord made of poly-aramid fiber.

7. The tube of claim 1 wherein the solid wall metal tube comprises incoloy, stainless steel, carbon steel, or galvanized carbon steel.

8. The tube of claim 1 further comprising a second inner jacket surrounding the tube wherein the second jacket is located between the outer surface of the tube and the inner diameter of the first jacket.

9. The tube of claim 1 further comprising a tear cord made of metal.

10. A jacketed metal tube wherein a first protective jacket surrounding a smooth solid wall metal tube, and a tear cord is helically wound around the tube and the tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube whereby the tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.

11. The tube of claim 1 further comprising a tear cord placed at a selected location on a length of the tube.

12. A jacketed metal tube comprising one or more steel ropes within one or more protective jackets surrounding a smooth solid wall tube and a tear cord is positioned next to each steel rope and tube wherein the rope has the same axis of orientation as the tube and is positioned adjacent to the tube within the jacket whereby each tear cord can be pulled back to create a slit in the protective jacket and to allow the protective jacket to be separated from the steel rope and metal tube without damage to the metal tube surface.

13. The tube of claim 1 further comprising a jacket of one or more materials of a group consisting of polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride and fluorinated ethylene propylene wherein the material is extruded onto the tube without radiation curing.

14. An encapsulated cable comprising a first protective jacket surrounding a plurality of solid wall metal tubes, and a plurality of tear cords with one tear cord located between the

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outside surface of each said tube and the inside diameter of said jacket whereby each tear cord is oriented longitudinally along the length of a tube, each tube further comprising smooth walls with sealing surfaces for attachment of compression fittings for performance in a negative or positive internal pressure environment and whereby the tear cord can be pulled back to create a slit in the protective jacket to allow the protective jacket to be separated from one or more metal tubes without damage to a metal tube sealing surface.

15. The cable of claim 14 further comprising at least one tube containing a fiber optic cable, electrical wire or data communication cable.

16. The cable of claim 14 further comprising at least one tube suitable for installation of compression fittings to convey hydraulic fluid.

17. The cable of claim 14 further comprising at least one tube suitable for installation of compression fittings to convey chemicals.

18. A method of conveying liquids into a well bore comprising:

- i. placing a tear cord adjacent to an outer sealing surface of a first spoolable, smooth, solid wall metal tube;
- ii. placing a protective jacket around the metal tube and the tear cord; and
- iii. pulling the tear cord back to create a slit in the protective jacket to allow the protective jacket to be separated from the metal tube without damage to a metal tube surface.

19. The method of claim 18 further comprising placing a second tear cord adjacent to the outer diameter of the protective jacket and covering the first jacket with a second jacket.

20. The method of claim 18 further comprising placing the tear cord on the outer surface of the tube at a selected location.

21. A cable comprising a first encapsulating protective jacket surrounding at least one solid wall metal tube, and at least one tear cord between the said tube and the jacket whereby the tear cord can be pulled back to create a slit in the protective jacket to allow the protective jacket to be separated from one or more metal tubes without damage to a metal tube surface and the cable further comprising at least one compression fitting.

22. The tube of claim 8 further comprising a second inner jacket surrounding the tube and said second jacket positioned between the first protective jacket and said metal tube, and a first tear cord positioned between the inner diameter of the first jacket and the outer diameter of the second jacket and a second tear cord positioned between the inner diameter of the second jacket and the outer surface of the metal tube.

23. The method of claim 18 further comprising jacketing the metal tube and tear cord with polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.

24. The jacketed metal tube of claim 1 further comprising a fiber optic cable, electrical wire or data communication cable.

* * * * *



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(12) **United States Patent**
Hurley et al.

(10) **Patent No.:** **US 7,113,680 B2**
(45) **Date of Patent:** **Sep. 26, 2006**

(54) **HIGH DENSITY FIBER OPTIC CABLE**

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(73) Assignee: **Corning Cable Systems, LLC**,
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(*) Notice: Subject to any disclaimer, the term of this
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(21) Appl. No.: **11/125,375**

(22) Filed: **May 9, 2005**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 10/005,325, filed on
Nov. 12, 2001, now Pat. No. 6,901,191.

(51) **Int. Cl.**
G02B 6/44 (2006.01)

(52) **U.S. Cl.** **385/113; 385/112**

(58) **Field of Classification Search** **385/109-114**
See application file for complete search history.

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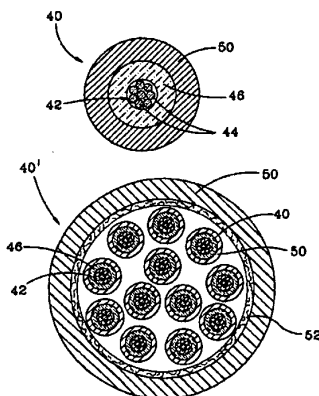
Assistant Examiner—Thomas R. Artman

(74) *Attorney, Agent, or Firm*—Michael E. Carroll, Jr.

(57) **ABSTRACT**

A fiber optic cable includes at least one at least one bundle having a plurality of non-tight buffered optical fibers and a binder element for maintaining the integrity of the bundle. The binder element may be, for example, a binder thread. The fiber optic cable may exclude a grease or a grease-like composition being in contact with the at least one bundle for filling interstices of the cable thereby blocking water from flowing through the cable. The fiber optic cable also includes a separation layer for inhibiting adhesion between the bundles of optical fibers and the cable jacket. In another embodiment, a fiber optic cable includes a plurality of optical fibers and a binder element forming at least one bundle. The at least one bundle is surrounded by an armor layer and the fiber optic cable excludes a cable jacket within the armor layer.

22 Claims, 6 Drawing Sheets



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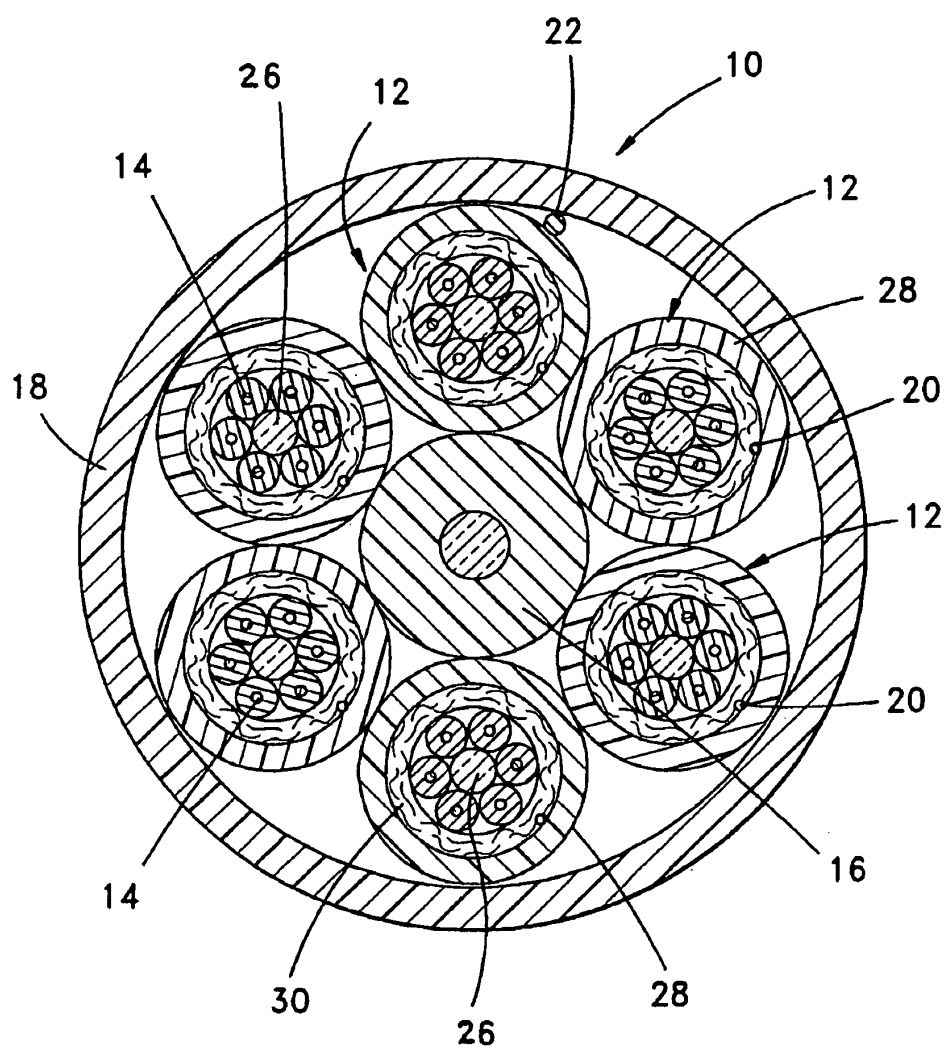
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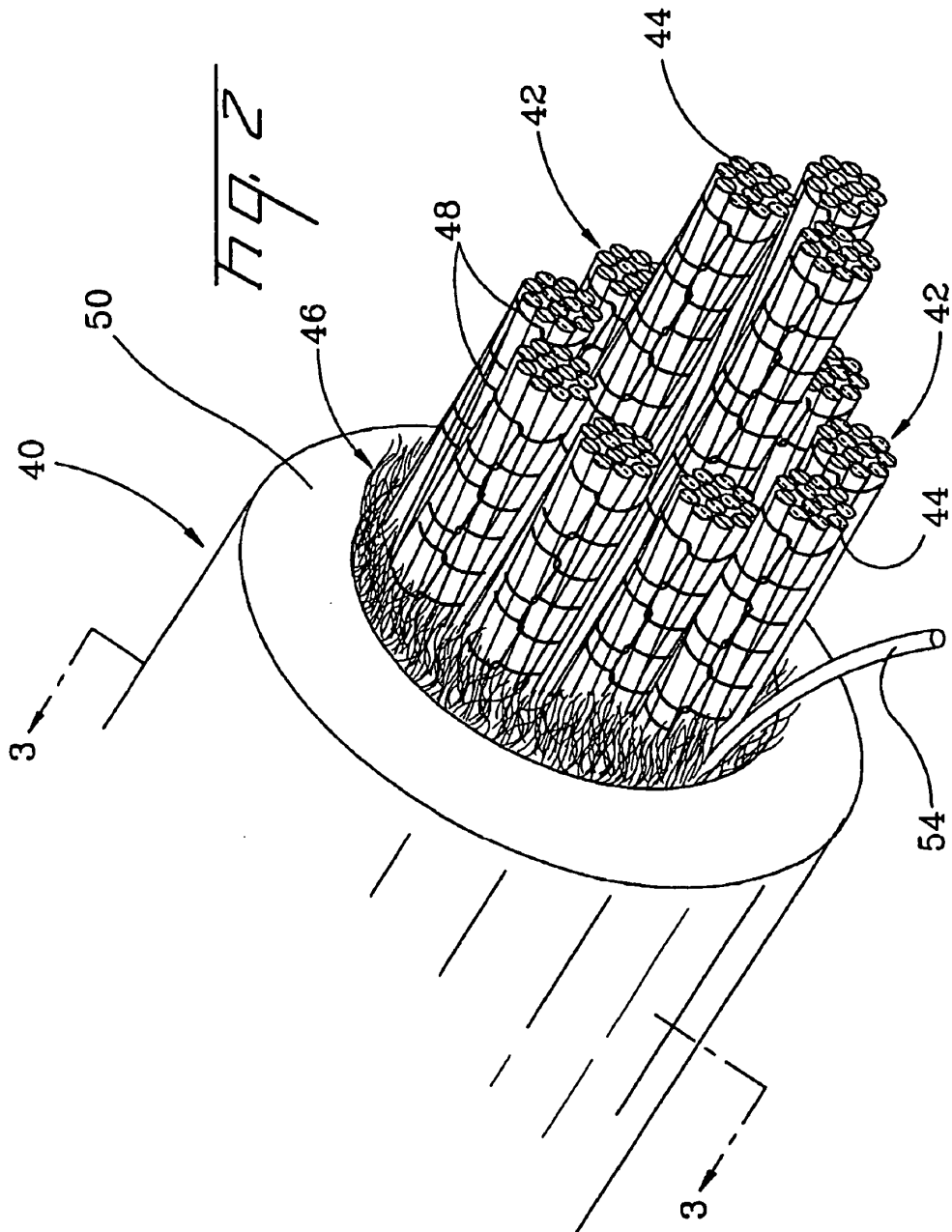
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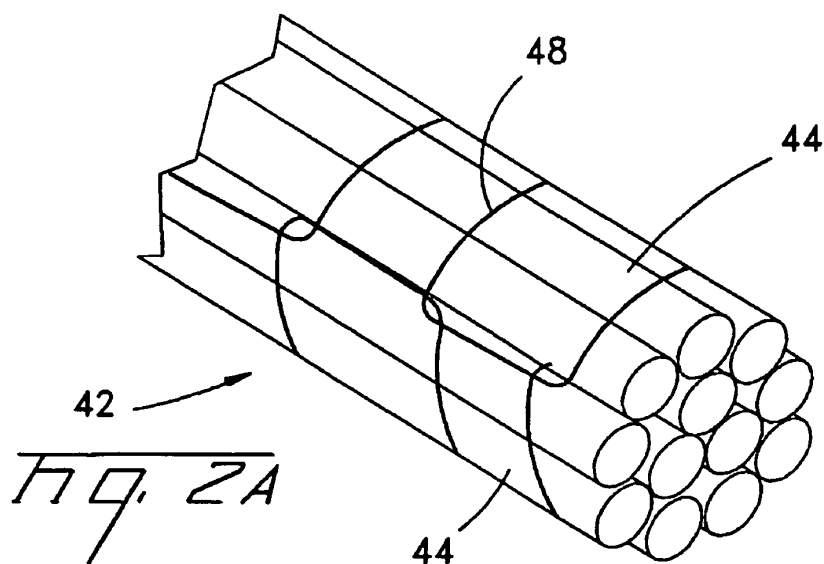
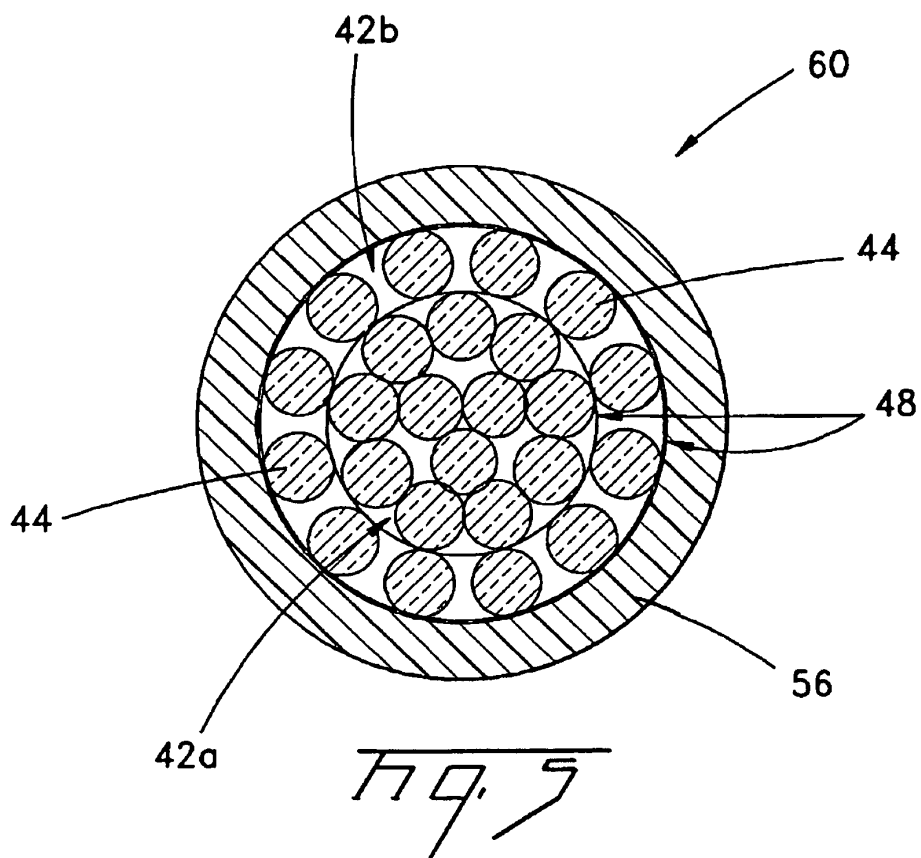
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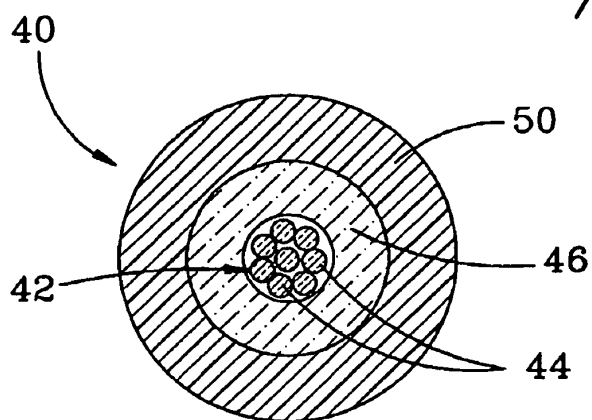
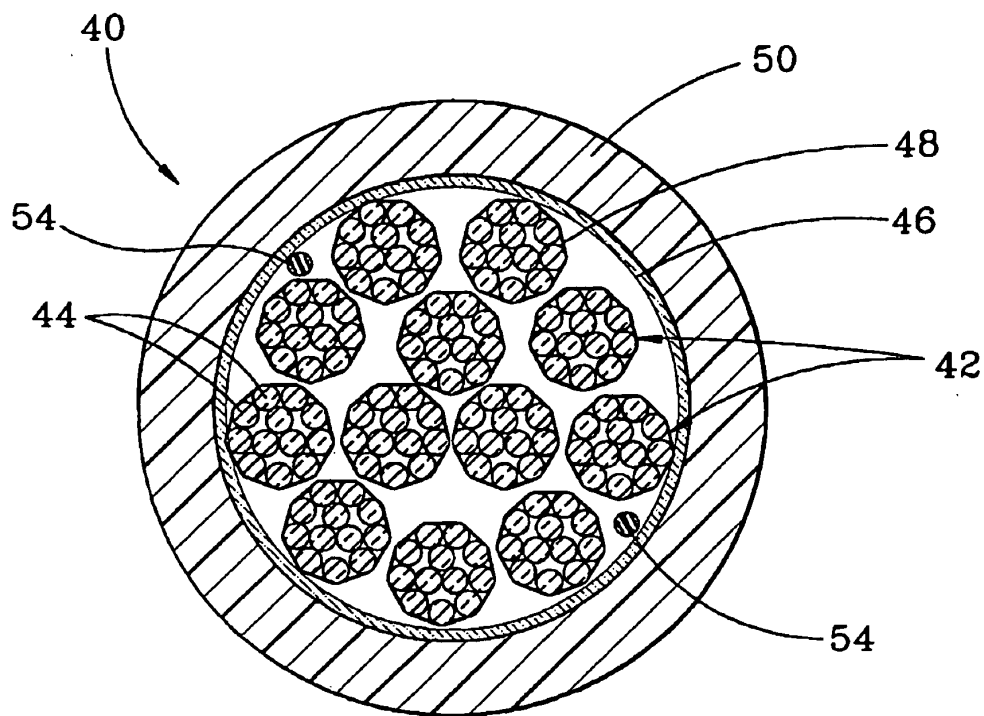


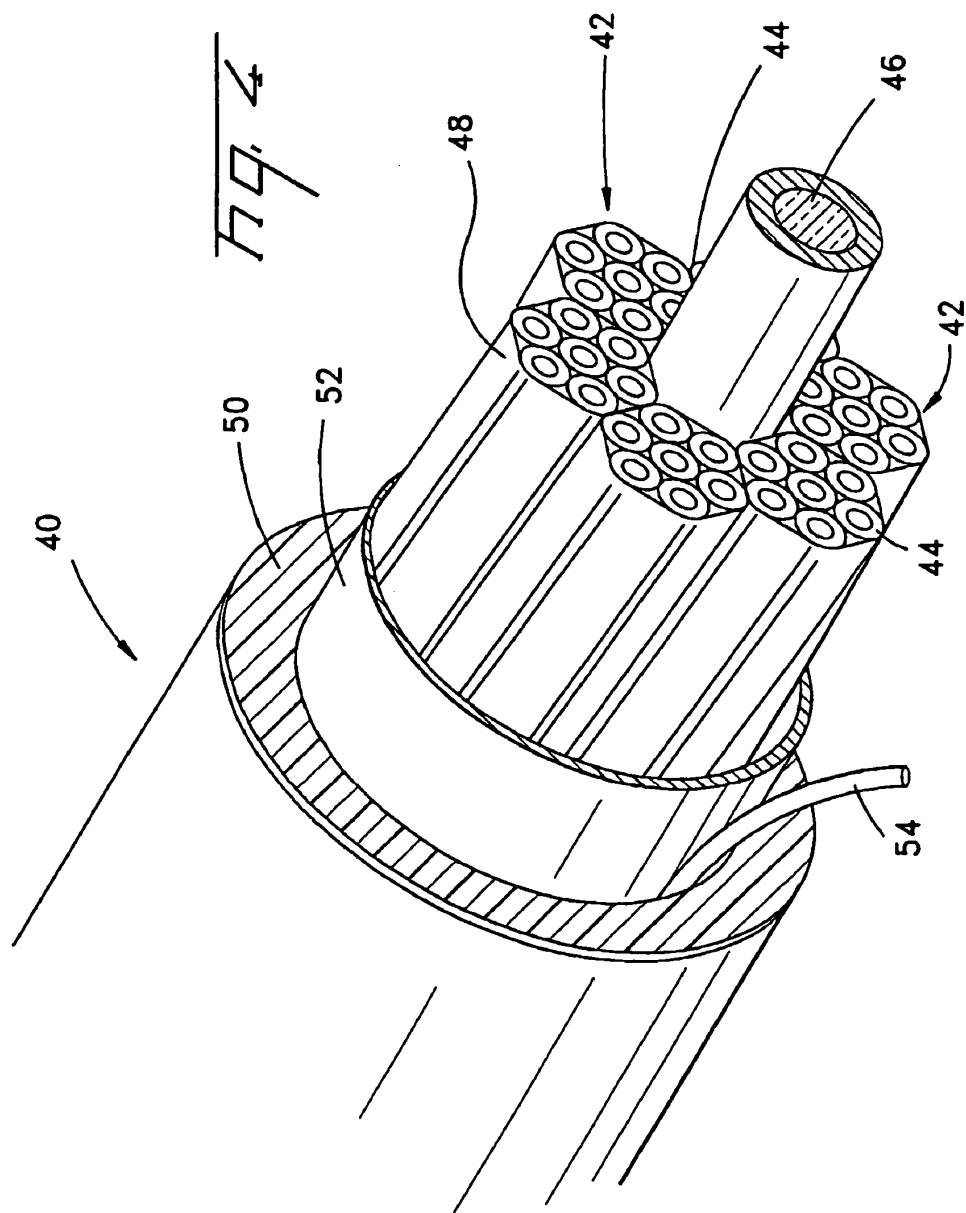
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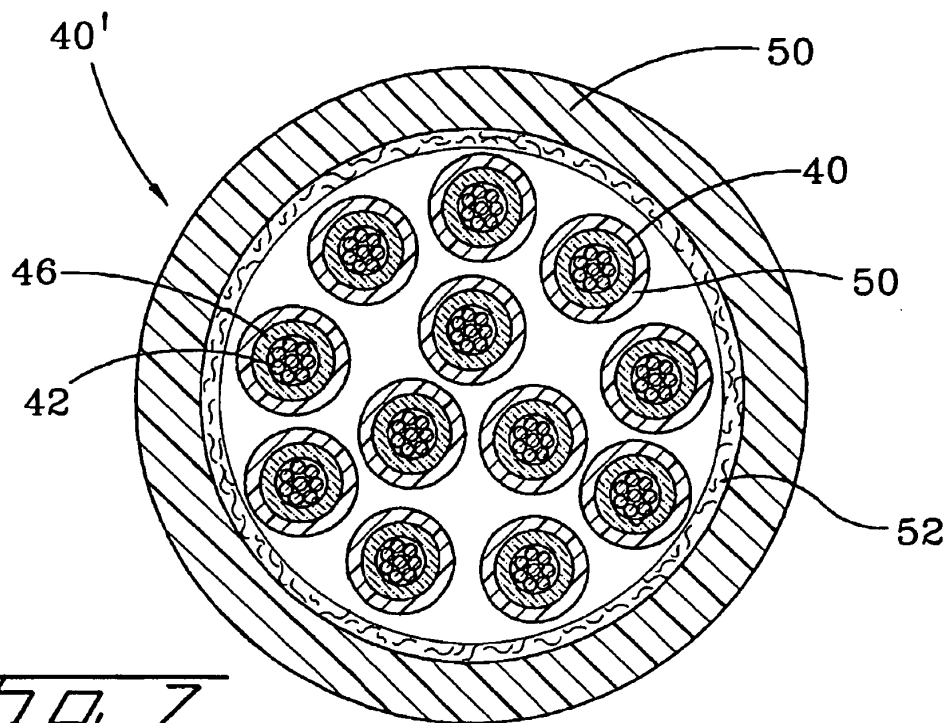


Fig. 7

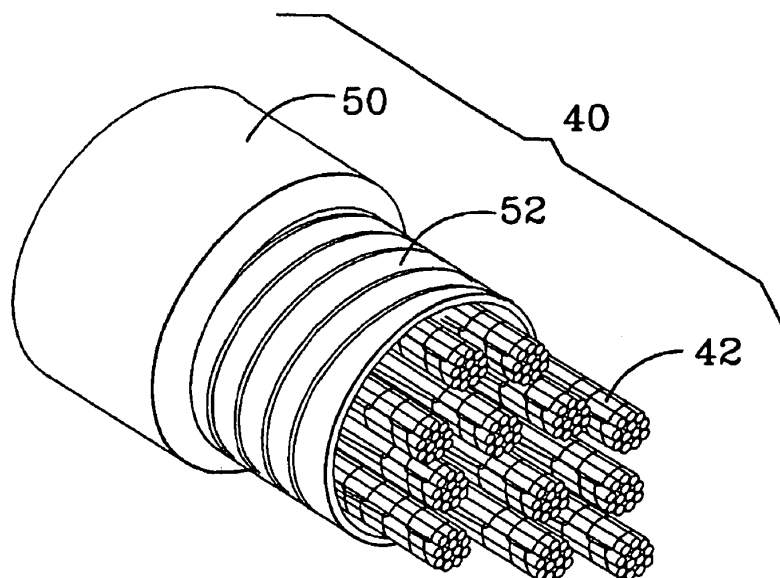


Fig. 8

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HIGH DENSITY FIBER OPTIC CABLE

RELATED APPLICATIONS

The present application is a Continuation of U.S. Ser. No. 10/005,325 filed on Nov. 12, 2001 now U.S. Pat. No. 6,901,191, which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to fiber optic cables and, more particularly, to high density fiber optic cables.

BACKGROUND OF THE INVENTION

In many applications, it is desirable for a fiber optic cable to include a plurality of optical fibers. With the increased demand for optical communications, there has been a corresponding demand to increase the number of optical fibers, i.e., the fiber count, of a fiber optic cable. By increasing the fiber count of a fiber optic cable, a single fiber optic cable would be able to support additional optical communications channels.

In order to increase the fiber count of fiber optic cables, unitized fiber optic cables have been developed. As shown in FIG. 1, a unitized fiber optic cable 10 includes a number of bundles 12 of optical fibers 14 that are stranded about a common central strength member 16. A unitized fiber optic cable 10 also includes a cable jacket 18 extruded about the bundles 12 of optical fibers 14, and an optional ripcord 22 for facilitating removal of cable jacket 18. As shown in FIG. 1, each bundle 12 of optical fibers 14 includes at least two and, more commonly, six or twelve optical fibers that are stranded together.

Optical fibers 14 are typically tight buffered optical fibers. A tight buffered optical fiber 14 includes a single mode or multi-mode optical fiber that may be surrounded by an interfacial layer. The interfacial layer can be formed of a Teflon® containing material and is surrounded by a tight buffer layer; however, other suitable interfacial layers may be used, for example, an UV acrylate. The tight buffer layer is typically formed of a plastic, such as polyvinyl chloride (PVC). As an alternative to PVC, the tight buffer layer can be formed of a non-halogenated polyolefin, such as a polyethylene or a polypropylene. Still further, the tight buffer layer can be formed of EVA, nylon or polyester.

Each bundle 12 of optical fibers 14 also includes a central strength member 26 about which the plurality of tight buffered optical fibers is stranded. Each bundle 12 of optical fibers 14 further includes a jacket 28 that surrounds the plurality of optical fibers, and an optional ripcord 20 for facilitating removal of jacket 28. Jacket 28 serves to protect optical fibers 14 and to maintain the bundle of optical fibers in a stranded relationship about central strength member 26. Jacket 28 is typically formed of a polymer, such as PVC. As an alternative to PVC, jacket 28 may be formed of a fluoro-plastic, such as polyvinylidene fluoride (PVDF), a fluoro-compound as disclosed by U.S. Pat. No. 4,963,609 or blends of PVC and PVDF or PVC and polyethylene (PE). Jacket 28 is typically relatively thick and, in one embodiment, has a thickness of about 0.8 millimeters.

During fabrication, a bundle 12 of optical fibers 14 is passed through an extruder cross head and jacket 28 is extruded thereabout in order to maintain the optical fibers in position within the bundle. Since the tight buffer layer of the tight buffered optical fibers 14 is typically formed of a

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plastic, the plastic that is extruded to form jacket 28 will tend to adhere to the tight buffer layer of the tight buffered optical fibers 14 in the absence of a barrier therebetween. In this regard, the plastic that is extruded to form jacket 28 of a bundle 12 of optical fibers 14 may partially melt the outermost portion of the tight buffer layer of the tight buffered optical fibers 14 such that jacket 28 and the tight buffered optical fibers will adhere to one another as the plastic cools. Unfortunately, the adherence of the tight buffered optical fibers 14 to the surrounding jacket 28 generally decreases the performance of the optical fibers. In this regard, signals propagating along optical fibers 14 generally experience greater attenuation as fiber optic cable 10 is bent or flexed in instances in which the tight buffered optical fibers are adhered to jacket 28 since the optical fibers will no longer be free to move relative to jacket 28 in order to accommodate bending or flexure of fiber optic cable 10.

Each bundle 12 of optical fibers 14 therefore also generally includes a barrier 30 disposed between the plurality of tight buffered optical fibers and jacket 28 in order to separate the tight buffered optical fibers from jacket 28 and to prevent adherence therebetween that otherwise would result from the extension of jacket 28 about optical fibers 14. As such, optical fibers 14 can move somewhat relative to jacket 28 as fiber optic cable 10 is flexed. Barrier 30 is typically formed of a layer of strength members, such as aramid yarn, that are typically stranded about the optical fibers. The layer of strength members is also generally relatively thick and may have a thickness of about 0.2 mm in one embodiment.

Each bundle 12 of optical fibers 14 is typically stranded about common central strength member 16 of fiber optic cable 10. Like central strength member 26 of each bundle 12 of optical fibers 14, central strength member 16 of fiber optic cable 10 is typically formed of a relatively stiff fiber or glass reinforced plastic, or a relatively flexible combination of aramid fiber that may or may not be overcoated with a plastic material. Fiber optic cable 10 also includes a protective cable jacket 18 that surrounds each of the bundles 12 of optical fibers 14. Cable jacket 18 is typically formed of a plastic, such as PVC. As an alternative to PVC, cable jacket 18 may be formed of a fluoro-plastic, such as PVDF, a fluoride-compound or blends of PVC and PVDF or PVC and PE.

As described above in conjunction with jacket 28 that surrounds each bundle 12 of optical fibers 14, cable jacket 18 is also typically extruded over the plurality of bundles of optical fibers. As a result of the plastic materials that form cable jacket 18 and the jackets 28 that surround the respective bundles 12 of optical fibers 14, cable jacket 18 and the jackets that surround the respective bundles of optical fibers may also adhere to one another following the extrusion of cable jacket 18 about the bundles of optical fibers. While the adherence of cable jacket 18 to the jackets 28 of the respective bundles 12 of optical fibers 14 does not impair the performance of fiber optic cable 10 as significantly as adherence between jacket 28 of a bundle 12 of optical fibers 14 and the tight buffer layer of the tight buffered optical fibers, the adherence of cable jacket 18 and the jackets of the respective bundles of optical fibers does disadvantageously impair the flexibility of fiber optic cable 10 somewhat.

Accordingly, fiber optic cable 10 can also include a surface coating on at least that portion of the exterior surface of jacket 28 of each bundle 12 of optical fibers 14 that otherwise would be in contact with cable jacket 18. The surface coating is typically formed of powdered talc that

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serves to prevent or reduce adhesion between cable jacket 18 and the jackets 28 of the respective bundles 12 of optical fibers 14.

Unitized fiber optic cable 10 as depicted in FIG. 1 is generally relatively large. For example, unitized fiber optic cable 10 depicted in FIG. 1 having six bundles 12 of optical fibers 14 stranded about a central strength member 16 with each bundle of optical fibers having six tight buffered optical fibers stranded about a respective strength member 26 generally has a diameter of about 18.8 millimeters. In many applications, it is desirable to minimize the size of fiber optic cable 10 while maintaining or increasing the number of optical fibers 14 within fiber optic cable 10. As such, it would be advantageous to develop a unitized fiber optic cable having a relatively high fiber count while also being somewhat smaller.

SUMMARY OF THE INVENTION

One aspect of the present invention is directed to a fiber optic cable including at least one bundle having a plurality of non-tight buffered optical fibers and a binder element. The binder element maintains the plurality of non-tight buffered optical fibers in the at least one bundle. A separation layer generally surrounds the at least one bundle, and a cable jacket surrounds the separation layer inhibiting adhesion between the at least one bundle and the cable jacket without surrounding each bundle of optical fibers with a respective jacket. The fiber optic cable excludes a grease or a grease-like composition being in contact with the at least one bundle for filling interstices of the cable thereby blocking water from flowing through the cable.

Another aspect of the present invention is directed to a fiber optic cable including at least one bundle having a plurality of non-tight buffered optical fibers and at least one binder thread encircling the plurality of optical fibers to thereby maintain the plurality of optical fibers in the bundle. A separation layer surrounds the at least one bundle, and a cable jacket surrounds the separation layer inhibiting adhesion between the at least one bundle and the cable jacket without surrounding each bundle of optical fibers with a respective jacket. The fiber optic cable excludes a grease or a grease-like composition being in contact with the at least one bundle for filling interstices of the cable thereby blocking water from flowing through the cable.

A further aspect of the present invention is directed to a fiber optic cable including a central member and at least one bundle. The at least one bundle includes a plurality of non-tight buffered optical fibers and a binder element. The binder element maintains the plurality of non-tight buffered optical fibers in the at least one bundle and a cable jacket surrounds the at least one bundle. A separation layer inhibits adhesion between the at least one bundle and the cable jacket. The fiber optic cable excludes a grease or a grease-like composition being in contact with the at least one bundle for filling interstices of the cable thereby blocking water from flowing through the cable.

A still further aspect of the present invention is directed to a fiber optic cable including at least one bundle having a plurality of optical fibers and a binder element. The binder element maintains the plurality of optical fibers in the at least one bundle. An armor layer surrounds the at least one bundle. The fiber optic cable excludes a cable jacket within the armor layer.

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BRIEF DESCRIPTION OF THE DRAWINGS

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1 is a cross-sectional view of a conventional fiber optic cable having a unitized design according to the prior art;

FIG. 2 is fragmentary perspective view of an exemplary fiber optic cable according to one embodiment of the present invention;

FIG. 3 is a cross-sectional view of the fiber optic cable of FIG. 2;

FIG. 2A is fragmentary perspective view of one bundle of optical fibers of the fiber optic cable of FIG. 2;

FIG. 4 is a fragmentary perspective view of an exemplary fiber optic cable according to another embodiment of the present invention;

FIG. 5 is a cross-sectional view of an exemplary tube-assembly of a fiber optic cable according to another embodiment of the present invention;

FIG. 6 is a cross-sectional view of an exemplary fiber optic cable according to another embodiment of the present invention;

FIG. 7 is a cross-sectional view of an exemplary fiber optic cable according to another embodiment of the present invention; and

FIG. 8 is a fragmentary perspective view of an exemplary fiber optic cable according to another embodiment of present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Referring now to FIGS. 2 and 3, a fiber optic cable 40 according to one embodiment of the present invention is illustrated. Fiber optic cable 40 of the present invention can have other configurations as described below, although the fiber optic cable of FIG. 2 will be described in more detail hereinbelow for purposes of illustration. Fiber optic cable 40 includes at least one bundle 42 having optical fibers 44 that are non-tight buffered; however, optical fibers 44 may be tight-buffered or zipped together. Optical fibers 44 may include, for example, a conventional single mode or multi-mode optical fibers; however, other suitable optical waveguides may be used. Strength members 46 such as an aramid yarns may be disposed around bundle 42; however, in other embodiments a plurality of bundles 42 may be disposed around strength member(s) 46 disposed in the center of cable 40. More particularly, strength members 46 include a plurality of aramid yarns stranded around two layers of bundles 42; however, other suitable strength members may be used, for example, fiberglass yarns. Other embodiments of the present invention may include other suitable layers of bundles 42, bundles 42 within the same cable having different numbers of optical fibers 44, and/or different types of optical waveguides in the same cable.

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Fiber optic cable 40 also includes a cable jacket 50 that surrounds bundles 42 of optical fibers 44, and an optional ripcord 54 for facilitating removal of cable jacket 50. Additionally, strength members 46 provides a separation layer between optical fibers 44 of bundles 42 and cable jacket 50 inhibiting the extruded cable jacket 50 from sticking to optical fibers 44 and/or bundles 42.

Fiber optic cables of the present invention are of a dry cable design. In other words, bundles 42 of the present invention exclude a grease, or a grease-like composition in contact therewith for filling interstices of the cable thereby blocking water from flowing through interstices of the cable. However, fiber optic cables of the present invention may include lubricants allowing bundles 42 and/or optical fibers 44 to move relative to each other, for example, during bending to improve optical performance. Grease compositions are among other things messy and susceptible to dripping at high temperatures. Moreover, craftsman must clean the grease from the optical fibers before working with the optical fibers which is a time consuming process. On the other hand, dry cables of the present invention allow the craftsman to work with the optical fibers without first cleaning the grease or grease-like compositions from the optical fibers.

Fiber optic cable 40 of FIGS. 2 and 3 has twelve bundles 42 of twelve optical fibers 44 for a 144-fiber count cable having a relatively small diameter. Each bundle 42 may contain twelve different colored optical fibers 44 aiding identification of the optical fibers 44 of each bundle 42 by the craftsman. Optical fibers 44 are non-stranded, but may be stranded. Bundles 42 of the embodiment are arranged in a first layer having three bundles helically stranded, a second layer having nine bundles counter-helically stranded around the first layer and strength members 46 helically stranded around the second layer. In other embodiments, the first layer of bundles 42 may be stranded around a central member that may be a strength member, for example, aramid yarns, a glass reinforced plastic, or fiberglass yarns. In still another embodiment, a filler rod or other suitable filler member may be used rather than a bundle 42 of optical waveguides to form fiber optic cable 40.

However, the concepts of the present invention may include any suitable number of bundles having any suitable number of optical waveguides. For example, fiber optic cable 40 may be configured as: a single layer of three bundles having twelve optical fibers for a 36 optical fiber count cable; a 72 optical fiber count cable having a single layer of six bundles stranded around a strength member; an eight-fiber count interconnect cable; or a 288 optical fiber count cable. The concepts of the present invention may also be practiced with other suitable cable constructions, for example, S-Z stranding or planetary stranding of bundles 42.

Bundles 42 of fiber optic cable 40 include a plurality of non-tight buffered optical fibers 44 allowing direct optical fiber to optical fiber contact among optical fibers 44 and/or bundles 42. However, other embodiments of the present invention may include tight buffered optical fibers 44. By eliminating the tight-buffered layer around optical fiber 44, the cable diameter may be advantageously reduced allowing for a relatively high fiber density. For example, in one embodiment a 144 optical fiber count cable has a diameter of about 10 mm or less. Embodiments including optical fibers 44 with a tight buffer layer generally increase the cable diameter with a corresponding decrease in the optical fiber density. For example, in one embodiment a 144 optical fiber count cable having tight buffered optical fibers 44 has a

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diameter of about 20 mm or less, whereas a conventional unitized cable construction has a diameter of about 30 mm.

Embodiments that include tight buffered optical fibers 44 may be surrounded by an interfacial layer. The interfacial layer is generally formed of a Teflon® containing material. The interfacial layer therefore serves as a release layer that provides a controlled bond between the tight buffer layer and the optical fiber so that a craftsman can easily strip the tight buffer layer from the optical fiber during a termination procedure. The tight buffer layer is typically a plastic such as PVC. However, the tight buffer layer can be formed of other plastics including non-halogenated polyolefins, such as PE or polypropylene, a fluoro-plastic such as PVDF or an ultraviolet (UV) light curable material. Although not necessary for the practice of the present invention, the tight buffer layer can also be designed to be flame resistant and to have a riser, a plenum and/or a low smoke zero halogen rating as described by U.S. Pat. No. 6,167,178, the subject matter of which is incorporated herein by reference. For example, the tight buffer layer of the tight buffered optical fibers can include aluminum trihydrate, antimony trioxide or other additives to improve the flame resistance of the tight buffer layer.

Each bundle 42 of optical fibers 44 also includes a binder element 48 that encircles the optical fibers to maintain optical fibers 44 in the bundle. In one embodiment depicted in FIGS. 2 and 2A, at least one binder thread 48 encircles the optical fibers 44. Fiber optic cable 40 can include various binder threads 48 or binder yarns. Binder thread 48 is preferably an air-entangled, textured, continuous multi-filament thread. In addition, binder thread 48 may be a synthetic thread that is resistant or impervious to bacterial decomposition that would otherwise create hydrogen which, in turn, may cause undesirable increases in the attenuation of the signals transmitted via optical fibers 44. By way of example, binder thread 48 may be formed of polyester, rayon, nylon or the like. Moreover, binder thread 48 is preferably pre-shrunk.

Binder thread 48 advantageously has a large spread factor and therefore flattens once the binder thread is wrapped about optical fibers 44. Additionally, binder thread 48 may readily deform when subjected to additional forces, such as the forces created by bending fiber optic cable 40. Binder thread 48 typically has no more than about 25 twists per inch in order to avoid undesirable attenuation of the signals transmitted via optical fibers 44. Most commonly, binder thread 48 has between about 2 twists per inch and about 6 twists per inch and, more preferably, about 4 twists per inch. Binder thread 48 also preferably has a TEX number between about 18 and about 60 and, more preferably, between about 30 and about 40 such as about 35 in one embodiment such that the binder thread has a fluffy feel. Additionally, binder thread 48 advantageously has a denier between about 150 and about 2600 such as about 250 in one embodiment.

Binder thread 48 also preferably includes a finish that is inert with respect to the components of fiber optic cable 40 with which the binder thread will come into contact. In this regard, the finish of binder thread 48 is preferably inert with respect to the embodiments having tight buffered optical fibers 44, cable jacket 50 and other suitable cable components and/or materials. For example, binder thread 48 of one advantageous embodiment includes a silicone wax emulsion finish that facilitates processing of the binder thread. Binder thread 48 may also be designed to be non-wicking and/or can include a super-absorbent polymer in order to reduce or prevent water migration through fiber optic cable 40.

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Binder thread 48 is typically stranded about a respective bundle 42 of optical fibers 44 in a helical manner with a pitch of between 10 mm and 70 mm and, more preferably, about 50 mm to facilitate fabrication of the bundle of the optical fibers. As illustrated in more detail in FIG. 2A, binder thread 48 of one advantageous embodiment includes a pair of threads, namely, a looper thread and a needle thread. As illustrated, one thread, which could be either the looper thread or the needle thread, alternately passes back and forth over the upper portion of bundle 42, while the other thread alternately passes back and forth under the lower portion of the bundle. With reference to the embodiment of FIG. 2A, and for purposes of example, the leftmost thread at the end of the bundle that is illustrated extends lengthwise along the bundle to a first stitch at which point the threads are secured by means of an overlooked stitch. The thread then helically encircles the lower portion of the bundle to a second overlooked stitch on the far side of the illustrated bundle at which point the threads are again secured to one another. The thread then extends lengthwise along the far side of the bundle to a third overlooked stitch before again helically encircling the lower portion of the bundle to a fourth overlooked stitch. This pattern is repeated for each thread along the length of the bundle in order to secure optical fibers 44 together in an integral manner. In this embodiment, the looper thread and the needle thread are typically secured to one another at a plurality of stitch locations along the length of the bundle of optical fibers, typically at a pitch of 10 mm to 70 mm and, more preferably, at a pitch of 50 mm, by means of an overlooked stitch. The resulting binder thread has a zig-zag appearance and is therefore sometimes termed a zig-zag binder.

Further, binder thread 48 can include indicia, such as an identification marking or a color, in order to identify the respective bundle of optical fibers encircled by the binder thread and to distinguish one bundle from another. For example, one white binder thread 48 may be used with a set of twelve different colored binder threads 48 identifying twelve bundles 42; however, two sets of twelve different colored binder threads 48 may be used to identify a plurality of bundles 42.

Binder thread 48 securely maintains the plurality of optical fibers 44 within bundle 42, while also maintaining the shape and size of the bundle of optical fibers such that the optical fibers need not be disposed within a respective jacket or buffer tube as required by conventional fiber optic cables. By eliminating the jacket or buffer tube in which a bundle of optical fibers were traditionally disposed, the resulting bundle of optical fibers and, in turn, fiber optic cable 40, can be reduced in size relative to a conventional fiber optic cable having the same number of optical fibers. Moreover, binder thread 48 inhibits optical fibers 44 from being entangled with, for example, aramid fibers.

While a binder thread, such as those described above are advantageous for maintaining optical fibers 44 in a bundle 42, each bundle of optical fibers can include other types of binders, if so desired. For example, binder element 48 may be formed of a tape or a film, such as a polymer film, that is wrapped about optical fibers 44 as depicted in FIG. 4. In contrast to the polymer jackets that surround the individual bundles of optical fibers of conventional unitized fiber optic cables, the polymer film is generally quite thin, such as between about 1 mil and 10 mils in one embodiment. Additionally, since the polymer film can be wrapped about the bundle 42 of optical fibers 44 and need not be extruded, the polymer film can be wrapped directly about the optical fibers and no barrier is required between the polymer film

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and the optical fibers since the polymer film will not adhere to the tight buffer layer and/or optical fiber in the same manner that an extruded polymeric jacket would adhere to the tight buffer layer of the tight buffered optical fibers of a conventional unitized fiber optic cable. Although the polymer film can be formed of various materials, the polymer film of one embodiment is formed of polyester, such as a polyethylene terephthalate, having a thickness of about 1 mil. For example, the polymer film may be a MYLAR® film having indicia, for example, different colors to identify different bundles 42. Additionally, bundle 42 may also be disposed within a soft housing such as disclosed in U.S. patent application Ser. No. 09/966,646 filed on Sep. 28, 2001, which is incorporated herein by reference.

Cable jacket 50 can be formed of various materials, but is typically formed of a plastic, such as PVC. As an alternative to the PVC, cable jacket 50 may be formed of other plastics including fiber-reinforced polyethylene, a fluoro-plastic, such as PVDF, a fluoro-compound as disclosed by U.S. Pat. No. 4,963,609, blends of PVC and PVDF, blends of PVC and PE, or other suitable polymeric blends. As described above in conjunction with the tight buffer layer of the tight buffered optical fibers 44, cable jacket 50 can also be designed to have increased flame resistance such that the fiber optic cable has a riser, a plenum and/or a low smoke zero halogen rating. In this regard, cable jacket 50 can include aluminum trihydrate, antimony trioxide or other additives that increase the flame resistance of the cable jacket as known to those skilled in the art and as described by U.S. Pat. No. 6,167,178. Additionally, cable jacket 50 can be designed to be resistant to UV light, if so desired.

Cable jacket 50 is typically extruded about the plurality of bundles 42 of optical fibers 44. Since bundles 42 of optical fibers 44 need not be jacketed as described below, fiber optic cable 40 preferably includes a separation element and/or layer 52 (FIG. 4) for inhibiting adhesion between the plurality of bundles of optical fibers and cable jacket 50. Separation element 52 includes a separation layer disposed within cable jacket 50 and surrounding the plurality of bundles 42 of optical fibers 44. Separation layer 52 is preferably formed of a material having a melting point that is greater than the respective melting point(s) of cable jacket 50 and, if used, the tight buffer layer of the tight buffered optical fibers 44 in order to inhibit adherence between cable jacket 50 and the bundles of optical fibers. For a cable jacket 50 formed of PVC having a melting temperature of 190° C., separation element 52 can be formed of a polyester, such as a MYLAR® film having a melting point of about 235° C.

Cable jacket 50 is typically extruded about the plurality of bundles 42 of optical fibers 44 at the melting temperature of the plastic that forms the cable jacket. By being formed of a material, such as a polyester, having a melting point greater than the melting point of the plastic that forms cable jacket 50, separation layer 52 does not melt as cable jacket 50 is extruded thereover. As such, separation layer 52 inhibits adherence between cable jacket 50 and the bundles 42 of optical fibers 44 such that the optical fibers are able to move somewhat relative to cable jacket 50 as fiber optic cable 10 is flexed or bent, thereby permitting optical signals to be transmitted via the optical fibers without disadvantageous optical attenuation as fiber optic cable 10 is bent or flexed.

As shown in FIG. 2, strength members 46, for example an aramid yarn such as Kevlar®, at least partially performs as separation layer 52 while providing tensile strength to fiber optic cable 40. However, other suitable strength members 46 may be used, for example, Zylon®, Vectran®, Technora®, or Spectra®. Strength members 46 may have a parallel

direction of lay relative to bundles 42 of optical fibers 44 or may be stranded about bundles 42. However, in order to reduce the quantity of aramid yarns used for coverage, rather than strength, separation layer 52 can be formed of various other tapes, films, threads and/or fibrous materials. For example, separation layer 52 can be formed from a plurality of Kevlar® ends and a plurality of polyester yarn ends stranded around a bundle 44. In each of these embodiments, however, separation layer 52 is designed to inhibit adhesion between the plurality of bundles 42 of optical fibers 44 and cable jacket 50. Moreover, separation layer 52 of each of these embodiments is generally relatively thin so as not to unnecessarily increase the size of fiber optic cable 40.

Separation layer 52 can be formed of other, non-polymeric materials, if so desired. For example, separation layer 52 can be formed of a water swellable tape in order to increase the water resistance of fiber optic cable 40. Additionally, a separation layer 52 may be formed of a MYLAR® film having a thickness of about 1 mil.

Separation element 52 can be formed in other manners without departing from the spirit and scope of the present invention. For example, in the embodiment of fiber optic cable 40 depicted in FIG. 4, each bundle 42 of optical fibers 44 includes a polymer film 48 surrounding the plurality of tight buffered optical fibers 44; however, optical fibers 44 may be non-tight buffered. By appropriately designing polymer film 48, polymer film 48 not only serves as the binder for the respective bundle 42 of optical fibers 44, but also serves as the separation element. In this regard, polymer film 48 is preferably formed of a material having a melting point greater than the melting point of the plastic that forms cable jacket 50. For example, for a fiber optic cable 40 having a cable jacket 50 formed of PVC having a melting point of 190° C., polymer film 48 can be formed of a polyester, such as a MYLAR® film, having a melting point of 235° C. As such, the polymer film 48 surrounding each bundle 42 of optical fibers 44 will not melt as cable jacket 50 is extruded about the plurality of bundles of optical fibers. Thus, polymer film 48 will serve to inhibit adhesion between cable jacket 50 and the plurality of tight buffered optical fibers 44 of each bundle 42.

Still further, separation element 52 can be formed of a surface coating on each bundle 42 of optical fibers 44. In this regard, the surface coating is preferably applied to at least that portion of each bundle 42 of optical fibers 44 that would otherwise contact cable jacket 50. The surface coating is preferably formed of a material that also has a melting point greater than the melting point of the plastic from which cable jacket 50 is formed. For example, the surface coating may be formed of powdered talc that is applied to the outer surface of the plurality of bundles 42 of optical fibers 44. The surface coating of talc effectively inhibits adhesion between cable jacket 50 and the tight buffered optical fibers 44 as the cable jacket is extruded thereover.

According to one embodiment of the present invention, each individual bundle 42 of optical fibers 44 is unjacketed. That is, each individual bundle 42 of optical fibers 44 is bound together by a binder element 48, such as a binder thread, a thin polymeric layer or the like, and does not include a polymeric jacket as in conventional unitized fiber optic cables. As such, those embodiments of fiber optic cable 40 in which each bundle 42 is bound with a binder thread 48 permit direct contact between the non-tight buffered optical fibers and/or tight buffered optical fibers of adjacent bundles.

The jackets surrounding the bundles of optical fibers of conventional unitized fiber optic cables are relatively thick. Likewise, the layer of strength members, tight buffering, or

the like disposed between the jacket of each individual bundle of optical fibers and the optical fibers is also relatively thick. By designing fiber optic cable 40 such that the bundles 42 of optical fibers 44 need not include a polymeric jacket and/or a layer of strength members for separating the optical fibers from the polymeric jacket, each bundle of optical fibers can be substantially reduced in size and, correspondingly, fiber optic cable 40 can be substantially reduced in size. Likewise, non-tight buffered optical fibers 44 can substantially reduce bundle size and, correspondingly, fiber optic cable 40 can be substantially reduced in size.

For comparison purposes, fiber optic cable 40 according to one embodiment of the present invention has six bundles 42 of optical fibers 44 with each bundle of optical fibers including six tight buffered optical fibers stranded about a central strength member 46. While the size and thickness of various cable components may be varied depending upon the application, such as by varying the thickness of cable jacket 50 to alter the crush and impact resistance and/or the flame retardance, fiber optic cable 40 of one embodiment also includes a separation layer 52 of a polyester, such as a MYLAR® film surrounding the bundles 42 of optical fibers 44 and a cable jacket 50 having a thickness of 1.3 millimeters surrounding the separation layer such that fiber optic cable 40 has a total diameter of 10.9 millimeters. As described above, a conventional unitized fiber optic cable having the same number of bundles and the same number of total optical fibers generally has a diameter that is substantially larger, such as 18.8 millimeters. As such, the conventional fiber optic cable has a cross-sectional area that is about three times larger than the fiber optic cable according to the foregoing exemplary embodiment. Thus, fiber optic cable 40 of the present invention can include the same number of optical fibers 44 while being much smaller than conventional fiber optic cables. Alternatively, fiber optic cable 40 can include a greater number of optical fibers, i.e., a higher fiber count, while having the same size as a conventional fiber optic cable.

While various embodiments of fiber optic cable 40 have been described above, fiber optic cable 40 can include other features without departing from the spirit and scope of the present invention. For example, fiber optic cable 40 can be constructed to have increased water resistance by including a variety of water swellable tapes, threads and/or powders. For example, separation layer 52 can be formed of a water swellable tape as described above. In another embodiment, separation layer 52 can be formed from by an armor layer, for example, a metal or dielectric layer that may be formed from one or more pieces. In addition to acting as a separation layer, an armor layer may provide, for example, crush resistance and/or tensile strength. In yet another embodiment, bundles 42 of optical fibers 44 may be stranded around an electrical component, for example, a coaxial cable or other suitable electrical components.

While one unitized design of fiber optic cable 40 has been described hereinabove, fiber optic cable 40 may have other configurations. In this regard, the embodiment of fiber optic cable 40 depicted in FIG. 2 includes a plurality of bundles 42 of optical fibers 44 having strength members 46 and surrounded by cable jacket 50. However, in other embodiments fiber optic cable 40 can include a number of tube assemblies surrounded by cable jacket 50 with each tube assembly including multiple bundles of optical fibers. In order to minimize the size of each tube assembly required to contain a predetermined number of optical fibers; however, each bundle of optical fibers of a tube assembly is preferably

non-jacketed as described above in conjunction with the embodiment of FIGS. 2 and 3.

While the bundles of optical fibers may be arranged in various manners, each tube assembly 60 of fiber optic cable 40 can include concentric bundles 42 of optical fibers 44 with some bundles of optical fibers within other bundles of optical fibers as depicted in the embodiment of FIG. 5. In this regard, tube assembly 60 includes an inner bundle 42a of optical fibers 44. Inner bundle 42a includes a plurality of optical fibers 44 and at least one binder thread 48 encircling the plurality of optical fibers to maintain the integrity of the bundle. Although not illustrated, inner bundle 42a may also include a central strength member along which optical fibers 44 extend, if so desired. Inner bundle 42a can include any number of optical fibers 44, but typically includes 6 or 12 optical fibers. Each optical fiber of inner bundle 42a preferably includes indicia, such as a color, for uniquely identifying the respective optical fiber relative to other optical fibers of the inner bundle. While inner bundle 42a may include various binder threads, binder thread 48 of one advantageous embodiment is an air entangled, textured, continuous multi-filament thread as described above in more detail.

Tube assembly 60 of the embodiment depicted in FIG. 5 also includes an outer bundle 42b of optical fibers 44 having a plurality of optical fibers positioned circumferentially about the inner bundle 42a of optical fibers. While outer bundle 42b may include any number of optical fibers, the outer bundle of the illustrated embodiment includes 12 optical fibers. Like inner bundle 42a, each optical fiber 44 of outer bundle 42b also preferably includes indicia, such as a color, for uniquely identifying the respective optical fiber relative to other optical fibers of the outer bundle. While each optical fiber 44 of inner bundle 42a and each optical fiber of the outer bundle 42b is uniquely identified, such as by having a unique color, with respect to other optical fibers of the respective bundle, optical fibers of inner bundle 42a may have the same colors as optical fibers of outer bundle 42b. However, optical fibers 44 of the inner and outer bundles that have the same color may be distinguished from one another based upon the respective bundle in which the optical fibers are included. Outer bundle 42b of optical fibers also includes at least one binder thread 48 encircling the plurality of optical fibers to maintain the integrity of the optical fibers of the outer bundle about inner bundle 42a. While inner bundle 42a may include various binder threads, binder thread 48 of one advantageous embodiment is also an air entangled, textured, continuous multi-filament thread as described above in more detail.

Additionally, tube assembly 60 of FIG. 5 can include a tubular member 56, such as a buffer tube, surrounding outer bundle 42b of optical fibers 44 as described above. Moreover, any voids within tubular member 56 may be filled with a filling compound to inhibit the migration of water, such as disclosed in U.S. patent application Ser. No. 09/322,625 filed May 28, 1999, which is incorporated herein by reference.

As depicted in FIG. 5, at least the outer bundle 42b of optical fibers 44 and, more preferably, both the outer and inner bundles of optical fibers are non-jacketed such that the cross-sectional size of the resulting tube assembly 60 can be minimized for a predetermined number of optical fibers. In order to inhibit adhesion between tubular member 56 and outer bundle 42b of optical fibers 44, tube assembly 60 of FIG. 5 can also include a separation element, such as a

separation layer that surrounds the outer bundle of optical fibers or a surface coating on the outer bundle of optical fibers, as described above.

By encircling inner bundle 42a with optical fibers 44 of outer bundle 42b, tube assembly 60 of the embodiment of FIG. 5 will include a dense collection of optical fibers in order to maximize the number of optical fibers included within a buffer tube of a particular cross-sectional size. However, each optical fiber of tube assembly 60 can be uniquely identified by means of the indicia, such as the color, of each optical fiber and the separation of the optical fibers into inner and outer bundles.

In one embodiment, utilizing tube assembly 60, a plurality of tube assemblies are extended alongside a central strength member 46, typically by being stranded about central strength member 46. A cable jacket 50 is then extruded over the plurality of tube assemblies 54. To inhibit adhesion between tubular members 56 of tube assemblies 60 and cable jacket 50, fiber optic cable 40 can also include a separation element disposed between tube assemblies 60 and cable jacket 50 as described above in conjunction with the other embodiments. By including tube assemblies, each of which generally include multiple bundles of optical fibers, fiber optic cable 40 of this embodiment can include even greater numbers of optical fibers, such as 288 optical fibers or more, while continuing to minimize the overall cross-sectional size of the cable. However, each optical fiber 44 of fiber optic cable 40 of this embodiment may be uniquely identified since tubular member 56 of each tube assembly 54 may include indicia, such as a color, to uniquely identify the respective tube assembly and the indicia, such as the color, of each optical fiber and the separation of the optical fibers into inner and outer bundles permit each optical fiber of a respective tube assembly to be uniquely identified as described above.

FIG. 6 depicts fiber optic cable 40 another embodiment of the present invention. Fiber optic cable 40 of FIG. 6 includes cable jacket 50 that generally surrounds strength members 46 such as aramid yarns and bundle 42. Bundle 42 includes a plurality of non-tight buffered optical fibers 44, for example, eight optical fibers held together by binder thread 48 (not shown) that inhibits non-tight buffered optical fibers 44 from being entangled with strength members 46. Fiber optic cable 40 of FIG. 6 has an optical fiber 44 on optical fiber 44 construction among non-tight buffered optical fibers 44; however, optical fibers 44 may include a tight buffer layer. Fiber optic cable may also include a ripcord 54 for facilitating removal of cable jacket 50. Fiber optic cable 40 of FIG. 6 has a generally round cross-section and may be used as an interconnect cable.

Conventional optical fiber ribbon interconnect cables generally include a preferential bend characteristic due to the planar orientation of the optical fibers in the optical fiber ribbon. Consequently, conventional eight-fiber ribbon interconnect cables are difficult to bend and store in tight quarters such as splice trays. Because fiber optic cable 40 has a generally round cross-section it generally does not have a preferential bend characteristic allowing for easier bending and routing in splice trays.

In one embodiment, fiber optic cable 40 of FIG. 6 includes a cable jacket 50 generally surrounding three ends of 2450 denier aramid yarns stranded around a bundle 42 having eight single-mode optical fibers 44 secured by binder thread 48 (not shown) with a cable diameter of about 3 mm or less. However, other configurations may be used and/or the cable diameter may be greater than 3 mm. However, other suitable embodiments may be practiced, for example, a cable jacket

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50 generally surrounding four ends of 2450 denier aramid yarns stranded around a bundle 42 having twelve multi-mode optical fibers 44 secured by binder thread 48 with a cable diameter of about 3–4 mm. However, the cable diameter may be greater than 3–4 mm.

FIG. 7 depicts fiber optic cable 40' another embodiment of the present invention. The fiber optic cable 40' of FIG. 7 includes a plurality of fiber optic cables 40 of FIG. 6 stranded together forming a breakout cable. Moreover, other suitable cables of the present invention may be constructed as breakout cables. Fiber optic cables 40' includes a first layer having three fiber optic cables 40 helically stranded, a second layer having nine fiber optic cables 40 counter-helically stranded around the first layer, and a cable jacket 50. Embodiments of fiber optic cable 40' may include, for example, a separation layer 52 such as a water blocking tape, a central member, a ripcord, and/or other suitable cable components.

FIG. 8 depicts fiber optic cable 40 another embodiment of the present invention. The fiber optic cable 40 of FIG. 8 includes at least one unjacketed bundle 42 of non-tight buffered optical fibers 44 having a binding thread 48 there-around. However, optical fibers 44 may be tight buffered and/or other binding elements may be used. Bundles 42 are stranded together; however, they may be unstranded. More particularly, fiber optic cable 40 includes a first layer having three bundles 42 helically stranded and a second layer having nine bundles 42 counter-helically stranded around the first layer. Separation layer 52 surrounds bundles 42 of fiber optic cable 40 of FIG. 8 and is formed from a flexible armor. The flexible armor preferably includes a smooth inner surface for contacting bundles 42 and/or optical fibers 44. For example, CPID interlock armor available from Eastern Wire & Conduit of Ontario, Canada; however, other suitable armor may be used for separation layer 52. The flexible armor may also provide bend control to fiber optic cable 40 by inhibiting small bend radii that may cause optical attenuation. A cable jacket 50 surrounds the armor separation layer 52 of FIG. 8; however, embodiments of FIG. 8 may be practiced without cable jacket 50.

Additionally, fiber optic cable 40 of FIG. 8 does not include a bundle and/or a cable jacket within separation layer 52; however, embodiments may be practiced with bundle jackets. Eliminating a jacket from individual bundles 42 and/or a jacket around the stranded bundles 42 within the armor separation layer 52 allows for a higher optical fiber packing density within the armor separation layer 52. Embodiments of fiber optic cable 40 of FIG. 8 may include, for example, a central member, a ripcord, a water blocking tape wrapped around the bundles and/or other suitable cable components.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A fiber optic breakout cable comprising a plurality of cable units disposed within an outer jacket, wherein each of the plurality of cable units comprises:

at least one bundle, the at least one bundle comprising a plurality of non-tight buffered optical fibers and a

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binder element for maintaining the plurality of non-tight buffered optical fibers in the at least one bundle; a separation layer contacting at least some of the plurality of non-tight buffered optical fibers, wherein the separation layer is formed from a plurality of tensile yarns for providing a tensile strength characteristic for the cable unit; and

a cable unit jacket, the cable unit jacket surrounding the at least one bundle and the separation layer and contacting a portion of the separation layer thereby forming the respective cable unit, wherein the separation layer inhibits adhesion between the at least one bundle and the cable unit jacket and wherein the fiber optic breakout cable excludes a grease or a gel composition being in contact with the at least one bundle for filling interstices of the cable unit thereby blocking water from flowing through the cable.

2. The fiber optic breakout cable of claim 1, wherein the plurality of cable units each have twelve optical fibers.

3. The fiber optic breakout cable of claim 1, wherein the plurality of cable units have a diameter of about 4 millimeters or less.

4. The fiber optic breakout cable of claim 1, the binder element being selected from a binder thread, a binder yarn, a thin film, and a tape.

5. The fiber optic breakout cable of claim 1, the binder element being a binder thread encircling the plurality of non-tight buffered optical fibers.

6. The fiber optic breakout cable of claim 1, the plurality of cable units being stranded around a central member.

7. The fiber optic breakout cable of claim 1, further including an armor layer.

8. The fiber optic breakout cable of claim 1, further including a plurality of strength members disposed between the outer jacket and the respective cable unit jackets of the plurality of cable units.

9. The fiber optic breakout cable of claim 1, the cable unit jacket contacting at least a portion of the separation layer being an inner surface of the cable unit jacket.

10. A fiber optic breakout cable comprising two cable units disposed within an outer jacket, wherein one of the cable units comprises:

at least one bundle, the at least one bundle comprising a plurality of non-tight buffered optical fibers and a binder element for maintaining the plurality of non-tight buffered optical fibers in the at least one bundle; a separation layer, the separation layer being adjacent to at least some of the plurality of non-tight buffered optical fibers, wherein the separation layer is formed from a plurality of tensile yarns for providing a tensile strength characteristic for the cable unit; and

a cable unit jacket, the cable unit jacket surrounding the at least one bundle and the separation layer and having a diameter of about 4 millimeters or less, wherein the cable unit jacket contacts a portion of the separation layer, wherein the separation layer inhibits adhesion between the at least one bundle and the cable unit jacket and wherein the fiber optic breakout cable excludes a grease or a gel composition being in contact with the at least one bundle for filling interstices of the cable unit thereby blocking water from flowing through the cable.

11. The fiber optic breakout cable of claim 10, wherein the plurality of cable units each have twelve optical fibers.

12. The fiber optic breakout cable of claim 10, the binder element being selected from a binder thread, a binder yarn, a thin film, and a tape.

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13. The fiber optic breakout cable of claim 10, the binder element being a binder thread encircling the plurality of non-tight buffered optical fibers.

14. The fiber optic breakout cable of claim 10, further including an armor layer.

15. The fiber optic breakout cable of claim 10, further including a plurality of strength members disposed between the outer jacket and the cable unit jacket of the one cable unit.

16. The fiber optic breakout cable of claim 10, the plurality of non-tight buffered optical fibers further including a tight buffered layer.

17. The fiber optic breakout cable of claim 10, the cable unit jacket that contacts the a portion of the separation layer being an inner surface of the cable unit jacket.

18. A fiber optic cable comprising:

at least one bundle, the at least one bundle comprising twelve non-tight buffered optical fibers and a binder element for maintaining the non-tight buffered optical fibers in the at least one bundle;

a separation layer contacting at least one of the twelve non-tight buffered optical fibers, wherein the separation

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layer is formed from a plurality of tensile yarns for providing a tensile strength characteristic; and

a cable jacket, the cable jacket contacting a portion of the separation layer, wherein the separation layer inhibits adhesion between the at least one bundle and the cable jacket and wherein the fiber optic cable excluding a grease or a gel composition being in contact with the at least one bundle for filling interstices of the cable jacket thereby blocking water from flowing through the cable.

19. The fiber optic cable of claim 18, wherein the fiber optic cable has a diameter of about 5 millimeters or less.

20. The fiber optic cable of claim 18, the binder element being selected from a binder thread, a binder yarn, a thin film, and a tape.

21. The fiber optic cable of claim 18, the binder element being a binder thread encircling the plurality of non-tight buffered optical fibers.

22. The fiber optic cable of claim 18, the cable jacket contacting a portion of the separation layer being an inner surface of the cable jacket.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,113,680 B2
APPLICATION NO. : 11/125375
DATED : September 26, 2006
INVENTOR(S) : William C. Hurley and Martyn N. Easton

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Col. 15,
Claim 13, line 2 delete "encircling" and insert -- encircling -- therefor.

Col. 16, line 16;
Claim 21, line 2 delete "encircling" and insert -- encircling -- therefor.

Signed and Sealed this

Fifteenth Day of May, 2007

A handwritten signature in black ink, appearing to read "Jon W. Dudas", is written over a rectangular area with a light gray dot grid background.

JON W. DUDAS
Director of the United States Patent and Trademark Office



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TIANO (43) Pub. Date: **Oct. 18, 2001**

(54) **FIBER OPTIC CABLE RIPCORD TOOL AND METHOD OF USE**

Publication Classification

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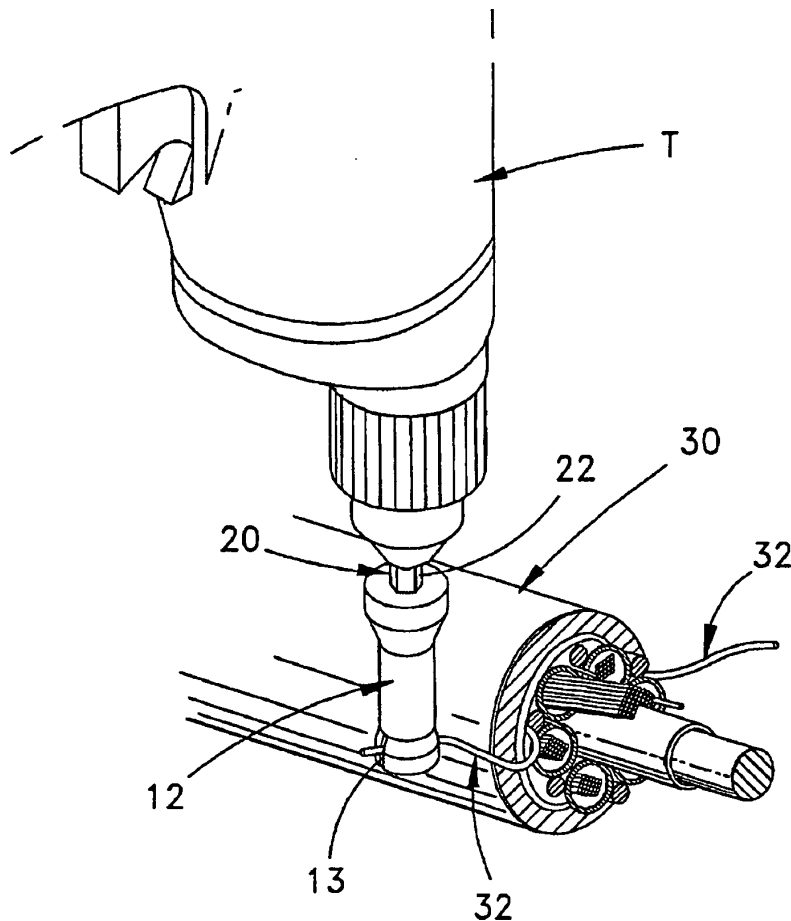
(57) **ABSTRACT**

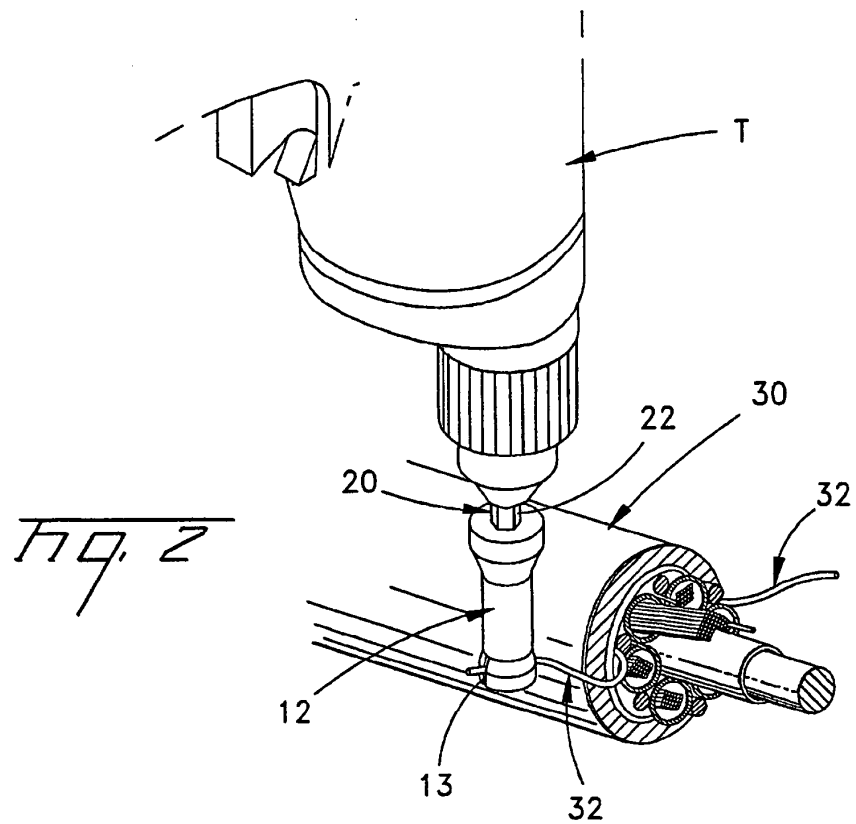
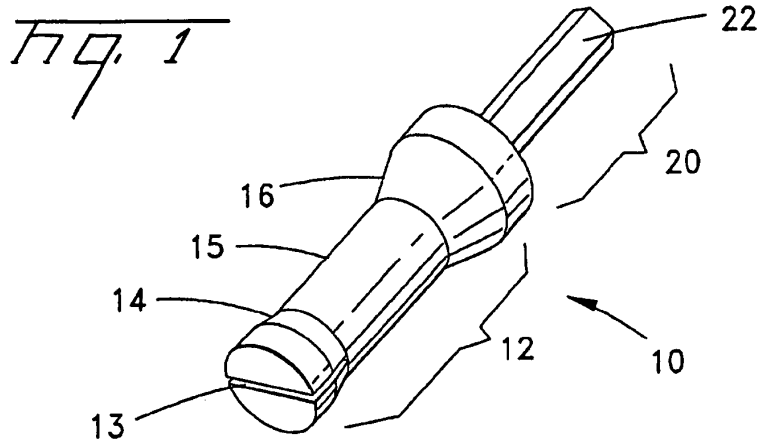
(*) Notice: This is a publication of a continued prosecution application (CPA) filed under 37 CFR 1.53(d).

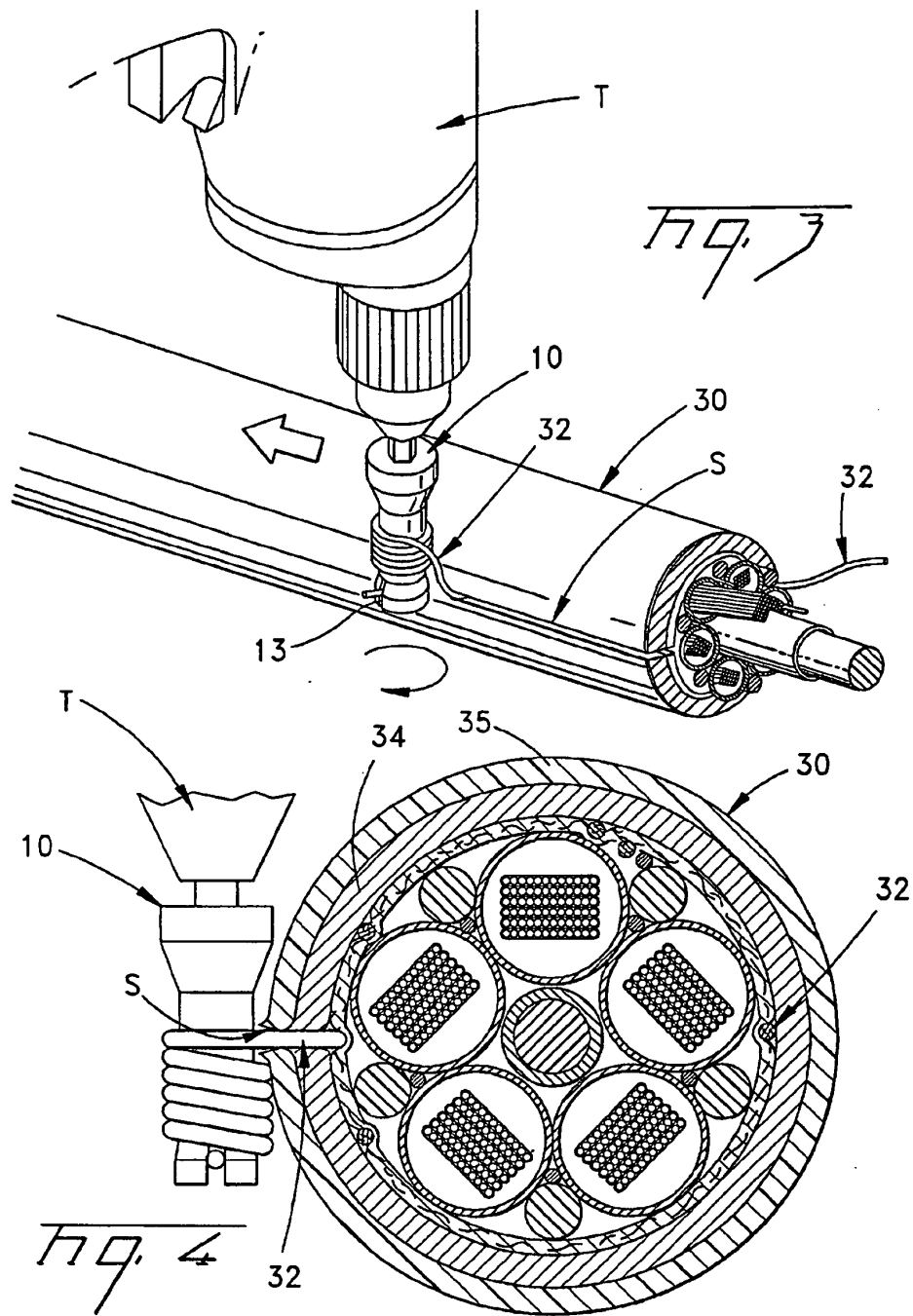
A ripcord tool for receiving a ripcord of a cable and facilitating the making of a slit in the cable. The tool includes a ripcord section having a ripcord attachment feature for attaching the ripcord to the ripcord section. The tool also includes a torque section operative to transmit torque to the ripcord section, such that rotation of the torque section causes the ripcord section to rotate for wrapping the ripcord about the ripcord section and ripping a component of the cable. A method of using the tool is also disclosed.

(21) Appl. No.: **09/467,416**

(22) Filed: **Dec. 20, 1999**







FIBER OPTIC CABLE RIPCORD TOOL AND METHOD OF USE

[0001] The present invention relates to a tool for use with cables, and, more particularly, to a tool for connecting to a ripcord of a cable for ripping at least one component of the cable.

[0002] The background of the present invention will be described with reference to exemplary fiber optic cables. Fiber optic cables include optical fibers that transmit voice, video, and computer data information. Fiber optic cables designed for indoor, outdoor, or indoor/outdoor applications may include one or more ripcords and may include one or more binders.

[0003] Ripcords are typically used by craftsmen to rip cable components, for example, an armor tape of the cable and/or the cable jacket, whereby the tear facilitates removal of the armor tape and/or cable jacket for accessing buffer tubes and optical fibers in the cable. To avoid breakage of the ripcord during the ripping action, a typical ripcord is preferably made of a high-strength material having a suitable denier. A denier is a unit of weight per length of material for measuring the fineness of threads, yarns, and the like. Binders are tape-like members that are typically used in a fiber optic cable to bind groups of cable components together. For example, one or more binders may be stranded around a cable core prior to the extrusion of a cable jacketing material therearound. Moreover, one or more binders may be used to retain a water swellable tape about a core prior to the cable jacketing operation. Additionally, binders may be stranded about groups of optical fibers to form optical fiber bundles.

[0004] When it is desired to gain access to the buffer tubes and optical fibers therein, a craftsman typically must use a cutting tool, e.g., a razor or hook blade, to cut the cable jacket and/or armor tape. Alternatively, the craftsman may use needle-nose pliers to grip and pull the ripcord for the same purpose. The use of a cutting tool or pliers, however, is time consuming, and creates the potential for injury to the craftsman and inadvertent damage to the buffer tubes or other cable components.

[0005] The present invention is suitable for use with known fiber optic cables that include at least one ripcord. For example, U.S. Pat. No. 5,642,452 discloses a fiber optic cable with two ripcords. A radially outermost ripcord is located radially inwardly of strength members for ripping the strength members and an outer cable jacket. A radially innermost ripcord is located radially inwardly of an inner jacket for ripping the inner jacket. U.S. Pat. No. 5,621,841 discloses a fiber optic cable having two ripcords. The ripcords are in diametrically opposed locations relative to a center of the cable, and the ripcords are located radially inwardly of a steel tape and an outer sheath. The ripcords are arranged for ripping the armor and possibly the outer sheath as well. U.S. Pat. No. 4,913,515 discloses a fiber optic cable with a glass or aramid fiber ripcord located radially inwardly of optical fibers embedded in a plastic jacket. The ripcord is operative to rip the plastic jacket, and the fiber optic cable may then be unrolled to define an optical fiber ribbon. U.S. Pat. No. 5,268,983 discloses a fiber optic cable with two ripcords. A radially outermost nylon ripcord is located radially inwardly of an outer jacket for ripping the outer jacket. A radially innermost ripcord is part of a core-tube

jacket for ripping the core-tube jacket. U.S. Pat. No. 5,029,974 discloses a fiber optic cable with a high-strength ripcord for ripping an armor tape and a cable sheath. U.S. Pat. No. 5,173,961 discloses a fiber optic cable with two ripcords that lie partly within a metallic cable sheath and partly outside of the metallic cable sheath by extending between overlapping edges of the metallic sheath. U.S. Pat. No. 5,321,788 discloses a fiber optic cable that includes a color marker under a tape, and includes two ripcords for facilitating removal of an armor tape and a cable jacket.

SUMMARY OF THE INVENTION

[0006] One aspect of the present invention is a ripcord tool for receiving a ripcord of a cable. The ripcord tool comprises a ripcord section having a ripcord attachment feature for attaching the ripcord to the ripcord section, and a torque section operative to transmit torque to the ripcord section. Rotation of the torque section causes the ripcord section to rotate for wrapping the ripcord about the ripcord section and ripping a component of the cable.

[0007] Another aspect of the invention is a method of forming a slit in a cable comprising the steps of: attaching a cable ripcord to the ripcord tool; applying torque to the ripcord tool; and ripping at least one cable component with said ripcord.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0008] FIG. 1 is an isometric view of a ripcord tool according to the present invention.

[0009] FIG. 2 is an isometric view of the ripcord tool of FIG. 1 being prepared to wrap a ripcord of, for example, a fiber optic cable.

[0010] FIG. 3 is an isometric view of the ripcord tool of FIG. 1 during a cable component ripping operation.

[0011] FIG. 4 is a cross sectional view of cable components being ripped with a ripcord using the ripcord tool according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Referring to FIGS. 1-4, an exemplary embodiment of a ripcord tool 10 and a method for using the ripcord tool according to the present invention will be described. The present invention will be described with reference to an exemplary fiber optic cable 30 having at least one ripcord 32 therein. Ripcord 32 is typically a relatively strong aramid material. Where a cable includes two ripcords they are typically located 180° apart relative to the center of fiber optic cable 30. An armor tape 34 and cable jacket 35 surround ripcord 32 (FIG. 4).

[0013] Ripcord tool 10 preferably includes at least one ripcord section 12 and at least one torque section 20. Ripcord section 12 includes a ripcord attachment feature, for example, a recess that preferably defines the shape of a slot 13. Slot 13 is sized to releasably/attachably receive a ripcord therethrough. In addition, ripcord section 12 preferably includes a ramp-like guide 14, a wrap surface 15, and an end section 16. During rotation of tool 10, guide 14 preferably guides the ripcord from slot 13 to wrap surface

15. Wrap surface 15 is preferably generally cylindrical and smooth, but it can be, for example, tapered, contoured, ridged, knurled, and/or grooved to wrapingly receive the ripcord. Additionally, the diameter of wrap surface 15 can be adjusted to accommodate the wrapping of large lengths of ripcord or to adjust for torque requirements. Preferably, guide 14 and end section 16 have respective diameters that are larger than the diameter of wrap surface 15.

[0014] Torque section 20 includes a torque member 22 that is preferably mechanically robust enough to transmit forces from a torque generating source to ripcord section 12 for wrapping the ripcord thereabout. Moreover, torque member 22 is preferably shaped to be coupled to a torque generating source in a way that avoids slippage therebetween. For example, torque member 22 can have a polygonal cross section, for example, a hexagonal, square, star shaped, or gear-like profile. Alternatively, torque member 22 can have a circular profile, e.g., a friction roller, or a semicircular profile.

[0015] Ripcord tool 10 can be monolithically formed of a metallic material, e.g. aluminum, or a non-metallic material, e.g., a thermoplastic or thermosetting material with suitable mechanical properties. In a preferred embodiment, ripcord section 12 and torque section 20 are separate pieces connected together. The connection can be made by, for example, a set screw, a press-fit connection, a weld, or any other suitable connection means. When the ripcord and torque sections 12, 20 are distinct pieces they can be made of the same or different compatible materials. For example, ripcord section 12 can be formed of aluminum and torque section 20 can be formed of steel.

[0016] An exemplary working embodiment of tool 10 was made and tested. In the working embodiment: the overall length of tool 10 was 3.25 inches; ripcord section 12 was aluminum and 2 inches in length; torque member 22 was a hexagonal steel shaft 1.75 inches in length; slot 13 was 0.025 inches wide by 0.25 inches deep; guide 14 had a diameter of 0.75 inches; and wrap surface 15 was cylindrical with a 0.5 inch diameter. Torque member 22 was connected to ripcord section 12 by a set screw that was screwed into a tapped hole made in ripcord section 12.

[0017] Exemplary operation of tool 10 according to the present invention will now be described. When it is desired to access the buffer tubes and/or optical fibers in fiber optic cable 10, the cable is cut transversely of its longitudinal axis (FIGS. 2-4). Torque section 20 is connected to a torque generating source T, for example, a hand-held power drill or power screw driver. As an illustration, a hex head portion of torque member 22 can be inserted in the complementary shaped clamping jaws of a hand-held drill (FIG. 2). A length of ripcord 32 is attached to ripcord section 12 by insertion of the ripcord through slot 13. Next, the operator will activate the torque source whereby the ripcord will be wrapped about tool 10. The operator and ripping action will move tool 10 longitudinally away from the transverse cable cut as the ripcord is wrapped about tool 10 (FIG. 3). As this occurs, guide 14 guides ripcord 32 to wrap section 15 and the ripcord is wrapped thereabout. End section 16 can reverse the wrap of ripcord 32 so that multiple layers of wrapped ripcord can be supported by wrap section 15. Further, the torque is converted to a pulling force on the ripcord thereby pulling the ripcord through armor tape 34

and cable jacket 35 (FIG. 4). The ripping operation forms a longitudinal slit S in the cable (FIGS. 3-4). The foregoing procedure can be repeated for as many ripcords as the cable contains. For example, if two ripcords are ripped according to the present invention, then cable jacket 35 and armor tape 34 can be peeled away from the cable core. A craftsman need not use a cutting tool to cut binders and/or tape, which saves time and avoids potential injury to the craftsman and inadvertent damage to buffer tubes or other cable components.

[0018] The present invention has thus been described with reference to the foregoing embodiments, which embodiments are intended to be illustrative of the inventive concepts rather than limiting. Persons of skill in the art will appreciate that variations and modifications of the foregoing embodiments may be made without departing from the scope of the appended claims. For example, ripcord section 12 may include alternative ways of gripping a ripcord in lieu of or in addition to slot 13, for example, clamps, adhesives, magnets, catches, snagging edges, wedges, fasteners, hooks, and/or springs. In addition, torque source T need not be an electrical device as it can be a hand powered device, e.g., with a T-shaped handle or other gripping structure suitable for use with an operator's hand. In addition, tool 10 can be combined with other tools or tool features, for example, a ratchet driver or a cable stripper as disclosed in U.S. Pat. No. 4,472,877, which is incorporated by reference herein. Furthermore, a series of tools 10 can be operatively connected together through gears and shafts so that a single torque source can be used to power the tools automatically, for example, for ripping opposing sides of a cable at the same time. The present invention is suitable for use with any type of cable having a ripcord or the like, for example, electrical or fiber optic cables.

Accordingly, what is claimed is:

1. A ripcord tool for receiving a ripcord of a cable, said ripcord tool comprising:

a ripcord section, said ripcord section having a ripcord attachment feature for attaching said ripcord to said ripcord section; and

a torque section, said torque section being operative to transmit torque to said ripcord section, whereby rotation of said torque section causes said ripcord section to rotate for wrapping said ripcord about said ripcord section and ripping a component of said cable.

2. The ripcord tool of claim 1, said ripcord attachment feature comprising a slot sized to receive said ripcord.

3. The ripcord tool of claim 1, said ripcord section comprising a wrap surface.

4. The ripcord tool of claim 1, said torque section comprising a polygonal cross sectional shape.

5. The ripcord tool of claim 1, said torque section comprising a cross sectional shape selected from the group consisting of hexagonal, circular, and semi-circular cross sectional shapes.

6. The ripcord tool of claim 1, said ripcord section comprising a guide for guiding said ripcord as it is wrapped about said ripcord tool.

7. The ripcord tool of claim 1, said ripcord section comprising an end section.

8. The ripcord tool of claim 1, said ripcord section comprising a guide and an end section having respective diameters, and a wrap surface having a diameter that is less than at least one of said guide and end section diameters.

9. A method of forming a slit in a cable comprising the steps of:

attaching a cable ripcord to a ripcord tool;
applying torque to the ripcord tool; and
ripping at least one cable component with said ripcord.

10. In the method of claim 9, the step of attaching a cable ripcord to said ripcord tool comprising inserting said cable ripcord into a recess formed in said tool.

11. In the method of claim 9, the step of applying torque to said ripcord tool comprising rotating said ripcord tool with a torque source and wrapping said cable ripcord about a portion of said ripcord tool as said cable component is ripped.

* * * * *



US006545222B2

(12) **United States Patent**
Yokokawa et al.

(10) Patent No.: **US 6,545,222 B2**
(45) Date of Patent: **Apr. 8, 2003**

(54) **CABLE, AND METHOD FOR REMOVING SHEATH AT INTERMEDIATE PART OF CABLE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 61 days.

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(65) Prior Publication Data

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(30) Foreign Application Priority Data

Jan. 11, 2000 (JP) 2000-006016

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(52) U.S. Cl. 174/110 R; 174/112; 174/41; 385/102

(58) Field of Search 174/36, 110 R, 174/111, 115, 113 R, 40 R, 41, 45 R; 385/113, 114, 109, 136, 102

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Assistant Examiner—William H. Mayo, III

(74) Attorney, Agent, or Firm—McDermott, Will & Emery

(57) **ABSTRACT**

A cable and a cable stripping method which facilitates the stripping of an intermediate part of a cable having a cable core covered by a plastic sheath provided around the outer periphery without damaging the cable core. In a cable having a plastic sheath 2 on a cable core 1, either a groove 2a is provided in the inner surface of the plastic sheath 2 extending in the longitudinal direction of the cable. A ripcord 3 is either fitted in the groove 2a or adhered to the inner surface of the plastic sheath. In either case, the position-indicating means 2b showing the position of the ripcord is provided on the outer surface of the plastic sheath 2 at the point where the ripcord 3 is fitted.

4 Claims, 4 Drawing Sheets

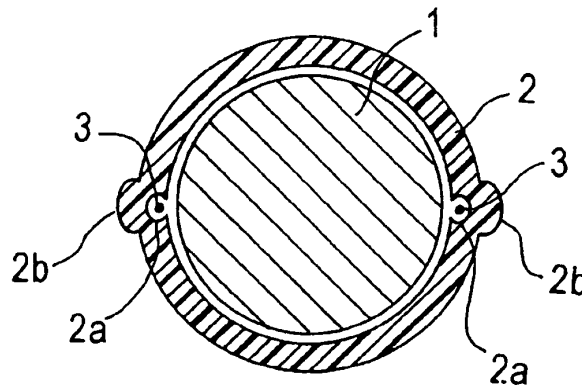


FIG. 1A

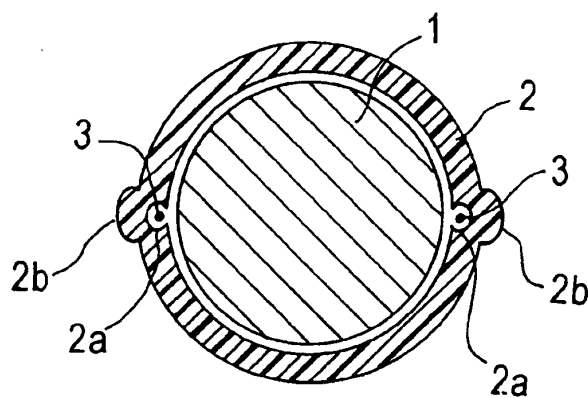


FIG. 1B

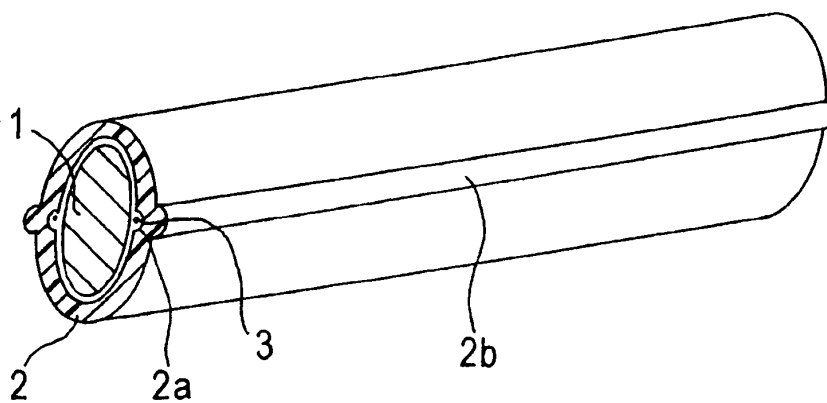


FIG. 2A

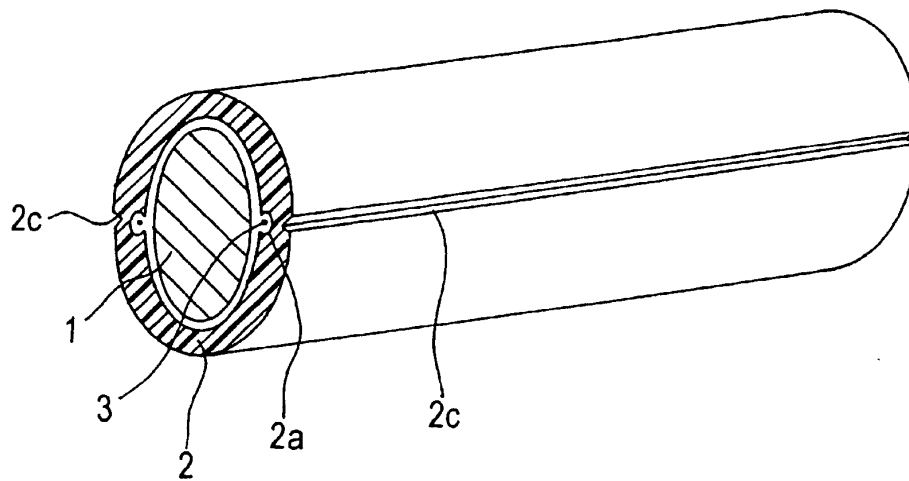


FIG. 2B

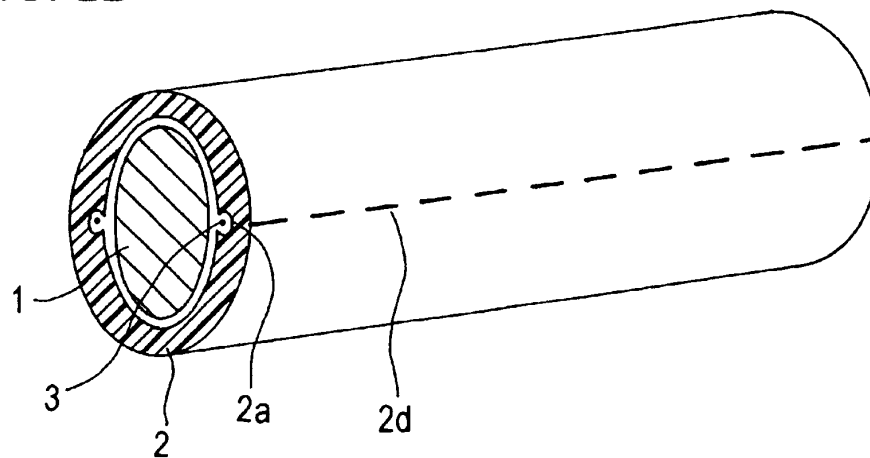


FIG. 3A

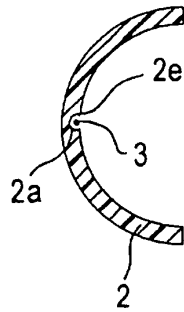


FIG. 3B

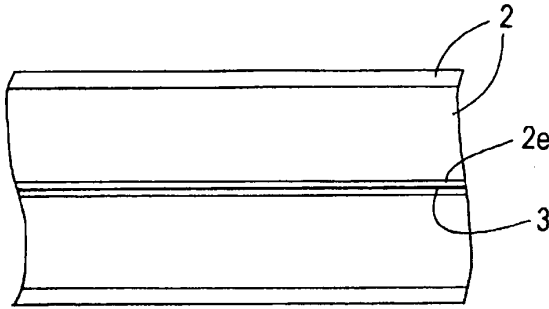


FIG. 4A

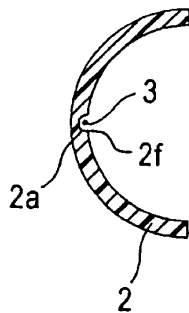


FIG. 4B

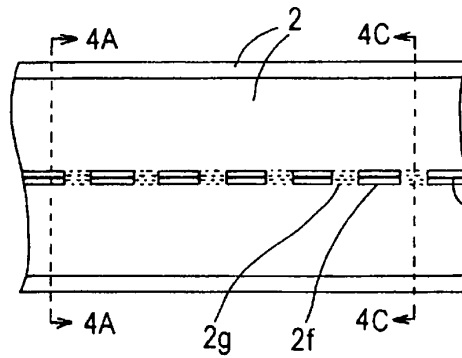


FIG. 4C

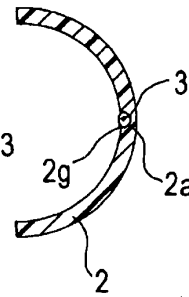


FIG. 5

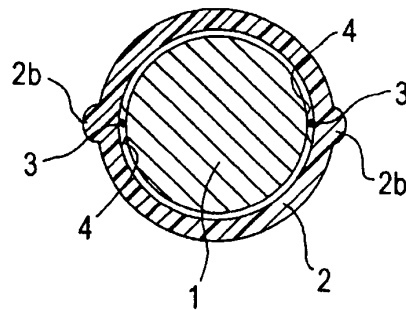


FIG. 6A

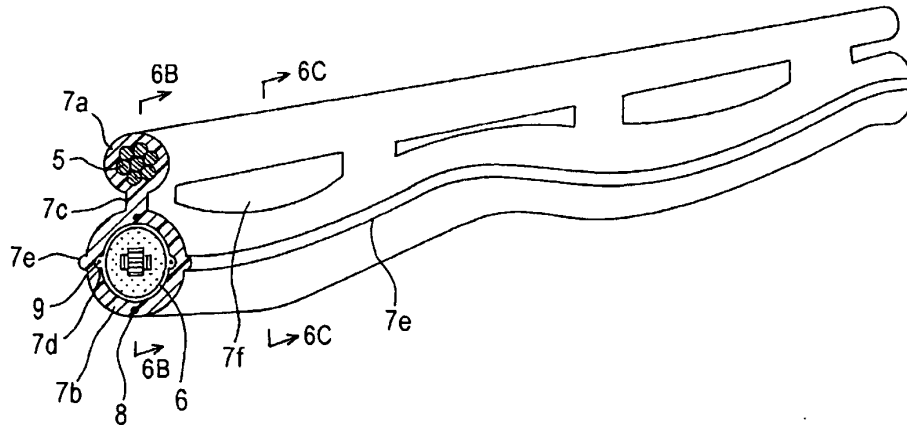


FIG. 6B

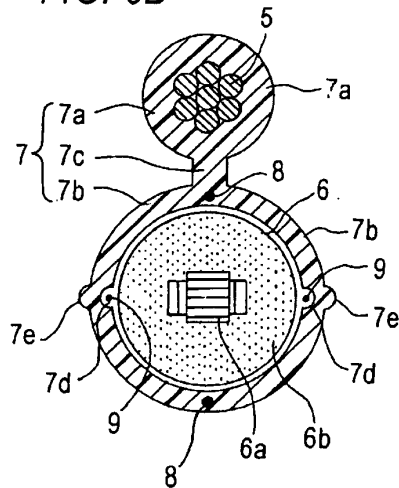
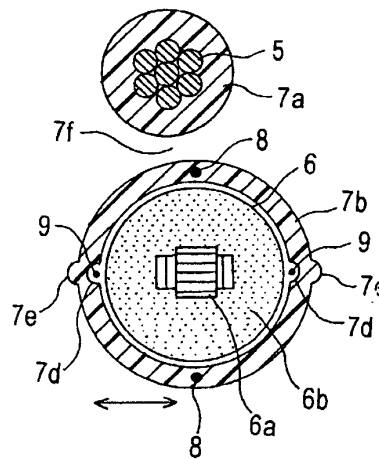


FIG. 6C



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CABLE, AND METHOD FOR REMOVING SHEATH AT INTERMEDIATE PART OF CABLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a cable with a ripcord, and a method for stripping an intermediate part of the cable.

2. Description of the Related Art

To remove the plastic sheath of a cable having a plastic sheath covering a cable core, first, a circumferential preparatory slit is made in the plastic sheath with a knife or the like at the end of the part to be removed. Then, one or two preparatory slits are made with a knife or the like in the longitudinal direction in the part of plastic sheath to be removed. These preparatory slits are then split open, and the plastic sheath is peeled off.

However, when making preparatory slits in a plastic sheath in the circumferential and longitudinal directions in this manner, great care is needed to avoid damage the cable core inside, and the work requires practice and skill.

Because of this, an alternative special tool for forming circumferential and longitudinal-direction preparatory slits has also been used to avoid damaging the cable core. However, different sizes of cable and different thicknesses and external diameters of sheaths and so on, require numerous different tools to be prepared, and the mechanism of the tool has been complicated.

A method has also been practiced wherein, to facilitate the removal the plastic sheath, a ripcord made, for example, of a tensile fiber is provided inside the plastic sheath in the longitudinal direction of the cable core, and the plastic sheath is removed using this ripcord.

In this method, the plastic sheath is split open in the longitudinal direction by pulling alongside the cable, an end of the ripcord extracted from an end of the cable back, and this split part of the plastic sheath is then cut off.

Thus, in this cable with a ripcord at an end, it is possible to strip off the plastic sheath easily, because an end of the ripcord can be extracted easily.

However, it is not easy to extract an end of the ripcord, at an intermediate part of the cable. This is because the location of the ripcord is not visible from the surface of the plastic sheath.

To extract the ripcord at an intermediate part of the cable, it is necessary to make a circumferential preparatory slit in the plastic sheath with a knife or the like and then locate and extract the ripcord.

Thus this case which also requires the operation of making a circumferential preparatory slit in the plastic sheath, requires great care and skill as well so as not to damage the cable core.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a cable and a stripping method with which the cable can be stripped easily without damaging the cable core even at an intermediate part of the cable.

The cable of this invention is a cable having a plastic sheath provided on a cable core; a groove extending in the longitudinal direction of the cable is formed in the inner surface of the plastic sheath, a ripcord is fitted in the groove, and a position-indicating means showing the position of the

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ripcord is provided on the outer surface of the plastic sheath in which the ripcord is fitted.

Alternatively, instead of providing the groove in the inner surface of the plastic sheath and inserting the ripcord into the groove, the ripcord can be fixed to the inner surface of the plastic sheath by direct adhesion and then a position-indicating means showing the position of the ripcord can be provided on the outer surface of the plastic sheath at the point where the ripcord is adhered.

A cable having a ripcord according to the invention can also be a self-supporting cable.

In a self-supporting cable, the cable is comprised of a supporting wire and a cable core, each covered with a plastic sheath, and the plastic sheath covering the supporting wire and the plastic sheath covering the cable core are connected to each other by plastic neck parts located intermittently in the longitudinal direction of the cable; also, on the side of the cable core plastic sheath nearest the supporting wire and the farthest side thereof from the supporting wire, a tensile member extending in the longitudinal direction is embedded in the sheath resin, respectively.

As a method of applying the invention to this kind of self-supporting cable, for example, in two locations of the plastic sheath, each 90° apart in the circumferential direction from the positions where the tensile members are embedded, either grooves extending in the longitudinal direction of the cable are provided in the inner surface of the plastic sheath and ripcords are fitted in the grooves, or ripcords are directly adhered to the inner surface of the plastic sheath, and a position-indicating means showing the positions of the ripcords are provided on the outer surface of the plastic sheath at the points where the ripcords are fitted or adhered.

When this is done, the operation of stripping an intermediate part of the self-supporting cable, facilitate the removal of the plastic sheath without damaging the cable core. And of course, the fundamental characteristics of the self-supporting cable are maintained. That is, because this self-supporting cable can tolerate wind pressures when used as an aerial cable, and also the cable core can be made to have surplus length, excessive tension does not act undesirably on the cable core and the cable is suitable as an optical fiber cable for subscriber line use.

In the case of the cable having on the outer surface of the plastic sheath a position-indicating means showing the position of the ripcords as described above, after the cable is installed, by cutting a part of the plastic sheath with a knife or the like at any intermediate position on the cable using the position-indicating means as a guide and then pulling the ripcords in the direction in which the plastic sheath is to be split, the plastic sheath can be split in the longitudinal direction of the cable, and this split part can then be cut off to expose the cable core. By means of this procedure even an intermediate part of the cable can be stripped easily, and thus simplifies intermediate branching work.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a sectional view and FIG. 1B a perspective view of a preferred embodiment of a cable according to the invention;

FIGS. 2A and 2B are perspective views showing other examples of position-indicators of cables according to the invention;

FIG. 3A is a sectional view and FIG. 3B a side view showing an example of a plastic sheath having a groove with a continuous opening;

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FIG. 4A is a sectional view on the line X—X, FIG. 4B a side view and FIG. 4C a sectional view on the line Y—Y showing an example of a plastic sheath having a groove with a non-continuous opening;

FIG. 5 is a sectional view showing another preferred embodiment of a cable according to the invention; and

FIG. 6A is a perspective view, FIG. 6B a sectional view on the line X—X and FIG. 6C a sectional view on the line Y—Y showing an example of the invention applied to a self-supporting cable for optical fiber use.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the invention will now be described in detail, using the accompanying drawings.

FIG. 1A is a sectional view and FIG. 1B a perspective view of a preferred embodiment of a cable according to the invention. In these figures, the reference numeral 1 denotes a cable core; 2 a plastic sheath; 2a a groove; 2b a position-indicator; and 3 a ripcord.

The cable core 1 is a cluster core made up of, for example, an optical fiber core, an insulated electric wire for communication use, an insulated electric wire for power use, and an insulated electric wire for control use, and the types of wires included in it are not particularly limited. The plastic sheath 2 is provided as a substantially circular tubular molding of thickness 1.3 mm to 2.0 mm on the outside of the cable core 1 by extrusion molding a plastic such as polyethylene or polyvinyl chloride resin.

The grooves 2a extend in the longitudinal direction of the cable in the inner surface of the plastic sheath 2, and the ripcords 3, each of which consists of an aramid fiber cord, a polyester fiber cord or a metal wire or the like, are fitted inside the grooves 2a. The grooves 2a in FIGS. 1A and 1B are hollows substantially circular in cross-section and having a part in the circumferential direction open, and their internal diameter is about 0.08 mm to 1.0 mm. The ripcords 3 fitted in the grooves 2a are preferably fiber cords of 2000 decitex to 5000 decitex. By using this kind of ripcord it is possible to split the plastic sheath 2 open in the longitudinal direction.

It is not necessary for the ripcords 3 to fit in the grooves 2a completely, and part of each of the ripcords 3 may project through the opening in the groove 2a. However, it is undesirable for the whole ripcord to slip out of the groove, because the position of the ripcord is then uncertain.

As a preventative method against the whole ripcord slipping out of the groove, the width of the opening may be made narrower than the thickness of the ripcord.

Position-indicating means 2b is provided on the outer surface of the plastic sheath 2 in the position where the ripcord 3 is fitted.

The grooves 2a and the position-indicators 2b can be formed for example by designing a nipple and a die used in extrusion-molding the plastic sheath to match their shapes. The ripcords 3 can be supplied in parallel with the cable core 1 and fitted in the grooves 2a simultaneously with the extrusion molding of the plastic sheath 2.

If the position-indicating means 2b is made in the form of a projecting tongue extending along the surface of the plastic sheath in the longitudinal direction as shown in the example of FIGS. 1A and 1B, the position at which the ripcord is fitted in the plastic sheath in the circumferential direction can be known at any position in the longitudinal direction of the cable.

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FIGS. 2A and 2B are perspective views showing other examples of position-indicating means: FIG. 2A shows an example wherein position-indicating means 2c is formed as a longitudinal notch, and FIG. 2B an example wherein position-indicating means 2d is formed as a line of dashes.

Because the position-indicating means provided on the outer surface of the plastic sheath need only show the position of the ripcord inside, provided that it extends in the longitudinal direction along the outer surface of the plastic sheath at the point where the ripcord is positioned and can be seen, it is not of particular significance whether the position-indicating means is a printed means or is a convexity or a concavity.

And although FIGS. 1A and 1B and FIGS. 2A and 2B show cases wherein there are two each of the grooves 2a, the ripcords 3 and the position indicators 2b, 2c and 2d, there may alternatively be one or three or more.

If two ripcords are fitted in positions 180° apart in the circumferential direction of the plastic sheath, even in the case of a relatively hard plastic sheath the cable core can be extracted from inside the plastic sheath easily, because the plastic sheath can be divided almost equally into two parts with the ripcords.

FIGS. 3A and 3B and FIGS. 4A through 4C are views showing other examples of forms of the groove. FIGS. 3A and 3B respectively are a sectional view and a side view of a plastic sheath having a groove with a continuous opening, and FIGS. 4A, 4B and 4C respectively are a sectional view on the line X—X, a side view and a sectional view on the line Y—Y of a plastic sheath having a groove with a non-continuous opening. In the figures, the reference numerals 2e and 2f denote openings and 2g a closure.

In the example shown in FIGS. 3A and 3B, the opening 2e of the groove 2a is open continuously in the longitudinal direction. In the example of FIGS. 4A through 4C, on the other hand, the opening 2f of the groove 2a is non-continuous in the longitudinal direction and openings 2f and closures 2g are formed alternately in the longitudinal direction in the form of a tear line. The openings 2f and the closures 2g do not need to be the same length, and nor do their respective lengths need to be fixed in the longitudinal direction.

Since the ripcord 3 is fitted inside the groove 2a and the cable core 1 is present inside the plastic sheath 2, normally the ripcord 3 does not slip out from the groove 2a. However, when the cable undergoes bending, for example when being installed, it is conceivable for the ripcord 3 to slip out from the groove 2a and fall into a gap between the cable core 1 and the plastic sheath 2. With respect to this, when the opening of the groove 2a is non-continuous and closures 2g are formed across it, the closures 2g perform the function of a lid and there is no risk of the ripcord 3 slipping out of the groove 2a.

Also, when grooves 2a and ripcords are disposed in two locations in the cross-section of the plastic sheath, when the plastic sheath 2 is split open with the ripcords 3 in the example shown in FIGS. 3A and 3B, the plastic sheath 2 is divided completely into two parts, and the cable core inside slips out from the plastic sheath 2. At this time, care must be taken to prevent the occurrence of accidents wherein the cable core having slipped out catches on another member for connection use or the like and is damaged.

In the example of FIGS. 4A through 4D, on the other hand, even when the plastic sheath 2 has been split open with the ripcords 3, because the plastic sheath 2 is not completely divided into two parts and is still held together by the sheath

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resin forming the closures 2g, the cable core does not spontaneously slip out. And because the resin thickness of the closures 2g is extremely thin and the plastic sheath 2 can be easily divided into two by being pulled, by gradually dividing the plastic sheath 2 at the closures 2g progressively in the longitudinal direction it is possible to extract the cable core from inside the plastic sheath smoothly.

The non-continuous opening structure of the groove 2a shown in FIGS. 4A through 4D can for example be manufactured by intermittently opening and closing a resin flow passage between a nipple and a die used to extrude the plastic sheath.

FIG. 5 is a sectional view showing another preferred embodiment of a cable according to the invention. In this cable no equivalent of the grooves of the cable shown in FIGS. 1A and 1B is provided, and instead the ripcords 3 are fixed with an adhesive 4. Position-indicating means 2b provided on the outer surface of the plastic sheath 2 is the same as that in FIGS. 1A and 1B.

The fixing of the ripcords 3 to the inner surface of the plastic sheath 2 by means of the adhesive 4 can be carried out for example by supplying ripcords coated with the adhesive at the time of extrusion of the plastic sheath 2 and pressing them against the inner surface of the plastic sheath.

FIG. 6A is a perspective view on the line X—X, FIG. 6B a sectional view and FIG. 6C a sectional view on the line Y—Y showing an example of the invention applied to a self-supporting cable for optical fiber use. In these figures, the reference numeral 5 denotes a supporting wire; 6 a cable core; 6a an optical fiber ribbon; 6b a protective fiber cord; 7 a plastic sheath; 7a a supporting wire side plastic sheath; 7b a cable core side plastic sheath; 7c a neck part; 7d a groove; 7e position-indicating means; 7f a window; 8 a tensile member; and 9 a ripcord.

The cable core 6 of this cable in FIGS. 6A through 6C, consists of multiple optical fiber ribbons 6a stacked and protected by a protective fiber cord 6b such as a polypropylene cord, and this cable core is covered by the cable core side plastic sheath 7b; however, the cable core 6 may alternatively be a cluster of insulated electric wires for communication use or the like.

In the cable core 6 of FIGS. 6A through 6C, to make the side have extra length with respect to the supporting wire 5 side, the cable core 6 side is connected to the supporting wire 5 side by neck parts 7c intermittently in the longitudinal direction in a snaking state. The parts between the neck parts 7c constitute windows 7f in the longitudinal direction and perform the function of alleviating stresses caused by wind pressure and the like when the cable is installed aerially. The supporting wire 5 is made for example from zinc-plated steel stranded wire of fiber reinforced plastic (FRP) or the like.

And, in the cable shown in FIGS. 6A through 6C, in a location on the side of the cable core side plastic sheath 7b nearest to the supporting wire and another location on the side farthest from the plastic sheath, tension members 8 consisting of steel wires or the like are embedded in the sheath resin, extending in the longitudinal direction. These tension members 8 hold the cable core side plastic sheath 7b to prevent it from contracting in the longitudinal direction, and fulfil the role of holding the extra length of the cable core at a predetermined value.

And, in this cable, in two locations 90° away from the tension members 8 in the circumferential direction of the cable core side plastic sheath 7b, grooves 7d are provided in the inner surface of the cable core side plastic sheath 7b, and the ripcords 9 are fitted in these grooves 7d.

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These grooves 7d have openings and closures of the kind shown in FIGS. 4A through 4C so that the ripcords 9 do not slip out of the grooves 7d.

Also, position-indicating means 7e showing the positions of the ripcords are provided on the outer surface of the plastic sheath 7b at the points where the ripcords 9 are disposed.

The position-indicating means shown in FIGS. 2A and 2B can alternatively be employed.

It is also possible for the ripcords 9 to be fixed to the inner surface of the plastic sheath 7b with adhesive, instead of the grooves being formed and the ripcords being fitted in the grooves.

In all of the cables described above with reference to FIGS. 1A through 6C, a ripcord is disposed in a predetermined position extending in the longitudinal direction along the inner surface of a plastic sheath provided on a cable core, and a position-indicating means showing the position of the ripcord is provided on the outer surface of the plastic sheath in the position where the ripcord is disposed.

Therefore, at any position on an intermediate part of the cable, by shaving the plastic sheath with a knife or the like with the position-indicating means as a guide, the ripcord can be exposed and easily pulled out without damaging the cable core.

By pulling in a direction in which the plastic sheath is to be split the ripcord that has been pulled out through the shaved part of the plastic sheath, it is possible to split the plastic sheath in the longitudinal direction. If one or two splits can be formed in the plastic sheath, the cable core can be extracted through them. And the part of the plastic sheath from which the cable core has been removed can be cut off without risk of damaging the cable core. In this way, it is possible to remove the plastic sheath easily and expose the cable core for intermediate branching or the like at any position on the intermediate part of the cable in the longitudinal direction.

When a ripcord made of a tensile fiber bundle is pulled out through a shaved part of the plastic sheath, it may result in only a part of the fiber bundle being pulled out as opposed to the entire fiber bundle. To avoid this, if the tensile fiber bundle of the ripcord is provided with a coating of, for example, a resin hardened by ultraviolet light, when the ripcord is pulled out the entire ripcord can be pulled out without any of the fiber bundle remaining inside the plastic sheath.

As described above, because a cable according to this invention has a groove in the inner surface of a plastic sheath provided on a cable core and a ripcord is fitted in this groove and a position-indicating means is provided on the outer surface of the plastic sheath in a position corresponding to that in which the ripcord is fitted, even at an intermediate part of the cable, by shaving off a portion of the plastic sheath with a knife or the like using the position-indicating means as a guide, it is possible to pull out the ripcord without damaging the cable core. By pulling the ripcord in the direction in which the plastic sheath is to be split and thereby splitting the plastic sheath and then extracting the cable core from inside the plastic sheath and then cutting off such part of the plastic sheath, it is possible to strip the cable without damaging the cable core.

And also if the position of the ripcord is fixed by directly adhering the ripcord to the inner surface of the plastic sheath, instead of forming a groove in the inner surface of the plastic sheath and fitting the ripcord therein, the operation of stripping an intermediate part of the cable can be

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carried out in the same way. And because the ripcord fixed with adhesive does not slip in the longitudinal direction, even when an intermediate part of the cable to be stripped is near an end of the cable and thus near an end of the ripcord, when the ripcord is pulled to split the plastic sheath, the plastic sheath can still be split with the ripcord, because the ripcord does not slip in the longitudinal direction.

The method provided by the present invention of disposing a ripcord in a predetermined position inside a plastic sheath and providing a position-indicating means on the outer surface of the plastic sheath can also be applied to a self-supporting cable, wherein a supporting wire and a cable core are each covered with a plastic sheath and the plastic sheath of the supporting wire side and the plastic sheath of the cable core side are connected to each other intermittently in the longitudinal direction of the cable by plastic constituting neck parts.

What is claimed is:

1. A cable having a plastic sheath provided around the outer periphery of a cable core, wherein:
 - a groove is provided extending in the cable longitudinal direction in the inner surface of the plastic sheath and a ripcord is fitted in the groove; and a position-indicating means showing the position of the ripcord is provided on the outer surface of the plastic sheath at the point where the ripcord is fitted, wherein an opening of

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the groove is non-continuous in the longitudinal direction of the cable.

2. A cable according to claim 1, wherein the ripcord is a tensile fiber coated with a layer of resin.

3. A cable having a supporting wire and a cable core each covered with a plastic sheath, the plastic sheaths of the supporting wire and the cable core being connected intermittently in the longitudinal direction of the cable by plastic constituting neck parts, wherein tension members are embedded in the longitudinal direction in a sheath resin of the side of the plastic sheath covering the cable core nearest the supporting wire and of the side farthest from the supporting wire; wherein grooves are provided extending in the cable longitudinal direction in the inner surface of the plastic sheath in two locations set apart by a predetermined angle in the circumferential direction from the positions of the tension members in such a plastic sheath ripcords are fitted in the grooves; and a position-indicating means showing the positions of the ripcords are provided on the outer surface of the plastic sheath at the point where the ripcords are fitted, wherein an opening of each of the grooves is non-continuous in the longitudinal direction of the cable.

4. A cable according to claim 3, wherein each of the ripcords is a tensile fiber bundle coated with a layer of resin.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,545,222 B2
DATED : April 8, 2003
INVENTOR(S) : Tomoyuki Yokokawa et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 8,

Line 17, change "in such a plastic sheath ripcords are fitted" to -- in such a plastic sheath and ripcords are fitted --.

Signed and Sealed this

Sixteenth Day of September, 2003

A handwritten signature in black ink, appearing to read "James E. Rogan", with a horizontal line drawn underneath it.

JAMES E. ROGAN
Director of the United States Patent and Trademark Office



US005524937A

United States Patent [19]

Sides, III et al.

[11] Patent Number: 5,524,937
[45] Date of Patent: Jun. 11, 1996

[54] INTERNAL COILED TUBING CONNECTOR

[75] Inventors: Winfield M. Sides, III, Houston;
Tracey Tollefsbol, Spring, both of Tex.

[73] Assignee: Camco International Inc., Houston,
Tex.

[21] Appl. No.: 349,913

[22] Filed: Dec. 6, 1994

[51] Int. Cl.⁶ F16L 47/00

[52] U.S. Cl. 285/133.1; 285/286; 285/323;
285/370

[58] Field of Search 285/131, 132,
285/133.1, 370, 286, 323

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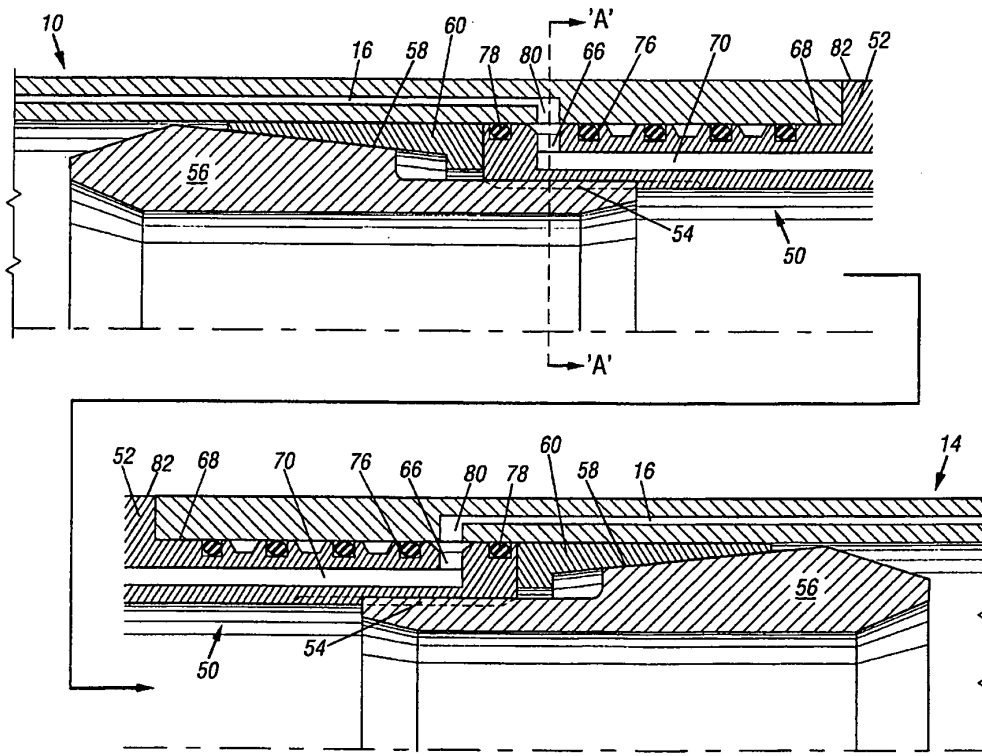
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Primary Examiner—Dave W. Arola

[57] ABSTRACT

An internal coiled tubing connector for connecting a first length of coiled tubing to a second length of coiled tubing includes a cylindrical body having a longitudinal bore therethrough and adapted to be inserted into the first length and the second length of coiled tubing; a by-pass passageway extending from a first opening in a longitudinal outer surface of the cylindrical body to a second opening in the longitudinal outer surface of the cylindrical body; and elastomeric seals mounted to the longitudinal outer surface of the cylindrical body adjacent the first opening and the second opening. When the first opening is placed in communication with a passageway within a wall of the first length of coiled tubing and when the second opening is placed in communication with a passageway within a wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

15 Claims, 11 Drawing Sheets



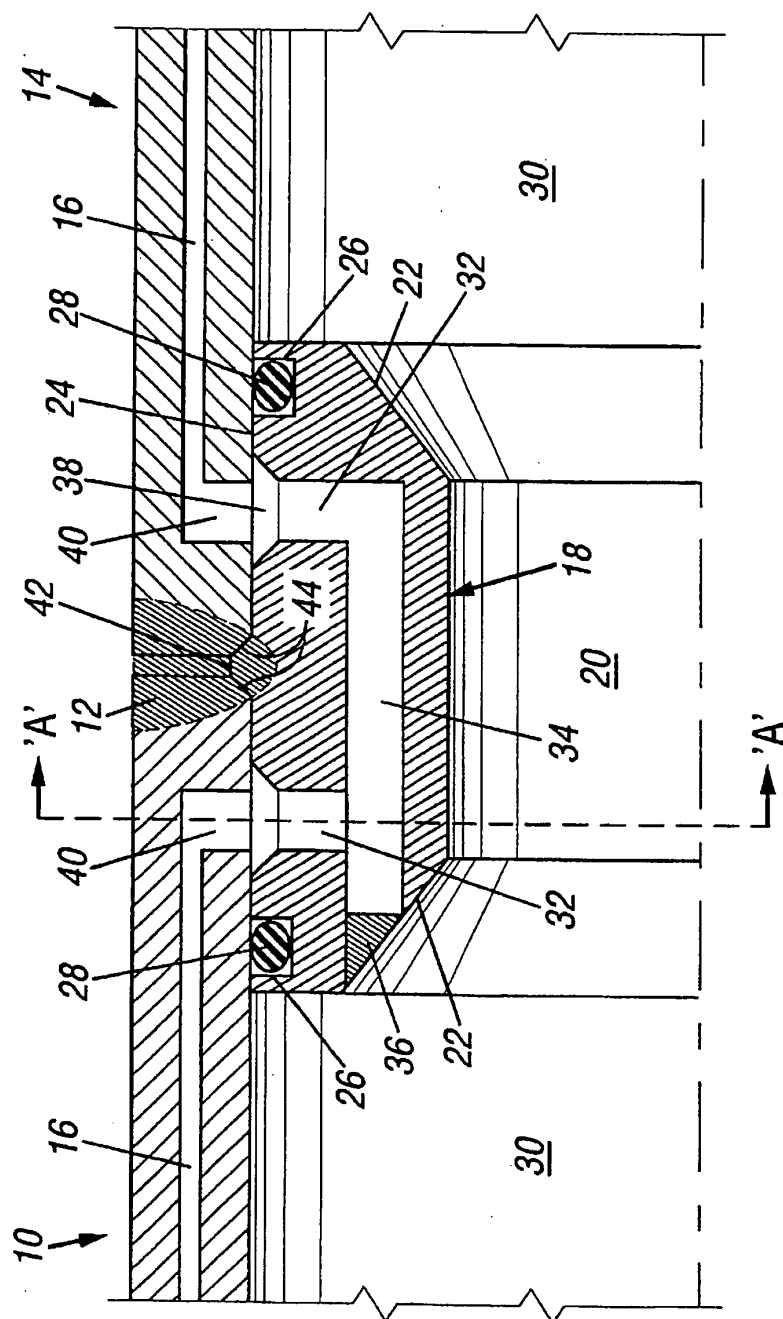
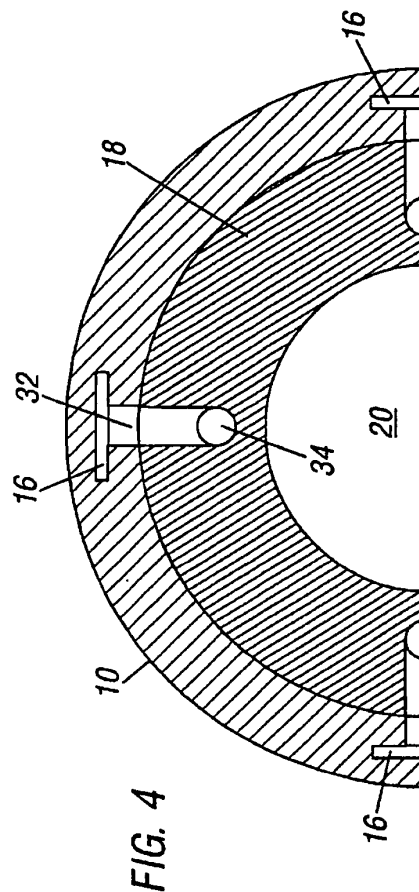
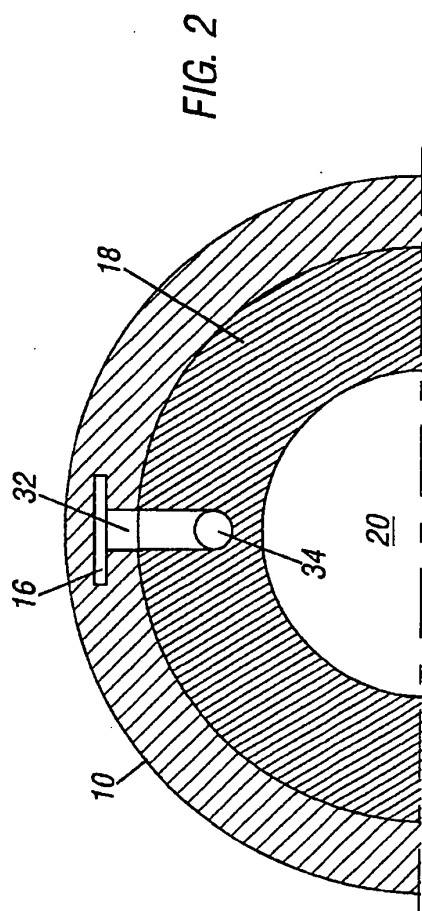


FIG. 1



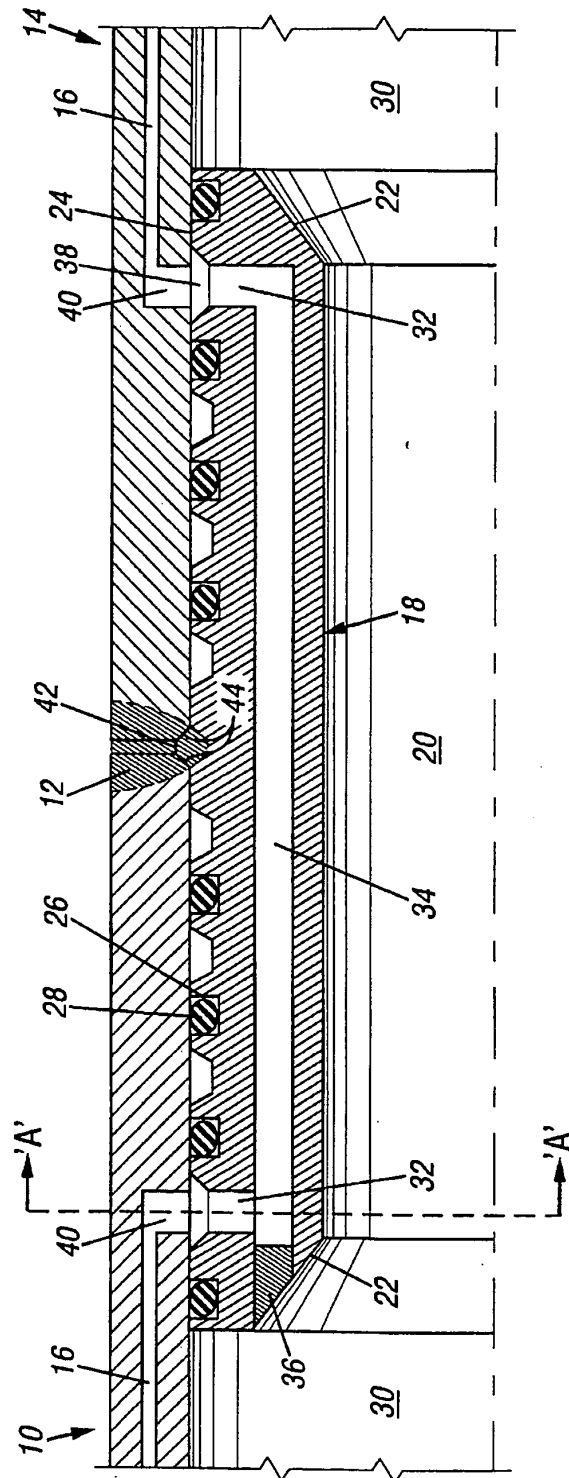


FIG. 3

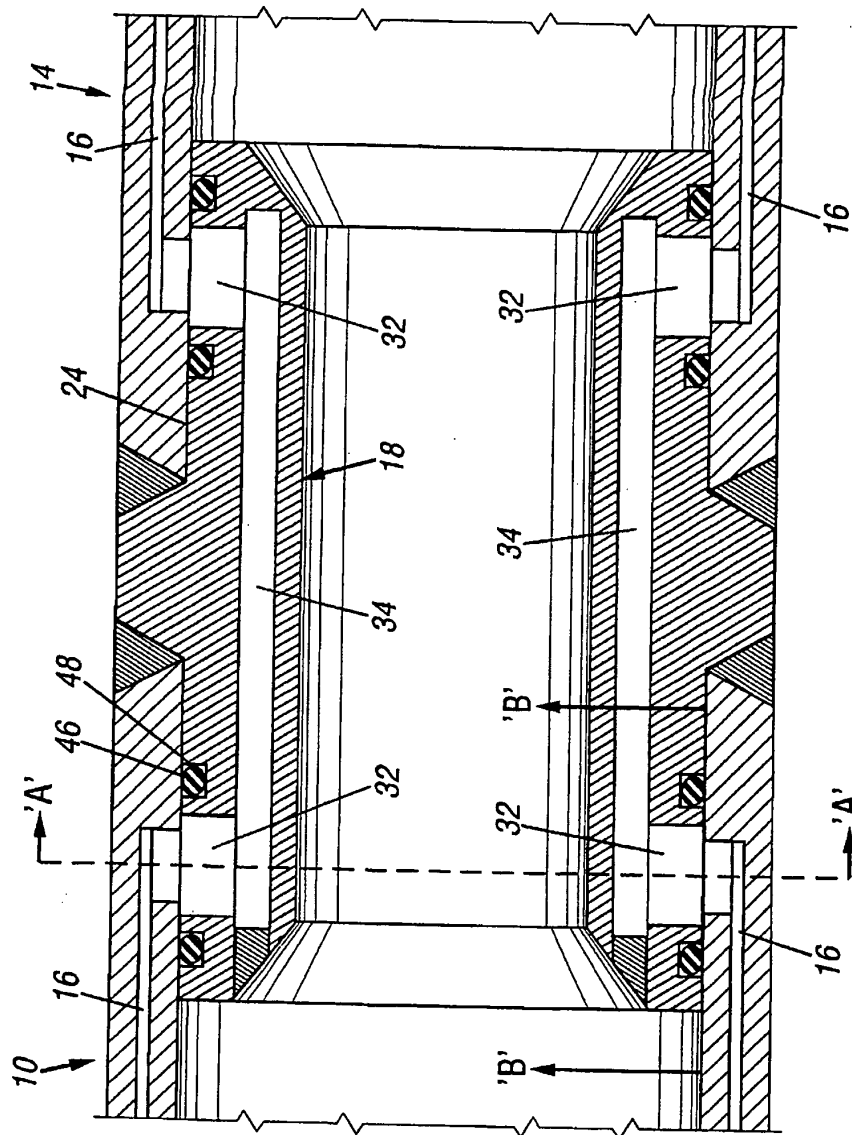


FIG. 5

FIG. 7

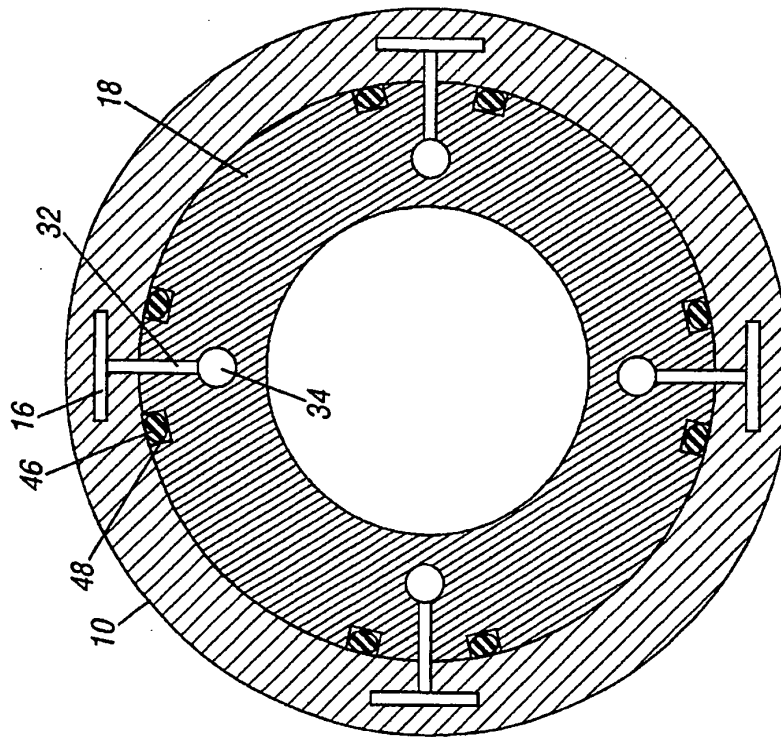
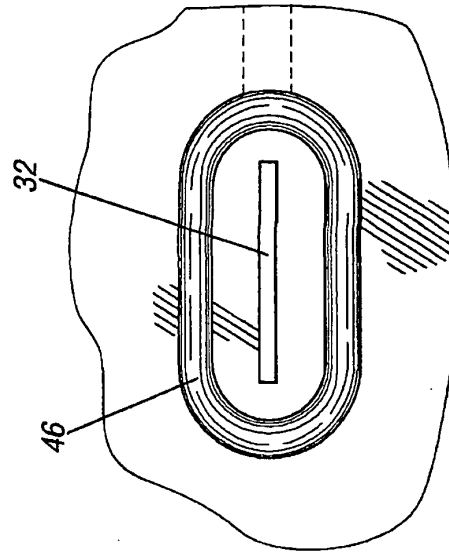
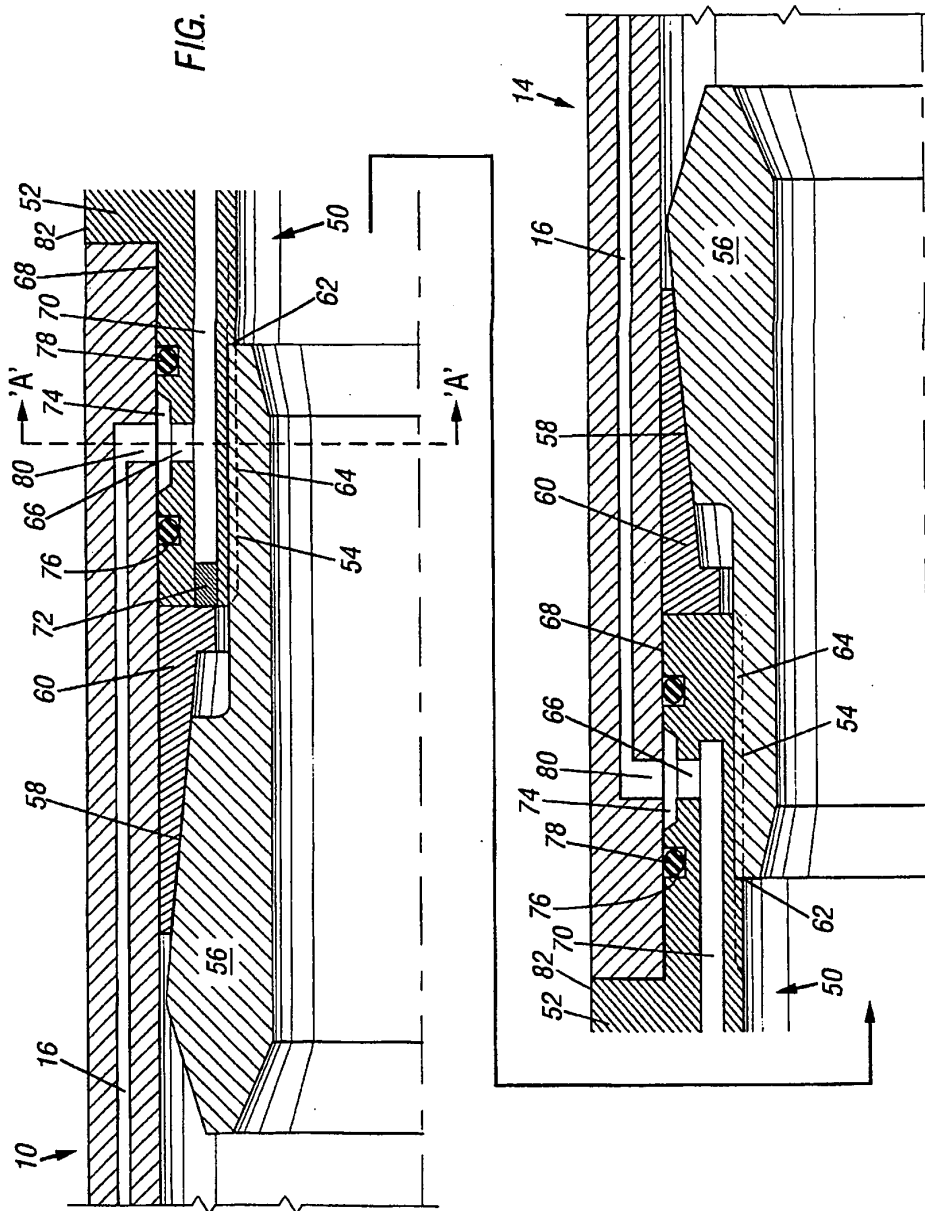
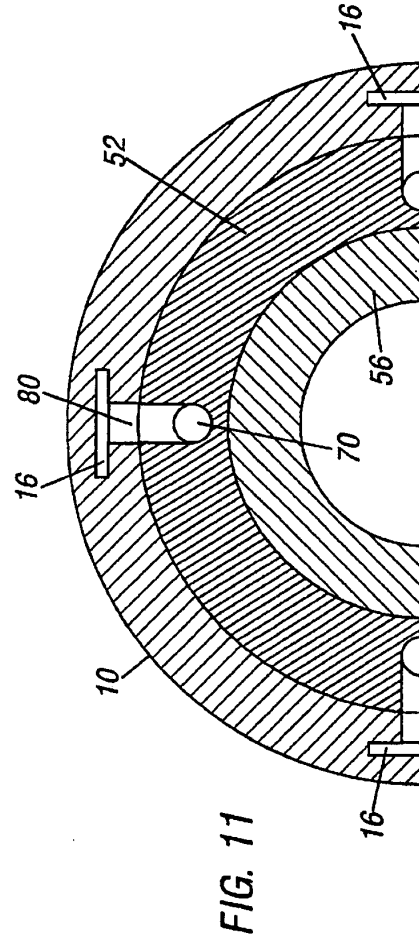
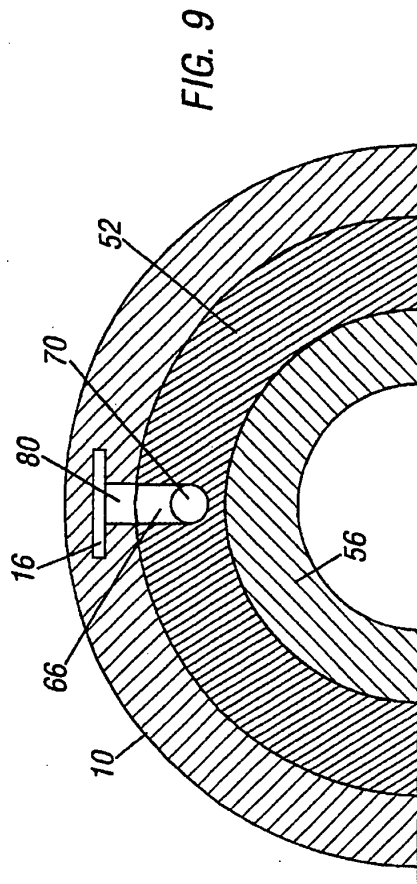
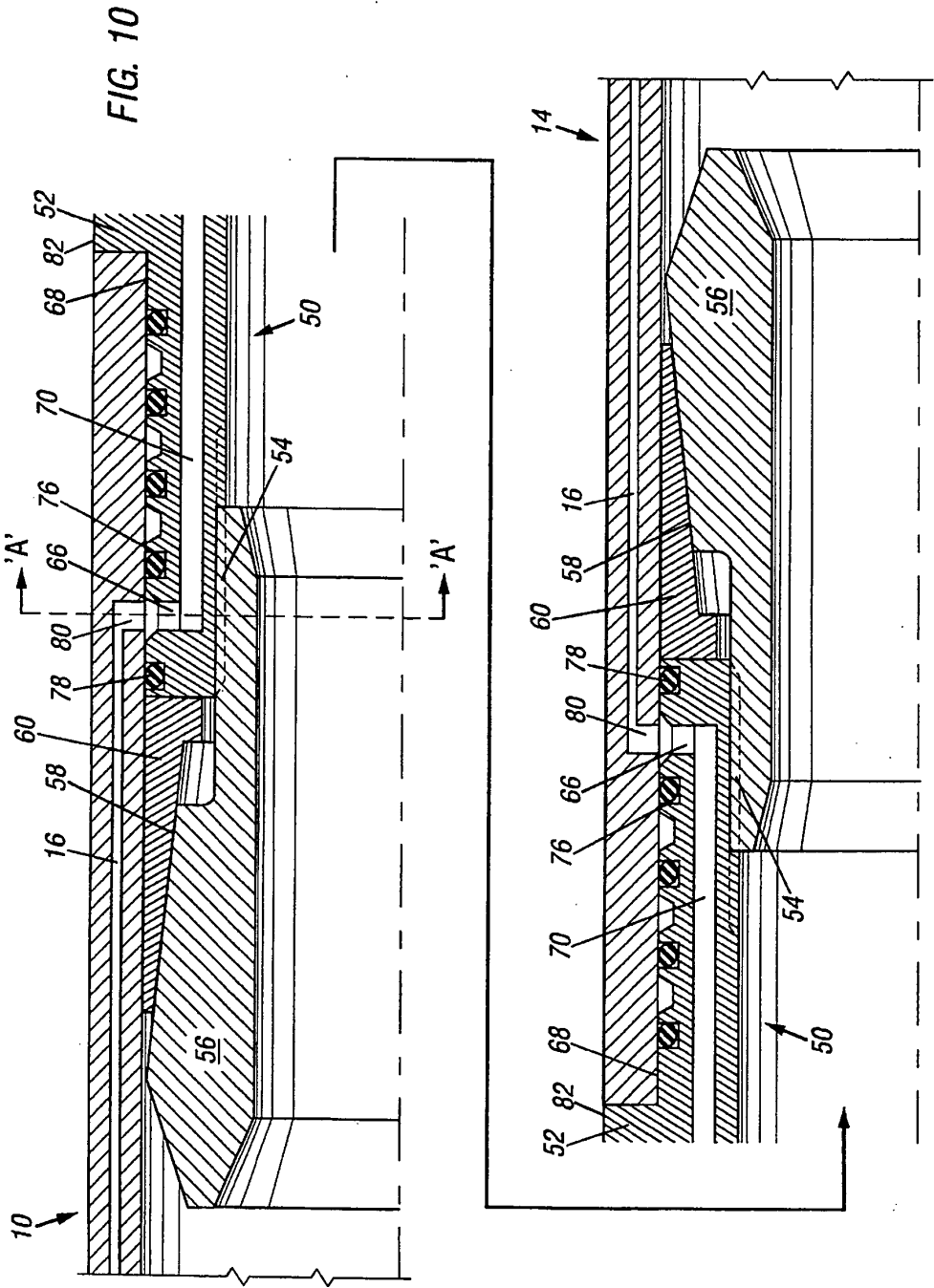


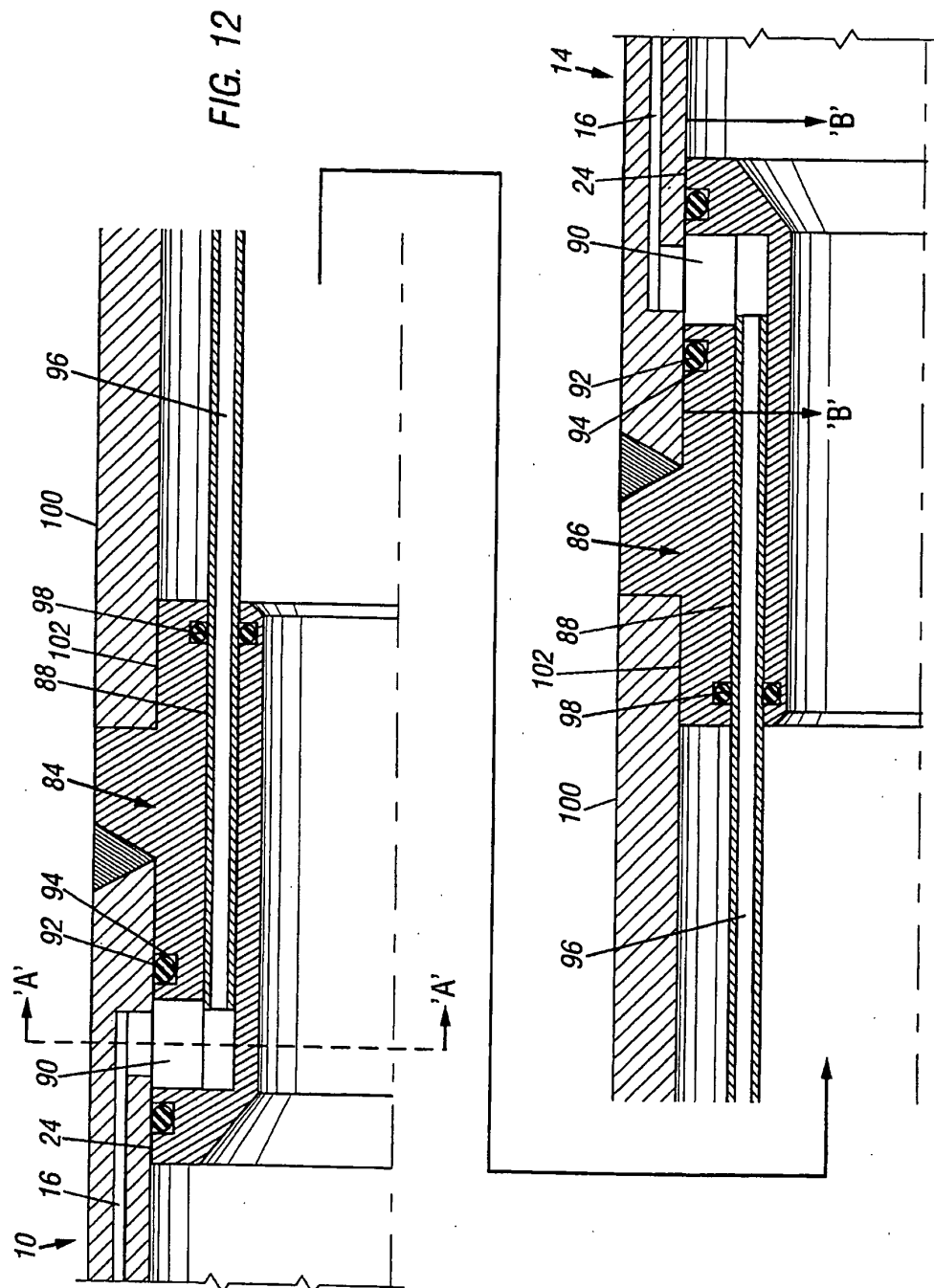
FIG. 6

FIG. 8









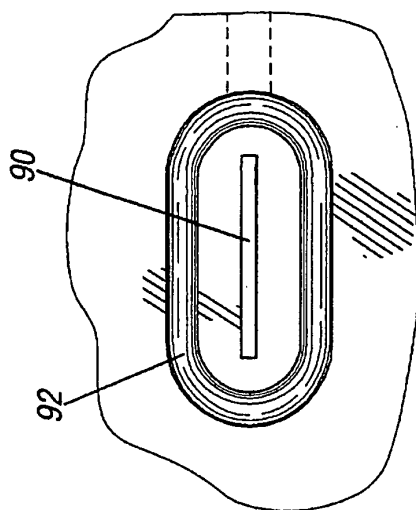


FIG. 14

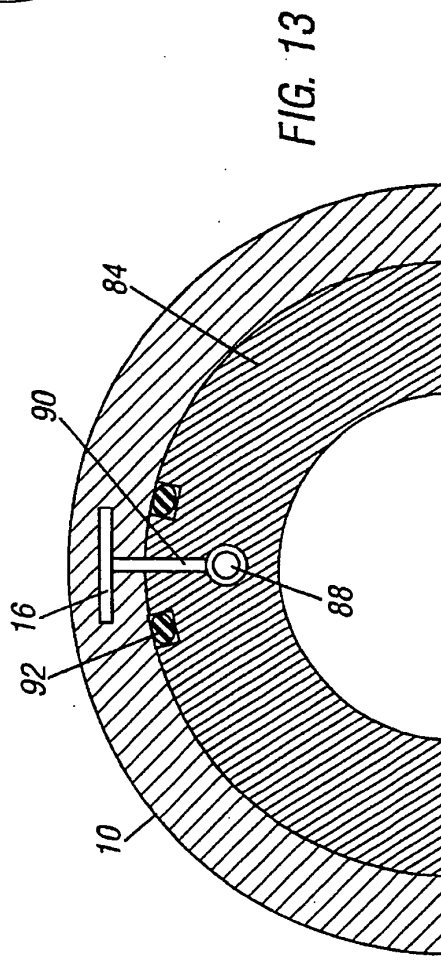


FIG. 13

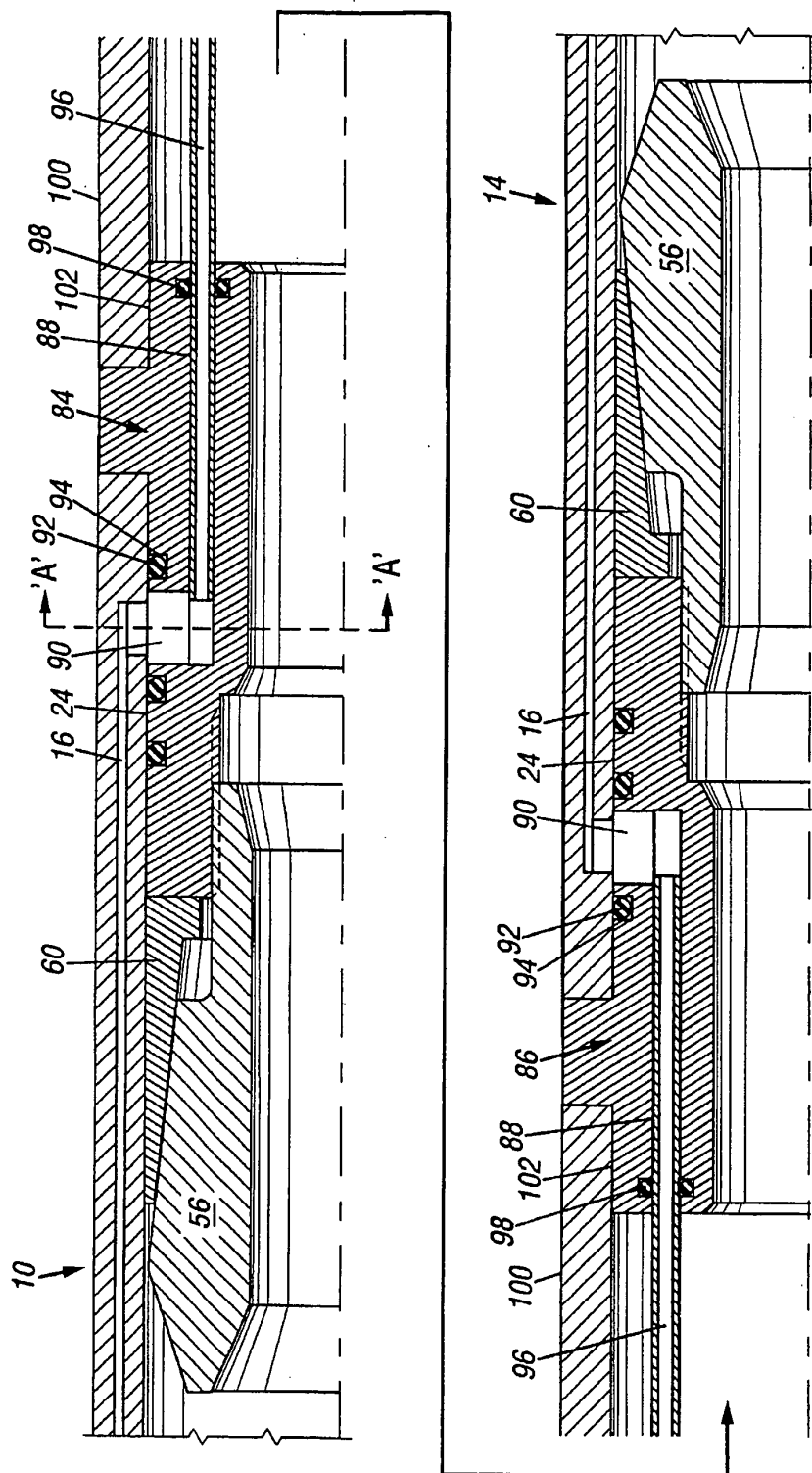


FIG. 15

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INTERNAL COILED TUBING CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an internal coiled tubing connector and, more particularly, to a connector that provides communication for internal passageways across a connection between lengths of coiled tubing.

2. Description of Related Art

Coiled tubing is used to provide a fluid passage within a wellbore, as well as to convey tools and equipment into and from a wellbore. Lengths of coiled tubing need to be joined in a manner wherein the external diameter remains constant to accommodate the spooling of the coiled tubing lengths on reels and passage of through the injector mechanisms. Examples of internal coiled tubing connectors are disclosed in U.S. Pat. Nos. 5,238,273 and 5,306,050, which are commonly assigned hereto.

Oftentimes downhole tools and equipment conveyed by coiled tubing require electrical and/or hydraulic control lines that are either disposed within the internal bore of the coiled tubing or are attached to the outer surface of the coiled tubing. The control lines within the coiled tubing render it difficult to impossible to perform wireline operations through the coiled tubing because the wireline tool can become tangled with the control lines. The control lines on the outside of the coiled tubing can become damaged when the coiled tubing is inserted into and withdrawn from the wellbore. Further, control lines on the outside of the coiled tubing hinder the packing off or sealing of the wellbore. To overcome these deficiencies, coiled tubing with an internal passageways within the wall of the coiled tubing has been developed. Such coiled tubing is disclosed within copending U.S. patent application No. 08/142,637, which is commonly assigned hereto.

There is a need for an internal coiled tubing connector that can provide for communication for the passageways within the wall of the coiled tubing across the connection between the lengths of such coiled tubing.

SUMMARY OF THE INVENTION

The present invention has been contemplated to overcome the foregoing deficiencies and meet the above described needs. Specifically, the present invention is an internal coiled tubing connector for connecting a first length of coiled tubing, which has at least one passage in the wall thereof, to a second length of similar coiled tubing. The internal coiled tubing connector includes a cylindrical body having a longitudinal bore therethrough and adapted to be inserted into the first length and the second length of coiled tubing; a by-pass passageway extending from a first opening in a longitudinal outer surface of the cylindrical body to a second opening in the longitudinal outer surface of the cylindrical body; and elastomeric seals mounted to the longitudinal outer surface of the cylindrical body adjacent the first opening and the second opening. When the first opening is placed in communication with a passageway within a wall of the first length of coiled tubing and when the second opening is placed in communication with a passageway within a wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is side elevational view in cross-section of one preferred embodiment of an internal coiled tubing connector

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welded within coiled tubing having a single internal passageway.

FIG. 2 is a view taken along line A—A of FIG. 1.

FIG. 3 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector welded within coiled tubing having a plurality of internal passageways.

FIG. 4 is a view taken along line A—A of FIG. 3.

FIG. 5 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector welded within coiled tubing having a plurality of internal passageways.

FIG. 6 is a view taken along line A—A of FIG. 5.

FIG. 7 is a view taken along line B—B of FIG. 5.

FIG. 8 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector mounted using wedge and slip mechanisms within coiled tubing having a single internal passageway.

FIG. 9 is a view taken along line A—A of FIG. 8.

FIG. 10 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector mounted using wedge and slip mechanisms within coiled tubing having a plurality of internal passageways.

FIG. 11 is a view taken along line A—A of FIG. 10.

FIG. 12 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector formed from two separate bodies welded within coiled tubing having at least one internal passageway.

FIG. 13 is a view taken along line A—A of FIG. 12.

FIG. 14 is a view taken along line B—B of FIG. 12.

FIG. 15 is side elevational view in cross-section of an alternate preferred embodiment of an internal coiled tubing connector formed from two separate bodies mounted using wedge and slip mechanisms within coiled tubing having at least one internal passageway.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As has been briefly described above, the present invention is an internal coiled tubing connector for providing internal passageway communication across a connection between a first length and a second length of coiled tubing. One preferred embodiment of the present invention includes a cylindrical body having a longitudinal bore therethrough and adapted to be inserted into the first length and the second length of coiled tubing; a by-pass passageway extending from a first opening in a longitudinal outer surface of the cylindrical body to a second opening in the longitudinal outer surface of the cylindrical body; and elastomeric seals mounted to the longitudinal outer surface of the cylindrical body adjacent the first opening and the second opening. When the first opening is placed in communication with a passageway within a wall of the first length of coiled tubing and when the second opening is placed in communication with a passageway within a wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

The present invention can be used to provide a by-pass passageway for fluids and control lines, electrical control lines and/or fiber optics across a connection of a first length of coiled tubing to a second length of coiled tubing. These fluid passageways, electrical control lines and/or fiber optics

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can be strung within the internal bore of the coiled tubing; however, the present invention is particularly adapted to provide the by-pass passageway for coiled tubing that has at least one internal passageway within the wall of the coiled tubing. Such coiled tubing is disclosed within copending U.S. patent application 08/142,637, which is commonly assigned hereto and which is incorporated herein by reference.

As used herein the term "communication" means the ability to pass hydraulic control and actuation fluids, even at elevated pressures, as well as the provision of a route for electrical wires and/or fiber optics within an encapsulated and protected environment.

In FIG. 1 a first length 10 of coiled tubing is shown connected by a welded joint 12 to a second length 14 of coiled tubing. At least one internal passageway 16 is provided within a wall 18 of the coiled tubing 10 and 14. As can be seen in FIG. 1, the welded joint 12 extends across and thereby will block the internal passageways 16 at the connection. Therefore, the present invention is provided to by-pass the welded joint 12 and thereby ensure communication through the internal passageways 16 in the coiled tubing 10 and 14. One preferred embodiment of the present invention is shown in FIG. 1 wherein a generally cylindrical body 18 includes a longitudinal bore 20 extending there-through. The outer diameter of the cylindrical body 18 is less than the internal diameter of the coiled tubing 10 and 14. The edges of the cylindrical body 18 adjacent the bore 20 are shown with flats or bevels 22, which are preferred to assist wireline equipment and fluids to freely pass through the bore 20, but the bevels 22 are not necessary to establish communication across the connector.

An outer longitudinal surface 24 of the cylindrical body 18 includes an annular recess 26 adjacent a first end and adjacent a second end thereof, and an annular elastomeric seal 28 is mounted within each recess 26. The seals 28 can be O-rings formed from any suitable elastomeric material, and are preferably formed from Aflas, Viton or nitrile rubber. The seals 28 provide a fluidic seal across the longitudinal outer surface 24 of the cylindrical body 18 when the seals 28 engage an inner surface of the longitudinal bore 30 within the coiled tubing 10 and 14.

As shown in FIGS. 1 and 2, at least two spaced bores 32 extend from the outer surface 24 of the cylindrical body 18 partially thereinto to intersect a longitudinal bore 34 extending partially through the cylindrical body 18. If the longitudinal bore 34 is formed by drilling, then a plug 36 of suitable metallic material seals an open end of the longitudinal bore 34. The outer surface 24 is provided with a counter bore at the intersection of the bores 32 with the outer surface 24 of the cylindrical body 18. Preferably, the outer surface 24 includes annular recesses 38 through which the bores 32 extend into the cylindrical body 18. The bores 32 and the longitudinal bore 34 define a by-pass passageway that provides a means for permitting communication between the internal passageways 16 of the coiled tubing 10 and 14 across the welded joint 12.

When the internal coiled tubing connector of the present invention is to be used, the internal passageways 16 within the coiled tubing 10 and 14 are cut, milled or drilled to create openings 40 adjacent the ends of the coiled tubing 10 and 14 to provide a passageway for communication into and from the bore 30 of the coiled tubing 10 and 14. The cylindrical body 18 is inserted into the first length of coiled tubing 10 so that one of the bores 32 is spaced adjacent and in communication with opening 40 in the passageway 16 of the

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coiled tubing 10. Likewise, the second length 14 of coiled tubing is brought into surrounding engagement with an opposite end of the cylindrical body 18 with the other bore 32 spaced adjacent and in communication with the opening 40 in the passageway 16 of the second length 14 of coiled tubing. To help ensure that the cylindrical body 18 is centered at the point of connection of the coiled tubing, an annular ridge 42 is provided at approximately the center line of the outer surface 24 of the cylindrical body 18, which is preferably the midway point between the bores 32. The outer diameter of the ridge 42 being greater than the internal diameter of the bore 30 in the coiled tubing 10 and 14 so that the cylindrical body 18 cannot move within the bore 30 of the coiled tubing 10 and 14. The annular ridge 42 fits within a bevel 44 formed on an inner edge of the ends of the coiled tubing 10 and 14. The ends of the coiled tubing 10 and 14 are then welded, as is well known to those skilled in the art, to create the welded joint 12. As shown in FIG. 1, the molten material generated during the welding process extends partly into the cylindrical body 18 so securely mount the cylindrical body 18 within the coiled tubing 10 and 14 at the point of connection.

Hydraulic fluid, electrical control lines and/or fiber optics are passed through the passageway 16 of the first length 10 of coiled tubing, through the bore 32, through the bore 34, through the other bore 32, and then into the passageway 16 of the second length 14 of coiled tubing. The use of the internal coiled tubing connector of the present invention permits lengths of coiled tubing to be connected and permit internal passageway communication that has not been available heretofore.

An alternate preferred embodiment of the internal coiled tubing connector of the present invention is shown in FIGS. 3 and 4 wherein the coiled tubing 10 and 14 include a plurality of passageways 16 with each radially spaced around the wall of the coiled tubing 10 and 14. To permit separate communication across the connection of the coiled tubing 10 and 14, a plurality of longitudinal bores 34 are spaced radially around the cylindrical body 18. Each such longitudinal bore 34 is intersected by its own respective set of bores 32 longitudinally spaced along the outer surface 24 of the cylindrical body 18. To prevent fluid communication between the respective sets of bores 32, the outer surface 24 is provided with a plurality of recesses 26 with elastomeric annular seals 28 mounted therein. The installation and the operation of this preferred embodiment of an internal coiled tubing connector of the present invention is essentially the same as for the embodiment described above in reference to FIGS. 1 and 2.

An alternate preferred embodiment of the internal coiled tubing connector of the present invention is shown in FIGS. 5, 6 and 7 wherein the coiled tubing 10 and 14 include a plurality of passageways 16 with each radially spaced around the wall of the coiled tubing 10 and 14. To permit separate communication across the connection of the coiled tubing 10 and 14, a plurality of longitudinal bores 34 are spaced radially around the cylindrical body 18. Each such longitudinal bore 34 is intersected by its own respective set of bores 32 radially spaced, and not longitudinally spaced as in FIGS. 3 and 4, around the outer surface 24 of the cylindrical body 18. To prevent fluid communication between the respective sets of bores 32, the outer surface 24 is not provided with annular recesses 26, annular O-ring seals 28 and recesses 38 (as shown in FIGS. 3 and 4), but is provided with a generally oval elastomeric seal 46 mounted within a respective oval recess 48 formed within the outer surface 24 of the cylindrical body 18. An oval seal 46

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surrounds each of the bores 32 to prevent any fluid leakage into and between the bores 32. Since the bores 32 with the individual oval seals 46 are spaced radially around the cylindrical body 18, this alternate preferred embodiment of the coiled tubing connector of the present invention can be made shorter in length than the embodiment shown in FIGS. 3 and 4. Again, the installation and operation of this embodiment of internal coiled tubing connector of the present invention is essentially the same as that described above.

In the event that a welded connection is not desired, an alternate preferred embodiment of an internal coiled tubing connector of the present invention can be used. As shown in FIGS. 8 and 9, an internal coiled tubing connector 50 is comprised of a generally cylindrical sleeve 52 mounted within an annular recess 54 within an opposed pair of wedge mandrels 56. Within a beveled recess 58 in each of the wedge mandrels 56 is disposed a slip 60 adapted to contact an internal surface of the coiled tubing 10 and 14. On an inner surface of the sleeve 52 an annular ratcheted recess 62 is provided adjacent each end thereof, cooperative with corresponding ratcheted surfaces 64 on the wedge mandrels 56. The configuration and operation of the mechanisms to connect the coiled tubing 10 and 14 can be adapted from any commercially available internal coiled tubing connector; however, it is preferred that wedge and slip mechanisms be used and most preferable of the type shown and described in U.S. Pat. Nos. 5,238,273 and 5,306,050, which are commonly assigned hereto and which are incorporated herein by reference.

The sleeve 52 includes at least two spaced bores 66 extend from an outer surface 68 of the sleeve 52 partially thereinto to intersect a longitudinal bore 70 extending partially through the sleeve 52. If the longitudinal bore 70 is formed by drilling, then a plug 72 of suitable metallic material seals an open end of the longitudinal bore 70. The outer surface 68 is provided with a counter bore at the intersection of the bores 66 with the outer surface 68 of the sleeve 52. Preferably, the outer surface 68 includes annular recesses 74 through which the bores 66 extend into the sleeve 52. The bores 66 and the longitudinal bore 70 define a by-pass passageway that provides a means for permitting communication between the internal passageways 16 of the coiled tubing 10 and 14 across the connection.

The outer surface 68 of the sleeve 52 includes an annular recess 76 adjacent a first end and adjacent a second end thereof, and an annular elastomeric seal 78 is mounted within each recess 76. The seals 78 can be O-rings formed from any suitable elastomeric material, and are preferably formed from Aflas, Viton or nitrile rubber. The seals 78 provide a fluidic seal across the outer surface 68 of the sleeve 52 when the seals 78 engage an internal surface of the longitudinal bore within the coiled tubing 10 and 14.

When this preferred embodiment of internal coiled tubing connector of the present invention is to be used, the internal passageways 16 within the coiled tubing 10 and 14 are cut, milled or drilled to create openings 80 adjacent the ends of the coiled tubing 10 and 14 to provide a passageway for communication into and from the internal bore of the coiled tubing 10 and 14. The first wedge and slip mechanism 56 and 60 is inserted into the first length of coiled tubing 10 so that one of the bores 66 is spaced adjacent and in communication with opening 80 in the passageway 16 of the coiled tubing 10. Likewise, the second length 14 of coiled tubing is brought into surrounding engagement with an opposite wedge and slip mechanism 56 and 60 with the other bore 66 spaced adjacent and in communication with the opening 80 in the passageway 16 of the second length 14 of coiled tubing.

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To help ensure that the coiled tubing connector 50 is centered at the point of connection of the coiled tubing, an annular ring 82 is provided at approximately the center line of the outer surface 68 of the sleeve 52, which is preferably the midway point between the two longitudinally spaced bores 66. The outer diameter of the ring 82 is approximately the same as the outer diameter of the coiled tubing 10 and 14 so that the sleeve 52 cannot move within the internal bore of the coiled tubing 10 and 14. The ends of the coiled tubing 10 and 14 are then forced under compression and then tension alternately to cause the slips 60 to be ratcheted along the wedge mandrels 56 to securely grip the internal surface of the coiled tubing 10 and 14, as is described fully in U.S. Pat. Nos. 5,238,273 and 5,306,050. The operation of this alternate preferred embodiment of an internal coiled tubing connector of the present invention is essentially the same as the preferred embodiment described above in reference to FIGS. 1 and 2.

An alternate preferred embodiment of the internal coiled tubing connector of the present invention is shown in FIGS. 10 and 11 wherein the coiled tubing 10 and 14 include a plurality of passageways 16 with each radially spaced around the wall of the coiled tubing 10 and 14. To permit separate communication across the connection of the coiled tubing 10 and 14, a plurality of longitudinal bores 70 are spaced radially around the sleeve 52. Each such longitudinal bore 70 is intersected by its own respective set of bores 66 longitudinally spaced along the outer surface 68 of the sleeve 52. To prevent fluid communication between the respective sets of bores 66, the outer surface 68 is provided with a plurality of recesses 76 with elastomeric annular seals 78 mounted therein. The installation and the operation of this preferred embodiment of an internal coiled tubing connector of the present invention is essentially the same as for the embodiment described above in reference to FIGS. 1 and 2.

An alternate preferred embodiment of the internal coiled tubing connector of the present invention is shown in FIGS. 12, 13 and 14 wherein the coiled tubing connector is comprised of two or more separate bodies with a by-pass conduit extending therebetween to provide the necessary by-pass communication. This embodiment is useful when the coiled tubing is to be bent around a relatively sharp radius that the previous internal coiled tubing connectors would not permit. In this embodiment, the coiled tubing 10 and 14 includes one or more passageways 16, and if there are more than one such passageway 16 then such passageways 16 are radially spaced around the wall of the coiled tubing 10 and 14. To permit communication across the connection of the coiled tubing 10 and 14, longitudinal bores 88 extend partially through the first and the second cylindrical bodies 84 and 86. Each such longitudinal bore 88 is intersected by a bores 90 either radially around and/or longitudinally along the outer surface 24 of the first and the second cylindrical bodies 84 and 86. To prevent fluid communication between the bore(s) 90, the outer surface 24 of each of the first cylindrical body 84 and the second cylindrical body 86 is provided with annular recesses and annular O-ring seals, or preferably with a generally oval elastomeric seal 92 mounted within a respective oval recess 94 formed within the outer surface 24 of the first and the second cylindrical bodies 84 and 86. An oval seal 92 surrounds each of the bores 90 to prevent any fluid leakage into and between the bores 90.

A by-pass conduit 96, formed from metallic hydraulic control line or from aircraft-style hose and fittings, is inserted into the respective longitudinal bores 88 of the first

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and the second cylindrical bodies 84 and 86, and is sealed therein by means of one or more elastomeric annular seals 98. The gap between the first and the second spaced cylindrical bodies 84 and 86 is determined by the length of the by-pass conduit 96 and a length of coiled tubing 100 that is mounted within annular notches 102 within opposed ends of the first and the second cylindrical bodies 84 and 86. The first and second cylindrical bodies 84 and 86 are welded in place as described above in reference to the embodiments shown in FIGS. 1 and 2 and FIGS. 5, 6 and 7. Additionally and preferably the coiled tubing 100 is welded to the first and the second bodies 84 and 86. Again, the operation of this alternate preferred embodiment of the internal coiled tubing connector of the present invention is essentially the same as that described above in reference to FIGS. 1 and 2 and FIGS. 5, 6 and 7.

FIG. 15 shows an alternate preferred embodiment of the internal coiled tubing connector of the present invention described in relation to FIGS. 12, 13 and 14, but that this embodiment uses internal wedge and slip mechanisms in place of welding, as previously described in relation to FIGS. 8 and 9 and FIGS. 10 and 11.

Whereas the present invention has been described in relation to the drawings attached hereto, it should be understood that other and further modifications, apart from those shown or suggested herein, may be made within the scope and spirit of the present invention.

What is claimed is:

1. An internal coiled tubing connector for connecting a first length of coiled tubing to a second length of coiled tubing, comprising:

a cylindrical body having a longitudinal bore therethrough and having means for gripping a respective end portion of the first length and the second length of coiled tubing;

the cylindrical body having a by-pass passageway extending from a first opening in a longitudinal outer surface of the cylindrical body to a second opening in the longitudinal outer surface of the cylindrical body; and elastomeric seals mounted to the longitudinal outer surface of the cylindrical body adjacent the first opening and the second opening;

wherein the coiled tubings have passageways within and parallel to the walls thereof, and when the first opening is placed in communication with the passageway within the wall of the first length of coiled tubing and when the second opening is placed in communication with the passageway within the wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

2. An internal coiled tubing connector of claim 1 wherein the by-pass passageway is formed within the wall of the cylindrical body.

3. An internal coiled tubing connector of claim 2 wherein the by-pass passageway comprises a longitudinal bore within a wall of the cylindrical body, with lateral bores extending through the wall of the cylindrical body from the first opening to the longitudinal bore and from the second opening to the longitudinal bore.

4. An internal coiled tubing connector of claim 1 wherein the longitudinal outer surface of the cylindrical body includes an annular ridge midway between the first opening and the second opening, the annular ridge having an outer diameter greater than an internal diameter of the first length and the second length of coiled tubing.

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5. An internal coiled tubing connector of claim 1 wherein the longitudinal outer surface of the cylindrical body includes annular recesses, and the elastomeric seals are received within the annular recesses.

6. An internal coiled tubing connector of claim 1 wherein the means for gripping the first length and the second length of coiled tubing includes a welded connection.

7. An internal coiled tubing connector of claim 1 and further comprising a plurality of separate by-pass passageways extending from separate first openings in the cylindrical body to separate second openings in the cylindrical body, each such by-pass passageway to establish communication by-passes with corresponding separate passageways within the walls of the first length and the second length of coiled tubing.

8. An internal coiled tubing connector of claim 7 wherein the plurality of separate first openings and second openings are radially spaced around the cylindrical body.

9. An internal coiled tubing connector of claim 8 wherein the plurality of separate first openings and second openings are longitudinally spaced along and radially spaced around the cylindrical body.

10. An internal coiled tubing connector of claim 9 wherein elastomeric seals surround each of the first openings and each of the second openings.

11. An internal coiled tubing connector of claim 1 wherein the gripping means comprises a first wedge and slip mechanism mounted adjacent a first end of the cylindrical body and a second wedge and slip mechanism mounted adjacent a second end of the cylindrical body, the first and the second wedge and slip mechanisms adapted to connect the first length and the second length of coiled tubing.

12. An internal coiled tubing connector of claim 11 wherein the first and the second wedge and slip mechanisms each include a ratchet means for ratcheting the wedges into wedging engagement with the slips upon alternate application of tension and compression to grip an internal surface of the first length and the second length of coiled tubing.

13. An internal coiled tubing connector for connecting a first length of coiled tubing to a second length of coiled tubing, comprising:

a cylindrical body having a longitudinal bore therethrough;

a first wedge and slip mechanism mounted adjacent a first end of the cylindrical body and a second wedge and slip mechanism mounted adjacent a second end of the cylindrical body, the first and the second wedge and slip mechanisms for insertion into respectively the first length and the second length of coiled tubing for connecting the first and second lengths of coiled tubing;

a by-pass passageway extending from a first opening in a longitudinal outer surface of the cylindrical body to a second opening in the longitudinal outer surface of the cylindrical body; and

elastomeric seals mounted to the longitudinal outer surface of the cylindrical body adjacent the first opening and the second opening;

wherein the coiled tubings have passageways within and parallel to the walls thereof, and when the first opening is placed in communication with the passageway within the wall of the first length of coiled tubing and when the second opening is placed in communication with the passageway within the wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

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14. An internal coiled tubing connector for connecting a first length of coiled tubing to a second length of coiled tubing, comprising:

a first cylindrical body having a longitudinal bore there-through and having means at an end thereof for grip-
ping an end position of the first length of coiled tubing,
a second cylindrical body having a longitudinal bore
therethrough and having means at an end thereof for
gripping an end portion of the second length of coiled
tubing;

a by-pass passageway extending from a first opening in a longitudinal outer surface of the first cylindrical body to a second opening in the longitudinal outer surface of the second cylindrical body; and

elastomeric seals mounted to the longitudinal outer sur-
face of the first and the second cylindrical bodies on
opposite sides of the first opening and the second
opening;

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wherein the coiled tubings have passageways within and parallel to the walls thereof, and when the first opening is placed in communication with the passageway within the wall of the first length of coiled tubing and when the second opening is placed in communication with the passageway within the wall of the second length of coiled tubing a communication by-pass is established across the connection of the first length and the second length of coiled tubing.

15. An internal coiled tubing connector of claim 14 wherein the gripping means further comprises a first wedge and slip mechanism mounted adjacent a first end of the first cylindrical body and a second wedge and slip mechanism mounted adjacent a second end of the second cylindrical body, the first and the second wedge and slip mechanisms adapted to connect the first length and the second length of coiled tubing.

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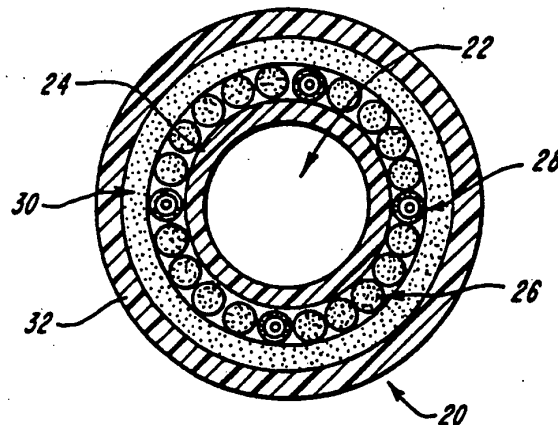
United States Patent [19]
Holmberg[11] Patent Number: **5,212,755**[45] Date of Patent: **May 18, 1993**[54] **ARMORED FIBER OPTIC CABLES**[75] Inventor: **Gerald E. Holmberg, Quaker Hill, Conn.**[73] Assignee: **The United States of America as represented by the Secretary of the Navy, Washington, D.C.**[21] Appl. No.: **896,633**[22] Filed: **Jun. 10, 1992**[51] Int. Cl.⁵ **G02B 6/44**[52] U.S. Cl. **385/107; 385/104**[58] Field of Search **385/100, 102, 104, 107, 385/108, 109; 174/102 R, 107, 110 R**[56] **References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—Frank Gonzalez
Attorney, Agent, or Firm—Michael J. McGowan;
Prithvi C. Lall; Michael F. Oglo

[57] **ABSTRACT**

An armored fiber optic cable is disclosed having both fiber optics and armor wires located outside the cable core in position where the fiber optics experience low strain when the cable is under stress. In one embodiment, metal armor wires and optical fibers embedded in metal tubes are arrayed in one or more layers about and outside the cable core. In another embodiment, Kevlar armor wires and optical fibers embedded within a hard composite shell are arrayed in one or more layers about and outside the cable core, and a layer of Kevlar armor is provided surrounding the one or more layers. In each of the embodiments the strains that the fiber optics experience due to core stresses and due to core residual strain is materially reduced over the heretofore known armored fiber optic cables.

13 Claims, 1 Drawing Sheet

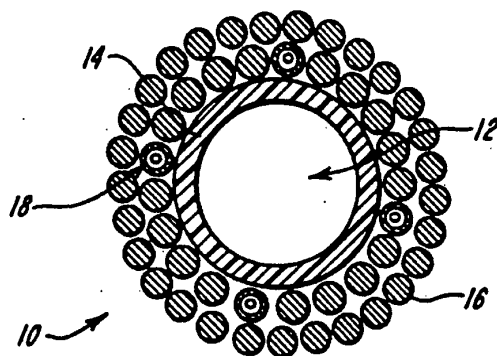


FIG. 1

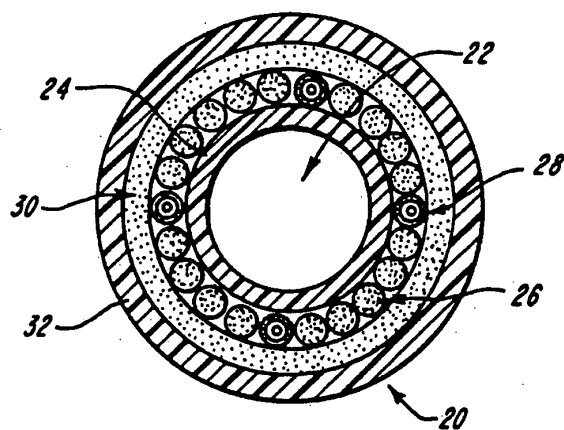


FIG. 2

ARMORED FIBER OPTIC CABLES

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

This invention is directed to the field of optics and more particularly, to a low-strain, armored, fiber optic cable.

(2) Description of the Prior Art

In the heretofore known armored fiber optic cables, two locations in the cable core have been used to provide protection for the fibers. One location is at the center of the cable core, where fibers may be helixed around a king wire in the center of the core or laid longitudinally in a metal tube which forms the center of the cable core. The second location is outside the center of but still within the cable core, where the fiber is helixed around the core and either protected in an interstice between electrical connectors or contained in a helixed metal tube near the center of the cable core. When such an armored cable is stressed, the cable core undergoes a larger strain than the armor. To reduce strain on optical fibers located in the cable core, they are commonly stranded at a high angle with respect to the cable axis, but the higher the helix angle, the smaller the radius the fiber experiences in the cable core. For small radii, bend-induced optical attenuation may result. Another adverse effect of the heretofore known armored optical fiber cables arises when the cable is first worked, in that a residual construction strain appears in the cable core due to cable elongation when the armor wires set themselves into the cable core jacket. This residual strain undesirably remains in the cable core after initial use.

SUMMARY OF THE INVENTION

In accord with the principal object of the present invention, an armored fiber optic cable is disclosed having both fiber optics and armor wires located outside the cable core in a position where the fiber optics experience low strain when the cable is under stress. In one embodiment, metal armor wires, and fiber optics embedded in metal tubes, are arrayed in one or more layers about the cable core. In another embodiment, armor wires of aramid fiber such as KEVLAR, and fiber optics embedded within a hard composite shell, are arrayed in one or more layers about the cable core, and a layer of KEVLAR armor wire is provided surrounding the one or more layers. The hard composite shell is preferably a reinforced matrix, reinforced with KEVLAR filaments. The KEVLAR armor wire preferably is embedded within the same hard composite shell. In each of the embodiments the strains that the fiber optics experience due to core stresses and due to core residual strain is materially reduced over the heretofore known armored fiber optic cables.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects advantages and features of the present invention will become apparent to those skilled in the art upon reference to the following de-

scription of the preferred embodiments and to the drawings, wherein:

FIG. 1 shows a cross-section of a steel-armored, low-strain fiber optic cable in accord with the instant invention; and

FIG. 2 shows a cross-section of a KEVLAR armored, low-strain fiber optic cable in accord with the instant invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, generally shown at 10 is a cross-section of a steel-armored, low-strain fiber optic cable in accordance with the present invention. The cable 10 is made up of a cable core generally designated 12, which may contain electrical conductors, a core jacket 14, such as one adapted to prevent water intrusion into the cable core, armor wires 16, arrayed in one or more layers, and fiber optics embedded in metal tubes generally designated 18 interspersed among the one or more layers of armor wires 16, and preferably in the innermost layers thereof to protect the fiber optic cables. The cable 10 may also have another jacket, not shown, such as of polyethylene or of polyurethane, over the outside of the outermost layers. The wires 16 are preferably filaments of galvanized improved plow steel (GIPS), although as will readily be appreciated by those skilled in the art, other metals and metal alloys and other materials can be employed. The optical fibers are preferably embedded in stainless steel tubes, and preferably are K-tubes commercially available from the Armor Tech Division of K-Tube Corporation. To manufacture the members 18, a strip of stainless steel or other suitable metal is rolled to a circular shape and the longitudinal seam is laser welded, and swaged to size. A fiber optic cable is inserted into the tube as it is being formed, and the tube is injected with a gel during swaging. The size of the members 18 is preferably selected to be of a size that preferably approximates or is slightly smaller than the size of the armor wires 16, so that they can be stranded onto the cable at the same time as the armor wires. It is desirable that back-twisting of the fiber-bearing tubes 18 be controlled during stranding so that they will lay untwisted in the final cable. For a torque-balanced cable with, for example, two contrahelically wound layers of armor wires, it is desirable for the fiber-bearing tubes 18 to be in the inner layer, where the tubes are protected when the cable is passed over sheaves. Special care should be taken where the armor is terminated to a body, such as in a tow cable application, so that the fiber-bearing tubes are not crushed at the termination point. For an underwater application, the fiber optics would then penetrate a pressure-tight housing. Such pressure penetrations are routinely done with fiber optics, using, for example, an epoxy or a gland seal. Referring now to FIG. 2, generally shown at 20 is a cross-section of a KEVLAR armored, low-strain fiber optic cable armored with KEVLAR or other suitable high strength synthetic material in accordance with the present invention. The cable 20 contains a cable core generally designated 22, which may contain electrical conductors, a core jacket 24, such as of polyethylene, to protect the core 22 against undesirable water seepage, one or more layers of KEVLAR armor wires generally designated 26 interspersed with optical fibers embedded within a KEVLAR reinforced matrix generally designated 28, a layer of KEVLAR armor constituted as plural KEVLAR filaments

generally designated 30, and a cable jacket 32. The armor wires 26 are preferably constituted as a group of KEVLAR filaments or fiber glass filaments or other synthetic material that are stabilized into a cylindrical shape. The filaments of the wires 26 may or may not be helically wound. Whenever they are helically wrapped, the filaments of the layer 30 are preferably contrahelically wrapped. The armor wires 28 containing fiber optics are preferably constructed by applying a hard reinforced matrix cylindrical shell over a jacketed fiber optic cable, the reinforcement preferably being of the same material as the armor wires. While KEVLAR is the presently preferred material, other synthetic materials or fiberglass can be employed as well. The jacket serves to cushion the fiber optic cable from external perturbations, and the hard reinforced matrix shell further shields the fiber from external influence. In the preferred embodiment, the hard shell of reinforced matrix within which the fiber optics are embedded is fabricated using either a thermal-cured epoxy or a uv-cured epoxy. Filaments of the KEVLAR or other synthetic material, which may be helically wrapped, are drawn through an epoxy bath along with one or more fiber optic cables and passed through a cylindrical forming dye. The epoxy, which may be, for example, a thermally cured or a uv cured epoxy, is then hardened in an oven or by uv-light, forming thereby the members 28. The process may be repeated in a repeat step to form a second layer which is also cured. The armor wires 26 are preferably similarly formed, but as will be appreciated by those skilled in the art, the fiber optic cable is omitted in forming the members 26, which may also be helically wrapped. It is preferred that the fibers used in the armored fiber bearing wires to be of the same material as that of the armor wires so that the fiber-bearing wires will have the same mechanical properties as the armor wires during cabling in the armor package. Layers of armor wires with interspersed fiber-bearing wires alternated with layers of KEVLAR filaments promotes cushioning of the fiber-bearing wires. For a torque-balanced cable with two contrahelically-wound layers of KEVLAR armor, it is desirable for the fiber-bearing wires to be on the inner layer so that they will be shielded from direct contact with sheaves, and it is further desirable to torsionally pre-distort them to compensate for their final helically wound geometry. Special attention should be given to fiber-bearing wires during armor termination, and, among other things, it may be necessary to add additional local composite material to each wire near the termination point. Many modifications of the present invention will become apparent to those skilled in the art without departing from the inventive concept.

What is claimed is:

1. A low-strain armored fiber optic cable, comprising:
 - a core having an interior;
 - a jacket concentric with the core defining an annular region between the jacket and core that is radially spaced from and outside the interior of the core;
 - a plurality of armor wires about the core in the annular region and defining at least one radially located layer circumferentially concentric with the spaced from said interior of the core; and
 - a plurality of armored fiber optic cables about the core in the annular region interspaced with the armor wires in at least one of each said at least one radially located layer;
- said armor wires being of a synthetic material and wherein said armored fiber optic cables being fiber optic cables embedded within a composite material.
2. The invention of claim 1, wherein said composite material is a reinforced composite material.
3. The invention of claim 2, wherein said reinforced composite material includes an epoxy.
4. The invention of claim 2, wherein said reinforced composite material is reinforced by filaments of said synthetic material.
5. The invention of claim 1, wherein said synthetic material is KEVLAR.
6. The invention of claim 1, wherein said synthetic material is fiber glass.
7. The invention of claim 5, wherein said composite material is a reinforced epoxy composite material reinforced with KEVLAR.
8. The invention of claim 6, wherein said composite material is a reinforced epoxy composite material reinforced with fiber glass.
9. The invention of claim 1, further including a sheath of filaments of synthetic material circumferentially surrounding at least one of said at least one radially located layers.
10. The invention of claim 1, wherein said armor wires are constituted as plural filaments of synthetic material embedded within a hard shell generally having a circular cross-section.
11. The invention of claim 10, wherein said fiber optic cables embedded within a composite material are constituted as plural filaments of synthetic material, at least one fiber optic cable, and an adhesive.
12. The invention of claim 11, wherein said adhesive is an epoxy.
13. The invention of claim 11, wherein said plural filaments are helically wrapped with said at least one fiber optic cable.

* * * * *

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US005268983A

United States Patent [19][11] **Patent Number:** 5,268,983

Tatarka et al.

[45] **Date of Patent:** Dec. 7, 1993[54] **ROUND, DRY, ALL DIELECTRIC, FAN OUT
COMPACT OPTICAL FIBER CABLE**

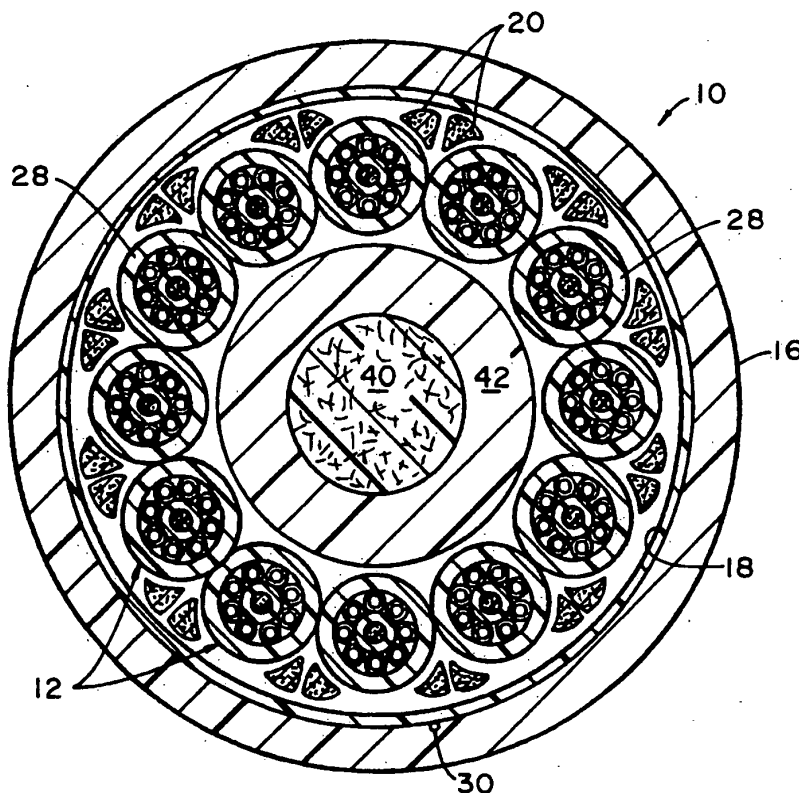
5,155,789 10/1992 Le Noane et al. 385/106

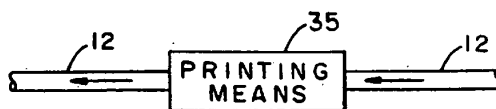
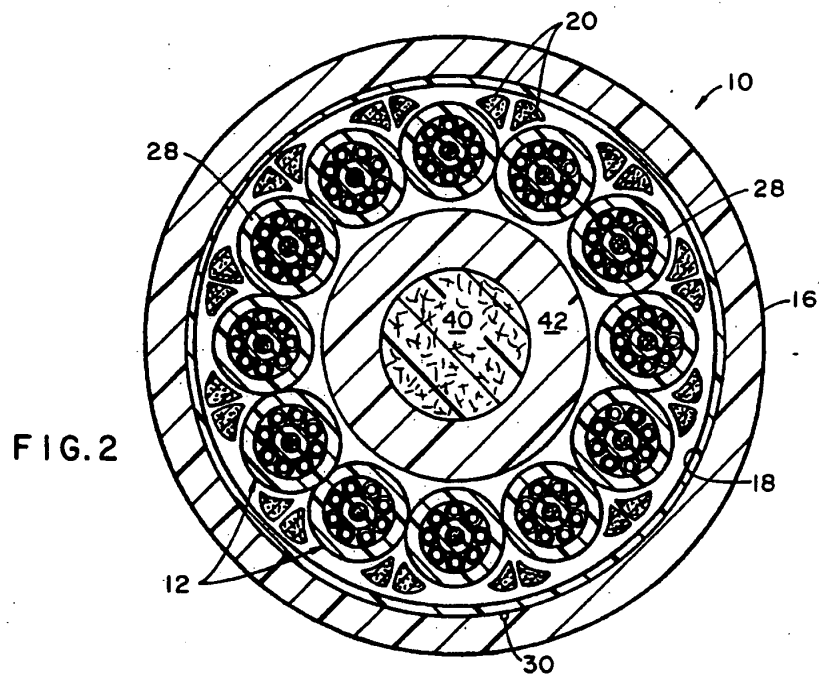
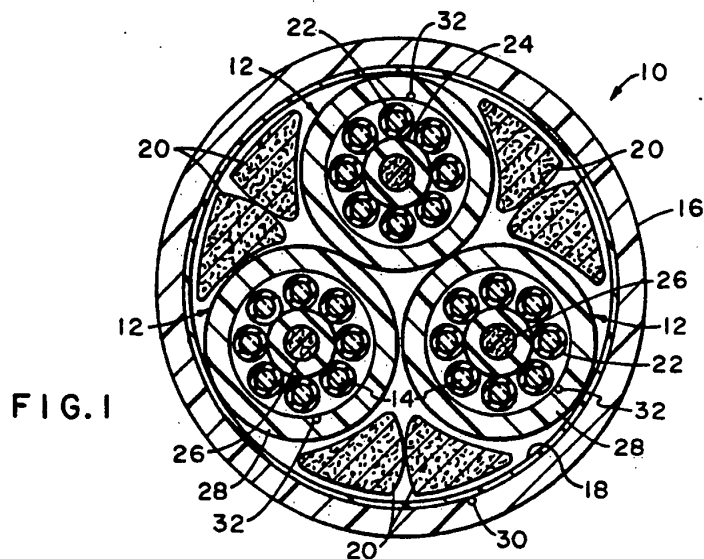
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Attorney, Agent, or Firm—Elroy Strickland[73] **Assignee:** Alcoa Fujikura Ltd., Brentwood,
Tenn.[57] **ABSTRACT**[21] **Appl. No.:** 986,682[22] **Filed:** Dec. 8, 1992[51] **Int. Cl.:** G02B 6/44[52] **U.S. Cl.:** 385/106; 385/103[58] **Field of Search** 385/102, 103, 106, 109,
385/112, 113

A round, compact, optical fiber cable comprises an outer protective jacket of insulating material having a plurality of individual bundles of optical fibers within the outer jacket. Each bundle includes an anti-buckling rod of electrically non-conductive material and encapsulated by a low modulus material. A plurality of optical fibers encapsulated also in a low modulus material is wound on and about the low modulus material encapsulating the rod in a manner that retards contraction and microbending of the optical fibers. Each of the bundles includes one or more protective jackets of electrically, non-conductive material enclosing the plurality of fibers, anti-buckling rod and encapsulating material. Also, means are provided for identifying individual bundles and fibers.

[56] **References Cited****U.S. PATENT DOCUMENTS**

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8 Claims, 1 Drawing Sheet



ROUND, DRY, ALL DIELECTRIC, FAN OUT COMPACT OPTICAL FIBER CABLE

BACKGROUND OF THE INVENTION

The present invention relates generally to optical fiber cables and more particularly to round "high count" fiber optic cables particularly useful for making multiple indoor connections between equipment and hardware that utilize (receive and send) large amounts of data transmitted through the fibers.

Present optical fiber technology typically uses individual or very low count cable (usually less than six fibers) to connect outdoor cables to central office switching equipment and hardware. Such individual or low count cables are inadequate since the amount of indoor connections, fiber counts, and central office racks required is in the hundreds and thousands, depending upon the demand at a given location. As a result, indoor locations have become and typically will become highly congested with cable unless action is taken to reduce the number of cables without reducing the number of optical fibers. In fact, the need is to reduce cable numbers while increasing fiber numbers.

Craftsmanship and the ease of cable handling when connecting fibers to equipment is proportional to (1) the compactness of the cable structure, (2) the accessibility to the fibers within each cable with commonly used craft tools such as strippers that do not nick the fibers, and (3) the adaptability of enclosures and equipment to the cable construction. In addition, supplemental identification techniques must be applied at the location of installation for most of the present cable designs. Hence, for the high count fiber cables, identification of each fiber becomes highly important in the fiber connection and termination process.

And, any new design is obviously more cost effective if existing cabling machinery can be used in making the new cable, as opposed to the use of specialized and dedicated equipment.

Hence, there are real needs for flexible optical fiber cables that can handle substantial amounts of information while remaining compact in size. As explained above, indoor office space is often unavailable for a substantial amount of cabling. When space is found, cables are snaked through and around equipment in a manner that requires a substantial amount of bending so that the fiber optics of the cable are subject to substantial bending and flexing. Any bending of the optics reduces the cables ability to conduct light and therefore can affect the ability to serve its purpose, which is the rapid transmission of substantial amounts of information and data in the form of light pulses.

Anti-buckling means in the fiber optic art, which can also serve as strain relief means for the more delicate optics, are known and have been the subject of patent disclosures, such as U.S. Pat. No. 4,269,024 to Ashpole et al and U.S. Pat. No. 5,101,467 to Bernard. Ashpole et al are concerned with strength (strain relief) members per se, while Bernard shows a cable primarily designed for outside pedestals located near ground level to receive underground cabling. Since the Bernard cable is for outdoor, underground use, the cable has a substantial amount of protective armoring.

In providing a cable for multiple connections to assorted equipment, each fiber within the cable must be accessible in a manner that leaves adjacent fibers intact, i.e., when one subunit or bundle of fibers is connected to

one item of equipment, the remaining bundles need to remain in tact for use at adjacent and/or other locations and equipment. In other words, when the outer jacket of a cable is opened to obtain access to subunits of fibers, the remaining subunits need to remain intact so that they can be directed and connected to other related or unrelated equipment. All of this, of course, requires an outer jacketing system that permits easy access to the subunits within the jacket system, and subunits with jackets that maintain the subunits intact when the main, outer jacket is opened.

SUMMARY OF THE INVENTION

The above concerns are met by the cable of the present invention in which bundles or subunits of optical fiber cables are contained in an outer jacket of an insulating material, with each of the bundles themselves having a protective jacket. The protective jacket of each bundle contains a substantial plurality of optical fibers, which it maintains as a unit until the jacket is opened for access to the fibers. Each optical fiber is coated with a low modulus material that permits easy removal of each fiber from a center, dielectric rod and strength member which is also encapsulated with a layer of low modulus material.

Within the confines of the outer jacket and between the outer jacket and inner jacket of the individual bundles are strands of an insulating yarn material that provide additional strength and strain relief for the optics. Further, the material of yarn is preferably one that prevents the migration of water and moisture down the length of the cable and thereby maintains the interior of the cable dry. In this manner, no water resistant filler material is needed within the cable to prevent ingress of moisture and water. Such filler materials are generally greasy and make it difficult to work with the individual fibers in the process of connecting the fibers to terminals and equipment.

The optical fibers are wound on the rod in a manner that ties them to the rod so that the fibers resist contraction and microbending. This is effected by the low modulus material encapsulating the fibers and rod, as explained in detail below.

With individual "packaging" of the fiber bundles or subunits, when the outer jacket is opened to obtain access to the bundles, and only one bundle is needed for the purposes at hand, the other bundles remain in tact and thus ready for use when and where needed.

The outer and inner jackets can be opened with a ripcord embedded in the jackets, as shown in FIG. 1 of Applicants' drawings.

The subject cable is an all dielectric insulating cable such that no electrically conductive elements are present that would be available for the conducting of high voltage transients into the equipment and apparatus to which the fiber optics are connected.

BRIEF DESCRIPTION OF THE DRAWINGS

The advantages and objectives of the invention will be best understood from consideration of the following detailed description and the accompanying drawings in which:

FIG. 1 is a cross-sectional view of a high count cable containing three bundles or subunits of eight fiber optics, the cable being constructed in accordance with the principles of the invention;

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FIG. 2 is a cross-sectional view of a high count cable having twelve bundles or subunits of eight optical fibers, again constructed in accordance with the principles of the invention; and

FIG. 3 shows schematically means for placing indicia on a bundle for identification purposes.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1 thereof shows in cross section a round, all dielectric cable 10 comprised of three round bundles or subunits 12 of optical fibers 14, the number of fibers (eight) in each subunit, and the total number of fibers in the cable (twenty-four) being given by way of example only.

Cable 10 includes an outermost jacket 16 of insulating material, such as a PVC riser compound, and a wrapping of high strength insulating tape 18, such as polyethylene terephthalate, disposed about the combination of the three optical bundles 12. If the cable is used in an outdoor environment, then riser or plenum (flame retardant) compounds may not be necessary. Electrical non-conductive strands 20 are located between the wrapping 18 and bundles 12 to provide strain relief for the optics of the bundles and preferably to provide absorption of any water or moisture that might enter the interior of the cable. A preferred material for strands 20 is a water absorbing aramid yarn.

The bundles 12 and yarns 20 are tightly stranded together in a helical fashion to provide a compact construction. An appropriate diameter for cable of FIG. 1 is 6.9 mm, while the diameter of each bundle is 2.7 mm.

It will be noted in FIG. 1 that the strands or yarns 20 occupy a substantial portion of the area or space between bundles 12 and wrap 18. In this manner, the strands will tend to absorb substantially all water and moisture in the interior of the cable. This is advantageous in that the interior is otherwise free of water repellent fillers so that the optics 14 remain free of contamination by filler materials, thereby easing the process of the connecting fibers to their destined terminals and equipment, i.e., filler materials are generally greasy substances that must be wiped or otherwise removed from the fibers before they can be properly connected to terminals, hardware, etc.

As shown, each bundle 12 comprises a plurality of optical fibers 14 individually coated and enclosed with a layer of electrically non-conductive low modulus material 22 and helically applied to a layer of electrically non-conductive low modulus material 24 located on and encapsulating a rod 26 of electrically non-conductive material. A preferable material of the rod is fiber reinforced plastic, while the low modulus material of layers 22 and 24 is a relatively soft silicone rubber. An appropriate thickness for layers 22 and 24 is simply that amount of material sufficient to completely surround and encapsulate the rod and optical fibers. The rod is a relatively stiff structure that does not buckle when the cable is handled and bent, thereby protecting the fibers from microbends and outright breakage. Yet, the material of the rod is flexible to the degree that the bundle and the overall cable can be manipulated into corners and around equipment, as needed.

The low modulus material of the layers provided on the fibers and rods causes the fibers and rods to adhere together so that the fibers are "fixed" to the rods. Such adherence of the fibers to the rods prevents microbending of the fibers that can occur with contraction of the

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cable unit caused by temperature changes because the center rods and fibers have similar coefficients of thermal expansion.

Also, because of the relative softness of the material of layers 22 and 24, individual fibers are easily removed from center rod 26 and the material easily removed from the individual fibers for connecting the fibers to terminals and hardware. The coating is removed with commonly used craft tools that do not nick the fibers.

The fibers, rod, and low modulus layers of each subunit 12 are bundled together by a protective jacket 28. The material of this jacket can also be a PVC riser compound, though other flame retardant materials can be used.

Access to bundles 22 can be provided by a ripcord 30 of strong insulating material such as nylon lying underneath the outer jacket 16. In the Figures, the ripcords are somewhat enlarged for purposes of illustration. In real life, the ripcords are quite small in cross section with the outer jacket material formed over them. Since the fibers within the outer jacket are contained within separate jackets 28, the opening of the outer jacket 16 and the unwrapping of tape 18 leaves the bundles intact so that they can be individually and diversely directed to the separate locations of equipment and hardware. When the end of each bundle is appropriately disposed for connection, end portions of inner jackets 28 can be removed from the fibers to allow connection of the fibers to the equipment. To this end, each inner jacket can also be provided with a ripcord 32 lying underneath the inner jacket.

All of the materials of cable 10, as thus described, are electrically non-conductive.

Each bundle 12 and each fiber 14 are identified by appropriate numbers or letters printed or otherwise located on the surfaces of the fibers or by different colors (or combinations of letters, numbers, and/or colors). The material of the fibers themselves can be individually colored, as well as the low modulus layers 22 and 24 and jackets 28. Such identifying indicia can be provided in and/or on the layers 22, 24, and 28 using known on-line printing devices. FIG. 3 of the drawings shows diagrammatically such means 35 for applying indicia on a bundle 12. Appropriate means include ink injection devices and printing cylinders. Printing cylinders imprint or emboss nomenclature on the jacket of the bundle.

FIG. 2 of the drawings shows a round cable construction having a 144 fiber count, using twelve bundles or subunits of the type shown in FIG. 1, i.e., with each subunit containing twelve optical fibers. In FIG. 2, those components that correspond to the components of FIG. 1 bear the same reference numerals.

In FIG. 2, an electrically non-conductive member 40 is located in the center of the cable, member 40 providing strain relief protection for optics 14. The material of this member can be that of rods 26 but is jacketed with a flexible PVC material 42, for example, to provide a surface area suitable for stranding the optic bundles thereover. The diameter of rod 40 is limited in size because if it is too large, it will not be sufficiently flexible for the purposes of the invention. Therefore, rod 40 is overcoated to provide a diameter that will accommodate more optical units 12.

The individual bundles or subunits 12 in FIG. 2 are made of the same general materials as those in FIG. 1 such that the cable structure of FIG. 2 is electrically non-conductive and provides all of the insulating ad-

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vantages of the cable of FIG. 1. The diameter of the cable of FIG. 2 is on the order of 15.0 mm. An appropriate diameter for center member 40 and 42 is on the order of 8.5 mm.

The cable structures shown in FIGS. 1 and 2 of the drawings can be manufactured with typical well known cabling equipment, as the structures are round. Specialized and dedicated equipment is not needed. The means for applying the components of the subunits 12 to center rod 26 are well known and used extensively in the industry. The same is true for winding the subunits on center member 40 in FIG. 2. Hence, capital outlays for making the cables of the invention are not a concern.

The all dielectric materials of the cable construction of the invention makes the cable light in weight such that the embodiment of FIG. 1 does not require a central strength member. Rather, the subunits 12 are helically wound together with the aramid yarns 20, the yarns and anti-buckling rods 26 providing more than sufficient strain relief for optics 14.

While the invention has been described in terms of preferred embodiments, the claims appended hereto are intended to encompass all embodiments which fall within the spirit of the invention.

What is claimed is:

1. A round, dry, compact, electrically non-conductive, optical fiber cable comprising:
 - an outer protective jacket of electrically non-conductive material;
 - a plurality of individual bundles of optical fibers located within said jacket, with each of said bundles including an anti-buckling rod made of electrically non-conductive material encapsulated by a low modulus material and a plurality of optical fibers encapsulated by a low modulus material wound on and around the low modulus material encapsulating said rod in a manner that retards contraction

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and microbending of the optical fibers and centers the anti-buckling rod in the plurality of optical fibers;

with each of said bundles including one or more protective jackets of electrically non-conductive material enclosing the plurality of optical fibers, anti-buckling rod, and encapsulating material; and multiple strands of high modulus, water absorbing, electrically non-conductive material located inside the outer protective jacket and adjacent the jackets enclosing the bundles of optical fibers wherein the bundles of optical fibers and the multiple strands of high modulus material are tightly stranded together in a helical fashion to provide compactness inside the outer protective jacket and throughout the cable to block water and moisture from traveling through the cable.

2. The cable of claim 1 including a center strength member made of a high modulus electrically non-conductive material, with the bundles of optical fibers being wound on said center member.

3. The cable of claim 2 in which the high modulus material of the center strength member is jacketed with an electrically non-conductive material.

4. The cable of claim 1 in which the material of the high modulus multiple strands is aramid yarn.

5. The cable of claim 1 in which a ripcord for opening the outer jacket lies under the jacket.

6. The cable of claim 1 in which a ripcord lies under each of the jackets of the bundles of optical fibers.

7. The cable of claim 1 in which the outer protective jacket includes an inner wrapping of high strength, electrically non-conductive tape.

8. The cable of claim 1 in which the material of the outer protective jacket includes a flame-retardant compound.

* * * * *



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(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2002/0085820 A1**
Gaillard et al. (43) **Pub. Date: Jul. 4, 2002**

(54) **CABLE ASSEMBLY HAVING RIPCORDS
WITH EXCESS LENGTH AND RIPCORDS
ATTACHED TO TAPE**

(57) **ABSTRACT**

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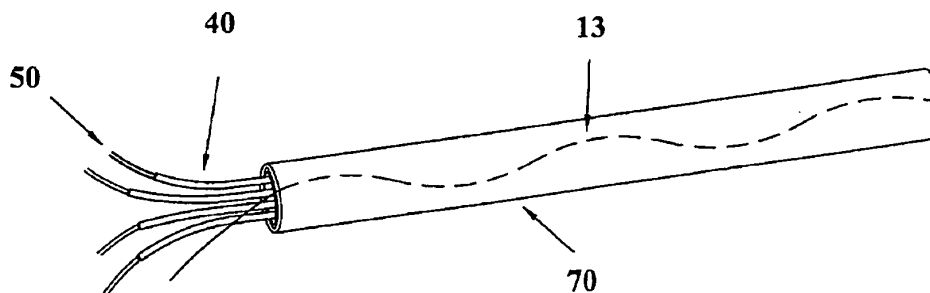
(21) **Appl. No.: 09/750,339**

(22) **Filed: Dec. 29, 2000**

Publication Classification

(51) **Int. Cl.⁷ G02B 6/44**
(52) **U.S. Cl. 385/113; 385/102; 385/109**

The invention is a cable assembly in which the ripcord is bonded or woven to the cable assembly's armor tape. This arrangement helps to prevent the ripcords from moving from their initial position, therefore allowing better dissection of a cable sheath and/or jacket. The cable assembly includes a cable core (e.g., soft buffer tubes surrounding optical fibers), a tape surrounding the cable core, at least one ripcord attached to the tape, and a cable jacket surrounding the tape. In a second embodiment of the present invention, a cable assembly includes a cable core having a predetermined axial length, a cable jacket for housing the cable core along the predetermined axial length of the cable core, and a ripcord disposed between the cable core and the cable jacket along the predetermined axial length, in a manner that the ripcord is contained within the predetermined axial length, but the ripcord has a length substantially longer than the predetermined axial length. In a preferred embodiment of the present invention, the ripcord is disposed along the predetermined axial length in a wavy shape, thus the ripcord is made "flexible", alleviating damage to the cable assembly that can occur from ripcord tension.



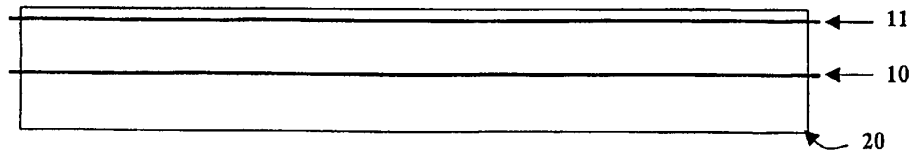


Figure 1

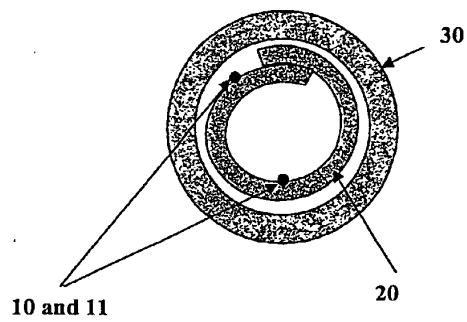


Figure 2a

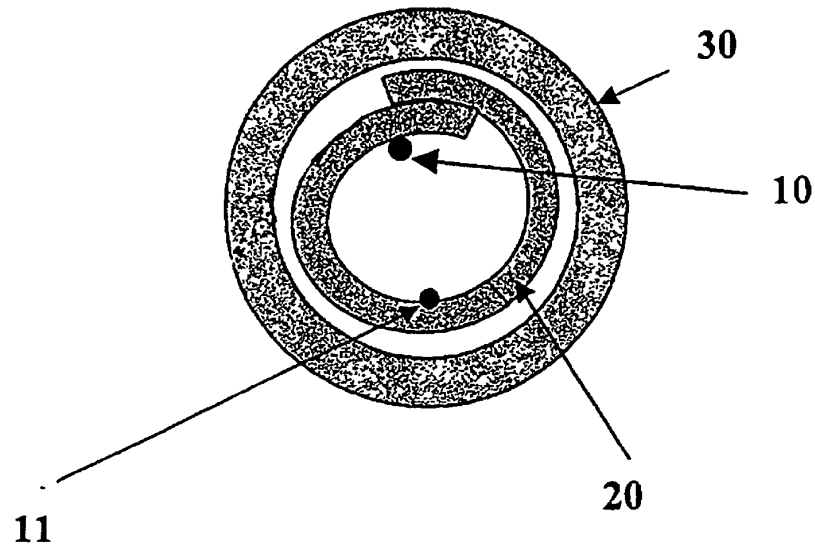


Figure 2b

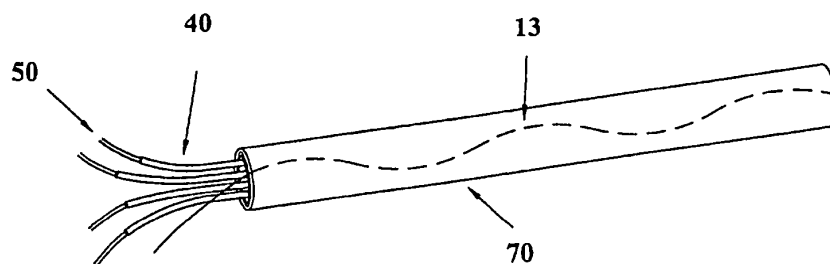


Figure 3

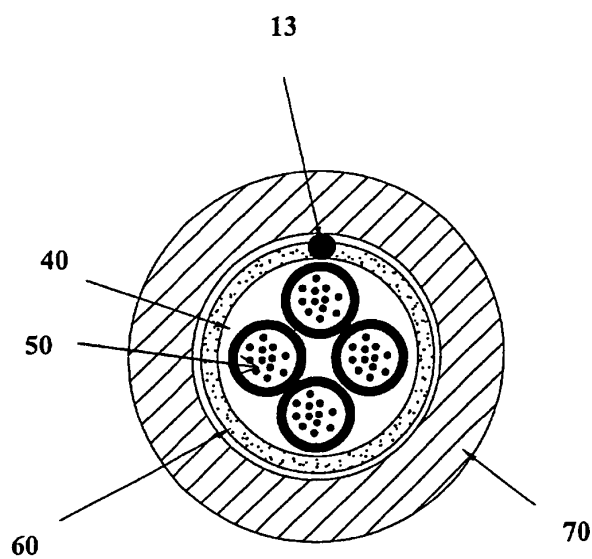


Figure 4

CABLE ASSEMBLY HAVING RIPCORDS WITH EXCESS LENGTH AND RIPCORDS ATTACHED TO TAPE

BACKGROUND OF THE INVENTION

[0001] 1. Field of Invention

[0002] This invention relates to a cable assembly in which removal of the protective jacket or sheath can be facilitated by having the ripcords attached to a tape in the cable assembly, which provides access to the underlying core. The ripcords placement in the cable assembly is also used as means for improving the ability of the cable assembly to withstand bending by using ripcords with excess length. The invention is particularly useful in optical cable assemblies, which have a tendency to be crush sensitive, and also other telecommunications cable assemblies including those containing fragile elements, such as copper wires insulated with thin, low resistance plastic such as cellular Pe.

[0003] 2. Related Art

[0004] Ripcords are used within a cable assembly to facilitate removal of a protective jacket or sheath, thus allowing direct access to the cable cores. Ripcords are generally introduced under the armor at the forming station (armored cables) or over the cable core at the jacket extruder head (dielectric cables) during the manufacture of a cable. The ripcords are disposed through the cable longitudinally or in a helical fashion having a long pitch. When two ripcords are provided, they are typically aligned to be 180 degrees apart, thereby potentially allowing for the cable jacket or sheath to be perfectly bisected. However, maintaining the position of the ripcords at 180 degrees becomes difficult during the manufacture of the cable assembly. Difficulties in maintaining the position of the ripcords can be, among other things, caused by core rotation relative to the armor, armor rotation relative to the cable sheath, intermittent sticking and slipping between the ripcords and the armor as the armor is formed, and/or inadequate ripcord pay-off tension.

[0005] The movement of the ripcords out of their initial position reduces functionality of the ripcord for a number of reasons. Among these reasons, ripcords that become positioned too close to the sharp edges of armor tape used in the manufacture of the cable can be cut, or they can "escape" from their desired location from under to over the armor. Also, if the ripcords move very close to each other, only a narrow slot (if no slot at all, as the second ripcord will slide through the opening created by the first one) is cut through the jacket or sheath, thus making extraction of the cable core very difficult.

[0006] A second problem in the prior art arises when the cable becomes bent. In this situation, ripcords that do not have excess length (that is, ripcords with a length that is nearly equal to the cable length) and which are not located on a neutral axis of the cable, are subjected to forces which tend to pull the ripcord toward the neutral axis of the cable. This stress of the ripcord may squeeze the cable core and damage, for example, the buffer tubes or optical fibers underneath, possibly causing attenuation increase or mechanical damage to the fiber coating. This is more particularly likely to happen in cable structures that have a tight fit between the core and the sheath/jacket, thus limiting the

possibilities for the ripcord to move around the core to reach the cable neutral bending plane. The present invention overcomes these problems.

BRIEF SUMMARY OF THE INVENTION

[0007] It is an object of the present invention to provide a cable assembly in which the ripcords are attached to the tape by, for example, bonding or weaving the ripcords to the tape, thus preventing movement of the ripcords from their initial position.

[0008] It is another object of the invention to provide a cable assembly having at least one ripcord with excess length disposed in the cable, which allows bending of the cable assembly with reduced ripcord tension.

[0009] Accordingly, the present invention provides a cable assembly comprising a cable core, a tape surrounding the cable core, at least one ripcord attached to the tape, and a cable jacket surrounding the tape. In addition to the cable jacket, the present invention can include a cable sheath disposed between the tape and the cable jacket for providing further protection to the cable core. As an example, a jacket referred to in this context can be a simple extruded plastic layer, while a sheath can represent a more complex protection (e.g., a sheath with additional reinforcement, such as an armor, a tape, or mechanical reinforcement). More particularly, the present invention comprises a cable assembly wherein the ripcord is attached to the tape by bonding or weaving the ripcord to the tape, thus providing for more secure placement of the ripcord and providing additional strength to the tape.

[0010] In a second embodiment of the present invention, a cable assembly comprises a cable core having a predetermined axial length, a cable jacket for housing the cable core along the predetermined axial length of the cable core, and a ripcord disposed between the cable core and the cable jacket along the predetermined axial length, in a manner that the ripcord is contained within the predetermined axial length, but the ripcord has a length substantially longer than the predetermined axial length. In a preferred embodiment of the present invention, the ripcord is disposed along the predetermined axial length in a wavy shape, for example sinusoidal, thus the ripcord is made "flexible", alleviating damage to the cable assembly that can occur from ripcord tension created by bending. When the cable returns from its bent position to a straight position, the ripcords can move back to their original path or locally buckle to accommodate a different path as they usually have a flexural stiffness that is low enough to easily allow this.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a diagram illustrating a section of tape with two ripcords positioned and bonded to the tape.

[0012] FIG. 2a is a diagram illustrating a cross-section of a cable assembly using the tape of FIG. 1 wherein ripcords are attached to the inside and outside of the tape.

[0013] FIG. 2b is a diagram illustrating a cross-section of a cable assembly using the tape of FIG. 1 wherein ripcords are attached to the inside of the tape.

[0014] FIG. 3 is a diagram illustrating a ripcord with excess length having the ripcord in a wavy shape.

[0015] FIG. 4 is a diagram depicting a cross-section of a cable assembly using a ripcord with excess length and "soft" buffer tubes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] The present invention allows for the ripcord location to be tightly controlled, which allows a jacket or sheath of a cable assembly to be bisected, and therefore, easy extraction of the cable core. FIG. 1 depicts a section of tape in which two ripcords are attached to the tape. More specifically, in FIG. 1, ripcord 10 and ripcord 11 are bonded to the tape 20 using an adhesive, chemical adhesion method, or a melting technique. The tape 20 used in a cable assembly can be of several types such as, for example, steel, paper, water swellable, heat-barrier, etc., these tapes being coated or not. In another embodiment of the present invention, ripcords 10 and 11 can be woven, instead of bonded, to tape 20. Weaving of the ripcord to the tape could take place during the manufacture of the tape, or by employing separate weaving processes tailored to the type of tape that is used.

[0017] By having the ripcords bonded or woven to the tape, the ripcords 10 and 11 are prevented from moving from their initial position. Therefore, the removal of a protective jacket or sheath is facilitated, and direct access to the cable cores can be obtained. One additional benefit of having the ripcords 10 and 11 bonded or woven to the tape 20 is that the ripcords 10 and 11 also carry a part of the tensile load of the tape, accordingly, providing a strength feature to the tape.

[0018] For a cable assembly using a laminated tape, e.g., a water-swellable tape, the tape contains at least two tape layers with for example, water swellable powder used in between the layers of the tape. When this type of tape is used, the ripcords 10 and 11 can be placed between the laminated layers, additionally providing strength to the tape 20.

[0019] FIGS. 2a and 2b illustrate a cross-section of a cable assembly of a preferred embodiment of the present invention, and depict how the tape 20 from FIG. 1 is placed and used in the cable assembly. Depending on the application, the ripcords 10 and 11 can be attached to the inside or the outside of the tape 20, or a combination thereof. FIG. 2a depicts ripcord 10 attached to the outside of tape 20, while ripcord 11 is attached to the inside of tape 20. Alternatively, FIG. 2b illustrates a cable assembly in which both ripcords 10 and 11 are attached to the inside of tape 20. In both FIGS. 2a and 2b, cable jacket 30 surrounds tape 20, providing protection to the cable core (not shown). The application of the ripcords 10 and 11 attached to the tape 20 is not particular to a cable design, but, could be used in most cable designs in which access to the cable is obtained by ripping an outer sheath or jacket 30. Also as shown in FIGS. 2a and 2b, ripcord 10 is aligned to be spaced apart from ripcord 11 (typically between 90 and 180 degrees), thereby allowing for bisection of the cable jacket 30.

[0020] Another embodiment of the present invention is shown in FIGS. 3 and 4. In FIGS. 3 and 4, the ripcord 13 has excess length which allows for bending of the cable assembly with reduced or negligible ripcord tension. In this embodiment, as shown in detail in FIG. 4, the ripcord 13 is placed between "soft" buffer tubes 40 surrounding optical fibers 50, and the outer sheath 70. The excess length should

be large enough to absorb strains caused on the ripcord by cable bending. In a preferred embodiment shown in FIG. 3, the ripcord 13 is placed with low tension to run interior to the outer sheath 70 in a wavy shape (nearly sinusoidal in FIG. 3). This wavy shape can be generated by a guiding die inserting the ripcord 13, where the guiding die is moved back and forth perpendicular to the cable assembly axis. An improvement of this technique could consist of bonding or gluing the ripcord on the tape following this wavy pattern so that the influence of the ripcord pay-off tension is minimized. An alternative solution to introduce overlength is to apply the ripcord with a low tension and stretch the core so that excess length is generated through relaxation of the core to generate the desired excess length due to the core relaxation. Using a ripcord with excess length enables a cable assembly to be bent without concern for damage to the cable core resulting from ripcord tension. Therefore, cable reliability can be improved during cable deployment and application, which promotes the use of ripcords in cable designs having soft cores of buffer tubes 40, e.g., FlexTube. In addition, in a further embodiment as shown in FIG. 4, the ripcord 13 can be attached to a core wrapping 60, which can be the tape as described above. Also, additional ripcords could be used, with the ripcords bonded or woven to the tape.

[0021] While the present invention has been described with what presently is considered to be the preferred embodiments, the claims are not to be limited to the disclosed embodiments. Variations can be made thereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A cable assembly comprising:
 - a cable core;
 - a tape surrounding said cable core;
 - at least one ripcord attached to said tape; and
 - a cable jacket surrounding said tape.
2. A cable assembly according to claim 1, wherein a cable sheath is disposed between said tape and said cable jacket.
3. A cable assembly according to claim 1, wherein said ripcord is attached to said tape in a wavy shape.
4. A cable assembly according to claim 1, wherein said ripcord is attached to said tape by bonding said ripcord to said tape.
5. A cable assembly according to claim 1, wherein said ripcord is attached to said tape by weaving said ripcord into a tape structure of said tape.
6. A cable assembly according to claim 3, wherein said ripcord is attached to said tape by bonding said ripcord to said tape.
7. A cable assembly according to claim 3, wherein said ripcord is attached to said tape by weaving said ripcord into a tape structure of said tape.
8. A cable assembly according to claim 1, wherein said cable core includes optical fibers enclosed by soft buffer tubes.
9. A cable assembly comprising:
 - a cable core;
 - a tape surrounding said cable core, wherein at least two tape layers are laminated to form said tape;

at least one ripcord disposed between said at least two tape layers; and

a cable jacket surrounding said tape.

10. A cable assembly according to claim 1, wherein a cable sheath is disposed between said tape and said cable jacket.

11. A cable assembly according to claim 9, wherein a water swellable powder is disposed between said at least two tape layers.

12. A cable assembly comprising:

a cable core having a predetermined axial length;

a cable jacket for housing said cable core along said predetermined axial length of said cable core;

a ripcord disposed between said cable core and said cable jacket along said predetermined axial length, in a manner that said ripcord is contained within said predetermined axial length, but said ripcord having a length substantially longer than said predetermined axial length.

13. A cable assembly according to claim 12, wherein said ripcord is disposed along said predetermined axial length in a wavy shape.

14. A cable assembly according to claim 12, further comprising a tape disposed between said cable core and said cable jacket.

15. A cable assembly according to claim 14, wherein said ripcord is bonded to said tape.

16. A cable assembly according to claim 14, wherein said ripcord is woven into said tape.

17. A cable assembly according to claim 14, wherein at least two tape layers are laminated to form said tape, said ripcord being disposed between said at least two tape layers.

18. A cable assembly according to claim 17, wherein a water swellable powder is disposed between said at least two tape layers.

19. A cable assembly according to claim 12, wherein said cable core includes optical fibers enclosed by soft buffer tubes.

* * * * *

June 20, 1967

S. GUARNASCHELLI

3,326,583

HIGH PRESSURE COMPRESSION FITTING FOR TUBING

Filed Aug. 24, 1964

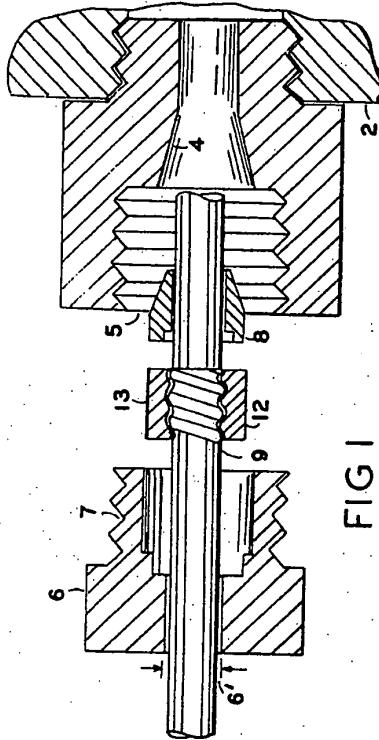


FIG 1

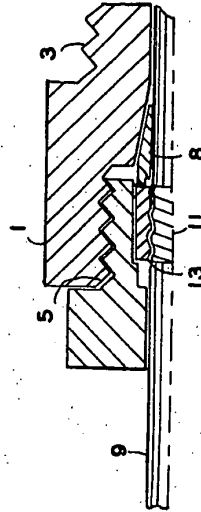


FIG 2

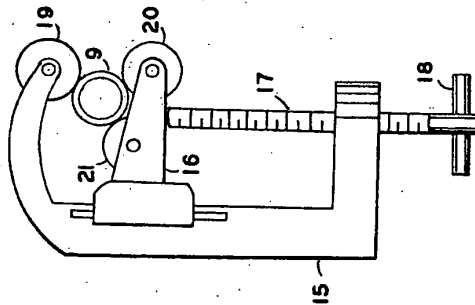


FIG 3

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3,326,583

HIGH PRESSURE COMPRESSION FITTING FOR TUBING

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Filed Aug. 24, 1964, Ser. No. 391,561

1 Claim. (Cl. 285—342)

This invention relates to high pressure compression fitting for tubing with metal to metal seals.

High pressure fittings for tubing are generally made with gaskets which are liable to become weakened and blow out causing leakage in the system.

The present invention eliminates the use of gaskets and provides a high pressure fitting which may be easily installed on the job.

Another conventional compression fitting sleeve type is one which bites into the tubing with either a single or double concentric sharp V-shaped edge.

The depth of the bite is so small it looks like a scratch mark and should the tube diameter vary i.e. be undersized, it no longer holds the fitting to the tube.

My system differs in principle. In my device locking is provided by deep helical or concentric grooves or threads which are rolled into the tubing resembling a threaded bolt with a coarse thread plus a nut split in halves to match its thread or grooves. Therefore, any variation in the diameter of the tube or solid rods does not make the fittings useless.

More specifically, the present invention generally comprises a fitting comprising a first member adapted to screw into an existing block such as an engine block or a tank, said member having an internal taper and internal threads. A nut member is provided having external threads adapted to put the internal threads of the said first member. A feature of the invention is a compression ring on the tubing which fits the internal taper of the first member. The compression ring is squeezed and locked into position by a pair of half nuts which fit on rolled on threads which are formed on the tubing by means of rotatable die members in a conventional manual cutter. The advantage of the rolled on threads is that no material is removed in forming the threads and the outside diameter of the threads is greater than the outside diameter of the tubing. Use is made of this feature to prevent the tubing from being blown through the nut member if the half nuts are stripped since the inside diameter of the nut member is made smaller than the outside diameter of the rolled on threads. Therefore, the joint has a plurality of substantially independent locking means.

Accordingly, a principal object of the invention is to provide new and improved high pressure fittings for tubing.

Another object of the invention is to provide new and improved high pressure fittings for tubing having metal to metal seals, eliminating the use of gaskets.

Another object of the invention is to provide a new and improved high pressure fitting for tubing utilizing a ring member which is adapted to be squeezed onto said tubing.

Another object of the invention is to provide a new and improved high pressure fitting with a plurality of substantially independent locking means.

Another object of the invention is to provide a new and improved high pressure fitting for tubing comprising a first hollow member adapted to fit into an existing block, said member having an internal taper and internal threads, a nut member having external threads adapted to fit said internal threads of said first member, said tubing having rolled on threads spaced a predetermined

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distance from said end of tubing, said threads being formed so that their outside diameter is greater than the outside diameter of said tubing, a ring member having an external taper mounted adjacent the end of said tubing, said tapered ring member being adapted to fit the internal taper of said first member, a pair of half nuts mounted on said rolled on threads, said nut member having a recess adapted to receive said half nuts and the inside diameter of said nut member being smaller than the outside diameter of said rolled on threads.

These and other objects of the invention will be apparent from the following specification and drawings of which:

FIGURE 1 is a sectional view illustrating an embodiment of the invention in exploded form.

FIGURE 2 is a view similar to FIGURE 1 with the member shown in connected position.

FIGURE 3 is a diagram illustrating a method of providing the rolled on thread used in the embodiments of FIGURES 1 and 2.

Referring to the figures, the invention generally comprises a first member 1 which is adapted to be screwed into an existing block 2 which may be for instance an engine block or a tank housing. The member 1 is hollow and has external threads 3 which are adapted to fit existing threads on the block 2. The member 1 has an internal taper 4 and internal threads 5.

A nut member 6 has external threads 7 which are adapted to fit the internal threads 5 of the member 1. Compression ring 8 fits near the end of the tubing 9. The tubing 9 has rolled on threads 11 which are formed by die members as will be explained. A pair of half nuts 12 and 13 are mounted on the rolled on threads. The nut member 6 is recessed to accommodate the half nuts 12 and 13 and the small diameter 6' of the nut member 6 is made smaller than the outside diameter of the threads 11 as will be discussed.

FIGURE 2 shows the parts in connected position with the half nuts 12 and 13 squeezing the ring 8 onto the tubing. The ring 8 has an external taper which is adapted to fit the internal taper of the member 1 to provide a metal to metal seal. As the nut member 6 is tightened up, it squeezes the half nuts 12 and 13 which in turn squeezes the ring member 8 so that it is wedged between the internal taper of the member 1 and the tubing. This provides a very tight connection between the ring 8 and the tubing 9 so that when the fitting is disassembled it is quite difficult to remove the ring 8 from the tubing.

FIGURE 3 illustrates a manual device for forming the rolled on threads. This device comprises a modified conventional tubing cutter 15 which includes a U-shaped frame which mounts a slidable member 16 which is adapted to be moved by means of the screw 17 and handle 18. The outer end of the frame supports a thread die 19 and on the slide 16 are mounted a thread die 20 and a flat roller 21 so that the tubing 9 is mounted between the three rotatable members 19, 20, and 21. The threads are formed by tightening up the handle so that there is pressure exerted by the three rotatable members on the tubing and then rotating the frame 15 around the tubing several turns. Several passes may be made to form suitable threads. The roller 21 is used to prevent the threads from becoming too sharp and thin in order to provide maximum strength.

Note, that no material is removed in forming these threads with the result that the outside diameter of the threads 11 is greater than the outside diameter of the tubing 9. This provides a safety feature in that even if the internal threads on the half nuts 12 and 13 are stripped, the tubing will still not be blown through the nut member 6, since the internal diameter 6' of the nut

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member 6 is made smaller than the outside diameter of the threads 11. Therefore, the nut 6 must be placed on the tubing 9 before the threads 11 are formed.

An advantage of the present invention is that the rolled on threads may be easily placed on the tubing with a simple manually operated tool as shown in FIGURE 3. This may be done on the job and precutting of the tubing and shop work on special lengths of the tubing are avoided.

Another advantage of the device is that practically unlimited pressure can be placed on the metal to metal seal, to squeeze the compression ring between the member 1 and the tubing, thereby providing an excellent seal without the use of any gaskets with a plurality of substantially independent locking means.

An embodiment of the invention has been successfully tested to 50,000 p.s.i. The elements are preferably made of cold steel or equivalent.

Many modifications may be made by those who desire to practice the invention without departing from the scope thereof which is defined by the following claim.

I claim:

A tube fitting comprising, a first member, a bore and a counterbore in said member, a junction between said bore and said counterbore including a tapered bore the largest diameter of which is adjacent said counterbore, a tube externally sized to be received in said bore, annular ridge means rolled on said tube adjacent one end thereof, the crest diameter of said ridge means being greater than outside diameter of said tube, a ring member adapted to be mounted on said tube, said ring member having an externally tapered surface adapted to fit in said tapered bore,

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collar means having a bore therethrough adapted to encircle said annular ridge means, said collar being longitudinally divided into at least two parts, the walls forming the bore in said collar means having formed therein annular ridge means adapted to mate with the ridge means on said tube, said collar means having one end face forming an abutment for said ring means, means retaining said collar means assembled on said tube ridge means, means to apply axial pressure to the other end of said collar means to retain the parts in assembled relation, and means to couple said first member to another fluid member.

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THOMAS F. CALLAGHAN, *Examiner.*



US006236790B1

(12) **United States Patent**
Okada et al.

(10) Patent No.: **US 6,236,790 B1**
(45) Date of Patent: **May 22, 2001**

(54) **OPTICAL-FIBER CABLE AND METHOD OF MANUFACTURING THE SAME**

(75) Inventors: **Naoki Okada; Hirohito Watanabe**, both of Yotsukaido; **Matsuhito Miyamoto, Sakura; Yoshiyasu Sato**, Chiba; **Koichiro Watanabe**, Tomisato-machi; **Hideyuki Iwata**, Tokyo, all of (JP)

(73) Assignees: **Fujikura Ltd.; Nippon Telegraph and Telephone Corporation**, both of Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(30) **Foreign Application Priority Data**

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Oct. 29, 1998	(JP)	10-309202
Oct. 29, 1998	(JP)	10-309207

Feb. 17, 1999 (JP) 11-039245

(51) Int. Cl.⁷ **G02B 6/44**

(52) U.S. Cl. **385/102; 385/103; 385/106; 385/100**

(58) Field of Search **385/100-114**

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Primary Examiner—Phan T. H. Palmer

(74) *Attorney, Agent, or Firm*—Oblon, Spivak, McClelland, Maier & Neustadt, P.C.

(57) **ABSTRACT**

There is provided an optical-fiber; and a cylinder body which is made from a cylindrically formed belt-shaped material and made of resin and which accommodates the optical-fiber therein.

10 Claims, 5 Drawing Sheets

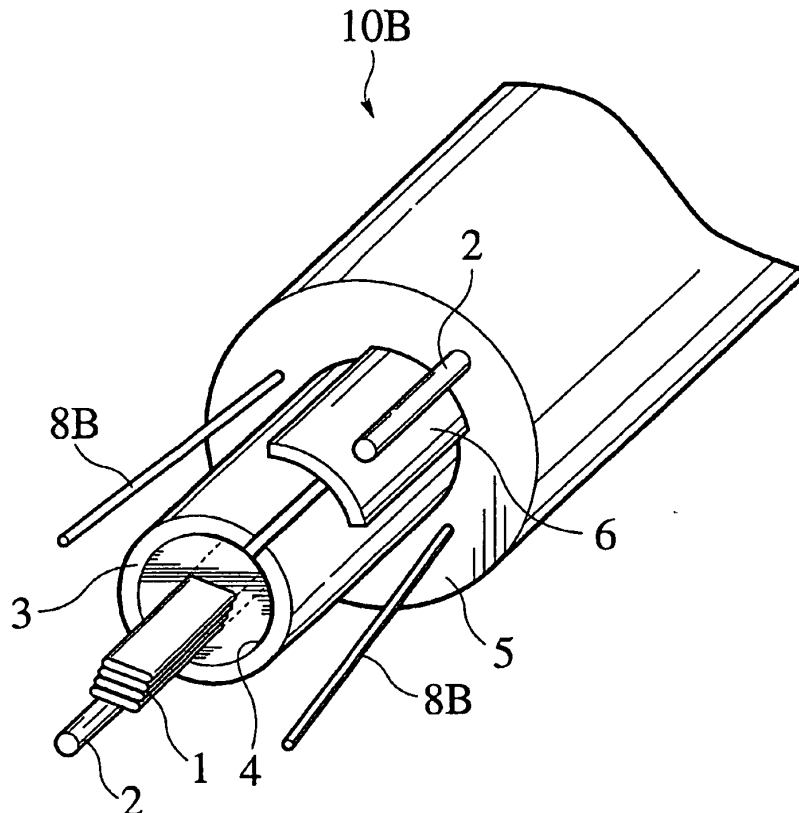


FIG.1

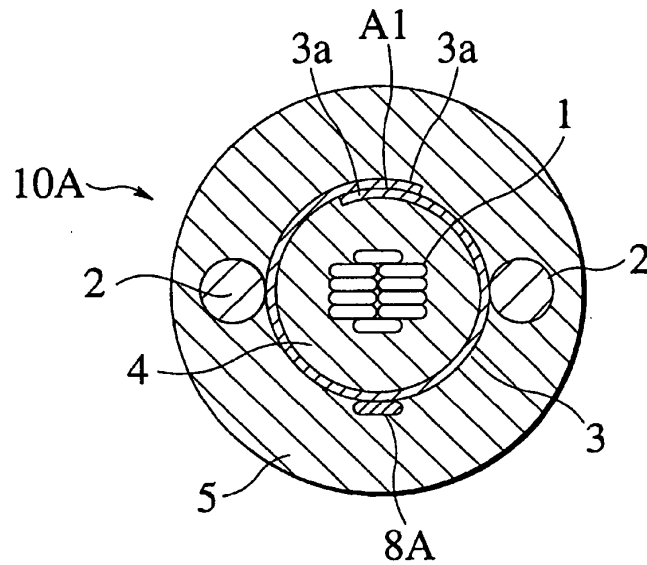


FIG.2

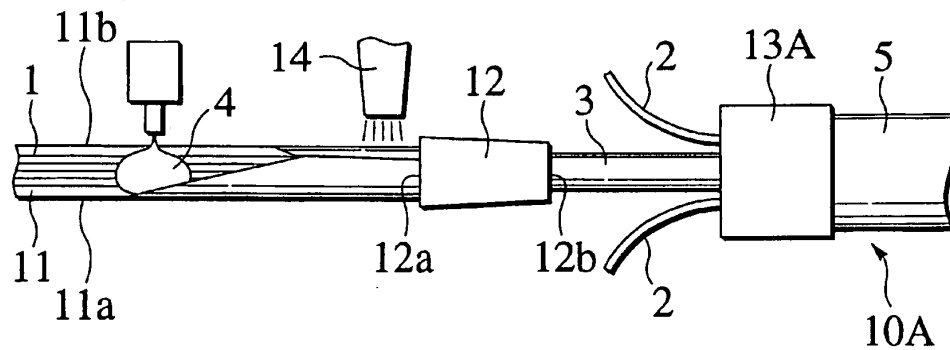


FIG.3

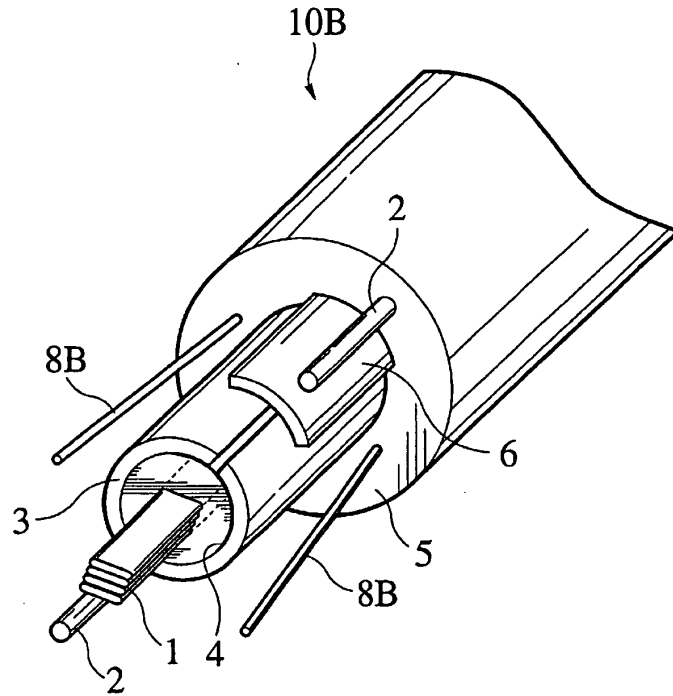


FIG.4

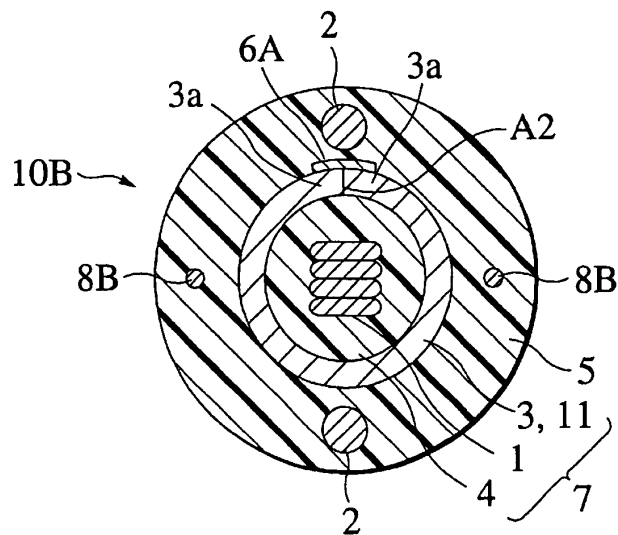


FIG.5

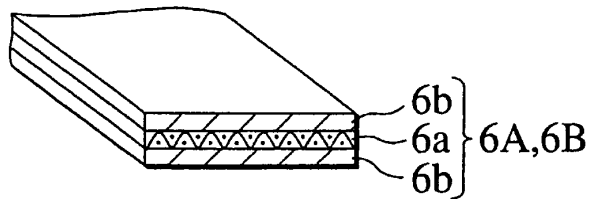


FIG.6

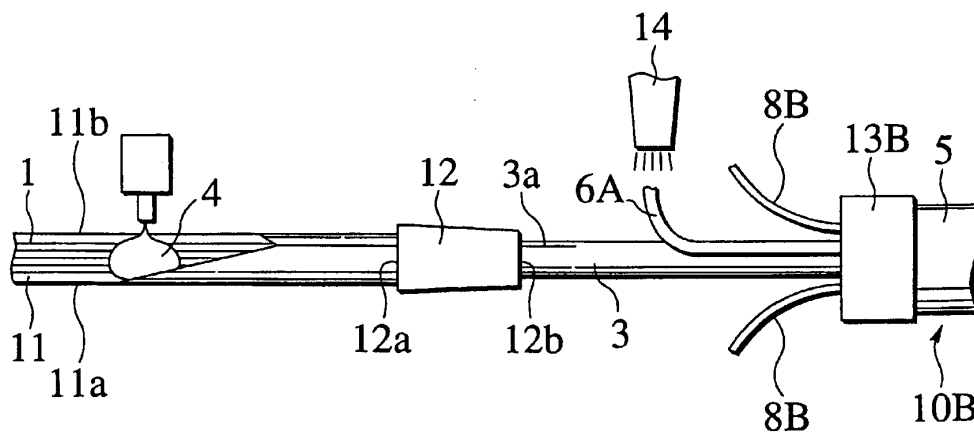


FIG.7

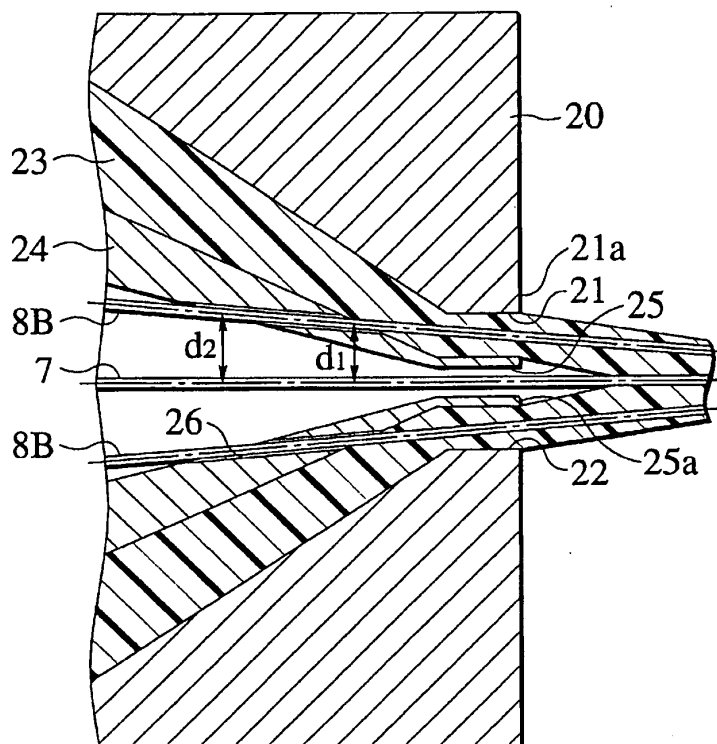


FIG.8

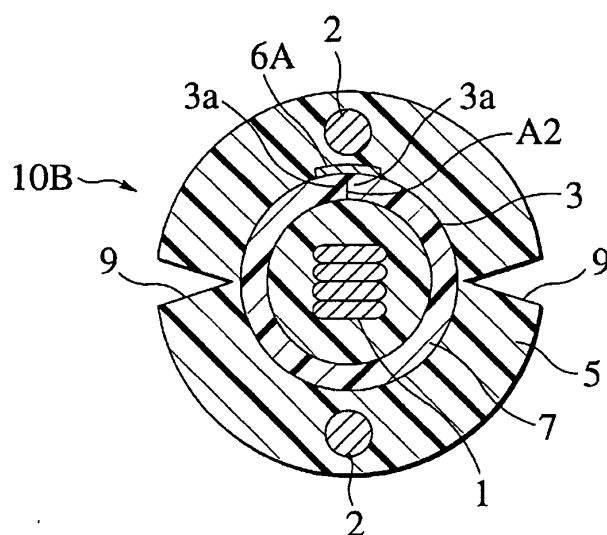


FIG.9

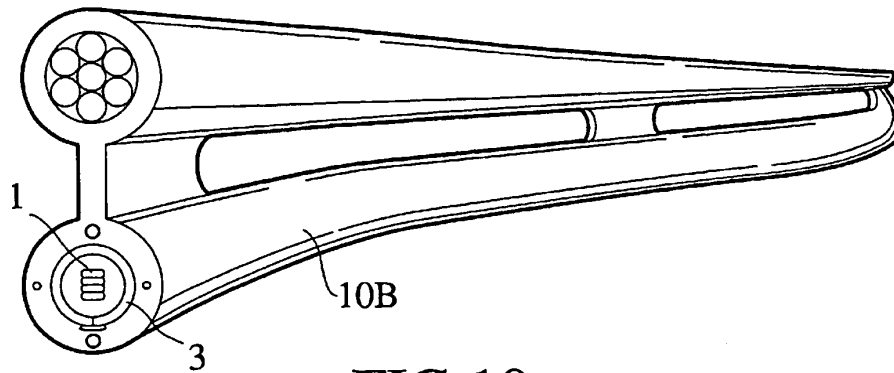


FIG.10

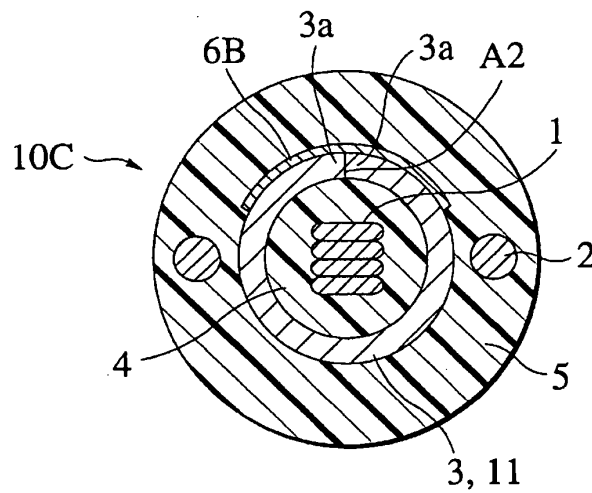
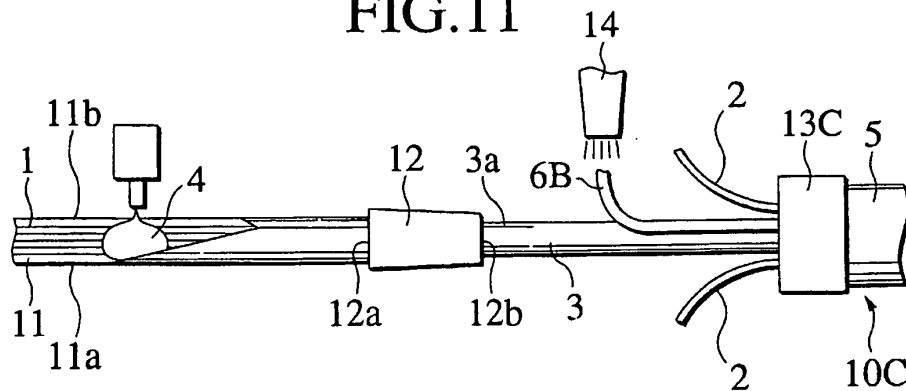


FIG.11



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OPTICAL-FIBER CABLE AND METHOD OF MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an optical-fiber cable having a cylinder body disposed at the center, with optical-fibers being accommodated in the cylinder body, and relates, more particularly, to an optical-fiber cable which can be manufactured easily at low cost by forming a belt-shaped material into a cylinder shape to form a cylinder body.

2. Description of Related Art

There have been known 1) a slot type cable, 2) a loose tube type cable and 3) a center tube type cable, for example, as structures of an optical-fiber cable for assembling several tens to several hundreds of optical-fibers together.

According to the slot type cable, optical-fiber ribbons are accommodated within grooves that is formed on the outer peripheral surface of a rod, and a pressed-wound layer and a sheath are formed sequentially on the periphery of the slotted rod. A tension member is disposed at the center of the slotted rod, with a rip cord disposed between the pressed-wound layer and the sheath.

According to the loose tube type cable, loose tubes accommodating optical fibers are stranded around central tension members, and a pressed-wound layer and a sheath are formed sequentially on this assembly. Jelly is filled within the loose tubes, and rip cords are distributed between the pressed-wound layer and the sheath.

According to the center tube type cable, there is disposed, at the center, a center tube accommodating optical-fiber ribbons therein, and a sheath is formed on the periphery. Tension members are embedded within the sheath, and jelly is filled within the center tube. Further, rip cords are disposed between the center tube and the sheath.

These optical-fiber cables have had the following problems.

The slot type cable has a suitable structure for obtaining a multiple-core optical-fiber cable as the optical-fibers are accommodated in the spiral grooves formed on the outer periphery of the rod. However, the slot type cable has a problem that its structure becomes costly in the case of a small-core optical-fiber cable due to high cost of the slotted rod.

The loose tube type cable has a suitable structure for obtaining a small-core optical-fiber cable by using single-core optical-fibers. However, the loose type cable has a problem of having a larger number of manufacturing processes because this structure requires a process of forming loose tubes and a process of assembling a plurality of loose tubes around a central tension member. Further, in the case of structuring a multiple-core optical-fiber cable by using optical-fiber ribbons, this has a problem that an external diameter becomes larger. Furthermore, as the loose tubes are manufactured by a method of forming a tube by extruding a resin while inserting optical-fibers at the same time, it has been unavoidable to charge jelly into the whole inside of the loose tubes in order to prevent a molten resin from adhering to the optical-fibers at the time of forming by extrusion. Accordingly, this has an inconvenience of incurring the cost of charging the jelly.

The center tube type cable can be manufactured in a relatively small number of processes because of its simple structure. However, the center tube is formed by extrusion while inserting optical-fibers and optical-fiber ribbons at the

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same time, as in the case of the loose tube type cable. Therefore, it has been unavoidable to charge jelly into the tubes in order to prevent a move of the optical-fiber ribbons in a longitudinal direction within the center tube. This has a problem of high manufacturing cost.

Moreover, both the loose tube type cable and the center tube type cable have had a problem that the tube has to be disconnected at the time of carrying out a connection such as a branch connection or the like.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an optical-fiber cable capable of being manufactured at lower cost than by the conventional method, and to provide a method of manufacturing this optical-fiber.

It is another object of the present invention to provide an optical-fiber cable that facilitates a connection such as a branch connection, and to provide a method of manufacturing this optical-fiber cable.

According to a first aspect of the present invention, there is provided an optical-fiber cable which comprises an optical-fiber; and a cylinder body which is made from a cylindrically formed belt-shaped material and made of resin and which accommodates the optical-fiber therein.

The optical-fiber includes a fiber ribbon type which has plural fibers and a single-fiber type.

Preferably, the optical-fiber cable further comprises a first tension member which is disposed at an outside of the cylinder body; and a sheath which covers the outside of the cylinder body and the tension member.

Preferably, the optical-fiber cable further comprises: a filler which is disposed with a distance along the optical-fiber in a longitudinal direction thereof and which is provided between the optical-fiber and the cylinder body for preventing a move of the optical-fiber in a longitudinal direction.

Preferably, the belt-shaped material has a first end and a second end, and an adhesive member is adhered to the first end and the second of the cylindrically-formed belt-shaped material.

Preferably, the adhesive member has a tension member therein.

Preferably, the optical-fiber cable further comprises: a first rip cord which is disposed at the outside of the cylinder body within the sheath.

Preferably, the optical-fiber cable further comprises: a second rip cord; and a second tension member. The first rip cord and the second rip cord are symmetric with respect to the optical-fiber. The first tension member and the second tension member are symmetric with respect to the optical-fiber. A first plane which includes the first rip cord and the second rip cord and a second plane which includes the tension first member and the second tension member cross each other.

Preferably, the rip cord has one of a high-tensile high-polymer fiber, a glass fiber, a cotton yarn and a metal wire.

According to a second aspect of the present invention, there is provided a method of manufacturing an optical-fiber cable, comprising the steps of: accommodating an optical-fiber in a cylinder body while forming a belt-shaped material into the cylinder body; disposing a tension member at an outside of the cylinder body; and covering the outside of the cylinder body and the tension member with a sheath.

Preferably, before forming the belt-shaped material into the cylinder body, the belt-shaped material is disposed along

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the optical-fiber, and a filler is applied with a distance along to one of the belt-shaped material and the optical-fiber in a longitudinal direction.

Preferably, an adhesive member is adhered to a first end and a second end of the cylindrically formed belt-shaped material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of an optical-fiber cable relating to a first embodiment of the present invention;

FIG. 2 is an explanatory view for showing a manufacturing process of the optical-fiber shown in FIG. 1;

FIG. 3 is a perspective view of an optical-fiber cable relating to a second embodiment of the present invention;

FIG. 4 is a cross sectional view of the optical-fiber cable shown in FIG. 3;

FIG. 5 is a perspective view for showing an adhesive tape shown in FIG. 3;

FIG. 6 is an explanatory view for showing a manufacturing process of the optical-fiber cable shown in FIG. 3;

FIG. 7 is a cross sectional view of an extrusion molder shown in FIG. 6;

FIG. 8 is an explanatory view for showing a method of taking out an optical-fiber ribbon from the optical-fiber cable shown in FIG. 3;

FIG. 9 is a perspective view for showing an example that the optical-fiber cable shown in FIG. 3 is applied to a self-support type cable;

FIG. 10 is a cross sectional view of an optical-fiber cable relating to a third embodiment of the present invention; and

FIG. 11 is an explanatory view for showing a manufacturing process of the optical-fiber cable shown in FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Embodiment

There will be explained the present invention in detail below. FIG. 1 shows the first embodiment of an optical-fiber cable of the present invention. A plurality of optical-fiber ribbons 1 as an optical-fiber are accommodated inside a cylinder body 3, and a filler 4 is filled between the optical-fiber ribbons 1 and the internal wall of the cylinder body 3.

Each of the optical-fiber ribbons 1 is structured by, for example, a four-fiber ribbon with a thickness of 0.3 mm and a width of 1.1 mm, including an optical fiber with a diameter of 0.250 mm, coated with an UV-curable resin (two-layer coated) for protecting the bare-fiber of a diameter of 0.125 mm and an UV-curable coloring resin for identification.

In the present embodiment, ten ribbons 1 are stacked. The number of the fiber ribbons 1 however, is not limited.

The cylinder body 3 is structured by a belt-shaped material formed in a cylindrical shape. On the outer periphery of the cylinder body 3, a joint part A1 is formed by joining both edges (ends) 3a of the belt-shaped material, along a longitudinal direction. A non-woven fabric tape or a plastic tape, for example, is used for the belt-shaped material to be used for forming the cylinder body 3. To the cylinder body 3, there may be applied a water-absorptive tape coated with a water-absorptive material, to provide the cylinder body 3 with waterproofing.

The filler 4 is not being filled continuously along the longitudinal direction of the cylinder body 3, but is being filled intermittently with a distance. For the filler 4, there is most suitably used a hot-melt type resin having a characteristic that this material is melted when heated and is

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solidified in a solid state at a room temperature. For example, there may be used a polyethylene resin, a styrene elastomer, a rubber resin, or the like.

Two tension members 2 are disposed on the outer periphery (outside) of the cylinder 3 along a longitudinal direction of the cylinder body 3. These tension members 2 can be structured by a suitable tensile stress-resistant material. For example, there will be preferably used a steel wire, a glass fiber reinforced resin, an aramid fiber (Kebler; a trade mark) reinforced resin, or the like.

A sheath 5 collectively covers the cylinder body 3 and the tension member 2. The sheath 5 is formed by extrusion to cover these members with a suitable resin material. For example, polyethylene (PE) is used for this purpose.

Further, a rip cord 8A is disposed between the cylinder body 3 and the sheath 5 along a longitudinal direction of the cylinder body 3. For this rip cord 8A, there is used, for example, an aramid fiber, a high-tensile high-polymer fiber of a polyethylene terephthalate fiber, Tetron fiber, a glass fiber, a metal fiber, a cotton yarn, a plastic tensile stress-resistant unit, a steel wire, an aluminum wire, a copper metal wire, or the like. There is preferably used an aramid fiber, a polyethylene terephthalate fiber or a cotton yarn.

An optical-fiber 10A of the above-described structure is manufactured as follows, for example. FIG. 2 is an explanatory view for showing a method of manufacturing the optical-fiber cable of the present invention.

An adhesive is coated in advance on one or both of edges (ends) 11a and 11b of a belt-shaped material 11, to form an adhesive layer (not shown). This adhesive layer is formed on a joint surface where both ends of the belt-shaped material 11 are put on each other when the belt-shaped material 11 is formed in a cylindrical shape in the later process.

Then, as shown in FIG. 2, a plurality of optical-fiber ribbons 1 are disposed on the belt-shaped material 11 in parallel with the belt-shaped materials 11. In this case, the belt-shaped material 11 and the fiber ribbons 1 may be in contact with each other or may be separated.

Next, a filler 4 is applied to the belt-shaped material 11 and the optical-fiber ribbons 1 intermittently with a distance in a longitudinal direction. In this case, it is necessary to prepare the filler 4 by at least the quantity which is sufficient to fix the optical-fiber ribbons 1 to the inner wall of the cylinder body 3 when the belt-shaped material 11 has been formed on the cylinder body 3 in the later process. Further, it is desirable, from the viewpoint of the waterproof function of the optical-fiber cable 10A, to obtain a quantity of the filler which is sufficient to fill completely the whole gap between the inner wall of the cylinder body 3 and the optical-fiber ribbons 1, if possible.

Next, the adhesive layer of both edges (ends) 11a and 11b (3a in FIG. 1) of the belt-shaped material is heated by heating means 14 such as a hot jet. Then, the adhesive of the adhesive layer is melted.

Next, the belt-shaped material 11 and the fiber ribbons 1 are guided into a former 12. The former 12 is formed in a conical tube shape, with its diameter being gradually reduced from an input part 12a, from which the belt-shaped material 11 and the fiber ribbons 1 are input, toward an exit part 12b. The belt-shaped material 11 is bent to surround the fiber ribbons 1 as they are passed through the former 12, and both edges (ends) 11a and 11b of the belt-shaped material 11 are overlapped to form a cylinder body 3. In this case, the adhesive is cooled, both ends 11a and 11b are adhered together, and a joint part A1 is formed.

Subsequently, in a state that two tension members 2 and a rip cord 8A (not shown) are set along the outside of the

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cylinder body 3 with the joint part A1 in the joined state, they are guided together into an extrusion molder 13A. By passing them through the extrusion molder 13A, the outer periphery of the tension members 2 and the rip cord 8A are covered together with the resin, thereby to form a sheath 5. Thus, a cable 10A is obtained.

According to the present embodiment, there are a small number of manufacturing processes since at the same time when the belt-shaped material 11 is formed into a cylinder shape, the fiber ribbons 1 are accommodated inside this cylinder, in manufacturing the optical-fiber cable 10A. Therefore, the optical-fiber cable 10A can be manufactured easily at low cost.

Further, since the process of forming the cylinder body 3, the process of accommodating the optical-fiber ribbons 1 inside this cylinder body 3 and the process of forming the sheath by collective covering, are carried out continuously, high manufacturing efficiency can be obtained.

Further, since the cylinder body 3 is formed by using the belt-shaped material 11, it is not necessary to form a tube by extrusion for accommodating the fiber ribbons 1, unlike the prior-art technique. Accordingly, the optical-fiber cable 10A can be manufactured at low cost, with a simple work for connection of the optical-fiber cable and a branching at a later stage.

Since the fiber ribbons 1 are fixed to the inner wall of the cylinder body 3 with the filler 4, it is possible to prevent the fiber ribbons 1 from being moved in a longitudinal direction within the cylinder 3. Further, as the filler 4 is filled intermittently without involving the filling of jelly, the work for connecting the optical-fiber cable is simple, with a satisfactory handling. The distance between the filling points of the filler is different depending on the diameter of the cable and the number of optical-fiber ribbons accommodated. However, if the distance between the filling points is too large, it is not possible to obtain the effect of preventing the move of the optical-fiber in a longitudinal direction on the waterproofing effect. On the other hand, if the distance between the filling of the filler is too small, it becomes costly, with poor work efficiency of branch connection. Therefore, usually, the filler is filled with a distance of about 0.2 to 2 m, preferably within a range of from 0.5 to 1 m. If the filler 4 is embedded into the gap between the inner wall of the cylinder body 3 and the fiber ribbons 1, this arrangement is desirable from the viewpoint of the waterproofing function as water invaded into the cylinder body 3 can be prevented from flowing through the whole inside of the cylinder body 3.

Further, at the time of branching at a later stage, the joint part A1 of the cylinder body 3 is peeled off and both ends 3a are separated in mutually opposite directions, so that the fiber ribbons 1 are taken out easily.

In the above embodiment, although the adhesive layer is provided in advance on both edges (ends) 11a and 11b of the belt-shaped material 11, it is also good to arrange such that, without providing the adhesive layer on the belt-shaped material 11 in advance, a suitable quantity of an adhesive is flown into the joint part A1 at the same time of forming the cylinder body 3 or after the forming of the cylinder body 3, and this may be hardened. Alternately, it may be arranged such that, without using an adhesive, the belt-shaped material 11 is formed in a belt shape, and thereafter, a yarn-shaped or tape-shaped material is wound around this belt.

Although the joint part A1 is formed by overlapping both edges (ends) 11a and 11b (3a in FIG. 1) of the belt-shaped material 11 in the above embodiment, the joint part may also be formed by facing both end surfaces of the belt-shaped

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material 11 together. In the case of winding a yarn-shaped or tape-shaped material without using an adhesive, it is not always necessary to form the joint part, but there may exist a gap between both edges (ends) 11a and 11b of the belt-shaped material 11.

Further, in the above embodiment, although explanation has been made of the case where a plurality of fiber ribbons 1 are accommodated with the cylinder body 3, there may also be accommodated a single-core optical-fiber.

Further, in the above embodiment, the filler is provided intermittently for preventing the move of the optical-fiber ribbons in a longitudinal direction. However, jelly may also be used instead of the filler if this permits cost allowance.

Second Embodiment

As shown in FIG. 3 and FIG. 4, an optical-fiber cable 10B has such a structure that a cylinder body 3 accommodating four optical-fiber ribbons 1 therein is disposed at the center, the outer periphery of the cylinder body 3 is covered with a sheath 5, and two rip cords 8B and two tension members 2 are embedded within the sheath 5. The cylinder body 3 is formed by joining both ends 3a of a belt-shaped material 11 in a width direction with an adhesive tape 6A to form a cylinder shape.

The same members as those in the first embodiment will hereinafter be attached with the same reference numbers, with their explanation being omitted.

Preferably, both ends 3a of the cylinder body 3 (belt-shaped material) are formed in a joint part A2, by facing both end surfaces of the belt-shaped material 11 together to be joined as shown in FIG. 4, or by facing both end surfaces with a slight gap left therebetween. Further, if both ends are joined satisfactorily with the adhesive tape 6A, there may be left a slight overlap portion at both ends 3a. However, if the overlap of both ends is too large, it becomes difficult to take out the fiber ribbons 1 from inside the cylinder body 3 at the time of branching at a later stage. Therefore, it is preferable that the size of the overlap is as small as possible.

For the adhesive tape 6A, there are used, for example, adhesive layers 6b laminated on both surfaces of a tape material 6a, as shown in FIG. 5. The tape material 6a is prepared by, for example, a plastic tape made of polyethylene terephthalate (PET), polypropylene (PP), or the like or a non-woven fabric tape. The adhesive layer 6b is a hot-melt type made of ethylene-vinyl acetate copolymer (EVA), for example.

It is necessary that the adhesive tape 6A has adhesive strength at least on the surface to be brought into contact with the cylinder body 3. It is more preferable to have adhesive strength on both surfaces, for improved adhesion with the sheath 5, which ensures the joint of both ends of the belt-shaped material 11.

If the width of the adhesive tape 6A is too small, it is not possible to join sufficiently both ends of the belt-shaped material 11, and it also becomes difficult to handle the adhesive tape 6A. Therefore, the width needs to be 3 mm or above. On the other hand, if the width is too large, it is not desirable because of poor workability at the time of disassembling the cylinder body 3 for branching at a later stage. In other words, in the case of branching the optical-fiber cable 10 at a later stage, for example, the adhesive tape 6A is peeled off from the cylinder body 3, the joint of both ends 3a of the belt-shaped material 11 is opened, and the optical-fiber ribbons 1 are taken out from this opening. If the width of the adhesive tape 6A is so large that one half or more portion of the periphery of the cylinder body 3 is covered by the adhesive tape 6A, it becomes difficult to peel off the adhesive tape 6A from the cylinder body 3. This requires too

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much cumbersome work. Therefore, it is preferable that the width of the adhesive tape 6A is less than one half of the outer periphery of the cylinder body 3.

Further, the adhesive tape 6A may be equipped with a tensile stress-resistant unit that is not disconnected easily when applied with a tensile stress. In this case, this tape can be utilized as a rip cord for tearing off the sheath 5 at the time of disassembling the sheath 5. For the tensile stress-resistant unit, there may be used, for example, a tensile stress-resistant fiber such as a glass fiber, an aramid fiber, a carbon fiber, or the like. A tape material 6a may also be formed by using a fiber reinforced resin including any one of these fibers. Alternately, a long tensile stress-resistant fiber may be used by being added vertically at a suitable position within the adhesive tape 6A.

The two rip cords 8B are at mutually symmetrical positions with respect to the center or the fiber ribbons 1 of the cable 10B. Further, the two members 2 are mutually at symmetrical positions with respect to the center or the fiber ribbons 1 of the cable 10B. Further, the plane including the two cords 2 and the plane including the two members 8B are at almost right angles with each other. In this case, the term almost right angles means that an angle formed by the two crossing planes is not limited to 90 degrees but is within a range from 45 to 135 degrees. The outer diameter of this cable 10B is, for example, about 10 mm.

For the rip cords 8B, there may be generally used, for example, a high-tensile high-polymer fiber, an aramid fiber, a glass fiber, a metal fiber, a steel wire, a cotton yarn, or a plastic tensile stress-resistant unit as well as the rip cord 8A.

The optical-fiber cable 10B is manufactured as follows, for example. FIG. 6 shows a method of manufacturing the optical-fiber cable of the present invention. The explanation of the manufacturing processes already explained in the first embodiment will be omitted.

The belt-shaped material 11 and the optical-fiber ribbons 1 are guided into a former 12.

The belt-shaped material 11 is bent to surround the fiber ribbons 1 while passing through the former 12, and both edges (ends) 3a of the belt-shaped material 11 are faced together, to form a cylinder main body 3. The cylinder body comes out from the former 12.

After that, the adhesive tape 6A is heated by heating means 14 such as a hot jet or the like, to melt the adhesive layer 6b thereof. The adhesive tape 6A is laminated on a joint part A2 of the cylinder body 3, and then both edges 3a of the belt-shaped material 11 are joined.

Subsequently, in a state that the rip cords 8B and two tension members not shown are set along the cylinder body 3 adhered with the adhesive tape 6A, they are guided together into an extrusion molder 13B. By passing these members through the extrusion molder 13B, a sheath 5 is formed to collectively cover the cylinder body 3, the rip cords 8B and the tension members with the resin, thereby to obtain the optical-fiber cable 10B.

For the molder 13B, there may be used a molder equipped with a dice and a nipple.

FIG. 7 is a cross sectional view of a front end part of a dice and a nipple, for showing one example of the molder 13 used in the present embodiment. A nipple 24 is provided within a dice 20. Between the dice 20 and the nipple 24, there is supplied a resin 23 in a melted state for being used to form the sheath 5. At the exit side of the dice 20, a dice hole 21 is provided, and a nipple hole 25 is provided at the front end of the nipple 24. The front end of the hole 21 and the front end of the hole 25 are on the same plane, and the hole 21 and the hole 25 are disposed concentrically.

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On the wall surface of the nipple 24, two rip cord through-holes 26 are provided for passing the rip cords 8B to the hole 21. Similarly, on the wall surface of the nipple 24, two tension-member through-holes not shown are formed for guiding the tension members 2 to between the holes 21 and the hole 25.

The center lines of the two through-holes 26 and the center lines of the two tension-member through-holes are respectively disposed at mutually symmetrical positions with respect to the center line of the hole 25. Further, the plane including the center lines of the two through-holes 26 and the plane including the center lines of the two tension-member through-holes are mutually in almost right angle positional relationship. The term almost right angle means that an angle formed by the two crossing planes is not limited to 90 degrees but is within a range from 45 to 135 degrees.

Further, there is a characteristic that, in the molder 13B, the center lines of the through-holes 26 of the rip cords 8B and the center lines of the tension-member through-holes are not in parallel respectively with the center line of the hole 25. In other words, the through-holes 26 are provided such that a distance d2 between the center line of the through-hole 26 and the center line of the hole 25 at an inner position of the nipple 24 is larger than a distance d1 between the center line of the through-hole 26 and the center line of the hole 25 at the hole 25 side. Similarly, the through-holes of the tension members not shown are also provided such that a distance between the center line of the tension-member through-hole and the center line of the hole 25 at an inner position of the nipple 24 is larger than a distance between the center line of the tension-member through-hole and the center line of the hole 25 at the hole 25 side.

An angle formed by the center line of the through-hole 26 and the center line of the hole 25 and an angle formed by the center line of the tension-member through-hole and the center line of the hole 25 are set respectively such that the rip cord 8B and the tension member 2 drawn out from the hole 21 gradually come close to a cable core 7 as they are away from the dice 20, and the rip cord 8B and the tension member 2 adhere to the core 7 before the resin around the dice 20 is hardened. Then, the respective angles thereafter are set according to the thickness of the core 7, the properties of the resin, the running speed, etc. so that the rip cord 8B, the tension member 2 and the core 7 run in parallel.

In this molder 13B, after the rip cord 8B and the tension member 2 have respectively passed through the through-hole 26 and the tension-member through hole, they pass through a melted resin 23 and run by gradually reducing the distance from the core 7. When the resin 23 around the rip cord 8B and the tension member 2 adheres to the core 7, the rip cord 8B, the tension member 2 and the core 7 become parallel with each other. The resin 23 is then hardened to form the sheath 5.

As explained above, when the molder 13B, in which the through-holes 26 and the tension-member through-holes are formed in a slope with respect to the center line of the hole 25, is used, the resin can be guided onto the core 7 to have a close adhesion even if the resin 23 gives a strong adhesive operation to the tension members 2 and the rip cords 8B within the molder 13B. Accordingly, it is possible to prevent a generation of a gap between the sheath 5 formed and the core 7. Particularly, in the vicinity of the rip cords 8B and the tension members 2, a generation of a gap can be prevented securely.

Further, it is also possible to prevent securely a generation of a gap between the core 7 and the sheath 5 at a portion

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other than the vicinity of the rip cords 8B and the tension members 2 by applying a vacuum pressure to the space around the cable drawn from the dice hole 25.

FIG. 8 shows one example of a method of taking out the optical-fiber ribbons 1 from the optical-fiber cable 10 according to the present invention.

Two rip cords 8B embedded within a sheath 5 are drawn out, and the sheath 5 is torn up to form two grooves 9 on the sheath. With these two grooves 9 as borders, the sheath 5 is further torn up in up and down directions. Then, a tape 6A is peeled off from a cylinder body 3, and both ends 3a of the cylinder body 3 are opened in directions to separate from each other. Thus, the fiber ribbons 1 are taken out.

Since the rip cords 8B are embedded within the sheath 5 and further both ends 3a of the cylinder body 3 are adhered by the adhesive tape 6, the fiber ribbons 1 can be taken out easily without disconnecting the optical-fiber 10B.

According to the above embodiment, it is easy to manufacture the optical-fiber as the cylinder body 3 is prepared by joining both ends 3a of the belt-shaped material 11 with the adhesive tape 6A. Particularly, if the adhesive tape 6A has adhesive strength on its both surfaces, a satisfactory adhesion can be obtained between the cylinder body 3 and the adhesive tape 6A and between the adhesive tape 6A and the sheath 5, by thermal fusion. Therefore, the joint between both ends 3a of the belt-shaped material 11 can be carried out easily and securely. Further, as the adhesive tape 6A is used for joining both ends 3a of the cylinder body 3, the cylinder body 3 can be disassembled easily by peeling off the adhesive tape 6A from the cylinder body 3 in case of the branching at a later stage. Thus, the fiber ribbons 1 can be taken out easily from the inside of the cylinder 3.

Further, if the adhesive tape 6A used has a tensile stress-resistant unit, this adhesive tape 6A can be used as a rip cord for tearing up the sheath 5.

The optical-fiber cable 10B has rip cords 8B embedded in the sheath 5. Thus, the optical-fiber ribbons 1 are taken out without braking the cable 10B, and it is easy to connect and branch at a later stage with a cable. The rip cords 8B is provided without preventing the sheath 5 and the cable core 7 from adhering, when the cable 10B is bent the cylinder body 3 does not yield, and the optical-fiber ribbons 1 in the cylinder 3 is not bent. Therefore, an excellent cable which has little transmission loss is obtained.

In the optical-fiber cable 10B, the rip cord 8B has a glass fiber, a metal fiber, a cotton yarn, or a plastic tensile stress-resistant unit, and sheath 5 is tore up easily.

Although the cylinder body 3 is disposed at the center in the present embodiment, the present invention is not limited to this structure. The invention can also be applied to optical-fiber cables of various types of structures such as, for example, an SSD type cable (self-supportive type cable) equipped with a cylinder body 3 accommodating optical-fiber ribbons 1 and a tensile stress unit 30, as shown in FIG. 9.

Third Embodiment

As shown in FIG. 10, an optical-fiber 10C relating to the present embodiment is structured such that there is disposed at the center a cylinder body 3 accommodating optical-fiber ribbons 1, and the outer periphery of the cylinder body 3 is covered by a sheath 5, with tension members 2 being provided within the sheath 5. The cable 10C has an outer diameter of about 10 mm.

The cylinder body 3 is formed by joining both ends 3a of a belt-shaped material 11 in a width direction with an adhesive tape 6B to form a cylinder shape. In the present embodiment, the outer circumference of the cylinder body 3

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has a size of 15 mm, and the adhesive tape 6B is set to have a width of about 5 mm, with the same structure as that of the adhesive tape 6A shown in FIG. 5.

The outer periphery of the cylinder body 3 is covered by the sheath 5, and two tension members 2 are embedded inside the sheath 5 along a longitudinal direction of the cylinder body 3. There may also be disposed rip cords (not shown) between the cylinder 3 and the sheath 5 along a longitudinal direction when necessary. However, if the adhesive tape 6B has a tensile stress-resistant unit as described above, the provision of the rip cords is not necessary.

The cable 10C is manufactured as shown in FIG. 11.

In a state that the two tension members 2 are set along the cylinder body 3 adhered with the adhesive tape 6B, they are guided into an extruding molder 13C. While passing through the molder 13C, the cylinder body 3 and the tension members 2 are collectively covered by the resin, to form the sheath 5. Thus, the optical-fiber cable 10C is obtained. The molder 13C used is the same as that shown in FIG. 7, and only tension-member through-holes are used.

What is claimed is:

1. An optical-fiber cable, comprising:

an optical-fiber; and

a belt-shaped member made of resin and formed in a tubular shape, the belt-shaped member having a first end and a second end joined to each other, the belt-shaped member accommodating the optical-fiber therein.

2. An optical-fiber cable according to claim 1, further comprising:

a first tension member disposed at an outside of the belt-shaped member; and

a sheath covering the outside of the belt-shaped member and the tension member.

3. An optical-fiber cable according to claim 2, further comprising:

a first rip cord disposed at the outside of the belt-shaped member within the sheath.

4. An optical-fiber cable according to claim 3, further comprising:

a second rip cord; and

a second tension member,

wherein said first rip cord and said second rip cord are symmetric with respect to said optical-fiber, said first tension member and said second tension member are symmetric with respect to said optical-fiber, a first plane including said first rip cord and said second rip cord and a second plane including said first tension member and said second tension member cross each other.

5. An optical-fiber cable according to claim 3, wherein said rip cord has one of a high-tensile high-polymer fiber, a glass fiber, a cotton yarn and a metal wire.

6. An optical-fiber cable according to claim 1, comprising: an adhesive member adhered to said first end and said second end of said belt-shaped member.

7. An optical-fiber cable according to claim 6, wherein said adhesive member has a tension member therein.

8. An optical-fiber cable according to claim 1, further comprising:

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a filler disposed with a distance along the optical-fiber in a longitudinal direction thereof, the filler being provided between the optical-fiber and the belt-shaped member for preventing a move of the optical-fiber in a longitudinal direction.

9. A method of manufacturing an optical-fiber cable, comprising the steps of:

forming a belt-shaped member in a tubular shape while enclosing an optical-fiber with the belt-shaped member;

joining a first end and a second end of the belt-shaped member to each other;

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disposing a tension member at an outside of the belt-shaped member; and
covering the outside of the belt-shaped member and the tension member with a sheath.

10. A method of manufacturing an optical-fiber cable according to claim 9, wherein

before forming said belt-shaped member into said tubular shape, said belt-shaped member is disposed along said optical-fiber, and a filler is applied with a distance along to one of said belt-shaped member and said optical-fiber in a longitudinal direction.

* * * * *



Re exam

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REQUEST FOR EX PARTE REEXAMINATION TRANSMITTAL FORM

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Attorney Docket No.: **SURP 13.01 REF**

Date: **12/20/2013**

1. ☒ This is a request for *ex parte* reexamination pursuant to 37 CFR 1.510 of patent number 7,581,565 issued September 1, 2008. The request is made by:
☐ patent owner. ☒ third party requester.
2. ☐ The name and address of the person requesting reexamination is:
Rockbestos Surprenant Cable Corp.
20 Bradley Park Road
East Granby, CT 06026
3. Requester claims ☐ small entity (37 CFR 1.27) or ☐ micro entity status (37 CFR 1.29) – only a patent owner requester can claim micro entity status.
4. ☐ a. A check in the amount of \$_____ is enclosed to cover the reexamination fee, 37 CFR 1.20(c)(1);
☐ b. The Director is hereby authorized to charge the fee as set forth in 37 CFR 1.20(c)(1) to Deposit Account No. _____;
☒ c. Payment by credit card. Form PTO-2038 is attached; or
☐ d. Payment made via EFS-Web.
5. ☒ Any refund should be made by ☐ check or ☐ credit to Deposit Account No. _____ 37 CFR 1.26(c). If payment is made by credit card, refund must be to credit card account.
6. ☒ A copy of the patent to be reexamined having a double column format on one side of a separate paper is enclosed. 37 CFR 1.510(b)(4).
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 - ii. ☐ paper
 - c. ☐ Statements verifying identity of above copies
9. ☐ A copy of any disclaimer, certificate of correction or reexamination certificate issued in the patent is included.
10. ☒ Reexamination of claim(s) 1-24 is requested.
11. ☒ A copy of every patent or printed publication relied upon is submitted herewith including a listing thereof on Form PTO/SB/08, PTO-1449, or equivalent.
12. ☐ An English language translation of all necessary and pertinent non-English language patents and/or printed publications is included.

[Page 1 of 2]

This collection of information is required by 37 CFR 1.510. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Ex Parte Reexam, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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13.	☒	The attached detailed request includes at least the following items: a. A statement identifying each substantial new question of patentability based on prior patents and printed publications. 37 CFR 1.510(b)(1). b. An identification of every claim for which reexamination is requested, and a detailed explanation of the pertinency and manner of applying the cited art to every claim for which reexamination is requested. 37 CFR 1.510(b)(2).									
14.	☐	A proposed amendment is included (only where the patent owner is the requester). 37 CFR 1.510(e).									
15.	☒	a. It is certified that a copy of this request (if filed by other than the patent owner) has been served in its entirety on the patent owner as provided in 37 CFR 1.33(c). The name and address of the party served and the date of service are: <u>David L. McEwing, Law Office of David McEwing</u> <u>PO BOX 70410, Houston, TX 77023</u> Date of Service: <u>December 20, 2013</u> ; or ☐ b. A duplicate copy is enclosed since service on patent owner was not possible. An explanation of the efforts made to serve patent owner is attached . See MPEP § 2220.									
16. Correspondence Address: Direct all communication about the reexamination to: ☒ The address associated with Customer Number: 26812 OR ☐ Firm or Individual Name _____ Address _____											
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">City</td> <td style="width: 25%;">State</td> <td style="width: 25%;">Zip</td> </tr> <tr> <td colspan="3">Country</td> </tr> <tr> <td>Telephone</td> <td colspan="2">Email</td> </tr> </table>			City	State	Zip	Country			Telephone	Email	
City	State	Zip									
Country											
Telephone	Email										
17. ☐ The patent is currently the subject of the following concurrent proceeding(s): ☐ a. Copending reissue Application No. _____ ☐ b. Copending reexamination Control No. _____ ☐ c. Copending Interference No. _____ ☐ d. Copending litigation styled: _____											
WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.											
 _____ Authorized Signature <u>12/20/2013</u> Date		☐ For Patent Owner Requester ☒ For Third Party Requester									
<u>Todd A. Sullivan</u> Typed/Printed Name		<u>47117</u> Registration No.									

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

12/26/2013 SDIRETA1 00000004 90020065
01 FC:1812 12000.00 OP

PTO-1556
(5/87)

*U.S. Government Printing Office: 2002- 489-267/69033



**REEXAMINATION - THIRD PARTY REQUESTER
POWER OF ATTORNEY OR
REVOCATION OF POWER OF ATTORNEY WITH
A NEW POWER OF ATTORNEY
AND
CHANGE OF CORRESPONDENCE ADDRESS**

Control Number(s)	
Filing Date(s)	2008-07-23
First Named Inventor	TORRANCE
Title	Tear Cord for Jacketed Tube
Patent Number	7,581,565
Examiner Name	Brinson, Patrick F.
Attorney Docket No(s).	SURP 13.01 REEXAM

I hereby revoke all previous requester powers of attorney given in the above-identified reexamination proceeding control number(s).

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the proceeding(s) identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

26812

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the proceeding(s) identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified reexamination proceeding control number(s) (more than one may be changed **only** if they are merged proceedings) to be:

☒ The address associated with the above-mentioned Customer Number.

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Address

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I am the *third party* requester.

☐ Proof of authority to act on behalf of requester submitted herewith or filed on _____.

SIGNATURE of Third Party Requester

Signature	/scott r. magner/	Date	2013-12-20
Name	Scott R. Magner	Telephone	
Title and Company	General Manager, Industrial - RSCC, Marmon Group Company		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Appln. Of: Torrance et al.
Patent No. 7,581,565
Filed: July 23, 2008
Issued: September 1, 2008
Reexam Serial No.: N/A
For: TEAR CORD FOR JACKETED TUBE
Original Art Unit: 3754
Original Examiner: Brinson, Patrick F.
Docket No: Surp 13.01 REEXAM

Mail Stop *Ex Parte* Reexam
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

EX-PARTE REQUEST FOR REEXAMINATION

Dear Sir:

RSCC Wire & Cable, LLC respectfully requests *Ex Parte* reexamination of U.S. Patent No. 7,581,565 to Torrance *et al.*, entitled, "Tear Cord for Jacketed Tube" (hereinafter, "the '565 patent'") attached hereto as Exhibit A, in accordance with 35 U.S.C. §302 and 37 C.F.R. § 1.510. The '565 patent issued September 1, 2008 to Roy Torrance and Jody James and it is still in force. This reexamination is requested because a review of the purported inventions that applicant claims were invented relative to the existing prior art reveals that, in fact, the technology was neither novel nor innovative,

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Request for *Ex Parte* Reexamination
U.S. Patent No. 7,581,565

but rather was anticipated and obvious in light of multiple printed publications more than one year before the earliest priority date (*i.e.*, July 23, 2008, the filing date of the '565 patent) to which the '565 patent is properly entitled, *i.e.*, July 23, 2007.

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INDEX OF EXHIBITS

- 1) U.S. Patent No. 7,581,565 to Torrance *et al.* (hereinafter, “the ‘565 patent” or “**Torrance**”), attached as Exhibit A;
- 2) U.S. Patent No. 7,113,680 to Hurley *et al.* (hereinafter, “the ‘164 patent” or “**Hurley**”), attached as Exhibit B;
- 3) U.S. Patent Publication No. 2001/0029814 to Tiano (hereinafter, “the ‘814 publication” or “**Tiano**”), attached as Exhibit C;
- 4) U.S. Patent No. 6,545,222 to Yokokawa *et al.* (hereinafter, “the ‘222 patent” or “**Yokokawa**”), attached as Exhibit D;
- 5) U.S. Patent No. 5,524,938 to Sides, III *et al.* (hereinafter, “the ‘937 patent” or “**Sides**”), attached as Exhibit E;
- 6) U.S. Patent No. 4,091,843 to Mikes *et al.* (hereinafter, “the ‘843 patent” or “**Mikes**”), attached as Exhibit F;
- 7) U.S. Patent No. 5,212,755 to Holmberg, (hereinafter, “the ‘755 patent” or “**Holmberg**”), attached as Exhibit G;
- 8) U.S. Patent No. 5,268,983 to Tatarka *et al.*, (hereinafter, “the ‘983 patent” or “**Tatarka**”), attached as Exhibit H;
- 9) U.S. Patent Publication No. 2002/0085820 to Gaillard *et al.* (hereinafter, “the ‘820 publication” or “**Gaillard**”), attached as Exhibit I;
- 10) U.S. Patent No. 3,326,583 to Guarnaschelli (hereinafter, “the ‘583 patent” or “**Guarnaschelli**”), attached as Exhibit J; and
- 11) U.S. Patent No. 6,236,790 to Okada *et al.* (hereinafter, “the ‘790 patent” or “**Okada**”), attached as Exhibit K.

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I. INTRODUCTION

This request presents substantial new questions of patentability based on prior art patents and printed publications not previously cited by or presented to the United States Patent and Trademark Office (USPTO). These newly cited prior art references anticipate or, in combination, render obvious the claims of the '565 patent references herein. Accordingly, RSCC requests that the USPTO order an *ex parte* reexamination of the '565 patent, in accordance with 35 U.S.C. §304 and 37 C.F.R. §1.525, and issue a certificate canceling these claims.

A. Statement of Representative Capacity (37 C.F.R. §1.510(f))

The undersigned attorney, Todd A. Sullivan (Reg. No. 47,117), hereby confirms that he is acting in a representative capacity for RSCC Wire & Cable, LLC, 20 Bradley Park Road, East Granby, CT 06026, in this matter pursuant to 37 C.F.R. §1.34.

B. Fee Payment (37 C.F.R. §1.20(c)(1))

In the event that additional costs or fees are necessary, the Commissioner is hereby authorized to charge Deposit Account No. 08-1391.

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II. **REQUEST FOR *EX PARTE* REEXAMINATION BASED UPON PRIOR ART PATENTS (35 U.S.C. §302)**

A. **Claims for Which Reexamination is Requested (37 C.F.R. §1.510(b)(2))**

RSCC formally requests *ex parte* reexamination of claims 1-24 of the '565 patent, and provides prior art patents not of record in the prosecution of the application that resulted in the '565 patent. Pursuant to 37 C.F.R. §1.510(b)(4), a copy of the '565 patent is submitted with this request.

B. **Newly Cited Prior Patents¹**

The substantial new question of patentability set forth in section III(C) below are based upon newly cited prior art patents and printed publications that either anticipate or, in combination with the prior art of record, render obvious for at least the afore-mentioned claims. Each of these references provides new, non-cumulative teachings that were not previously considered during prosecution of the application resulting in the '565 patent. Pursuant to 37 C.F.R. §1.501(b)(3), a copy of each patent or printed publication relied on is submitted with this request.

The newly cited prior art references are:

- U.S. Patent No. 7,113,680 to Hurley *et al.* ("**Hurley**", Exhibit B);
- U.S. Patent Publication No. 2001/0029814 to Tiano ("**Tiano**", Exhibit C);
- U.S. Patent No. 6,545,222 to Yokokawa *et al.* ("**Yokokawa**", Exhibit D);
- U.S. Patent No. 5,524,938 to Sides, III *et al.* ("**Sides**", Exhibit E);
- U.S. Patent No. 4,091,843 to Mikes *et al.* ("**Mikes**", Exhibit F);
- U.S. Patent No. 5,212,755 to Holmberg, ("**Holmberg**", Exhibit G);
- U.S. Patent No. 5,268,983 to Tatarka *et al.*, ("**Tatarka**", Exhibit H);

¹ For the Examiner's convenience in reviewing the present Request for *Ex Parte* Reexamination, all references to the newly cited art will be placed in bold throughout the remainder of the document.

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- U.S. Patent Publication No. 2002/0085820 to Gaillard *et al.* (“**Gaillard**”, Exhibit I);
- U.S. Patent No. 3,326,583 to Guarnaschelli (“**Guarnaschelli**”, Exhibit J); and
- U.S. Patent No. 6,236,790 to Okada *et al.* (“**Okada**”, Exhibit K).

(1) Newly Cited References are from the Same or Closely Related Field of Endeavor

When considering the scope of the prior art for purposes of determining anticipation under 35 U.S.C. §102 or obviousness under 35 U.S.C. §103(a), a reference in the same field of endeavor as the claimed invention is clearly relevant prior art. In addition, a reference in a difference field may be reasonably pertinent if the reference deals with an issue that logically would have commended itself to an inventor’s attention in considering his or her invention as a whole. *See* MPEP §2141.01(A).

The ‘565 patent is directed to a tear cord for use with a jacketed tube that can be used for transporting fluid and chemicals (*e.g.*, claims 16-17) and that can be used to transmit electrical signals within a fiber optic cable, electrical wire, or data communication cable (*e.g.*, claim 24). Each of the newly cited prior art references above is relevant to the underlying application of the ‘565 patent in question at the time it was filed, in that each of the references pertains to cables, tubes, or similar conduit structures, and connectors thereof, that are used for carrying fluids, chemicals, or electrical signals with fiber optic cable. The teachings of the prior art thereof would have been of interest to the inventor at the time the invention was made.

(2) General Rationale for Combining References

As discussed herein, each of the newly cited prior art references are in the same field of endeavor or in a very closely related field. Thus, the rationale for combining these

references is elementary: “[A]ny need or problem known in the field of endeavor at the time of the invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *KSR International Co v. Teleflex, Inc.*, 550 U.S. 398, 402 (2007). In this instance, each of the newly cited prior art references addresses the same or similar problems to those stated explicitly in the ‘565 patent.

C. Proposed Rejections

The subsections below set forth substantial new questions of patentability raised by the newly cited prior art regarding claims 1-14 of the ‘565 patent.

(1) Claims 1, 4-5, 13, and 24 of the ‘565 patent are anticipated under 35 U.S.C. §102(b) by **Hurley**.

(2) Claims 1, 4-5, 7, 8, 11, 13, 18, 20, and 23-24 of the ‘565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Tiano**, further in view of **Yokokawa**, and further in view of **Sides**.

(3) Claims 2, 3, 12, 18, 20, and 23 of the ‘565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Mikes**.

(4) Claims 6 and 9 of the ‘565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Okada**.

(5) Claims 7-8 of the ‘565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Holmberg**.

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(6) Claim 10 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Gaillard**.

(7) Claim 22 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Tatarka**.

(8) Claims 16-17 of the '565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Mikes**, and further in view of **Guarnaschelli**.

(9) Claims 14-15 of the '565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Tatarka** and further in view of **Guarnaschelli**.

(10) Claim 19 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Mikes**, further in view of **Tatarka**, and further in view of **Yokokawa**.

(11) Claim 21 of the '565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Guarnaschelli**.

D. Statement Pointing Out Each Substantial New Question of Patentability (37 C.F.R. §1.510(b)(1))

(1) A substantial new question of patentability as to claims 1, 4-5, 13, and 24 of the '565 patent are raised by **Hurley**.

(2) A substantial new question of patentability as to claims 1, 4-5, 7, 8, 11, 13, 18, 20, and 23-24 of the '565 patent are raised by **Hurley** in view of **Tiano**, further in view of **Yokokawa**, and further in view of **Sides**.

(3) A substantial new question of patentability as to claims 2, 3, 12, 18, 20, and 23 of the '565 patent are raised by **Hurley** in view of **Mikes**.

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(4) A substantial new question of patentability as to claims 6 and 9 of the '565 patent are raised by **Hurley** in view of **Okada**.

(5) A substantial new question of patentability as to claims 7-8 of the '565 patent are raised by **Hurley** in view of **Holmberg**.

(6) A substantial new question of patentability as to claim 10 of the '565 patent is raised by **Hurley** in view of **Gaillard**.

(7) A substantial new question of patentability as to claim 22 of the '565 patent is raised by **Hurley** in view of **Tatarka**.

(8) A substantial new question of patentability as to claims 16-17 of the '565 patent is raised by **Hurley** in view of **Mikes**, and further in view of **Guarnaschelli**.

(9) A substantial new question of patentability as to claims 14-15 of the '565 patent is raised by **Hurley** in view of **Tatarka**, and further in view of **Guarnaschelli**.

(10) A substantial new question of patentability as to claim 19 of the '565 patent is raised by **Hurley** in view of **Mikes**, further in view of **Tatarka**, and further in view of **Yokokawa**.

(11) A substantial new question of patentability as to claim 21 of the '565 patent is raised by **Hurley** in view of **Guarnaschelli**.

A detailed explanation of the pertinence and manner of applying the references to each claim for which reexamination is requested is presented below. Each of the references relied upon in this reexamination request are included in the accompanying Information Disclosure Statement, and contain a teaching that was not present during the prior examination of the patent under reexamination. It is believed that a reasonable Examiner would consider these

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teachings important in determining whether or not the claims are patentable. For this reason, it is submitted that the references referred to below raise a substantial new question of patentability.

III. DETAILED EXPLANATION APPLYING THE CITED PRIOR ART

A. Executive Summary of Detailed Explanation

(1) *Subject Matter of '565 Patent*

The subject matter described in claims 1-24 of the '565 patent are general directed to a cable or jacketed tube having a rip cord used for transporting fluid, chemicals, and/or electrical signals within a fiber optic cable, electrical wire, or data communication cable. In particular, independent claims 1, 2, 3, 10, and 12 are directed to a jacketed metal tube, independent claims 14 and 21 are directed to a cable with one or more encapsulating jackets, and independent claim 18 is directed to a method of conveying liquids using a jacketed metal tube having a tear cord.

(2) *Key Terms of the Claims of the '565 Patent*

The following analysis is being provided relative to selected key terms of certain claims of the '565 patent to show how the patentees of the '565 patent understood and defined the key terms:

a. "protective jacket"

The terms, "protective jacket", or a plural variant thereof, appear in all independent claims. Within the detailed description, relative to FIG. 1, the applicants teach that the tubes

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are “jacketed in one or more layers 2 of hard thermoplastic rubber or similar toughened and inert material to protect the tube and contents from the heat and corrosive environment of a well bore. The jacket also provides protection during installation and other events that may occur during operation of the well.” (Col. 1, lines 47-54). The applicants teach that the material of the protective jacket may comprise,

“polyamide (nylon) polyethylene, polypropylene, ethylene chlorotrifluoroethylene (Halar), engineering thermoplastic vulcanates (ETPV) or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene (Santoprene). It may also comprise perfluoroalkoxy (Teflon PFA), polyvinylidene fluoride (PVDF) or fluorinated ethylene propylene (Teflon FEP) Polyetheretherketone (PEEK), or similar material.” (Col. 2, line 62 to Col. 3, line 3).

b. “metal tube”

The terms, “metal tube”, or a plural variant thereof, appear in all independent claims. Within the detailed description, the applicants teach that the structure is “a solid wall metal tube” (Col. 1, lines 42-43) and may “comprise steel alloys such as but not limited to stainless steel, incoloy (an alloy comprising nickel-iron-chromium), duplex alloy, carbon steel, or galvanized carbon steel.” (Col. 2, lines 1-4). The walls are “smooth and solid. The tubing has an annular or duct-like structure 30 as illustrated in FIG. 1.” (Col. 2, lines 7-9). With respect to the surface of the tube, the applicants teach the outer surface of the tube is “required to be free from nicks and gouges.” (Col. 2, lines 29-30).

c. “tear cord”

The terms, “tear cord”, or a plural variant thereof, appear in all independent claims. Within the detailed description, the applicants teach that the tear cord is “used to conveniently

and safely remove a protective jacket surrounding a solid wall metal tube.” (Col. 1, lines 41-42). With regards to the materials of the tear cord, the applicants teach that it can be “a metal wire or other strong material such as Kevlar, a poly-aramid synthetic fiber. A Kevlar fiber is advantageous since the multiple fiber strands compress flat against the tubing or inner jacket, thereby not distorting the circumference of the outer jacket.” (Col. 3, lines 38-42).

The ‘565 patent discloses various locations and configurations of the tear cord. For example, the tear cord can be “placed between the tube and the protective jacket” (Col. 3, line 5) which includes, relative to FIG. 1, “placing a tear cord 3 adjacent to the tube 1 under the protective jacket 2.” (Col. 3, lines 22-23). Relative to FIG. 3, “at least one tear cord 13, 14, 15 is placed between the outer flat jacket 12 and each individual tube 9, 10, 11.” (Col. 3, lines 24-26). Further,

[t]he tear cord (sometimes referred to as a rip cord), can be oriented along longitudinal axis of the tube or wound in a helical pattern around the tube. This helical winding pattern is illustrated in FIG. 4 and may be particularly useful for cable consisting of a single tube with a protective jacket. FIG. 4 illustrates the encapsulating protective jacket 42 surrounding the tube 43 and the tear cord 44 between the tube and the jacket. The helical pattern facilitates removal of the jacket. The angled slit created in the jacket provides an edge that can easily be pulled from the end around and away from the tubing. (Col. 3, lines 27-37).

Relative to FIG. 5, the applicants teach that “tear cords 38, 39, 40, 41 installed adjacent to the tube and to each steel rope.”

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d. "pulled back to create a slit in protective jacket"

The terms, "pulled back to create a slit in protective jacket", or a variant thereof, appear in independent claims 1, 2, 3, 10, 12, and 14. Within the detailed description, the applicants teach that "protective jackets are difficult and dangerous to cut or slit with a knife blade" (Col. 1, lines 55-56) and that the "use of a tear cord placed between the tube and the protective jacket....allows the worker to pull back the tear cord and thereby create a slit in the jacket." (Col. 3, lines 5-7).

e. "without damage to the metal tube surface"

The terms, "without damage to the metal tube", "without damage to the metal tube sealing surface" or variants thereof, appear in all independent claims. Within the detailed description, the applicants teach that that "surface of the tubing is of prime importance, i.e., the wall of the tubing is to be free from nicks and gouges. This type of damage can result from use of a knife or other sharp edge instrument to cut away the protective jacket." (Col. 2, lines 21-24). Further, "the outer surface of the tube is required to be free from nicks and gouges since the tube connections can be made using compression fittings" (Col. 2, lines 29-31), since the nicks and gouges can lead to leaks within the tube and/or over-tightening of the fittings, which can compromise the seal of a compression fitting.

(3) *Overview of the Prior Art References*

All of the prior art references previously introduced involve jacketed cables and tubes that are used for carrying chemicals, fluids, and/or fiber optics. A brief analysis of each of the prior art references relative to their relevant explicit teachings of the subject matter claimed

by the '565 patent is provided herein. All prior art references were published more than one year before the earliest priority date to which the '565 patent is properly entitled, July 23, 2007.

a. **Hurley**

Hurley is directed to a fiber optic cable 40 having a separation layer 52 that can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). A cable jacket 50 is formed about the separation layer 52. The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52. A ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG. 2). The ripcord 54 can be pulled to allow removal of the jacket 50. (Col. 5, lines 2-3).

b. **Tiano**

Tiano is directed to a fiber optic cable ripcord and method of use. **Tiano** explicitly teaches a pulling force can be applied on the ripcord "thereby pulling the ripcord through armor tape 34 and cable jacket 35 (FIG. 4). The ripping operation forms a longitudinal slit S in the cable (FIGS. 3-4)." (Paragraph [0017])

c. **Yokokawa**

Yokokawa is directed to a cable, and a method for removing a sheath. Relative to the known prior art, **Yokokawa** discloses that making preparatory slits within the sheath of a cable can damage a cable core. Accordingly, **Yokokawa** discloses, as an object of the invention, a cable stripping method with which a cable can be stripped easily using a ripcord

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“without damaging the cable core.” (Col. 1, lines 59-66). More explicitly, **Yokokawa** teaches, “By pulling the ripcord in the direction in which the plastic sheath is to be split and thereby splitting the plastic sheath and then extracting the cable core from inside the plastic sheath and then cutting off such part of the plastic sheath, it is possible to strip the cable without damaging the cable core.” (Col. 6, lines 57-62).

d. Sides

Sides is directed to an internal coiled tubing connector and teaches of tubing that can have passageways which can transport or convey “[h]ydraulic fluid, electrical control lines, and/or fiber optics...” (Col. 4, lines 23-25).

e. Mikes

Mikes is directed to flexible tubes for hydraulic applications. As is disclosed in **Mikes**, tubing can be used for carrying chemicals, such as hydraulic fluid. (Col. 1, lines 6-10).

f. Holmberg

Holmberg is directed to an armored fiber optics cable that has an armor layer construed from metals, including stainless steel materials and that it is known in the art to put optical fibers within stainless steel tubes. (Col. 2, lines 12-32).

g. Tararka

Tararka is directed to a compact optical fiber cable and teaches of a cable with a plurality of bundles, each having a protective jacket, each having a ripcord. (FIG. 1; Col. 4, lines 15-31).

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h. Gaillard

Gaillard directed to a cable assembly having ripcords and discloses that it is known in the art for ripcords to be position through the cable longitudinally or in a helical fashion having a long pitch. (Paragraph [0004]).

i. Guarnaschelli

Guarnaschelli is directed to a high pressure compression fitting for tubing and discloses solid tubing used with compression fittings. (FIG. 1; Col. 1, lines 9-10).

j. Okada

Okada is directed to an optical-fiber cable and method of manufacturing the same. **Okada** discloses the use of ripcords that are made from aramid fiber (Col. 7, line 28)

B. Application of the Prior Art to Each Claim (37 C.F.R. §1.510(b)(2))

The detailed explanations below set forth the pertinency and manner of applying the newly cited prior art references to render claims 1-24 of the '565 patent invalid under either 35 U.S.C. §102(b) or §103(a).

- (1) *Claims 1, 4-5, 13, and 24 of the '565 patent are anticipated under 35 U.S.C. §102(b) by Hurley.*

U.S. Patent No. 7,581,656	
Claim 1	
1. A jacketed metal tube comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first protective jacket surrounding a	Hurley discloses a cable jacket 50 is formed about

smooth solid wall metal tube having an outer sealing surface and	the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
a tear cord between the inside diameter of said jacket and the outer surface of said tube	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)

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Claim 4

4. The tube of claim 1 wherein

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the jacket comprises polyamide, polyethylene, ethylene chlorotrifluoroerthlyene or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene.	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials. (Col. 8, lines 15-31).
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U.S. Patent No. 7,581,656 Claim 5	
5. The tube of claim 1 wherein the jacket comprises engineered thermoplastic vulcanates, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.	Hurley discloses that it is known in the art to form a cable jacket from polyvinylidene, or any number of other materials. (Col. 1, lines 48-62).

U.S. Patent No. 7,581,656 Claim 13	
13. The tube of claim 1 further comprising a jacket of one or more materials of a group consisting of polyethylene, ethylene chlorotrifluoroerthlyene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride and fluorinated ethylene propylene wherein the material is extruded onto the tube without radiation curing.	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials. (Col. 8, lines 15-31). Hurley discloses that it is known in the art to form a cable jacket consisting of polyvinylidene, or any number of other materials. (Col. 1, lines 48-62). Hurley discloses that it is known in the art to extrude the jacketing material on to the tube. (Col. 1, line 63 to Col. 2, line 18; Col. 8, lines 49-61). Hurley also discloses that it is known in the art to extrude a jacketing material without using radiation curing, <i>i.e.</i>, ultraviolet (UV) light radiation, such as when polyvinylidene fluoride (PVDF) is used to make the jacket, a material which Hurley teaches is distinct form other UV light curable materials. (Col. 2, lines 41-45; Col. 6, lines 12-15).

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U.S. Patent No. 7,581,656 Claim 24	
24. The jacketed metal tube of claim 1, further comprising	
a fiber optic cable, electrical wire or data communication cable.	Hurley discloses that the cable 40 may include optical fibers 44 (FIG. 4) for communication. (Col. 1, lines 17-24; Col. 4, lines 50-53).

(2) *Claims 1, 4-5, 7, 8, 11, 13, 18, 20, and 23-24 of the '565 patent are obvious under 35 U.S.C. §103(a) over Hurley in view of Tiano, in view of Yokokawa, and in view of Sides.*

U.S. Patent No. 7,581,656 Claim 1	
1. A jacketed metal tube comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first protective jacket surrounding a smooth solid wall metal tube having an outer sealing surface and	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
a tear cord between the inside diameter of said jacket and the outer surface of said tube	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50. Tiano is directed to a fiber optic cable ripcord and

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	method of use. Tiano explicitly teaches a pulling force can be applied on the ripcord “thereby pulling the ripcord through armor tape 34 and cable jacket 35 (FIG. 4). The ripping operation forms a longitudinal slit S in the cable (FIGS. 3-4).” (Paragraph [0017]) Based on the teachings of Hurley in view of Tiano, it would have been obvious for one having ordinary skill in the art to understand that pulling the tear cord would create a slit in the protective jacket.
to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.	The ‘565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 (“Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established.” <i>In re Best</i>, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).) Yokokawa discloses that stripping a jacket off of a cable with a ripcord, “it is possible to strip the cable without damaging the cable core.” (Col. 6, lines 57-62). Based on the teachings of Hurley in view of Yokokawa, it would have been obvious for one having ordinary skill in the art to understand that using the tear cord to remove the jacket would prevent damage to the metal tube under the jacket.

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U.S. Patent No. 7,581,656 Claim 4	
4. The tube of claim 1 wherein the jacket comprises polyamide, polyethylene, ethylene chlorotrifluoroethylene or a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene.	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials. (Col. 8, lines 15-31).

U.S. Patent No. 7,581,656 Claim 5	
5. The tube of claim 1 wherein the jacket comprises engineered thermoplastic vulcanates, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.	Hurley discloses that it is known in the art to form a cable jacket consisting of polyvinylidene, or any number of other materials. (Col. 1, lines 48-62).

U.S. Patent No. 7,581,656 Claim 7	
7. The tube of claim 1 wherein the solid wall metal tube comprises incoloy, stainless steel, carbon steel, or galvanized carbon steel.	Hurley discloses forming the separation layer 52 by an armor layer from metal. (Col. 10, lines 47-50). It is known in the art to make armor layers from various metals. It would have been obvious to one having ordinary skill in the art to select a material, such as incoloy or stainless steel, as the separation layer. "The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination." <i>Sinclair & Carroll Co. v. Interchemical Corp.</i>, 325 U.S. 327, 65 USPQ 297 (1945); See MPEP §2144.07.

U.S. Patent No. 7,581,656 Claim 8	
8. The tube of claim 1 further comprising	

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a second inner jacket surrounding the tube wherein the second jacket is located between the outer surface of the tube and the inner diameter of the first jacket.	Hurley generally discloses having more than one jacket on the cable 40, such as having a jacket 46 formed from strength members and a protective jacket 50. (FIG. 6; Col. 12, lines 36-50). It is known in the art to provide multiple jackets on a single cable, such that one jacket is positioned between the inner components of the cable and the exterior jacket. It would have been obvious for one having ordinary skill in the art to include a second jacket. Including an additional jacket would be obvious, as "mere duplication of parts has no patentable significance unless a new and unexpected result is produced." <i>In re Harza</i>, 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
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U.S. Patent No. 7,581,656 Claim 11	
11. The tube of claim 1 further comprising	
a tear cord placed at a selected location on a length of the tube.	Hurley discloses placing the ripcord along the length of the cable. As claimed, the "selected location" can include any location on the length of the tube. Thus, whatever location was selected to place the ripcord of Hurley would be the selected location of claim 11.

U.S. Patent No. 7,581,656 Claim 13	
13. The tube of claim 1 further comprising	
a jacket of one or more materials of a group consisting of polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride and fluorinated ethylene propylene	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials. (Col. 8, lines 15-31). Hurley also discloses that it is known in the art to form a cable jacket consisting of polyvinylidene, or any number of other materials. (Col. 1, lines 48-62).

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wherein the material is extruded onto the tube without radiation curing.

Hurley discloses that it is known in the art to extrude the jacketing material on to the tube. (Col. 1, line 63 to Col. 2, line 18; Col. 8, lines 49-61). **Hurley** also discloses that it is known in the art to extrude a jacketing material without using radiation curing, *i.e.*, ultraviolet (UV) light radiation, such as when polyvinylidene fluoride (PVDF) is used to make the jacket, a material which **Hurley** teaches is distinct from other UV light curable materials. (Col. 2, lines 41-45; Col. 6, lines 12-15).

U.S. Patent No. 7,581,656
Claim 18

18. A method of conveying liquids into a well bore comprising:

Sides discloses a tubing system with passageways which can transport or convey "[h]ydraulic fluid, electrical control lines, and/or fiber optics..." (Col. 4, lines 23-25). It would be obvious to use the system of **Sides** to convey liquids into a well bore.

i. placing a tear cord adjacent to an outer sealing surface of a first spoolable, smooth, solid wall metal tube;

Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52. When **Sides** is combined with **Hurley**, the resultant structure taught by **Hurley** can be used to carry fluids, as taught by **Sides**.

Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.

Hurley discloses that the separation layer 52 is a "flexible armor" which may provide "bend control" of the cable. (Col. 13, lines 34-39). **Hurley** also discloses the ability for the cable with

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	the metal separation layer to be “flexed or bent.” (Col. 8, line 59). The ability for the cable to flex or bend will inherently allow the cable to be spooled.
ii. placing a protective jacket around the metal tube and the tear cord; and	Hurley discloses a cable jacket 50 is formed about the separation layer 52 and the ripcord 54.
iii. pulling the tear cord back to create a slit in the protective jacket	The ‘565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50. Tiano is directed to a fiber optic cable ripcord and method of use. Tiano explicitly teaches a pulling force can be applied on the ripcord “thereby pulling the ripcord through armor tape 34 and cable jacket 35 (FIG. 4). The ripping operation forms a longitudinal slit S in the cable (FIGS. 3-4).” (Paragraph [0017]) Based on the teachings of Hurley in view of Tiano, it would have been obvious for one having ordinary skill in the art to understand that pulling the tear cord would create a slit in the protective jacket. The ‘565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 (“Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or

to allow the protective jacket to be separated from the metal tube without damage to a metal tube surface.

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	obviousness has been established.” <i>In re Best</i>, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).) Yokokawa discloses that stripping a jacket off of a cable with a ripcord, “it is possible to strip the cable without damaging the cable core.” (Col. 6, lines 57-62). Based on the teachings of Hurley in view of Yokokawa, it would have been obvious for one having ordinary skill in the art to understand that using the tear cord to remove the jacket would prevent damage to the metal tube under the jacket.
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U.S. Patent No. 7,581,656 Claim 20	
20. The method of claim 18 further comprising	
placing the tear cord on the outer surface of the tube at a selected location.	Hurley discloses placing the ripcord on the outer surface of the separation layer 52 along the length of the cable. As claimed, the “selected location” can include any location on the length of the tube. Thus, whatever location was selected to place the ripcord of Hurley would be the selected location of claim 11.

U.S. Patent No. 7,581,656 Claim 23	
23. The method of claim 18 further comprising	
jacketing the metal tube and tear cord with polyethylene, ethylene chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials. (Col. 8, lines 15-31). Hurley also discloses that it is known in the art to form a cable jacket consisting of polyvinylidene, or any number of other materials. (Col. 1, lines 48-62).

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U.S. Patent No. 7,581,656 Claim 24	
24. The jacketed metal tube of claim 1 further comprising	
a fiber optic cable, electrical wire or data communication cable.	Hurley discloses that the cable 40 may include optical fibers 44 (FIG. 4) for communication. (Col. 1, lines 17-24; Col. 4, lines 50-53).

(3) *Claims 2, 3, 12, 18, 20, and 23 of the '565 patent are obvious under 35 U.S.C.*

§103(a) over Hurley in view of Mikes.

U.S. Patent No. 7,581,656 Claim 2	
2. A jacketed metal tube comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first protective jacket surrounding a smooth solid wall metal tube,	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
wherein the tube conveys hydraulic fluid, and	Mikes discloses using a tube for carrying hydraulic fluid. (<i>E.g.</i> , Col. 2, lines 3-13).
a tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord.

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	Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)
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U.S. Patent No. 7,581,656 Claim 3	
3. A jacketed metal tube comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first protective jacket surrounding a smooth solid wall metal tube,	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
wherein the tube conveys chemicals, and	Mikes discloses using a tube for carrying hydraulic fluid, which is a chemical. (<i>E.g.</i> , Col. 2, lines 3-13).
a tear cord located between the inside diameter of the jacket and an outer sealing surface of the tube	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back

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	to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i>, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)

U.S. Patent No. 7,581,656 Claim 12	
12. A jacketed metal tube comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
one or more steel ropes within one or more protective jackets surrounding a smooth solid wall tube and	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52. Mikes discloses embedding steel ropes within the jacket. (FIG. 1; Col. 2, lines 14-32).
a tear cord is positioned next to each	Hurley discloses a ripcord 54 is positioned interior

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steel rope and tube	of the jacket 50 and exterior of the separation layer 52 (FIG.4). As the claim is written, the combination of Hurley and Mikes would produce a cable with the tear cord of Hurley positioned next to the tube of Hurley and positioned next to the steel rope of Mike.
wherein the rope has the same axis of orientation as the tube and is positioned adjacent to the tube within the jacket	Both Hurley and Mikes discloses the ripcord and steel rope(s), respectively, being positioned along the axis of the tube and positioned within the jacket.
whereby each tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50. As the claim is written, only one tear cord is required. However, including additional tear cords would be obvious, as "mere duplication of parts has no patentable significance unless a new and unexpected result is produced." <i>In re Harza</i>, 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
to allow the protective jacket to be separated from the steel rope and metal tube without damage to the metal tube surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or

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	obviousness has been established.” <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)
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U.S. Patent No. 7,581,656 Claim 18	
18. A method of conveying liquids into a well bore comprising:	Mikes discloses cable and tubes that can be used for hydraulic applications, such as to convey hydraulic fluids into a well bore.
i. placing a tear cord adjacent to an outer sealing surface of a first spoolable, smooth, solid wall metal tube;	Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a “separation layer” 52. When Mikes is combined with Hurley, the resultant structure taught by Hurley and Mikes can be used to carry fluids. Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4). The separation layer 52 can be formed from, “an armor layer, for example, a metal or dielectric layer...” (Col. 10, line 48-49). The separation layer 52 is taught to have a “smooth” surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52. Hurley discloses that the separation layer 52 is a “flexible armor” which may provide “bend control” of the cable. (Col. 13, lines 34-39). Hurley also discloses the ability for the cable with the metal separation layer to be “flexed or bent.” (Col. 8, line 59). The ability for the cable to flex or bend will inherently allow the cable to be spooled.
ii. placing a protective jacket around the metal tube and the tear cord; and	Hurley discloses a cable jacket 50 is formed about the separation layer 52 and the ripcord 54.
iii. pulling the tear cord back to create a slit in the protective jacket	The ‘565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will

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to allow the protective jacket to be separated from the metal tube without damage to a metal tube surface.	inherently create a slit in the cable jacket 50. The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i>, 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)
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U.S. Patent No. 7,581,656 Claim 20	
20. The method of claim 18 further comprising	
placing the tear cord on the outer surface of the tube at a selected location.	Hurley discloses placing the ripcord on the outer surface of the separation layer 52 along the length of the cable. As claimed, the "selected location" can include any location on the length of the tube. Thus, whatever location was selected to place the ripcord of Hurley would be the selected location of claim 11.

U.S. Patent No. 7,581,656 Claim 23	
23. The method of claim 18 further comprising	
jacketing the metal tube and tear cord with polyethylene, ethylene	Hurley discloses forming the jacket 50 consisting of polyethylene, or any number of other materials.

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chlorotrifluoroethylene, a thermoplastic elastomer cross linking ethylene propylene diene monomer rubber and polypropylene, perfluoroalkoxy, polyvinylidene fluoride or fluorinated ethylene propylene.	(Col. 8, lines 15-31). Hurley also discloses that it is known in the art to form a cable jacket consisting of polyvinylidene, or any number of other materials. (Col. 1, lines 48-62).
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(4) *Claims 6 and 9 of the '565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Okada**.*

U.S. Patent No. 7,581,656 Claim 6	
6. The tube of claim 1 further comprising	
a tear cord made of poly-aramid fiber.	Okada discloses the use of ripcords that are made from aramid fiber. (Col. 7, line 28)

U.S. Patent No. 7,581,656 Claim 9	
9. The tube of claim 1 further comprising	
a tear cord made of metal.	Okada discloses a ripcord made from a metal fiber or steel wire. (Col. 7, line 29)

(5) *Claims 7-8 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Holmberg**.*

U.S. Patent No. 7,581,656 Claim 7	
7. The tube of claim 1 wherein	
the solid wall metal tube comprises incoloy, stainless steel, carbon steel, or galvanized carbon steel.	Hurley discloses that separation layer 52 can be formed from by an armor layer, for example, a metal or dielectric layer that may be formed from one or more pieces. (Col. 10, lines 46-50). Holmberg discloses that the armor layer may include stainless steel materials, and that it is known in the art to put optical fibers within

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	stainless steel tubes. (Col. 2, lines 12-32).
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U.S. Patent No. 7,581,656 Claim 8	
8. The tube of claim 1 further comprising	
a second inner jacket surrounding the tube wherein the second jacket is located between the outer surface of the tube and the inner diameter of the first jacket.	Hurley generally discloses having more than one jacket on the cable 40, such as having a jacket 46 formed from strength members and a protective jacket 50. (FIG. 6; Col. 12, lines 36-50). Holmberg discloses a metal armor layer (FIG. 2, structures 26 and 28, generally) which has a protective inner jacket 30 and a second jacket 32 disposed thereon. The protective inner jacket 30 is located between the outer surface of the armor layer and the inner diameter of the jacket 32. (FIG. 2; Col. 2, line 67 – Col. 3, line 1).

(6) *Claim 10 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Gaillard**.*

U.S. Patent No. 7,581,656 Claim 10	
10. A jacketed metal tube	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
wherein a first protective jacket surrounding a smooth solid wall metal tube, and	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
a tear cord is helically wound around the tube and	Gaillard discloses that ripcords can be disposed "through the cable longitudinally or in a helical fashion having a long pitch." (Paragraph [0004]).
the tear cord located between the inside diameter of the jacket and an outer	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer

sealing surface of the tube	52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket and	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from the metal tube without damage to the metal tube surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)

(7) Claim 22 of the '565 patent is obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Tatarka**.

U.S. Patent No. 7,581,656 Claim 22	
22. The tube of claim 8 further comprising	
a second inner jacket surrounding the tube and	Hurley discloses a cable jacket 50 is formed about the separation layer 52.

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said second jacket positioned between the first protective jacket and said metal tube, and	Hurley generally discloses having more than one jacket on the cable 40, such as having a jacket 46 formed from strength members and a protective jacket 50. (FIG. 6; Col. 12, lines 36-50). It is known in the art to provide multiple jackets on a single cable, such that one jacket would cover a second jacket. Including an additional jacket would be obvious, as “mere duplication of parts has no patentable significance unless a new and unexpected result is produced.” <i>In re Harza</i>, 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
a first tear cord positioned between the inner diameter of the first jacket and the outer diameter of the second jacket and	Tararka , in at least FIGS. 1-2, discloses a cable with a tear cord 30 positioned between the outer jacket 16 and an inner jacket 18.
a second tear cord positioned between the inner diameter of the second jacket and the outer surface of the metal tube.	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4). Tararka discloses using two ripcords within a single cable, with a first tear cord 30 positioned between two jackets 16, 18, a second tear cord 32 positioned between a jacket 28 and bundles of fiber optic cables 22. (FIGS. 1-2). Thus, one having skill in the art would understand from the combination of Hurley in view of Tararka that two tear cords can be used in different locations within a single cable.

(8) *Claims 16-17 of the '565 patent are obvious under 35 U.S.C. §103(a) over Hurley in view of Mikes, and in view of Guarnaschelli.*

U.S. Patent No. 7,581,656 Claim 16	
16. The cable of claim 14 further comprising	
at least one tube suitable for installation of compression fittings to convey hydraulic fluid.	Mikes discloses using a tube for carrying hydraulic fluid. (<i>E.g.</i> , Col. 2, lines 3-13).

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	Guarnaschelli discloses that compression fittings can be used with high pressure tubing that uses metal-to-metal seals. (Col. 1, lines 9-10).
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U.S. Patent No. 7,581,656 Claim 17	
17. The cable of claim 14 further comprising	
at least one tube suitable for installation of compression fittings to convey chemicals.	Mikes discloses using a tube for carrying hydraulic fluid, which is a chemical. (<i>E.g.</i>, Col. 2, lines 3-13). Guarnaschelli discloses that compression fittings can be used with high pressure tubing that uses metal-to-metal seals. (Col. 1, lines 9-10).

(9) *Claims 14-15 of the '565 patent are obvious under 35 U.S.C. §103(a) over Hurley in view of Tatarka and in view of Guarnaschelli.*

U.S. Patent No. 7,581,656 Claim 14	
14. An encapsulated cable comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first protective jacket surrounding a plurality of solid wall metal tubes, and	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52. Tararka discloses a compact optical fiber cable and teaches of a cable with a plurality of bundles, each having a protective jacket, each having a ripcord. (FIG. 1; Col. 4, lines 15-31). It is known in the art to provide a single jacket on multiple inner tubes or cables. It would have been

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	obvious for one having ordinary skill in the art to include a plurality of metal tubes within the jacket since "mere duplication of parts has no patentable significance unless a new and unexpected result is produced." <i>In re Harza</i> , 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
a plurality of tear cords with one tear cord located between the outside surface of each said tube and the inside diameter of said jacket	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4). Including a plurality of tear cords, one for each metal tube, would have been obvious since "mere duplication of parts has no patentable significance unless a new and unexpected result is produced." <i>In re Harza</i> , 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
whereby each tear cord is oriented longitudinally along the length of a tube,	Hurley discloses the ripcord being oriented longitudinally along the axis of the tube.
each tube further comprising smooth walls with sealing surfaces for attachment of compression fittings for performance in a negative or positive internal pressure environment and	Hurley discloses the separation layer 52 has a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52. Guarnaschelli discloses that compression fittings can be used with high pressure tubing that uses metal-to-metal seals. (Col. 1, lines 9-10).
whereby the tear cord can be pulled back to create a slit in the protective jacket	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from one or more metal tubes without damage to a metal tube sealing surface.	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the

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	separation layer 52 and no other tools or devices, that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 ("Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established." <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)
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U.S. Patent No. 7,581,656 Claim 15	
15. The cable of claim 14 further comprising	
at least one tube containing a fiber optic cable, electrical wire or data communication cable.	Hurley discloses that the cable 40 may include optical fibers 44 (FIG. 4) for communication. (Col. 1, lines 17-24; Col. 4, lines 50-53).

(10) Claim 19 of the '565 patent is obvious under 35 U.S.C. §103(a) over *Hurley* in view of *Mikes*, in view of *Tatarka*, and in view of *Yokokawa*.

U.S. Patent No. 7,581,656 Claim 19	
19. The method of claim 18 further comprising	
placing a second tear cord adjacent to the outer diameter of the protective jacket and	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4). Yokokawa discloses two ripcords positioned radially of one another (FIG. 1).
covering the first jacket with a second jacket.	Hurley generally discloses having more than one jacket on the cable 40, such as having a jacket 46 formed from strength members and a protective jacket 50. (FIG. 6; Col. 12, lines 36-50). It is known in the art to provide multiple jackets on a single cable, such that one jacket would cover a second jacket. Including an additional jacket

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	would be obvious, as "mere duplication of parts has no patentable significance unless a new and unexpected result is produced." <i>In re Harza</i> , 274 F.2d 669, 124 USPQ 378 (CCPA 1960); MPEP 2144.04(VI)(B)).
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(11) Claim 21 of the '565 patent are obvious under 35 U.S.C. §103(a) over **Hurley** in view of **Guarnaschelli**.

U.S. Patent No. 7,581,656 Claim 21	
21. A cable comprising	As is shown in FIG. 4, Hurley teaches generally of a cable 40 that includes a jacket 50 covering a metal tube referred to as a "separation layer" 52.
a first encapsulating protective jacket surrounding at least one solid wall metal tube, and	Hurley discloses a cable jacket 50 is formed about the separation layer 52. (Col. 9, lines 14-54). The separation layer 52 can be formed from, "an armor layer, for example, a metal or dielectric layer..." (Col. 10, line 48-49). The separation layer 52 is taught to have a "smooth" surface (Col. 13, lines 30-31), and is shown as having a smooth, solid wall in FIG. 4 that seals the fiber optic bundles 42 within the separation layer 52.
at least one tear cord between the said tube and the jacket	Hurley discloses a ripcord 54 is positioned interior of the jacket 50 and exterior of the separation layer 52 (FIG.4).
whereby the tear cord can be pulled back to create a slit in the protective jacket	The '565 specification does not disclose any other structural elements needed for slit creation beyond the tear cord and the protective jacket. Hurley discloses the ripcord 54 can be pulled back to allow removal of the jacket 50, which will inherently create a slit in the cable jacket 50.
to allow the protective jacket to be separated from one or more metal tubes without damage to a metal tube surface and	The '565 specification does not reveal any ways of damaging the surface of the metal tube with a tear cord. Hurley inherently discloses that once the slit is formed in the cable jacket 50, it may be separated from the separation layer 52 without damaging the surface of the separation layer 52, since pulling of the ripcord 54 alone will not damage the separation layer 52 and no other tools or devices,

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	that could create gouges or nicks, are needed to remove the separation layer 52. <i>See</i> MPEP §2112.02 (“Where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a <i>prima facie</i> case of either anticipation or obviousness has been established.” <i>In re Best</i> , 562 F.2d 1252, 1255, 195 USPQ 430, 433 (CCPA 1977).)
the cable further comprising at least one compression fitting.	Guarnaschelli discloses that compression fittings can be used with cables and/or tubing that uses metal-to-metal seals. (Col. 1, lines 9-10).

IV. CONCLUSION

In view of the substantial new questions of patentability raised by the newly-cited prior art identified above, a new *ex parte* reexamination should be pursued in accordance with 35 U.S.C. §304 and claims 1-24 of the ‘565 patent rejected and subsequently canceled as anticipated or obvious.

Respectfully submitted,



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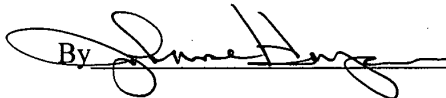
CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Mail Stop *Ex Parte* Reexam, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on December 20, 2013, at Manchester, New Hampshire.

By  _____

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §1.510(b)(5) and §1.33(c), I hereby certify that a copy of the foregoing document has been mailed this day **December 20, 2013**, via first class United States postage prepaid mail to the attorney of record for the '565 patent, David L. McEwing, Law Office of David McEwing, P.O. Box 70410, Houston, TX, 77023.

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AIA (First Inventor to File): YES				
INVENTORS 7581565, Residence Not Provided; ROY TORRANCE (INV), HOUSTON, TX; ROCKBESTOS SURPRENANT CABLE CORP. (3RD PTY REQ.), EAST GRANBY, CT;				
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** CONTINUING DATA ***** This application is a REX of 12/178,246 07/23/2008 PAT 7581565				
** FOREIGN APPLICATIONS *****				
Foreign Priority claimed ☐ yes ☐ no 35 USC 119 (a-d) conditions ☐ yes ☐ no ☐ Met after met Allowance Verified and Acknowledged ☐		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS 24 INDEPENDENT CLAIMS 8
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TITLE TEAR CORD FOR JACKETED TUBE				
FILING FEE RECEIVED 12000	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit	