

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
23 November 2006 (23.11.2006)

PCT

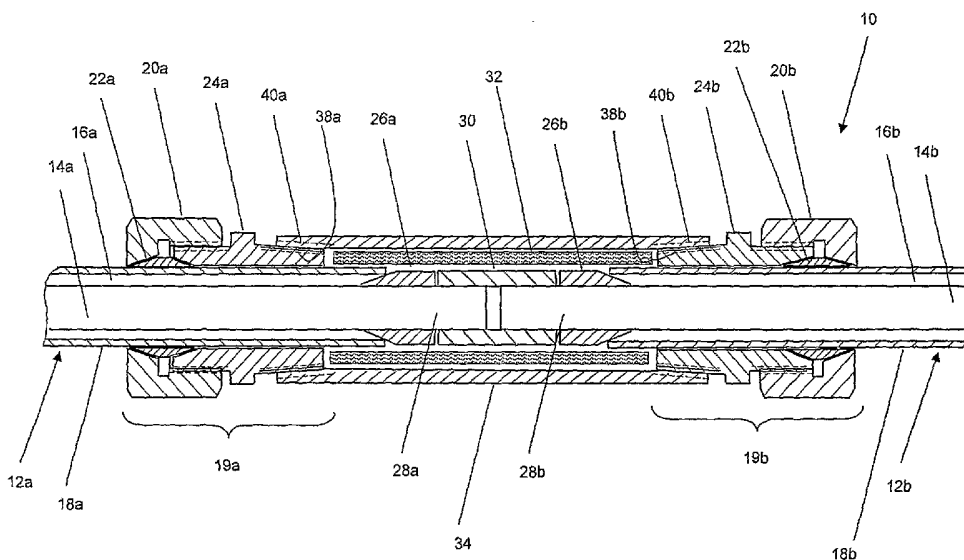
(10) International Publication Number
WO 2006/124409 A2

- (51) International Patent Classification:
H01R 13/40 (2006.01)
- (21) International Application Number:
PCT/US2006/017898
- (22) International Filing Date: 9 May 2006 (09.05.2006)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
2,507,103 11 May 2005 (11.05.2005) CA
- (71) Applicant (for all designated States except US): **TYCO THERMAL CONTROLS, LLC** [US/US]; 2415 Bay Road, Redwood City, CA 94063 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **CAI, GuanJun** [CN/CA]; 38 Tambrook Drive, Scarborough, Ontario M1W 3L9 (CA). **WEIR, Stuart** [GB/CA]; 674 Weese Road, Carrying Place, Ontario K0K 1L0 (CA). **BABCOCK, Jeff** [CA/CA]; 32 Gerow Road, Napanee, Ontario K7R 3L2 (CA). **RAYMOND, Hélèn** [FR/CA]; 126 Lyle Street, Po Box 228, Grafton, Ontario K0K 2G0 (CA).
- (74) Agents: **PRATT, Wyatt, B** et al.; IP Department, Tyco Engineered Products & Services, 9 Roszel Road, Princeton, NJ 08540 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— without international search report and to be republished upon receipt of that report

[Continued on next page]

(54) Title: CABLE CONNECTION APPARATUS AND METHOD



(57) Abstract: An apparatus for connecting a first cable to a second cable is disclosed. The apparatus includes a barrel defining a first open end, a second open end, and channel communicating with the first and second ends. The channel is receives a portion of the first cable and a portion of the second cable. A connector electrically connects the conductor of the first cable to the conductor of the second cable. A fire-resistant insulation is located in the channel. The insulation surrounds at least the connector and the exposed end portion of the conductors of the first and second cables. A first sealing means seals the first cable to the first end of the barrel and a second sealing means seals the second cable to the second end of the barrel.

WO 2006/124409 A2



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE: CABLE CONNECTION APPARATUS AND METHOD**FIELD OF THE INVENTION**

[0001] The invention relates to connecting cables, and in particular, to an apparatus for joining electrical cables.

BACKGROUND OF THE INVENTION

5 **[0002]** Many types of electrical cables are known in the art. One such type of cable is a mineral-insulated (MI) cable. MI cables are typically used in electricity transportation and electric heat tracing applications. MI cables typically include at least one inner conductor surrounded by a mineral-based insulation layer, such as magnesium oxide (MgO) powder insulation. The
10 insulation layer is surrounded by an outer sheath composed of a metal material, such as copper.

[0003] The above components of the MI cable are all produced together by series drawing, as is well known in the art. Due to the nature of the production process, the length of the MI cable which may be produced is
15 limited. Accordingly, lengths of MI cable frequently require connection to each other in the field. As MI cables are used in environments where high temperature or an aggressive medium may be present, it is desirable for MI cables to be fire-resistant. Consequently, it is preferred that any connections between two lengths of MI cable also be fire-resistant.

20 **[0004]** Prior art field connections for MI cables include a crimp-on splice connector to connect the two ends of the conductors. The exposed conductors are then covered by a plastic material, such as a tape and/or a PVC sleeve as a sealing insulation. The disadvantage of this prior art field connection is that it is not fire resistant due to the of the plastic tape and/or sleeve.

25 **[0005]** Another type of prior art MI cable connection may be made in a plant by welding the two ends of the MI cable. Such cable connections may be fire resistant, but have the disadvantage significant labor time and cost.

[0006] Accordingly, there is a need for a cable connection apparatus which may facilitate the joining of two lengths of cable in the field and provides a fire resistant connection.

SUMMARY OF THE INVENTION

- 5 **[0007]** According to a first aspect of the invention, an apparatus for connecting a first cable to a second cable is provided. Each of the first and second cables has at least one conductor, an insulating layer surrounding the conductor, and an outer sheath surrounding the insulating layer. The conductor of each cable has an exposed end portion. The apparatus comprises:
- 10 a) a barrel defining a first open end and a second open end, the barrel defining a channel therethrough, the channel communicating with the first and second ends, wherein the channel is adapted to receive a portion of the first cable and a portion of the second cable;
- b) a connector adapted to electrically connect the conductor of the first cable to
- 15 the conductor of the second cable;
- c) a fire-resistant insulation located in the channel, the insulation substantially surrounding at least the connector and the exposed end portion of the conductors of the first and second cables; and
- d) a sealing means for sealing the first cable to the first end of the barrel.
- 20 **[0008]** According to a second aspect of the invention, an apparatus for connecting a first cable to a second cable is provided. Each of the first and second cables has at least one conductor, an insulating layer surrounding the conductor, and an outer sheath surrounding the insulating layer. The conductor of each cable has an exposed end portion. The apparatus comprises:
- 25 a) a barrel defining a first open end and a second open end, the barrel defining a channel therethrough, the channel communicating with the first and second ends, wherein the channel is adapted to receive a portion of the first cable and a portion of the second cable;

- b) a connector adapted to electrically connect the conductor of the first cable to the conductor of the second cable;
- c) a fire-resistant insulation located in the channel, the insulation substantially surrounding at least the connector and the exposed end portion of the
- 5 conductors of the first and second cables;
- d) a first sealing means for sealing the first cable to the first end of the barrel; and
- e) a second sealing means for sealing the second cable to the second end of the barrel.
- 10 **[0009]** According to a third aspect of the invention, a method of connecting a first cable to a second cable is provided. Each of the first and second cables has at least one conductor, an insulating layer surrounding the conductor, and an outer sheath surrounding the insulating layer. The method comprises:
- 15 a) sliding a barrel on to the first cable;
- b) sliding an insulating spacer on to the end portion of the conductor and securing the spacer to the insulating layer;
- c) repeating step (b) for the second cable;
- d) electrically connecting the conductors of the first and second cable;
- 20 e) placing a fire-resistant insulation over exposed end portions of the conductors of the first and second cables and over the ceramic spacers connected to the first and second cable;
- f) sliding the barrel over the end portions of the conductors and the insulating spacers of the first and second cables; and
- 25 g) sealing the barrel to the first and second cables.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In the accompanying drawings:

Figure 1 is a cross-sectional view showing two lengths of MI cable joined by a preferred embodiment of the cable connection apparatus according to the present invention; and

Figure 2 is an exploded perspective view of one half of the embodiment shown in Fig. 1, with the other half being identical.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0011] Figures 1 and 2 show a cable connection apparatus **10** according to a preferred embodiment of the present invention, which may be used to connect a first cable **12a** to a second cable **12b**. Preferably, the first and second cables **12a**, **12b** are two lengths of the same type of cable.

[0012] Continuing to refer to Figures 1 and 2, each of the cables **12a**, **12b**, includes a corresponding conductor **14a**, **14b** which is surrounded by an insulating layer **16a**, **16b**, respectively. The insulating layers **16a**, **16b** of each cable **12a**, **12b** are surrounded by an outer sheath **18a**, **18b**, which is preferably made of a metal material, such as copper. The insulating layers **16a**, **16b** are preferably composed of a mineral insulation, such as magnesium oxide.

[0013] Continuing to refer to Figures 1 and 2, the connection apparatus **10** includes first and second sealing means **19a**, **19b** for sealing the first and second cables **12a**, **12b** to a barrel **34** which is fitted over the cable joint. Preferably, the first and second sealing means **19a**, **19b** comprise first and second nuts **20a**, **20b**, first and second sliding ferrules **22a**, **22b**, and first and second glands **24a**, **24b**, respectively. The first and second nuts **20a**, **20b**, first and second sliding ferrules **22a**, **22b**, and the first and second glands **24a**, **24b** fit onto the first and second cables **12a**, **12b**, respectively.

[0014] The apparatus **10** may also include first and second insulating spacers **26a**, **26b** which fit over corresponding exposed portions **28a**, **28b** of

conductors **14a, 14b**. Preferably, the insulating spacers **26a, 26b** are made from a ceramic material.

[0015] A connector **30** is provided to electrically connect the conductors **14a, 14b**. Preferably, the connector **30** is a crimp-on splice connector.

5 **[0016]** Fire-resistant insulation **32** is wrapped around the joined exposed portions **28a, 28b** of conductors **14a, 14b**, the connector **30**, as well as adjacent portions of first and second cables **12a, 12b**. Preferably, the fire-resistant insulation **32** is a ceramic filling or a fire-rated fiber.

[0017] The cable joint surrounded by the fire-resistant insulation **32** is received in a channel **37** in the barrel **34**. The channel **37** extends between
10 opposing first and second open ends **36a, 36b** of the barrel **34**. The first gland **24a** is connected to the first open end **36a** and the second gland **24b** is connected to the second open end **36b** of the barrel **34**. The first and second glands **24a, 24b** are connected to the barrel **34** by screwing first and second
15 outer threaded portions **38a, 38b** of the glands **24a, 24b**, respectively, to corresponding inner threaded portions **40a, 40b** of the barrel **34**. Preferably the outer threaded portions **38a, 38b** and the inner threaded portions **40a, 40b** of the barrel **34** are dry seal threaded connections.

[0018] Preferably, the nuts **20a, 20b**, sealing ferrules **22a, 22b**, glands
20 **24a, 24b** and the barrel **34** are all made from a metal material which is suitable for meeting the performance requirements for the connection. In one example, the foregoing components may be made of copper.

[0019] The operation of the apparatus **10** and the method according to a preferred embodiment of the present invention will now be described with
25 reference to Figures 1 and 2.

[0020] The outer sheath **18a, 18b** and insulating layer **16a, 16b** are peeled from the end of cables **12a, 12b**, respectively, to create the exposed end

portions **28a**, **28b** of the conductors **14a**, **14b**. Nuts **20a**, **20b**, sealing ferrules **22a**, **22b**, and glands **24a**, **24b** are then slid on to corresponding first and second cables **12a**, **12b**. Insulating spacers **26a**, **26b** are then fitted on to the exposed portions **28a**, **28b** of conductors **14a**, **14b** and secured to the

5 insulating layer **16a**, **16b** of corresponding cables **12a**, **12b**. The barrel **34** is then fitted on to one of the cables **12a** or **12b**. The connector **30** is crimped-on to the exposed portions **28a**, **28b** of the conductors **14a**, **14b** using hydraulic tool. The tool has crimp dies which deform the crimp-on connector **30** to crimp and hold the conductors. The fire-resistant insulation **32** is wrapped around

10 portions of the first and second cable **12a**, **12b**, and all other components located in the channel **37** of the barrel **34**, such as the exposed portions of the conductor **28a**, **28b**, connector **30**, and insulating spacers **26a**, **26b**. In this manner, the fire-resistant insulation **32** secures the insulating spacers in position. The barrel **34** is then moved into position and substantially centered

15 over the connector **30** to cover the fire-resistant insulation **32**. The first gland **24a** is then screwed into the inner threaded portion **40a** of the first end **36a** of the barrel **34** to seal the first gland to the barrel. The first nut **22a** is then tightened by screwing it to the other end of gland **24a** thereby pushing the first sealing ferrule **22a** into engagement with the first gland **24a** to seal the first

20 gland **24a** to first cable **12a**. The second gland **24b** and second nut **22b** are then tightened in the same manner to seal the second gland **24b** against the barrel **34** and the second cable **12b**.

[0021] The method and apparatus of the present invention provides the advantage of a fire resistant cable joint which can be assembled in the field and

25 which is sealed to keep out aggressive media which may be present in places where the cable is installed.

[0022] While the present invention as herein shown and described in detail is fully capable of attaining the above-described objects of the invention, it

is to be understood that it is the presently preferred embodiment of the present invention and thus, is representative of the subject matter which is broadly contemplated by the present invention, that the scope of the present invention fully encompasses other embodiments which may become obvious to those
5 skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." All structural and functional equivalents to the elements of the above-described preferred embodiment that
10 are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention, for it to be encompassed by the present claims.

CLAIMS:

1. An apparatus for connecting a first cable to a second cable, each of the first and second cables having at least one conductor, an insulating layer surrounding the conductor, and an outer sheath surrounding the insulating layer, the conductor having an exposed end portion, the apparatus comprising:
- 5 layer, the conductor having an exposed end portion, the apparatus comprising:
- a) a barrel defining a first open end and a second open end, the barrel defining a channel therethrough, the channel communicating with the first and second ends, wherein the channel is adapted to receive a portion of the first cable and a portion of the second cable;
 - 10 b) a connector adapted to electrically connect the conductor of the first cable to the conductor of the second cable;
 - c) a fire-resistant insulation located in the channel, the insulation substantially surrounding at least the connector and the exposed end portion of the conductors of the first and second cables; and
 - 15 d) a sealing means for sealing the first cable to the first end of the barrel.
2. The apparatus of claim 1, wherein the sealing means comprises a gland adapted to sealingly engage the first cable.
3. The apparatus of claim 2, wherein the gland comprises an outer threaded portion, the barrel comprising an inner threaded portion proximate to the first end, wherein the outer threaded portion of the gland is adapted to sealingly engage the inner threaded portion of the barrel.
- 20 4. The apparatus of claim 3, wherein the outer threaded portion of the gland and the inner threaded portion of the barrel form an air-tight seal.
- 25 5. The apparatus of claim 3, wherein the sealing means comprises a nut adapted to threadably engage the gland, and a sealing ferrule located between the nut and the gland, wherein the nut is adapted to urge the sealing ferrule to seal the gland to the first cable.

6. The apparatus of any one of claims 1-5, further comprising an insulating spacer adapted to be secured to the insulating layer, wherein the insulating spacer is adapted for location within the channel proximate to the exposed end portion of the conductor.
- 5 7. The apparatus of claim 6, wherein the spacer comprises a ceramic spacer.
8. The apparatus of any one of claims 1-7, wherein the insulating layer of the first cable comprises a mineral insulating layer.
9. The apparatus of claim 8, wherein the mineral insulating layer comprises
10 a magnesium oxide layer.
10. The apparatus of claim 5, wherein the nut, the gland, the ferrule, and the barrel are composed of a metal material, wherein the metal material matches the outer sheath.
11. The apparatus of claim 10, wherein the nut, the gland, the ferrule, and
15 the barrel are composed of a metal material.
12. The apparatus of any one of claims 1-10, wherein the fire-resistant insulation comprises a ceramic filling.
13. An apparatus for connecting a first cable to a second cable, each of the first and second cables having at least one conductor, an insulating layer
20 surrounding the conductor, and an outer sheath surrounding the insulating layer, the conductor having an exposed end portion, the apparatus comprising:
- a) a barrel defining a first open end and a second open end, the barrel defining a channel therethrough, the channel communicating with the first and second ends, wherein the channel is adapted to receive a portion of the
25 first cable and a portion of the second cable;
 - b) a connector adapted to electrically connect the conductor of the first cable to the conductor of the second cable;

c) a fire-resistant insulation located in the channel, the insulation substantially surrounding at least the connector and the exposed end portion of the conductors of the first and second cables;

d) a first sealing means for sealing the first cable to the first end
5 of the barrel; and

e) a second sealing means for sealing the second cable to the second end of the barrel.

14. The apparatus of claim 13, wherein the first sealing means comprises a first gland adapted to sealingly engage the first cable, and the second sealing
10 means comprises a second gland adapted to sealingly engage the second cable.

15. The apparatus of claim 14, wherein the first gland comprises a first outer threaded portion and the second gland comprises a second outer threaded portion, the barrel comprising a first inner threaded portion proximate to the first
15 end and a second inner threaded portion proximate to the second end, wherein the first outer threaded portion of the first gland is adapted to sealingly engage the first inner threaded portion of the barrel, and the second outer threaded portion of the second gland is adapted to sealingly engage the second inner portion of the barrel.

20 16. The apparatus of claim 15, wherein the outer threaded portion of the first gland and the inner threaded portion of the first end of the barrel form an air-tight seal, wherein the outer threaded portion of the second gland and the inner threaded portion of the second end of the barrel form an air-tight seal.

17. The apparatus of claim 17, wherein:

25 a) the first sealing means comprises a first nut adapted to threadably engage the first gland, and a first sealing ferrule located between the first nut and the first gland, wherein the first nut is adapted to urge the first sealing ferrule to seal the first gland to the first cable; and

b) the second sealing means comprises a second nut adapted to threadably engage the second gland, and a second sealing ferrule located between the second nut and the second gland, wherein the second nut is adapted to urge the second sealing ferrule to seal the second gland to the
5 second cable.

18. The apparatus of any one of claims 13-17, further comprising a first insulating spacer and a second insulating spacer, wherein the first and second spacers are adapted for location in the channel, wherein the first spacer is adapted to be secured to the insulating layer of the first cable, and the second
10 spacer is adapted to be secured to the insulating layer of the second cable.

19. The apparatus of claim 18, wherein the first spacer is located proximate to the exposed end portion of the conductor of the first cable, and the second spacer is located proximate to the exposed end portion of the conductor of the second cable.

15 20. The apparatus of claim 19, wherein the first and second spacers are ceramic spacers.

21. The apparatus of any one of claims 13-20, wherein the insulating layers of the first and second cable comprise a mineral insulating layer.

22. The apparatus of any one of claims 13-21, wherein the mineral insulating
20 layer comprises a magnesium oxide layer.

23. The apparatus of claim 17, wherein the first and second nuts, first and second glands, first and second ferrules, and the barrel are composed of a metal material.

24. The apparatus of any one of claims 13-23, wherein the fire-resistant
25 insulation comprises a ceramic filling.

25. A method of connecting a first cable to a second cable, each of the first and second cables having at least one conductor, an insulating layer surrounding the conductor, and an outer sheath surrounding the insulating layer, the method comprising:

- 5 a) sliding a barrel on to the first cable;
 b) sliding an insulating spacer on to the end portion of the conductor and securing the spacer to the insulating layer;
 c) repeating step (b) for the second cable;
 d) electrically connecting the conductors of the first and second
10 cable;
 e) placing a fire-resistant insulation over exposed end portions of the conductors of the first and second cables, over the connector, and over the ceramic spacers connected to the first and second cable;
 f) sliding the barrel over the end portions of the conductors and
15 the insulating spacers of the first and second cables; and
 g) sealing the barrel to the first and second cables.

26. The method of claim 25, further comprising:

- (i) sliding a nut on to the first cable;
 (ii) sliding a sealing ferrule on to the first cable;
20 (iii) sliding a gland on to the first cable; and
 (iv) repeating steps (i) to (iii) for the second cable.

27. The method of claim 25 or 26, wherein the sealing step further comprises:

- a) threadably connecting gland on the first cable to an end of
25 the barrel to seal the gland to the end of the barrel;
 b) tightening the nut to the gland in order to push the sealing ferrule against the gland, thereby sealing the gland to the first cable; and
 c) repeating steps (a) and (b) for the second cable.

28. The method of any one of claims 25-27, further comprising exposing an end portion of the conductor of the first cable and the second cable.

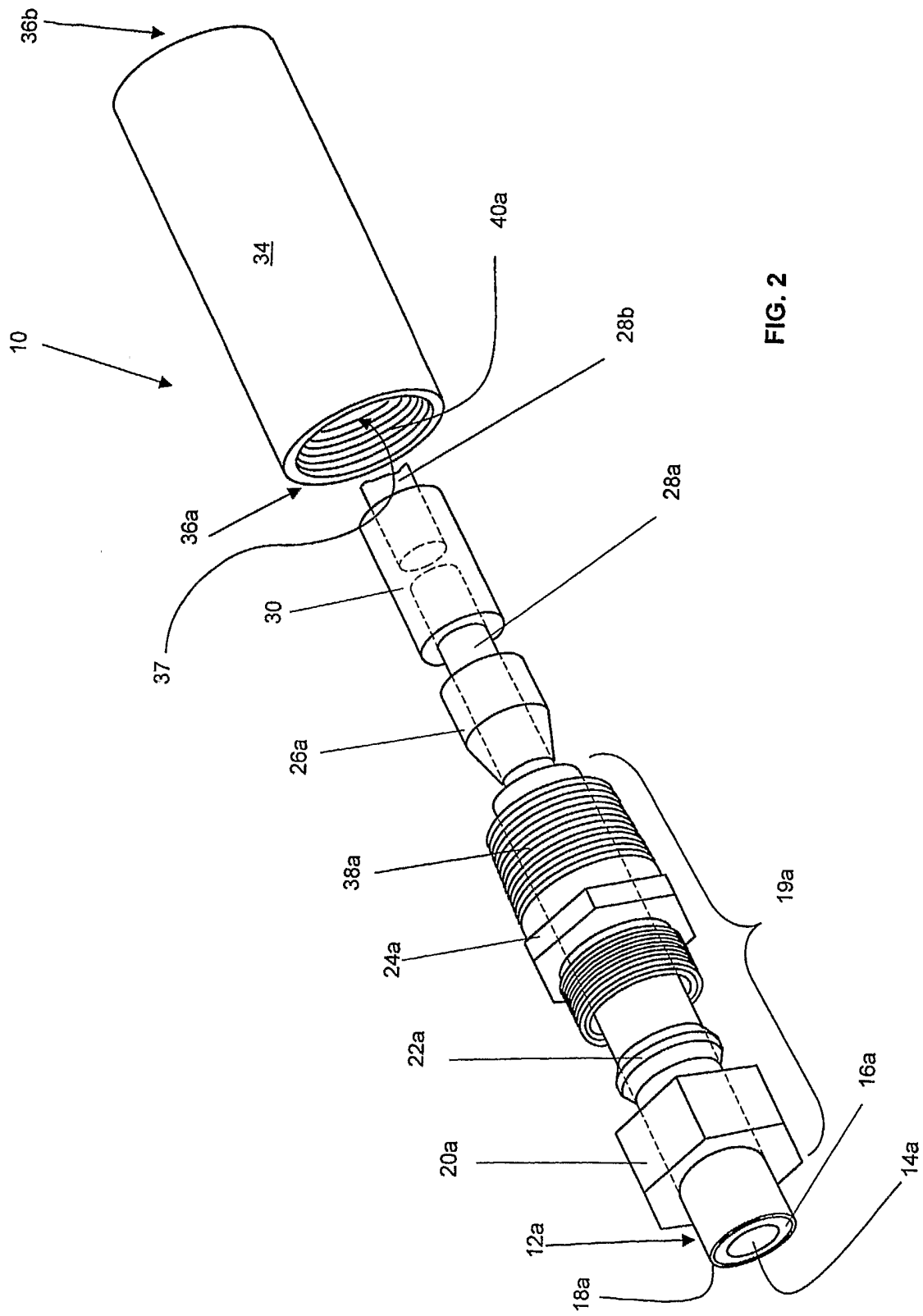


FIG. 2

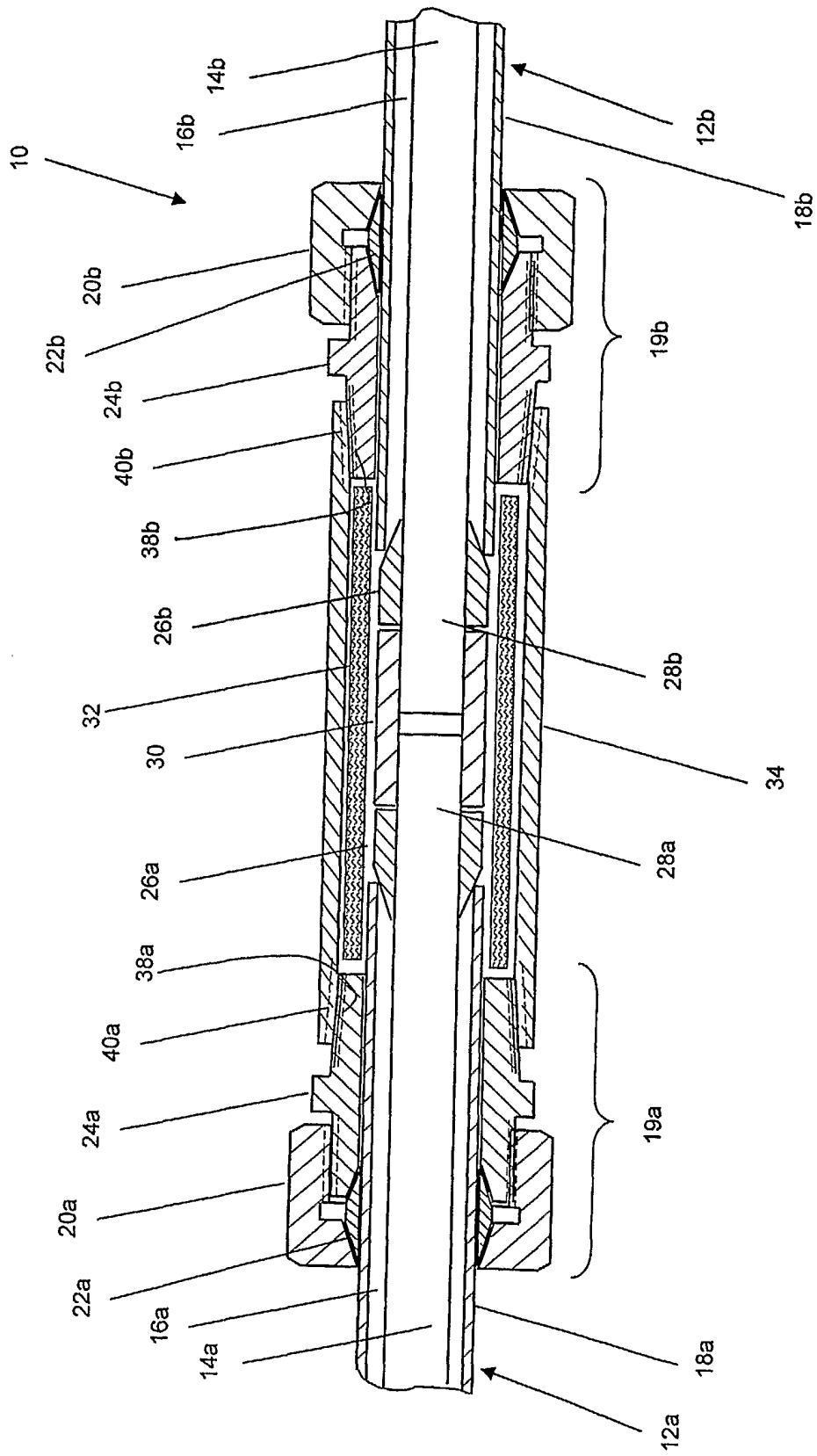


FIG. 1