



(43) International Publication Date
13 September 2012 (13.09.2012)

- (51) International Patent Classification:
H01R 13/58 (2006.01) *H01R 13/56* (2006.01)
- (21) International Application Number:
PCT/US2012/028015
- (22) International Filing Date:
7 March 2012 (07.03.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/450,591 8 March 2011 (08.03.2011) US
13/246,048 27 September 2011 (27.09.2011) US
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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(54) Title: STRAIN-RELIEF MEMBERS FOR CABLES AND METHODS FOR MAKING THE SAME

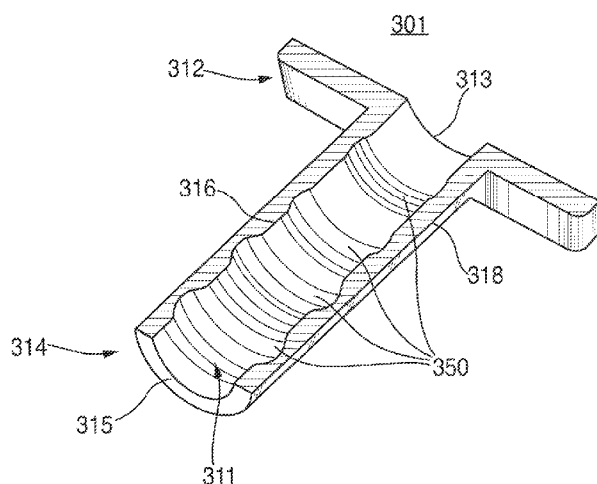


FIG. 3A

(57) Abstract: Aesthetically pleasing strain-relief members for cables and methods for making the same are disclosed. The strain-relief members are constructed to have one or more tuning members that provide selective strain relief for the cable. Each tuning member can vary the wall thickness of the strain relief member, and depending on several factors such as how many tuning members are present, their shape, and their positions within the strain-relief member, the strain-relief member can be specifically tailored to meet desired strain relief characteristics.



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS,

SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

STRAIN-RELIEF MEMBERS FOR CABLES
AND METHODS FOR MAKING THE SAME

Background of the Invention

[0001] Cables are commonly used with electronic devices such as computers, cellphones, and portable media devices. When cables are subject to repeated physical manipulations that exert bend and strain forces on the cable, the cable can eventually break or tear. Smaller diameter cables and cables used in connection with portable electronic devices are generally more susceptible to breakage because they are more frequently handled by being bent, pulled, tangled, or wrapped. Cable manufacturers have conventionally used strain-relief mechanisms to ease the stress burden on cables. However, many of these conventional strain-relief mechanisms are ineffective or are not aesthetically pleasing.

Summary

[0002] Aesthetically pleasing strain-relief members for cables and methods for making the same are disclosed. The strain-relief members are constructed to have one or more tuning members that provide selective strain relief for the cable.

Each tuning member can vary the wall thickness of the strain relief member, and depending on several factors such as how many tuning members are present, their shape, and their positions within the strain-relief member, the strain-relief member can be specifically tailored to meet desired strain relief characteristics.

Brief Description of the Drawings

[0003] The above and other aspects and advantages of the invention will become more apparent upon consideration of the following detailed description, taken in conjunction with accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

[0004] FIG. 1 is a perspective view of an illustrative cable assembly with strain relief according to an embodiment of the invention;

[0005] FIG. 2 is a cross-sectional view of a conventional strain-relief member;

[0006] FIGS. 3A-B show cross-sectional views of different illustrative strain-relief members according to embodiments of the invention;

[0007] FIG. 4 is a cross-sectional top view of another strain-relief member according to an embodiment of the invention;

[0008] FIG. 5 is a cross-sectional top view of yet another strain-relief member according to an embodiment of the invention;

[0009] FIG. 6 is an illustrative flow chart for manufacturing a strain-relief member according to an embodiment of the invention; and

[0010] FIG. 7 is a flow chart of a method for manufacturing a cable assembly with a strain-relief member according to an embodiment of the invention.

Detailed Description of the Disclosure

[0011] FIG. 1 is a perspective view of an illustrative cable assembly 100 according to an embodiment of the invention. Cable assembly 100 can include strain-relief member 110, cable 120, connector housing 130 and plug 132. In some embodiments, such as the one shown, a portion of member 110 can be integrated within housing 130. This portion (not shown) is referred to herein as a housing engagement member - see, for example, FIGS. 3A-B for illustrations of housing engagement member 312. This portion can be secured within housing 130 with an adhesive, thermal bond, or one or more mechanical clips.

[0012] In another embodiment, the housing engagement member of strain-relief member 110 may be coupled to the outer surface of the connector housing 130. Any suitable method for securing strain-relief member 110 may be employed. For example, strain-relief member 110 can be directly coupled to the outer surface of connector housing 130 with an adhesive or thermal bonding.

[0013] The strain-relief part of member 110, which is the portion shown extending through opening 134 away from housing 130, engages cable 120, which passes through member 110 into housing 130. The portion of cable 120 that engages strain-relief member 110 is provided with strain relief. Embodiments according to this invention provide strain relief tuned specifically to the type of cable 120 being used in cable assembly 100. For example, some cables may be better suited to have enhanced strain relief in the region of member 110 that abuts housing 130, whereas other cables may be better suited to have reduced strain relief in that same region. As another

example, strain relief may be selectively tuned along the length of strain-relief member **110** based on, for example, the type of cable for which it is providing strain relief.

[0014] Strain-relief member **110** may be constructed from silicone, thermoplastic elastomer ("TPE"), polyurethane, or other suitable material. In addition, strain-relief member **110** is constructed to have an aesthetically pleasing outer shell that has a smooth and continuous shape. As shown, the outer shell has a smooth and uninterrupted cylindrical shape. In contrast, and by way of example, a non-smooth and discontinuous outer shell could have corrugations, ridges, or cutouts.

[0015] Connector housing **130** may provide protection for physical and electrical connections between cable **120** and plug **132** (e.g., solder connections). Connector housing **130** may be constructed from a resilient material (e.g., plastic or metal). Plug **132** may be any type of electrical connector (e.g., RCA, DVI, HDMI, HDCP, VGA, display port, USB, Mini USB, Micro USB, a power connector, a magnetic connector, a 30-pin connector, or any other standard or proprietary interface) operable to couple a cable (e.g., cable **120**) to an electronic device.

[0016] FIG. 2 is a cross-sectional perspective view of conventional strain-relief member **210**. Strain-relief member **210** can include housing engagement member **212**, strain-relief part **214**, and wall **217**, which has inner surface **216** and outer surface **218**. Cable receiving passage **211** is operable to receive a cable (e.g., cable **120** of FIG. 1) and includes first end **213** and second end **215**. The thickness of wall **217** is substantially constant along the length of part **214**. The design of strain-relief member **210** results in uniform flex characteristics throughout, leading to the creation of a relatively high-stress point for any cable contained within cable receiving passage **211** at second end **215**.

[0017] FIG. 3A is a cross-sectional perspective view of illustrative strain-relief member **301** according to an embodiment of the invention. Strain-relief member **301** includes housing engagement member **312**, strain-relief part **314**, and wall **317**, which has inner surface **316** and outer surface **318**. Cable receiving passage **311** is operable to receive a cable (e.g., cable **120** of FIG. 1) and includes first end **313** and second end **315**. Strain-relief member **301** also includes one or more tuning members **350**, each of which changes the contours/dimensions of inner surface **316** and the corresponding thickness of wall **317**, thereby resulting in variable wall thickness along the length of part **314**.

[0018] Tuning members **350** provide tunable flex and/or strain relief characteristics for strain-relief part **314**. Any suitable number of factors can be employed to tune strain-relief part **314**. For example, the number of tuning members **350** used in part **314** and the spacing between tuning members **350** can contribute to the tuning of part **314**. In addition, the shape and size of each tuning member **314** can be constructed to achieve desired flex characteristics. For example, a tuning member can have a ring or doughnut shape in which the depth, width, and taper angle can be varied. As shown in FIG. 3A, a series of ring or doughnut shaped tuning members **350** provides a corrugated or undulating, accordion like cable receiving passage **311**. As another example (not shown), the tuning members can have a shape that is more angular in nature than a ring or doughnut shape. For example, a trapezoidal or triangular shape may be used.

[0019] Flexibility increases with decreased wall thickness and decreases with increased wall thickness. Using this generalization as a design roadmap, it can be appreciated that strain-relief member **301** is tuned to be more flexible near end **315** than at end **313**. The concentration of tuning

members **350** are more concentrated near end **315**, and as a result of this concentration, the thickness of wall **317** is thinner near end **315** than at end **313**. This is illustrated more clearly in FIG. 3B, which shows a cross-sectional top view of strain-relief member **301**.

[0020] Tuning members **350** are now specifically identified as tuning members **352**, **354**, **356** and **358**. Strain-relief member **301** is designed to provide stiff support for a cable at end **313** (e.g., the portion of member **301** where a cable interfaces with a connector housing. Members **352**, **354**, **356**, and **358** gradually increase in width and depth from tuning member **352** to tuning member **358**, thereby allowing for increasingly more cable flex along the length of strain-relief part **314** as the cable approaches second end **313**. With strain-relief member **301** tuned in this manner, the strain on the cable near second end **315** is substantially mitigated.

[0021] Depending on the dimensions and shape of tuning members used in a strain-relief member, all or a portion of the inner surface of wall **317** is in contact with the cable (not shown) in cable receiving passage **311**. In some embodiments, the portions of wall **317** that do not have tuning members may fit flush against the cable. For example, the portion of cable receiving passage **311** at second end **315** may form a tight interference fit with the cable. The cable may be free floated within cable receiving passage **311** (i.e., not physically bonded to the inner surface of wall **317**). In other embodiments, the cable can be bonded (by a thermal bond or an adhesive) to at least a portion of the inner surface of wall **317**.

[0022] FIG. 4 is a cross-sectional top view of strain-relief member **401** according to an embodiment of the invention. Strain-relief member **401** has many of the same attributes of strain-relief member **301**, and therefore similar features are similarly

labeled, except instead of "3XX," the features are now labeled "4XX." Member **401** includes cable receiving passage **411** and wall **417**, which has outer surface **418** and inner surface **416**. Strain-relief member **401** differs from strain-relief member **301** in that strain-relief part **414** has a shorter a length. In addition, tuning members **452**, **454** and **456** are designed so member **401** has more flex near end **413** than at end **415**.

[0023] FIG. 5 is a cross-sectional top view of strain-relief member **501** according to an embodiment of the invention. Strain-relief member **501** includes lone tuning member **552**. Tuning member **552** can include tapered portion **553** and necked portion **554**, which provides a step change in wall thickness of wall **517**, and non-tapered portion **555**. Tapered portion **553** can gradually decrease wall thickness from first end **513** as it extends towards necked portion **554**. At necked portion **554**, the wall thickness changes to accommodate the wall thickness of non-tapered portion **555**. If desired, non-tapered portion **555** can be designed to taper.

[0024] FIG. 6 is an illustrative flow chart for manufacturing a strain-relief member according to an embodiment of the invention. Beginning at step **610**, a mold is provided that forms the external dimensions of a strain-relief member. For example, the mold can form the outer dimensions of the housing engagement member and strain relief part. At step **620**, a removable rod is positioned within the mold and held in place during a molding step. The rod is shaped to ensure the cable receiving passage (e.g., passage **311** of FIG. 3A) with one or more appropriately sized and shaped tuning members is formed.

[0025] At step **630**, the stress-relief member is molded using the mold and removable rod. In one embodiment, a compression mold may be used to mold the stress-relief member. Compression molds may be made using any number of different techniques. In

one approach, silicon sheets can be molded around the rod. In another approach, a combination of urethane sheets and foam can form the stress-relief member. In another embodiment, an injection mold process may be used to mold the stress-relief member. At step **640**, the removable rod is removed to yield a strain-relief member having one or more tuning members according to an embodiment of the invention.

[0026] FIG. 7 is an illustrative flow chart for manufacturing cable assembly having a strain-relief member according to an embodiment of the invention. At step **710**, a strain-relief member (e.g., strain-relief member **110** of FIG. **1**) is provided. Next, at step **720**, a cable (e.g., cable **120**) can be electrically coupled to a plug (e.g., plug **132**). Electrical coupling between the cable and plug can include, for example, solder connections between individual wires in the cable and electrically conductive contacts on the plug.

[0027] At step **730**, the cable is slid through a cable receiving passage (e.g., cable receiving passage **311** of FIG. **3**) of the strain-relief member. The strain-relief member may be oriented such that the strain-relief part will pass through an opening of a connector housing when inserted into the connector housing. At step **740**, the plug, cable, and strain relief member are inserted into a connector housing and permanently attached thereto. A housing engagement member of the strain-relief member may be secured to the connector housing using any suitable method.

[0028] It is understood that the various features, elements, or processes of the foregoing figures and description are interchangeable or combinable to realize or practice the invention described herein. Those skilled in the art will appreciate that the invention can be practiced by other than the described embodiments, which are presented for purposes of

illustration rather than of limitation, and the invention is limited only by the claims, which follow.

What is claimed is:

1. A cable strain-relief member comprising:
a housing engagement member; and
a strain-relief part that extends away from the housing engagement member, the strain-relief part comprising:
an outer surface that defines an outer dimension of the strain-relief part;
a cable receiving passage extending from a first end of the strain-relief part to a second end of the strain-relief part; and
an inner wall defining dimensions of the cable receiving passage, the inner wall having at least one tuning member that defines a flex characteristic of the strain relief part.
2. The strain-relief member of claim 1, wherein the housing engagement member and strain-relief part comprise an integrated structure.
3. The strain-relief member of claim 1, wherein the outer surface resembles a cylindrical body.
4. The strain-relief member of claim 1, wherein the at least one tuning member is operative to selectively provide strain relief for the portion of the strain relief part at which the at least one tuning member resides.
5. The strain-relief member of claim 1, wherein the at least one tuning member comprises a plurality of tuning members.

6. The strain-relief member of claim 5, wherein a predetermined amount of space exists between each of the tuning members.

7. The strain-relief member of claim 6, wherein the predetermined amount of space between each tuning member is the same.

8. The strain-relief member of claim 6, wherein the predetermined amount of space between each tuning member is different.

9. The strain-relief member of claim 5, wherein each of the tuning members has different dimensions.

10. The strain-relief member of claim 5, wherein the tuning members are positioned and dimensioned to provide more strain relief at the first end than at the second end.

11. The strain-relief member of claim 5, wherein the tuning members are positioned and dimensioned to provide more strain relief at the second end than at the first end.

12. The strain-relief member of claim 1, wherein the at least one tuning member comprises a ring or doughnut shape.

13. The strain-relief member of claim 1, wherein the at least one tuning member comprises a taper region, a neck region and a non-taper region.

14. The strain relief member of claim 1, wherein the strain-relief member is constructed from silicone.

15. A cable assembly comprising:
a plug;
a connector housing coupled to the plug;
a strain-relief member coupled to the connector housing, the strain-relief member comprising at least one tuning member that varies a wall thickness of the strain-relief member to provide selective strain relief; and
a cable coupled to the connector housing, strain-relief member, and plug, wherein the strain-relief member provides selective strain relief to the cable.

16. The cable assembly of claim 15, wherein the strain-relief member is coupled to the connector housing with an adhesive.

17. The cable assembly of claim 15, wherein the strain-relief member further comprises a housing engagement member that engages the connector housing.

18. The cable assembly of claim 17, wherein the housing engagement member is encased inside the connector housing.

19. The cable assembly of claim 15, wherein the strain-relief member comprises a strain-relief part and the connector housing comprises an opening, and the strain-relief part extends away from the connector housing through the opening.

20. A method for making a stress-relief member, the method comprising:

providing a mold that forms external dimensions of a strain-relief member;

securing a removable rod within the mold during a molding step, the rod shaped to ensure a cable receiving passage with one or more tuning members is formed;

molding the stress-relief member using the mold and removable rod; and

removing the removable rod to yield the strain-relief member having the one or more tuning members.

21. The method of claim 20, wherein molding the stress-relief member comprises compression molding the stress-relief member.

22. The method of claim 20, wherein molding the stress-relief member comprises injection molding the stress-relief member.

23. A method for making a cable assembly, the method comprising:

providing a strain-relief member having a cable receiving passage that has at least one tuning member;

coupling a cable to a plug;

sliding the cable through the cable receiving passage; and

inserting the plug, cable, and strain relief member into a connector housing and securing the plug, cable, and strain relief member in the connector housing.

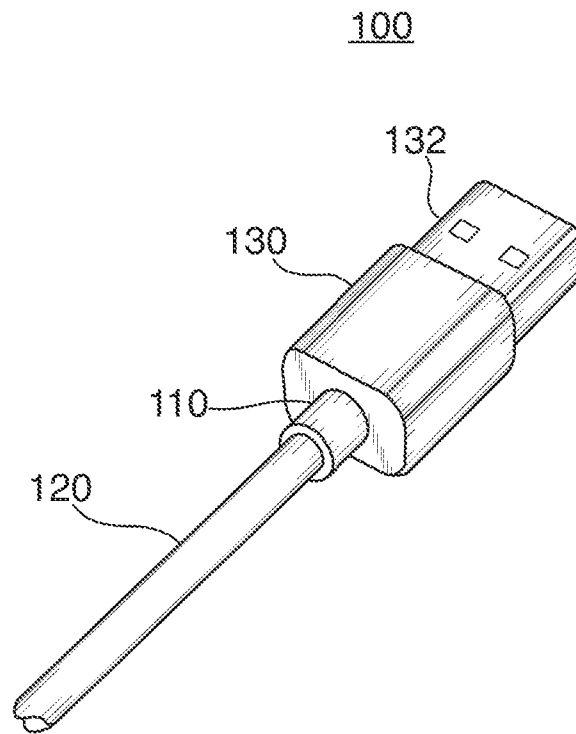


FIG. 1

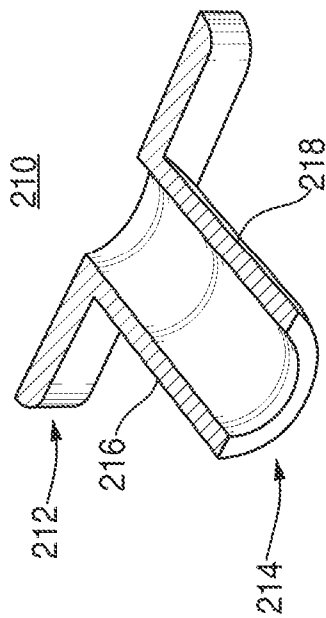


FIG. 2
(PRIOR ART)

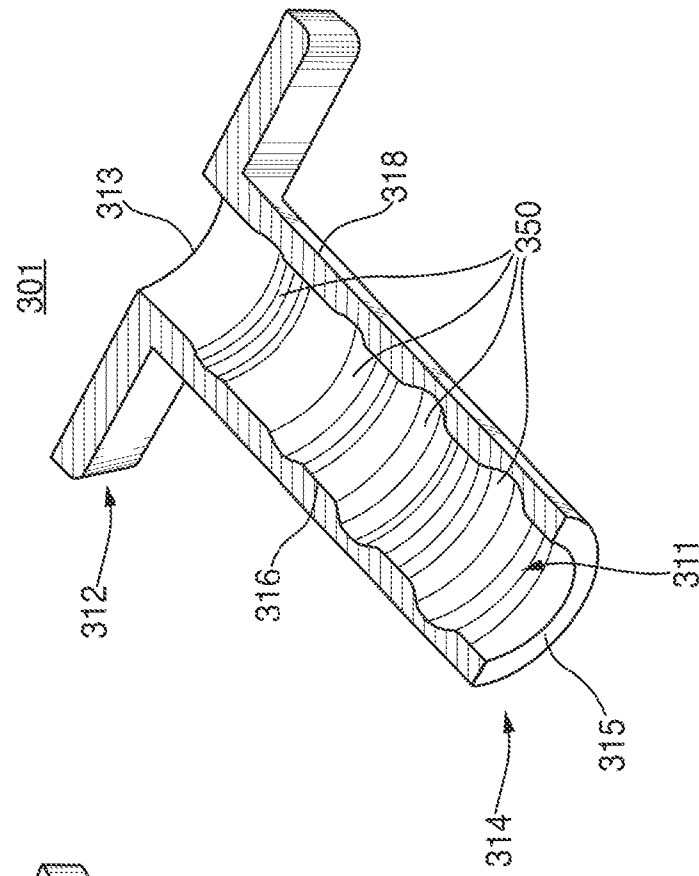


FIG. 3A

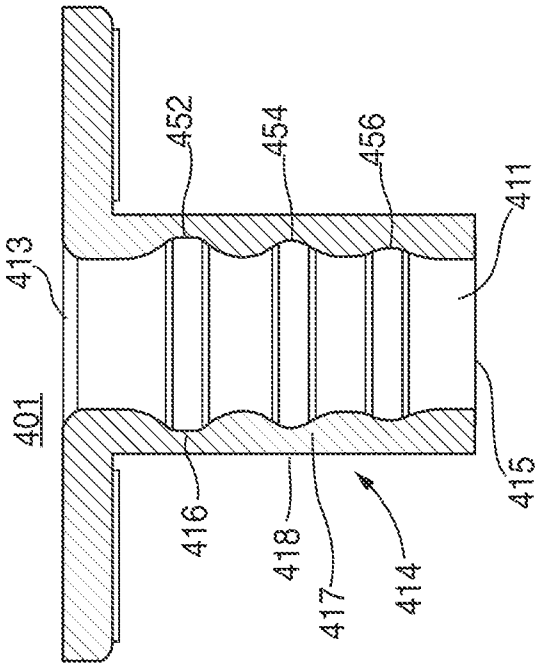


FIG. 4

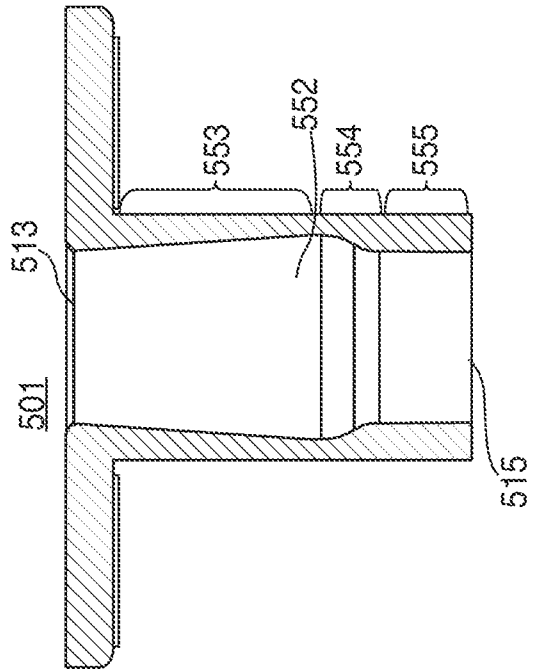


FIG. 5

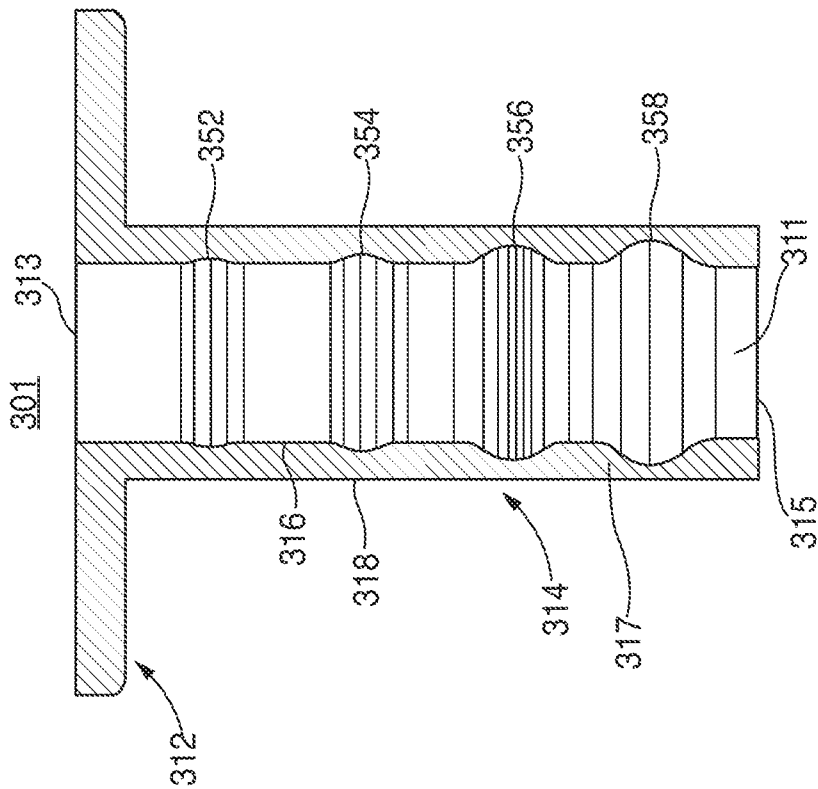


FIG. 3B

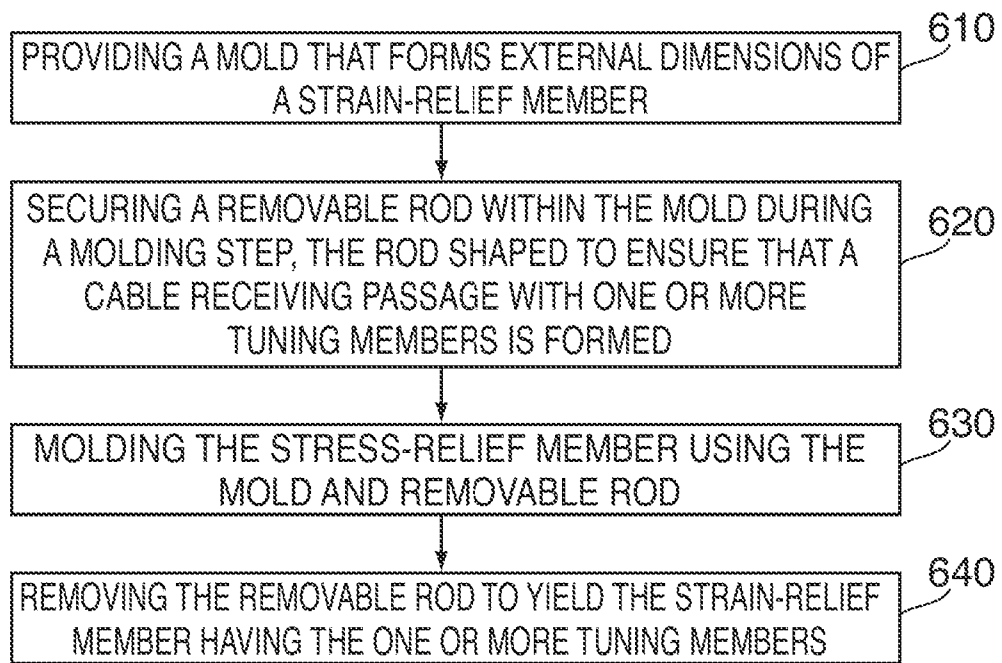


FIG. 6

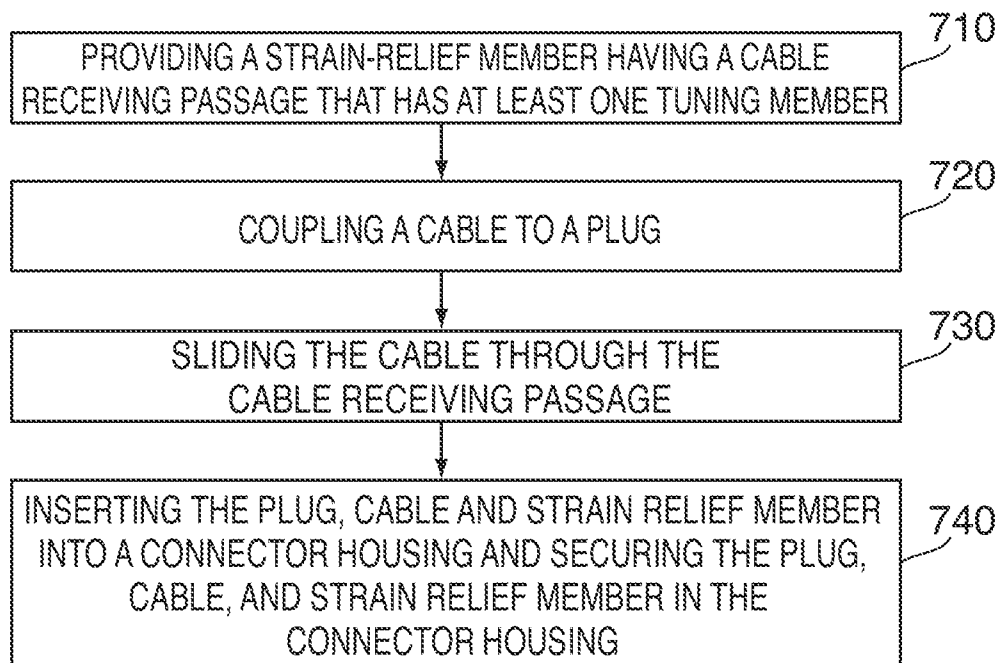


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/028015

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R13/58 H01R13/56
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2003/199192 A1 (CAVENEY JACK E [US] ET AL) 23 October 2003 (2003-10-23) figure 1	1-9,12, 14-17, 19-23
X	DE 10 2005 057266 A1 (BOSCH GMBH ROBERT [DE]) 6 June 2007 (2007-06-06) figures 1-3 ----- -/-	1-12, 14-23



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 May 2012

Date of mailing of the international search report

05/06/2012

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Camerer, Stephan

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/028015

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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