



(51) International Patent Classification:

*H02G 3/18* (2006.01) *H02G 3/14* (2006.01)  
*H01R 4/66* (2006.01) *H05K 9/00* (2006.01)

(21) International Application Number:

PCT/CA2016/050157

(22) International Filing Date:

19 February 2016 (19.02.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/119,877 24 February 2015 (24.02.2015) US

(71) Applicant: **TM4 INC.** [CA/CA]; 135 J.-Armand Bombardier, Bureau 25, Boucherville, Québec J4B 8P1 (CA).

(72) Inventors: **LATULIPE, Éric**; 291 De Normandie, Ste-Julie, Québec J3E 1A7 (CA). **LAVIGNE, Jean-François**; 125 Boulevard des Prés-Verts, LaPrairie, Québec J5R 3Y7 (CA).

(74) Agent: **PRINCE, Gaetan**; 1100 Rene-Levesque boul. West, 25th floor, Montreal, Quebec H3B 5C9 (CA).

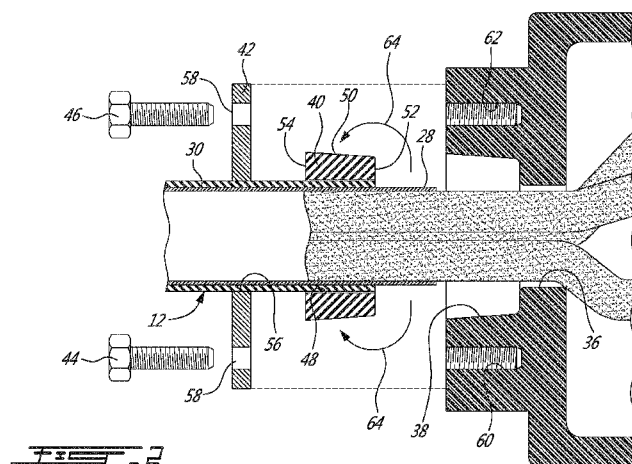
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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.

(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, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, 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, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(54) Title: SEALING GROMMET ASSEMBLY AND INSTALLATION METHOD THEREFOR



(57) Abstract: A sealing grommet assembly to be connected to a cavity of a casing provided with a sloping peripheral wall is described herein. The sealing grommet assembly comprises a body including an aperture to receive an electrical cable therethrough and a tapered peripheral wall so configured and sized as to fit in the cavity of the casing and a flat top portion. The sealing grommet assembly also comprises a cover so configured and sized as to fit onto the flat top portion of the body and means for securing the cover to the casing.



**TITLE**

Sealing grommet assembly and installation method therefor

**FIELD**

**[0001]** The present disclosure relates to sealing grommets. More specifically, the present disclosure is concerned with a sealing grommet assembly used to allow an electrical cable to enter a casing while both providing a shield connection and preventing the elements from entering the casing. The present disclosure is also concerned with the installation method of such a grommet assembly.

**BACKGROUND**

**[0002]** Sealing grommets used to allow electrical cable to enter a casing while preventing the elements from entering the casing are known in the art. When an electrical cable includes a shield that is to be connected to the casing, this connection is conventionally done inside the casing by fastening the shield to a predetermined connection point in the casing, which takes some real estate of the casing, adds to the cost of the hardware and increases the assembly time.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**[0003]** In the appended drawings:

**[0004]** Figure 1 is a sectional side elevation view illustrating an electrical cable mounted to a casing via a sealing grommet assembly according to a first illustrative embodiment;

**[0005]** Figure 2 is a top exploded view of the cable of Figure 1;

**[0006]** Figure 3 is a top exploded view illustrating the sealing grommet assembly of Figure 2 being inserted in the cavity of the casing;

**[0007]** Figure 4 is a sectional top plan view of the electrical cable and casing of Figure 1;

**[0008]** Figure 5 of the appended drawings is a top plan view similar to Figure 4, but illustrating a sealing grommet assembly according to a second illustrative embodiment;

**[0009]** Figure 6 is a sectional view taken along line 6-6- of Figure 5; and

**[0010]** Figure 7 is a top exploded view similar to Figure 2 illustrating a sealing grommet assembly according to a third illustrative embodiment.

#### **DETAILED DESCRIPTION**

**[0011]** In accordance with an illustrative embodiment, there is provided a sealing grommet assembly to be connected to a cavity of a casing; the cavity being provided with a sloping peripheral wall. The sealing grommet assembly comprising a body including an aperture to receive an electrical cable therethrough and a tapered peripheral wall so configured and sized as to fit in

the cavity of the casing and a flat top portion. The sealing grommet assembly also comprises a cover so configured and sized as to fit onto the flat top portion of the body and means for securing the cover to the casing.

**[0012]** In accordance with another aspect, there is provided a method for installing an electrical cable provided with a shield to a cavity of a casing using a sealing grommet and a cover, the sealing grommet including at least one aperture to receive the electrical cable; the grommet having a tapered peripheral wall so configured and sized as to fit in the cavity and a flat top portion and the cover having an aperture to receive the electrical cable; the cavity being provided with a sloping peripheral wall. The method including: inserting the electrical cable in the cover aperture; inserting the electrical cable in the grommet aperture; folding the shield of the electrical cable over a portion of the tapered peripheral of the grommet; inserting the grommet in the cavity, thereby creating an electrical connection between the shield and the casing; and mounting the cover to the casing.

**[0013]** The use of the word “a” or “an” when used in conjunction with the term “comprising” in the claims and/or the specification may mean “one”, but it is also consistent with the meaning of “one or more”, “at least one”, and “one or more than one”. Similarly, the word “another” may mean at least a second or more.

**[0014]** As used in this specification and claim(s), the words “comprising” (and any form of comprising, such as “comprise” and “comprises”), “having” (and any form of having, such as “have” and “has”), “including” (and any form of including, such as “include” and “includes”) or “containing” (and any form of containing, such as “contain” and “contains”), are inclusive or open-ended and do not exclude additional, unrecited elements or process steps.

**[0015]** In the present specification and in the appended claims, various terminology which is directional, geometrical and/or spatial in nature such as "longitudinal", "horizontal", "front", "rear", "upwardly", "downwardly", etc. is used. It is to be understood that such terminology is used for ease of description and in a relative sense only and is not to be taken in any way as a limitation upon the scope of the present disclosure.

**[0016]** The expression "connected" should be construed herein and in the appended claims broadly so as to include any cooperative or passive association between mechanical parts or components. For example, such parts may be assembled together by direct connection, or indirectly connected using further parts therebetween. The connection can also be remote, using for example a magnetic field or else.

**[0017]** It is to be noted that the expression "electrical cable" is to be construed herein and in the appended claims as one or more electrical conductors that are included in a tubular shield and covered by a sheath.

**[0018]** Other objects, advantages and features of the sealing grommet and installation method therefor will become more apparent upon reading of the following non-restrictive description of illustrative embodiments thereof, given by way of example only with reference to the accompanying drawings.

**[0019]** Figures 1 to 4 illustrate a sealing grommet assembly 10 allowing an electrical cable 12 to be inserted into a casing 14 while providing a seal against the elements and an electric connection between a shield of the electrical cable 12 and the casing 14.

**[0020]** The electrical cable 12 includes three electrical wires 16, 18, 20 each fitted with a connector 22 that may be secured to a circuit 24 located in the casing 14 via a fastener 26. The electrical cable 12 also includes a shield 28 enclosing the wires 16-20 and an insulating sheath 30 covering the shield 28.

**[0021]** The casing 14 includes a body 32 and a cover 34. The body including an aperture 36 allowing the electric wires 16-20 therethrough and a grommet-receiving cavity 38 aligned with the aperture 26 and having sloping peripheral walls.

**[0022]** The sealing grommet assembly 10 includes a sealing grommet 40, a cover 42 and fasteners 44, 46 (see Figure 2) in the form of bolts.

**[0023]** As can be better seen from Figure 2, the sealing grommet 40 includes a central aperture 48 configured to receive the electrical cable 12 therethrough, a tapered peripheral wall 50, a flat bottom wall 52 and a flat top wall 54. The angle of the tapered peripheral wall 50 is configured to generally correspond to the sloping peripheral wall of the grommet receiving cavity 38 as will be described hereinbelow.

**[0024]** The sealing grommet 40 is made of a slightly deformable and sealing material such as, for example, rubber. Of course, other materials such as other elastomers could also be used to manufacture the sealing grommet 40.

**[0025]** The cover 42 is made of rigid material such as metal and includes a central aperture 56 allowing the electrical cable 12 therethrough and

fastening apertures 58 allowing the fasteners 44 and 46 therethrough. Of course, other type of hard material could be used.

**[0026]** As can be better seen from this figure, the body 32 of the casing 14 includes threaded apertures 60 and 62 configured to respectively receive fasteners 44 and 46. Of course, untapped can be used if the fasteners 44 and 46 are of the self-tapping type.

**[0027]** Turning now to Figures 2 to 4 of the appended drawings, the method of installation of the sealing grommet assembly 10 to the casing 14 will be described.

**[0028]** In Figure 2, the sheath 30 of the cable 12 has been removed at the free end thereof to expose a predetermined length of the shield 28. This removal is advantageously done after the grommet 40 is inserted onto the cable 12.

**[0029]** Then, the exposed length of shield 28, which is conventionally made of a number of thin wires braided together, can be folded onto the tapered peripheral wall 50 of the grommet 40 as illustrated by arrows 64.

**[0030]** Figure 3 shows the shield 28 so folded onto the grommet 40 and illustrates the beginning of the insertion of the grommet 40 into the cavity 38. As can be seen from this figure, the length of shield that was exposed is such that only a portion of the tapered peripheral wall 50 of the grommet 40 is covered thereby. The purpose of which will be described hereinbelow.

**[0031]** A force applied to the flat top wall 54 (see arrows 66) causes the beginning of the insertion. When the grommet 40 is in a position similar to the one shown in Figure 3, the cover 42 can then be applied to the flat top wall 54, the fasteners 44 and 46 can be engaged to the threaded apertures 60 and 62 to thereby apply a force (see arrows 68) that completes the insertion of the grommet 40 partially enclosed by the shield 28.

**[0032]** As can be seen in Figure 4, the shield 28 enclosing a portion of the grommet 40 is compressed into the peripheral wall 50 of the grommet 40, which is made of deformable material as discussed hereinabove. Accordingly, since the body 32 is made of electrically conductive material, there is an electrical connection between the shield 28 and the casing 14. Furthermore, since the shield 28 only covers a portion of the peripheral wall 50 of the grommet 40, the compression of the rest of the peripheral wall 50 against the sloping peripheral wall of the cavity 38 creates a seal against the elements. This compression also creates a seal between the sheath 30 of the cable 12 and the grommet 40.

**[0033]** It will be understood by one skilled in the art that the fasteners 44 and 46 could be different. As a non-limiting example, a collet that can be screwed (not shown) could be used.

**[0034]** While the bottom and top walls 52 and 54 of the sealing grommet 40 are described hereinabove as being flat, other shape could be provided as long as the cover 42 can apply sufficient pressure to cause the seal between the grommet and the casing.

**[0035]** Of course, while the electric cable 12 has been illustrated herein as including three (3) electrical wires, any number of wires could be present in the cable. Similarly, while the electric cable 12 is shown as being a

power cable, data cable (not shown) could also be paired with an appropriately sized sealing grommet assembly.

**[0036]** Turning now to Figures 5 and 6 of the appended drawings, a sealing grommet assembly 100 allowing three electrical cables 102, 104 and 106 to be inserted into a casing 108 while providing a seal against the elements and an electric connection between the individual shields of the electrical cables and the casing will be briefly described.

**[0037]** Since the sealing grommet assembly 100 and the sealing grommet assembly 10 of Figures 1 to 4 are very similar, only the differences therebetween will be described hereinbelow, for concision purpose.

**[0038]** Each cable 102-106 is provided with a respective shield 110, 112, 114 and is inserted in one of the three aperture of the grommet 116.

**[0039]** The shields 110-114 are then each separated in two and folded on the top and bottom of the grommet 116 as can be seen from Figure 6. Accordingly, each shield will be in contact with the casing 108.

**[0040]** Again, as mentioned hereinabove, since the shields 110-114 only covers a portion of the peripheral wall of the grommet 116, the compression of the rest of the peripheral wall against the sloping peripheral wall of the cavity creates a seal against the elements. This compression also creates a seal between the sheaths of the cables 102-106 and the grommet 116.

**[0041]** The cover 118 is permanently mounted to a shoulder portion 120 of the casing 108 and the walls 122 surrounding the cover 118 are then

deformed to maintain the cover in place without separate fasteners. More specifically, Figure 5 illustrates the walls 122 prior to deformation while Figure 6 shows the same wall 122 after the deformation.

**[0042]** Finally, turning to Figure 7 of the appended drawings, a sealing grommet assembly 200 according to a third illustrative embodiment will be described. Since the sealing grommet assembly 200 is very similar to the sealing grommet assembly 10 of Figures 1 to 4 are very similar, only the differences therebetween will be describes hereinbelow, for concision purpose.

**[0043]** Generally stated, the major differences between the sealing grommets assemblies 200 and 10 lie in the size and shape of the sealing grommet 202 and in the size of the corresponding grommet-receiving cavity 204. Indeed, as can be seen from Figure 7, the sealing grommet 202 is longer that the sealing grommet 40 of Figures 1 to 4. Accordingly, the grommet-receiving cavity 204 is deeper so that the installed grommet does not overly protrude from the casing 14. This increase in length improves the seal between the grommet 202 and the cavity 204 should lateral pressure be applied to the electrical cable 12.

**[0044]** Another seal-improving feature of the grommet 202 with respect to the grommet 40 of Figures 1 to 4 consists in the three integral circumferential protrusions 206 that are provided on the tapered peripheral wall of the grommet 202. These protrusions 206 may be viewed as three integral O-rings. One skilled in the art will understand that these protrusions 206 will improve the seal between the grommet 202 and the cavity 204 during normal operation and when lateral pressure is applied to the electrical cable 12.

**[0045]** It is to be understood that the sealing grommet and installation method therefor is not limited in its application to the details of

construction and parts illustrated in the accompanying drawings and described hereinabove. The sealing grommet and installation method therefor is capable of other embodiments and of being practiced in various ways. It is also to be understood that the phraseology or terminology used herein is for the purpose of description and not limitation. Hence, although the sealing grommet and installation method therefor has been described hereinabove by way of illustrative embodiments thereof, it can be modified, without departing from the spirit, scope and nature thereof.

What is claimed is:

1. A sealing grommet assembly to be connected to a cavity of a casing; the cavity being provided with a sloping peripheral wall, the sealing grommet assembly comprising:

a body including an aperture to receive an electrical cable therethrough; a tapered peripheral wall so configured and sized as to fit in the cavity of the casing and a flat top portion;

a cover so configured and sized as to fit onto the flat top portion of the body;

means for securing the cover to the casing.

2. The sealing grommet of claim 1, wherein the securing means includes at least one fastener.

3. The sealing grommet of claim 1, wherein the electrical cable receiving aperture includes three electric cable receiving apertures.

4. The sealing grommet of claim 1, wherein the sealing grommet body is made of rubber.

5. A sealing grommet assembly as recited in claim 1, wherein the tapered peripheral wall of the body includes at least one circumferential protrusion, integrally formed thereon.

6. A sealing grommet assembly as recited in claim 5, wherein the at least one circumferential protrusion includes three circumferential protrusions.

7. A method for installing an electrical cable provided with a shield to a cavity of a casing; the cavity being provided with a sloping peripheral wall; the method including:

providing a sealing grommet including an aperture to receive the electrical cable; the grommet having a tapered peripheral wall so configured and sized as to fit in the cavity and a flat top portion;

providing a cover having an aperture to receive the electrical cable;

inserting the electrical cable in the cover aperture;

inserting the electrical cable in the grommet aperture;

folding the shield of the electrical cable over a portion of the tapered peripheral wall of the grommet;

inserting the grommet in the cavity, thereby creating an electrical connection between the shield and the casing;

mounting the cover to the casing.

8. The method of claim 7, wherein the cover mounting is done via at least one fastener.

9. The method of claim 7, wherein the cover mounting is done via the deformation of a portion of the casing.

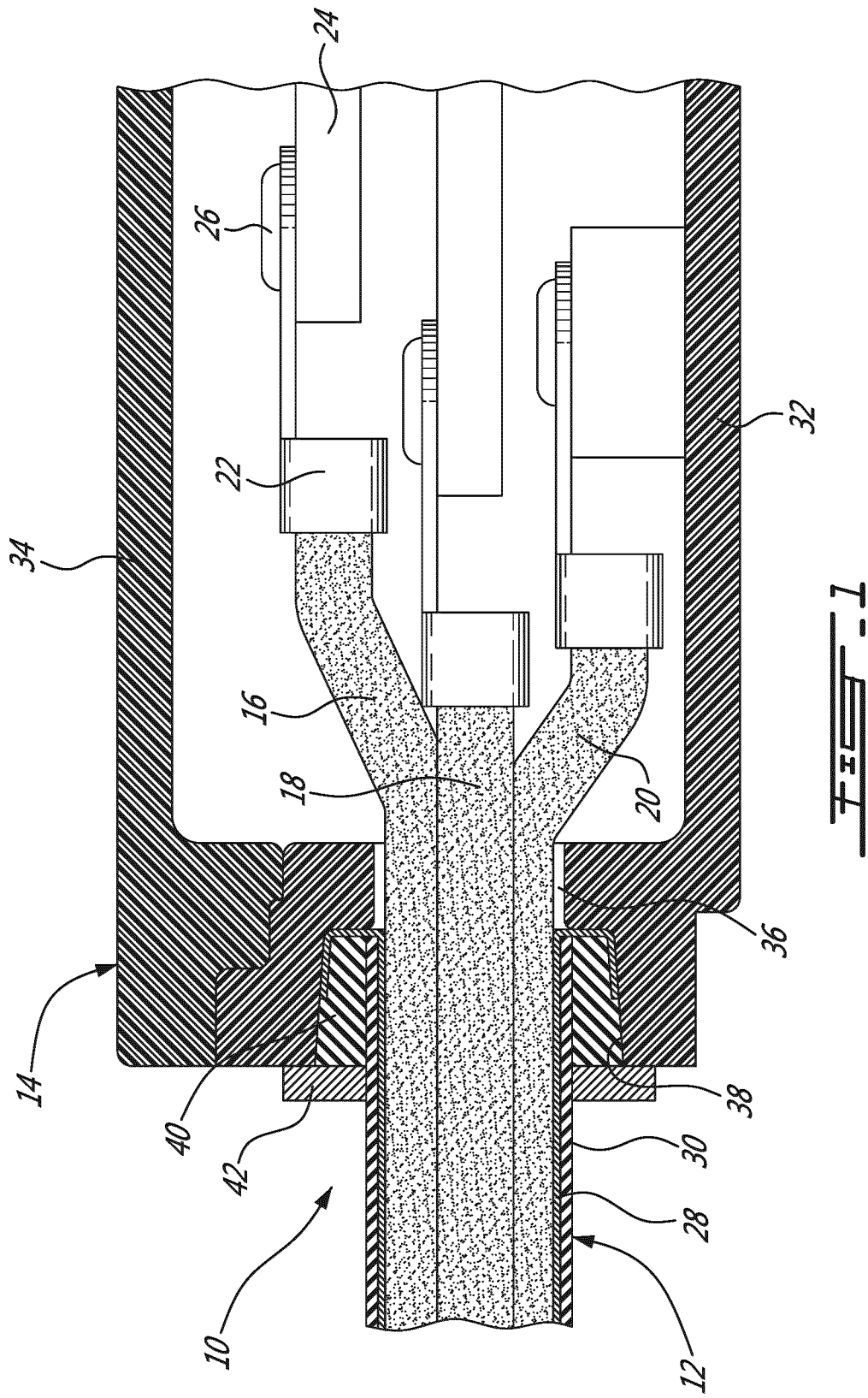
10. A method for installing an electrical cable provided with a shield to a cavity of a casing using a sealing grommet and a cover, the sealing grommet including at least one aperture to receive the electrical cable; the grommet having a tapered peripheral wall so configured and sized as to fit in the cavity and a flat top portion and the cover having an aperture to receive the electrical cable; the cavity being provided with a sloping peripheral wall; the method including:

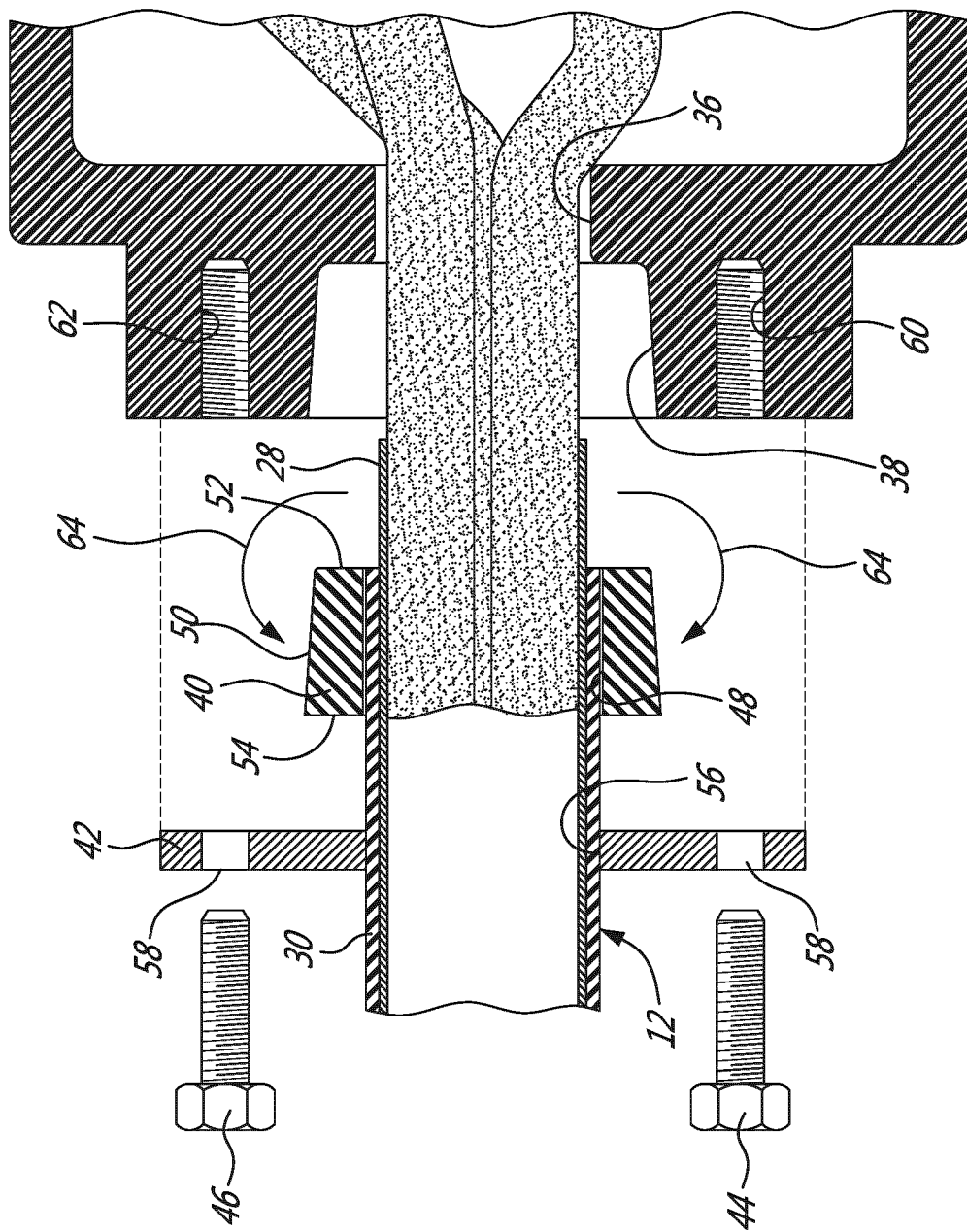
inserting the electrical cable in the cover aperture;

inserting the electrical cable in the grommet aperture;  
folding the shield of the electrical cable over a portion of the tapered peripheral of the grommet;  
inserting the grommet in the cavity, thereby creating an electrical connection between the shield and the casing;  
mounting the cover to the casing.

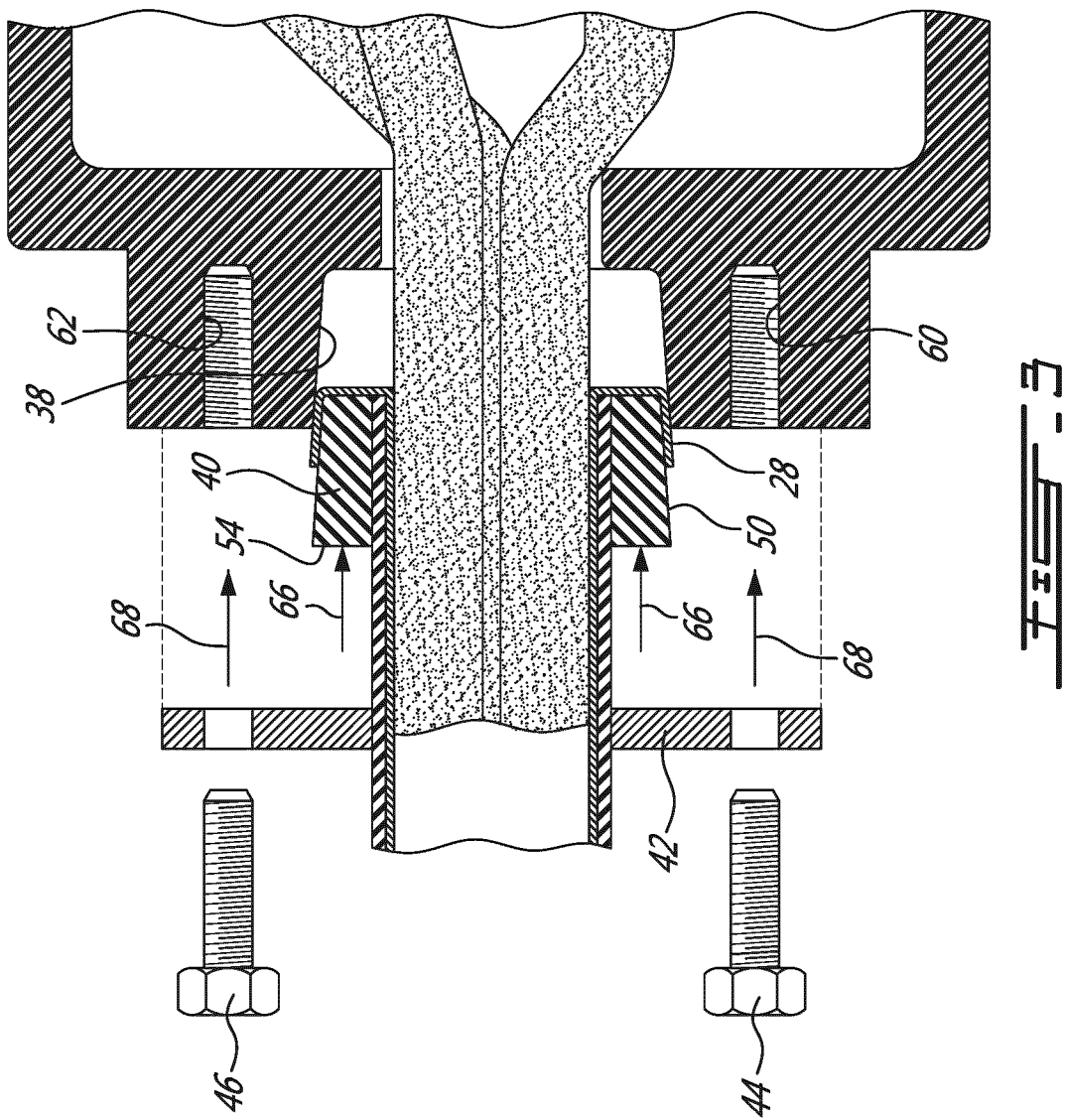
11. The method of claim 10, wherein the cover mounting is done via at least one fastener.

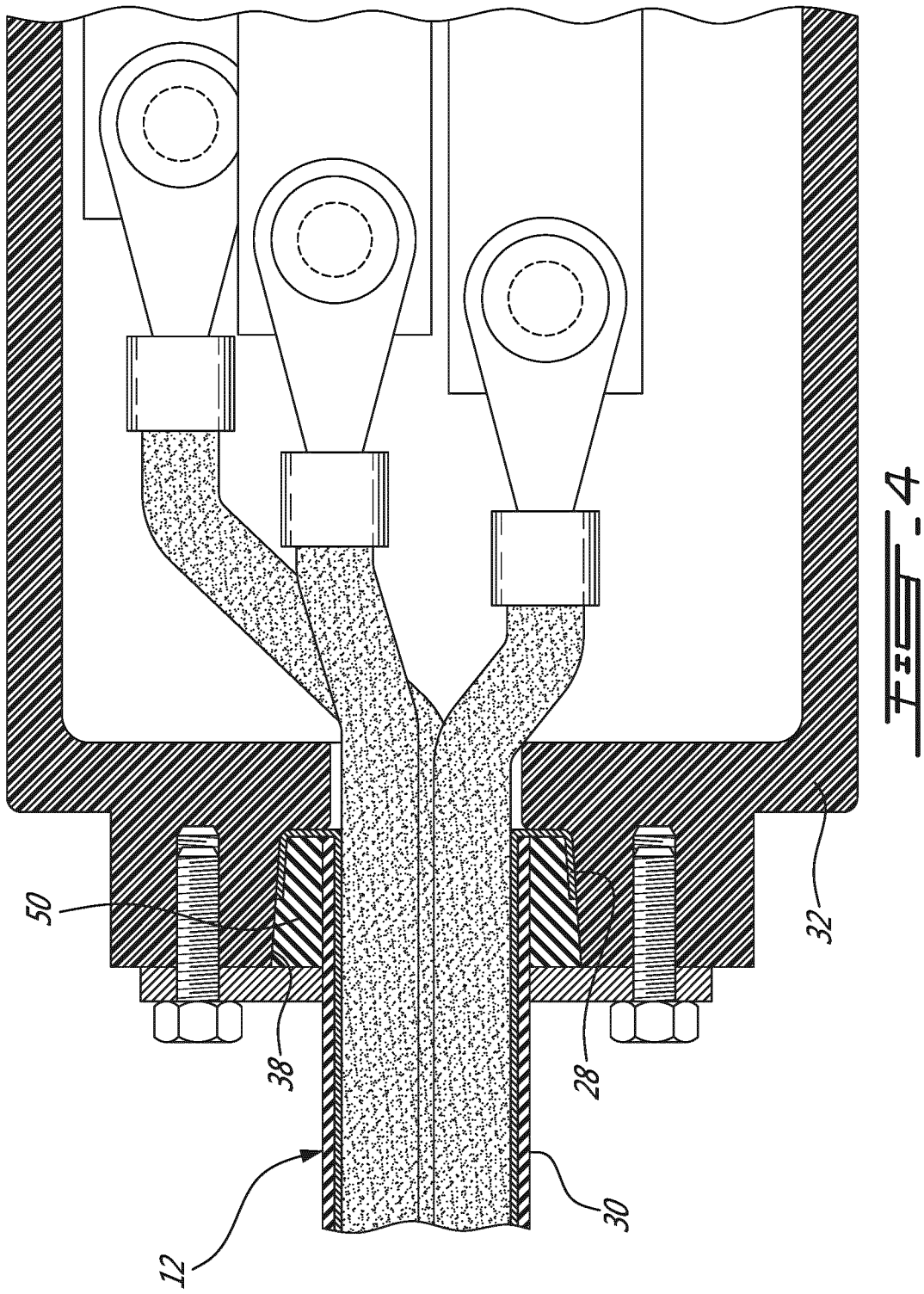
12. The method of claim 10, wherein the cover mounting is done via the deformation of a portion of the casing.

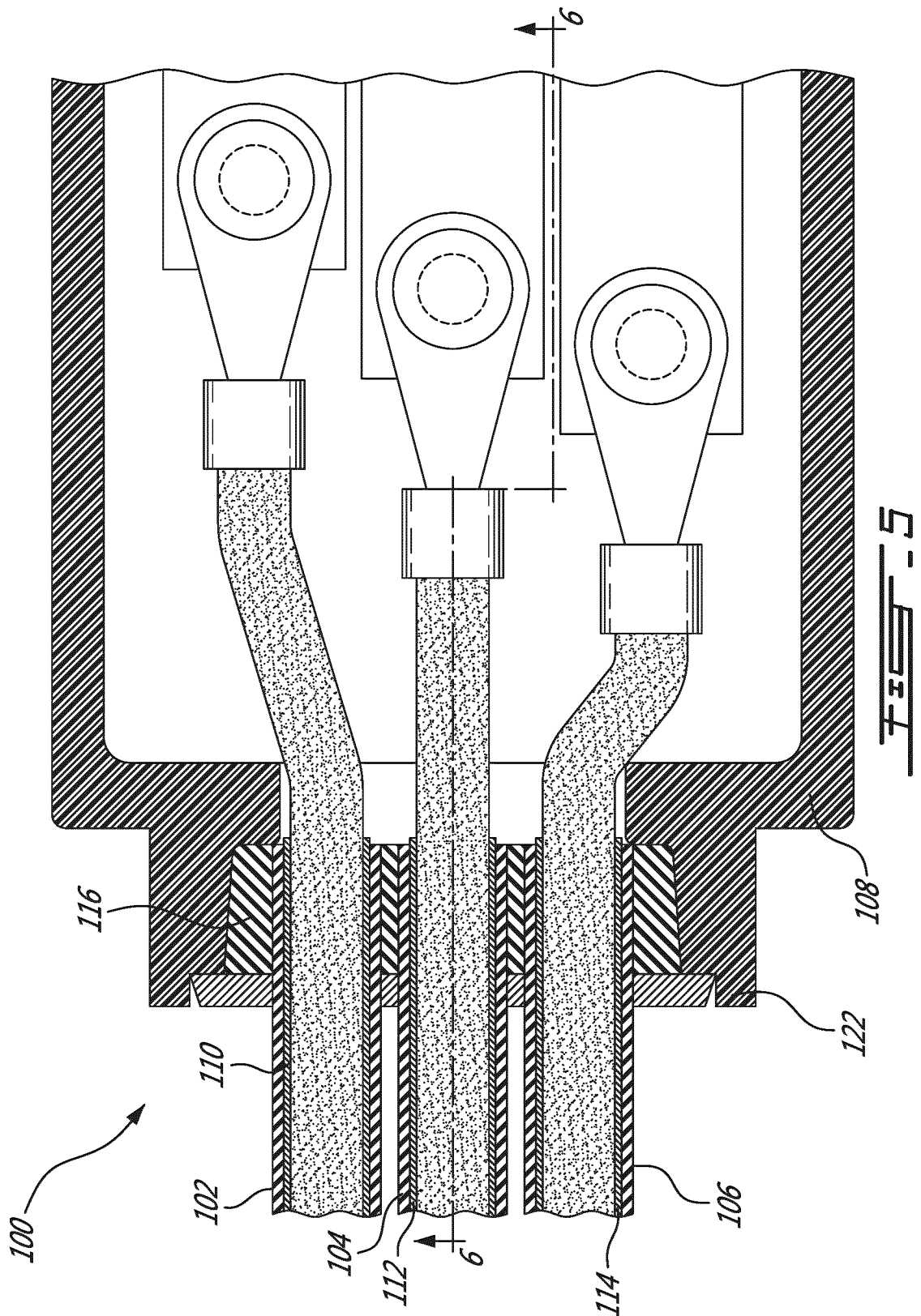


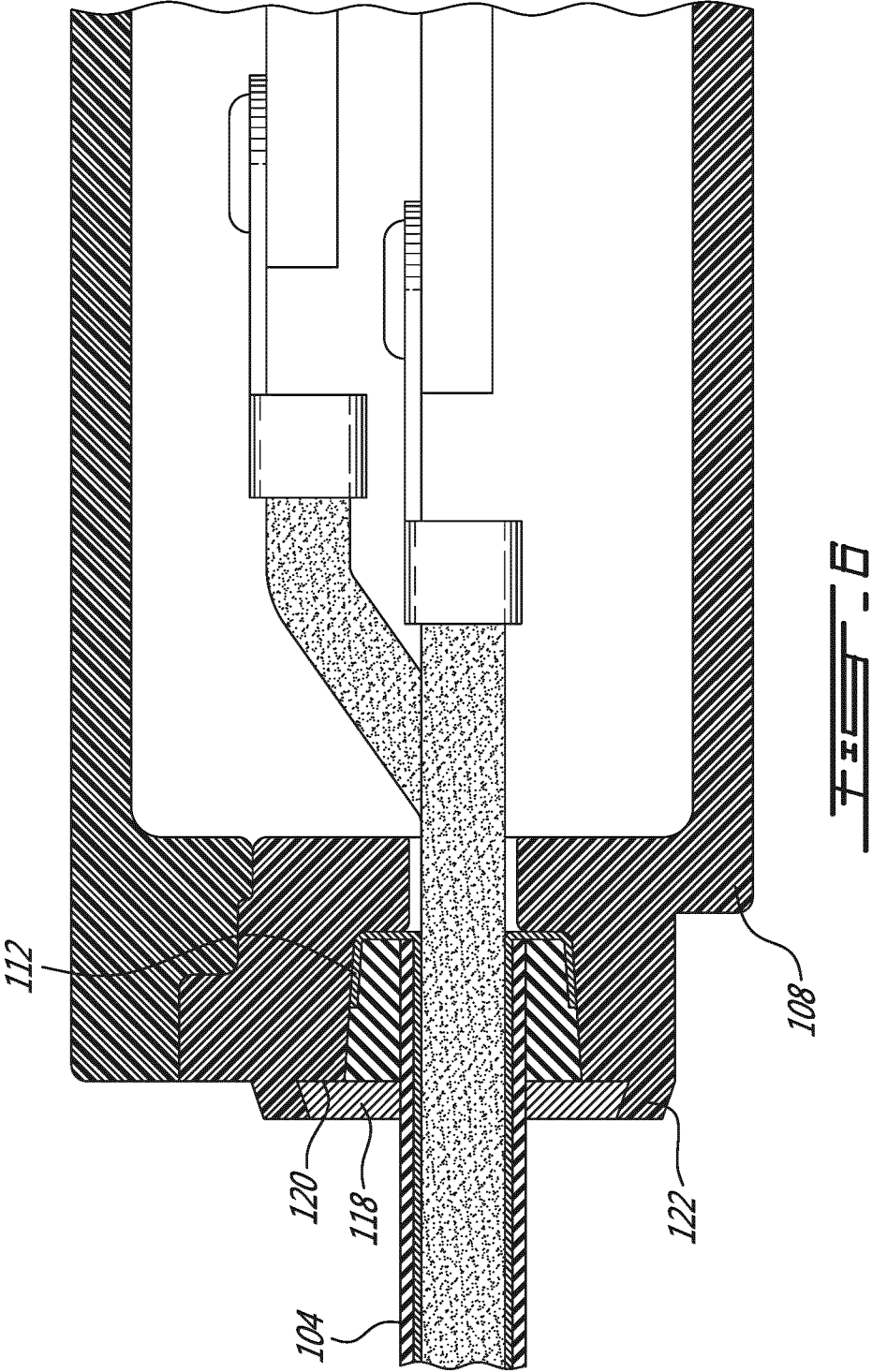


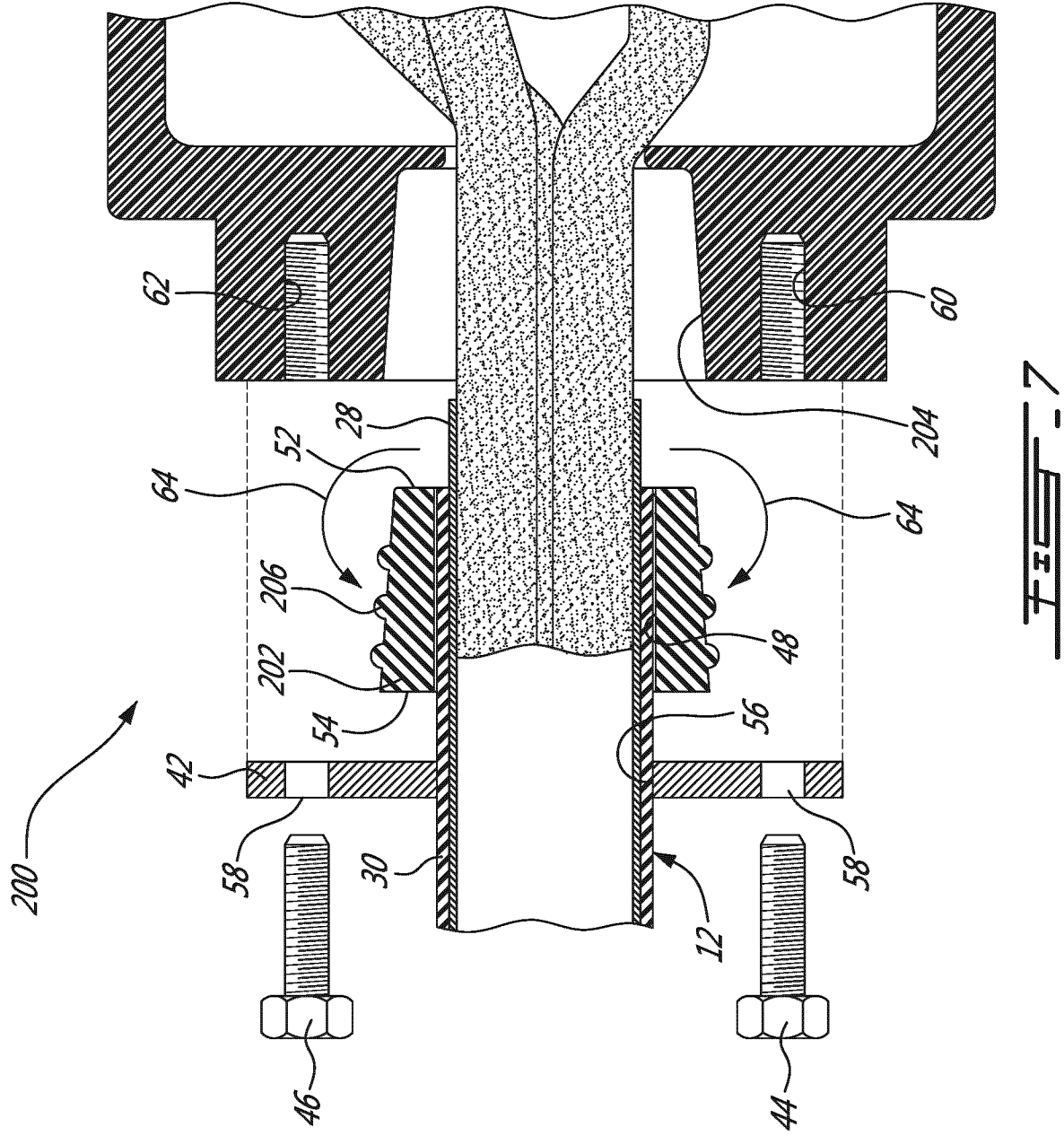
2-11-11











## INTERNATIONAL SEARCH REPORT

International application No.

**PCT/CA2016/050157**

## A. CLASSIFICATION OF SUBJECT MATTER

IPC: **H02G 3/18** (2006.01), **H01R 4/66** (2006.01), **H02G 3/14** (2006.01), **H05K 9/00** (2006.01)

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)

**H02G** (2006.01), **H01R** (2006.01), **H05K** (2006.01)

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

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

Questel Orbit (FAMPAT)

Keywords: electric, wire, cable, grommet, rubber, seal, waterproof, angle, slope, taper

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|------------------------------------------------------------------------------------|-----------------------|
| X         | WO2008141458A1, (CROTEAU et al.) 27 November 2008 (27-11-2008)                     | 1-6                   |
| Y         | EP1195856A2, (YASUDA et al.) 10 April 2002 (10-04-2002)                            | 6                     |
| A         | WO2014112146A1, (NAKAI, H.) 24 July 2014 (24-07-2014)                              | All                   |
| A         | US4674807A, (BOTELER et al.) 23 June 1987 (23-06-1987)                             | All                   |
| A         | US4490576A, (BOLANTE et al.) 25 December 1984 (25-12-1984)                         | All                   |

Further documents are listed in the continuation of Box C.

See patent family annex.

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| *<br>"A"<br>"E"<br>"L"<br>"O"<br>"P" | Special categories of cited documents:<br>document defining the general state of the art which is not considered to be of particular relevance<br>earlier application or patent but published on or after the international filing date<br>document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)<br>document referring to an oral disclosure, use, exhibition or other means<br>document published prior to the international filing date but later than the priority date claimed | "T"<br>"X"<br>"Y"<br>"&" | 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<br>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<br>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<br>document member of the same patent family |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Date of the actual completion of the international search  
07 April 2016 (07-04-2016)Date of mailing of the international search report  
07 April 2016 (07-04-2016)Name and mailing address of the ISA/CA  
Canadian Intellectual Property Office  
Place du Portage I, C114 - 1st Floor, Box PCT  
50 Victoria Street  
Gatineau, Quebec K1A 0C9  
Facsimile No.: 819-953-2476

Authorized officer

Heather Scott (819) 639-7898

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/CA2016/050157**

| Patent Document<br>Cited in Search Report | Publication<br>Date           | Patent Family<br>Member(s)                                                                                                                                                               | Publication<br>Date                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| WO2008141458A1                            | 27 November 2008 (27-11-2008) | WO2008141458A1<br>CA2684934A1<br>US2009130898A1<br>US7614910B2                                                                                                                           | 27 November 2008 (27-11-2008)<br>27 November 2008 (27-11-2008)<br>21 May 2009 (21-05-2009)<br>10 November 2009 (10-11-2009)                                                                                                                                                                                                                                           |
| EP1195856A2                               | 10 April 2002 (10-04-2002)    | EP1195856A2<br>EP1195856A3<br>EP1195856B1<br>CN1349282A<br>CN1258839C<br>DE60110015D1<br>DE60110015T2<br>ES2239651T3<br>JP2002117930A<br>KR20020027239A<br>US2002040802A1<br>US6787701B2 | 10 April 2002 (10-04-2002)<br>09 April 2003 (09-04-2003)<br>13 April 2005 (13-04-2005)<br>15 May 2002 (15-05-2002)<br>07 June 2006 (07-06-2006)<br>19 May 2005 (19-05-2005)<br>09 March 2006 (09-03-2006)<br>01 October 2005 (01-10-2005)<br>19 April 2002 (19-04-2002)<br>13 April 2002 (13-04-2002)<br>11 April 2002 (11-04-2002)<br>07 September 2004 (07-09-2004) |
| WO2014112146A1                            | 24 July 2014 (24-07-2014)     | WO2014112146A1<br>CN104937795A<br>JP2014138470A<br>US2015364856A1                                                                                                                        | 24 July 2014 (24-07-2014)<br>23 September 2015 (23-09-2015)<br>28 July 2014 (28-07-2014)<br>17 December 2015 (17-12-2015)                                                                                                                                                                                                                                             |
| US4674807A                                | 23 June 1987 (23-06-1987)     | US4674807A<br>CA1286743C                                                                                                                                                                 | 23 June 1987 (23-06-1987)<br>23 July 1991 (23-07-1991)                                                                                                                                                                                                                                                                                                                |
| US4490576A                                | 25 December 1984 (25-12-1984) | None                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                       |