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CLOSURE PLUG AND ELECTRICAL CONNECTOR SYSTEM

- (57) The present disclosure relates to a closure plug (10) for closing an empty, in particular substantially circular, cable receiving opening (22) of an electrical connector housing (21). The closure plug (10) comprises a polymer sealing element (11) for sealing the cable receiving opening (22) against dust and/or water, and a metal shielding element (13) for electromagnetically shielding the cable receiving opening (22). Moreover, the present disclosure relates to an electrical connector system (20) which comprises said at least one closure plug (10).

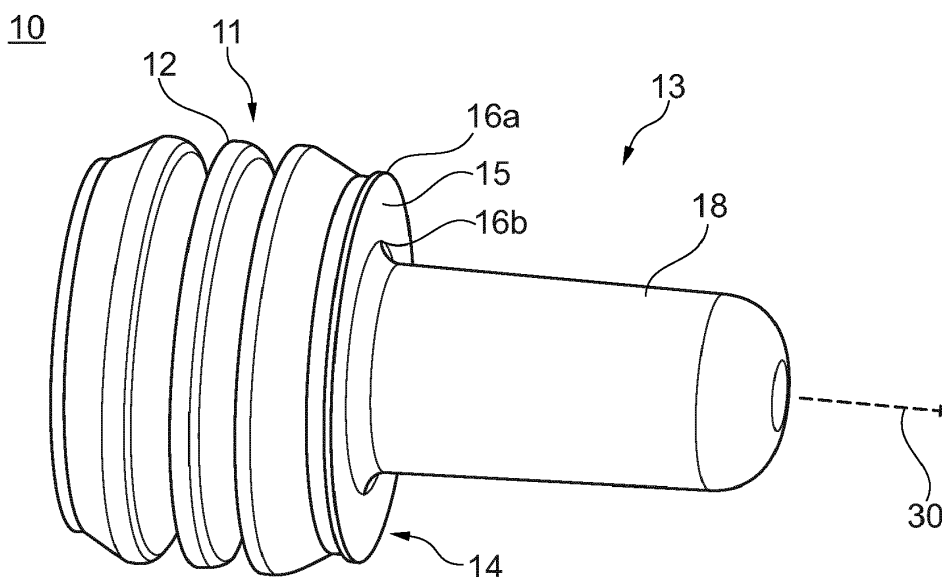


Fig. 1

Description

1. Technical field

[0001] The present disclosure relates to a closure plug for closing an empty cable receiving opening of an electrical connector housing and to an electrical connector system comprising said closure plug.

2. Prior art

[0002] It is generally known that electrical connector systems are subject to various requirements which depend on the particular application of the respective system.

[0003] For example, it often must be ensured that no dust and/or water can penetrate into a housing of an electrical connector system. Otherwise, malfunctions such as short circuits can result. In this respect, a specific problem arises if an electrical connector system comprises fewer cables or other conductors than are regularly provided for this system. Exemplarily, if four cable receiving openings are provided in a housing of an electrical connector system for receiving corresponding cables, but only three cables are used for the specific application. Consequently, this leaves one cable receiving opening empty which allows dust and/or water to enter the housing.

[0004] To address this problem, sealing plugs are currently used to close cable receiving openings which remain empty, i.e., without a cable or another conductor arranged therein. However, these sealing plugs regularly have disadvantages, some of which are described below.

[0005] Firstly, the known sealing plugs often have the disadvantage of becoming untight or even detaching from the corresponding cable receiving opening under mechanic and/or thermal load, e.g., when the electrical connector system experiences vibration and/or is heated.

[0006] Secondly, particularly in view of the ongoing electrification of the mobility sector, electrical connector systems are required to meet certain requirements relating to electromagnetic compatibility (EMC). For example, it must be ensured in a vehicle that a high-voltage connection is shielded in such a way that there is no negative interference with other electronic components of the vehicle. Known sealing plugs are regularly unable to meet this requirement. Particularly, empty cable receiving openings of a housing of an electrical connector system in which the sealing plugs are inserted result in the required levels of EMC not being achieved.

[0007] Thus, it is an object of the present disclosure to provide a closure plug for closing an empty cable receiving opening of an electrical connector housing and an electrical connector system comprising said closure plug that overcome the aforementioned drawbacks at least partially.

3. Summary of the invention

[0008] This object is achieved by a closure plug and an electrical connector system as defined in the independent claims. Further aspects of the present disclosure are defined in the dependent claims.

[0009] In particular, the object is achieved by a closure plug for closing an empty, in particular substantially circular, cable receiving opening of an electrical connector housing.

[0010] A cable receiving opening may be referred to as an opening in an electrical connector housing which is configured for receiving at least one cable. Hence, it is understood that an empty cable receiving opening may be referred to as an opening in an electrical connector housing in which no cable is arranged, i.e., received.

[0011] The closure plug comprises a polymer sealing element for sealing the cable receiving opening against dust and/or water, and a metal shielding element for electromagnetically shielding the cable receiving opening.

[0012] It is understood that the specific configuration of the closure plug may depend on the respective cable receiving opening. However, the skilled person may determine if a closure plug comprises a polymer sealing element and a metal shielding element, wherein the sealing element is able to seal an opening and the metal shielding element is able to electromagnetically shield this opening.

[0013] The polymer sealing element is preferably injection molded. Moreover, the polymer sealing element preferably comprises an outer circumferential surface which allows for sealing. It is understood that the sealing function of the polymer sealing element may be achieved in different ways. Exemplarily by means of a rib structure, as set out in further detail below, and/or a specific polymer mixture.

[0014] The metal shielding element is preferably made of a metal with an electric conductivity σ which is at least 3×10^6 S/m and further preferably at least 3×10^7 S/m. Particularly, the metal shielding element may be substantially made of iron, copper, aluminum, silver, gold, and/or a combination thereof.

[0015] The aspect of electromagnetically shielding may refer to the shielding element providing electromagnetic compatibility (EMC) for the cable receiving opening. Thereby EMC may be generally defined as the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. Hence, the metal shielding element may be configured such that it prevents electromagnetic disturbances to protrude through the closure plug, particularly along the direction in which the closure plug is insertable into the cable receiving opening.

[0016] The closure plug according to the present disclosure provides advantages over the prior art sealing plugs, wherein some of those advantages become apparent when studying the present disclosure.

[0017] Particularly, it has shown that the combination of the polymer sealing element and the metal shielding element allows for an improved durability of the closure plug according to the present invention compared to existing sealing plugs. One reason therefor may lie therein that the metal shielding element provides stability to the closure plug which avoids the closure plug to become untight or even detach from the cable receiving opening under mechanic and/or thermal load.

[0018] Moreover, the closure plug according to the present disclosure allows that for an empty cable receiving opening of a housing of an electrical connector system in which the closure plug is inserted an increased level of EMC can be achieved, particularly when compared to existing sealing plugs. Hence, it may be ensured in a vehicle that a high-voltage connection is shielded in such a way that there is no negative interference with other electronic components of the vehicle.

[0019] It is understood that the aforementioned advantages may also apply for the following in different expression.

[0020] Preferably, when the closure plug is linearly projected onto a plane being perpendicular to the direction in which the closure plug is insertable into the cable receiving opening then the projected shielding element represents at least 70 %, preferably at least 80 %, and further preferably at least 90 % of the projected total area. Exemplarily, the sealing element may be a substantially cylindrical element for being inserted into a substantially circular cable receiving opening and the shielding element may be a circular plate attached centrally to one of the base surfaces of the cylindrical element. Hence, if the centrally attached circular plate covers 95 % of said base surface, then the shape of the shielding element, i.e., the circular plate, represents 95 % of the projected total area, when said closure plug is linearly projected onto a plane being perpendicular to the direction in which the closure plug is insertable into the cable receiving opening. It is understood that in this case the projected total area is defined by the base surface of the substantially cylindrical element. It has shown that the above configuration allows for an electromagnetic shielding which is sufficient for a variety of applications, while the mentioned at least 90 % are particularly preferable.

[0021] Further, the shielding element may comprise an abutment portion for circumferentially contacting the cable receiving opening, wherein the abutment portion preferably has a substantially circular outer circumference. A circumferential contact may be defined in that a closed contact line between the abutment portion and the cable receiving opening exists. It has been shown that a shielding element having an abutment portion which circumferentially contacts the cable receiving opening is particularly advantageous in that the electromagnetic shielding provided by the shielding element can be further enhanced, particularly compared to the case where no circumferential contact can be established. Thus, EMC is further improved. It is understood that different configurations

of said abutment portion are conceivable. Exemplarily, the abutment portion may have an outer circumferential edge being configured for a line contact with a respective cable receiving opening. A further example is set out in the following.

[0022] An end of the sealing element relative to the direction in which the closure plug is insertable into the cable receiving opening maybe adjacent to the abutment portion. Hence, a compact design of the closure plug may be achieved. Moreover, the abutment portion may be supported by the sealing element, e.g., against bending.

[0023] The abutment portion may comprise an abutment surface with a circular outer circumference and a circular inner circumference, wherein the abutment surface preferably faces in the direction in which the closure plug is insertable into the cable receiving opening. Generally said abutment surface allows that an areal contact of the abutment portion with a respective counter abutment portion may be achieved. This was found to further enhance the electromagnetic shielding provided by the shielding element. Thus, EMC is further improved. Moreover, by the abutment surface facing in the direction in which the closure plug is insertable into the cable receiving opening the insertion depth of the closure plug may be defined by the abutment surface. This can enhance a precise positioning of the closure plug inside a respective cable receiving opening.

[0024] Particularly, the abutment surface may be inclined relative to the direction in which the closure plug is insertable into the cable receiving opening by an angle which lies in the range from 30° to 90°, preferably from 60° to 90°, and further preferably from 80° to 90°. These angles allow to further enhance the electromagnetic shielding provided by the shielding element and for a particularly precise positioning of the closure plug inside a respective cable receiving opening.

[0025] The shielding element may comprise a connecting portion being overmolded by the sealing element, wherein the connecting portion preferably comprises at least one through hole which form-fittingly engages with the sealing element. By said overmolded connecting portion and particularly said at least one through hole a reliable connection between the shielding element and the sealing element can be achieved. It is understood that the form-fitting engagement of the at least one through hole with the sealing element may be achieved by a portion of the sealing element protruding through the at least one through hole.

[0026] Furthermore, the shielding element may comprise a pin that protrudes from the closure plug along the direction in which the closure plug is insertable into the cable receiving opening, wherein preferably the pin, the abutment portion, and the connecting portion are integrally formed, wherein further preferably the pin is a stamped blind tube. The pin preferably has a substantially circular cross-section relative to the direction in which the closure plug is insertable into the cable receiving opening. Exemplarily, the pin may comprise a cylindrical

dricial shape and/or a hollow cylindrical shape. Moreover, the pin may be arranged adjacent to the abutment portion and in particular to the abutment surface. The pin may serve to stabilize and/or guide the closure plug with respect to the cable receiving opening. Further, it may provide a larger contact surface for contacting the cable receiving opening. This may further increase the electromagnetic shielding provided by the closure plug. Moreover, by the pin, the abutment portion, and the connecting portion being integrally formed, e.g., from a bent sheet metal, a simple manufacturing of the closure plug may be achieved. Particularly if the pin is a stamped blind tube.

[0027] The shielding element may comprise at least one latching means for engaging with a respective counter latching means formed inside the cable receiving opening, wherein the shielding element preferably comprises two latching means. Exemplarily, the at least one latching means may comprise a resilient latching arm. Further, the at least one latching means may be configured to engage with a recess formed inside the cable receiving opening. The at least one latching means may reliably hold the closure plug in position. Hence, the latching means may at least partially avoid that the closure plug becomes untight or even detaches from the corresponding cable receiving opening under mechanic and/or thermal load, e.g., when the electrical connector system experiences vibration and/or is heated.

[0028] The pin may protrude from inside of the circular inner circumference. Thus, if the cable receiving opening has a smaller section corresponding to the dimensions of the pin, the pin may guide the abutment surface towards a respective counter abutment portion and hold it in position.

[0029] Alternatively, the at least one latching means may protrude from inside of the circular inner circumference. This arrangement has proven to be particularly compact what can be advantageous for short cable receiving openings.

[0030] The sealing element may comprise ribs on an outer circumferential surface, wherein the ribs preferably extend substantially perpendicular to the direction in which the closure plug is insertable into the cable receiving opening. By this configuration the sealing properties of the sealing element and the seat of the closure plug within a cable receiving opening can be improved.

[0031] The sealing element preferably comprises silicone and/or rubber. Further preferably, the sealing element substantially consists of silicone and/or rubber. These materials have proven to be particularly advantageous with regards to a sufficient sealing in combination with a metal shielding element. Nevertheless, other polymer materials such as a variety of thermoset materials and/or thermoplastic material are also conceivable.

[0032] Further, the above object is particularly achieved by an electrical connector system comprising an electrical connector housing, wherein at least one, in particular substantially circular, cable receiving opening is formed into the electrical connector housing. The elec-

trical connector system further comprises at least one closure plug as described in the present disclosure, wherein preferably the closure plug is arranged in the cable receiving opening and thereby closes the cable receiving opening. Since the electrical connector system comprises the closure plug, as described herein, it is understood that features and/or advantages described with respect to the closure plug may at least partially also apply for the electrical connector system. Further, it is understood that a plurality of cable receiving openings may be formed into the electrical connector housing, wherein in some of these cable receiving openings cables may be arranged respectively.

[0033] The electrical connector housing preferably substantially consists of a metal, wherein further preferably the electrical connector housing substantially consists of aluminum. Particularly, the electrical connector housing preferably substantially consists of a metal with an electric conductivity σ which is at least 3×10^6 S/m and further preferably at least 3×10^7 S/m. Moreover, the electrical connector housing may substantially consist of iron, copper, aluminum, silver, gold, and/or a combination thereof. By the metal shielding element of the closure plug together with the electrical connector housing which substantially consists of a metal a particularly high level of electromagnetic shielding of the electrical connector system can be achieved. Thus, the EMC of the electrical connector system can be further improved.

[0034] As also mentioned above, the shielding element may comprise an abutment portion, wherein the cable receiving opening comprises a counter abutment portion that circumferentially contacts the abutment portion. Preferably the abutment portion comprises an abutment surface with a circular outer circumference and a circular inner circumference, wherein the abutment surface is in areal contact with the counter abutment portion. The advantages and/or features mentioned above with regards to the closure plug may apply.

4. Brief description of the accompanying figures

[0035] In the following, the accompanying figures are briefly described:

Fig. 1 shows a closure plug according to a first embodiment of the present invention in perspective view;

Fig. 2 shows the closure plug according to the first embodiment in cut view;

Fig. 3 shows the shielding element of the closure plug according to the first embodiment in perspective view;

Fig. 4 shows the shielding element of the closure plug according to the first embodiment in perspective view before its manufacturing is finished;

Fig. 5 shows a closure plug according to a second embodiment of the present invention in perspective view;

Fig. 6 shows the closure plug according to the second embodiment in cut view;

Fig. 7 shows the shielding element of the closure plug according to the second embodiment in perspective view;

Fig. 8 shows an electrical connector system according to the present invention in perspective view, wherein the closure plug is hidden;

Fig. 9 shows the electrical connector system according to the present invention with the closure plug according to the first embodiment in perspective view, and

Fig. 10 shows the electrical connector system according to the present invention with the closure plug according to the second embodiment in perspective view.

5. Detailed description of the figures

[0036] Figs. 1 to 4 show a closure plug or parts thereof according to a first embodiment of the present invention.

[0037] Fig. 1 shows a closure plug 10 for closing an empty, in particular substantially circular, cable receiving opening 22 of an electrical connector housing 21. The closure plug 10 comprises a polymer sealing element 11 for sealing the cable receiving opening 22 against dust and/or water. Further, the closure plug 10 comprises a metal shielding element 13 for electromagnetically shielding the cable receiving opening 22.

[0038] As in Fig. 1 and Fig. 2, when the closure plug 10 is linearly projected onto a plane being perpendicular to the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22 then the projected shielding element 13 represents at least 90 % of the projected total area.

[0039] Further, as shown in Fig. 1 and Fig. 2 the shielding element 13 comprises an abutment portion 14 for circumferentially contacting the cable receiving opening 22, wherein the abutment portion 14 has a substantially circular outer circumference. An end of the sealing element 11 relative to the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22 is adjacent to said abutment portion 14. Moreover, the abutment portion 14 comprises an abutment surface 15 with a circular outer circumference 16a and a circular inner circumference 16b, wherein the abutment surface 15 faces in the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22. Particularly, the abutment surface 15 is inclined relative to the direction 30 in which the closure plug 10 is insertable into

the cable receiving opening 22 by an angle of 90°.

[0040] Even further, as also shown in Fig. 1 and Fig. 2 the sealing element 11 comprises ribs 12 on an outer circumferential surface, wherein the ribs 12 extend substantially perpendicular to the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22.

[0041] Furthermore, as shown in Fig. 2 and Fig. 3, the shielding element 13 comprises a connecting portion 17 being overmolded by the sealing element 11, wherein the connecting portion 17 comprises six through holes which form-fittingly engage with the sealing element 11.

[0042] The Figs. 1 to 4 illustrate that the shielding element 13 of the closure plug according to the first embodiment comprises a pin 18 that protrudes from the closure plug 10 along the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22. Moreover, as will be particularly understood from Fig. 4, said pin 18, the abutment portion 14, and the connecting portion 17 are integrally formed from a bent sheet metal. Moreover, the pin 18 is a stamped blind tube. Further, the pin 18 protrudes from inside of the circular inner circumference 16b.

[0043] Figs. 5 to 7 show a closure plug or parts thereof according to a second embodiment of the present invention, which essentially corresponds to that of the first embodiment. In the following, therefore, only the differences will be discussed, and identical and functionally identical parts are provided with the same reference signs.

[0044] Figs. 5 to 7 show that the shielding element 13 comprises two latching means 19a, 19b for engaging with a respective counter latching means 24 formed inside the cable receiving opening 22. In particular, the latching means 19a, 19b are latching arms being configured to engage with a counter latching means 24 being a recess. The latching means 19a, 19b protrude from inside of the circular inner circumference 16b. Particularly, the latching means 19a, 19b protrude along the direction 30 in which the closure plug 10 is insertable into the cable receiving opening 22 and radially outward relative to said direction 30.

[0045] Figs. 8 to 10 show an electrical connector system 20 according to the present invention. As depicted, the electrical connector system 20 comprises an electrical connector housing 21, wherein at least one substantially circular cable receiving opening 22 is formed into the electrical connector housing 21. It is understood that in Figs. 8 to 10 the upper half of the electrical connector housing 21 is hidden. Moreover, it is understood that the electrical connector housing 21 comprises a further circular cable receiving opening in which a cable 25 is arranged with a respective circular sealing element. Even though not explicitly derivable from the Figs. 8 to 10 the electrical connector housing 21 substantially consists of cast aluminum.

[0046] As shown in Fig. 9 and Fig. 10, the electrical connector system 20 further comprises the closure plug 10 according to the first embodiment (cf. Fig. 9) or ac-

cording to the second embodiment (cf. Fig. 10). In Fig. 9 and Fig. 10 the closure plug 10 is arranged in the cable receiving opening 22 and thereby closes the cable receiving opening 22.

[0047] Further, as already mentioned above and as shown in Fig. 9 and Fig. 10, the shielding element 13 comprises an abutment portion 14. Moreover, the cable receiving opening 22 comprises a counter abutment portion 23 that circumferentially contacts the abutment portion 14. Particularly, the abutment portion 14 comprises an abutment surface 15 with a circular outer circumference 16a and a circular inner circumference 16b (cf. Figs. 1 and 5). Said abutment surface 15 is in areal contact with the counter abutment portion 14.

List of reference signs

[0048]

10	closure plug	
11	polymer sealing element	
12	ribs	
13	metal shielding element	
14	abutment portion	
15	abutment surface	
16a	circular outer circumference of the abutment surface	
16b	circular inner circumference of the abutment surface	
17	connecting portion	
18	pin	
19a	first latching means	
19b	second latching means	
20	electrical connector system	
21	electrical connector housing	
22	cable receiving opening	
23	counter abutment portion	
24	counter latching means	
25	electric cable	
30	direction in which the closure plug is insertable into the cable receiving opening	

Claims

1. A closure plug (10) for closing an empty, in particular substantially circular, cable receiving opening (22) of an electrical connector housing (21), wherein the closure plug (10) comprises
 - a polymer sealing element (11) for sealing the cable receiving opening (22) against dust and/or water, and
 - a metal shielding element (13) for electromagnetically shielding the cable receiving opening (22).

2. The closure plug (10) according to the preceding

claim, wherein when the closure plug (10) is linearly projected onto a plane being perpendicular to the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22) then the projected shielding element (13) represents at least 70 %, preferably at least 80 %, and further preferably at least 90 % of the projected total area.

3. The closure plug (10) according to any one of the preceding claims, wherein the shielding element (13) comprises an abutment portion (14) for circumferentially contacting the cable receiving opening (22), wherein the abutment portion (14) preferably has a substantially circular outer circumference.

4. The closure plug (10) according to the preceding claim, wherein an end of the sealing element (11) relative to the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22) is adjacent to the abutment portion (14).

5. The closure plug (10) according to any one of claims 3 or 4, wherein the abutment portion (14) comprises an abutment surface (15) with a circular outer circumference (16a) and a circular inner circumference (16b), wherein the abutment surface (15) preferably faces in the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22).

6. The closure plug (10) according to the preceding claim, wherein the abutment surface (15) is inclined relative to the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22) by an angle which lies in the range from 30° to 90°, preferably from 60° to 90°, and further preferably from 80° to 90°.

7. The closure plug (10) according to any one of the preceding claims, wherein the shielding element (13) comprises a connecting portion (17) being overmolded by the sealing element (11), wherein the connecting portion (17) preferably comprises at least one through hole which form-fittingly engages with the sealing element (11).

8. The closure plug (10) according to any one of the preceding claims, wherein the shielding element (13) comprises
 - a pin (18) that protrudes from the closure plug (10) along the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22), wherein preferably the pin (18), the abutment portion (14), and the connecting portion (17) are integrally formed, wherein further preferably the pin (18) is a stamped blind tube.

9. The closure plug (10) according to any one of the

preceding claims, wherein the shielding element (13) comprises
 at least one latching means (19a, 19b) for engaging with a respective counter latching means (24) formed inside the cable receiving opening (22), wherein the shielding element (13) preferably comprises two latching means (19a, 19b).

with the counter abutment portion (14).

10. The closure plug (10) according to any one of claims 6 or 7, wherein

the pin (18) according to claim 8 protrudes from inside of the circular inner circumference (16b), or wherein

the at least one latching means (19a, 19b) according to claim 9 protrudes from inside of the circular inner circumference (16b).

11. The closure plug (10) according to any one of the preceding claims, wherein the sealing element (11) comprises ribs (12) on an outer circumferential surface, wherein the ribs (12) preferably extend substantially perpendicular to the direction (30) in which the closure plug (10) is insertable into the cable receiving opening (22).

12. The closure plug (10) according to any one of the preceding claims, wherein the sealing element (11) comprises silicone and/or rubber.

13. An electrical connector system (20) comprising

an electrical connector housing (21), wherein at least one, in particular substantially circular, cable receiving opening (22) is formed into the electrical connector housing (21), and

at least one closure plug (10) according to any one of the preceding claims, wherein preferably the closure plug (10) is arranged in the cable receiving opening (22) and thereby closes the cable receiving opening (22).

14. The electrical connector system (20) according to the preceding claim, wherein the electrical connector housing (21) substantially consists of a metal, wherein preferably the electrical connector housing (21) substantially consists of aluminum.

15. The electrical connector system according to any one of the preceding claims, wherein the shielding element (13) comprises an abutment portion (14), wherein the cable receiving opening (22) comprises a counter abutment portion (23) that circumferentially contacts the abutment portion (14), wherein preferably the abutment portion (14) comprises an abutment surface (15) with a circular outer circumference (16a) and a circular inner circumference (16b), and wherein the abutment surface (15) is in areal contact

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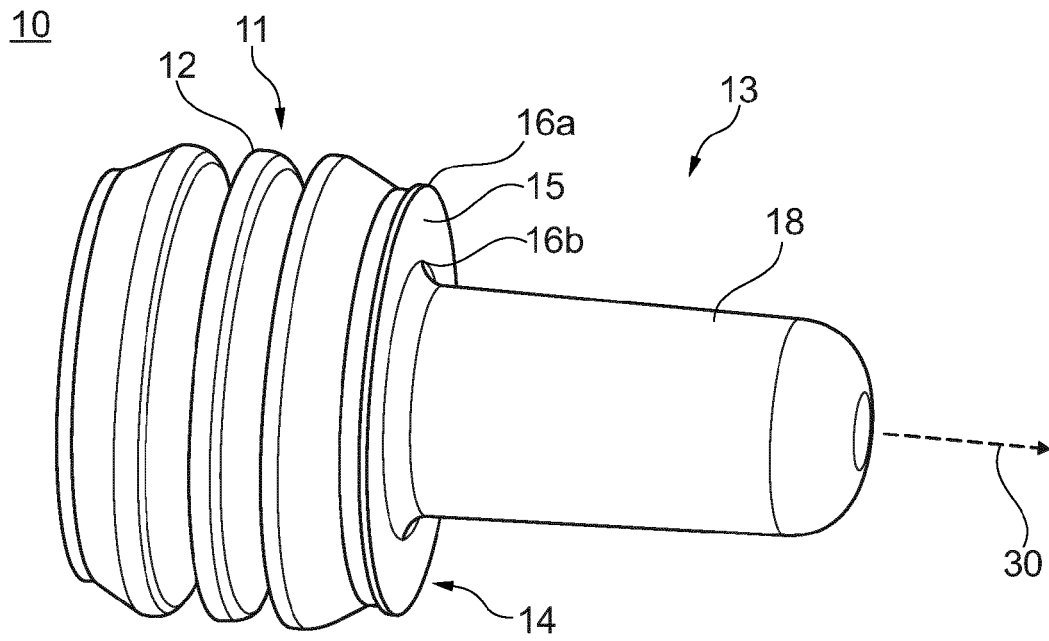


Fig. 1

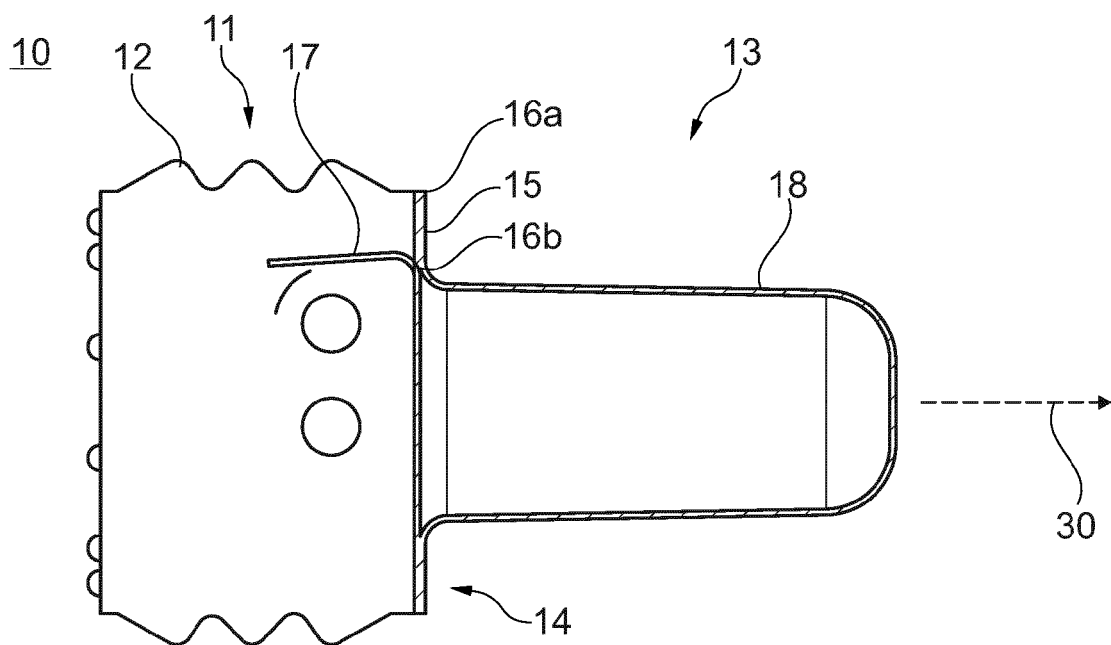


Fig. 2

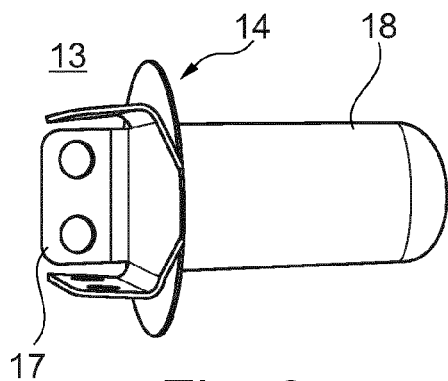


Fig. 3

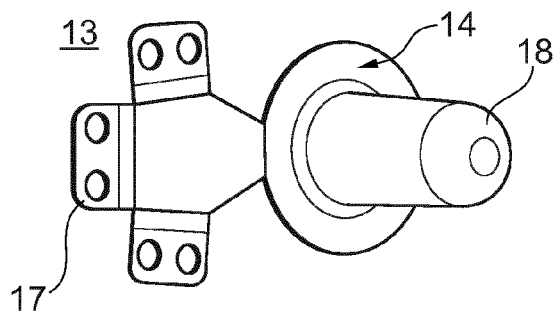


Fig. 4

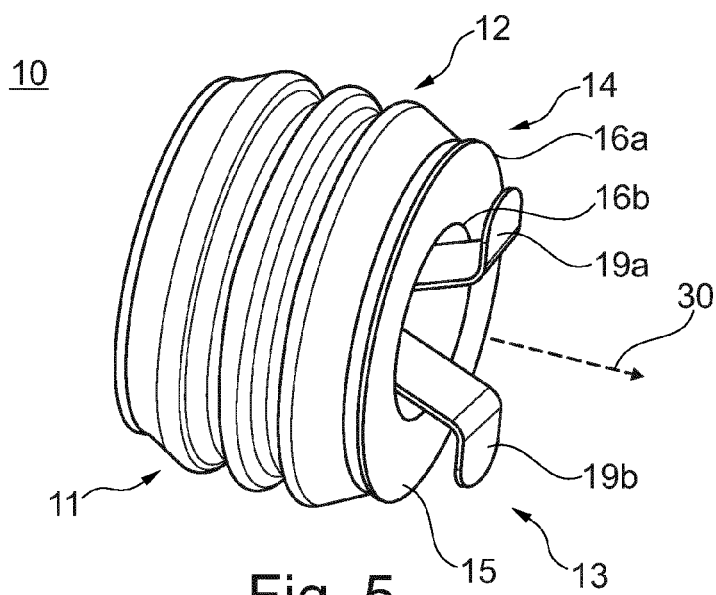


Fig. 5

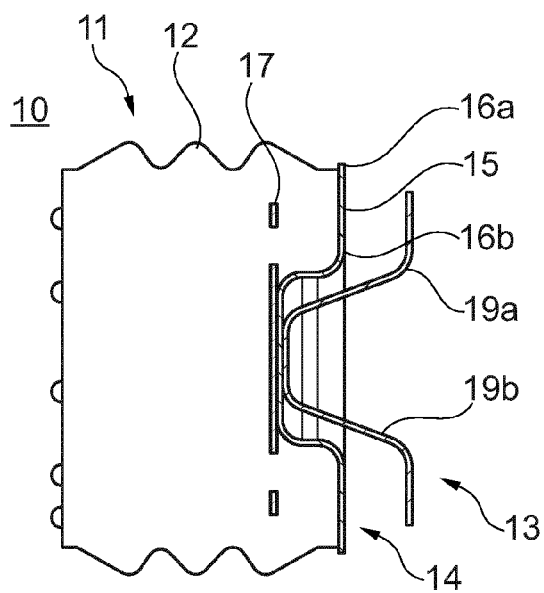


Fig. 6

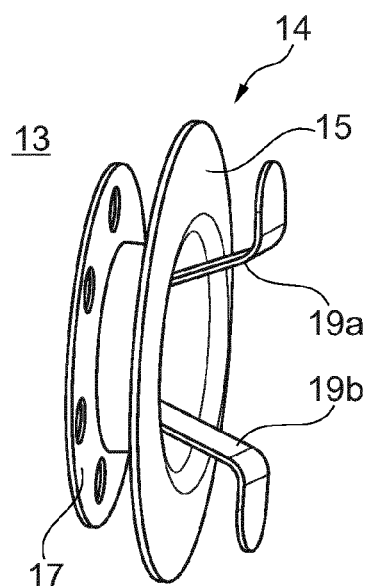
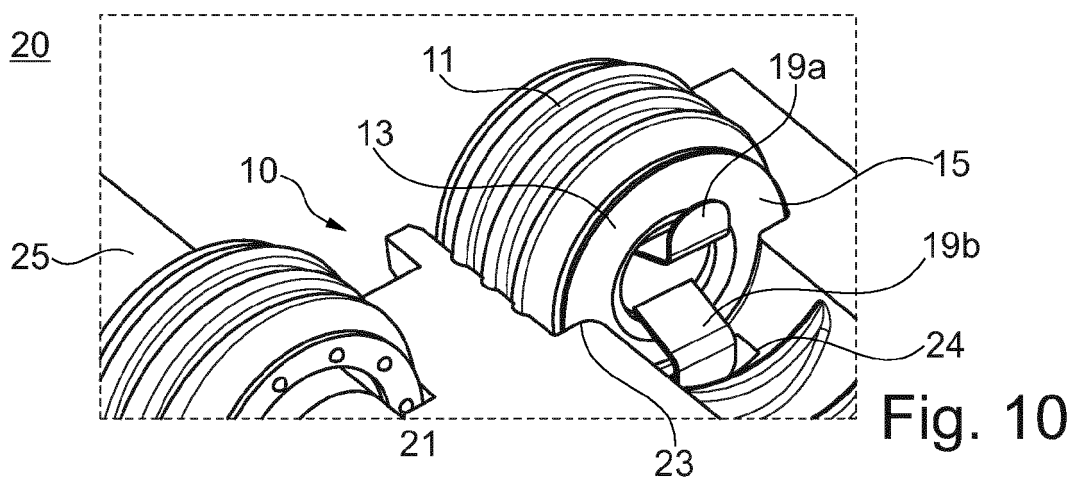
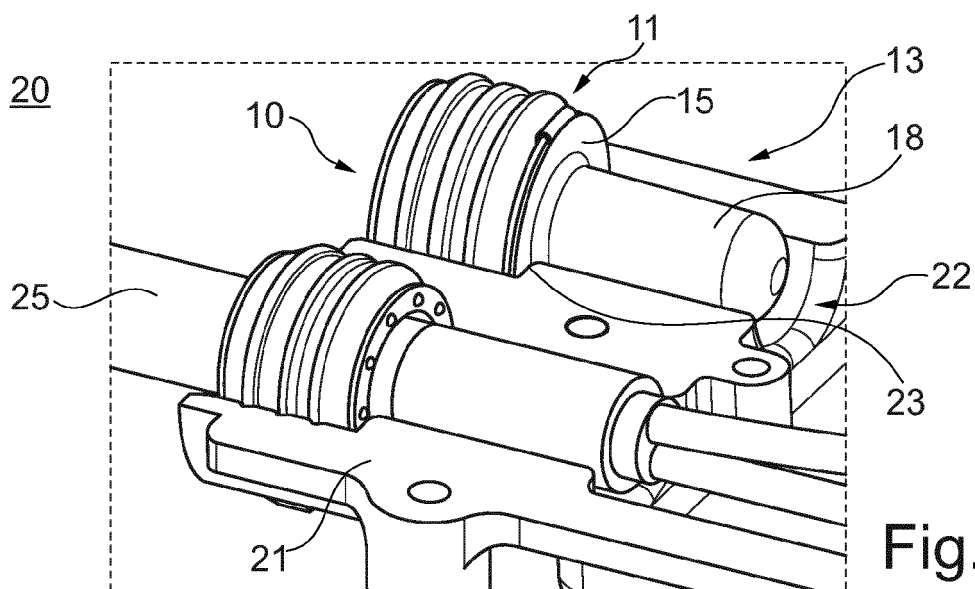
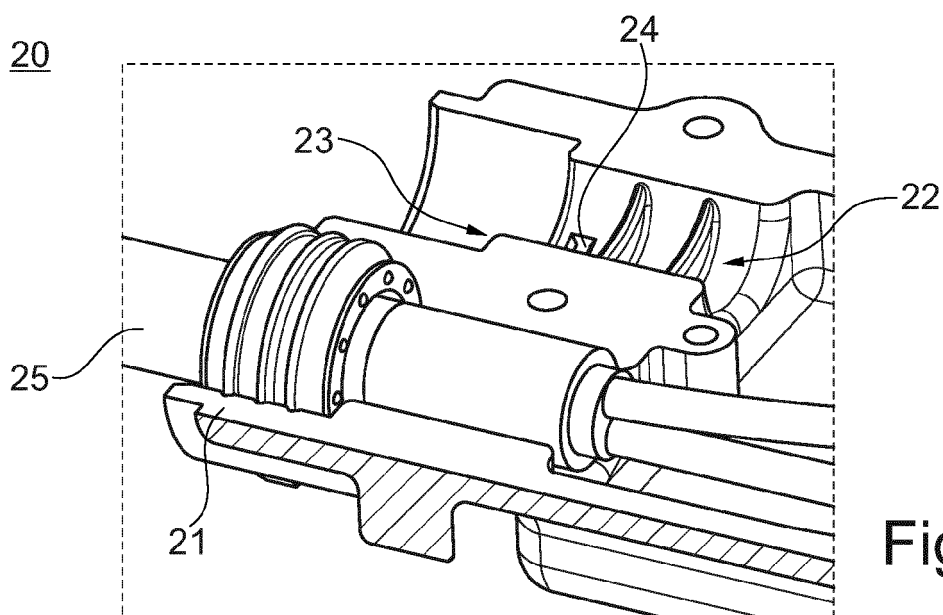


Fig. 7





EUROPEAN SEARCH REPORT

Application Number

EP 23 16 8858

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
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Y	* the whole document *	9, 11, 12	H01R13/52 H01R13/6581
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			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 September 2023	Examiner Henrich, Jean-Pascal
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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