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(54) Electrical connector

(57) The present invention relates to an electrical connector (1) with an electrical contact element (2) that is fixed to an electrically insulating body (3), wherein the body is covered with an electrically conducting layer (4), wherein on an outer face (19) of a connecting section (5) of the body (3) a first recess (15) is arranged, wherein an interface element (7) is arranged at least partly in the first recess (15), wherein a second recess (16) is formed at an outer surface of the interface element (7), wherein the second recess (16) is provided for at least partly receiving and fixing an element, which may be a retainer ring (8) or a sensor element (41).

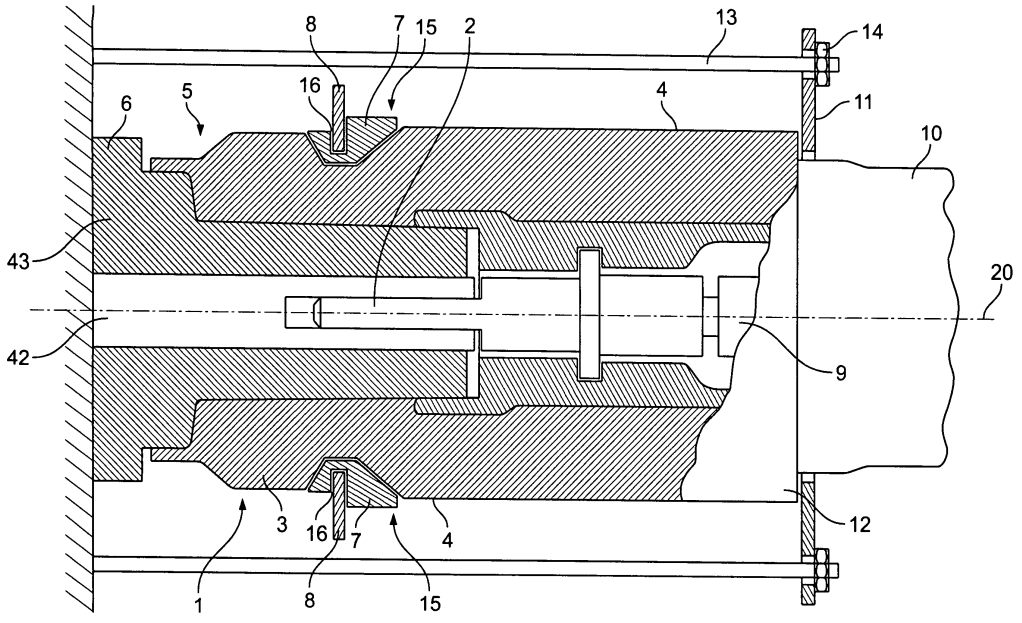

Fig. 1

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Description

[0001] The present invention generally relates to an electrical connector with an interface element that is embodied to receive a retainer ring.

[0002] It is known from the state of the art to provide an electrical connector with a contact element that is arranged in a body. The body is often made of EPDM material. The body is covered by a thick wall representing a conductive layer. The thick wall comprises at an outer face a groove that receives a retainer ring.

[0003] An object of the invention is to provide an electrical connector that can be produced in a cost-efficient and simple manner.

[0004] The object of the invention is achieved by the electrical connector of claim 1.

[0005] Further embodiments of the invention are disclosed in the dependent claims.

[0006] The proposed electrical connector can be produced in a simple manner with low costs.

[0007] The simple production is attained by coating the insulating body with an electrically conducting layer. The layer can be easily damaged by fixing an element for example a the retainer ring or a sensor element to the layer or by any relative movement between the element and the insulating body due to usage of the connector, e.g. by heating up and cooling down due to varying electrical load or environmental temperature.

[0008] Therefore, an interface element is provided that is arranged between the element and the layer. The interface element protects the layer. Therefore, the element can be fixed to the connector without damaging the layer.

[0009] The replacement of the thick conducting wall by the coated thin conducting layer reduces the costs and simplifies the production process. The interface element provides a simple and secure fixing of the element without damaging the damageable conducting layer.

[0010] In a further embodiment, the element is a retainer ring or a sensor element. The proposed structure assists the fixing of a retainer ring or a sensor element to the connector.

[0011] In a further embodiment the first recess is of a partial circular shape or of a circular shape. The partial circular shape or the circular shape provides a secure form-fit or force-fit fixing of the interface element.

[0012] In a further embodiment the interface element is of partial circular shape or of a circular shape. The partial circular shape or the circular shape provides a secure form-fit or force-fit fixing of an element with a partial circular shape or with a circular shape.

[0013] In a further embodiment the second recess is of a partial circular shape or of a circular shape. The partial circular shape improves the fixing of an element with a partial circular shape. The circular shape improves the fixing of an element with a circular shape.

[0014] In a further embodiment, the layer is made of a sprayed layer. Spraying the layer simplifies the production process and reduces the costs. The sprayed layer provides a sufficient conductivity.

[0015] In a further embodiment, the layer has a thickness that is smaller than 0.3 mm, preferably smaller than 0.1 mm. This thickness is sufficient for providing the necessary electric conductivity for electrical grounding of the connector. The electrical grounding is necessary for a high-voltage and/or a high-current application of the connector.

[0016] In a further embodiment, the interface element is embodied as an open ring that can be flexibly bent to a larger radius by mounting the interface element onto the connector or to a smaller radius for mounting the interface element on the retainer ring. Furthermore, the shape of an open ring can be produced in an easy and cost-efficient manner. Furthermore, the open-ring structure provides a secure fixing of the interface element to the connector and to the retainer ring.

[0017] In a further embodiment, the recess for receiving the interface element is formed in a partly-circular cross-section along a longitudinal axis of the connecting section. The partly-circular cross-section provides a simple mounting of the interface element and a sufficient fixing of the interface element and the retainer ring.

[0018] In a further embodiment, the recess comprises a cross-section with at least one protrusion and at least one lug for receiving a radial inner face of the interface element. The arrangement of the at least one protrusion and at least one lug improves the fixing of the interface element from moving or pulling off the interface element from the electrical connector.

[0019] In a further embodiment, the body is made of a mold material, e. g. comprising silicone or EPDM or TPE. The production of the body by using a mold material is cost-efficient and can be combined with the low-cost process of spraying the conducting layer on the body. Therefore, the production of the connector is simplified and can be performed at low costs.

[0020] In a further embodiment, the interface element is made of a flexible material, e. g. with a Shore hardness of A20 or higher.

[0021] In a further embodiment, the interface element is made of a rigid material, e. g. thermoplastics. Also, a rigid material can be used for the interface element because it is still sufficiently soft for mounting the interface element to the connector without damaging the conducting layer. The interface element could also be made of an elastomeric material with a Shore hardness above A40. The interface element could also be made of an elastomeric material with reinforcement by e.g. metal insert elements.

[0022] In a further embodiment, the interface element is made of electrically-conducting material. Therefore, the retainer ring that may be made of electrically-conducting material is also electrically connected to the electrically conducting layer.

[0023] In a further embodiment, the interface element comprises a flexible section. The flexible section im-

proves the flexibility of the interface element. Other parts of the interface element may be made of stiffer material. The stiffer material may increase the fixing forces that hold the retainer ring to the connector.

[0024] In a further embodiment, the interface element is made of several elements that are connected by flexible parts. This embodiment increases the flexibility without reducing the fixing forces.

[0025] In order to have the present invention more readily understood, reference will in the following be made to the accompanying drawings, in which:

Figure 1 illustrates a schematic cross-sectional view of a connector;

Figure 2 illustrates a schematic cross-sectional view of the interface element and a part of the connector;

Figure 3 illustrates a schematic cross-sectional view of a second embodiment of the connector and a second embodiment of the interface element;

Figure 4 illustrates a schematic cross-sectional view of a third embodiment of the interface element and a third embodiment of the connector;

Figure 5 illustrates a schematic side view of a an interface element;

Figure 6 illustrates in a schematic side view a further embodiment of the interface element;

Figure 7 illustrates in a schematic side view a further embodiment of the interface element;

Figure 8 illustrates in a schematic side view a further embodiment of the interface element;

Figure 9 illustrates in a schematic side view a further embodiment of the interface element;

Figure 10 illustrates a cross-sectional view of a further embodiment of the interface element;

Figure 11 illustrates a schematic side view of the retainer ring;

Figure 12 illustrates a retainer ring with a mounted interface element;

Figure 13 illustrates a further embodiment of an electrical connector; and

Figure 14 illustrates a schematic cross sectional view of the connector of Figure 13.

[0026] Figure 1 refers to an exemplary embodiment, wherein a schematic cross-section of a connector 1 is shown that comprises electrical contact elements 2 that are arranged in an electrically-insulating body 3. The body 3 is covered with an electrically-conducting layer 4. The contact elements 2 are arranged in a connecting section at a front end of the connector 1 that is provided for being plugged to a corresponding connector 6. The body 3 comprises an interface element 7 that is arranged on an outer face of the connector 1. The interface element 7 is provided for fixing an element that is embodied as a retainer ring 8. The interface element 7 comprises a first recess 15 with the shape of a circular groove 16 that is provided for receiving a part of a radial inner shape of the retainer ring 8. The connector 1 comprises a cable 9 with conductors that are fixed to the contact elements 2. The body 3 of the connector 1 has an end section 10 with a reduced diameter. At the end section 10, a plate 11 is mounted on the connector 1 abutting against a side wall 12 of the body 3. The plate 11 is fixed by rods 13 to the further connector 6. The rods 13 may be guided through holes of the plate 11 and fixed to the plate 11 by means of screws 14. The retainer ring 8 is arranged within two opposite rods 13 and holds the connector 1 in a stable position within the rods 13. The retainer ring 8 represents a theft protection system and prevents an easy removal of the connector 1. In particular if high voltages or high current is guided through the connector 1, a simple removal of the connector 1 should be prevented.

[0027] The retainer ring 8 is made of a hard material to hold the connector 1 in a predetermined orientation for example referring to a device mounted on the corresponding connector 6. The corresponding connector 6 may comprise a further contact element 42 that fits to the contact element 2, wherein the further contact element 42 is arranged within a further electrically insulating body 43. The retainer ring 8 may be made of metal with sharp edges that may damage the layer 4 during the mounting of the retainer ring 8 on the connector 1 and/or during product usage. The body 3 is made of an insulating material, e. g. plastic, silicone or EPDM or TPE. In one embodiment, the body 3 is made of molded material. This provides a cost-efficient and simple manner of production of the connector 1 with the embedded contact elements 2. The layer 4 is made of a thin layer, e. g. with a thickness in the range of 3 mm or less. Preferably, the layer 4 has a thickness smaller than 0.1 mm. The function of the layer 4 is to provide an electrically-conducting layer for electrical grounding. The thin layer 4 is sufficient to provide the necessary grounding and is cost-efficient in production. In a further embodiment, the layer 4 is coated on the body 3 by spraying material on the body 3. The spraying is a simple and cost-efficient production method that can e. g. be easily combined with molding the body 3.

[0028] The interface element 7 may be made of a flexible material such as rubbers (LSR, EPDM, HTV, TPE) with a Shore hardness A30-A50 or also higher hardness such as A60-A80. Depending on the embodiment, the interface element may also be made of other materials, e. g. of rigid materials such as thermoplastics (PP, PA,

ABS, PVC and so on). Furthermore, the material of the interface element 7 may be UV-resistant and may be electrically-conductive.

[0029] The connector 1 has a specific shape on the outer face for example in the connecting section 5 to provide a recess or a shape for receiving and fixing the interface element 7. The interface element 7 itself also comprises a shape or recess for receiving a part of the retainer ring 8 on an outer face.

[0030] The retainer ring 8 may be made of metal, at least of a hard material and is inserted in the interface element before or during an installation process of the connector 1 to the further connector 6. The connecting section 5 of the body 3 can be pressed together before the installation on the further connector 6 to facilitate the mounting of the interface element 7 and/or the retainer ring 8. The interface element 7 is either inserted by a cable jointer or is mounted on the connector in the factory by producing the connector 1. If the interface element is inserted by the cable jointer, it is preferably prior to that mounted on the inside of the retainer ring 8. The interface element 7 has a groove on the outside for the retainer ring 8 to be positioned in. On an inside, the interface element comprises a shape corresponding to the shape of an outer face of the connector 1. The corresponding shapes are designed to improve the force-fit and/or form-fit connection. The corresponding shapes are preferably further optimized to minimize electrical stress in the body material. The shapes may also allow sliding the retainer ring 8 with the interface element over the connector 1 and allow for maximum pull-off forces once the connector 1 is installed on the further connector 6.

[0031] Preferably the pull-off forces are also very high even when the connector 1 is not yet installed on the corresponding connector 6. The proposed connector provides a cost reduction by having the interface element 7 mounted after the molding of the body 3 and coated the body 3 with the conductive layer 4. This avoids costly overmolding with increased cycle time and increased molding efforts. The layer 4 may consist of the same material as the body 3, e. g. silicone or polymer, and mixed with electrically-conductive material, e. g. carbon black. The layer 4 may be put on the body 3 by dipcoating or by painting or by spraying. Furthermore, powder-coating with a curing process may be used for coating the body 3 with the layer 4. The layer 4 may cover the entire outer surface of the body or parts of it, as depending on the design selected areas may not require a conductive coating from the electrical point of view. This may reduce the cost. A further cost reduction is attained by having the interface element 7 made of lower-cost material, e. g. EPDM, HTV or thermoplastic or elastomeric materials. Furthermore, the connector 1 can also be supplied without the interface element 7 if a customer does not require a retainer ring 8.

[0032] Figures 2 to 4 illustrate in schematic views several embodiments of the interface element 7 and the connector 1. The cross-sections of the figures 2 to 4 are arranged through a middle axis 20 of the connector 1. The shown shapes are axially symmetric to the middle axis.

[0033] Figure 2 depicts a partial cross-sectional view of the interface element 7, the retainer ring 8 and a part of the layer 4 and the body 3. The connector 1 comprises at an outer face 19 an annular first recess 15. The first recess 15 is provided to at least partly receive an inner part of the annular interface element 7. Figure 2 shows an embodiment of the connector 1 with a first recess 15 with an evenly rounded cross-section. The interface element 7 also comprises a radial inner face 18 that is also evenly rounded and fits to the outer face 19 of the connector 1. In the shown embodiment, the entire interface element 7 is arranged within the first recess 15. Depending on the used embodiment, the interface element 7 may protrude above the connector 1. The interface element 7 comprises an annular second recess 16. The second recess 16 is embodied in the shown embodiment as a simple rectangular groove. The retainer ring 8 is partly arranged with an inner section in the second recess 16. The dimension of the second recess 16 may have e.g. a width of 2 mm and a depth of 3 mm. Apart from receiving a retainer ring 8 the recess 16 may receive a device for monitoring e.g. inductive sensor or thermal sensor.

[0034] Figure 3 shows a further embodiment of a connector 1 and an interface element 7, wherein the annular first recess 15 of the connector 1 has an unevenly rounded cross-section with a chamfer 21 on the right-hand side. The interface element 7 has a corresponding shape that fits in the first recess 15. The shape of the interface element 7 allows for low slide-on forces. This shape may be of advantage if the interface element 7 is slid into position together with the retainer ring 8 by an installer. The interface element 7 has an annular inner face 18 that is mostly radially oriented on the left-hand side to increase the form-fit and force-fit connection and to increase pull-off forces once the connector 1 is installed. The inner face 18 of the interface element 7 on the right-hand side also has a chamfer 21 that assists sliding the interface element 7 coming from the left-hand side to the first recess 15. The sliding of the interface element 7 may be improved by oil, e. g. installation silicone oil. For secure fixing of the interface element 7, an adhesive, e. g. a silicone adhesive, may also be used. The cross-section of the second recess 16 is the same as in figure 2.

[0035] The interface element 7 comprises at an outer face a protruding second side wall 22 that is embodied as a ring face. The second side wall 22 prevents during the mounting of the retainer ring that the retainer ring 8 may be slid to the right-hand side coming from the left-hand side over the interface element 7. The second side wall 22 protrudes above a first section 23 of the interface element 7 over that the retainer ring 8 has to be pulled to rest in the second recess 16. The second side wall 22 is arranged at a predetermined distance from the second recess 16. The second side wall 22 prevents the retainer ring 8 from being pushed to the layer 4. The second side

wall 22 may also be used to push the interface element 7 into position with a device.

[0036] Figure 4 shows a further embodiment of an interface element 7 and a connector 1, wherein the annular first recess 15 at the outer face of the connector 1 comprises several protrusions 24, 25, 26 and lugs 27, 28, 29 along a middle axis 20 that represents a longitudinal axis of the connector 1. In the shown embodiment, there are three protrusions 24, 25, 26 and three lugs 27, 28, 29. The interface element 7 and the retainer ring 8 are mounted on the connector 1 from the left-hand side and moved to the right-hand side. A first mounting section 30 of the outer face of the connector 1 has a smaller radial distance from the middle axis 20 than the first protrusion 24. The first protrusion 24 is also embodied as an annular protrusion. Beside the first protrusion 24, a first lug 27 is arranged that has the same radial distance to the middle axis 20 as the first mounting section 30. Beside the first lug 27, the second protrusion 25 is arranged. The second protrusion 25 is also an annular protrusion and has a larger radial distance to the middle axis 20 than the first protrusion 24. Beside the second protrusion 25, a second lug 28 is arranged.

[0037] The second lug 28 has the same radial distance to the middle axis 20 as the first mounting section 30. Beside the second lug 28, a third annular protrusion 26 is arranged. The third protrusion 26 has the same radial distance to the middle axis 20 as the second protrusion 25. Beside the third protrusion 26, a third annular lug 29 is arranged. The third lug 29 has the same radial distance to the middle axis 20 as the second lug 28. Beside the third lug 29, the connector 1 comprises a further section 31 that has a larger radial distance to the middle axis 20 than the third protrusion 26. The retainer ring 8 has an inner diameter that may be larger than an outer diameter of the second and third protrusions 25, 26. The retainer ring 8 is basically fixed to the connector 1 by a force-fit connection.

[0038] In the embodiment in that the interface element 7 is to be installed by the jointer and is molded from a thermoplastic or any other rigid material, the design should incorporate means to insert into the metal ring. The figures 5 to 10 show several embodiments for the interface element 7 to provide the possibility for mounting the interface element 7 to the retainer ring 8.

[0039] Figure 5 shows a schematic side view of an interface element 7 that is embodied as an open ring with an opening 32. In the shown embodiment, 10 % of the ring may be open. The interface element 7 is made of a flexible material or a thermoplastic material like e.g. PP, PVC, PA or the like so that it can be bent to a larger diameter for mounting on the connector 1. The interface element 7 of figure 5 is flexible enough to be mostly elastically deformed during the insertion in the retainer ring 8. The interface element 7 may be made of softer thermoplastic materials, in the example soft PVC or of higher Shore hardness elastomers such as EPDM or silicones.

[0040] Figure 6 shows a further embodiment with an interface element 7 in the shape of an open ring, wherein opposite to the opening 32 of the ring, a flexible section 33 is arranged. The flexible section 33 may be attained by a smaller diameter of the cross-section of the interface element 7 or by providing recesses in the interface element 7 or by a more flexible material that is arranged in the flexible section 33. The interface element 7 of figure 6 is also embodied as an open ring but has a weakening preferably opposite to the opening 32 of the ring for allowing a better flexing of the interface element 7. The flexible section 33 may be embodied as a flexible thin wall element that allows for elastic flexing with little force. After the flexing, the interface element 7 firmly sits in the retainer ring 8.

[0041] Figure 7 shows a further embodiment of an interface element 7 with three elements 35 that are flexibly connected by flexible parts 34. Each element 35 has the shape of a part of a ring. The flexible parts 34 may be made of the same material as the elements 35 for example as a flexible thin wall. In a further embodiment, the flexible parts 34 may be embodied as spring elements that are fixed to opposite ends of the elements 35. In the shown embodiment, there are three elements 35 that are connected via flexible parts 34. Depending on the used embodiment, there may be less or more elements 35 that are connected together by flexible parts 34. Furthermore, in another embodiment, two of the several elements 35 may not be connected by a flexible part 34 basically representing an open-ring structure.

[0042] Figure 8 represents a further embodiment of the interface element 7 that comprises two half-ring shaped elements 35 that are connected by fixing elements 36. The fixing elements 36 connect the endings of the two half-circular shaped elements 35. The fixing elements 36 may be bolts and screws. The interface element 7 of figure 8 can comprise two or more elements 35 that may be made of rigid material and that are linked to each other by a pin-and-hole arrangement as a fixing element 36. When the pins are inserted into the holes, the assembly is small enough in diameter to fit into the retainer ring 8. After the mounting of the interface element 7 in the retainer ring 8, the elements 35 are moved apart from each other, preferably still having the pins 39 being inserted into the holes 40 to a certain extent to avoid the elements 35 from falling off the retainer ring 8.

[0043] Figure 9 shows a third embodiment of an interface element 7 that comprises three partially ring-shaped elements 35 that may be press-fit to the connector 1 and/or press-fit to the retainer ring 8. The embodiment of the interface element 7 shown in figure 9 comprises two or more individual elements 35. The elements 35 are force-fit to the retainer ring 8 so that the elements 35 can be mounted on the inside of the retainer ring 8 without falling off. The force-fit can be achieved e. g. by little protrusions in the second recess 16 that is arranged on an annular outer face of the elements 35 or by having a smaller size of the second recess than the width of the retainer ring 8.

[0044] Figure 10 shows a further embodiment of an annular interface element 7 that is made of two parts that are fixed by a press-fit connection and that has an open ring structure. The embodiment of the interface element 7 shown in figure 10 is made of two or more mainly rigid parts 37, 38 with an axial split rather than a circumferential split shown in figure 8. Again, these parts 37, 38 can be mounted onto the metal ring prior to sliding over the connecting section 5 of the connector 1. An option for ease of handling is an additional force-fit of pins 39 in holes 40 of the parts 37, 38.

[0045] Figure 11 shows in a schematic side view a retainer ring 8.

[0046] Figure 12 shows in a schematic view an interface element 7 that is mounted on a retainer ring 8. The interface element 7 is embodied as an open ring as shown in figure 5.

[0047] Figure 13 shows a further embodiment of an electrical connector 8 that is basically shaped in the same structure as the connector 8 of figure 1, wherein the first recess 15, the interface element 7, the second recess 16 and the element have another shape. The first recess 15 is arranged along a longitudinal axis of the connector 8 and has a rectangular cross section along ht longitudinal axis and across the longitudinal axis. The interface element 7 has a rectangular cross section along and across its longitudinal axis. The interface element 7 is hold by a form-fit and/or a force-fit connection to the body 3. The second recess 16 has a rectangular cross section along and across its longitudinal axis. The element is embodied as a sensor element 41 and has a rectangular cross section along and across its longitudinal axis. The sensor element 41 may be embodied to measure a current flowing through the connector. In a further embodiment the sensor element may be embodied to measure a temperature of the connector. Depending on the used embodiment the sensor element 41 may also measure other parameter.

[0048] Figure 14 shows a schematic cross sectional view across the longitudinal axis of the connector.

[0049] In a further embodiment the sensor element 41 may have a circular shape or a partial circular shape. In this embodiment the first recess 15 is also embodied with a circular or a partial circular shape that is arranged across the longitudinal axis of the connector as shown in figure 1.

[0050] The shapes and structures shown in the figures are only exemplary examples. Depending on the used embodiment the body 3, the first recess 15, the interface element 7, the second recess 16 and/or the element 8, 41 may have any suitable shape. Furthermore the first recess 15 and/or the second recess 16 may be arranged in line or across or perpendicular with a longitudinal axis of the connector.

List of reference numerals

[0051]

1 connector
2 contact element
3 body
4 layer
5 connecting section
6 further connector
7 interface element
8 retainer ring
9 cable
10 end section
11 plate
12 side wall
13 rod
14 screw
15 first recess
16 second recess
18 inner face
19 outer face
20 middle axis
21 chamfer
22 second side wall
23 first section
24 first protrusion
25 second protrusion
26 third protrusion
27 first lug
28 second lug
29 third lug
30 first mounting section
31 further section
32 opening
33 flexible section
34 flexible part
35 element
36 fixing element
37 first part
38 second part
39 pin
40 hole
41 sensor element
42 further contact element
43 further body

Claims

1. Electrical connector (1) with an electrical contact element (2) that is fixed to an electrically insulating body (3), wherein the body (3) is covered with an electrically conducting layer (4), wherein on an outer face (19) of a connecting section (5) of the body (3)

a first recess (15) is arranged, wherein an interface element (7) is arranged at least partly in the first recess (15), wherein a second recess (16) is formed at an outer surface of the interface element (7), wherein the second recess (16) is provided for at least partly receiving and fixing an element (8, 41).

2. The connector of claim 1, wherein the element is a retainer ring (8) or a sensor element (41).

3. The connector of any one of the preceding claims, wherein the first recess (15) is of a partial circular shape or of a circular shape, and/or wherein the interface element (7) is of partial circular shape or of a circular shape, and/or wherein the second recess (16) is of a partial circular shape or of a circular shape.

4. The connector of any one of the preceding claims, wherein the layer (4) is made of a sprayed layer (4).

5. The connector of any one of the preceding claims, wherein the layer (4) is smaller than 0.3 mm preferably smaller than 0.1 mm.

6. The connector of any one of the preceding claims, wherein the interface element (7) is embodied as an open ring that can be flexibly bent.

7. The connector of any one of the preceding claims, wherein along a longitudinal axis of the connecting section (5) a partly circular cross-section is formed on an outer face (19) of the second recess (16), wherein the partly circular cross-section is provided for receiving a radial inner face (18) of the interface element (7) and fixing the interface element (7) to the connector (1).

8. The connector of any one of the preceding claims, wherein along a longitudinal axis of the connecting section (5) a cross-section with at least one protrusion (24, 25, 26) and at least one lug (27, 28, 29) for receiving a radial inner face (18) of the interface element (7) is formed in the second recess (16).

9. The connector of any one of the preceding claims, wherein the body (3) is made of mold material, for example silicone.

10. The connector of any one of the preceding claims, wherein the interface element (7) is made of flexible material for example with a shore hardness of A30 or higher.

11. The connector of any one of the preceding claims 1 to 5, wherein the interface element (7) is made of rigid material for example thermoplastics.

12. The connector of any one of the preceding claims, wherein the interface element (7) is made of electrically conducting material.

13. The connector of any one of the preceding claims, wherein the interface element (7) comprises a flexible section (33).

14. The connector of any one of the preceding claims, wherein the interface element (7) is made of several elements (35, 37, 38) that are fixed together, e. g. by flexible parts.

15. The connector of any one of the preceding claims, wherein a shape of an inner face (18) of the interface element (7) corresponds to a shape of the outer face (19) of the first recess (15).

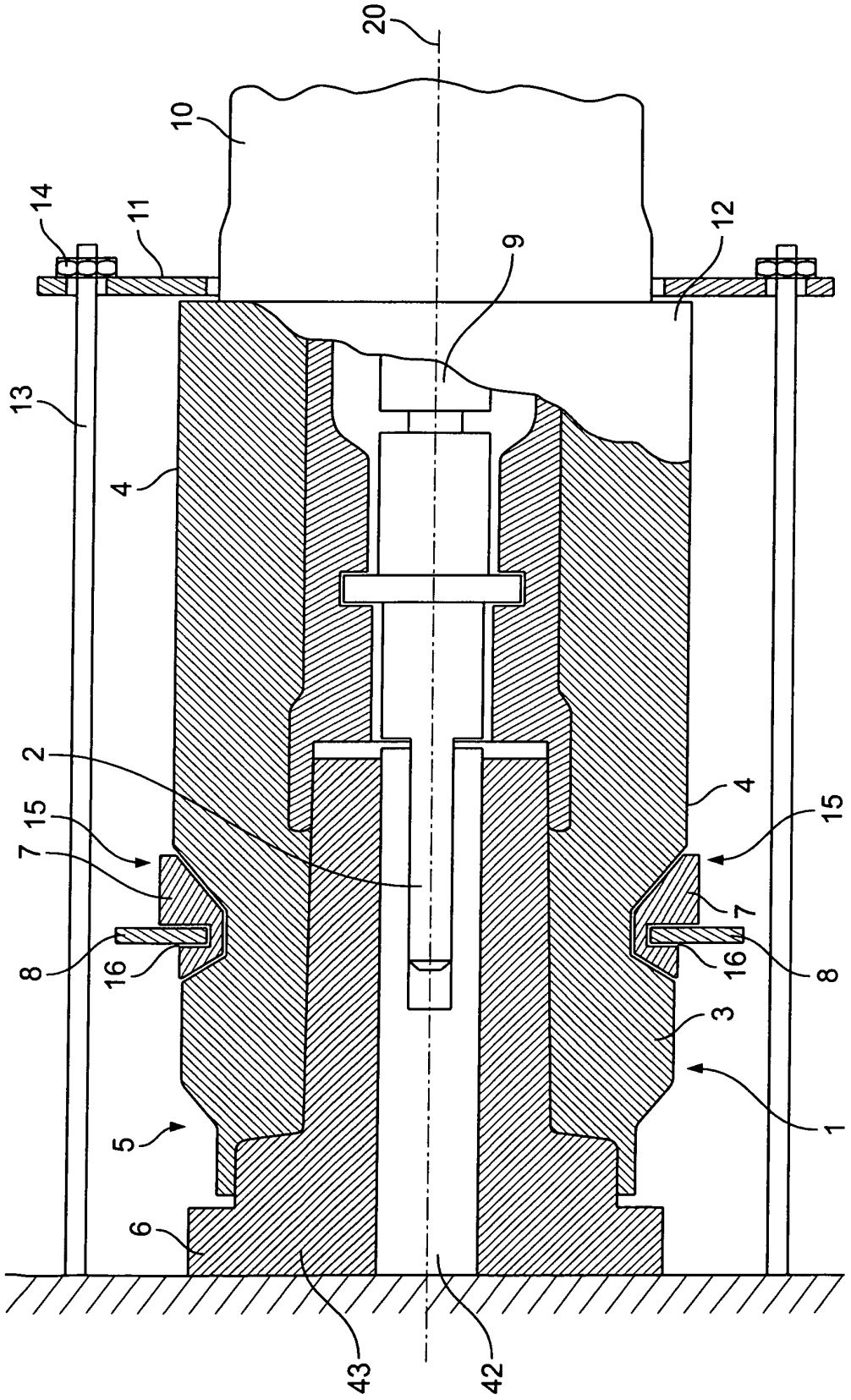

Fig. 1

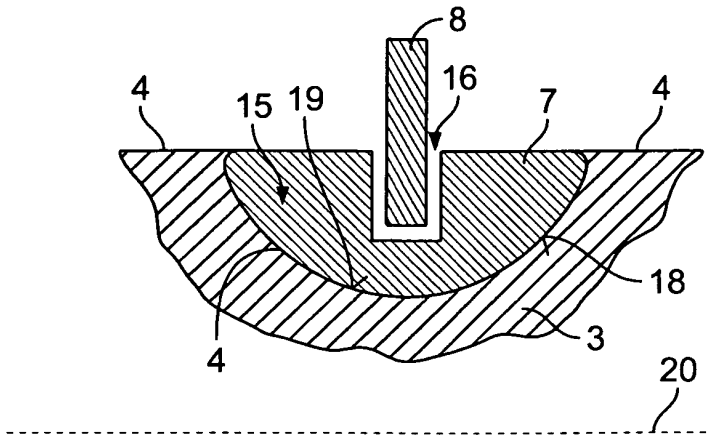

Fig. 2

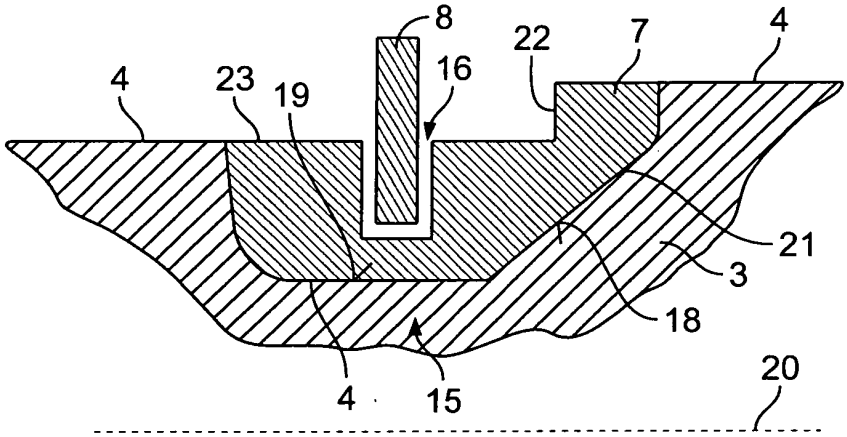

Fig. 3

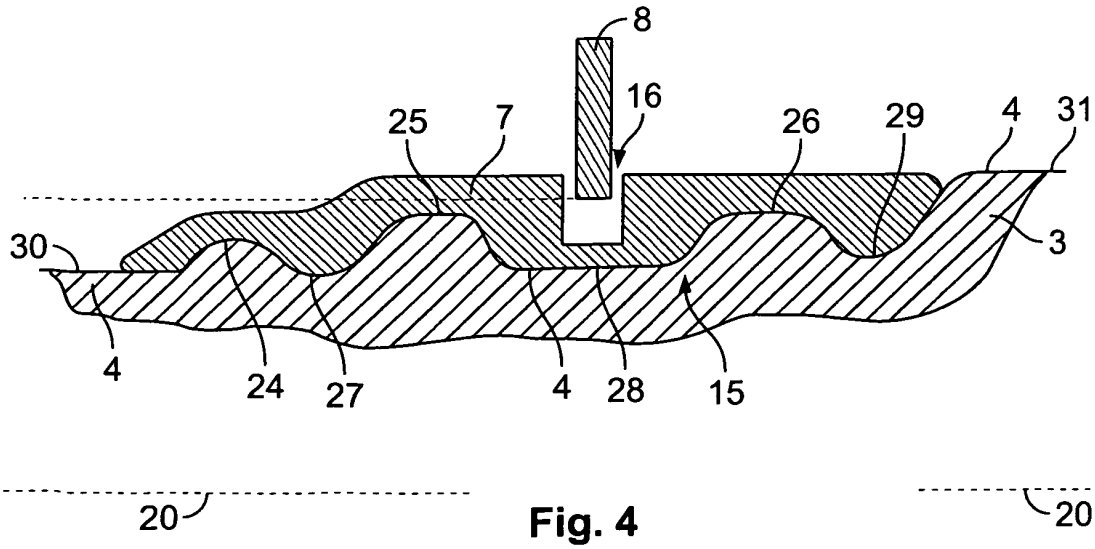

Fig. 4

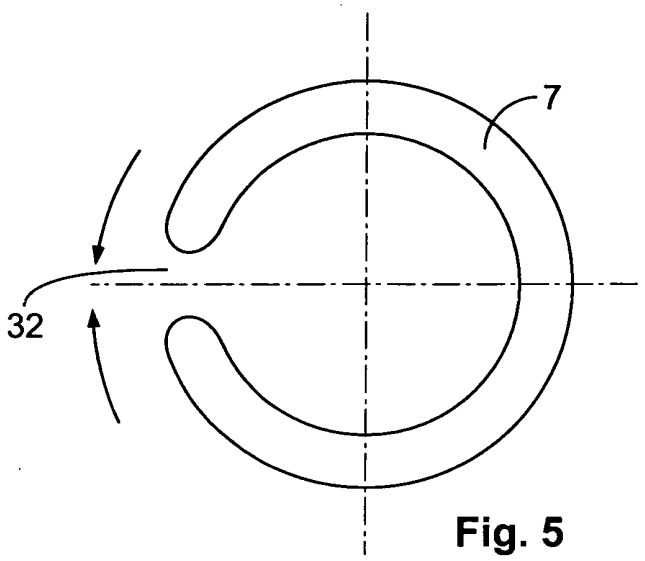

Fig. 5

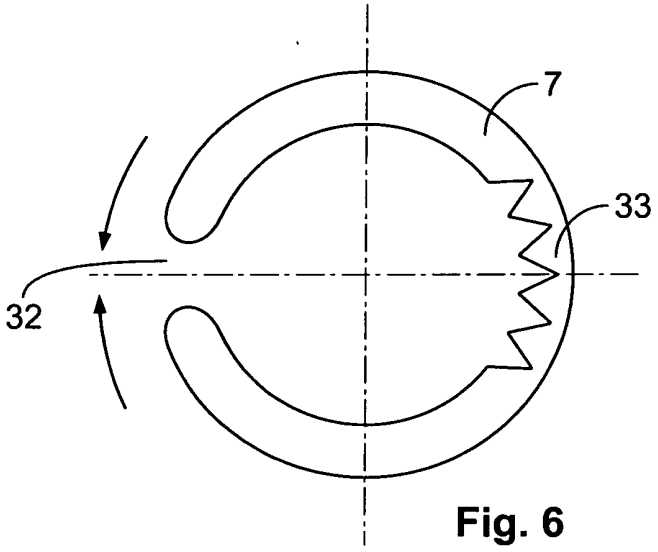

Fig. 6

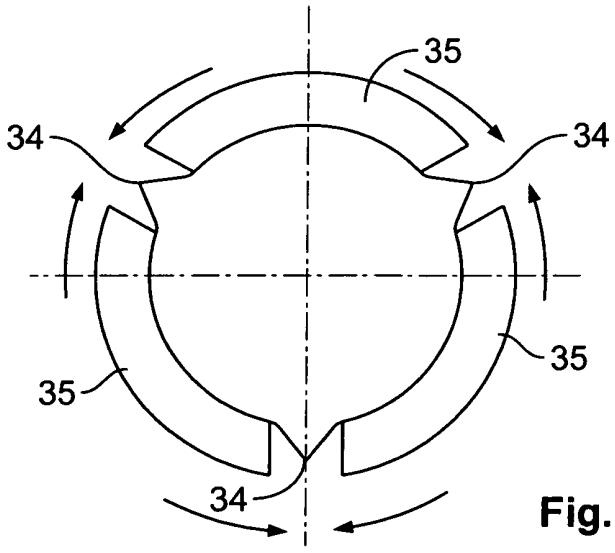

Fig. 7

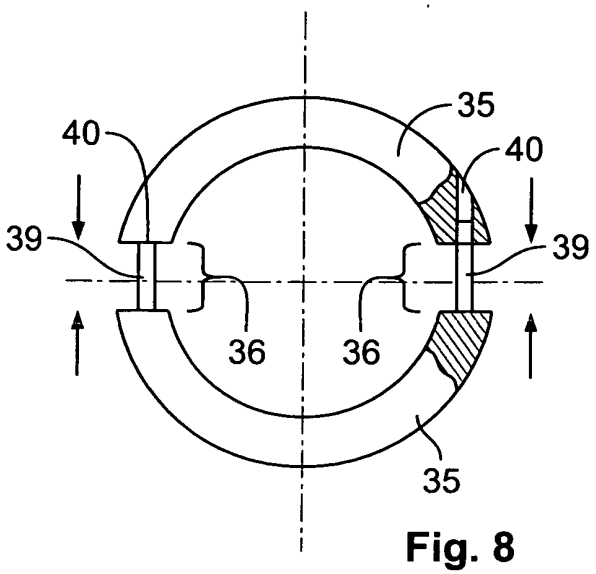

Fig. 8

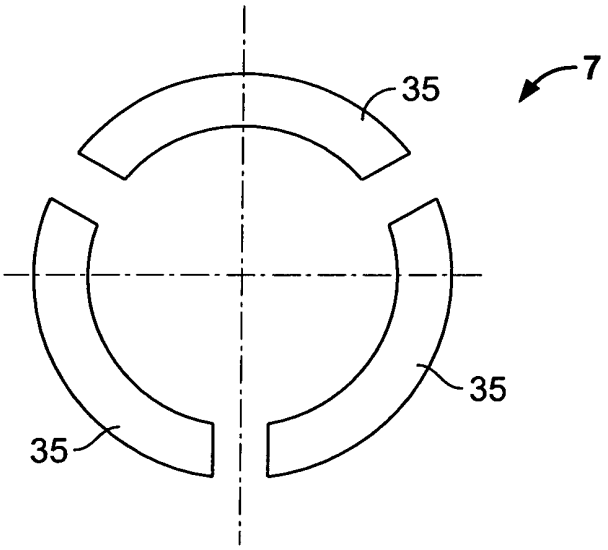

Fig. 9

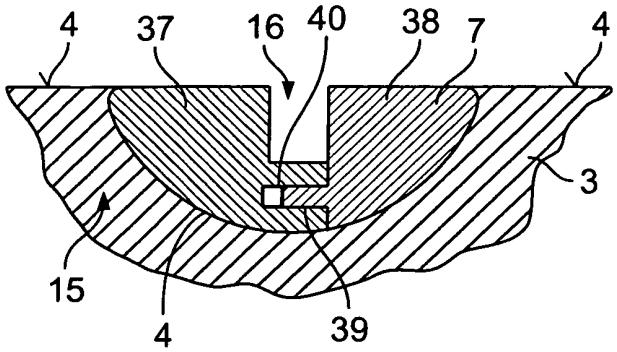

Fig. 10

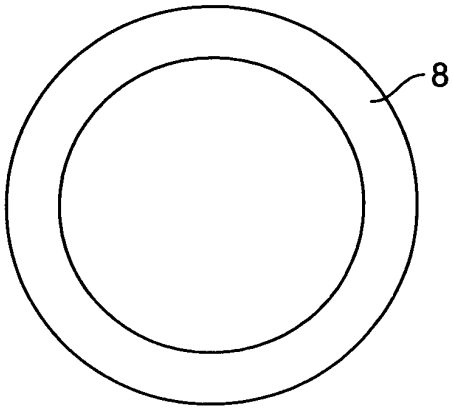

Fig. 11

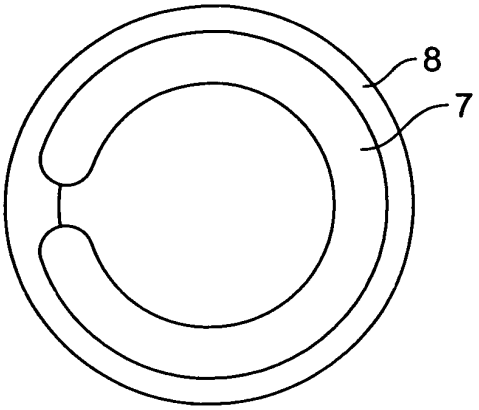

Fig. 12

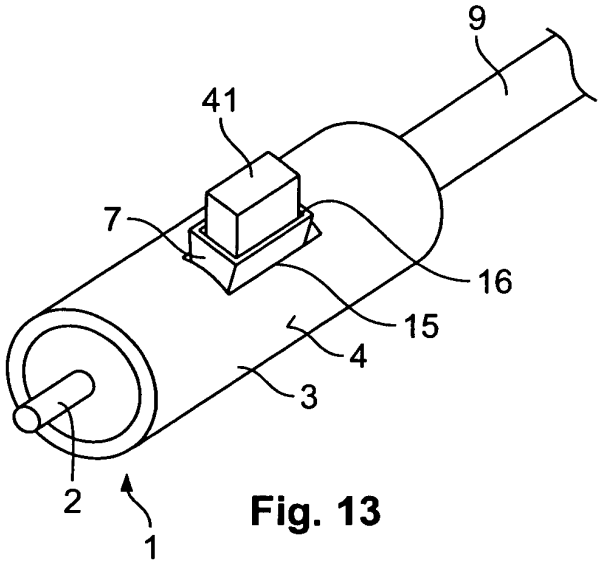

Fig. 13

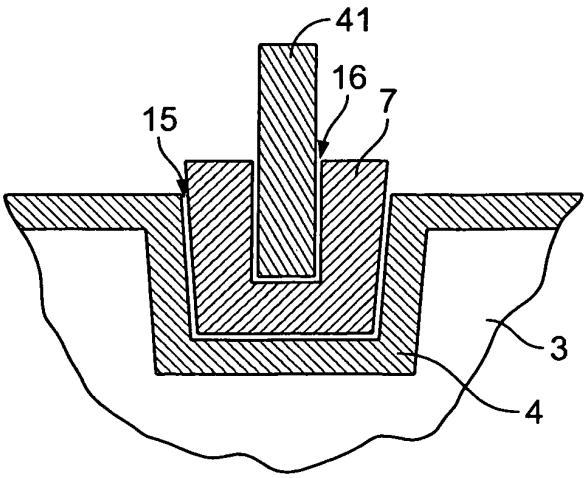

Fig. 14

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EUROPEAN SEARCH REPORT

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EP 13 15 4013

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Place of search	Date of completion of the search	Examiner
The Hague	14 June 2013	Salojärvi, Kristiina

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