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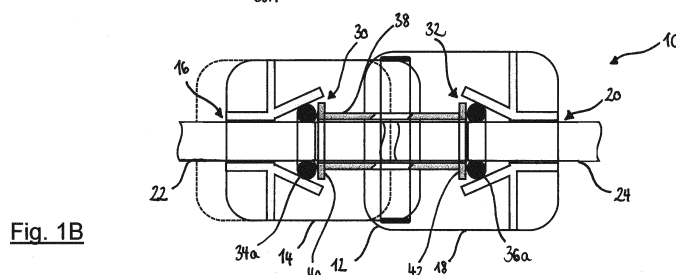
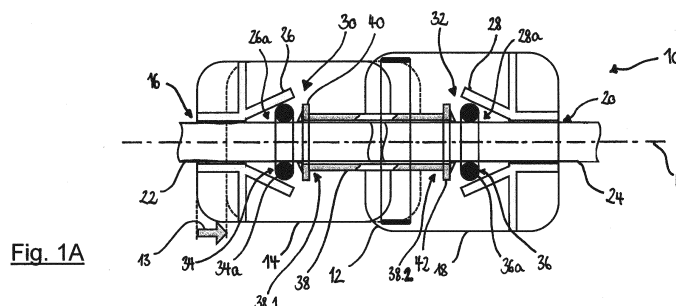
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(54) **ELECTRICAL CONNECTOR WITH STRAIN RELIEF AND SEALING**

(57) An electrical connector comprises a housing (12) and a wire (22) extending into the housing (12), the housing (12) comprising a first housing part (14) and a second housing part (18) movable relative to each other between a pre-assembled position and an assembled position along a longitudinal axis (L) of the wire (22). The electrical connector further comprises a first sealing and strain relief structure (30) comprising a housing bevel (26) formed by the first housing part (14) and defining a receptacle (26a) accommodating the wire (22) and a sealing element (34) positioned around the wire (22), a

wire inlet (16) arranged in the first housing part (14) and leading into the receptacle (26a), and a positioning means (38) securing the wire (22) in the assembled position and comprising a clamping element (40) positioned around the wire (22) adjacent to the sealing element (34) on a side opposite from the wire inlet (16). Upon a relative movement of the first and second housing parts (14, 18) from the pre-assembled into the assembled position, the sealing element (34) is pressed against the housing bevel (26) and the clamping element (40) is pressed radially inward against the wire (22).



Description

FIELD

[0001] The present disclosure relates to an electrical connector comprising a sealing and strain relief structure and to a method of assembling an electrical connector.

BACKGROUND

[0002] Electrical connectors used, for example, in vehicle electrical systems require reliable sealing of every wire inlet. Typically, injection-molded sealing elements having a plurality of sealing lips are used, which are tailored to the specifics of the wire to be sealed, the compression required and the connector housing portion. Each wire entering or leaving the electrical connector is sealed by means of an individually fitted set of seal, compression elements, and housing portion in an individual assembly process. Thus, during assembly of the electrical connector, many individual and different components need to be handled, each requiring individual processing steps and processing tools. Adding a strain relief structure for each wire adds to the complexity of the electrical connector and its assembly process and, eventually, to the cost. Furthermore, with every additional component and processing step, the failure probability during assembly increases, further driving up the costs.

[0003] Accordingly, there is a need to provide an improved electrical connector which can be manufactured at low cost and with high reliability and which provides a reliable sealing and strain relief of each wire.

SUMMARY

[0004] The present disclosure provides an electrical connector comprising a sealing and strain relief structure and a method of manufacturing such an electrical connector according to the independent claims. Embodiments are set out in the dependent claims, the description and the drawings.

[0005] In an aspect, the present disclosure is directed at an electrical connector comprising: a housing; a wire extending into the housing; the housing comprising a first housing part and a second housing part movable relative to each other, between a pre-assembled position and an assembled position, along a longitudinal axis defined by the wire. The electrical connector further comprises a first sealing and strain relief structure associated with the first housing part, comprising: a housing bevel formed by the first housing part and defining a receptacle; a sealing element configured to be positioned around the wire; a wire inlet arranged in the first housing part, the wire inlet leading into the receptacle, the receptacle being configured to accommodate the wire and the sealing element; a positioning means configured to secure the wire in the assembled position and comprising a clamping element configured to be positioned around the wire adjacent to

the sealing element on a side opposite from the wire inlet. The sealing element is configured to be pressed against the housing bevel upon a relative movement of the first and second housing parts from the pre-assembled into the assembled position, and at least a section of the clamping element is configured to be pressed radially inward against the wire upon a relative movement of the first and second housing parts from the pre-assembled into the assembled position.

[0006] Generally, in the electrical connector according to the present disclosure, sealing, strain relief and assembly of the housing are established all in one assembly step and with a reduced number of individual or different components. The assembly process is thus automation-ready and the concept for sealing and strain relief is applicable to a huge variety of electrical connectors, for example also to high voltage applications.

[0007] The electrical connector may be used in conjunction with single core or multi core wires having an almost arbitrary cross-section. The wires may have an insulating outer jacket and/or a wire shield.

[0008] The housing and in particular both the first housing part and the second housing part are typically made from an electrically insulating material, e.g. from a plastic material or resin. The housing defines a housing interior. The first and second housing parts may be connected to each other in a plane which is typically perpendicular to the longitudinal axis defined by the wire. The connection of the first and second housing parts includes moving the parts towards each other in an axial direction into the assembled position.

[0009] The wire inlet may be arranged on a side of the first housing part opposite from the connection plane. The wire inlet may be formed by an opening in the first housing part and the housing bevel may be formed, e.g. by injection-molding, as an integral part of the first housing part. Alternatively, a separate part forming the housing bevel may be attached to the housing. The wire inlet leads into a receptacle with a beveled surface on the housing interior side. Inside the housing interior, in particular on the housing interior side of the housing bevel, the route of the wire may deviate from the axial direction which is defined by the wire entering the housing through the wire inlet.

[0010] On the housing interior side, a sealing element surrounds the wire. The sealing element may have the shape of a ring or a sleeve and it is typically made from an elastic material like rubber or silicone. It may be an injection-molded part. The sealing element may comprise one or more sealing lips which may be oriented towards the wire and/or towards the housing. The sealing element is arranged around the wire such that it can be brought into contact with the beveled surface of the receptacle.

[0011] Next to the sealing element, on a side of opposite from the wire inlet, a positioning means is arranged which fulfills at least two functions. On the one hand, the positioning means comprises a clamping element sur-

rounding the wire and being equipped to provide strain relief by clamping the wire in a defined position. On the other hand, the positioning means is dimensioned such that it ensures correct positioning of the sealing element inside the receptacle in an assembled position of the housing in order to provide proper sealing. In particular, the positioning means may be dimensioned such that it spans substantially the full length of the housing interior in the axial direction, in particular the full length between the sealing element and the opposite side of the housing. To fulfill this task, the positioning means is made from a sufficiently sturdy material or is reinforced so as to withstand the pressure exerted by the first and second housing parts in the assembled position. The positioning means may be injection-molded and the clamping element may be an integral part of the positioning means. The wire, the sealing element, the housing bevel, and the positioning means and/or the clamping element may be arranged coaxially.

[0012] In the assembled position, strain relief is provided by the clamping element being at least partially pressed against the wire or, if available, a protective outer jacket of the wire. For engaging with the wire, the clamping element may comprise, for example arranged on its radial inner side, a clamping edge and/or a clamping surface which engages with the wire in a force fit or a form fit. The clamping element may be formed by an end section of the positioning means facing the sealing element.

[0013] In the assembled position the sealing element is pressed against the housing bevel by the positioning means. The housing bevel may be designed to exert a force directed radially inward onto the sealing element ensuring a reliable sealing contact between the sealing element and the wire.

[0014] All relevant forces and counterforces for ensuring sealing and strain relief are provided by moving the first and second housing parts towards each other from a pre-assembled position into the assembled position. By this movement, the second housing part exerts a force on the positioning means, which in turn exerts a force on the sealing element, thereby pressing the sealing element against the housing bevel of the first housing part. The counterforce exerted by the first housing part ensures that sealing and strain relief are established.

[0015] As the housing bevel may be an integral part of the first housing part and the positioning means may include the clamping element, the number of individual components can be significantly reduced while still ensuring proper sealing and strain relief, thereby saving assembly steps and costs.

[0016] According to an embodiment, the electrical connector comprises a further wire extending into the housing and a second sealing and strain relief structure associated with the second housing part, said second sealing an strain relief structure, comprising a housing bevel formed by the second housing part and defining a receptacle, a sealing element configured to be positioned around the further wire, a wire inlet arranged in the sec-

ond housing part, the wire inlet leading into the receptacle, the receptacle being configured to accommodate the wire and the sealing element, a positioning means configured to secure the wire in the assembled position and comprising a clamping element configured to be positioned around the wire adjacent to the sealing element on a side opposite from the wire inlet, the sealing element being configured to be pressed against the housing bevel upon a relative movement of the first and second housing parts from the pre-assembled into the assembled position, and at least a section of the clamping element being configured to be pressed radially inward against the wire upon a relative movement of the first and second housing parts from the pre-assembled into the assembled position. In structure and function, the second sealing and strain relief structure may correspond to the first sealing and strain relief structure. The specific dimensions of the components of the second sealing and strain relief structure, e.g. the diameter of the wire inlet and the sealing element, the exact shape of the housing bevel or the positioning means may deviate from those of the first sealing and strain relief structure depending on the requirements.

[0017] In a further embodiment, the first and second sealing and strain relief structures may be arranged on opposite sides of the housing. The wire inlet arranged in the first housing part and the wire inlet arranged in the second housing part may in fact serve as wire inlet and wire outlet of the electrical connector. For example, a first wire may enter the first housing part, an electrical connection, e.g. an electrical splice connection, to a second wire may be formed inside the housing interior, and the second wire may leave the housing through the wire inlet in the second housing part. The first wire may, for example, be connected to a power supply and the second wire may be connected to an electric consumer. However, for the sake of simplicity, in the context of this disclosure the term wire inlet will be used for referring to both wire inlets and wire outlets.

[0018] At least one of the first and second housing parts may comprise more than one sealing and strain release structure, allowing more than one wire to enter and/or leave the electrical connector. The number of wire inlets may differ between the first and second housing part.

[0019] In an embodiment, the electrical connector comprises a plurality of wires, wherein the positioning means is configured to secure the plurality of wires in the assembled position. Two or more of the wires of the plurality of wires may be connected to each other inside the housing interior. Optionally, further electrical components and circuitry may be connected to one or more of the wires, e.g. sheet metal parts serving as busbar elements, fuses, etc. The wires may have different wire cross sections depending on the required power loads, wherein thinner wires may be protected by a fuse. The plurality of wires may be connected to each other and to further electrical components by welding, soldering, crimping or similar methods or by plug-in electrical con-

nector terminals.

[0020] In a further embodiment, the positioning means comprises a plurality of clamping elements configured to secure the plurality of wires. At least two first and/or second sealing and strain relief structures may share the same positioning means, wherein each sealing and strain relief structure comprises a corresponding clamping element of the positioning means. The shape of the positioning means may follow the contour of the plurality of wires and further electrical components inside the housing. Each clamping element may be adjusted to fit the cross section of the respective wire. Thus, only one positioning means is required for providing strain relief for a plurality of wires, optionally for all wires of the electrical connector.

[0021] In an embodiment, the positioning means serves as an insulation element, the positioning means being formed from an electrically insulating material. The positioning means may enclose the wire or plurality of wires and further electrical components, providing insulation towards the outside of the electrical connector and/or towards a potential shielding structure of the electrical connector, such as a metal layer or wire mesh. Alternatively or in addition, the positioning means may be designed to electrically insulate individual wires or groups of wires of a plurality of wires from each other inside the electrical connector. In this way, several voltage layers may effectively be separated inside the electrical connector, e.g. by the positioning means reaching between the wires of different voltage layers. For example, two voltage layers may be established which may be connected to the + and - poles of a power supply, thus establishing a two-way electrical connector. As the positioning means takes over the insulation function in the electrical connector, the number of individual parts of the electrical connector may be further reduced.

[0022] In a further embodiment, the positioning means comprises two parts configured to be mounted on opposite sides of the wire. The positioning means may comprise more than two parts, which are configured to be mounted from several different sides of the wire. The parts may be joined along mounting planes which may contain the longitudinal axis defined by at least one wire. In case the electrical connector comprises a plurality of wires which are connected to each other forming a wire assembly, a single positioning means comprising several parts can be used to enclose the wire assembly by mounting the parts from several sides of the wire assembly.

[0023] According to an embodiment, the clamping element comprises at least one axially extending clamping tongue configured to be elastically deflected in a radial direction. In particular, the clamping element may comprise a plurality of clamping tongues surrounding the corresponding wire. In other words, the clamping element may comprise a section that is segmented along the axial direction. Pressed inwards in the assembled position, the clamping tongues may provide strain relief.

[0024] In an embodiment, the clamping element com-

prises a control element configured to interact with the sealing element upon an axial relative movement of the first and second housing parts from the pre-assembled to the assembled position, such that at least a portion of the clamping element is forced radially inwards. The portion pressed inwards may comprise one or more clamping tongues of the clamping element.

[0025] Specifically, when the first and second housing portions are moved towards each other into the assembled state, the force exerted by this movement may establish operative contact of the housing bevel, the sealing element and the control element, with the sealing element acting on the control element. The control element may be configured to convert the force exerted along the axial direction by the sealing element into a force acting in a radial direction on the portion of the clamping element to be deflected. Thus, the control element converts the axial relative movement of the first and second housing parts into the assembled position into a radial force providing strain relief.

[0026] In an embodiment, the control element comprises a beveled surface located at the end face of the clamping element facing the sealing element. The beveled surface may comprise a clamping edge and/or a clamping surface on its radial inner side.

[0027] In a further embodiment, the diameter of the receptacle widens towards a centre of the housing, i.e. the diameter of the receptacle increases in an axial direction starting from the wire inlet towards the housing interior. In particular, the widening receptacle may have a conical shape, the cone being defined by the surface of the housing bevel. The opening angle of the cone or widening receptacle may vary so as to account for the properties of the wire and sealing element used. The receptacle may widen in a continuous or monotonous way, compensating certain tolerances in the diameter of the sealing element or wire. The receptacle wall serves as a control surface acting on the sealing element, converting the axial force exerted by the first and second housing portions in the assembled position onto the sealing element into a radial force pushing the sealing element radially inwards towards the wire. Thus, a proper sealing of the wire inlet is ensured, while at the same time the sealing element also supports strain relief by establishing tight contact with the wire.

[0028] In an embodiment, the sealing element comprises at least one O-ring. O-rings are affordable sealing means available in a huge variety of sizes and materials, e.g. EPDM rubber, polyurethane, silicone. Thus, O-rings provide a cost-efficient way of adapting the sealing means to the specific requirements of the electrical connector, e.g. concerning temperature compatibility, hardness level and elasticity requirements, etc. A sealing element may comprise more than one O-ring. For example, two O-rings positioned adjacent to each other may be used to meet increased sealing requirements, wherein the O-rings may have different characteristics in order to further optimize the sealing element. Furthermore, the

space between the housing bevel and the positioning means may be adjusted by using O-rings of suitable size and number.

[0029] According to an embodiment, in the assembled position, the first housing part and the second housing part are locked to each other in position, for example by a latch lock or other generally known ways of locking. By fixing the first and second housing parts in a defined relative position to each other, the axial force exerted by the first and second housing parts onto the first and/or second sealing and strain relief structures is defined. In particular, the relative position is optimized to fit the dimensions of all components of the first and/or second sealing and strain relief structures, e.g. the sealing elements, the positioning means and the clamping elements.

[0030] In a further embodiment, the housing comprises a housing sealing element sealing the first housing part and the second housing part against each other in the assembled position. The housing sealing element may be provided by or pre-assembled with one or the other of the first and second housing parts. It may comprise a sealing ring made from an elastomer material or a sealing tape.

[0031] In another aspect, the present disclosure is directed at a method of assembling an electrical connector, in particular an electrical connector in accordance with the present disclosure. The method comprises the following steps: providing a wire, providing a housing comprising a first housing part forming a housing bevel defining a receptacle and having a wire inlet leading into the receptacle, and a second housing part; inserting the wire from a housing exterior side into the wire inlet; positioning a sealing element around the wire on a housing interior side; mounting a positioning means on the wire to secure the wire in an assembled position and positioning a clamping element of the positioning means around the wire adjacent to the sealing element on a side facing away from the wire inlet. The method further comprises moving the first and second housing parts towards each other, from a pre-assembled position into the assembled position, along a longitudinal axis defined by the wire such that the sealing element is pressed against the housing bevel and at least a section of the clamping element is pressed radially inward against the wire by the sealing element. With the method of the present disclosure sealing and strain relief of the electrical connector may be provided in one assembly step, namely by moving the first and second housing parts into the assembled position.

DRAWINGS

[0032] Exemplary embodiments and functions of the present disclosure are described herein in conjunction with the following drawings in which:

Fig. 1A shows a cross-section of an electrical connector

- Fig. 1B shows a cross-section of the electrical connector of Fig. 1A in an assembled position.
- Fig. 2A shows a face view of the positioning means of the electrical connector of Fig. 1A.
- Fig. 2B shows a side view of the positioning means of Fig. 2A.
- Fig. 2C shows a cross-section of a clamping tongue of the positioning means of Fig. 2A.
- Fig. 3A shows a cross-section of an electrical connector providing sealing and strain relief according to a second embodiment in a pre-assembled position.
- Fig. 3B shows a cross-section of the electrical connector of Fig. 3A in an assembled position.
- Fig. 4A shows a first assembly step of an electrical connector according to a third embodiment.
- Fig. 4B shows a second assembly step of the electrical connector of Fig. 4A.
- Fig. 4C shows a third assembly step of the electrical connector of Fig. 4A.
- Fig. 4D shows the partially assembled electrical connector of Fig. 4A after repeated execution of the first, second and third assembly steps.
- Fig. 4E shows a further assembly step of the electrical connector of Fig. 4A.
- Fig. 4F shows the fully assembled electrical connector of Fig. 4A.
- Fig. 5A shows a positioning means of the electrical connector according to the third embodiment.
- Fig. 5B shows a positioning means of an electrical connector according to a fourth embodiment.

DETAILED DESCRIPTION

[0033] Fig. 1A depicts an electrical connector 10 according to a first embodiment having a housing 12, which is depicted in a pre-assembled position. The housing 12 comprises a first housing part 14 having a first wire inlet 16 and a second housing part 18 having a second wire inlet 20 arranged on the opposite side of the housing 12 from the first wire inlet 16.

[0034] First and second wires 22, 24 extend into the housing 12 through the first and second wire inlets 16, 20, respectively. The wires 22, 24 define a common longitudinal axis L. The wires 22, 24 may be part of a continuous wire extending through the housing 12 with an insulation gap inside the housing 12. Alternatively, the wires 22, 24 may be connected to each other inside the housing 12, either directly or via a circuitry element like a busbar element 66, 70 (see Fig. 4D).

[0035] The electrical connector 10 comprises a first sealing and strain relief structure 30 associated with the first housing part 14 and a second sealing and strain relief structure 32 associated with the second housing part 18. As part of the structures 30 and 32, the first and second

wire inlets 16 and 20 lead into first and second housing bevels 26 and 28, respectively, which are an integral part of the corresponding first and second housing parts 14 and 18, respectively. Each housing bevel 26, 28 defines a receptacle 26a, 28a for receiving the corresponding wire 22, 24 led into the housing 12 through the corresponding wire inlet 16, 20. Both receptacles 26a and 28a have a conical shape, the diameter of each receptacle 26a and 28a widening along the longitudinal axis L starting from each wire inlet 16, 20 towards the centre of the housing 12.

[0036] The first and second sealing and strain relief structures 30, 32 further comprise first and second sealing elements 34 and 36, which are each positioned around the corresponding first and second wire 22 and 24. Each of the sealing elements 34, 36 is an O-ring 34a, 36a, fitted to the size of the corresponding wire 22, 24 and fitted to be accommodated, together with a section of the corresponding wire 22, 24, inside the corresponding receptacle 26a, 28a.

[0037] Further, the first and second sealing and strain relief structures 30, 32 comprise a positioning means 38. As shown in Fig. 1A and 1B, the first and second sealing and strain relief structures 30, 32 both share a common positioning means 38. Optionally, individual positioning means may be used for the first and second sealing and strain relief structures 30, 32. The positioning means 38 is positioned adjacent to and, thus, between the first and second sealing elements 34 and 36 and extends across a major part of the housing interior between the housing bevels 26, 28 of the first and second housing parts 14, 18. In particular, the positioning means is dimensioned such that - in an assembled position of the housing 12 as shown in Fig. 1B - it pushes the first and second sealing elements 34, 36 into their respective housing bevels 26, 28 with a defined pressure, thereby ensuring a tight sealing of the wire inlets 16, 20.

[0038] The positioning means 38 further comprises a first clamping element 40 positioned around the first wire 22 adjacent to the first sealing element 34 and a second clamping element 42 positioned around the second wire 24 adjacent to the second sealing element 36. The first and second clamping elements 40, 42 are formed by first and second end sections 38.1, 38.2 of the positioning means 38, which are arranged on opposite sides of the positioning means 38.

[0039] In order to provide strain relief for both wires 22, 24, the clamping elements 40, 42 are configured to be pressed radially inward against the wire, when the first and second housing parts 14, 18 are moved relative to each other into the assembled position shown in Fig. 1B. As indicated by the arrow 13 in Fig. 1A, the first housing part 14 may be moved towards the second housing part 18 into the assembled position.

[0040] Figs. 2A-C provide a detailed view of the first clamping element 40. Fig. 2A shows a view onto a face side 44 of the first clamping element 40 as seen from the sealing element 34 along the longitudinal axis L. The face

side 44 and an adjoining portion of the positioning means 38 are segmented along the axial direction (see side view in Fig. 2B). The individual segments of the first clamping element 40 form several axially extending clamping tongues 46, which may be elastically deflected in a radial direction, in particular towards the wire 22 enclosed by the first clamping element 40.

[0041] On the face side 44, the first clamping element 40 and, more precisely, each clamping tongue 46 comprises a beveled surface 48. The beveled surface 48 serves as a control element configured to convert a force exerted on the first clamping element 40 along the longitudinal axis L into a radial force deflecting the spring-like clamping tongues 46 radially inwards. As the beveled surface 48 is the most protruding part of the first clamping element 40, it is designed to interact with the sealing element 34, in particular, when the sealing element 34 and the clamping element 40 are forced towards each other during the relative movement of the first and second housing parts 14, 18 into the assembled position.

[0042] In order to engage effectively with the wire 22, the first clamping element 40 has a clamping ledge 50 on the radial inner side of the beveled surface 48 of each clamping tongue 46 as shown in Fig. 2C. The clamping ledge 50 is configured to dive into the wire 22 or a protective outer jacket of the wire 22, thereby providing strain relief by securing the wire 22.

[0043] The second clamping element 42 is formed accordingly, having a beveled surface 56 and clamping ledges 58 on its face side 52 and segmented clamping tongues 54, as exemplarily illustrated in Fig. 3A.

[0044] When pushing the first and second housing parts 14, 18 towards one another along the longitudinal axis L starting from the pre-assembled position of Fig. 1A and into the assembled position of Fig. 1B, the force exerted during the assembly of the housing 12 acts through the housing bevels 26, 28 onto the sealing elements 34, 36, pushing them towards the positioning element 38. The sturdy positioning element 38 exerts a counterforce onto the sealing elements 34, 36 pushing them into the housing bevels 26, 28 towards the wire inlets 16, 20. The slanted walls of the housing bevels 26, 28 in turn partially convert this axial force exerted onto the sealing elements 34, 36 into a radial force, pushing the sealing elements 34, 36 radially inwards into tight sealing contact with the wires 22, 24.

[0045] In order to allow convenient assembly of the positioning means 38 around a single wire 22 or a plurality of wires 23, 230 (see Fig. 4E), the positioning means including the clamping means may comprise two parts first and second parts 38a, 38b, in particular two half shells, which are brought into contact with each other in a mounting plane M (Fig. 2A). This allows easy and automation-friendly assembly from opposite sides of the wire 22 or plurality of wires 23, 230.

[0046] Furthermore, the axial force exerted by the sealing elements 34, 36 onto the clamping elements 40, 42 and their respective beveled surfaces 48, 56 leads to the

deflection of the clamping tongues 46, 54 towards the wires 22, 24. Strain relief is provided by the clamping ledges 50, 58 engaging with the wire surface.

[0047] Figs. 3A and 3B show a second embodiment of an electrical connector 10 in a pre-assembled and an assembled position, respectively. This electrical connector 10 differs from the first embodiment of Figs. 1A and 1B merely insofar as the first and second sealing elements 34, 36 each comprise two O-rings 34a, 34b and 36a, 36b arranged directly next to each other. By adding a second O-ring 34b, 36b to each sealing element 34, 36, higher sealing requirements may be met. In addition, the properties of the sealing elements 34, 36 may be fine-tuned to the application requirements. For example, the O-rings 34a, 36a adjoining each corresponding wire inlet 16, 20 may be of a softer or more elastic material in order to provide a perfect fit of the O-rings 34a, 36a around the corresponding wires 22, 24 and into the corresponding housing bevels 26, 28 in order to optimize the sealing effect. The O-rings 34b, 36b adjoining each clamping element 40, 42 may be of a harder or more rigid material in order to optimize the transmission of radial force onto each corresponding clamping element 40, 42 for achieving optimum strain relief.

[0048] Figs. 4A to 4F illustrate assembly steps of a method for manufacturing an electrical connector 10 according to a third embodiment. According to this embodiment, the electrical connector 10 comprises two first sealing and strain release structures 30 associated with the first housing part 14, and four second sealing and strain release structures 32 associated with the second housing part 18 (Fig. 4F, for sake of simplicity, the positioning means, wire inlets and housing bevels are omitted). The electrical connector 10 comprises a plurality of wires, specifically two wires 22, 220 extending into the housing 12 through two first wire inlets 16 arranged in the first housing part 14 and four wires 24, 24', 240, 240' extending through four second wire inlets 20 into the second housing part 18 (Fig. 4F).

[0049] In a first assembly step 60 shown in Fig. 4A, the first wire 22 is inserted into the first housing part 14 (depicted only in abstract form in Figs. 4A-4C) from a housing exterior side through a first wire inlet 16. In a second assembly step 62, a first sealing element 34, specifically an O-ring 34a, is positioned around the first wire 22 on a housing interior side. In a third assembly step 64, an end portion 22a of the first wire 22 is connected to a first connection portion 66a of a first busbar element 66, e.g. by welding or soldering, on the housing interior side. The first busbar element 66 has three connection portions 66a, 66b, 66c in the depicted embodiment, enabling the connection not only to the first wire 22, but also to the second wire 24 and the third wire 24'. Accordingly, the first, second and third assembly steps 60, 62, and 64 of Figs. 4A to 4C are repeated for the second and third wires 24, 24', which are each inserted into a second housing part 18 from a housing exterior side through second wire inlets 20 and which are each equipped with a second

sealing element 36, specifically with an O-ring 36a.

[0050] In the resulting first group of wires 23 comprising the first, second and third wires 22, 24, 24', the first busbar element 66 connects the first and second wires 22, 24 with each other via the connection portions 66a, 66b. In addition, via the connection portion 66c, the first wire 22 is connected to a third wire 24' having a smaller wire cross section. In order to provide fuse protection, the third wire 24' and the connection portion 66c are connected via a first fuse 68.

[0051] In addition, a further group of wires 230 similar to the first group of wires 23 is part of the electrical connector 10. It comprises a further set of first, second and third wires 220, 240, 240', connected to each other by a second busbar element 70 (Fig. 4D). Specifically, the first, second and third assembly steps 60, 62, and 64 of Figs. 4A to 4C are repeated for the further first, second and third wires 220, 240, 240', which are connected to each other by a second busbar element 70. As shown in Fig. 4D, O-rings 34a, 36a are positioned around each wire 220, 240, 240' and the end portions 220a, 240a, 240'a are connected to each other via further electrical components.

[0052] Specifically, the second busbar element 70 connects the further first wire 220 and the further second wire 240 with each other via connection portions 70a and 70b of the second busbar element 70. In addition, via a connection portion 70c, the further third wire 220 is connected to a further third wire 240' with a smaller wire cross-section via a second fuse 72.

[0053] In a further assembly step 74 depicted in Fig. 4E, a positioning means 38 is mounted on the groups of wires 23, 230 in between the sealing elements 34, 36. The positioning means 38 comprises individual clamping elements 40, 42, 42', 400, 420, 420' for providing strain relief for each of the wires 22, 24, 24', 220, 240, 240' according to the principle described in connection with Figs. 2A to 2C.

[0054] The positioning means 38 is designed to enclose the groups of wires 23, 230 in a sleeve-like manner in order to provide insulation against a shielding means of the electrical connector 10 (not shown). The positioning means 38 comprises two parts, specifically a top first part 38a as depicted in Fig. 4E and a bottom second part 38b. The top and bottom first and second parts 38a, 38b are mounted on opposite sides of the wires 22, 24, 24', 220, 240, 240', i.e. from above and below the drawing layer of Fig. 4E. As mentioned before, the first and second parts 38a, 38b are contacting each other in a mounting plane M, which is defined by the drawing layer in the shown embodiment (compare mounting plane M shown in Fig. 2A). The first and second parts 38a, 38b are generally half shells of the positioning means 38, designed to enclose the wires 22, 24, 24', 220, 240, 240' and any additional electrical components, thereby serving as an insulation element of the electrical connector 10.

[0055] In addition, the positioning means 38 is designed to interleave (not shown) between the first group

of wires 23 comprising the first, second and third wires 22, 24 and 24' and the first busbar element 66 and the second group of wires 230 comprising the further first, second and third wires 220, 240 and 240' and the second busbar element 70. The positioning means thus provides electrical insulation between the two groups of wires 23, 230 and thereby generates two voltage layers inside the electrical connector 10, which may have different electrical potentials.

[0056] In a final assembly step shown in Fig. 4F, the first and second housing parts 14 and 18 are moved towards each other into the assembled position along an axial direction defined by, e.g., the first wire 22, which is parallel to the axial extension of all other wires in the first and second group of wires 23, 230. The first and second sealing and strain relief structures 30, 32 of the electrical connector are thus activated according to the force transmission mechanisms described in connection with Figs. 1A to 1B and 2A to 2C (the housing bevels and positioning means are not shown in Fig. 4F for sake of clarity). Furthermore, in the third embodiment, a housing sealing element 74 pre-assembled with the first housing part 14 is put into effect in the assembled position, sealing the first and second housing parts 14 and 18 against each other.

[0057] In order to fix the first and second housing parts 14, 18 relative to each other along the longitudinal axis L, they may be connected by a latch lock or a similar locking mechanism (not shown).

[0058] The resulting electrical connector 10 of Fig. 4F may, for example, be used in a vehicle electrical connector as a two-way high voltage splice in order to supply more than one electric consumer with different current requirements. For example, first wires 22, 220 may be input wires connected to the poles of a high voltage battery, while the second and third wires 24, 24', 240, 240' arranged on the opposite side of the connector housing 12 may be output wires. For example, the second wires 24, 240 may be connected to a main electric consumer such as an electric motor. The third wires 24' and 240' may lead to a secondary electric consumer, which is protected by the first and second fuses 68 and 72. Of course, other variants of the electrical connector 10 are possible, for example, having a different number of input and/or output wires and/or having different wire sizes and/or wire orientations.

[0059] In Fig. 5A, a part of the positioning means 38, e.g. the top first part 38a, according to the embodiment of Figs. 4A-4F is depicted in a two-dimensional representation. In Fig. 5B an alternative positioning means 38 is depicted, the alternative positioning means 38 comprising two parts, namely an upper first part 38a and a lower second part 38b which can be brought into contact with each other in a mounting plane M. The alternative positioning means 38 comprises six clamping elements 40, 42, 42', 400, 420, 420'. In contrast to Fig. 4E, the mounting plane M of the positioning means of Fig. 5B is oriented perpendicular to the longitudinal axis L defined by one or more wires (not shown) of the electrical con-

connector 10. The clamping elements 40, 42, 42', 400, 420, 420' and the upper first and lower second parts 38a, 38b are each drawn over the associated wires 22, 24, 24', 220, 240, 240' like a sleeve, completely enclosing the wires 22, 24, 24', 220, 240, 240' in the circumferential direction. By moving the first and second housing parts 14, 18 from the pre-assembled into the assembled position, the upper and lower first and second parts 38a, 38b are moved into contact with each other along the arrows 39, thereby establishing the assembled positioning means 38.

[0060] The upper and lower first and second parts 38a, 38b of the positioning means 38 of Fig. 5B cannot be mounted on fully assembled groups of wires 23, 230 which may also comprise, e.g., sheet metal parts 66, 70 and fuses 68, 72. Thus, the individual wires 22, 24, 24', 220, 240, 240' need to be inserted into the clamping elements 40, 42, 42', 400, 420, 420' in the same manner as they are inserted into the respective housing parts 14, 18 in assembly step 60 (Fig. 4A). The insertion into the clamping elements 40, 42, 42', 400, 420, 420' needs to occur prior to positioning an O-ring sealing element 34, 36 around each wire, i.e. prior to assembly step 62 illustrated in Fig. 4B.

Reference numeral list

[0061]

10	electrical connector
12	housing
13	arrow indicating movement into assembled position
14	first housing part
16	first wire inlet
18	second housing part
20	second wire inlet
22	first wire
22a	end portion of the first wire 22
23	first group of wires
24	second wire
24'	third wire
26	first housing bevel
26a	first receptacle
28	second housing bevel
28a	second receptacle
30	first sealing and strain relief structure
32	second sealing and strain relief structure
34	first sealing element
34a	first O-ring of the first sealing element 34
34b	second O-ring of the first sealing element 34
36	second sealing element
36a	first O-ring of the second sealing element 36
36b	second O-ring of the second sealing element 36
38	positioning means
38a	first part of the positioning means 38
38b	second part of the positioning means 38
38.1	first end section of the positioning means 38

38.2	second end section of the positioning means 38	
39	arrow indicating assembly of the positioning means 38	
40	first clamping element	
42	second clamping element	5
44	face side of the first clamping element 40	
46	clamping tongue of the first clamping element 40	
48	beveled surface of the clamping tongue 46	
50	clamping ledge of the clamping tongue 46	10
52	face side of the second clamping element 42	
54	second clamping tongue of the second clamping element 42	
56	beveled surface of the second clamping tongue 54	15
58	clamping ledge of the second clamping tongue 54	
60	first assembly step	
62	second assembly step	
64	third assembly step	20
66	first busbar element	
66a	first connection portion of the first busbar element 66	
66b	second connection portion of the first busbar element 66	25
66c	third connection portion of the first busbar element 66	
68	first fuse	
70	second busbar element	
70a	first connection portion of the second busbar element 70	30
70b	second connection portion of the second busbar element 70	
70c	third connection portion of the second busbar element 70	35
72	second fuse	
74	further assembly step	
220	further first wire	
220a	end portion of the further first wire 220	
230	second group of wires	40
240	further second wire	
240a	end portion of the further second wire 240	
240'	further third wire	
240'a	end portion of the further third wire 240'a	45

L longitudinal axis

Claims

1. An electrical connector (10) comprising:

a housing (12);
a wire (22) extending into the housing (12);
the housing (12) comprising a first housing part (14) and a second housing part (18) movable relative to each other, between a pre-assembled position and an assembled position, along a lon-

gitudinal axis (L) defined by the wire (22);
a first sealing and strain relief structure (30) associated with the first housing part (14), comprising:

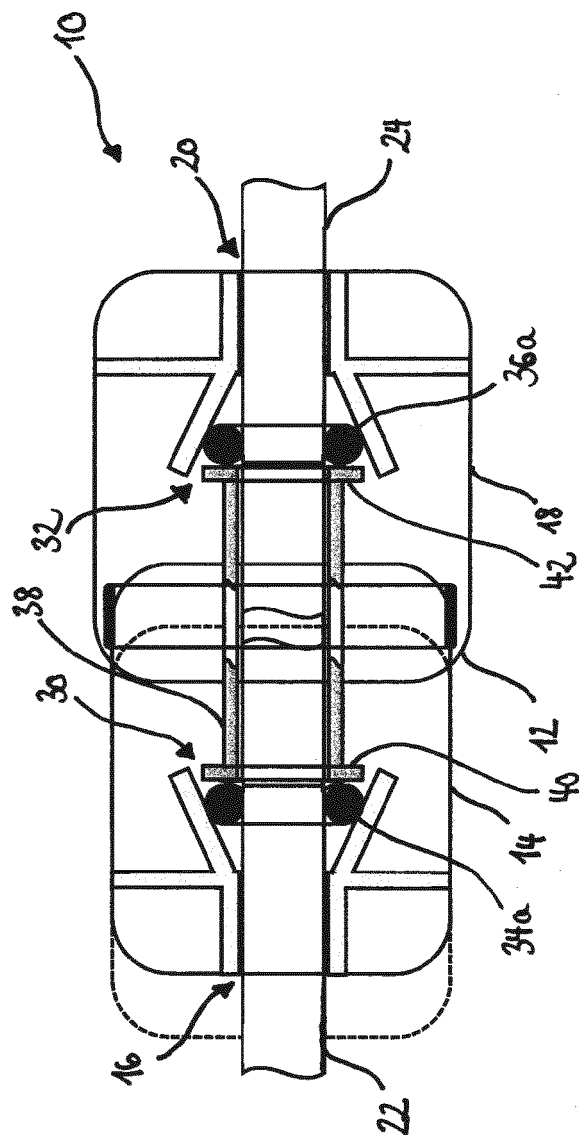
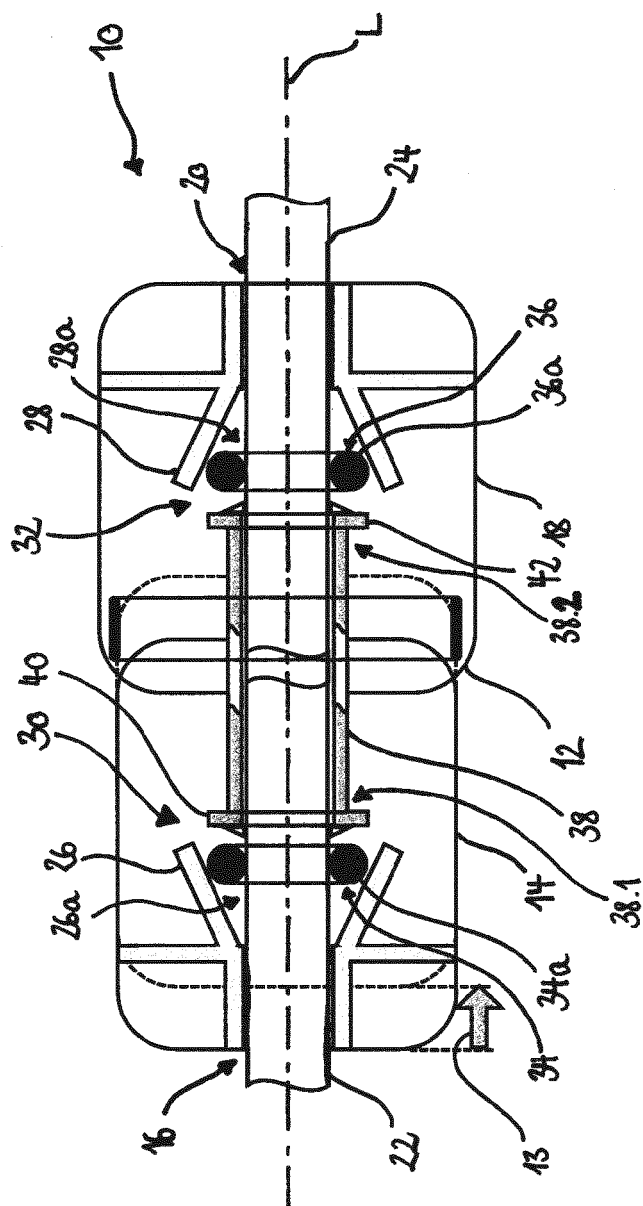
- a housing bevel (26) formed by the first housing part (14) and defining a receptacle (26a),
- a sealing element (34) configured to be positioned around the wire (22),
- a wire inlet (16) arranged in the first housing part (14), the wire inlet (16) leading into the receptacle (26a), the receptacle (26a) being configured to accommodate the wire (22) and the sealing element (34),
- a positioning means (38) configured to secure the wire (22) in the assembled position and comprising a clamping element (40) configured to be positioned around the wire (22) adjacent to the sealing element (34) on a side opposite from the wire inlet (16),

the sealing element (34) being configured to be pressed against the housing bevel (26) upon a relative movement of the first and second housing parts (14, 18) from the pre-assembled into the assembled position, and
at least a section of the clamping element (40) being configured to be pressed radially inward against the wire (22) upon a relative movement of the first and second housing parts (14, 18) from the pre-assembled into the assembled position.

2. The electrical connector (10) of claim 1, further comprising a further wire (24) extending into the housing (12) and a second sealing and strain relief structure (32) associated with the second housing part (18), comprising:

- a housing bevel (26) formed by the second housing part (18) and defining a receptacle (28a),
 - a sealing element (36) configured to be positioned around the further wire (24),
 - a wire inlet (20) arranged in the second housing part (18), the wire inlet (20) leading into the receptacle (28a), the receptacle (28a) being configured to accommodate the wire (24) and the sealing element (36),
 - a positioning means (38) configured to secure the wire (24) in the assembled position and comprising a clamping element (42) configured to be positioned around the wire (24) adjacent to the sealing element (36) on a side opposite from the wire inlet (20),
- the sealing element (36) being configured to be pressed against the housing bevel (28) upon a

- relative movement of the first and second housing parts (14, 18) from the pre-assembled into the assembled position, and
at least a section of the clamping element (42) being configured to be pressed radially inward against the wire (24) upon a relative movement of the first and second housing parts (14, 18) from the pre-assembled into the assembled position.
3. The electrical connector (10) of claim 2, wherein the first and second sealing and strain relief structures (30, 32) are arranged on opposite sides of the housing (12).
 4. The electrical connector (10) of any of the preceding claims, further comprising a plurality of wires (22, 24, 24', 220, 240, 240'), wherein the positioning means (38) is configured to secure the plurality of wires (22, 24, 24', 220, 240, 240') in the assembled position.
 5. The electrical connector (10) of claim 4, the positioning means (38) comprising a plurality of clamping elements (40, 42, 42', 400, 420, 420') configured to secure the plurality of wires (22, 24, 24', 220, 240, 240').
 6. The electrical connector (10) of any one of the preceding claims, the positioning means (38) serving as an insulation element.
 7. The electrical connector (10) of any one of the preceding claims, the positioning means (38) comprising two parts (38a, 38b) configured to be mounted on opposite sides of the wire (22).
 8. The electrical connector (10) of any one of the preceding claims, the clamping element (40, 42) comprising at least one axially extending clamping tongue (46, 54) configured to be elastically deflected in a radial direction.
 9. The electrical connector (10) of any one of the preceding claims, the clamping element (40, 42) comprising a control element configured to interact with the sealing element (34, 36) upon an axial relative movement of the first and the second housing parts (14, 18) from the pre-assembled to the assembled position, such that at least a portion of the clamping element (40, 42) is forced radially inwards.
 10. The electrical connector (10) of claim 9, the control element comprising a beveled surface (48, 56) located at an end face (44, 52) of the clamping element (40, 42) facing the sealing element (34, 46).
 11. The electrical connector (10) of any one of the preceding claims, wherein the diameter of the receptacle (26a, 28a) widens towards a centre of the housing (10).
 12. The electrical connector (10) of any one of the preceding claims, the sealing element (34, 36) comprising at least one O-ring (34a, 34b, 36a, 36b).
 13. The electrical connector (10) of any one of the preceding claims, wherein, in the assembled position, the first housing part (14) and the second housing part (18) are locked to each other in position, for example by a latch lock.
 14. The electrical connector (10) of any one of the preceding claims, wherein the housing (12) comprises a housing sealing element (74) sealing the first housing part (14) and the second housing part (18) against each other in the assembled position.
 15. A method of assembling an electrical connector (10), in particular in accordance with any one of the preceding claims, the method comprising:
 - providing a wire (22);
 - providing a housing (12) comprising a first housing part (14) forming a housing bevel (26) defining a receptacle (26a) and having a wire inlet (16) leading into the receptacle (26a), and a second housing part (18);
 - inserting (60) the wire (22) from a housing exterior side into the wire inlet (16);
 - positioning (62) a sealing element (34) around the wire (22) on a housing interior side;
 - mounting (74) a positioning means (38) on the wire (22) to secure the wire (22) in an assembled position and positioning a clamping element (40) of the positioning means (38) around the wire (22) adjacent to the sealing element (34) on a side opposite from the wire inlet (16),
 - moving the first and second housing parts (14, 18) towards each other, from a pre-assembled position into an assembled position, along a longitudinal axis (L) defined by the wire (22) such that the sealing element (34) is pressed against the housing bevel (26) and at least a section of the clamping element (40) is pressed radially inward against the wire (22) by the sealing element (34).



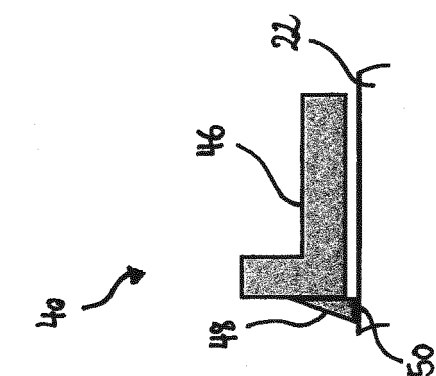


Fig. 2C

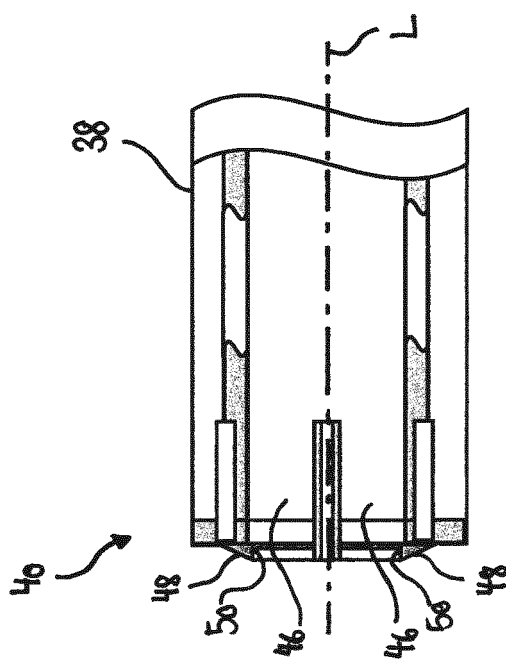


Fig. 2B

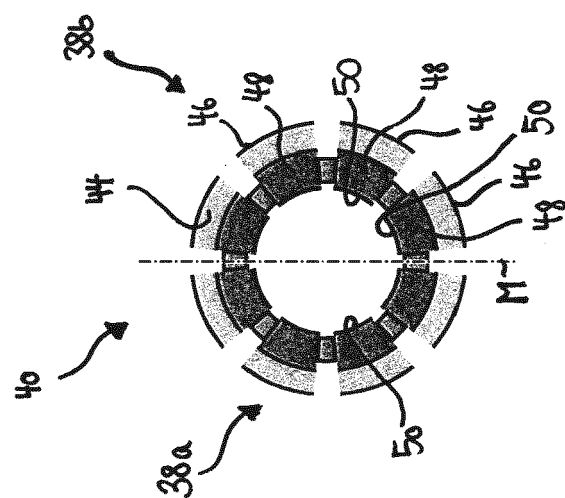


Fig. 2A

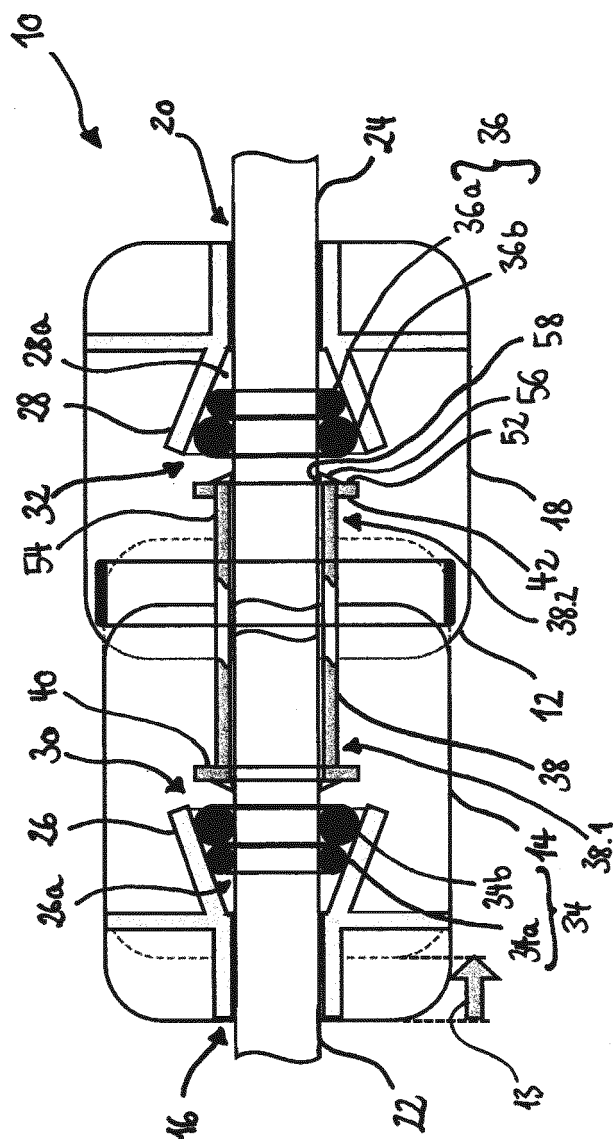


Fig. 3A

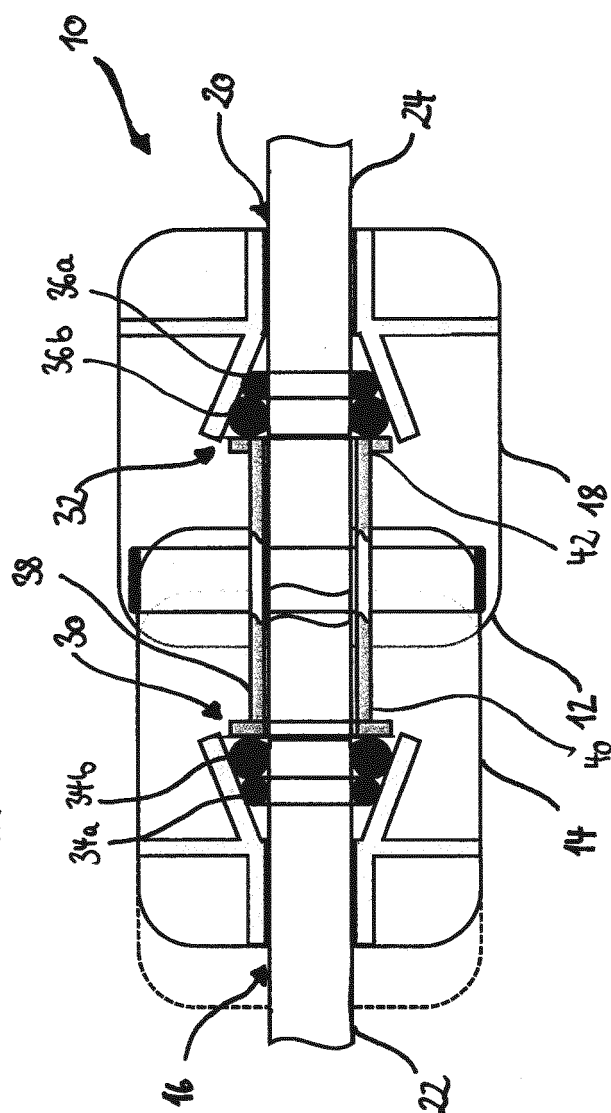


Fig. 3B

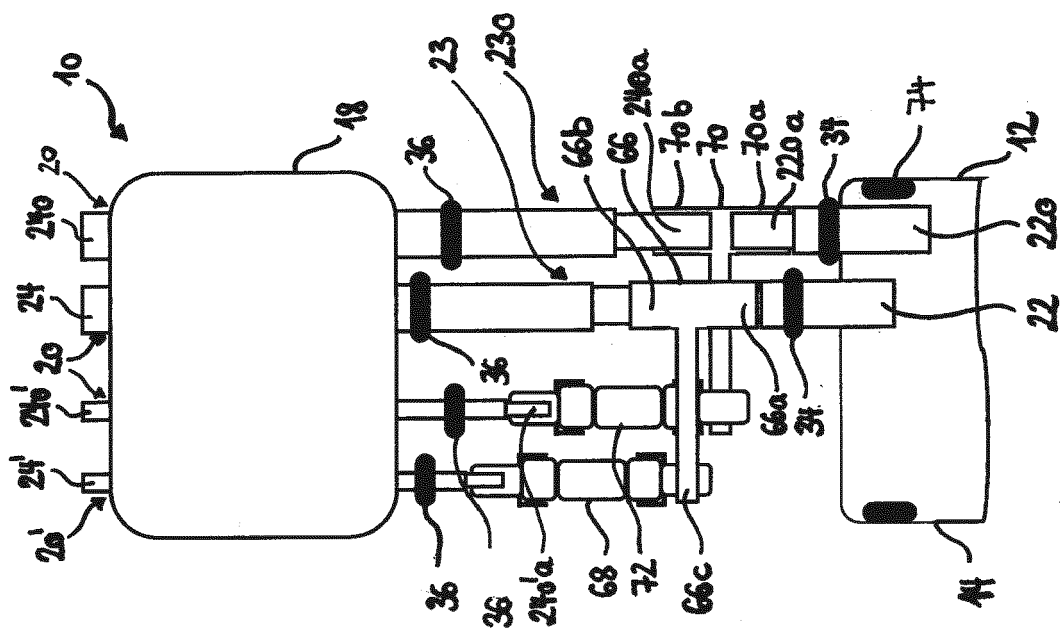


Fig. 4D

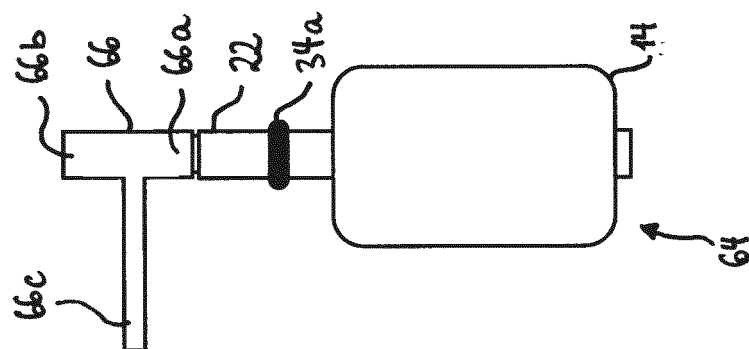


Fig. 4C

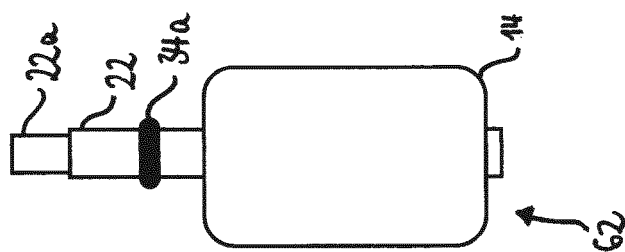


Fig. 4B

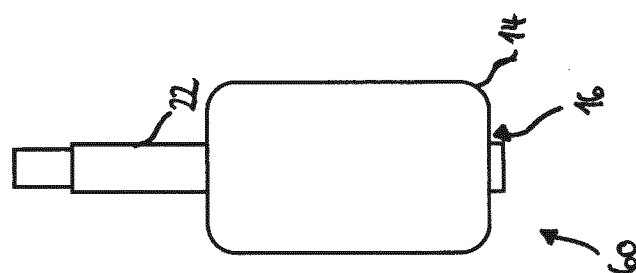


Fig. 4A

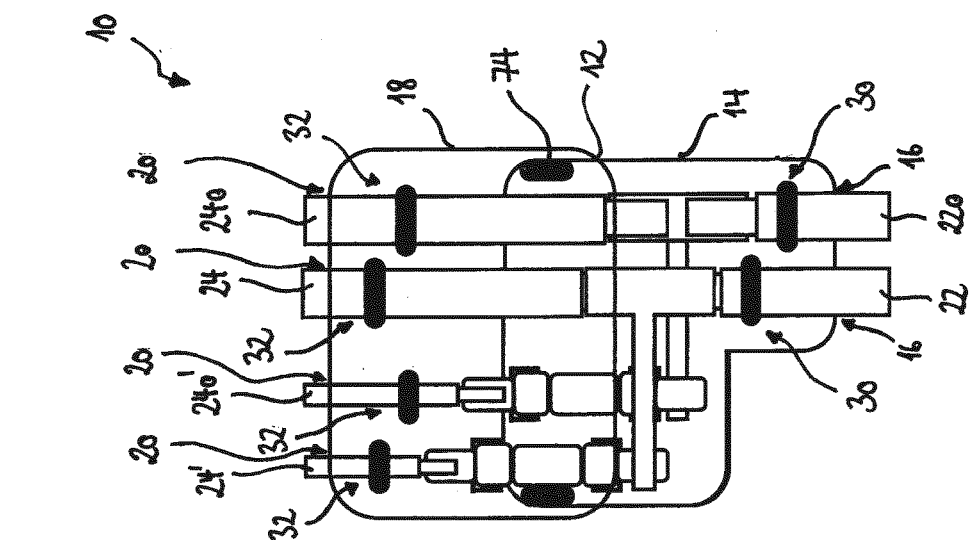


Fig. 4E

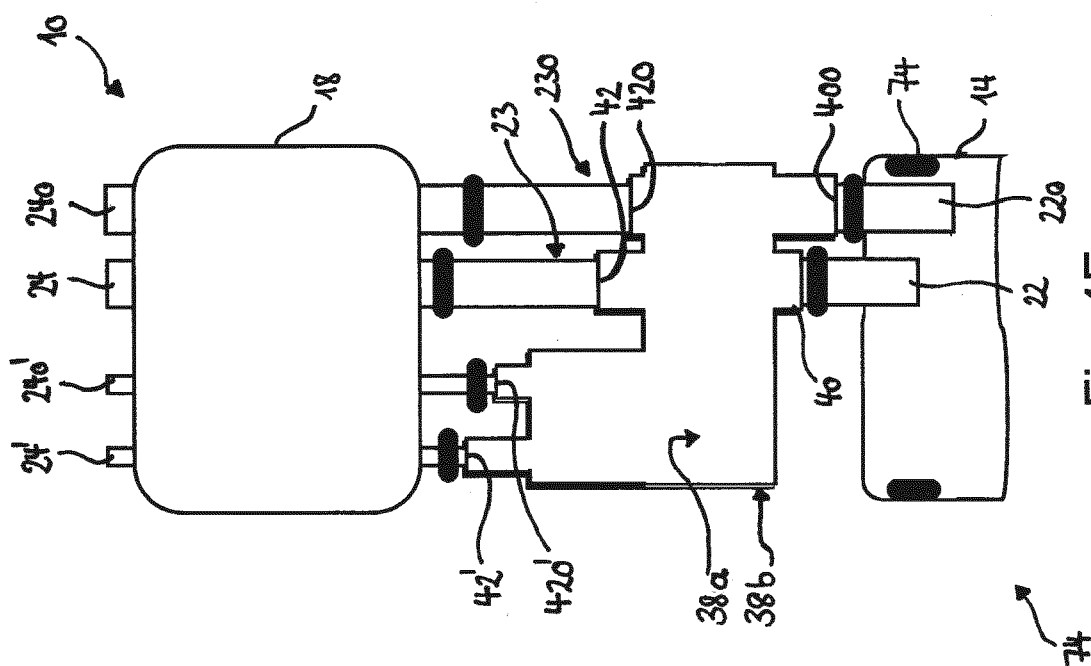


Fig. 4F

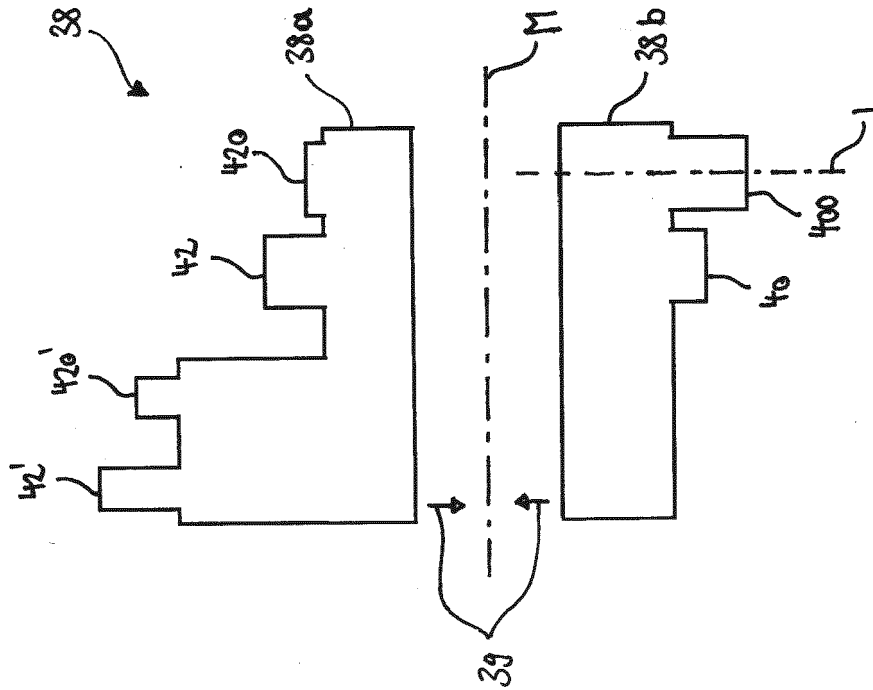


Fig. 5B

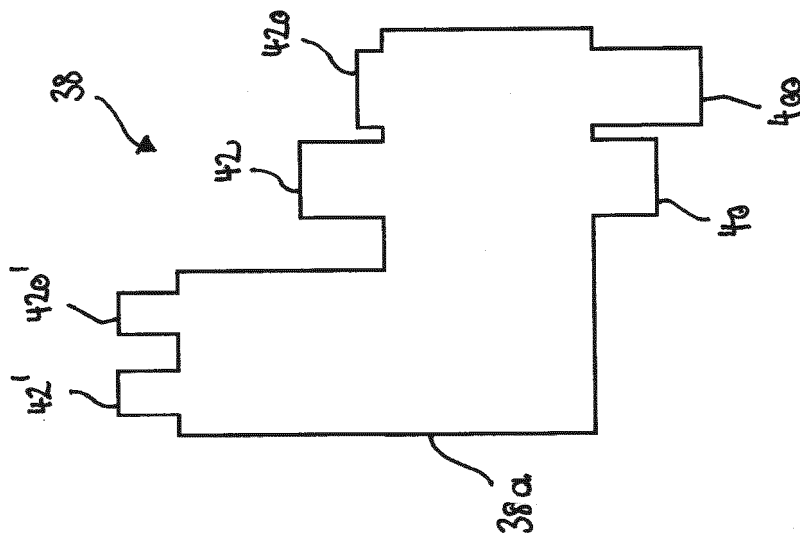


Fig. 5A



EUROPEAN SEARCH REPORT

Application Number
EP 21 16 0909

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Y	* paragraphs [0073], [0074], [0079], [0087], [0088], [0123]; figures 7-13,20,21 *	2,3	H01R13/52 H01R43/20
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Place of search		Date of completion of the search	Examiner
The Hague		20 August 2021	Teske, Ekkehard
CATEGORY OF CITED DOCUMENTS			
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