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(71) Applicants:
• **TE Connectivity Germany GmbH**
64625 Bensheim (DE)
• **Tyco Electronics AMP Italia S.r.l.**
10093 Collegno (Torino) (IT)

(72) Inventors:
• **SEIPEL, Volker**
64625 Bensheim (DE)
• **GREGOR, Christian Walter**
64673 Zwingenberg (DE)
• **BLUEMMEL, Uwe**
69502 Hemsbach (DE)

• **VAN DE BURGT, Guido**
64625 Bensheim (DE)
• **MUELLER, Wolfgang**
64285 Darmstadt (DE)
• **ULRICH, Harald**
64405 Fischbachtal (DE)
• **GENTA, Alessandro**
10191 Albignano (IT)
• **ZANNINI, Raoul**
10044 Pianezza (IT)
• **MEIER, Rüdiger**
69151 Neckargemünd (DE)

(74) Representative: **Patentanwaltskanzlei WILHELM & BECK**
Prinzenstraße 13
80639 München (DE)

Remarks:

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(54) **WIRE SEAL, PARTICULARLY SINGLE-WIRE SEAL**

(57) The present invention relates to a wire seal (10), particularly a single-wire seal (10) for a wire (30), for example an aluminium wire (30) and an electric crimp terminal (20), especially for the automotive industry, having a sealing section (110) for sealing off the electric crimp terminal (20) against an environment, wherein the wire seal (10) comprises an anti-kink section (100) at a trailing end of the sealing section (110), wherein the anti-kink section (100) prevents the wire (30) from being bent or buckled at the trailing end of the sealing section (110).

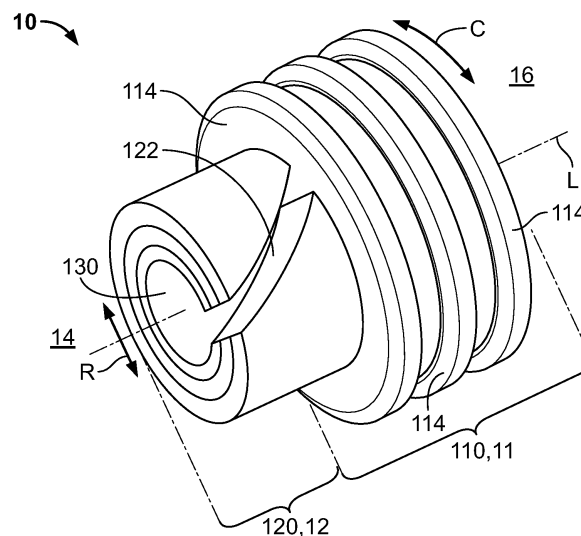


Fig. 1

Description

[0001] The present invention relates to a wire seal, particularly a single-wire seal for an aluminium wire and an electric crimp terminal, especially for the automotive industry. The invention further relates to a cable assembly or cable harness for the automotive industry, wherein the cable assembly or the cable harness comprises an inventive wire seal, particularly an inventive single-wire seal.

[0002] In engineering and in particular in electrical engineering, a large number of electrical connectors and mating connectors of many different types are known. These serve to transmit electrical power and/or electrical signals with the widest possible range of voltages, currents, frequencies and data rates. Furthermore, electrical connectors and mating connectors have to fulfil other functions. For damp, dusty or chemically aggressive environments, electrical connectors and mating connectors comprise seals which prevent penetration of surrounding media into the electrical connectors and mating connectors and corrosion thereof, or the formation of conductive deposits therein.

[0003] Due to a wide range of applications and conditions of use, a wide variety of optimised electrical (mating) connectors, terminals and seals can therefore be found. A new field is the application of aluminium wires or their strands instead of copper wires or their strands for electrical connectors, particularly in the automotive industry, because of significantly lower costs and weight of aluminium. - However, the application of aluminium has certain drawbacks. Aluminium has other material properties than copper, whereby it is prone to overstressing, oxidises when it is exposed to air and it is not as strong as copper. Furthermore, an aluminium wire or its strands are more difficult to strip, to splice, to feed, to cut and/or to crimp than a cable comprising a copper wire. Particularly small aluminium cables and wires raise many challenges.

[0004] In the following, a wire or an electrical cable comprises an electric wire surrounded by an electrical insulation, wherein the wire or the electrical cable is stripped at a longitudinal end portion. The electric wire in turn may comprise a plurality or a bundle of strands, wherein such an electric wire may also be called multi-stranded electric wire, hereinafter also referred to as electric wire. Further, the electric wire itself may be a single strand, i. e. a massive lead. The electric wire or its strands are preferably made from aluminium or an aluminium alloy, also copper or a copper alloy is applicable.

[0005] The biggest problems lie in crimping and subsequently in avoiding bending the electric wire with a comparatively small radius and/or even buckling of the electric wire. Particularly overstressing a crimped aluminium wire at an electric crimp terminal has to be avoided. Here, two problem areas are identified. The first area lies between a wire crimp section and an insulation crimp section in the presence of a wire seal also crimped at the

insulation crimp section of the terminal, due to the comparatively soft wire seal allowing for too much movement of the electric wire in the insulation crimp section and thus at the wire crimp section of the crimp terminal. The first problem area is addressed by EP 2 819 249 B1. The second problem area lies at a trailing end of the crimp terminal or the soft wire seal, which is addressed by this document. At these positions the aluminium wire runs the risk of being buckled because of an improper use of the terminal and/or the electric wire.

[0006] EP 2 166 624 A1 teaches a waterproof electrical connector comprising an electrical cable whose electric wire is electrically connected to a crimp terminal. Further, the electrical cable comprises a resilient plug mounted on an electrical insulation on an end portion of the cable, wherein the resilient plug is held in place by the crimp terminal. The resilient plug comprises a main body having outer lips projecting therefrom. The outer lips are resiliently held in a close contact with an inner surface of a cavity of an housing of the electrical connector. Auxiliary lips which are smaller than the outer lips also project from the main body of the resilient plug. The outer lips and the auxiliary lips are arranged so as to lean against each other for securing waterproofness of the electrical connector when the electrical cable is bent.

[0007] It is an object of the invention to provide an improved wire seal for an electric crimp terminal by means of which it is at least possible to decrease the problem of overstressing crimped aluminium wires at the identified second problem area. Further, a two-in-one solution for both problem areas should be indicated. - Here, a mounting surrounding of the wire seal should not be affected, i. e. the electric crimp terminal and/or a contact chamber for the crimp terminal should not have to be alternated because of the inventive wire seal. Further, an inventive wire seal should have a competitive price and should tighten at least as well as a wire seal according to the state of the art. Moreover, the inventive wire seal should be quick and easy to manufacture and thus be cost efficient.

[0008] The object of the present invention is solved by means of a wire seal, particularly a single-wire seal for an aluminium wire and an electric crimp terminal, especially for the automotive industry, according to claim 1; and by means of a cable assembly or cable harness for the automotive industry, according to claim 12. Advantageous embodiments, additional features and/or advantages of the invention may be derived from the dependent claims and the following description.

[0009] The wire seal according to the invention comprises a sealing section for sealing off the electric crimp terminal against an environment. The wire seal further comprises an anti-kink section at a trailing end of the sealing section, wherein the anti-kink section prevents an electric wire from being bent or buckled at the trailing end of the sealing section. The anti-kink section preferably comprises an anti-kink body which is preferably shaped as an essentially hollow-cylindrical portion. Fur-

ther, the anti-kink section preferably further comprises a grommet or sleeve at a trailing end portion of the anti-kink body.

[0010] By means of the anti-kink section, it is possible to avoid bending the electric wire with a comparatively small radius. Thus, buckling of the electric wire is effectively avoided. Particularly the grommet or sleeve at the trailing portion together with the anti-kink body achieves this goal, because by appearance of a bending or buckling force at the end of a crimped electrical cable the grommet or sleeve continuously introduces a bending force into the anti-kink body and from there into a housing for the crimp terminal. The mechanical tensions do not remain in the electric wire, as they are expanded and deflected into the housing.

[0011] A flexibility or a mechanical pliability of the anti-kink section or the anti-kink body may correspond to a flexibility or a mechanical pliability of the sealing section. Here, a median axial section modulus of the anti-kink section or the anti-kink body preferably corresponds to a median axial section modulus of the sealing section. I. e. these values do not differ more than essentially 5%, 10%, 15%, 20%, 25%, 50%, 75% or 100% from one another. A length of the anti-kink section, a length of the anti-kink body and/or a length of the grommet may amount to essentially 50%, 75%, 100%, 125%, 150% or 200% of the length of the sealing section or the crimping section.

[0012] The wire seal preferably comprises a crimping section at a leading end of the sealing section for crimping the wire seal to the electric crimp terminal. Further, the wire seal is preferably made from a comparatively soft silicone or rubber, wherein the wire seal may be produced by preferably a one-shot injection moulding process. I. e. the anti-kink section, the sealing section and the crimping section are preferably produced as a one-piece or integral wire seal. Here, a structure of the wire seal is kept together by a material bond (adhesion) and/or cohesion. Preferably the anti-kink section, the sealing section and/or the crimping section, or the wire seal are rotationally symmetrical.

[0013] A changeover of the anti-kink body to the grommet or sleeve may be an abrupt (circumferential zone of discontinuity) or a continuous changeover. A course of a cavity of the wire seal in the anti-kink section for the wire may be a tapering in the direction of the trailing end. At a longitudinal end or end portion of the grommet, an inner diameter of the grommet may preferably be less than an outer diameter of an insulation of the wire. Hereby, it is guaranteed that the wire is sealed also in the anti-kink section against a surrounding media. Due to a good flexibility of the grommet, the grommet also seals when it is bent. Furthermore, before a first inner sealing lip has to tighten the wire against an environment, this task is overtaken by the grommet so that an inventive wire seal achieves better sealing.

[0014] In a variant of the invention the wire seal comprises a crimping section for crimping the wire seal to the

electric crimp terminal and a sealing section of the wire seal is made from a comparatively or relatively soft material, and the crimping section of the wire seal is made from a comparatively or relatively hard material. I. e. these two materials are in relation to each other, wherein the material of the sealing section is softer than the material of the crimping section. And vice versa, i. e. the material of the crimping section is harder than the material of the sealing section. A choice of one material is a limitation for the other material.

[0015] In an embodiment of the variant, in a ready-for-use wire seal, the sealing section and the crimping section are held together by an undercut, a back-taper, a catch mechanism, a latching connection and/or by adhesion. Here, the sealing section and the crimping section may be stuck, put, plugged and/or glued together. Furthermore, the sealing section and the crimping section are produced together as a one-piece wire seal, which may be carried out by a two-component moulding process. The sealing section is preferably made from a comparatively soft silicone or rubber, whereas the crimping section is preferably made from a comparatively hard silicone or rubber.

[0016] According to the invention, the wire seal may comprise a weakened segment in a rotation-symmetric portion, particularly in an essentially hollow-cylindrical portion of its crimping section, wherein the crimping section preferably comprises a recess on an outside and/or an inside of this portion. Such a recess, weakened segment or deviation from an ideal rotation-symmetric circumferential portion of the crimping section extends in a longitudinal, radial and circumferential direction of the wire seal. The weakened segment in the rotation-symmetric portion enables the crimping section to be deformed by an insulation crimp wing of the insulation crimp section of the terminal such that the wire seal may be crimped to the crimp terminal.

[0017] The recess, weakened segment or deviation may be a longitudinal and/or circumferential slot in the crimping section. Preferably, the longitudinal and/or circumferential slot completely passes through the crimping section in radial direction, wherein the slot preferably extends over essentially the entire longitudinal length of the crimping section. Here, the wire seal may be constructed in such a way that the crimping section is at least partially moveable or slidable at/in the sealing section mainly in radial direction. Further, at least a circumferential portion of the crimping section or the entire crimping section may be rotationally moveable in relation to the sealing section. In embodiments of the invention, a leading sealing lip inside or outside of the wire seal may extend farther in a radial direction than a vicinal sealing lip at the same circumferential side of the wire seal.

[0018] Further, the wire seal may be formed such that at least one weakened segment is established in the crimping section in such a way that it constitutes a predetermined breaking, folding or deforming area for the crimping section during crimping to the electric crimp ter-

minal. I. e. during crimping the wire seal (containing the wire) with its crimping section to the insulation crimp section of the crimp terminal, the weakened segments of the crimping section break open or bend in an elastic and/or plastic manner. Thereby, the wire seal is mounted to the crimp terminal with its relatively hard component, and its relatively soft component protrudes from a trailing end of the crimp terminal ready for sealing the crimp terminal in a contact chamber against the environment of the contact chamber.

[0019] Furthermore, the crimping section of the wire seal is preferably a non-rotation-symmetric section due to the weakened segment. The sealing section of the wire seal is preferably a rotation-symmetric section. Moreover, a structure of the wire seal is kept together by a force closure, a form closure and/or an adhesive bond. The latter may be achieved by gluing the crimping section and the sealing section to each other or by a two-component moulding process.

[0020] The crimping section may comprise a projection or collar preferably at a leading end of the crimping section. Furthermore, in all embodiments of the invention, the sealing section preferably comprises at least one outer and/or at least one inner sealing lip. The wire seal, i. e. its sealing section comprises one, two, three or four outer and/or inner sealing lips, wherein the sealing section may comprise more inner than outer sealing lips. Furthermore, it is preferred that the entire wire seal is essentially tubular. Naturally, the wire seal is also constituted as a cable seal for an electrical cable.

[0021] The cable assembly or the cable harness comprises an inventive wire seal, particularly an inventive single-wire seal. The cable assembly or the cable harness particularly further comprises at least one crimp terminal and at least one electrical cable. Preferably, the wire or electrical cable has an electric wire comprising aluminium, but also an electric wire comprising copper is suitable. The cable harness may further comprise an inventive cable assembly and/or a non-inventive cable assembly.

[0022] Preferred exemplary variants and embodiments of the present invention are explained below in more detail with reference to the accompanying drawing. Elements of the same design and function that appear in different figures (fig.) of the drawing are identified by the same reference numerals. In the drawing:

- fig. 1 shows a first embodiment of a variant of a wire seal constituted as a two-component single-wire seal in a perspective view;
- fig. 2 shows a cable assembly comprising an electrical cable, an electric crimp terminal and the wire seal from fig. 1 in a three-dimensional front view from above;
- fig. 3 shows a second embodiment of the variant of the wire seal comprising a crimping section made from a hard component and a sealing section made from a soft component in a central

cross-sectional view;

- fig. 4 shows the wire seal of fig. 3 in a front view, wherein also a weakened segment in the crimping section, constituted as a clearance slot can be seen;

- fig. 5 shows an embodiment of a variant of an inventive wire seal constituted as a single-wire seal comprising an anti-kink section in a central cross-sectional view;

- fig. 6 shows the wire seal from fig. 5 in a contact chamber and in a back-tolerance position (an electrical cable and an electric crimp terminal are omitted) in a central cross-sectional view;

- fig. 7 shows in an analogous manner the wire seal from fig. 6, wherein the wire seal is in a middle-tolerance position; and

- fig. 8 shows in an analogous manner the wire seal from fig. 6, wherein the wire seal is in a front-tolerance position.

[0023] The invention will be described hereinafter in greater detail based on exemplary embodiments of two exemplary variants of a single-wire seal 10 for a wire 30 and an electric crimp terminal 20 for electric connections in a motor vehicle. However, the invention is not limited to these embodiments, but may be applied to diverse electric contacts or electrical connectors, also to a non-single-wire seal. Further, the invention is not restricted to the automotive industry. Wherever electricity in form of currents, voltages, signals, frequencies and/or data has to be transmitted the invention may be applied. Further, the invention is applicable to optical cables or wires (pigtailed) as well as to optoelectrical or optoelectronic means, devices and/or apparatuses.

- [0024]** Fig. 1 to 4 show a variant of a wire seal 10 which is constituted as a two-component wire seal 10, particularly a two-component single-wire seal 10, formed as a radial and mechanical sealing 10, gasket 10 or sealing plug 10 particularly for an electric contact 20 which can be seen in fig. 2. The electric contact 20 is preferably constituted as a crimp terminal 20, a crimp contact 20 or an electrical connector (not depicted). The crimp terminal 20 comprises a wire crimp section 210 having at least one wire crimp wing by means of which a stripped tip end portion of a wire 30 or an electrical cable 30 may be crimped onto the crimp terminal 20. The wire 30 preferably comprises a plurality or a bundle of aluminium strands. Copper strands are also applicable. Furthermore, the wire 30 or electrical cable 30 may be constituted as a cable harness or as a part of it.

[0025] At a leading portion of the crimp terminal 20, the crimp terminal 20 itself comprises an electric contact section 220 or contact body 220 which may be constituted as a receptacle (cf. fig. 2), socket, tab, pin (rest is not shown) etc. Furthermore, at a trailing portion 14 of the crimp terminal 20, the crimp terminal 20 itself comprises an insulation crimp section 200 (cf. fig. 2) which has at least one insulation crimp wing. By means of the insula-

tion crimp wing, an electrically isolated portion of the wire 30 or electrical cable 30 may be crimped onto the crimp terminal 20. Furthermore, between the insulation crimp wing of the crimp terminal 20 and the isolated portion of the wire 30, the wire seal 10 may also be crimped onto the crimp terminal 20.

[0026] Fig. 2 shows a cable assembly 1 or part of an cable harness comprising the wire seal 10 and the wire 30 crimped to each other at the electric crimp terminal 20. In a manufacturing process, the wire seal 10 and the wire 30 are simultaneously crimped to the electric terminal 20. The crimped terminal 20 constituting a tip end portion of the cable assembly 1 is afterwards locked (not depicted) in a contact chamber 400 of a housing 40 or casing 40 (cf. 6 to 8) of an electrical connector, device etc. (not shown). The crimped wire seal 10 seals off the crimped terminal 20 against an environment of the housing 40.

[0027] The wire seal 10 according to the fig. 1 to 4 is composed as a two-component seal 10 wherein a first component 11 of the wire seal 10 is made from a first material 11 and a second component 12 of the wire seal 10 is made from a second material 12. The first material 11 is preferably a comparatively soft material 11 and the second material 12 is preferably a comparatively hard material 12, both materials being preferably made from a silicone and/or a rubber. The comparatively soft component 11 is for tightening or sealing and the comparatively hard component 11 is for crimping the wire seal 10 to the insulation crimp section 200 of the crimp terminal 20.

[0028] Preferably both components 11, 12 are essentially hollow-cylindrical parts connected to each other by a form closure (cf. fig. 3), a force closure and/or by an adhesive or material bond. - The comparatively soft component 11 constitutes a sealing section 110 of the wire seal 10 preferably comprising a hollow-cylindrical base 112 having at least one, preferably a plurality of particularly radial inner sealing lips 115. The inner sealing lips 115 serve to seal off a fluid passage to the crimp terminal 20 at an electrical insulation of the wire 30. Further, the base 112 comprises at least one, preferably a plurality of particularly radial outer sealing lips 114. The outer sealing lips 114 serve to seal off a fluid passage to the crimp terminal 20 at an inside of the contact chamber 400 (cf. 6 to 8).

[0029] The comparatively hard component 12 constitutes a crimping section 120 of the wire seal 10. The crimping section 120 is arranged at a leading or front side 14 and the sealing section 110 is arranged at a trailing or back side 16 of the wire seal 10. I. e. the sealing section 110 constitutes a trailing portion and the crimping section 120 constitutes a leading portion of the wire seal 10. In the depicted embodiment, the crimping section 120 and the sealing section 110 are locked to, latched to, clicked to and/or engaged with each other. In other embodiments (not shown), the crimping section 120 and the sealing section 110 may be glued to each other.

[0030] As shown in fig. 3, at the trailing side 16 of the crimping section 120 a locking element 126, particularly a locking projection 126 is provided which is locked with a locking element 116, particularly a locking recess 116 of the sealing section 110 at its leading side 14, or vice versa. Here, the locking elements 116, 126 are formed as complementary or corresponding locking elements 116, 126. The locking elements 116, 126 extend in a circumferential direction C of the wire seal 10, wherein the locking element 126 of the crimping section 120 may be interrupted by preferably only one recess 122 (see below).

[0031] The crimping section 120 and the sealing section 110 may be produced independently from each other and may afterwards be mechanically stuck, put or plugged to each other. Moreover, the sealing section 110 and the crimping section 120 may be produced at the same time by a two-component moulding process, particularly a two-component injection moulding process. I. e. the two-component wire seal 10 is produced as a one-piece wire seal 10. In such embodiments, the crimping section 120 and the sealing section 110 may at least partially adhere to each other, or the crimping section 120 and the sealing section 110 may be rotationally moveable against each other in circumferential direction C.

[0032] For good crimping results, the crimping section 120 may comprise a weakened segment 122 which weakens the crimping section 120 in its circumferential direction C so that it is possible to reduce a diameter of the crimping section 120 during crimping the wire seal 10 at the terminal 20. I. e. a wall thickness of a longitudinal portion of the crimping section 120 is not constant in circumferential direction C, wherein a mechanical strength of the crimping section 120 is degraded at the location of the weakened segment 122. During crimping, the facing circumferential portions of the crimping section 120 act as crimp wings which may be moved towards each other, the diameter of the crimping section 120 being reduced in the process.

[0033] The weakened segment 122 serves for a mechanical deformability of the crimping section 120 during crimping. Such a mechanical deformability may be an elastic and/or plastic deformability of the crimping section 120. In the case of an nearly exclusively elastic deformation of the crimping section 120 during crimping, the crimping section 120 is a resilient or spring-loaded crimping section 120 (see below, weakened segment 122 as a clearance slot 122). Further, the weakened segment 122 may be a mechanically, elastically and/or plastically deformable weak spot 122 of the crimping section 120 of the wire seal 10. Despite of this, the other portions of the crimping section 120 may also be mechanically, elastically and/or plastically deformed during crimping, but not to an extend of the weakened segment 122.

[0034] The weakened segment 122 mainly extends in longitudinal direction L in the crimping section 120, wherein the weakened segment 122 preferably com-

pletely passes through the crimping section 120 (cf. fig. 3, first embodiment). Further, the weakened segment 122 may also extend in circumferential direction C as depicted in fig. 1 (second embodiment), wherein the weakened segment 122 may just extend in an inclined manner with regard to the longitudinal axis L or may be part of a helix or spiral. In the shown embodiments, the weakened segment 122 is a slot 122, particularly a slot completely passing through (clearance slot 122) the crimping section 120 in radial R and longitudinal direction L which gives the crimping section 120 the appearance of an open jacket or round cramp.

[0035] Instead of a slot 122, it is also possible to apply a deviation from a thickness of a wall of the crimping section 120, a recess, especially a clearance recess, a hole, especially a clearance hole, etc. Of course it is possible to apply more than one of such weakened segments 122 in the crimping section 120. Further, the weakened segment 122 may be designed as a predetermined breaking, folding or deforming area for the crimping section 120 during crimping. In such cases a cross-section of the crimping section 120 may be formed as an oval, a triangle, a cross or may be shaped as a star. Further, the crimping section 120 may comprise integral hinges which fold, collapse or break open when the crimping section 120 is crimped to the terminal 20. All such cross-sections of the crimping section 120 may be regular or irregular cross-sections.

[0036] The relatively hard crimping section 120 (second component 12) provides a good fixation of the wire 30 at the insulation crimp section 200 (insulation crimp barrel 200 in crimped state, cf. fig. 2) of the terminal 20. Thus, the crimping section 120 prevents a transfer of a bending force of the wire 30 or the strands of the wire 30 into the wire crimp section 210 (wire crimp barrel 210 in crimped state, cf. fig. 2) of the crimp terminal 20. The fixation minimises any load and deformation caused by wire bending behind the insulation crimp barrel 200. According hereto, a present design of the crimp terminal 20 may be kept, merely new wire seals 10 have to be applied to significantly improve the bending or buckling problems at a crimp terminal 20. The embodiments are applicable to nearly all electrical terminals of nearly all design principles, particularly for aluminium terminations.

[0037] Fig. 5 to 8 show a variant of an inventive wire seal 10 which is constituted as a one-component wire seal 10, particularly a one-component single-wire seal 10. The sealing section 110 and/or the crimping section 120 of the wire seal 10 may be constituted as the sealing section 110 and/or the crimping section 120 of the variant according to figs 1 to 4. The crimping section 120 may comprise a radial collar 124, at least one radial projection 124, hook 124 or catch 124 at its tip end, i. e. at the leading end 14 of the wire seal 10. Such a projection 124 prevents the wire seal 10 from slipping out or disengaging from a crimped insulation crimp section 200 (insulation crimp barrel 200) of the terminal 20.

[0038] According to the invention, the wire seal 10

comprises an anti-kink section 100 particularly made from a sealing material (cf. above, e. g. the first material 11). Preferably, the anti-kink section 100 is joined to the sealing section 110 of the wire seal 10 now constituting a middle portion of the wire seal 10 in a fixed manner. The anti-kink section 100 and the sealing section 110 and/or the crimping section 120 of the wire seal 10 may be produced as a one-piece (essentially material bond) or integral (essentially cohesion) wire seal 10. The anti-kink section 100 comprises a preferably hollow-cylindrical anti-kink body 102 constituting a tube-like portion 102 of the wire seal 10. At a trailing end 16 of the anti-kink body 102, the wire seal 10 preferably comprises a grommet 104 or sleeve 104.

[0039] A thickness (radial direction R) of the grommet 104 may be considerably smaller than a thickness of the directly adjacent anti-kink body 102. Preferably, a changeover of the anti-kink body 102 to the grommet 104 may be constituted by a sharp curve in a longitudinal cross-section (cf. fig. 5), but may also be uninterrupted, i. e. a steady changeover from the anti-kink body 102 to the grommet 104 may be applied. - The elongated wire seal 10, particularly the new anti-kink section 100 or body 102 are adapted to an acceptable or maximally admissible bending radius of the wire 30. Furthermore, the dimensions of the anti-kink body 102 are adapted to tolerances of the contact chamber 400 in the housing 40 for the crimped terminal 20. Hence, a more stable system is achieved.

[0040] Before crimping the inventive wire seal 10 to the insulation crimp section 200 of the crimp terminal 20, the wire seal 10 is preferably moved with its trailing side 16 ahead onto the stripped wire 30. Here, the wire 30 is placed in a cavity 130 or through-hole 130 inside of the wire seal 10, wherein a wall of the cavity 130, particularly the inner sealing lips 115, preferably an inner area of the anti-kink body 102 and preferably an inside of the grommet 104 sit at the insulation of the wire 30 in a sealing manner. A portion of the cavity 130 in the anti-kink section 100 is preferably conical, wherein the cavity 130 is reducing its diameter towards its trailing end 16. This ensures a good sealing effect of the grommet 104 and consequently of the anti-kink section 100. - Further, the longitudinal axis L of the wire seal 10 is a rotational axis L for the rotation-symmetric portions 100, 110, 120 of the wire seal 10.

[0041] Due to extending the wire seal 10 at the side of the wire 30 (trailing side 16), better sealing results are achieved wherein the wire seal 10 and/or the cable assembly 1 may still be handled with already existing machines and/or an adjustment/pre-setting of such a machine. The elongated wire seal 10 follows a bend of the wire 30 or electrical cable 30 (cf. fig. 6 to 8) and does not allow for water ingress into the wire seal 10. Here, the appliance of the grommet 104 is of advantage. Due to a larger bracing length of the wire seal 10, i. e. its entire length, a buckling of the electric wire is avoided and hence failures during transport and/or an appliance of

the wire seal 10 or the cable assembly 1 in a contact chamber 400 in the housing 40 are avoided.

[0042] According to the invention, one or a plurality of features of the variant according to figs 1 to 4 is applicable to the variant according to figs 5 to 8, and vice versa.

List of reference numerals

[0043]

- 1 cable assembly, cable harness particularly for automotive industry, e. g. for motor vehicles
- 10 wire seal, one- or two-component wire seal; particularly single-wire seal, (radial, mechanical) sealing, gasket, sealing plug, particularly for a crimp terminal 20
- 11 first component of the wire seal 10, first material; comparatively soft component for tightening/sealing, soft section of the wire seal 10 made from a comparatively soft material particularly silicone and/or rubber
- 12 second component of the wire seal 10, second material; comparatively hard component for crimping, hard section of the wire seal 10 made from a comparatively hard material particularly silicone and/or rubber
- 14 leading, front side/portion/end of the wire seal 10, trailing side/portion of the crimp terminal 20
- 16 trailing, back side/portion/end of the wire seal 10
- 20 electric crimp terminal/contact, electrical connector; electric contact element, receptacle, socket, tab, pin etc.
- 30 electrical cable, wire (one or preferably a plurality or a bundle of strands), preferably comprising an aluminium or copper wire (electric wire), (part of a) cable harness
- 40 housing, casing of an electrical connector, device etc. for the crimp terminal 20
- 100 (trailing, back) anti-kink section made from the first material 11
- 102 anti-kink body, preferably hollow-cylindrical portion
- 104 grommet, sleeve
- 110 (trailing/back, middle) sealing section made from the first material 11
- 112 base of the sealing section 110
- 114 outer (radial) sealing lip
- 115 inner (radial) sealing lip
- 116 locking element, particularly locking recess
- 120 (leading, front) crimping section made from the first material 11 or the second material 12
- 122 weakened segment for mechanical, elastic and/or plastic deformability of the of the crimping section 120, weak spot; recess, deviation, clearance recess/hole/slot; longitudinal slot which may also extend in circumferential direction
- 124 collar, projection, hook, catch
- 126 locking element, particularly locking projection

- 130 cavity, through-hole for the wire 30
- 200 insulation crimp section of crimp terminal 20, insulation crimp barrel in crimped state of the terminal 20, with at least one, preferably two insulation crimp wings
- 210 wire crimp section of crimp terminal 20, wire crimp barrel in crimped state of the terminal 20), with at least one, preferably two wire crimp wings
- 220 electric contact section, contact body, receptacle, socket, tab, pin etc. of crimp terminal 20
- 400 contact chamber in housing 40 for the crimped terminal 20 with its wire seal 10, for the tip end portion of cable assembly 1
- C circumferential direction of wire seal 10
- L longitudinal direction, longitudinal axis of wire seal 10, crimp terminal 20, cable assembly 1, rotational axis of wire seal 10
- R radial, radius direction of wire seal 10

Claims

1. Wire seal (10), particularly single-wire seal (10) for a wire (30), for example an aluminium wire (30) and an electric crimp terminal (20), especially for the automotive industry, having a sealing section (110) for sealing off the electric crimp terminal (20) against an environment, **characterised in that** the wire seal (10) comprises an anti-kink section (100) at a trailing end of the sealing section (110), wherein the anti-kink section (100) prevents the wire (30) from being bent or buckled at the trailing end of the sealing section (110).
2. Wire seal (10) according to claim 1, **characterised in that** the anti-kink section (100) comprises an anti-kink body (102) which is preferably shaped as an essentially hollow-cylindrical portion (102), wherein the anti-kink section (100) preferably further comprises a grommet (104) or sleeve (104) at a trailing end portion of the anti-kink body (102).
3. Wire seal (10) according to claim 1 or 2, **characterised in that** a flexibility or a mechanical pliability of the anti-kink section (100) or the anti-kink body (102) corresponds to a flexibility or a mechanical pliability of the sealing section (110), wherein a median axial section modulus of the anti-kink section (100) or the anti-kink body (102) preferably corresponds to a median axial section modulus of the sealing section (110).
4. Wire seal (10) according to any of the claims 1 to 3, **characterised in that:**
 - the wire seal (10) comprises a crimping section (120) at a leading end of the sealing section (110) for crimping the wire seal (10) to the elec-

- tric crimp terminal (20);
- the anti-kink section (100), the sealing section (110) and the crimping section (120) are produced as a one-piece or integral wire seal (10);
 - a structure of the wire seal (10) is kept together by a material bond and/or cohesion; and/or
 - the wire seal (10) is made from a comparatively soft silicone (11) or rubber (11).
5. Wire seal (10) according to any of the claims 1 to 4, **characterised in that** the wire seal (10) comprises a/the crimping section (120) for crimping the wire seal (10) to the electric crimp terminal (20), wherein the sealing section (110) of the wire seal (10) is made from a comparatively soft material (11) and the crimping section (120) of the wire seal (10) is made from a comparatively hard material (12).
6. Wire seal (10) according to claim 5, **characterised in that** in a ready-for-use wire seal (10), the sealing section (110) and the crimping section (120) are held together by an undercut, a back-taper, a catch mechanism, a latching connection and/or by adhesion, wherein the sealing section (110) and the crimping section (120) may be stuck, put, plugged and/or glued together, or the sealing section (110) and the crimping section (120) are produced together as a one-piece wire seal (10).
7. Wire seal (10) according to claim 5 or 6, **characterised in that** the wire seal (10) comprises a weakened segment (122) in a mainly or fully rotation-symmetric portion, particularly in an essentially hollow-cylindrical portion of its crimping section (120), wherein the crimping section (120) preferably comprises a recess (122) at/in an outside and/or an inside of its rotation-symmetric portion.
8. Wire seal (10) according to any of the claims 5 to 7, **characterised in that** the weakened segment (122) is a longitudinal (L) and/or circumferential (C) slot (122), particularly a longitudinal (L) and/or circumferential (C) slot (122) completely passing through the crimping section (120) in radial direction (R), wherein the slot (122) preferably extends over essentially the entire longitudinal (L) length of the crimping section (120).
9. Wire seal (10) according to any of the claims 5 to 8, **characterised in that** at least one weakened segment (122) is established in the crimping section (120) in such a way that it constitutes a predetermined breaking, folding or deforming area for the crimping section (120) during crimping to the electric crimp terminal (20).
10. Wire seal (10) according to any of the claims 5 to 9, **characterised in that**:
- the crimping section (120) is at least partially moveable or slidable at/in the sealing section (110);
 - the wire seal (10) is produced by a two-component moulding process;
 - a structure of the wire seal (10) is kept together by a form closure, a force closure and/or an adhesive bond; and
 - the sealing section (110) is made from a comparatively soft silicone (11) or rubber (11); and/or
 - the crimping section (120) is made from a comparatively hard silicone (12) or rubber (12).
11. Wire seal (10) according to any of the claims 1 to 10, **characterised in that**:
- the crimping section (120) comprises a projection (124) or collar (124) at a leading end of the crimping section (120);
 - the sealing section (110) comprises at least one outer (114) and/or at least one inner sealing lip (115);
 - essentially the entire wire seal (10) is tubular; and/or
 - the wire seal (10) is constituted as a cable seal (10) for an electrical cable (30).
12. Cable assembly or cable harness for the automotive industry, **characterised in that** the cable assembly (1) or the cable harness (1) comprises a wire seal (10), particularly a single-wire seal (10), according to any of the claims 1 to 11.

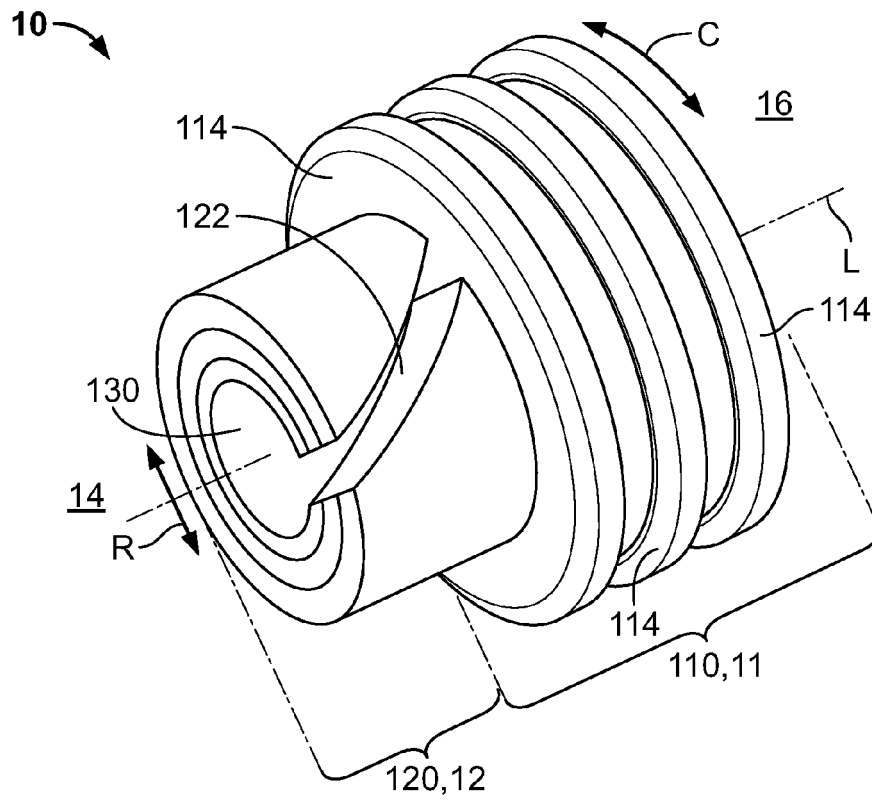


Fig. 1

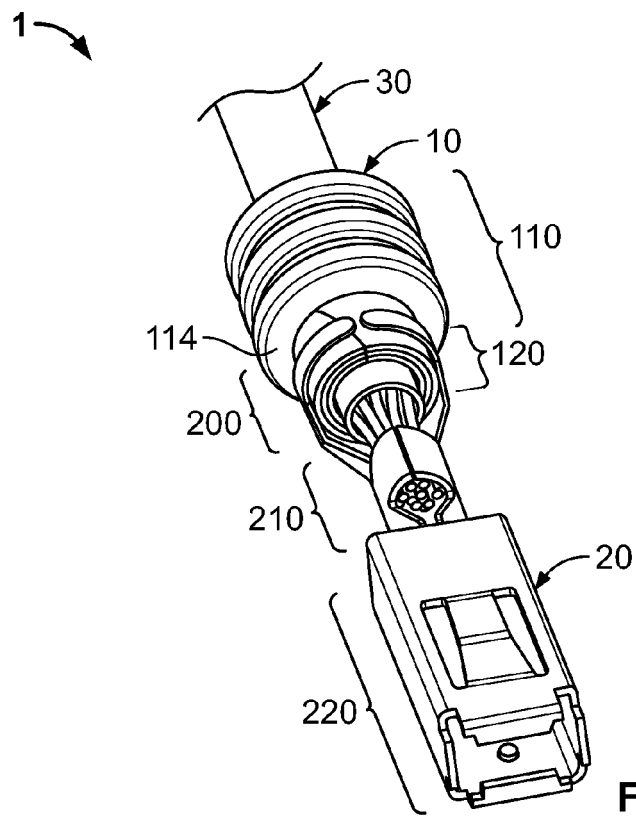


Fig. 2

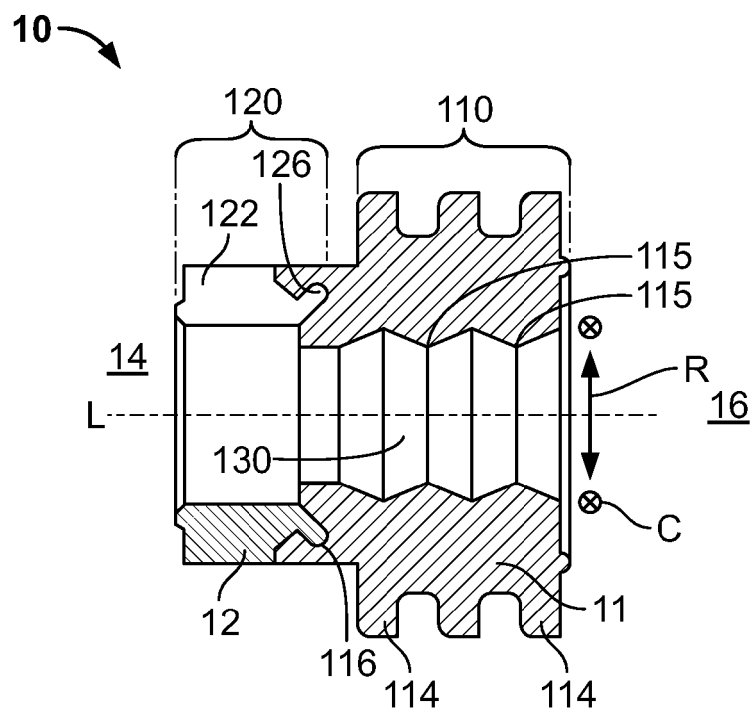


Fig. 3

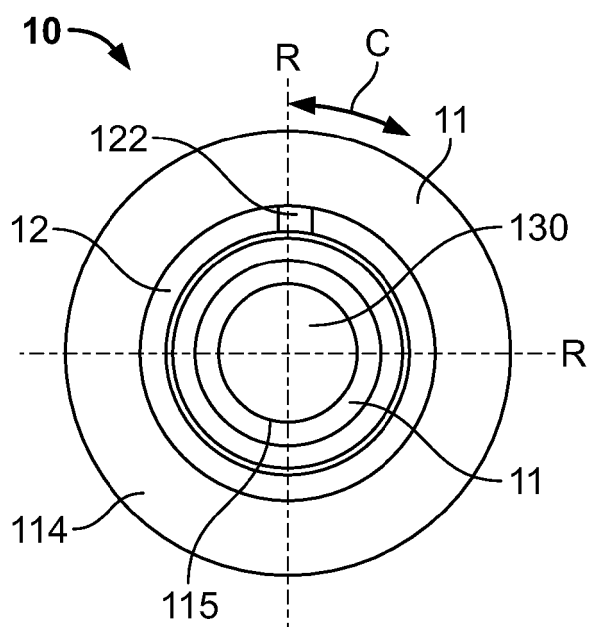


Fig. 4

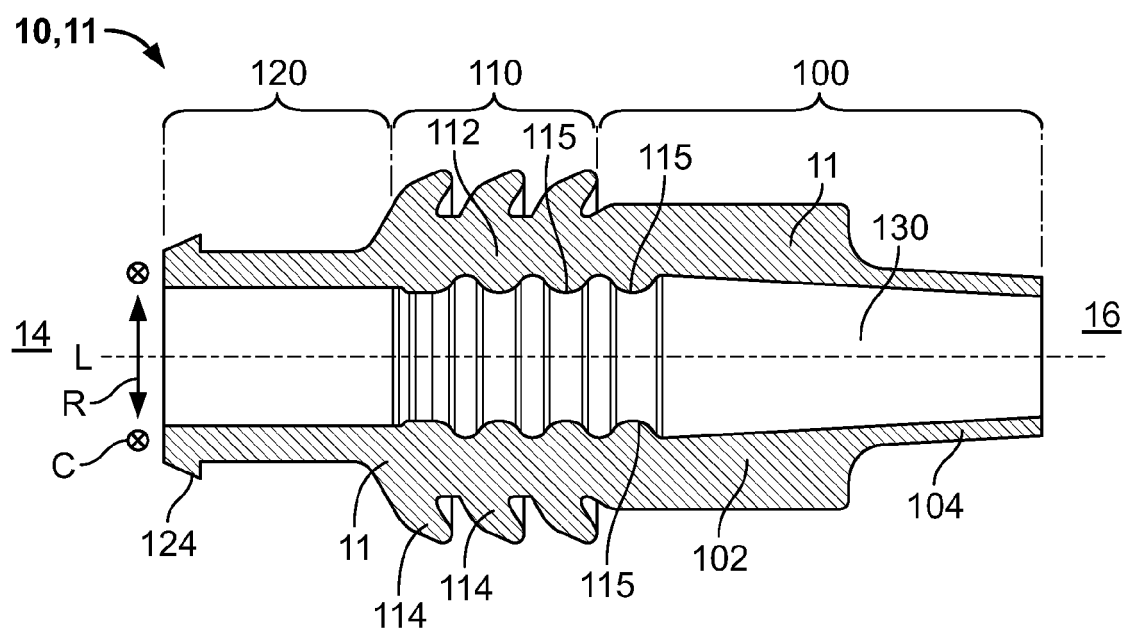


Fig. 5

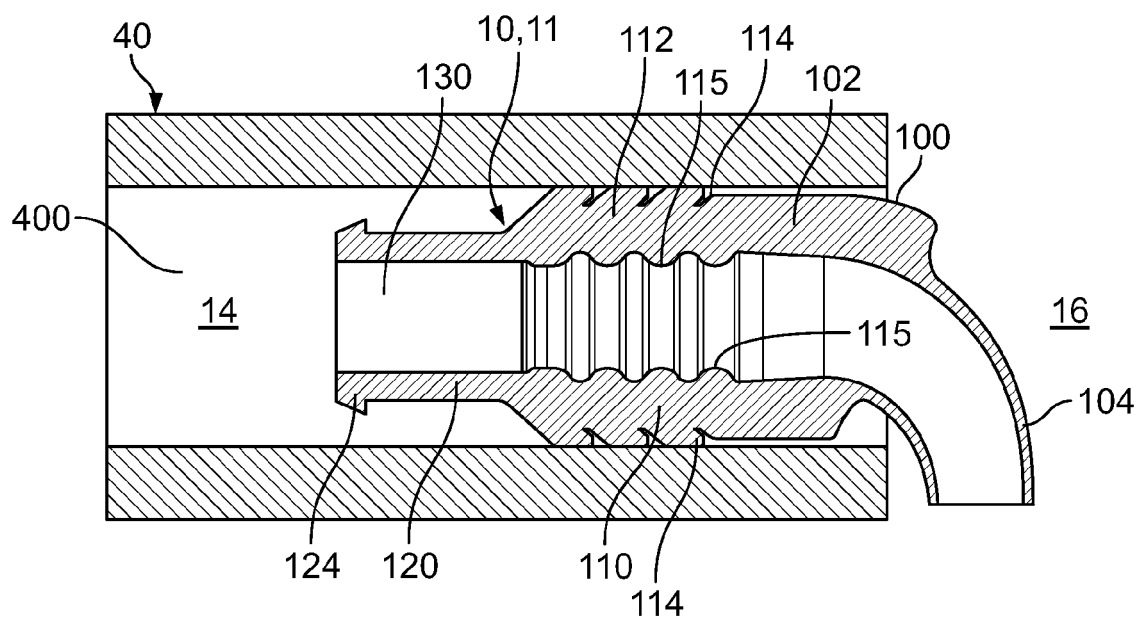


Fig. 6

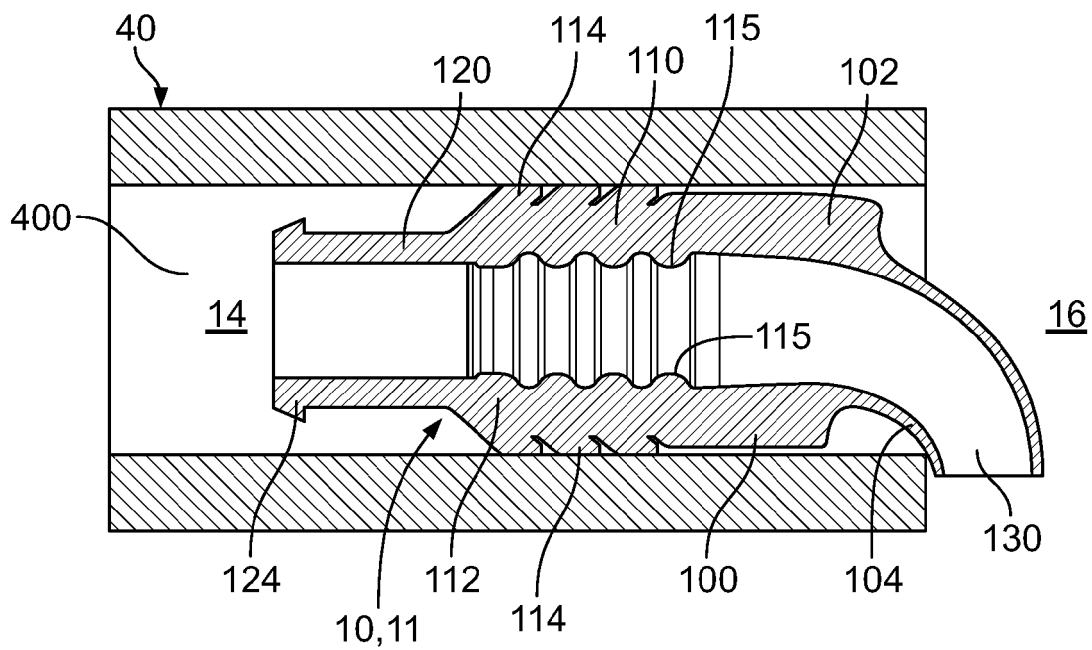


Fig. 7

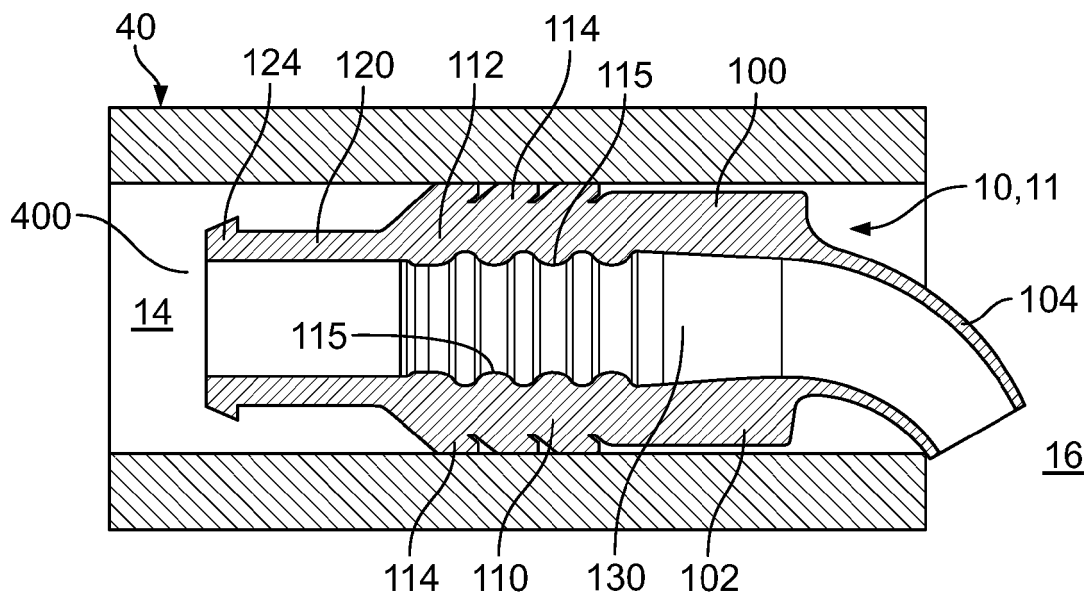


Fig. 8



EUROPEAN SEARCH REPORT

Application Number
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X	EP 0 694 993 A1 (SUMITOMO WIRING SYSTEMS [JP]) 31 January 1996 (1996-01-31)	1-4	
Y	* figures 6,7,9,10 *	5-12	
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	* figure 1 *		
	* column 3, line 3 - column 3, line 10 *		
	* column 1, line 66 - column 2, line 16 *		
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 18 January 2017	Examiner Camerer, Stephan
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	

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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