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(54) **BUSBAR CONNECTION**

(57) The present invention relates to an electrical connector for connecting a conductive element to a counter connector, comprising a terminal, of the conductive element, having a first surface and defining a through-hole in the first surface extending through the terminal; a first element separate from the terminal and in engagement with the terminal; wherein the first element comprises a hollow portion extending through the through-hole of the terminal and a collar covering at least a part of a periphery of the through-hole on the first surface of the terminal, wherein a main surface of the collar facing the first surface of the terminal is structured such that rotation of the element in the through-hole is prevented. It further relates to an electrical connector system, a first element for facilitating an electrical connection, a method for assembling an electrical connection and a method for connecting an electrical connector to a counter connector.

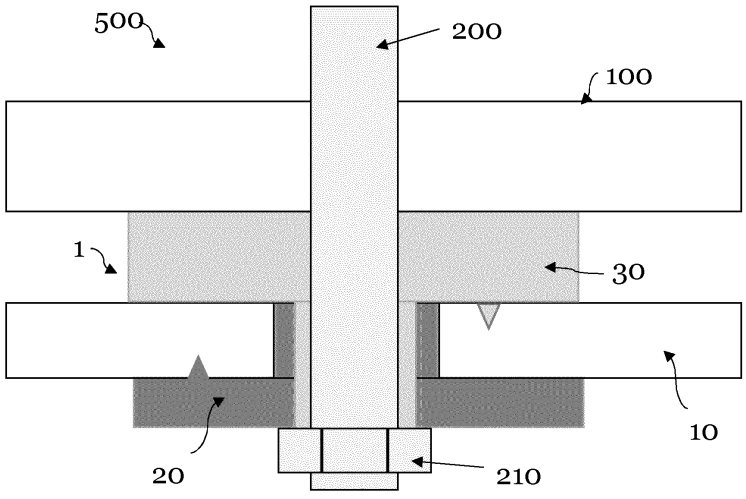

Fig. 7B

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Description

Field of the invention

[0001] The present invention relates to an electrical connector, an electrical connector system, a first element for an electrical connector, a method of assembling an electrical connector and a method of connecting an electrical connector to a counter connector. In particular the present invention relates to support electrical connection by an electrical connector comprising a terminal and an element.

Background

[0002] Electrical current carrying structures or conductive elements, such as busbars are well known in the art. They are used for conducting electrical power, particularly for conducting high electrical current, potentially in regimes of high voltages. With the emerging numbers of electric vehicles, such as electric cars, busbar are increasingly used in the automotive sector. For instance, busbars are used to provide an electrical connection between a vehicle's drive, a vehicle's battery and/or a charging unit. In addition, further industry sectors are subject to a drastic increase in the number of electrical components. For instance, the air traffic sector is facing a paradigm shift to all-electric-aircrafts, wherein controls are performed mostly electrically. In general, any evolving technology relies at least in some part of electrical power transmission and thus requires electrical connection.

[0003] For instance, during assembly of a vehicle, busbars have to be connected to further parts, such as a further busbars, busbar portions and/or terminals. As an example, the busbar may be connected to a terminal of the vehicle's drive, battery and/or charging unit.

[0004] In this field, there are specific requirements that must be met. Among these are a proper electrical connection for high reliability to cope with highly demanding environmental conditions, such as high or low temperature regimes, dust, dirt or interference with any foreign object that could adversely affect the connection. Further challenges are high current density prevailing at small contact points and the potential of arising contact corrosion. In addition, simplified assembling of the parts is required, which is a predominant factor to avoid making mistakes during assembling.

[0005] In the prior art, attempts have been made to address these requirements. For instance, for busbar connections, an aluminum busbar is first welded to a copper terminal by resistance welding, brazing or ultrasonic welding technology. Then the terminal is screwed to another electrical carrying part, for instance to battery pins.

[0006] Other attempts target the connection of a busbar to another part, wherein flat surfaces of aluminum, copper or bronze are connected using a contact bolt, which passes through holes of both parts to connect both parts. Further, the contact bolt passes through a contact disc, arranged between the contact surfaces of both parts. During the assembly, the contact disc gets in contact with the terminal surfaces and provides for electrical connection.

[0007] However, in the prior art there pertains a gap between the existing solutions and the stringent requirements imposed on busbar connections by the industry sector. In particular, some solutions necessitate welding, which is expensive and subject to failure. In addition, the existing material gets adversely affected by the thermal treatment. Further, additional and exhaustive process steps are required for providing a connection between a busbar and other electrical carrying parts. Other solutions, relying on a connection by screwing or using bolts, require exact placement of a contact disc before establishing the connection, which adversely affects the assembly and is subject to failure, for instance if the disc falls off before assembly. In addition, it cannot cope properly with vibrating regimes.

Summary

[0008] It is thus an object of the present invention to overcome some or all of the deficiencies of the prior art. In particular, it is an object of the invention to provide for an electrical connector with improved vibration resistance and/or improved electrical contact for improved transmission of electrical power, for instance in high-voltage regimes. It is a further object of the invention to provide for robust and repeatable connections, wherein the production of the connections is facilitated and simplified with less complex parts which should alleviate potential failures during the assembly. The time required for the assembling step should further be reduced. It is a further object to improve the impediment that could arise by contact corrosion, high or low temperature environments, dusty environments or environments that are subject to any foreign matter and/or particles.

[0009] These objects are at least partially achieved by an electrical connector, an electrical connector system, a first element for an electrical connector, a method for assembling an electrical connector and a method for connecting an electrical connector to a counter connector according to the independent claims. Preferred aspects are subject of the dependent claims, and the skilled person finds hints for other suitable aspects of the present invention through the overall disclosure of the present application.

[0010] According to a 1st embodiment of the invention, there is provided an electrical connector for connecting a conductive element to a counter connector, which comprises a terminal, of the conductive element, having a first surface and defining a through-hole in the first surface extending through the terminal. The electrical connector further comprises a first element separate from the terminal and in engagement with the terminal, wherein the first element comprises a hollow portion extending through the through-hole of the terminal and a collar cov-

ering at least a part of a periphery of the through-hole on the first surface of the terminal, wherein a main surface of the collar facing the first surface of the terminal is structured such that rotation of the element in the through-hole is prevented.

[0011] The terminal could be a part of a conductive element, a busbar, a busbar portion or anything that can carry electrical current, and which is to be connected to another part, e.g. a counter connector. The terminal has a through-hole, which could be a recess on the first surface. This through hole may be extending through the terminal and may have the shape of an empty cylinder, but also other shapes are possible. The separate first element is another part that engages with the terminal. It may be fixed, attached or somehow connected to the terminal, preferably it is substantially rigidly fixed to the terminal. This beneficially provides for electrical current from the terminal to the first element. The first element further has a hollow portion that extends through the through-hole of the terminal. Preferably this hollow portion has the shape of a cylinder, but also other shapes are possible. Preferably, the shape of the outer surface of the hollow portion is similar or equal to the shape of the through-hole. This advantageously provides for a proper positioning within the through-hole. The collar covers at least a part of a periphery of the through-hole. This periphery could be the circumference of the through-hole on the first surface but also this periphery is not limited to this and can also be a surface, preferably a ring circle around the through-hole on the first surface. The main surface of the collar that faces the first surface of the terminal is structured to substantially prevent rotation of the element in the through-hole. This rotation could be understood as a rotation around a longitudinal axis along the hollow portion of the first element, which may be substantially perpendicular to the first surface of the terminal and which may be parallel to a longitudinal axis of the through-hole. By way of this structured main surface, the element is maintained in its position, for instance if a rotating force acts on it, which could be the case if a screw nut was rotated while touching the first element. This could be the case if the electrical connector was to be connected to a counter connector by a screw. By preventing rotation of the element, its position is beneficially maintained during any screwing process. Thus, this first element prevents any mistakes during setup of an electrical connection of an electrical connector to a counter connector. Thereby, assembling is improved and simplified. Further, the electrical connection does not require expensive welding of a conductive element, such as a busbar portion to other parts. Thereby, assembling is facilitated because users do not require extensive teaching. The through-hole has an axis along the direction of the through-hole which may be substantially perpendicular to the first surface of the terminal and thereby also to the main surface of the collar.

[0012] According to a 2nd embodiment, in the first embodiment the main surface of the collar that is facing the first surface of the terminal is structured along a circumferential direction of the collar.

[0013] With this embodiment, a structure of the main surface along a circumferential direction is provided. This structure could be uniformly or non-uniformly. Preferably the circumferential direction of the collar is a direction around and perpendicular to a longitudinal direction of the hollow portion. Further preferably, this circumferential direction is the direction in which rotation is prevented by way of the structure of the main surface. This provides the benefit that the structure can easily be manufactured by appropriate machines. Further, it improves that a rotation of the element is prevented. Having such a structured main surface of the collar could mean for instance that a circular ring, forming part of the main surface, is structured, i.e. it could have elevations and dimples or grooves in the circumferential direction of the collar. Thus, it may a certain structure. In one example this could mean that in the circumferential direction, the surface has a pattern or relief, distinct from a substantially flat surface. In one example the main surface has a non-unitary structure in a circumferential direction. This non-unitary structure could further improve preventing a rotation.

[0014] According to a 3rd embodiment, in any one of the preceding embodiments, the first element further comprises at least one protrusion on the main surface of the collar.

[0015] This protrusion is located on the main surface of the collar and is preferably directed towards or faces the first surface of the terminal. This is to be understood that, for instance if the protrusion has an elongate or pointed shape, the axis of elongation or the direction, in which the pointed shape points is substantially perpendicular to the first surface of the terminal. The protrusion could be located anywhere on the main surface and amounts to its structured characteristic. The protrusion could be anything that extends from the main surface of the collar towards the first surface of the terminal. It could be for instance a bump, preferably it has a pointed or sharper tip. Further, the at least one protrusion could have a tapered shape, an elongated shape, a cylindrical shape, a cubic shape, a cuboid shape, a pointed shape, a conical and/or a pyramidical shape or combinations thereof.

[0016] According to a 4th embodiment, in the preceding embodiment, the at least one protrusion comprises a tip portion and a base portion, wherein the tip portion is facing the terminal and the base portion is opposite of the tip portion and located on the main surface of the collar, wherein a peripheral dimension of the tip portion is smaller than a peripheral dimension of the base portion.

[0017] The peripheral dimension could be for instance a circumference. If the protrusion is a conical cylinder, the top circumference would thus be smaller than the bottom circumference. In this example, the top circumference of the cylinder is a peripheral dimension of the top portion and the bottom circumference of the cylinder

is a peripheral dimension of the base portion. By providing a smaller peripheral dimension of the tip portion, this could be more easily inserted or pressed into another material and advantageously provides for a fixed connection.

[0018] According to a 5th embodiment, in any one of the embodiments 3 or 4, the at least one protrusion is pressed at least partially into the terminal, wherein at least 5 % of a height of the at least one protrusion extending from the main surface of the collar is pressed into the terminal, preferably at least 10%, more preferably at least 40%, even more preferably at least 60%, even more preferably at least 80%, most preferably 100% of the height of the at least one protrusion.

[0019] The height could be measured from a tip portion to a bottom portion of the protrusion. Preferably the height is measured from a part of the tip portion of the protrusion that has the furthest distance to the base portion, preferably wherein the distance is perpendicular to the main surface. With this embodiment, the at least one protrusion is pressed into the terminal, preferably the protrusion is pressed completely, that is to about 100% of its height into the terminal. This bears the potential that a great contact area is provided for the electrical current to flow from the terminal to the element. Further, any oxidation that might be present on the terminal or busbar portion, on which the element could be connected, in particular any oxidation of the first surface of the terminal is thus broken and electrical current can flow beneficially. Thus, there is no need to provide any additional connection point, for instance by welding an additional part to the terminal. Instead, the element can be used as for instance a substantially mechanical fixed bushing. Next to the advantage of breaking any surface oxidation of the terminal, the protrusion also improves that a rotation of the element is prevented. It could be said that a further pressing of the protrusion into the terminal, provides for an even better prevention of a rotation. Further, pressing the protrusion into the terminal substantially prevents any dirt or dust from outside to penetrate into a gap that could be formed between the first surface of the terminal and the main surface of collar. Thus, corrosion is beneficially prevented.

[0020] According to a 6th embodiment, in any one of the embodiments 3 to 5, wherein the at least one protrusion has a height of at least 0.2 mm, preferably at least 0.4 mm, more preferably at least 0.6 mm, even more preferably at least 0.8 mm, most preferably of at least 1.0 mm; and/or wherein the at least one protrusion has a height of at most 15 mm, preferably at most 8 mm, more preferably at most 5 mm, even more preferably at most 3 mm, most preferably of at most 1 mm.

[0021] The height may be measured as described above. A greater height of the protrusion may provide for an even better advantage with respect to breaking an oxidation layer of the terminal and preventing a rotation of the first element. However, it could be the case that a greater height may be difficult to manufacture. Thus, if the height was too large, this could be disadvantageous out of a manufacturing perspective. The heights could also be understood relative to other dimensions of the element. For instance, if a diameter of the collar was defined as being 100%, then the protrusion could have a height of at least 0.5%, preferably at least 1%, more preferably at least 2%, most preferably of at least 4% of that diameter. Further, the at least one protrusion could have a height of at most 10%, preferably at most 8%, more preferably at most 6%, most preferably of at most 5% of that diameter.

[0022] According to a 7th embodiment, in any one of the preceding embodiments, the first element comprises a plurality of protrusions on the main surface of the collar, wherein the plurality of protrusions is preferably distributed equally on the main surface of the collar facing the first surface of the terminal.

[0023] The plurality of protrusions could comprise any number of protrusions of at least 2, preferably of at least 5, more preferably of at least 10, even more preferably of at least 20, most preferably of at least 40. Further, the plurality of protrusions could comprise any number of protrusions of at most 200, preferably of at most 150, more preferably of at most 100, even more preferably of at most 80, most preferably of at most 60. A higher number of protrusions can provide for an even better effect in terms of preventing any rotation of the element and for breaking an oxidation layer of the terminal. Thus, electrical connection between the terminal and the first element is further improved and assembling this electrical connector to other parts by way of a screw is facilitated and simplified. As a screw, a size of M2, M4, M6, M8 or M10, representing diameters of the screw of 2 mm to 10 mm respectively, may be used. However, also larger or smaller screws may be employed. Preferably M6 or M8 screws maybe employed. The number of protrusions that are comprised may also depend on the size of the screws used. It may be the case that, if larger screws were used, the number of protrusions is beneficially increased. The plurality of protrusions may also advantageously provide for a pattern on the main surface of the collar, wherein the pattern has the appearance of elevations and lowerings or elevations and sinkings. This beneficially provides for improved prevention of rotation of the element, for instance if a force acts on the element in an attempt to rotate the element. Thus, the element is physically stabilized better at its location. Further, breaking an oxidation layer of the terminal may be improved by the pattern.

[0024] According to an 8th embodiment, in any one of the preceding embodiments, a material of the first element is harder than a material of the terminal, preferably a material of the first element has a Brinell hardness number which is larger by at least 10%, preferably by at least 30%, more preferably by at least 80%, even more preferably by at least 140%, further even more preferably by at least 200%, most preferably by at least 300% as compared to the Brinell hardness number of a material of the terminal. As an example, if the Brinell hardness

number of the first element is larger by at least 30% than the Brinell hardness number of the terminal, this means that if the terminal is of pure aluminum, having a Brinell hardness of 15 HB, then the first element has 19,5 HB. If may also be possible that the hardness is measured according to the Rockwell or Vickers scale.

[0025] By providing a harder material of the element as compared to the material of the terminal, the protrusions can beneficially be better pressed into the terminal. The protrusions preferably comprise the same material as the element. Preferably the protrusions do not substantially deform from a first state before they are pressed into the terminal with respect to a second state after they are pressed into the terminal to form an electrical connector.

[0026] According to a 9th embodiment, in any one of the preceding embodiments, the terminal has a second surface opposite of the first surface and wherein the through-hole extends through the terminal from the first surface to the second surface. The connector further comprises a second element separate from the terminal and the first element, the second element having a hollow portion received within the hollow portion of the first element, wherein the second element has a collar covering at least a part of a periphery of the through-hole on the second surface of the terminal.

[0027] The through-hole may substantially form an empty cylinder within the terminal and connects the first and the second surface of the terminal. The first and the second surface of the terminal could be substantially parallel to each other. The through-hole has an axis along the direction of the through-hole, wherein the axis maybe substantially perpendicular to the first surface of the terminal. The axis of the through hole may be substantially perpendicular to the second surface of the terminal. The second element has a collar similar to the collar of the first element and it covers a periphery of the through-hole, such as a circumference of the ring surface around the through-hole on the second surface. This provides the benefit that the second element can be connected to the terminal and further supports transmission of electrical power by way of an increased surface area. The outer surface of the hollow portion of the second element and the inner surface of the hollow portion of the second element preferably have a cylindrical shape, however different shapes are possible as described with reference to the hollow portion of the first element. By receiving the hollow portion of the second element within the hollow portion of the first element, a connection of both elements could be improved.

[0028] According to a 10th embodiment, in the preceding embodiment, an outer surface of the hollow portion of the second element is in form-fit connection with the inner surface of the hollow portion of the first element.

[0029] Preferably the outer surface of the hollow portion of the second element and the inner surface of the hollow portion of the first element have a cylindrical shape. By way of a form-fit connection an easy and simplified connection between the first and second element and the terminal can be established. Beneficially, the second element could also have protrusions as described with reference to the first element. Thus, the protrusions of the second element are located on a main surface of the collar of the second element facing the second surface of the terminal. This further enhances to prevent any rotation of the first and the second element and further improves breaking an oxidation layer of the terminal and thereby facilitates electrical connection.

[0030] An 11th embodiment of this invention is directed to an electrical connector system, comprising an electrical connector according to any one of the embodiments 1 to 10 and a counter connector. The electrical connector system further comprises fixing means, optionally a screw, extending through the hollow portion of the first element and fixing the electrical connector to the counter connector.

[0031] With this embodiment an electrical connection of the terminal to a counter connector is provided in a simple and easy way. Assembling of the electrical connector to a counter connector is improved, because the elements are substantially rigidly connected to the terminal and rotation is prevented. This is also the case if a screw nut was used to fix a screw on the first or second element.

[0032] An 12th embodiment of this invention is directed to a first element for facilitating an electrical connection of a conductive element to a counter connector. The first element comprises a hollow portion extending along a longitudinal axis and having two opposite ends on the longitudinal axis; a collar extending perpendicular to the longitudinal axis from one end of the first element, the collar having a main surface facing towards a second end of the first element along the longitudinal axis; at least one protrusion, preferably a plurality of protrusions, on the main surface of the collar; wherein the main surface of the collar is structured along a circumferential direction of the collar, preferably wherein the at least one protrusion comprises a tip portion and a base portion, wherein the tip portion is facing the second end and the base portion is opposite of the tip portion and located on the surface of the collar, wherein a peripheral dimension of the tip portion is smaller than a peripheral dimension of the base portion. With this embodiment the first element beneficially supports to electrically connect two parts to each other, for instance a terminal to a counter connector as described above. The first element of this embodiment can comprise all aspects that were mentioned with respect to the first and/or second element of the previous embodiments. Thus, this first element it can be beneficially used to provide an assembly of an electrical connector, wherein substantially rotation of the element with respect to a longitudinal axis of the hollow portion is prevented.

[0033] A 13th embodiment of this invention is directed to a method of assembling an electrical connector, the method comprising the steps of:

(a) providing a terminal having a first surface and defining a through-hole in the first surface extending through the terminal;
(b) providing a first element according to the 12th embodiment;
(c) inserting the first element into the through-hole such that the main surface of the collar of the first element faces the first surface of the terminal; and
(d) deforming the first element at least partially such that the first element is fixed to the terminal.

[0034] This method provides the benefit for assembling an electrical connector in an easy and simplified way. The advantages and benefits described with reference to the previous embodiments equally apply in here. Further, the aspects mentioned with reference to the terminal and the first element are also applicable to the terminal, the first element of the method of this embodiment. The deformation of the first element provides for a proper fixation of the first element to the terminal. In particular, the deformation could be established by pressing means, such as a clinching mandrel, which is removed after deforming the first element. Substantially the connection is established by press-fitting the first element to the terminal.

[0035] According to a 14th embodiment, in the preceding embodiment, the method further comprises the steps of:

(b2) providing a second element comprising a hollow portion extending along a longitudinal axis and having two opposite ends on the longitudinal axis, a collar extending perpendicular to the longitudinal axis from one end of the second element, the collar having a main surface facing towards second end of the second element along the longitudinal axis;
(c2) at least partially inserting the second element into the through-hole such that the main surface of the collar of the second element faces a second surface of the terminal opposite of the first surface of the terminal, thereby bringing an outer surface of the hollow portion of the second element in communication with an inner surface of the hollow portion of the first element;
wherein step (d) comprises deforming the second element at least partially such that the second element deforms the first element at least partially such that the first element is fixed to the terminal.

[0036] Thus, a second element is beneficially provided, which improves a connection of the first and second element to the terminal. Further, the aspects mentioned with reference to the terminal and the first element are also applicable to the terminal and the second element of the method of this embodiment. For instance, in this embodiment, the second element could also have all the features as described with reference to the first element, e.g. it could have protrusions on the main surface of the collar. The second element is inserted into the through-hole. Preferably the hollow portion of the second element overlaps with the hollow portion of the first element. Even more preferably, the hollow portion of the second element extends completely through the hollow portion of the first element. Thus, a rotation of the first and the second element is beneficially prevented.

[0037] A 15th embodiment of this invention is directed to a method of connecting an electrical connector to a counter connector, the method comprising the steps of:

(a) providing an electrical connector according to any one of embodiments 1 to 10;
(b) providing a counter connector comprising a through-hole;
(c) inserting a fixing means, optionally a screw, through the hollow portion of the first element of the electrical connector such that the fixing means extends through the hollow portion, through the through-hole of the electrical connector, and through the through-hole of the counter connector, and
(d) connecting the electrical connector to the counter connector by means of the inserted fixing means such that the electrical connector is fixed to the counter connector.

[0038] With this embodiment a method for connecting an electrical connector to a counter connector is provided. in a simple and easy way. This method provides for a simplified assembling of the electrical connector to a counter connector. Further, this method does not require welding, which could be expensive, to connect a terminal to a counter connector. Further, the elements provide for improved electrical contact, by breaking an oxidation layer of the terminal. Further, the elements to not move during assembling of the fixing means, such as a screw. This in particular is advantageous if this method was performed in different environments that are subject to vibration, or where access to the electrical parts to be connected is not easy. As a screw, a size of M2, M4, M6, M8 or M10, representing diameters of the screw of 2 mm to 10 mm respectively, may be used. However, also larger or smaller screws may be employed. Preferably M6 or M8 screws may be employed.

Brief description of the figures

[0039] In the following, the accompanying figures are briefly described.

Figure 1A: shows an electrical connector, according to an embodiment of the invention, in a perspective view.

Figure 1B: shows an electrical connector, according to the embodiment of Fig. 1A of the invention, in a side view.

Figure 2: shows an electrical connector, according to an embodiment of the invention.

Figure 3: shows an electrical connector, according to an embodiment of the invention.

Figure 4: shows an electrical connector, according to an embodiment of the invention, in a disassembled and assembled arrangement.

Figure 5A: shows an element for an electrical connector, according to an embodiment of the invention.

Figure 5B: shows another element for an electrical connector, according to an embodiment of the invention.

Figure 6: shows an element for an electrical connector, according to an embodiment of the invention.

Figure 7: shows shapes of protrusions as used in the elements, according to embodiments of the invention.

Figure 7B: shows an electrical connector system, according to an embodiments of the invention.

Figure 8: shows a flow diagram of a method, according to an embodiments of the invention.

Figure 9: shows a flow diagram of another method, according to an embodiments of the invention.

Figure 10: shows an electrical connector with a clinching mandrel as used in a step of a method according to an embodiments of the invention.

Figure 11: shows an electrical connector with a clinching mandrel as used in a step of a method according to an embodiments of the invention.

Figure 12: shows a flow diagram of a further method, according to embodiments of the invention.

Detailed description of the figures

[0040] In the following, exemplary embodiments of the present invention are described in more detail. However, the present invention is not limited to these, and a multitude of other embodiments are applicable without departing from the spirit of the invention.

[0041] Fig. 1A shows an electrical connector 1 according to an embodiment of the invention, which comprises a terminal 10 and a first element 20 that is separate from the terminal. The terminal 10 has a first surface 11, and the terminal has a through-hole 15 on the first surface 11. In this embodiment, the through-hole extends through the terminal. The terminal could be for instance part of a conductive element such as a busbar or anything that is suitable for carrying electrical current and which should be electrically connected to another part to transfer electrical power. In this embodiment, the terminal is a portion of a busbar which is to be electrically connected to another terminal, part, busbar or the like. The first element 20 is made of aluminum or copper alloy material and the terminal 10 is made of aluminum. The material of the first element 20 is harder than the material of the terminal 10. If a second element 30 is used (not shown in the embodiment of Fig. 1, the second element 30 is made of aluminum or copper alloy and is harder than the material of the terminal 10. In a further preferred example of this embodiment, the first element 20 and the second element 30 (if available) is treated by plating to be substantially safe from oxidation. In this case, plating is an oxidation-reduction reaction, where one material gives up electrons and the other material gains electrons. The first element 20 has a hollow portion 21, which has an outer and an inner surface in the shape of a cylinder. In one example of this embodiment, each of the outer and inner surface has the shape of a cylinder. The outer and an inner surface of the hollow portion could also have different shapes. In one example of this embodiment, the shape of the outer and inner surface deviates slightly from a cylinder, for instance the shape is a rounded shape. In another example of this embodiment, they have a shape corresponding to a slotted hole. This hollow portion 21 extends through the through-hole 15, such that it is inserted into the through-hole. The through-hole has the shape of a cylindrical hole or cavity, in which the material of the terminal is not present. The outer surface of the hollow portion is in substantially direct vicinity of the through-hole, i.e. the cylindrical hole of the terminal. For instance, the outer surface of the hollow portion could be in contact and/or in form-fit with the through-hole. The first element 20 further comprises a collar 25, which extends radially in a perpendicular direction to the longitudinal direction of the hollow portion. This collar is located on one end of the first element 20 and covers a periphery of the through-hole on the first surface of the terminal. The collar has a main surface 26 that faces the first surface 11 of the terminal. This main surface 26 of the collar 25 is structured such that rotation of the first element 20 in the through-hole 15 is prevented.

[0042] By this configuration, if a rotating force would act on the first element 20, the first element 20 could resist this rotation and beneficially maintains its position. Thereby, damage of the first surface of the terminal 10 and/or the surface of the collar facing the first surface of the terminal 10 is prevented. This damage could lead to

corrosion and thus adversely affect an electrical contact. Thus, corrosion is alleviated by that.

[0043] In an embodiment, the first element 20 further comprises at least one protrusion 50 on the surface of the collar 21 facing the first surface 11. This protrusion is at least partially pressed into the terminal. This is beneficial, for instance the protrusions can penetrate through an oxide layer of the surface of the first element 20 and thereby further enhance electrical contact between the terminal and the first element 20. This protrusion also supports that a rotation of the first element 20 is prevented in case a rotating force acts on the first element 20. This could for instance be the case if the first element 20 is to be brought in electrical contact with a counter connector and screws were used to connect the terminal with the first element 20 to the counter connector. These screws could entail a rotating force on the first element 20. In one embodiment, the protrusions can comprise a plurality of protrusions.

[0044] Fig. 1B shows an electrical connector 1 according to the embodiment of the invention of Fig. 1A in a side view. In this example a multitude of protrusions 50 are shown. The protrusions are pressed into the terminal along their total height or length of a base portion to the tip portion of the protrusion. They are pressed through the first surface 11 of the terminal along a longitudinal direction 22 of the hollow portion of the first first element 20. The outer surface of the hollow portion of the first element 20 is in form-fit with the inner surface of the through-hole.

[0045] Fig. 2 shows an electrical connector 1 according to an embodiment of the invention, which comprises a terminal and a first element 20 that is separate from the terminal. The terminal could be for instance a part of a conductive element such as a busbar or anything that is suitable for carrying electrical current and which should be electrically connected to another part to transfer electrical power. In this embodiment, the terminal is a portion of a busbar which is to be electrically connected to another terminal, part, busbar or the like. This embodiment further comprises a second element 30, that is separate from the terminal 10 and the first element 20. The first element 20 and the second element 30 are made of aluminum or copper alloy material and the terminal 10 is made of aluminum. The material of the first element 20 and the second element 30 is harder than the material of the terminal 10. The terminal 10 has a first surface 11, and a second surface 12 opposite of the first surface 11 and a through-hole 15, which extends through the terminal 10 from the first surface 11 to the second surface. This through-hole is a through hole extending through the material of the terminal. The first element 20 is similar to the first element 20 as described in an embodiment with reference to Fig. 1A and comprises protrusions 50 on the main surface 26 of the collar 25 facing the first surface 11 of the terminal 10. The second element 30 has a hollow portion 31 that is received within the hollow portion 21 of the first element 20. The hollow portion of the second element has an outer and an inner surface in the shape of a cylinder. The outer and an inner surface of the hollow portion of the second element could also have different shapes. The second element has a collar, which extends radially in a perpendicular direction to the longitudinal direction of the hollow portion of the hollow portion of the second element. The collar of the second element covers a periphery of the through-hole on the second surface of the terminal. In this embodiment the hollow portion of the second element is in form-fit connection with the inner surface of the hollow portion of the first element. In one embodiment, the first element, the second element and the terminal are connected to each other. This could be done for instance like connections of two rivets to another part.

[0046] In one embodiment the first element 20, the second element 30 and the terminal 10 are connected to each other such that the at least one protrusion or the plurality of protrusions of the surface of the collar of the first element are at least partially pressed into the terminal. In one embodiment the protrusions are pressed along their total length into the terminal. The length of a protrusion of the first element is measured from an outermost point of a protrusion to the surface of the collar substantially in a parallel direction towards the longitudinal axis of the hollow portion of the first element.

[0047] Fig. 3 shows an electrical connector 1 according to an embodiment of the invention, which comprises a terminal and a first element 20 that is separate from the terminal. The terminal could be for instance a part of a conductive element such as a busbar or anything that is suitable for carrying electrical current and which should be electrically connected to another part to transfer electrical power. In this embodiment, the terminal is a portion of a busbar which is to be electrically connected to another terminal, part, busbar or the like. The first element is similar to the first element as described in an embodiment with reference to Fig. 1A and Fig. 2 and comprises protrusions on the side of the collar facing the first surface of the terminal. The second element is similar to the second element as described in an embodiment with reference to Fig. 2 and further comprises protrusions on the side of the collar facing the second surface of the terminal. In one embodiment the protrusions of the second element are pressed along their total length into the terminal. The length of a protrusion of the second element is measured from an outermost point of a protrusion to the surface of the collar substantially in a parallel direction towards the longitudinal axis of the hollow portion of the second element. In one embodiment all protrusions of the first element and the second element are pressed into the terminal.

[0048] Fig. 4 shows on the left side a disassembled electrical connector according to an embodiment of the invention, which comprises a terminal and a first element that is separate from the terminal and a second element that is separate from the terminal. The first and second element are shown apart from the terminal in a state prior

to assembly for illustrative purposes Fig. 4 shows on the right side an electrical connector 1 according to an embodiment of the invention, which comprises a terminal and a first element that is separate from the terminal and a second element that is separate from the terminal.

[0049] Fig. 5A shows an element 20, 30 for an electrical connector according to an embodiment of the invention. This element 20, 30 can be a first element 20 or a second element 30. In this example it is referred to as the first element 20. This element 20 could be used for instance as an element in the embodiments shown in previous Figures. The element has a hollow portion extending along a main axis and a collar extending perpendicular to the main axis from one end of the element. The collar has a surface facing the second end of the element. The surface of the collar is structured nonuniformly along a circumferential direction and the element further comprises at least one protrusion on the surface of the collar. The hollow portion has an outer and an inner surface in the shape of a cylinder. The outer and an inner surface of the hollow portion could also have different shapes. This hollow portion could be received in a through-hole, such that it could be inserted into the through-hole. In one embodiment the element has a plurality of protrusions on the surface of the collar. These protrusions all have substantially the same shape and are positioned substantially in an equidistant manner. The protrusions have a tip portion and a base portion, wherein the tip portion is facing the second end and the base portion is opposite of the tip portion and located on the surface of the collar. In this embodiment the distance from the tip to the base portion is a length of the protrusion and is about 1 mm. The size of the length of the protrusion 50 depends on the overall size of the element and could be greater if the element is greater.

[0050] Fig. 5B shows an element 30, 20 for an electrical connector according to an embodiment of the invention. This element 20, 30 can be a first element 20 or a second element 30. In this example it is referred to as the second element 30. This second element 30 is similar to the first element 20 as described in an embodiment with reference to Fig. 5A. The second element 30 comprises a different hollow portion as compared to the embodiment of Fig. 5A. The hollow portion has an outer diameter of the hollow portion that is not greater than an inner diameter of the hollow portion of the embodiment in Fig. 5A, i.e. the first element 20. This facilitates that the hollow portion of the second element 30 can be received within the hollow portion of the first element 20 in the embodiment of Fig. 5A.

[0051] Fig. 6 shows an element 20, 30 for an electrical connector according to an embodiment of the invention. This element 20, 30 can be a first element 20 or a second element 30. In this embodiment, different locations of the at least one protrusion 50 on the surface of the collar of the element are exemplarily shown. However, further locations are also possible. The surface of the collar faces the opposite, i.e. the second end of the element. The at least one protrusion can be positioned at an outer region of the surface of the collar and/or at an inner region of the surface of the collar and/or in the middle thereof. The protrusion of this example is depicted as a having pyramid portion or pyramid shape. However, different shapes or also possible. The tip portion of the protrusion, i.e. the tip of the pyramid in one example is facing in the direction of the second end of the element in the examples on the left side of collar in Fig. 6. On the right side in Fig. 6 an exemplary protrusion is shown having a pyramid portion or shape, wherein the tip of the pyramid is facing a radial outer direction, substantially perpendicular to a longitudinal axis 22 of the hollow portion 21 of the element 20, 30. This exemplary protrusion is still contacting the surface of the collar facing the second end of the element. As another example a protrusion having a cylindrical portion or shape is also depicted in Fig. 6 on the outer region of the surface of the collar on the right side. Although Fig. 6 shows a multitude of protrusions, not all of these must be present, i.e. not all of these must be comprised by the element. At least one protrusion is comprised in this embodiment. However, also combinations of the depicted protrusions, their portions or shapes and their locations are possible.

[0052] Fig. 7 shows different shapes of protrusions according to an embodiment of the invention. These different shapes of protrusions can be applied for any protrusion used in any embodiment of the invention and the examples shown in Fig. 7 are not limiting. The illustrated shapes of protrusions are just examples and further shapes are also possible. Example a) shows a pyramid shape. Reference signs are applied to example a) and are to be understood equally present in the remaining examples. The protrusion 50 has a base portion 51 and a tip portion 52. As can be seen in example a), a peripheral dimension of the tip portion 52 is smaller than a peripheral dimension of the base portion 51. In this example a peripheral dimension of the base portion 51 is the length of the circumference of the base portion 51 and a peripheral dimension of the tip portion 52 is the length of the circumference of the tip portion 52. The pyramid in example a) can have a square ground surface forming part of the base portion 51, i.e. a surface having four corners, such as a rectangular or quadradic surface. However, different ground surfaces are also encompassed, such as a triangle, pentagon, hexagon, heptagon and octagon. In case of a triangular ground surface, the shape is a tetrahedron. Further, example b) shows a pyramid shape with 5 corners of the ground surface that can be seen from this perspective. The examples a) and b) can also have a plurality of corners on the ground surface. The pyramid shapes can also have a flatter tip as compared to the illustrated tip. Example c) shows a cylindrical shape. Example d) shows a conical shape. Example e) shows one of many examples of a tapered shape.

[0053] A protrusion can also have a combination of the illustrated shapes. In this case, one specific shape may be referred to as a portion of the protrusion. For instance,

example f) comprises a cylindrical portion and a conical portion. In this case, the base portion 51 and the tip portion 52 of the protrusion 50 are still referred to with respect to the overall protrusion 50 and not with respect to the cylindrical portion and the conical portion. The height or length of the protrusion is indicated in Fig. 7 with reference sign 53. Then a surface has such protrusions, as shown in Fig. 7, according to an embodiment of the invention those can be pressed into a terminal to a degree of 100% of the height 53.

[0054] Fig. 7B shows an electrical connector system 500 according to an embodiment of the invention. An electrical connector 1 is shown a counter connector 100. Furthermore, fixing means 200 are shown that connect the electrical connector 1 and the counter connector 100. In this example a screw 200 is used that extends through the hollow portion of the second element 30 and thereby also through the hollow portion of the first element 20 and through the through-hole. A screw nut 210 fixes one end of the screw, i.e. the bottom end in the Fig. 7B. As a further preferred example of this embodiment, a M6 screw is employed. As another preferred example of this embodiment, a M8 screw is employed. In this embodiment, the electrical connector 1 is in physical contact with the counter connector 100. Thus, the transmission of electrical power from the terminal 10 to the counter connector 100 by way of the first element 20 and/or the second element 30 is beneficially ensured. As a preferred example of this embodiment, a multitude of protrusions, e.g. 20 to about 60 protrusions, are applied to the main surface of the collar of the first element 20 and/or the second element 30. All of which beneficially provide for electrical contact by being pressed into the terminal 10.

[0055] Fig. 8 shows a flow diagram of the method for connecting a first element 20 to a terminal 10 to provide an electrical connector according to an embodiment of the invention. The method 1000 comprises the steps of providing a terminal 1100, which has a first surface and a through-hole on the first surface, which extends through the terminal. In step 1200 a first element configured as described above, for instance according to the embodiment of Fig. 6, is provided. Then in step 1300 the first element is inserted into the through-hole from the first surface side. Then in step 1400 the first element is deformed and thereby pressed into the terminal by pressing means. This is done by inserting a clinching mandrel into the hollow portion of the first element. Apart from a clinching mandrel also any other suitable pressing means, such as rods, would work. The clinching mandrel has a bigger diameter than the inner diameter of the hollow portion of the first element. Thus, when the clinching mandrel is inserted into the hollow portion of the first element, the first element is pressed along the longitudinal axis of the hollow portion of the first element against the terminal, e.g. by deformation. Thereby, the first element is connected to the terminal. The protrusions of the surface of the collar are thereby also pressed into the terminal. In this step, the first element is also deformed by the forces of the clinching mandrel that are acting upon it. Due to the deformation, a proper clamping force between the first element and the terminal is established. In this step 1400, the terminal is hold in position by means that provide a counter-force, that acts on the opposite side to the first surface of the terminal where the through-hole is located.

[0056] Fig. 9 shows a flow diagram of the method for connecting two elements, i.e. a first element 20 and a second element 30 to a terminal to provide an electrical connector according to an embodiment of the invention. The method 2000 comprises the steps of providing a terminal 2100, which has a first surface, and a second surface opposite of the first surface and a through-hole, which extends through the terminal from the first surface to the second surface. In step 2200 a first element 20 and a second element 30 are provided. The first element 20 is configured as described above, for instance according to the embodiment of Fig. 6. The second element can also be configured as described above, for instance according to the embodiment of Fig. 6. However, the second element does not necessarily have to have the at least one protrusion on the surface of the collar facing the terminal. Then in step 2300 the first element 20 is inserted into the through-hole from the first surface side and the second element 30 is inserted into the through-hole from the second surface side. Thereby the outer surface of the hollow portion of the second element 30 is brought in close contact or in close vicinity to the inner surface of the hollow portion of the first element 20. Thus, they overlap within the through-hole. Then in step 2400 the first element 20 and the second element 30 are deformed and thereby pressed into the terminal by pressing means. This is done by inserting a clinching mandrel into the hollow portion of the second element 30. Apart from a clinching mandrel also any other suitable pressing means, such as rods would work as well. This clinching mandrel has a bigger diameter than the inner diameter of the hollow portion of the second element 30. Thus, when the clinching mandrel is inserted into the hollow portion of the second element 30, the second element 30 is pressed along the longitudinal axis of the hollow portion of the second element 30 and against the element, e.g. by deformation. Thereby, the first element 20 and the second element 30 are connected to the terminal. The protrusions of the surface of the collar of the first element 20 are thereby also pressed into the terminal, e.g. through the first surface. In case the second element 30 comprises protrusions, these are also pressed into the terminal, e.g. through the second surface. In this step, the second element 30 and the first element 20 are deformed by the forces of the clinching mandrel that are acting upon the second element 30 and thereby also on the first element 20. Due to the deformation, a proper clamping or clinching force between the first element 20, the second element 30 and the terminal is established. In this step 2400, the terminal is hold in position by means that provide a counter-force, that acts on the opposite

side to the insertion side of the clinching mandrel, i.e. this counter-force acts on the collar of the first element 20.

[0057] In both methods 1000 and 2000, the through-hole has the shape of a cylindrical hole and the hollow portions have a cylindrical outer and inner surface. The material of the first and/or second element 30 is harder than the material of the terminal. The terminal is a busbar made of Aluminum and the elements are made of aluminum or copper alloy, which is treated by platting to be safe from oxidation.

[0058] Fig. 10 shows part of step 2400 of the method described above. The clinching mandrel is pressed into the second element 30 along the longitudinal direction of the hollow portion of the first element 20. In this embodiment, the overlapping region of the hollow portions of the first and second element 30 extends along the overall length of the hollow portion of the first element 20.

[0059] Fig. 11 shows another part of step 2400 of the method described above. The clinching mandrel is pressed with force F2 into the second element 30 along the longitudinal direction of the hollow portion of the second element 30 and thereby creates a force in the radial outer direction that deforms the second element 30 and further presses it against the first element 20, which deforms as well. Force F1 acts as a force to press the protrusions into the terminal and acts on the top and is directed downward in a vertical direction. This could be achieved for instance by providing a counter force F1 acting at the bottom and being directed upwards in a vertical direction as indicated in Fig. 11, i.e. at the element 20. The element 20 could for instance be supported by laying on a ground, or table, thereby providing a corresponding counter force F1 being directed downward in a vertical direction. The force F1 acting on the top and being directed downward in a vertical direction as indicated in Fig. 11 may be a force additional to the force F2, i.e. for instance by separate pressing means or by way of the clinching mandrel that provides for this force in the downward vertical direction.

[0060] Fig. 12 shows a flow diagram of the method for connecting an electrical connector to a counter connector according to an embodiment of the invention. The method 3000 comprises the steps of providing an electrical connector 3100 as described above, for instance as provided by the method 2000. Then another busbar or another terminal is provided as a counter connector in step 3200. In step 3300 the electrical connector is connected to the counter connector by inserting a screw through the hollow portion of the second element 30. Thereby, the screw is also within the through-hole of the terminal and within the hollow portion of the first element 20. The screw is then connected to the counter connector. Also within this step 3300 one end of the screw is fixed by a screw nut that is screwed such that is touches a surface of the collar of the first element 20, which is opposite to the surface that has the protrusions and contacts the terminal. By fixing the screw nut a rotating force acts on the first element 20. The first element 20 is prevented from rotation and/or movement by way of the surface that faces the first side of the terminal and which has protrusions pressed into the terminal.

List of reference signs

[0061]

1	electrical connector
10	terminal
11	first surface of the terminal
12	second surface of the terminal
15	through-hole
20	first element
21	hollow portion of the first element
22	longitudinal axis
25	collar of the first element
26	main surface of the collar of the first element (facing the first surface of the terminal)
30	second element
31	hollow portion of the second element
35	collar of the second element
36	main surface of the collar of the second element (facing the second surface of the terminal)
50	at least one protrusion, plurality of protrusions
51	base portion of a protrusion
52	tip portion of a protrusion
53	height of a protrusion
100	counter connector
200	fixing means, e.g. a screw
210	screw nut
500	electrical connector system
1000	method for connecting an element to a terminal
2000	method for connecting two elements to a terminal
3000	method for connecting an electrical connector to a counter connector

Claims

1. An electrical connector (1) for connecting a conductive element to a counter connector (100), comprising:

a terminal (10), of the conductive element, having a first surface (11) and defining a through-hole (15) in the first surface (11) extending through the terminal (10);

a first element (20) separate from the terminal (10) and in engagement with the terminal (10);

wherein the first element (20) comprises a hollow portion (21) extending through the through-hole (15) of the terminal (10) and a collar (25) covering at least a part of a periphery of the through-hole (15) on the first surface (11) of the terminal (10),

wherein a main surface (26) of the collar (25)

facing the first surface (11) of the terminal (10) is structured such that rotation of the first element (20) in the through-hole (15) is prevented.

2. The electrical connector (1) according to claim 1, wherein the main surface (26) of the collar (25) facing the first surface (11) of the terminal (10) is structured along a circumferential direction of the collar (25).

3. The electrical connector (1) according to any one of the preceding claims, wherein the first element (20) further comprises at least one protrusion (50) on the main surface (26) of the collar (25).

4. The electrical connector (1) according to claim 3, wherein the at least one protrusion (50) comprises a tip portion (52) and a base portion (51), wherein the tip portion (52) is facing the terminal (10) and the base portion (51) is opposite of the tip portion (52) and located on the main surface (26) of the collar (25), wherein a peripheral dimension of the tip portion (52) is smaller than a peripheral dimension of the base portion (51).

5. The electrical connector (1) according to claim 3 or 4, wherein the at least one protrusion (50) is pressed at least partially into the terminal (10),
wherein at least 5 % of a height (53) of the at least one protrusion (50) extending from the main surface (26) of the collar (25) is pressed into the terminal (10), preferably at least 10%, more preferably at least 40%, even more preferably at least 60%, even more preferably at least 80%, most preferably 100% of the height (53) of the at least one protrusion (50).

6. The electrical connector (1) according to any one of claims 3 to 5,

wherein the at least one protrusion (50) has a height (53) of at least 0.2 mm, preferably at least 0.4 mm, more preferably at least 0.6 mm, even more preferably at least 0.8 mm, most preferably of at least 1.0 mm; and/or
wherein the at least one protrusion (50) has a height (53) of at most 15 mm, preferably at most 8 mm, more preferably at most 5 mm, even more preferably at most 3 mm, most preferably of at most 1 mm.

7. The electrical connector (1) according to any one of the preceding claims, wherein the first element (20) comprises a plurality of protrusions (50) on the main surface (26) of the collar (25), wherein the plurality of protrusions (50) is preferably distributed equally on the main surface (26) of the collar (25) facing the first surface (11) of the terminal (10).

8. The electrical connector (1) according to any one of the preceding claims, wherein a material of the first element (20) is harder than a material of the terminal (10),
preferably wherein a material of the first element (20) has a Brinell hardness number which is larger by at least 10%, preferably by at least 30%, more preferably by at least 80%, even more preferably by at least 140%, further even more preferably by at least 200%, most preferably by at least 300% as compared to the Brinell hardness number of a material of the terminal (10).

9. The electrical connector (1) according to any one of the preceding claims, wherein the terminal (10) has a second surface (12) opposite of the first surface (11) and wherein the through-hole (15) extends through the terminal (10) from the first surface (11) to the second surface (12), the connector further comprising:

a second element (30) separate from the terminal (10) and the first element (20), the second element (30) having a hollow portion (31) received within the hollow portion (21) of the first element (20);
wherein the second element (30) has a collar (35) covering at least a part of a periphery of the through-hole (15) on the second surface (12) of the terminal (10).

10. The electrical connector (1) according to claim 9, wherein an outer surface of the hollow portion (31) of the second element (30) is in form-fit connection with the inner surface of the hollow portion (21) of the first element (20).

11. An electrical connector system (500), comprising:

an electrical connector (1) according to any one of claims 1 to 10;
a counter connector (100); and
fixing means (200), optionally a screw, extending through the hollow portion (21) of the first element (20) and fixing the electrical connector (1) to the counter connector (100).

12. A first element (20) for facilitating an electrical connection of a conductive element to a counter connector (100), the first element (20) comprising:

a hollow portion (21) extending along a longitudinal axis and having two opposite ends on the longitudinal axis;
a collar (25) extending perpendicular to the longitudinal axis from one end of the first element (20), the collar (25) having a main surface (26) facing towards a second end of the first element (20) along the longitudinal axis;

at least one protrusion (50), preferably a plurality of protrusions (50), on the main surface (26) of the collar (25);
wherein the main surface (26) of the collar (25) is structured along a circumferential direction of the collar (25),
preferably wherein the at least one protrusion (50) comprises a tip portion (52) and a base portion (51), wherein the tip portion (52) is facing the second end and the base portion (51) is opposite of the tip portion (52) and located on the surface (26) of the collar (25), wherein a peripheral dimension of the tip portion (52) is smaller than a peripheral dimension of the base portion (51).

13. A method of assembling an electrical connector (1), the method comprising the steps of:

(a) providing a terminal (10) having a first surface (11) and defining a through-hole (15) in the first surface (11) extending through the terminal (10);
(b) providing a first element (20) according to claim 12;
(c) inserting the first element (20) into the through-hole (15) such that the main surface (26) of the collar (25) of the first element (20) faces the first surface (11) of the terminal (10); and
(d) deforming the first element (20) at least partially such that the first element (20) is fixed to the terminal (10).

14. The method of claim 13, further comprising the steps of:

(b2) providing a second element (30) comprising a hollow portion (31) extending along a longitudinal axis and having two opposite ends on the longitudinal axis, a collar (35) extending perpendicular to the longitudinal axis from one end of the second element (30), the collar (35) having a main surface (36) facing towards the second end of the second element (30) along the longitudinal axis;
(c2) at least partially inserting the second element (30) into the through-hole (15) such that the main surface (36) of the collar (35) of the second element (30) faces a second surface (12) of the terminal (10) opposite of the first surface (11) of the terminal (10), thereby bringing an outer surface of the hollow portion (31) of the second element (30) in communication with an inner surface of the hollow portion (21) of the first element (20);
wherein step (d) comprises deforming the second element (30) at least partially such that the second element (30) deforms the first element (20) at least partially such that the first element (20) is fixed to the terminal (10).

15. A method of connecting an electrical connector (1) to a counter connector (100), the method comprising the steps of:

(a) providing an electrical connector (1) according to any one of claims 1 to 10;
(b) providing a counter connector (100) comprising a through-hole;
(c) inserting a fixing means (200), optionally a screw, through the hollow portion (21) of the first element (20) of the electrical connector (1) such that the fixing (200) means extends through the hollow portion (21), through the through-hole (15) of the electrical connector (1), and through the through-hole of the counter connector (1), and
(d) connecting the electrical connector (1) to the counter connector (100) by means of the inserted fixing means (200) such that the electrical connector (1) is fixed to the counter connector (100).

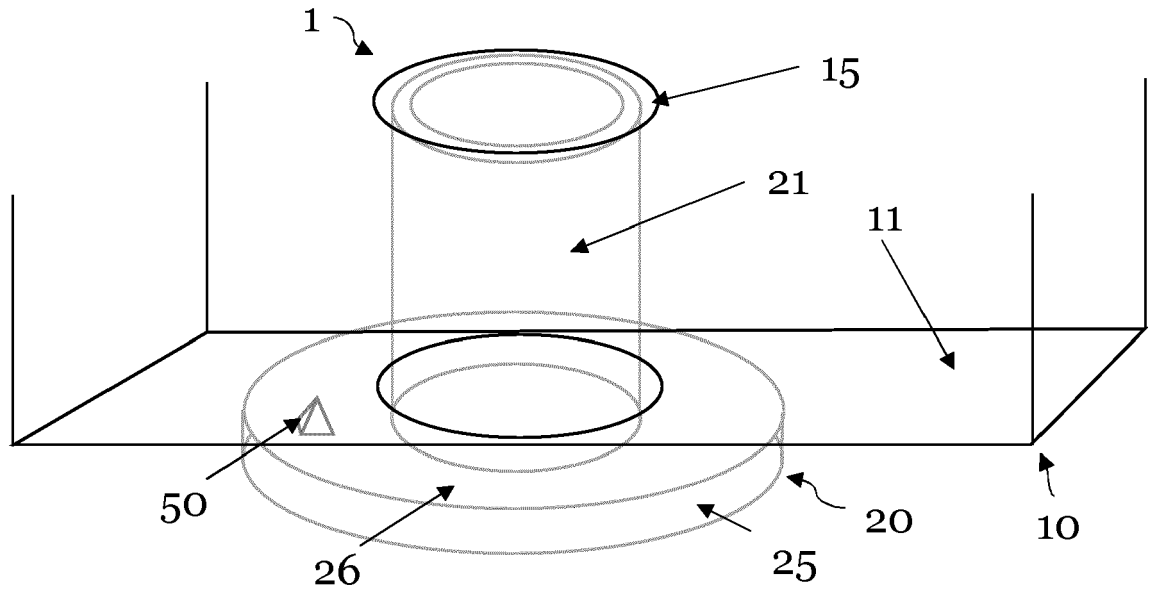

Fig. 1A

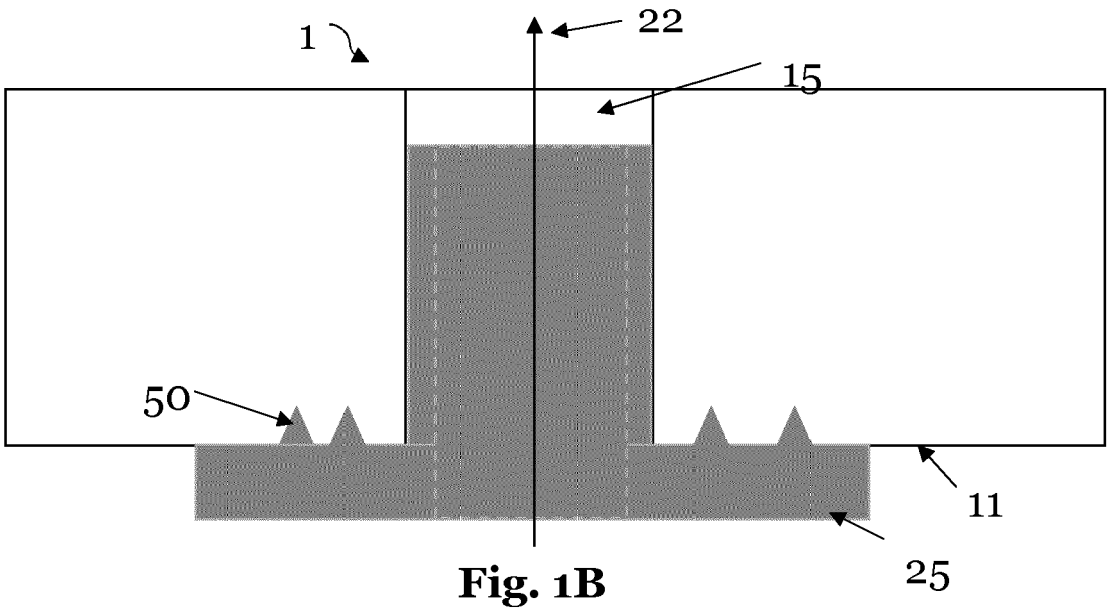

Fig. 1B

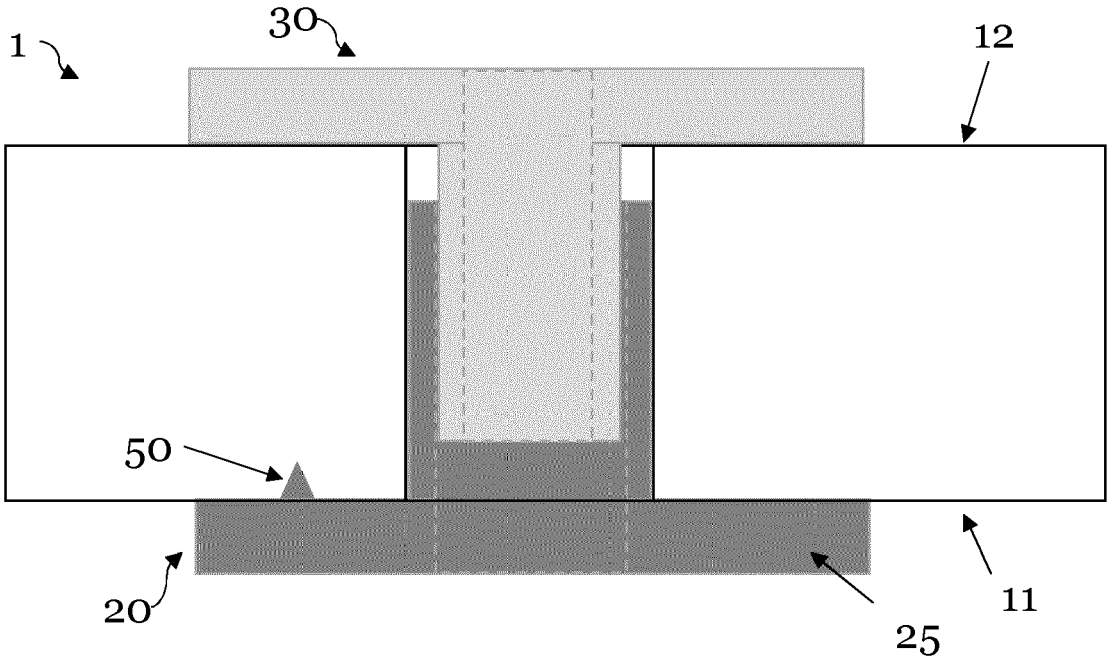

Fig. 2

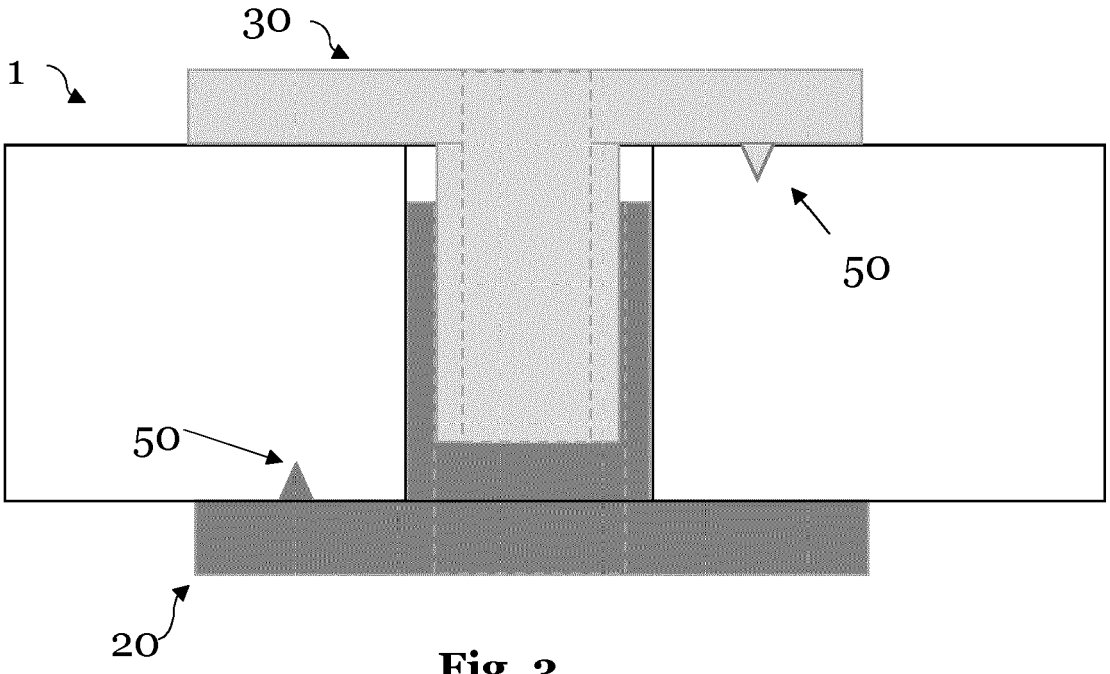

Fig. 3

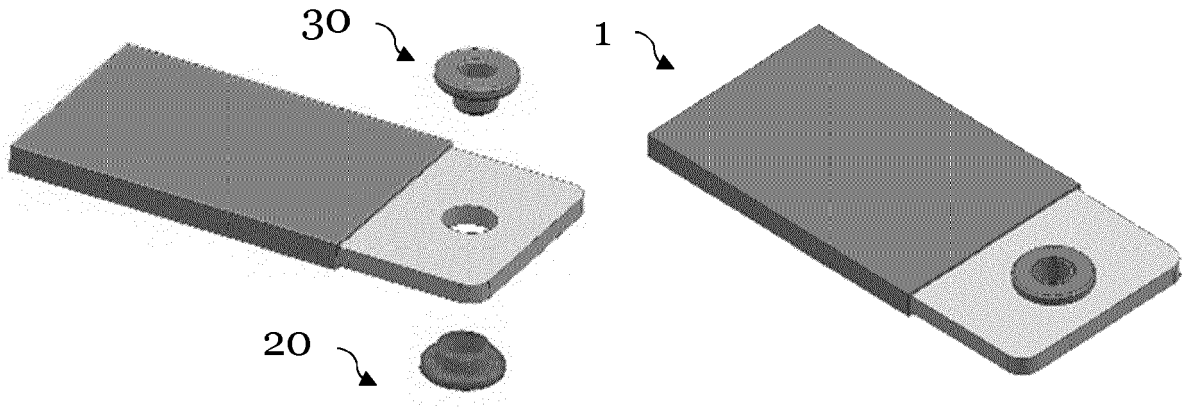

Fig. 4

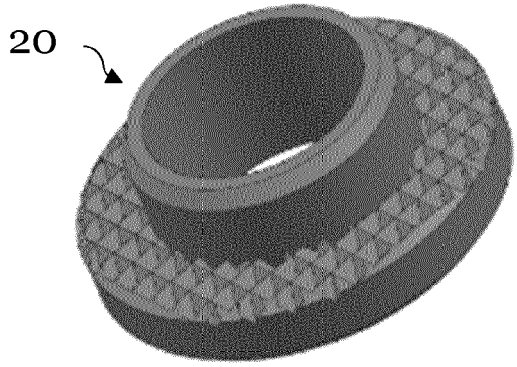

Fig. 5A

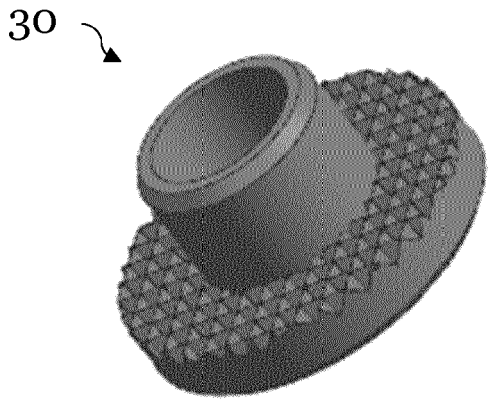

Fig. 5B

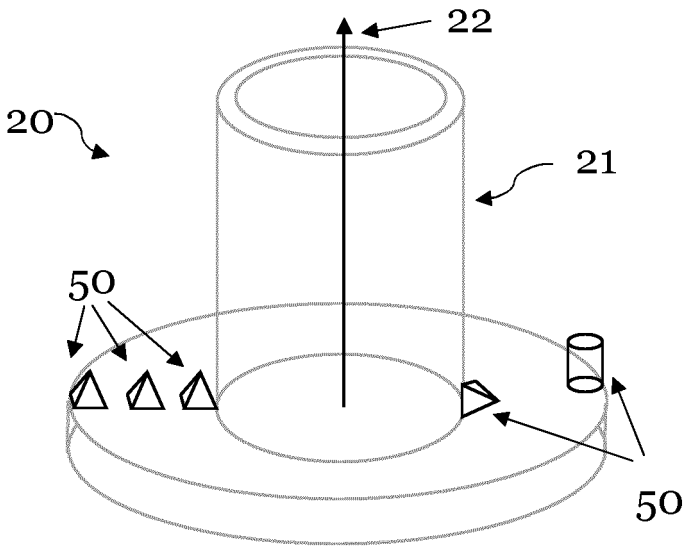

Fig. 6

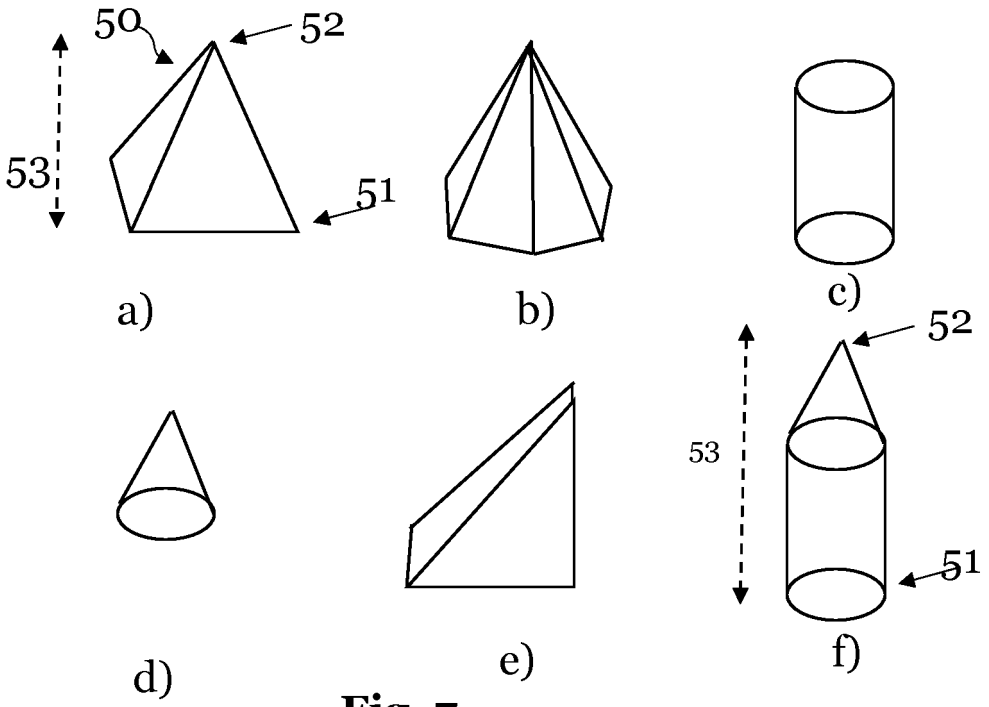

Fig. 7

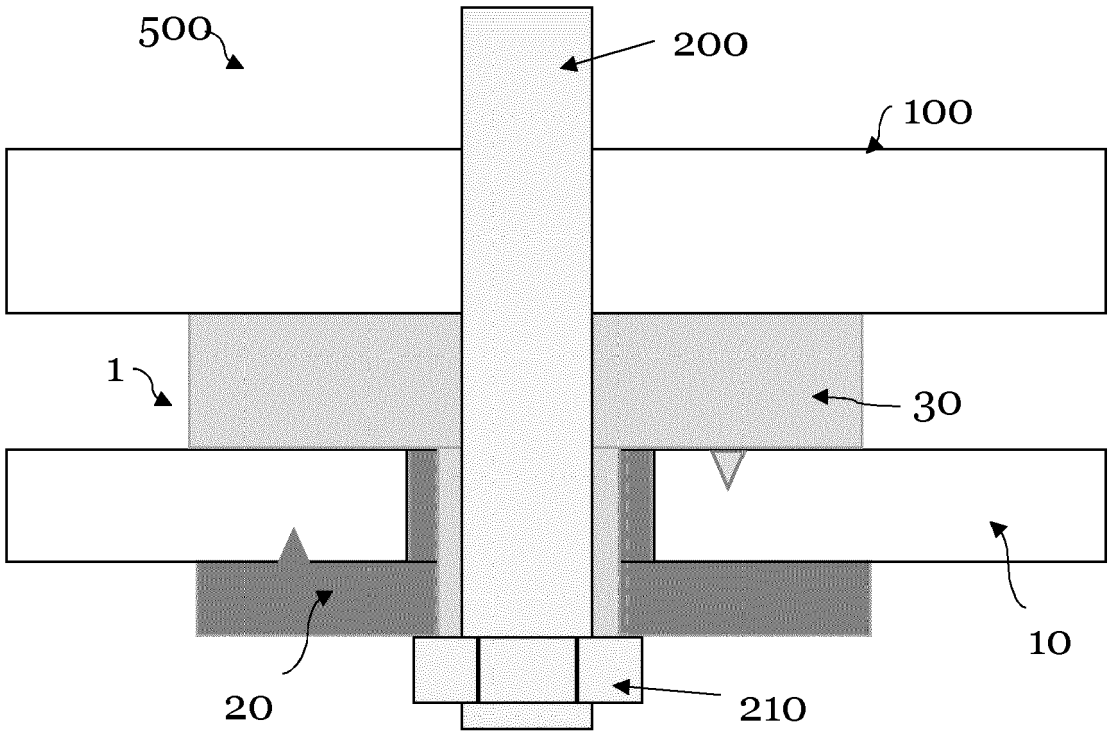

Fig. 7B

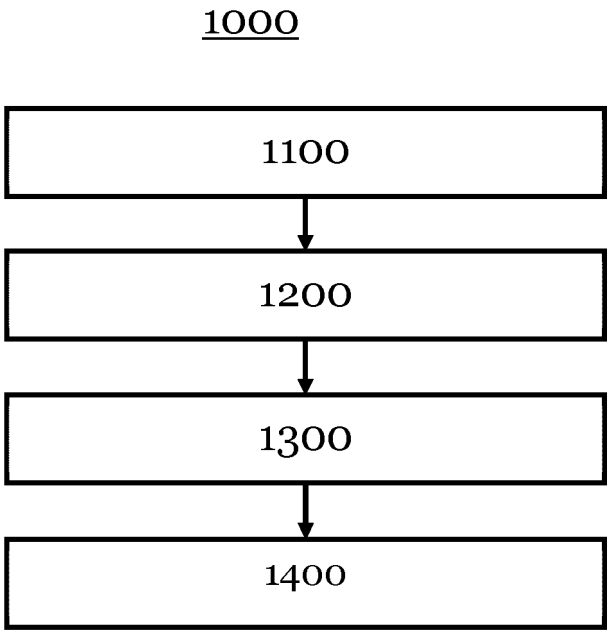

Fig. 8

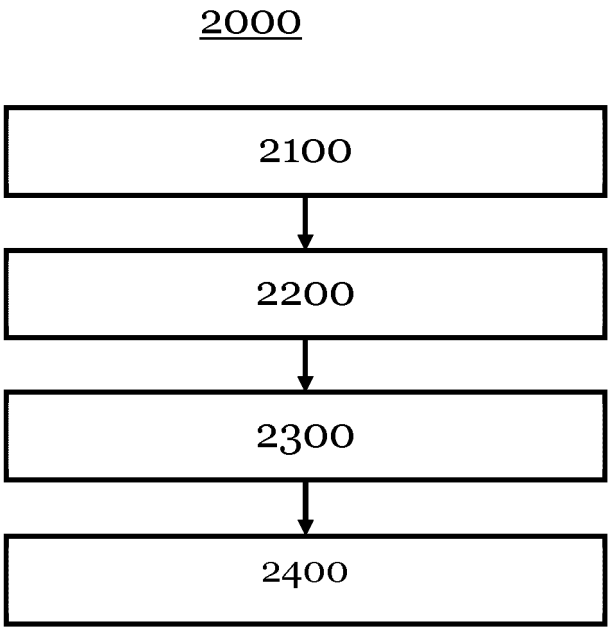

Fig. 9

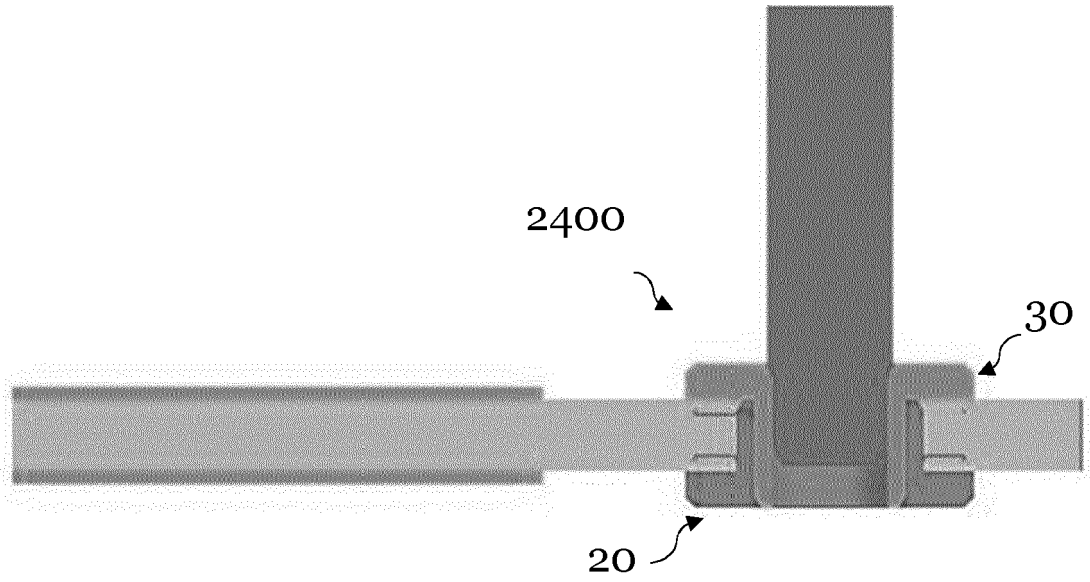

Fig. 10

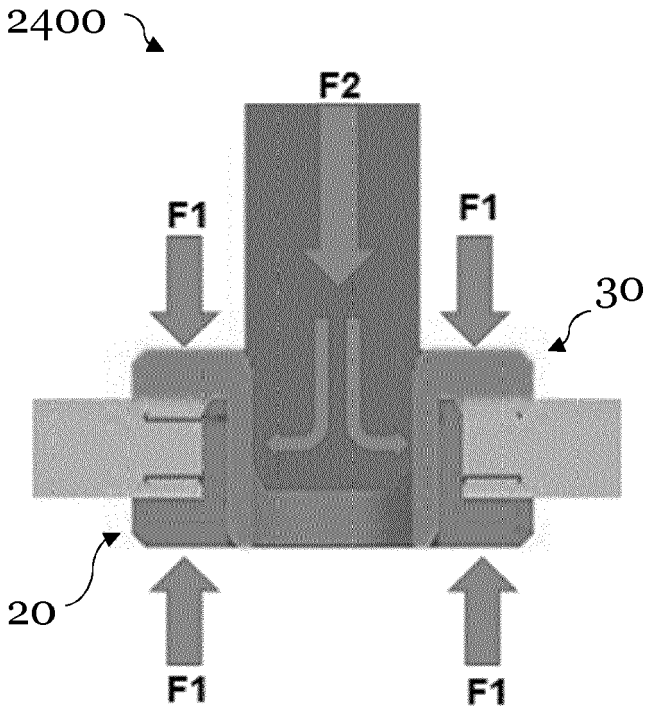

Fig. 11

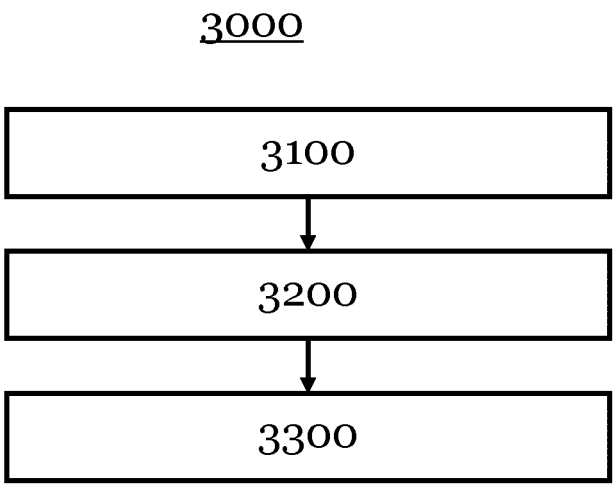

Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	1 June 2022	Jiménez, Jesús

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