



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.08.2020 Bulletin 2020/34

(51) Int Cl.:
H01R 11/28 (2006.01) H01R 13/639 (2006.01)

(21) Application number: **19400004.8**

(22) Date of filing: **12.02.2019**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventor: **Bammer, Benedikt**
D-83727 Schliersee (DE)

(74) Representative: **Pouillot, Laurent Pierre Paul**
GPI & Associés
1330, Rue Guilibert de la Lauzière
EuroParc de Pichaury, Bât B2
13856 Aix-en-Provence Cedex 3 (FR)

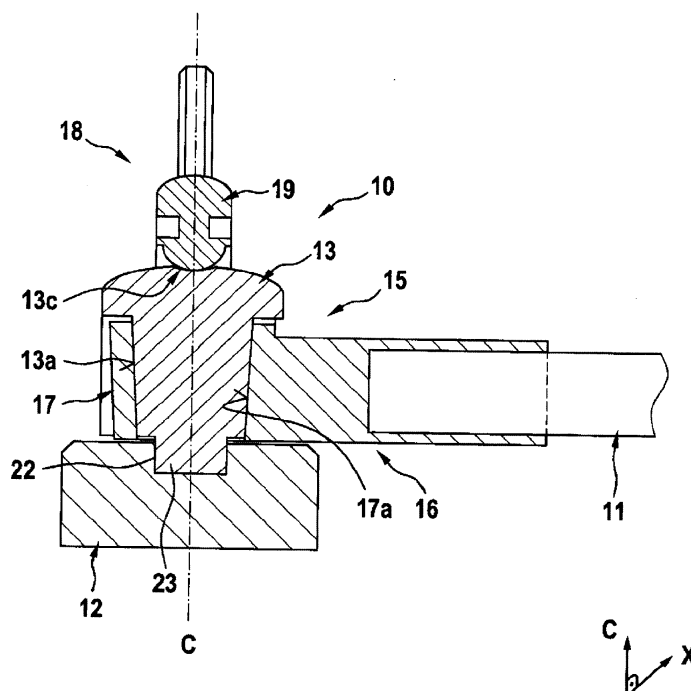
(71) Applicant: **AIRBUS HELICOPTERS**
DEUTSCHLAND GmbH
86609 Donauwörth (DE)

(54) **AN ELECTRICAL CONNECTOR SYSTEM**

(57) An electrical connector system 10 for connecting a transmission line 11 with an electrical component 12 includes a counter element 13 that is coupled to the electrical component 12, a lug 15 and a locking device 18. Counter element 13 includes an outer surface 13a and a groove 13c. Lug 15 includes receiving element 16

that receives transmission line 11 and connecting element 17 that has an inner surface 17a. Locking device 18 is attached to the electrical component 12 and rigidly connects the connecting element 17 with the counter element 13.

Fig. 1



Description

[0001] The present embodiments relate to an electrical connector system and, more particularly, to an electrical connector system for attaching a transmission line to an electrical component.

[0002] Electrical connector systems generally use a cable lug to connect a transmission line to a contact element such as the terminal block of a battery. The cable lug is often tightened around the contact element with a nut and a threaded bolt to create a frictionally locking contact between the cable lug and the contact element. In order to maintain a predefined electrical resistance between the contact element and the transmission line via the cable lug during the entire service life, high contact pressure between the cable lug and the contact element is often required, which in turn generally implies high tightening torques for the nut.

[0003] Usually, a lubricant is used for screwing the nut to the threaded bolt. In case of not using a lubricant in connector systems when the nut is tightened together with friction and adhesion forces on contact surfaces, a "galling of the thread" may occur.

[0004] Conventionally, in mass production (e.g., within the scope of a motor vehicle or aircraft), the fastening devices (e.g., a threaded bolt and a nut) are coated with a lubricant. In particular, all locations on the fastening device are coated with the lubricant.

[0005] Although the lubricant promotes the fastening suitability at high tightening torques for ensuring a secure mechanical connection, it has poor electrical conductivity. Additionally, because of its sliding characteristics during service life of the contact element, the lubricant increases friction corrosion at the contact surfaces with respect to the contact element.

[0006] Document US 9,735,478 B2 describes a cable lug or functional part in combination with a nut. The cable lug or functional part has a tubular receiving portion for a cable, an integrally formed flat part connecting portion connected to the tubular receiving portion, the flat part connecting portion having a hole therethrough defined by a wall said hole having a central axis. The nut includes a body having an undercut. The nut is held captively and rotatably on the flat part connecting portion. The nut does not pass through the flat part connecting portion that is held by a reshaped holding material portion of the flat part connecting portion which projects into the undercut. The reshaped holding material portion is accommodated in the undercut, and an axial clearance is provided between the reshaped holding material and the wall which defines the hole.

[0007] Document BE 763,154 A describes a battery terminal which can quickly and easily be secured to a battery post without the aid of tooling and which is resistant to battery acids relative to prior art battery terminals. This is provided by the use of a threaded connector element which is inwardly compressible by a threaded cap, resistant to battery acids and the like, which is threaded

onto the connector and compresses the portions thereof inwardly to make a frictionally locking contact with the battery post.

[0008] However, most of the current solutions provide a connector system for connecting a battery with a cable, possibly combined with a lug having a flat part that provides small electrical contacted surfaces and does not solve any surface imperfection problems. Most of those solutions operate at voltages that are between a range of 12-28V and need high torque to get enough pressure between its parts.

[0009] Furthermore, the above-mentioned connector systems are provided with a cable lug in combination with a nut and a safety washer. In these connector systems, the torque of the nut is crucial to have enough contact pressure between the surfaces of the lug and the battery terminal, which is important to have a low resistance between the lug and the battery terminal. The above-mentioned systems also require the nut to have a big diameter to reach a desired torque for high current contact which often results in heavy connector system designs.

[0010] Furthermore, using nuts and washers may provide for an unhandy mounting situation. Moreover, securing such connections is generally not provided, which may constitute a safety issue in applications that require fail-safe electrical connector systems such as most aerospace and aeronautical applications.

[0011] Based on the limitations and drawbacks of the prior art, an objective is to provide an electrical connector system for attaching a transmission line to an electrical component. The electrical connector system should require low axial forces for tightening its parts. The electrical connector system should also have a simple and lightweight design, and be easy to install. Additionally, the electrical connector system should use standard assembly tools for attaching a transmission line to an electrical component. Furthermore, in the scenario of using fasteners (e.g., a threaded bolt and a nut) for locking the parts of the electrical connector system, the electrical connector system should provide fail-safe connections between the fastener and the remaining parts of the electrical connector system.

[0012] This objective is solved by an apparatus comprising the features of claim 1.

[0013] More specifically, an electrical connector system for connecting a transmission line with an electrical component comprises a counter element that is coupled to the electrical component, a lug, and a locking device. The counter element comprises an outer surface that is angled at a constant angle relative to a central axis of the counter element. The lug comprises a receiving element that receives the transmission line, and a connecting element for connecting with the counter element, wherein the connecting element is arranged in direction of the central axis and has an inner surface that is angled at the constant angle. The locking device is attached to the electrical component and rigidly connects the connecting element with the counter element, thereby con-

necting the transmission line with the electrical component.

[0014] According to some embodiments, the electrical connector system may be used in high current applications.

[0015] According to some embodiments, the connecting element of the lug may have a conically shaped hole that extends in direction of the central axis.

[0016] According to some embodiments, the counter element of the lug may exhibit a conical shape that attaches to the conically shaped hole of the connecting element, thereby defining a big contact surface between the counter element and the connecting element.

[0017] According to some embodiments, the contact surface between the connecting element and the counter element provides lower resistance in the electrical connector system.

[0018] According to some embodiments, the contact surface between the connecting element and the counter element may exhibit a Morse taper.

[0019] According to some embodiments, the contact surface between the connecting element and the counter element may provide a need of low axial forces in direction of the central axis in the electrical connector system.

[0020] According to some embodiments, the locking device may include fasteners that provide the electrical connector system to operate under high dynamic loads and vibrations.

[0021] According to some embodiments, the contact surface between the connecting element and the counter element may allow to use one or more small and light-weight designed fasteners in the locking device.

[0022] According to some embodiments, the one or more fasteners may include a screw or a nut.

[0023] According to some embodiments, the counter element may include a threaded hole that receives the screw.

[0024] According to some embodiments, the counter element may include a threaded shaft that receives the nut.

[0025] According to some embodiments, due to the conically shaped contact surfaces, a small torque on the fastener may be sufficient to guarantee a contact with low resistance between the connecting element and the counter element. Thus, fasteners with a small thread size may suffice.

[0026] According to some embodiments, the locking device may include a securing element that includes washers or a wire fuse.

[0027] According to some embodiments, the locking device may include a stirrup clamp.

[0028] According to some embodiments, the counter portion may include a groove.

[0029] According to some embodiments, the stirrup clamp may secure the counter element to the connecting element by resting in the groove of the counter element.

[0030] According to some embodiments, the conically shaped contact surface between the connecting element

and the counter element may require less space than a conventional lug.

[0031] According to some embodiments, the contact surface between the connecting element and the counter element may provide a conical angle that is between 1,5° to 3°.

[0032] According to some embodiments, due to the conical angle, a comparably low-pressure force for tightening the electrical connector system may be required.

[0033] According to some embodiments, the conically shaped contact surface between the connecting element and the counter element may require a relatively low pressure between the locking device and the electrical component while still providing a very high contact pressure between the counterpart and the connecting part and thereby eliminate the need of threaded fasteners in the electrical connector system.

[0034] According to some embodiments, the electrical connector system may provide a light-weight design.

[0035] According to some embodiments, a transmission line may be attached to the receiving element of the lug with a standard crimping tool.

[0036] According to one aspect, the counter element is part of the electrical component.

[0037] According to one aspect, the locking device comprises a fastener.

[0038] According to one aspect, the fastener comprises at least one of a screw, a bolt, or a nut.

[0039] According to one aspect, the counter element has a threaded hole that receives the fastener.

[0040] According to one aspect, the counter element has a threaded shaft that receives the fastener.

[0041] According to one aspect, the locking device further comprises a securing element that secures the fastener to the counter element.

[0042] According to one aspect, the securing element comprises at least one of a cotter-pin or a wire fuse.

[0043] According to one aspect, the counter element further comprises a groove that extends in direction of a vertical axis that is perpendicular to the central axis.

[0044] According to one aspect, the locking device comprises a clamp.

[0045] According to one aspect, the clamp settles in the groove and locks the counter element to the connecting element and the electrical component.

[0046] According to one aspect, the electrical connector system further comprises an additional counter element coupled to the electrical component, and an additional lug. The additional counter element comprises an additional outer surface that is angled at the constant angle relative to the central axis, and an additional groove that extends in direction of a vertical axis that is perpendicular to the central axis. The additional lug comprises an additional receiving element that receives an additional transmission line, and an additional connecting element that is arranged in direction of the central axis, has an additional inner surface that is angled at the constant angle, and wherein the clamp settles in the additional

groove and locks the additional counter element to the additional connecting element and the electrical component.

[0047] According to one aspect, the inner surface of the connecting element exhibits at least one of a frustoconical shape, a pyramidal shape, a stepwise frustoconical shape, a stepwise pyramidal shape, or a stepwise conical shape.

[0048] According to one aspect, the outer surface of the counter element exhibits at least one of a frustoconical shape, a pyramidal shape, a stepwise frustoconical shape, a stepwise pyramidal shape, or a stepwise conical shape.

[0049] According to one aspect, the electrical connector system is adapted to be used in systems that operate at voltages that are greater than 300V.

[0050] Embodiments are outlined by way of example in the following description with reference to the attached drawings. In these attached drawings, identical or identically functioning components and elements are labeled with identical reference numbers and characters and are, consequently, only described once in the following description.

- Figure 1 is a diagram of an illustrative sectional side view of an electrical connector system in accordance with some embodiments,
- Figure 2A is a perspective view of an illustrative electrical connector system with a locking device that includes a threaded bolt in accordance with some embodiments,
- Figure 2B is a sectional view of an illustrative electrical connector system that includes a counter element having a threaded hole in accordance with some embodiments,
- Figure 2C is a partly sectional view of an illustrative electrical connector system with a locking device that includes a threaded bolt in accordance with some embodiments,
- Figure 3A is a perspective view of an illustrative electrical connector system with a locking device that includes a nut in accordance with some embodiments,
- Figure 3B is a sectional view of an illustrative electrical connector system that includes a counter element with a threaded shaft in accordance with some embodiments,
- Figure 3C is a partly sectional view of an illustrative electrical connector system with a locking device that includes a nut in accordance with some embodiments,

5

10

15

20

25

30

35

40

45

50

55

- Figure 4A is an exploded view of an illustrative electrical connector system that includes a counter element having a frustoconical shape in accordance with some embodiments,
 - Figure 4B is an exploded view of an illustrative electrical connector system that includes a counter element having a pyramidal shape in accordance with some embodiments,
 - Figure 4C is an exploded view of an illustrative electrical connector system that includes a counter element having a stepwise conical shape in accordance with some embodiments,
 - Figure 5 is a diagram of an illustrative electrical connector system with three lugs and a locking device with a clamp in accordance with some embodiments,
 - Figure 6A is a sectional side view of an illustrative electrical connector system that includes a locking device with a clamp that is in a released position in accordance with some embodiments,
 - Figure 6B is a sectional side view of an illustrative electrical connector system that includes the locking device with a clamp that moves over the counter element in accordance with some embodiments,
 - Figure 6C is a sectional side view of an illustrative electrical connector system that includes the locking device with a clamp that locks the counter element to the lug in accordance with some embodiments,
 - Figure 7A is a diagram of an illustrative electrical connector system that includes a locking device with a securing element that includes a cotter-pin in accordance with some embodiments,
 - Figure 7B is an exploded view of an illustrative electrical connector system that includes a locking device with a securing element that includes a cotter-pin in accordance with some embodiments,
 - Figure 8A is a diagram of an illustrative electrical connector system that includes a locking device with a securing element that includes a wire in accordance with some embodiments, and
 - Figure 8B is an exploded view of an electrical connector system that includes a locking device with a securing element that includes a wire in accordance with some embodiments.
- [0051]** Exemplary embodiments may be used in any device or system in which an electrical component is connected with a transmission line. Examples of such devices or systems with electrical components may include

electrical power generation plants, the electrical power grid, power distribution facilities, musical devices, household appliances, consumer electronics, telecommunication devices, vehicles such as airplanes, quadcopters, helicopters, drones, cars, buses, trucks, e-bikes, motorcycles, ships, etc., industrial machines, etc. Examples for electrical components may include batteries, amplifiers, transformers, electric motors, power supplies, or any other electrical or electronic devices with a terminal that is connected with a transmission line.

[0052] Figure 1 shows an illustrative sectional side view of electrical connector system 10 that connects transmission line 11 with electrical component 12. As shown, electrical connector system 10 may include counter element 13, lug 15 and locking device 18. Counter element 13 may include outer surface 13a and groove 13c that extends in direction of vertical axis X that is perpendicular to central axis C of electrical connector system 10.

[0053] Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17 that is arranged in direction of central axis C. Connecting element 17 may include inner surface 17a that is attached to outer surface 13a of counter element 13. Locking device 18 may be attached to electrical component 12 and may include clamp 19 that locks counter element 13 to connecting element 17 and electrical component 12.

[0054] If desired, electrical connector system 10 may be used in an aircraft and may be attached to a battery as electrical component 12. Batteries may include lead acid batteries such as valve-regulated lead acid (VRLA) batteries or nickel-cadmium (NiCd) batteries. Aircraft batteries may be used for ground power, emergency power, improving DC bus stability, and fault clearing, etc. If desired, the battery of the aircraft may be connected via a transmission line to an electric motor that drives one or more rotors of the aircraft.

[0055] If desired, electrical connector system 10 may be attached to electrical component 12 that operates at voltages higher than 300V.

[0056] For example, electrical component 12 may include lead acid batteries. In this case, acids of electrical component 12 may cause corrosion of parts of electrical component 12 and of electrical connector system 10. The corrosion of at least a part of electrical component 12 may result from a chemical reaction of counter element 13 and connecting element 17 of lug 15 when exposed to the acids from the batteries. This in turn may lead to a higher electrical resistance between electrical component 12 and transmission line 11.

[0057] In order to avoid the problems arising from the chemical reaction and the resulting corrosion of the contacts between transmission line 11 and electrical component 12, counter element 13 and connecting element 17 may include an electrically conductive material that is resistant to the corrosion caused by acids of electrical component 12.

[0058] In some embodiments, transmission line 11

may be a cable, a line, or a wire. Transmission line 11 may be adapted to transmit electric power at relatively high voltages. For example, transmission line 11 may be adapted to transmit electric power at voltages above 300V.

[0059] If desired, transmission line 11 may be adapted to transmit electric power from a power supply (e.g., a wall plug, a battery, an electric generator, etc.) to a power consuming device (e.g., an electric motor, an electrical heating device, an electrical appliance, etc.) or any intermediate device (e.g., a transformer). For example, transmission line 11 may transmit electric power from a battery to an electric motor.

[0060] According to some embodiments, counter element 13 may include outer surface 13a that may exhibit a frustoconical shape around central axis C. Outer surface 13a may be formed by standard metal drawing techniques such as sheet, tube, or bar metal drawing.

[0061] If desired, receiving element 16 may be attached to transmission line 11 by a number of different methods including e.g., screw-on, press-on, crimp-on, or any combination thereof. For example, as shown in Figure 1, receiving element 16 may have an opening that extends in direction of an axis that is perpendicular to central axis C.

[0062] The opening of receiving element 16 may exhibit conical, pyramidal, cylindrical, or rectangular shape. Receiving element 16 may have an electrical insulation. If desired, receiving element 16 may be insulated against corrosion caused, for example, by acid leaking from electrical component 12.

[0063] Counter element 13 may have projection 23 that protrudes from the frustoconical shape. If desired, electrical component 12 may have recess or cavity 22 that mirrors projection 23 and into which projection 23 of counter element 13 may snugly fit. Projection 23 may have any shape. For example, projection 23 may have a cylindrical, conical, pyramidal, or any other shape of a convex polyhedron. Thus, recess 22 may have a corresponding cavity that has a cylindrical, conical, pyramidal, or any other shape of a convex polyhedron.

[0064] As shown in Figure 1, counter element 13 may include a U-shaped top portion. The top portion of counter element 13 may provide groove 13c that extends in direction of vertical axis X. Groove 13c may be formed by machine cutting processes such as drilling, milling, bending, grinding, etc. Groove 13c may provide a narrow flange that guides clamp 19. Clamp 19 may settle in groove 13c, thereby locking counter element 13 to connecting element 17.

[0065] Figure 2A shows an illustrated electrical connector system 10 that is attached to electrical component 12. As shown, electrical connector system 10 may include lug 15 and locking device 18. Lug 15 may include receiving element 16 and connecting element 17. Locking device 18 may include fastener 20.

[0066] As an example, electrical connector system 10 may be used in an aircraft or any other vehicle, and elec-

trical component 12 may include a battery or any other electrical component onboard the aircraft or vehicle. Electrical component 12 may include nickel-cadmium (NiCd) batteries. However, lead acid types of batteries, such as valve-regulated lead-acid (VRLA) batteries may also be used.

[0067] If desired, receiving element 16 of lug 15 may have an opening that receives a transmission line (e.g., transmission line 11 of Figure 1). The opening of receiving element 16 may fasten the transmission line by a number of methods, including e.g., screw-on, press-on, or crimp-on. The opening of receiving element 16 may exhibit a conical, pyramidal, cylindrical, or rectangular shape. If desired, receiving element 16 may be electrically insulated and/or protected against corrosion.

[0068] As shown, locking device 18 may include fastener 20 that provides an externally threaded surface. In other words, fastener 20 may include a screw or a bolt with a threaded shaft. Externally threaded fastener 20 may include a machine screw, hex cap screw, lag screw, round head bolt, track bolt, plow bolt, etc.

[0069] A counter element (e.g., counter element 13 of Figure 1) may be attached to electrical component 12. As an example, the counter element may be a terminal of electrical component 12. In other words, the counter element may be firmly and non-removably attached to electrical component 12.

[0070] If desired, the counter element may have a threaded hole that receives fastener 20. Fastener 20 with an externally threaded shaft and the counter element with an internally threaded hole may form locking device 18 that rigidly connects connecting element 17 with the counter element.

[0071] If desired, locking device 18 may include an additional fastener 20 in combination with the externally threaded fastener 20. Additional fastener 20 may include a wave washer, split washer, curved disk washer, etc.

[0072] Figure 2B illustrates a cross section of electrical connector system 10 that includes counter element 13 and connecting element 17. Counter element 13 may include outer surface 13a that is angled at constant angle α . If desired, counter element 13 may have threaded hole 13b that extends in direction of central axis C of electrical connector system 10. Connecting element 17 may be arranged in direction of central axis C. Connecting element 17 may include inner surface 17a that is attached to outer surface 13a of counter element 13. Outer surface 13a of counter element 13 may be angled at constant angle α . Constant angle α may be between 1° and 5° .

[0073] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may include a battery and counter element 13 may be a terminal of the battery. If desired, electrical connector system 10 may be installed in an aircraft.

[0074] As shown in Figure 2B, outer surface 13a of counter element 13 may exhibit a frustoconical shape around central axis C. Outer surface 13a may be formed

by standard metal drawing techniques such as sheet, tube, or bar metal drawing.

[0075] If desired, counter element 13 may include hole 13b that is internally threaded. Hole 13b may be adapted to receive a locking device (e.g., locking device 18 of Figure 2A). Threaded hole 13b may exhibit a cylindrical shape or non-cylindrical shape. Threaded hole 13b may be formed by using machining techniques such as drilling, reaming, tapping, boring, counterboring, counter-sinking, etc. Threaded hole 13b may be threaded partly or completely.

[0076] In some embodiments, connecting element 17 may include inner surface 17a that is angled at constant angle α relative to central axis C. Inner surface 17a with constant angle α may exhibit a frustoconical shape. Inner surface 17a may include an electrically conductive material that is resistant to corrosion.

[0077] Inner surface 17a of connecting element 17 may be attached to outer surface 13a of counter element 13. Therefore, a contact surface of constant angle α may be defined between inner surface 17a and outer surface 13a. The contact surface between inner surface 17a and outer surface 13a may exhibit a Morse taper. The Morse Taper may have constant angle α around central axis C. Constant angle α of the Morse taper may enable high contact stresses and ensure high stability between inner surface 17a and outer surface 13a. Therefore, electrical connector system 10 may require comparatively low axial forces for tightening counter element 13 to connecting element 17.

[0078] If desired, inner surface 17a of connecting element 17 and outer surface 13a of counter element 13 may be both uniformly tapered, thereby ensuring a close contact between inner surface 17a and outer surface 13a.

[0079] Figure 2C shows a cross section of electrical connector system 10 that is attached to electrical component 12. Electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Counter element 13 may include outer surface 13a and threaded hole 13b that extends in direction of central axis C of electrical connector system 10.

[0080] Lug 15 may include connecting element 17 that is arranged in direction of central axis C. Connecting element 17 may include inner surface 17a that is attached to outer surface 13a of counter element 13. Locking device 18 may include fasteners 20 that lock counter element 13 to connecting element 17 and electrical component 12.

[0081] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may include a battery and counter element 13 may be a terminal of the battery. If desired, counter element 13 may be made of electrically conductive material that is resistant to corrosion caused by acids (e.g., from the battery in case of a leak).

[0082] In some embodiments, outer surface 13a of counter element 13 may exhibit a frustoconical shape

around central axis C. Outer surface 13a may be formed by standard metal drawing techniques such as sheet, tube, or bar metal drawing.

[0083] If desired, counter element 13 may include internally threaded hole 13b. Threaded hole 13b may receive locking device 18. Locking device 18 may attach counter element 13 with connecting element 17. If desired, locking device 18 may be secured to prevent rotation around central axis C.

[0084] Threaded hole 13b may exhibit a cylindrical shape or non-cylindrical shape. Threaded hole 13b may be formed by using machining techniques such as drilling, reaming, tapping, boring, counterboring, counter-sinking, etc. Threaded hole 13b may be threaded partly or completely.

[0085] As shown, locking device 18 may include fastener 20. If desired, fastener 20 may have an externally threaded surface. For example, fastener 20 may include a screw or a bolt such as a machine screw, a hex cap screw, a lag screw, a round head bolt, a track bolt, a plow bolt, etc.

[0086] Threaded hole 13b of counter element 13 may receive fastener 20. If desired, externally threaded fastener 20 may rigidly attach counter element 13 with connecting element 17.

[0087] Locking device 18 may include an additional fastener 20. Additional fastener 20 may include a wave washer, split washer, curved disk washer, etc.

[0088] In some embodiments, inner surface 17a may exhibit a frustoconical shape. Inner surface 17a of connecting element 17 may be attached to outer surface 13a of counter element 13. The contact surface between inner surface 17a and outer surface 13a may exhibit a Morse taper. This may enable high contact stresses and ensure a very stable connection between connecting element 17 and counter element 13. Thus, relatively low axial forces on fastener 20 may be sufficient to rigidly attach counter element 13 to connecting element 17.

[0089] Figure 3A shows an illustrated electrical connector system 10 that is attached to electrical component 12. Electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Lug 15 may include receiving element 16 and connecting element 17. Locking device 18 may include fastener 20 that rigidly attaches counter element 13 with connecting element 17 and electrical component 12.

[0090] In some embodiments, counter element 13 may be a part of electrical component 12. As an example; electrical component 12 may include a battery. In this case, corrosion of at least a part of electrical component 12 may occur, caused by a chemical reaction when battery acid comes into contact with counter element 13. If desired, counter element 13 may be made from an electrically conductive material that is resistant to corrosion caused by battery acids.

[0091] If desired, receiving element 16 of lug 15 may be attached to a transmission line (e.g., transmission line 11 of Figure 1). The transmission line may be attached

to receiving element 16 by a number of methods including e.g., screw-on, press-on, or crimp-on, if desired.

[0092] The opening of receiving element 16 may exhibit pyramidal, cylindrical, or rectangular shape. Receiving element 16 may be electrically insulated and/or protected against corrosion.

[0093] If desired, counter element 13 may include an externally threaded shaft. The externally threaded shaft may receive fastener 20. Fastener 20 may be internally threaded. For example, as shown in Figure 3A, fastener 20 may include a nut. The nut may have any shape and any size that fits onto the externally threaded shaft of counter element 13.

[0094] The nut may have a threaded opening. The threaded opening of the nut may provide a compression with a friction of its threats when fastened onto externally threaded shaft of counter element 13.

[0095] The combination of compression forces with the friction of threats may rigidly connect counter element 13 with connecting element 17. If desired, locking device 18 may include additional fastener 20. Additional fastener 20 may include a wave washer, split washer, curved disk washer, etc.

[0096] Figure 3B illustrates a sectional view of electrical connector system 10 that includes counter element 13 and lug 15. Counter element 13 may include outer surface 13a that is angled at constant angle α and threaded shaft 14 that extends in direction of central axis C.

[0097] Lug 15 may include connecting element 17 that is arranged in direction of central axis C. Connecting element 17 may include inner surface 17a that is attached to outer surface 13a of counter element 13. Inner surface 17a may be angled at constant angle α .

[0098] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may include a battery and counter element 13 may be a terminal of the battery.

[0099] If desired, counter element 13 may include outer surface 13a that may exhibit a frustoconical shape around central axis C. Outer surface 13a may be formed by standard metal drawing techniques such as sheet, tube, or bar metal drawing.

[0100] If desired, counter element 13 may include externally threaded shaft 14. Externally threaded shaft 14 may extend in direction of central axis C. Externally threaded shaft 14 of counter element 13 may be adapted to receive an internally threaded fastener (e.g., fastener 20 of Figure 3A).

[0101] Threaded shaft 14 may exhibit a cylindrical shape or non-cylindrical shape. Threaded shaft 14 may be formed by using machining techniques such as thrilling, milling, grinding, etc.

[0102] In some embodiments, connecting element 17 may include inner surface 17a that is angled at constant angle α relative to central axis C. Inner surface 17a with constant angle α may exhibit a frustoconical shape. Inner surface 17a may have a coating of electrically conductive material that is resistant to corrosion.

[0103] Inner surface 17a of connecting element 17 may be attached to outer surface 13a of counter element 13. The contact surface between inner surface 17a and outer surface 13a may have constant angle α . The contact surface between inner surface 17a and outer surface 13a may exhibit a Morse taper.

[0104] The Morse taper may have constant angle α relative to central axis C. Constant angle α of Morse taper may enable high contact stresses between connecting element 17 and counter element 13 and thereby guarantee a high stability of the connection between connecting element 17 and counter element 13. Therefore, the contact surface may lead to a reduction of the axial force that is required for rigidly attaching counter element 13 to connecting element 17.

[0105] Figure 3C illustrates a sectional view of illustrative electrical connector system 10 that is attached to electrical component 12. Electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Counter element 13 may include outer surface 13a and threaded shaft 14 that extends in direction of central axis C of electrical connector system 10.

[0106] Lug 15 may include connecting element 17 that is arranged in direction of central axis C. Connecting element 17 may include inner surface 17a that is attached to outer surface 13a of counter element 13. Locking device 18 may include fasteners 20 that lock counter element 13 to connecting element 17 and electrical component 12.

[0107] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may include a battery and counter element 13 may be a terminal of the battery or electrical component may be an electric motor and counter element may be a terminal of the electric motor.

[0108] If desired, counter element 13 may include outer surface 13a. Outer surface 13a of counter element 13 may exhibit a frustoconical shape around central axis C. Outer surface 13a may be formed by standard metal drawing techniques such as sheet, tube, or bar metal drawing.

[0109] If desired, counter element 13 may include externally threaded shaft 14. Externally threaded shaft 14 may receive fastener 20. Fastener 20 may be tightened onto threaded shaft 14, thereby attaching counter element 13 with connecting element 17. Threaded shaft 14 may exhibit a cylindrical shape or non-cylindrical shape. Threaded shaft 14 may be formed by using machining techniques such as thrilling, milling, grinding, etc.

[0110] As shown, fastener 20 may include a nut which is internally threaded and designed for tightening onto threaded shaft 14. If desired, the outside of the nut may have the form of a polygonal shape such as a triangular shape, a square shape, a rectangular shape, a pentagonal shape, a hexagonal shape, a heptagonal shape, an octagonal shape, etc.

[0111] If desired, locking device 18 may include additional fastener 20. Additional fastener 20 may include a

wave washer, split washer, curved disk washer, etc.

[0112] Figure 4A shows an exploded view of electrical connector system 10 that includes counter element 13 and lug 15. Counter element 13 may include outer surface 13a. Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17 that includes inner surface 17a that is angled at constant angle α .

[0113] If desired, receiving element 16 may have an opening that extends in direction of an axis that is perpendicular to central axis C. The opening of receiving element 16 may exhibit pyramidal, cylindrical or rectangular shape.

[0114] In some embodiments, receiving element 16 of lug 15 may be attached to transmission line 11. For example, receiving element 16 may be attached to transmission line 11 by screw-on, press-on, or crimp-on. Receiving element 16 may be electrically insulated and able to withstand corrosion caused by acids.

[0115] As shown in Figure 4A, inner surface 17a of connecting element 17 that may exhibit a frustoconical shape around central axis C. Inner surface 17a may be in contact with outer surface 13a of counter element 13. The frustoconical shape may have a circular, oval, elliptical, etc. base.

[0116] The contact surface between inner surface 17a and outer surface 13a may exhibit a Morse taper. The Morse taper may have constant angle α around central axis C. Constant angle α of the Morse taper may provide for high contact stresses between inner surface 17a and outer surface 13a and thereby ensure a very stable connection between connecting element 17 and counter element 13. Thus, comparatively low axial forces in direction of central axis C may be sufficient for rigidly attaching counter element 13 to connecting element 17.

[0117] Figure 4B shows an exploded view of electrical connector system 10 that includes counter element 13 and lug 15. Counter element 13 may include outer surface 13a. Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17 that includes inner surface 17a that is angled at constant angle α .

[0118] As shown in Figure 4B, inner surface 17a of connecting element 17 may exhibit a pyramidal shape around central axis C. Outer surface 13a may exhibit a pyramidal shape that is angled at constant angle α and fits with inner surface 17a.

[0119] The contact surface between inner surface 17a and outer surface 13a may allow stress distribution between connecting element 17 and counter element 13. The pyramidal shape may have a triangular, rectangular, pentagonal, hexagonal, heptagonal, etc. base surface.

[0120] In some embodiments, one or more edges of the pyramidal shape may be rounded. A rounded edge at the outer surface 13a of counter element 13 may be mirrored by a rounded edge at the inner surface 17a of connecting element 17 so as to provide a snug fit between counter element 13 and connecting element 17.

[0121] If desired, the pyramidal shape may include several steps. In other words, inner surface 17a of connecting element 17 may exhibit a stepwise pyramidal shape. Similarly, outer surface 13a of counter element 13 may exhibit a stepwise pyramidal shape.

[0122] Figure 4C shows electrical connector system 10 that includes counter element 13 and lug 15. Counter element 13 may include outer surface 13a. Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17 that includes inner surface 17a that is angled at constant angle α .

[0123] For example, as shown in Figure 4C, inner surface 17a may exhibit a stepwise conical shape or a stepwise frustoconical shape. Outer surface 13a may exhibit a matching stepwise conical shape or matching stepwise frustoconical shape to inner surface 17a. The stepwise frustoconical shape may have a circular, oval, elliptical, etc. base.

[0124] Thus, matching inner surface 17a and outer surface 13a may form a contact surface that results in small electrical resistance between counter element 13 and connecting element 17.

[0125] If desired, inner surface 17a of connecting element 17 and outer surface 13a of counter element 13 may be both uniformly tapered. When inner surface 17a is connected with outer surface 13a, they may come into close contact.

[0126] Figure 5 shows illustrated electrical connector system 10 that connects three transmission lines 11 with one electrical component 12. If desired, electrical connector system 10 may connect any number of transmission lines 11 with electrical component 12. For example, electrical connector system 10 may connect one, two, three, four, five, six, seven, eight, etc. transmission lines 11 with electrical component 12.

[0127] As shown, electrical connector system 10 may include counter element 13, lugs 15, and locking device 18. Counter element 13 may include groove 13c. Locking device 18 may be attached to electrical component 12 and may include handle 19a and clamp 19. Groove 13c may provide a narrow flange that guides clamp 19. Thus, clamp 19 may settle in groove 13c, thereby locking counter element 13 to connecting element 17 and electrical component 12.

[0128] In some embodiments, electrical connector system 10 may be attached to a battery. As an example, electrical connector system 10 may be used in an aircraft and be connected to a lead acid battery. Acid from a leaking battery may cause corrosion of counter element 13 and connecting element 17, which in turn may lead to an increased electrical resistance between the battery and connecting element 17. To avoid problems caused by corrosion, counter element 13 and connecting element 17 may consist of an electrically conductive material that has a predetermined resistance to corrosion caused by acids from electrical component 12.

[0129] Each one of lugs 15 may include connecting element 17 and receiving element 16 that receives trans-

mission line 11. In some embodiments, transmission line 11 may be a cable, a line, a wire, or any other component that is designed to conduct a current to and/or from electrical component 12.

[0130] If desired, transmission line 11 may be attached to receiving element 16 by a number of methods including screw-on, press-on, or crimp-on. For example, receiving element 16 may have an opening that extends in a direction that is perpendicular to groove 13c. The opening of receiving element 16 may exhibit a circular, oval, elliptical, or polygonal (e.g., triangular, rectangular, etc.) shape. Receiving element 16 may have an electrically insulated outer surface, if desired.

[0131] As shown, electrical connector system 10 may include three counter elements 13. Each counter element 13 may have a projection (e.g., projection 23 of Figure 1). If desired, electrical component 12 may have a corresponding recess or cavity (e.g., recess 22 of Figure 1) that mirrors the projection and into which the projection of counter element 13 may snugly fit.

[0132] In some embodiments, locking device 18 may include handle 19a that is attached to clamp 19. Clamp 19 may be moved by handle 19a manually over the U-shaped top portion of counter element 13 and settle in groove 13c.

[0133] Figure 6A illustrates a sectional side view of electrical connector system 10 that connects transmission line 11 with electrical component 12. Electrical connector system 10 may include counter element 13 that is coupled to electrical component 12, lug 15, and locking device 18. Locking device 18 may include clamp 19 that is in a released position.

[0134] Counter element 13 may include outer surface 13a that is arranged in direction of central axis C, and groove 13c that extends in direction of vertical axis X. Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17. Connecting element 17 may include inner surface 17a that is angled at constant angle α . Locking device 18 may be attached to electrical component 12 and may include handle 19a and clamp 19 that locks counter element 13 to connecting element 17 and electrical component 12.

[0135] If desired, counter element 13 may have projection 23 at its bottom, and electrical component 12 may include recess 22 on its top. In some embodiments, projection 23 of counter element 13 may neatly fit into recess 22 of electrical component 12. In a released position of locking device 18, projection 23 of counter element 13 may be arranged above recess 22 of electrical component 12.

[0136] As shown, inner surface 17a of connecting element 17 may exhibit a frustoconical shape around central axis C. Inner surface 17a may receive outer surface 13a of counter element 13. The contact surface between inner surface 17a and outer surface 13a may exhibit a Morse taper. The Morse taper may have constant angle α around central axis C. Constant angle α of the Morse taper may allow high contact stresses and provide for a

very stable connection between counter element 13 and connecting element 17.

[0137] In some embodiments, locking device 18 may include handle 19a that is attached to clamp 19. Handle 19a may assist in moving clamp 19 from the released position to a locked position (e.g., the position shown in Figure 6C).

[0138] Figure 6B illustrates a sectional side view of electrical connector system 10 that connects transmission line 11 with electrical component 12. Electrical connector system 10 may include counter element 13 that is coupled to electrical component 12, lug 15, and locking device 18. Locking device 18 may include clamp 19 that moves over counter element 13.

[0139] Counter element 13 may include outer surface 13a that is arranged in direction of central axis C. Counter element 13 may have groove 13c that extends in direction of vertical axis X.

[0140] Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17. Connecting element 17 may include inner surface 17a that is angled at constant angle α .

[0141] Locking device 18 may be attached to electrical component 12. Locking device 18 may include handle 19a and clamp 19 that locks counter element 13 to connecting element 17 and electrical component 12.

[0142] Counter element 13 may have a top portion that is formed in a U-shaped form and that includes groove 13c. Groove 13c may extend in direction of vertical axis X. The U-shaped top portion of counter element 13 may guide clamp 19 to move into groove 13c.

[0143] If desired, counter element 13 may include projection 23 at its bottom. Electrical component 12 may include recess 22 on its top that may mirror the shape of projection 23. As shown in Figure 6B, when clamp 19 moves over counter element 13, projection 23 of counter element 13 may settle into recess 22 of electrical component 12.

[0144] Figure 6C illustrates a sectional side view of electrical connector system 10 that connects transmission line 11 with electrical component 12. Electrical connector system 10 may include counter element 13 that is coupled to electrical component 12, lug 15, and locking device 18.

[0145] Counter element 13 may include groove 13c that receives clamp 19. Counter element 13 may have outer surface 13a that is arranged in direction of central axis C. Lug 15 may include receiving element 16 that receives transmission line 11 and connecting element 17. Connecting element 17 may include inner surface 17a that is angled at constant angle α .

[0146] Locking device 18 may be attached to electrical component 12. If desired, locking device 18 may include handle 19a attached to clamp 19. Such a clamp is sometimes also referred to as a stirrup clamp. Clamp 19 may lock counter element 13 to connecting element 17 and electrical component 12. Handle 19a may assist in moving clamp 19 with comparatively low effort.

[0147] In some embodiments, counter element 13 may have a U-shaped top portion that includes groove 13c which extends in direction of vertical axis X. After moving clamp 19 over the U-shaped top portion of counter element 13, clamp 19 may settle in groove 13c and lock counter element 13 to connecting element 17 and electrical component 12.

[0148] Figure 7A shows illustrative electrical connector system 10 that is attached to electrical component 12. Electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Locking device 18 may include fasteners 20 and securing element 21. Counter element 13 may have threaded shaft 14 that receives fastener 20. Lug 15 may include receiving element 16 and connecting element 17.

[0149] In some embodiments, counter element 13 may include threaded shaft 14 that may receive fasteners 20. Fasteners 20 may be tightened on threaded shaft 14, thereby rigidly connecting counter element 13 with connecting element 17. Threaded shaft 14 may provide for a high tensile strength. The high tensile strength in threaded shaft 14 may result in high fatigue and wear resistance in electrical connector system 10. Threaded shaft 14 may exhibit a cylindrical shape or non-cylindrical shape. Threaded shaft 14 may be formed by using machining techniques such as thrilling, milling, grinding, etc.

[0150] If desired, locking device 18 may include additional fastener 20. Additional fastener 20 may include a wave washer, split washer, curved disk washer, etc.

[0151] As shown, locking device 18 may include securing element 21 that allows to hold fastener 20 and threaded shaft 14 together. Securing element 21 may secure fastener 20 to counter element 13. For example, securing element 21 may prevent a rotational movement of fastener 20 on threaded shaft 14. As shown, securing element 21 may include a cotter-pin. However, other pin types for securing element 21 may be available, such as clinch pin, grooved pin, dowel pin, lynch pin, taper pin, etc. In some embodiments, securing element 21 may be a wire or any other device that prevents a rotational movement of fastener 20 on threaded pin 14.

[0152] Figure 7B illustrates an exploded view of electrical connector system 10 that is attached to electrical component 12. Electrical connector system 10 includes counter element 13, lug 15, and locking device 18. As shown, locking device 18 may include two fasteners 20 and securing element 21.

[0153] Lug 15 may include receiving element 16 and connecting element 17. Counter element 13 may include threaded shaft 14 that receives fasteners 20. If desired, counter element 13 may be rigidly attached to electrical component 12.

[0154] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may be a battery and counter element 13 may be a terminal of the battery. As another example, electrical component 12 may be an electric motor and counter element 13 may be a contact of the elec-

tric motor.

[0155] Counter element 13 may include externally threaded shaft 14 that may receive internally threaded fastener 20. For example, fastener 20 may include a nut. The nut may be tightened on threaded shaft 14, thereby rigidly connecting counter element 13 with connecting element 17, and thus a transmission line with electrical component 12.

[0156] If desired, locking device 18 may include additional fastener 20. Additional fastener 20 may include a wave washer, split washer, curved disk washer, etc.

[0157] Counter element 13 and the nut may include openings that allow securing element 21 to pass through counter element 13 and the nut.

[0158] For example, threaded shaft 14 may include a hole that may extend through threaded shaft 14. The hole of threaded shaft 14 may receive securing element 21 that allows to hold fastener 20 and threaded shaft 14 together.

[0159] Securing element 21 may secure fastener 20 to counter element 13 by preventing a rotational movement between fastener 20 and threaded shaft 14. Securing element 21 may include a cotter-pin. However, securing element 21 may be a different pin such as clinch pin, grooved pin, dowel pin, lynch pin, taper pin, etc. If desired, securing element may be a wire or any other device that prevents a rotational movement of fastener 20 on externally threaded shaft 14.

[0160] Figure 8A illustrates electrical connector system 10 that is attached to electrical component 12. As shown, electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Lug 15 may include receiving element 16 and connecting element 17. As shown, locking device 18 may include two fasteners 20 that rigidly attach counter element 13 with connecting element 17. If desired, locking device 18 may include securing element 21 that secures fastener 20 to counter element 13.

[0161] In some embodiments, fasteners 20 may be inserted into counter element 13. Fastener 20 may tighten connecting element 17 with counter element 13 using an externally threaded shaft. As an example, externally threaded fastener 20 may be a screw or an externally threaded bolt, such as a machine screw, hex cap screw, lag screw, round head bolts, track bolts, plow bolts, etc.

[0162] If desired, locking device 18 may include additional fastener 20 in combination with the externally threaded fastener 20. As shown in Figure 8A, locking device 18 may include securing element 21 that secures fasteners 20 to counter element 13.

[0163] For example, counter element 13 may include one or more notches 24, and additional fastener 20 may have one or more projections 25 that fit into the corresponding notches 24. Thus, additional fastener 21 may be unable to rotate relative to counter element 13 when additional fastener 21 is fastened to counter element 13 such that projections 25 have settled in the corresponding notches 24.

[0164] Fastener 20 and additional fastener 20 may each have eye 26. If desired, securing device 21 may include a wire that connects fastener 20 with additional fastener 20 through the respective eyes 26.

[0165] Figure 8B illustrates an exploded view of electrical connector system 10 of Figure 8A. As shown, electrical connector system 10 may be attached to electrical component 12. Electrical connector system 10 may include counter element 13, lug 15, and locking device 18. Counter element 13 may include one or more notches 24.

[0166] Lug 15 may include receiving element 16 and connecting element 17. Locking device 18 may include fastener 20 that rigidly connects counter element 13 with connecting element 17. If desired, locking device 16 may include securing element 21 that secures fastener 20 to counter element 13.

[0167] In some embodiments, counter element 13 may be a part of electrical component 12. As an example, electrical component 12 may include a battery, and counter element 13 may be a terminal or contact of the battery. As another example, electrical component 12 may be a transformer or an electric motor, and counter element 13 may be a contact of the transformer or the electric motor.

[0168] If desired, counter element 13 may include internally threaded hole 13b that may receive externally threaded fastener 20. Fastener 20 that is settled in threaded hole 13b may rigidly attach counter element 13 with connecting element 17.

[0169] As shown, externally threaded fastener 20 may include a screw or a bolt. Externally threaded fastener 20 may have eye 26 that is adapted to receive a wire. If desired, for increasing tightening forces between counter element 13 and connecting element 17, locking device 18 may include additional fastener 20.

[0170] Additional fastener 20 may have one or more projections that are adapted to settle in notches 24 of counter element 13. Thus, additional fastener 21 may be unable to rotate relative to counter element 13. Additional fastener 20 may have eye 26 that receives securing element 21. Such an additional fastener 20 is sometimes also referred to as a securing washer or a locking tab.

[0171] If desired, securing device 21 may be a wire that connects fastener 20 with additional fastener 20 through the respective eyes 26. Thus, fastener 20 may be prevented from performing a rotational movement relative to counter element 13 when additional fastener 21 is fastened to counter element 13 such that projections 25 have settled in the corresponding notches 24.

[0172] As a result, securing element 21, together with fastener 20, additional fastener 20, projections 25, and notches 24 may ensure that fastener 20 remains rigidly attached to counter element 13, thereby ensuring the lug 15 remains tightly coupled to electrical component 12.

[0173] It should be noted that the above-described embodiments are merely described for illustration purposes, but not in order to restrict the present invention thereto. Instead, multiple modifications and variations of the presented embodiments are possible and should, therefore,

also be considered as being part of the invention.

[0174] For example, electrical connector system 10 of Figure 5 is shown with three counter elements 13 that are attached to three connecting elements 17. However, electrical connector system 10 of Figure 5 may have any number of counter elements 13 with any number of connecting elements 17. For example, electrical connector system 10 of Figure 5 may have five counter elements 13 that are attached to five connecting elements 17, two counter elements 13 that are attached to two connecting elements 17, etc.

[0175] As another example, electrical connector system 10 of Figures 1 to 4C and 6A to 8C is shown to include one lug 15 with one connecting element 17. However, electrical connector system 10 of Figures 1 to 4C and 6A to 8C may have any number of lugs 15 with any number of connecting elements 17. For example, the number of connecting elements 17 may be the same as the number of lugs 15 or may be greater than the number of lugs 15.

[0176] Moreover, in Figures 1, 5 and 6A to 6C, it is shown that receiving element 16 of lug 15 receives one transmission line 11. However, electrical connector system 10 of Figures 1, 5 and 6A to 6C may have any number of receiving elements 16 with any number of transmission lines 11. If desired, receiving element 16 may include a hole that may receive any shape including polygonal, irregular, or rounded shapes, such as triangular, rectangular, trapezoidal, round, oval, elliptical, or hourglass shapes.

[0177] Furthermore, the described and illustrated configurations of electrical connector system 10 can be varied arbitrarily without influencing an underlying functionality thereof. As a consequence, corresponding configurations of counter element 13 and lug 15 can be adapted as required, and so on.

Reference List

[0178]

- 1.0 electrical connector system
- 11 transmission line
- 12 electrical component
- 13 counter element
- 13a outer surface
- 13b threaded hole
- 13c groove
- 14 threaded shaft
- 15 lug
- 16 receiving element
- 17 connecting element
- 17a inner surface
- 18 locking device
- 19 clamp
- 19a handle
- 20 fastener
- 21 securing element
- 22 recess, cavity

- 23 projection
- 24 notch
- 25 projection
- 26 eye
- 5 C central axis
- X vertical axis
- α angle

10 Claims

1. An electrical connector system (10) for connecting a transmission line (11) with an electrical component (12), comprising:

a counter element (13) that is coupled to the electrical component (12) and comprises:
an outer surface (13a) that is angled at a constant angle (α) relative to a central axis (C) of the counter element (13);
a lug (15) that comprises:

a receiving element (16) that receives the transmission line (11), and
a connecting element (17) for connecting with the counter element (13), wherein the connecting element (17) is arranged in direction of the central axis (C) and has an inner surface (17a) that is angled at the constant angle (α); and

a locking device (18) that is attached to the electrical component (12) and rigidly connects the connecting element (17) with the counter element (13), thereby connecting the transmission line (11) with the electrical component (12).

2. The electrical connector system (10) of claim 1, wherein the counter element (13) is part of the electrical component (12).

3. The electrical connector system (10) of claim 2, wherein the locking device (18) comprises a fastener (20).

4. The electrical connector system (10) of claim 3, wherein the fastener (20) comprises at least one of a screw, a bolt or a nut.

5. The electrical connector system (10) of any one of claims 3 or 4 wherein the counter element (13) has a threaded hole (13b) that receives the fastener (20).

6. The electrical connector system (10) of any one of claims 3 or 4, wherein the counter element (13) has a threaded shaft (14) that receives the fastener (20).

7. The electrical connector system (10) of claim 3,

wherein the locking device (18) further comprises:
a securing element (21) that secures the fastener
(20) to the counter element (13).

8. The electrical connector system (10) of claim 7,
wherein the securing element (21) comprises at least
one of a cotter-pin or a wire fuse. 5
9. The electrical connector system (10) of claim 1,
wherein the counter element (13) further comprises:
a groove (13c) that extends in direction of a vertical
axis (X) that is perpendicular to the central axis (C). 10
10. The electrical connector system (10) of claim 1,
wherein the locking device (18) comprises a clamp
(19). 15
11. The electrical connector system (10) of claim 10,
wherein the clamp (19) settles in the groove (13c)
and locks the counter element (13) to the connecting
element (17) and the electrical component (12). 20
12. The electrical connector system (10) of claim 10, fur-
ther comprising: 25
an additional counter element (13) coupled to
the electrical component (12) that comprises:
an additional outer surface (13a) that is an-
gled at the constant angle (α) relative to the 30
central axis (C), and
an additional groove (13c) that extends in
direction of the vertical axis (X) that is per-
pendicular to the central axis (C); and 35
an additional lug (15) that comprises:
an additional receiving element (16) that re-
ceives an additional transmission line (11),
and 40
an additional connecting element (17) that
is arranged in direction of the central axis
(C), has an additional inner surface (17a)
that is angled at the constant angle (α), and 45
wherein the clamp (19) settles in the addi-
tional groove (13c) and locks the additional
counter element (13) to the additional con-
necting element (17) and the electrical com-
ponent (12). 50
13. The electrical connector system (10) of any one of
the preceding claims, wherein the inner surface
(17a) of the connecting element (17) exhibits at least
one of a frustoconical shape, a pyramidal shape, a
stepwise frustoconical shape, a stepwise pyramidal 55
shape, or a stepwise conical shape.
14. The electrical connector system (10) of any one of

the preceding claims, wherein the outer surface
(13a) of the counter element (13) exhibits at least
one of a frustoconical shape, a pyramidal shape, a
stepwise frustoconical shape, a stepwise pyramidal
shape, or a stepwise conical shape.

15. The electrical connector system (10) of any one of
the preceding claims, wherein the electrical connec-
tor system is adapted to be used in systems that
operate at voltages that are greater than 300V.

Fig. 1

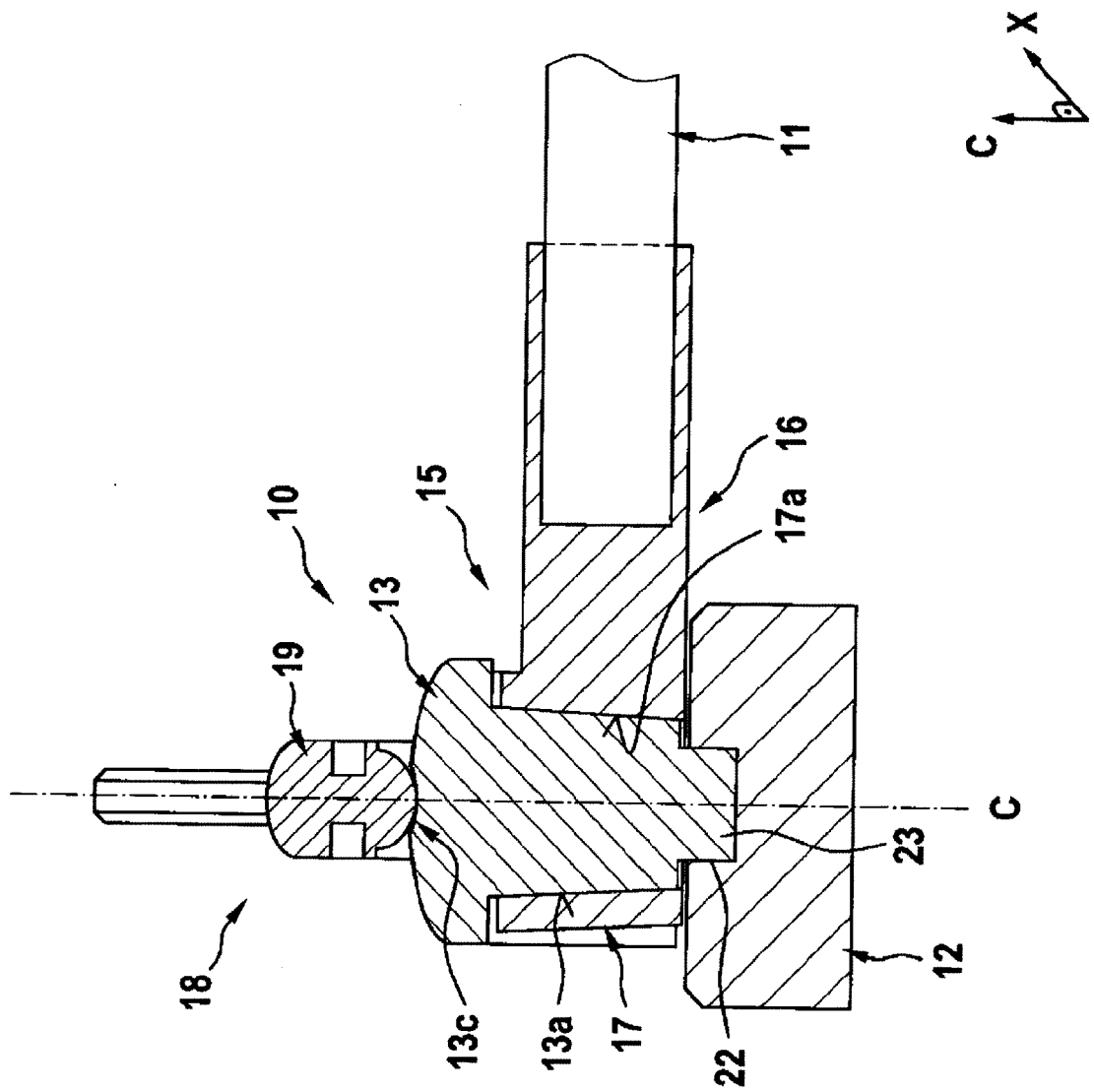


Fig. 2A

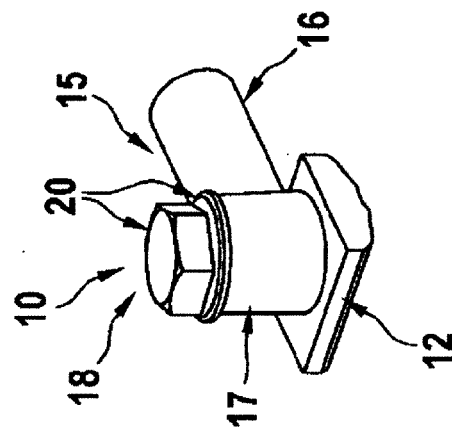


Fig. 2B

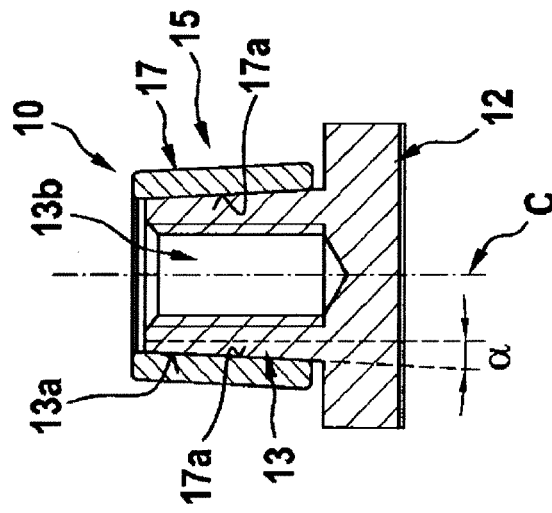


Fig. 2C

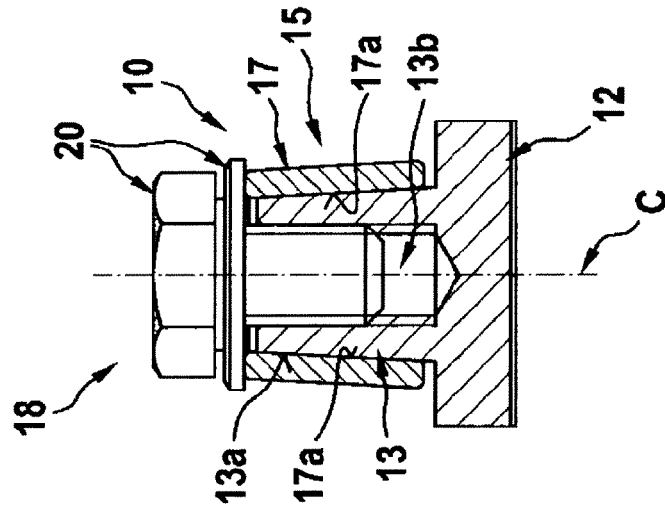


Fig. 3A

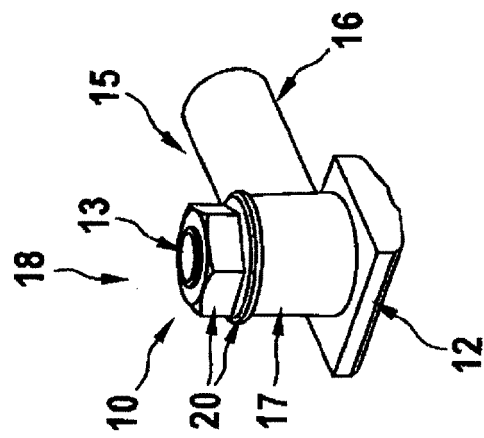


Fig. 3B

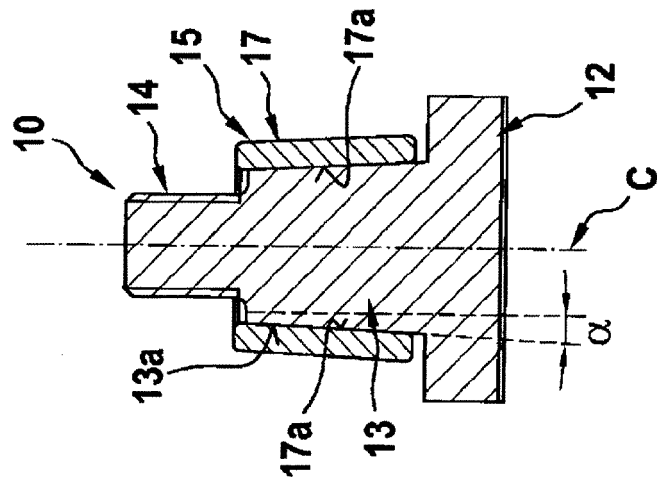


Fig. 3C

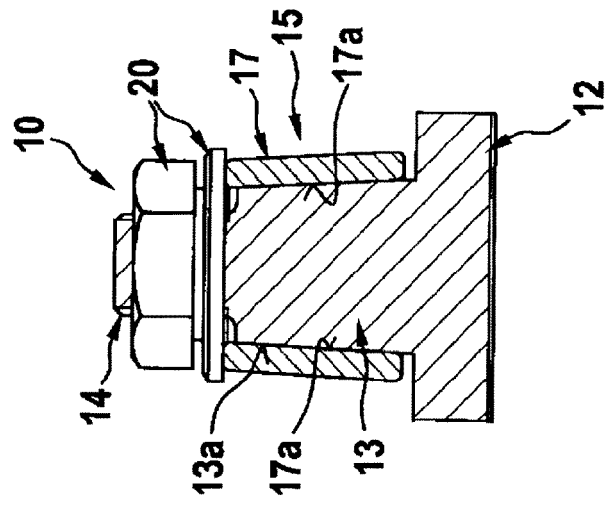


Fig. 4A

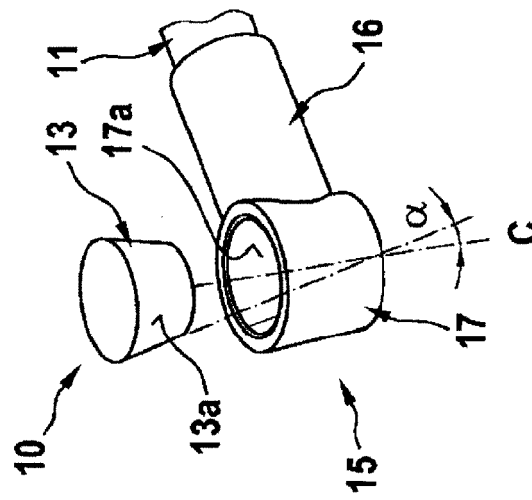


Fig. 4B

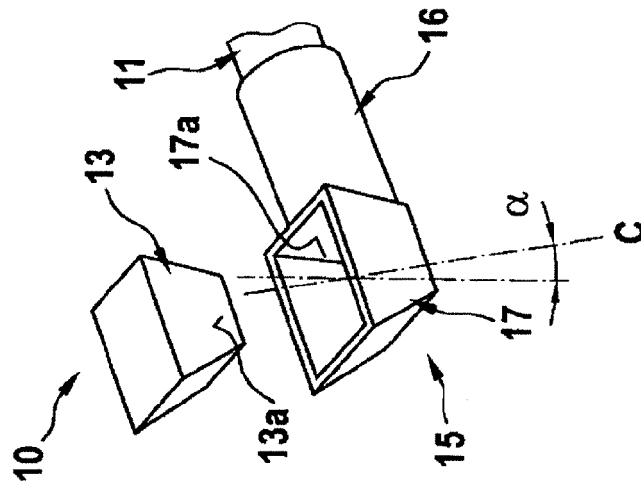


Fig. 4C

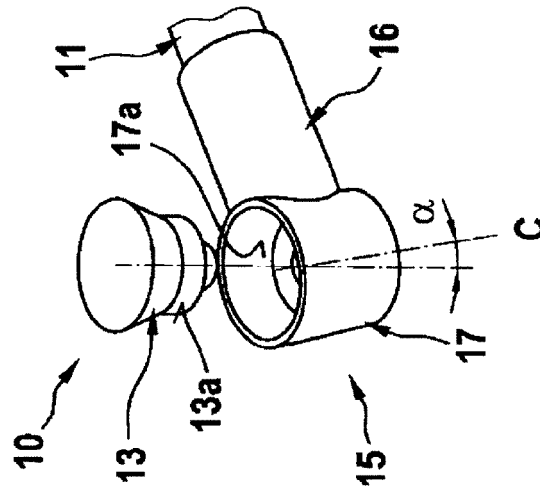


Fig. 5

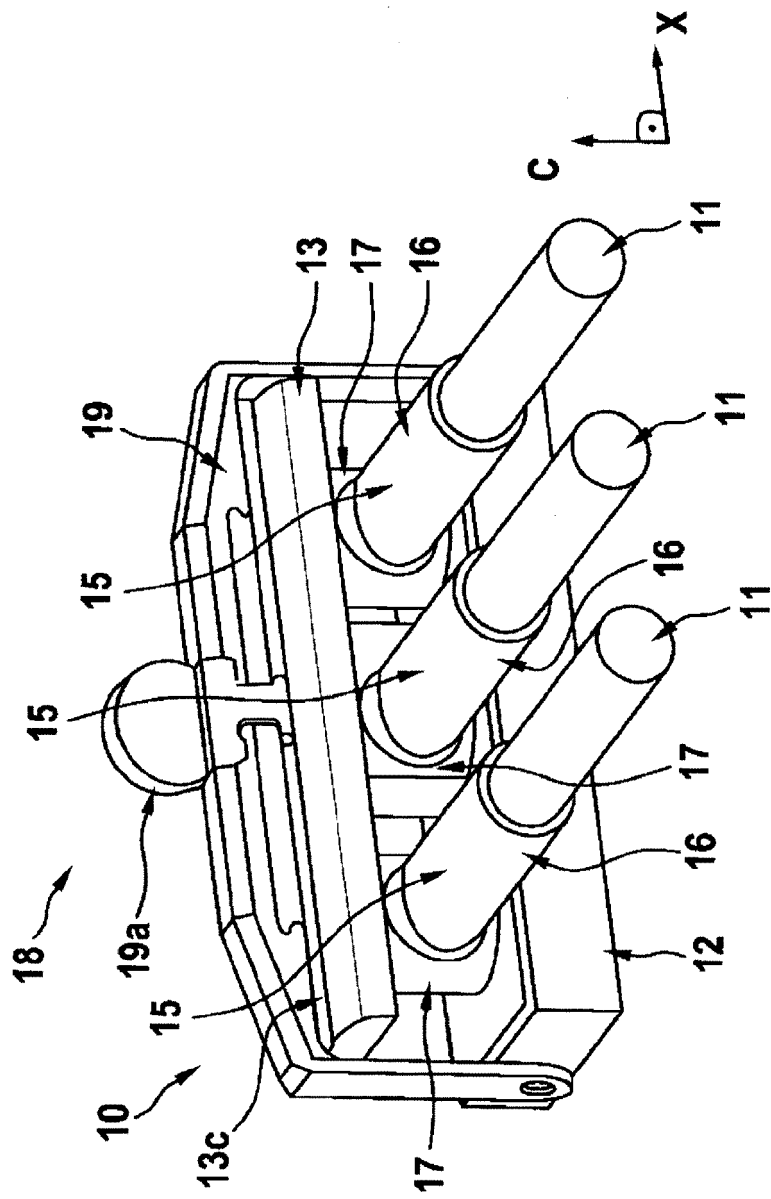


Fig. 6A

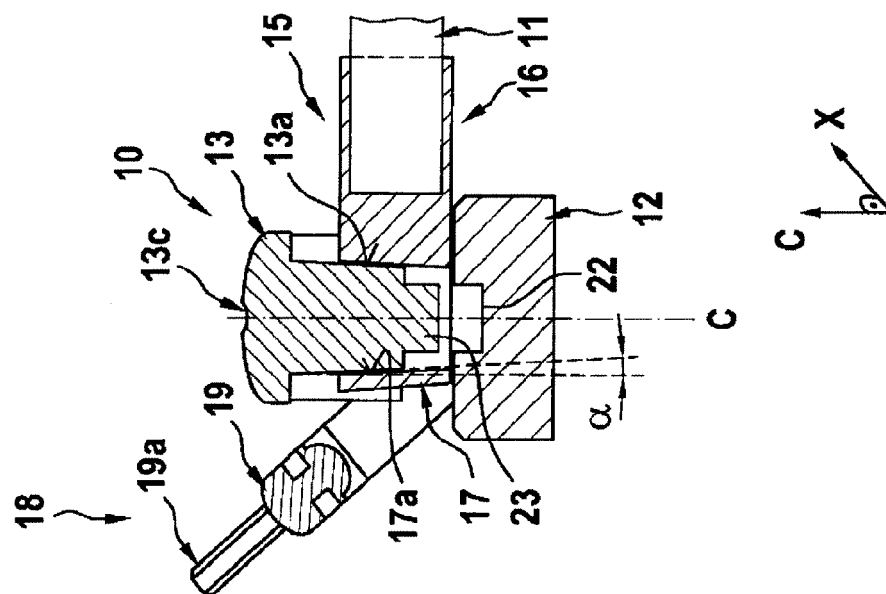


Fig. 6B

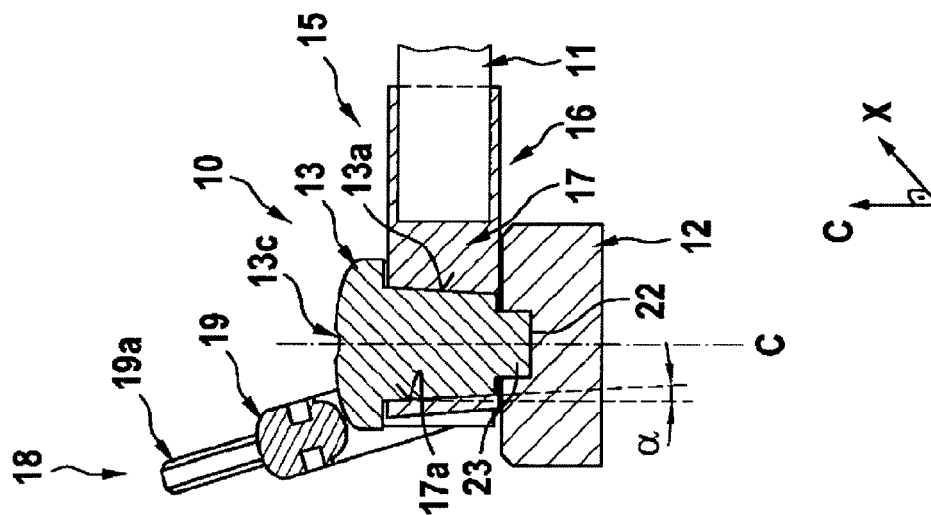


Fig. 6C

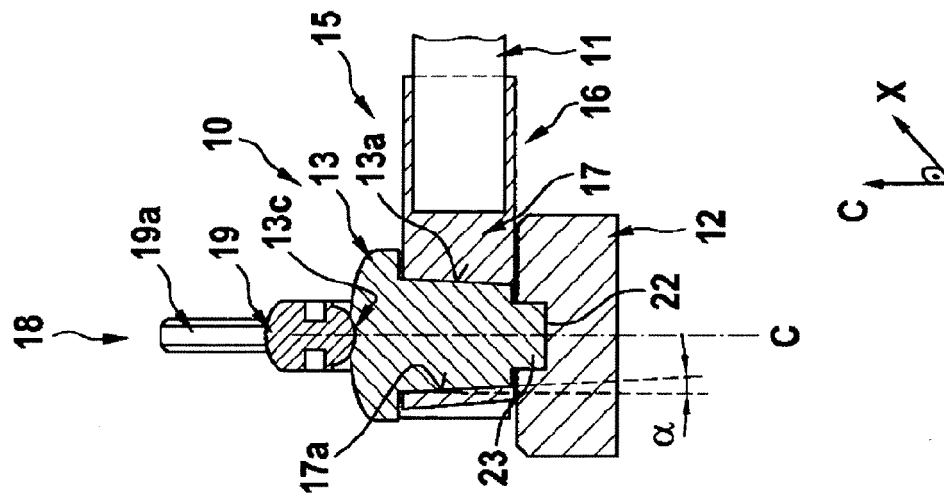


Fig. 7A

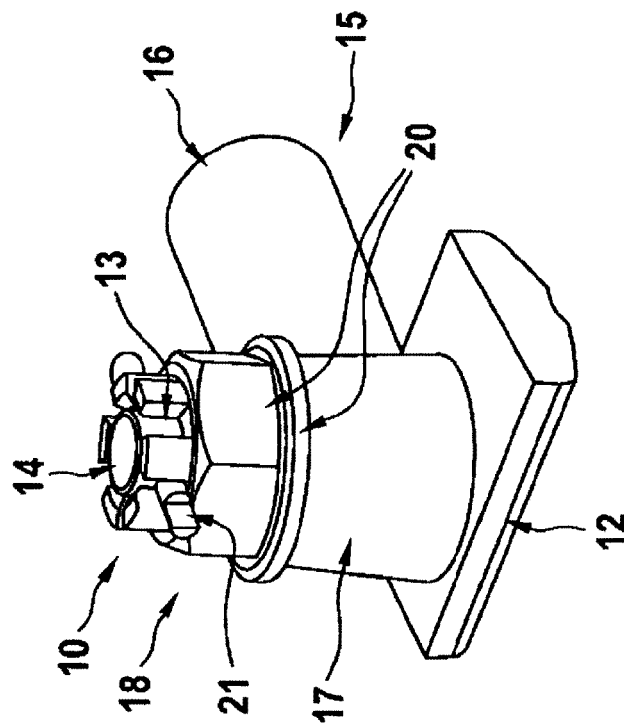


Fig. 7B

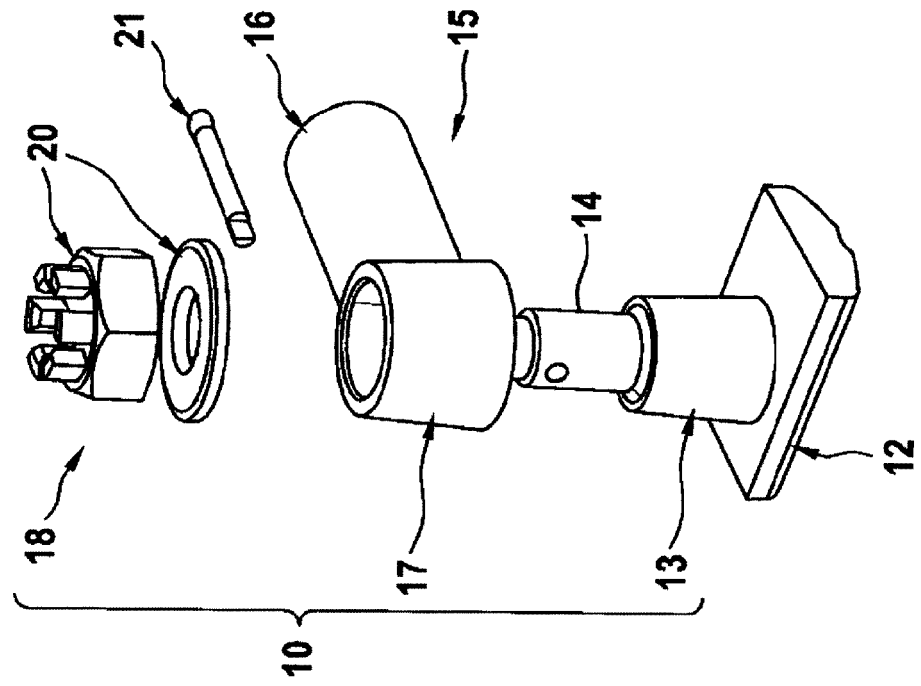


Fig. 8A

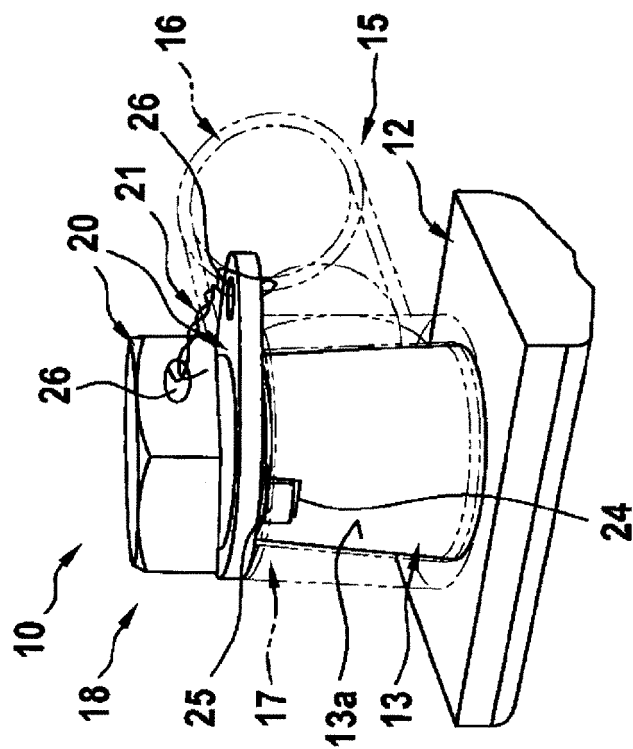
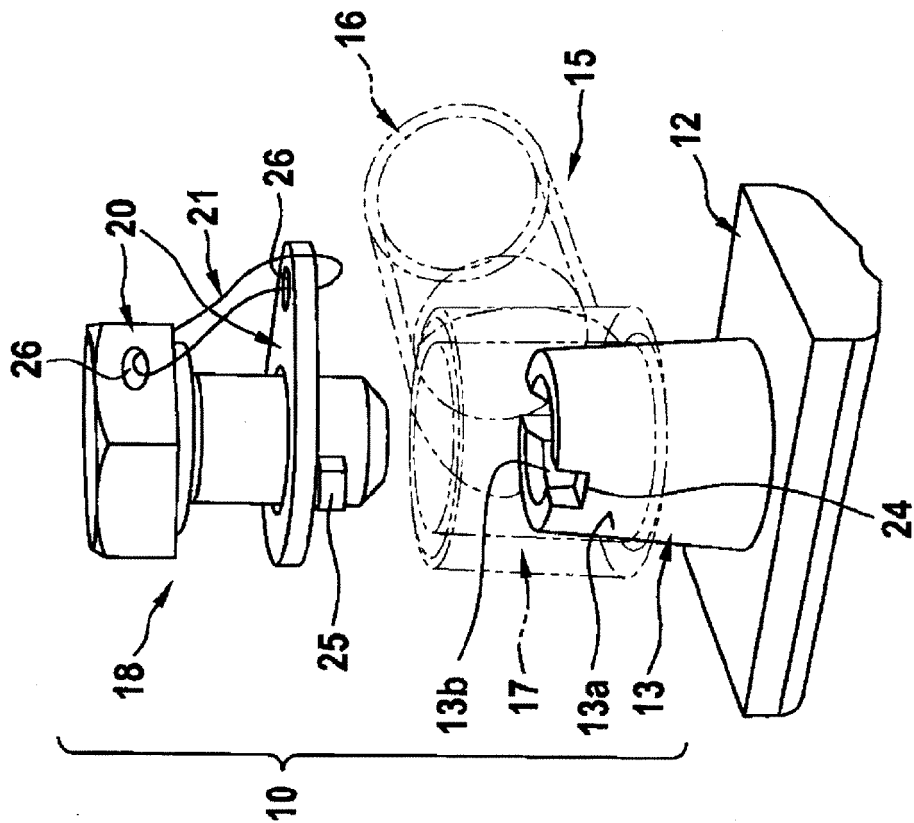


Fig. 8B





EUROPEAN SEARCH REPORT

Application Number
EP 19 40 0004

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 196 22 406 A1 (EMITEC EMISSIONSTECHNOLOGIE [DE]; BAYERISCHE MOTOREN WERKE AG [DE]) 11 December 1997 (1997-12-11) * column 3, line 42 - column 5, line 30; figures 1-4 *	1-9, 13-15	INV. H01R11/28 H01R13/639
X	US 5 132 194 A (WILLIAMS FRED G [US]) 21 July 1992 (1992-07-21) * column 2, line 55 - line 65 * * column 4, line 6 - line 42; figures *	1,2,9-15	
A	US 2018/123264 A1 (HUEHNER STEFAN [DE] ET AL) 3 May 2018 (2018-05-03) * paragraphs [0021], [0032], [0036] - [0038]; figures 1-5 *	1,10,12	
A	GB 2 061 636 A (VARTA BATTERIE) 13 May 1981 (1981-05-13) * page 1, lines 90-124; figures *	1,10,12	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 14 October 2019	Examiner Gélébart, Yves
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			

EPO FORM 1503 03.82 (P04C01)



Application Number

EP 19 40 0004

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



LACK OF UNITY OF INVENTION
SHEET B

Application Number

EP 19 40 0004

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9, 13-15

A cone connector system comprising a counter element coupled to an electrical component, a lug, and a locking device, the counter element being part of the electrical component.

2. claims: 10-12

A cone connector system comprising a counter element coupled to an electrical component, a lug, and a locking device, wherein the locking device comprises a clamp.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 19 40 0004

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

14-10-2019

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19622406 A1	11-12-1997	CN 1221518 A	30-06-1999
		DE 19622406 A1	11-12-1997
		EP 0902991 A1	24-03-1999
		JP 2000511685 A	05-09-2000
		RU 2196373 C2	10-01-2003
		WO 9747057 A1	11-12-1997

US 5132194 A	21-07-1992	NONE	

US 2018123264 A1	03-05-2018	CN 107251325 A	13-10-2017
		DE 102015203518 A1	01-09-2016
		EP 3262717 A1	03-01-2018
		US 2018123264 A1	03-05-2018
		WO 2016134871 A1	01-09-2016

GB 2061636 A	13-05-1981	AT 376067 B	10-10-1984
		DE 7930150 U1	24-01-1980
		FR 2468214 A1	30-04-1981
		GB 2061636 A	13-05-1981

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 9735478 B2 [0006]
- BE 763154 A [0007]