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(54) METHOD FOR FORMING AN ELECTRICAL CONNECTION, ELECTRICAL CONNECTION SYSTEM AND ELECTRICAL CONNECTION

(57) Electrical connection system, electrical connection and method for forming an electrical connection (10) comprising the steps of providing an electrical elongated component (12) having a cylindrical body (18, 18") extending along a longitudinal axis (X), a first fastening portion (20, 20") and a securing portion (22); attaching the securing portion (22) of the elongated component to a workpiece (16); providing a cable component (14) having a second fastening portion (26, 26', 26"); arranging the cable component (14) and the body (18, 18") concentrically, such that one fastening portion (20, 20", 26, 26', 26") coaxially surrounds the other fastening portion (20, 20", 26, 26', 26") and the first fastening portion (20, 20") is facing the second fastening portion (26, 26', 26"); providing a heat source (44); arranging the heat source around the first and second fastening portions (20, 20", 26, 26', 26"); heating one of the first or second fastening portion (20, 20", 26, 26', 26") with the heat source; cooling the one of the first or second fastening portion such that the cable component (14) and the body (18) are secured together by shrinking of the one of the first or second fastening portion.

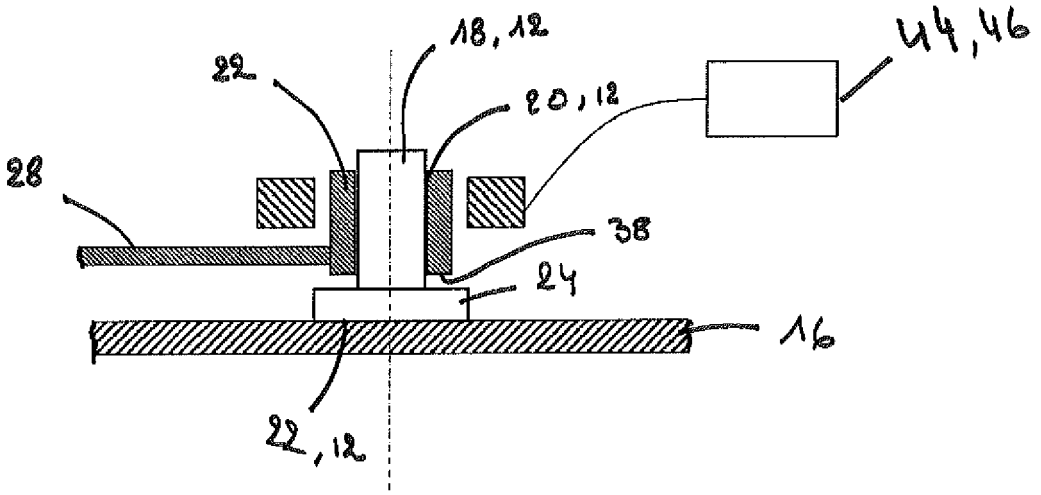

Fig. 4

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Description

[0001] The present invention relates to a method for forming an electrical connection, to an electrical connection system and to an electrical connection. More particularly, the present invention is directed to electrical connections for an automotive vehicle employing a grounding stud.

[0002] It is common to arc weld an enlarged circular end of a threaded metal stud onto a sheet metal body panel of an automotive vehicle. Various parts are then inserted upon the single threaded stud and an internally threaded nut is rotationally inserted onto the stud.

[0003] Vehicle electrical systems may include a ground wire or cable component attached to the vehicle frame or other vehicle component with an electrical system. Conventional threaded weld studs have been employed as electrical grounding points for a vehicle wire harness to an engine compartment frame or panel. Traditionally, after the stud is welded onto the panel, the vehicle is dipped into an E-coat bath to obtain a corrosion resistant coating and then a spray paint coating is applied. An elastomeric or plastic cap is typically secured onto the stud during the E-coat and paint processes in order to prevent the nonconductive coatings from adhering to the otherwise electrically conductive stud. After painting, the cap is removed and then the stud is inserted into a lug or an eyelet of an electrical cable component. A conventional internally threaded nut is rotated onto the stud by an operated torque wrench to secure the eyelet or lug. Thus, the electrical connection is securely held. Screws have also been used to retain an electrical eyelet to a grounding panel.

[0004] Conventional eyelets require upturned tabs to prevent rotation of the eyelets during installation of nuts for the stud construction or when screws are installed. This adds extra cost and complexity to the eyelet.

[0005] Moreover, these traditional constructions and installations are very time-consuming, especially when multiplied by the number of ground studs used in the vehicle. They often lead to undesirably varying fastening forces. Therefore, quality control and repeatability are difficult to maintain due to possible under-torquing of the nut or screw, loss of nuts or screws, and other intermittent electrical failure concerns, especially when the installation is occurring on a quickly moving vehicle assembly line.

[0006] Document EP1017129A2 is directed to a method of assembling an electrical system comprising a stud having an external pattern, an electrically conductive member (or nut) and a panel. The method comprises the steps of securing the stud to the panel, applying a coating to at least part of the external pattern of the stud, positioning the member partially around the stud, deformably compressing the member into engagement with the external pattern of the stud in order to fasten the member to the stud and conducting electricity between the member and the stud. The coating is scratched away by the member (or nut). An eyelet is secured between the nut and the stud and electricity is conducted between the eyelet, the nut and the stud. The installation of the member (or nut) onto the stud can create an electrically conductive path between an attached conductive member and a panel. The stud can be an electrically grounding weld stud. Such assembly is advantageous since it does not require a nut with an internal thread. Thus, the costs can be reduced. Moreover, engagement of the nut onto the stud does not require any torque upon the nut, thereby reducing the likelihood of inadvertent fracture of the assembly between the stud and adjacent panel.

[0007] Even if such method is advantageous, a need still exists to maximize the electrical contact area between the stud and the nut or the eyelet.

[0008] Document EP1362390A1 discloses an electrical connection that maximizes the electrical contact with a polygonal shoulder. More particularly, the electrical connection comprises a stud with a threaded segment, a shoulder having at least eight flat faces and defining a polygonal cross sectional shape, an enlarged flange and a securing segment. A rotatable nut having an internal thread operably engaging the thread of the stud is removably secured to the stud. Such assembly allows to maximize the electrical contact area between the stud and the eyelet while also providing a set angular orientation to the eyelet and wire once the nut has been fastened onto the stud.

[0009] The use of a nut with an internal thread is needed, which may imply loss of nuts, undesirably varying fastening forces ... Moreover, the method for forming the electrical connection can be time consuming.

[0010] It is hence an object of the present invention to at least alleviate the aforementioned shortcomings. More particularly one objective of the present invention is to provide a method for forming an electrical connection that is easy to implement, without or only few spare parts and maximizing the electrical contact between a cable component and a stud. Another objective of the present invention is to provide an electrical connection equipment adapted for the method which is compact and can be easily installed in an industrial area, and in particular on a vehicle assembly line. A further objective of the present invention is to provide an electrical connection which is robust and in which a twist of the cable component is avoided.

[0011] To this aim, according to the invention, it is provided a method for forming an electrical connection comprising the steps:

- Providing an electrical elongated component having a cylindrical body extending along a longitudinal axis, a first fastening portion and a securing portion;
- Attaching the securing portion of the elongated component to a workpiece;
- Providing a cable component having a second fastening portion;
- Arranging the cable component and the body con-

centrically, such that one fastening portion coaxially surrounds the other and the first fastening portion is facing at least a portion of the second fastening portion;

- Providing a heat source;
- Arranging the heat source around the first and second fastening portions;
- Heating one of the first or second fastening portion with the heat source;
- Cooling the one of the first or second fastening portion such that the cable component and the body are secured together by shrinking of the one of the first or second fastening portion.

[0012] For example, the method for forming the electrical connection is provided with a step of heating the first fastening portion and cooling the first fastening portion or with the steps of heating and cooling the second fastening portion. Such method allows a connection between the cable component and the elongated component without any further part or spare part. Besides, the cable component can be fixed in any orientation and cannot be twisted once attached to the stud. The joining through retraction or shrinking allows a removable or detachable assembly. More particularly, the first or second fastening portion can be heated, such that a dilatation of the material occurs and the first or second fastening portion is released from the second or first fastening portion. The contact area between the cable component and the elongated component is the contact area between the two fastening portions and can be adapted to be maximized. The assembly does not require any torque. The two fastening portions are tightly sealed together through the shrinking.

[0013] In some embodiments, the heat source is an induction loop adapted to be arrange surrounding the first and second fastening portions. For example, the second fastening portion extends between the induction loop and the first fastening portion. In another embodiment, the first fastening portion extends between the induction loop and the second fastening portion. The induction loop is compact, easy to implement and able to heat exactly the fastening portion to be heated, without interfering with the rest of the connection. In alternative embodiments, other heat sources such as radiant warmers, resistance heating, lasers ... may be implemented.

[0014] In some embodiments, a cooling device is provided, and the one of the first or second fastening portion is cooled by the cooling device. The cooling device allows to quickly cool the fastening portion to be cooled after heating. Thus, the assembly or mounting time is reduced.

[0015] In some embodiments, the body comprises an enlarged flange transversely larger than the fastening portion and extending between the fastening portion and the securing portion. The enlarged flange allows a reliable and stable attachment between the elongated component and the workpiece.

[0016] In some embodiments, the fastening portion, the flange and the securing portion are parts of a single metallic member operable to conduct electricity. The fastening portion, the flange and the securing portion form a ground stud.

[0017] In some embodiments, the securing portion is welded to the workpiece. The welding enables a good and secure joining of the stud with the workpiece. The workpiece is for example a panel.

[0018] In some embodiments, the cable component is provided with a measurement sensor. The measurement sensor is integrated to the cable component. For example the measurement sensor is integrated proximate to or in the second fastening portion. The measurement sensor is for example adapted to measure a temperature parameter or an electrical parameter.

[0019] In some embodiments, the elongated component is provided with a measurement sensor. The measurement sensor is integrated to the elongated component. For example the measurement sensor is integrated proximate to or in the first fastening portion.

[0020] In some embodiments, the second fastening portion comprises a sleeve with (or defining) a through hole or a blind hole adapted to receive the first fastening portion. The sleeve and the surface of the sleeve is thus available to provide an important electrical contact surface.

[0021] In some embodiments, the sleeve is arranged surrounding the first fastening portion. The contact area is thus maximized.

[0022] In some embodiments, the diameter of the hole, before arranging the cable component and the body member concentrically, is smaller than the diameter of the fastening portion of the body, such that the first fastening portion is press-fitted onto the hole. The press-fit allows to ensure the contact between the first and second fastening portions to conduct electricity.

[0023] In an additional embodiment, the heat source heats the second fastening portion such that the hole is dilated and the diameter of the hole expands.

[0024] In an alternative embodiment, the body comprises a body aperture, and the second fastening portion of the cable component is arranged in the body aperture.

[0025] In some embodiments, the elongated component is provided with a cover adapted to protect the first fastening portion during a cathodic dip-paint coat (or E-coat and/or paint processes). The cover allows to protect the first fastening portion and to maintain its capability to conduct electricity.

[0026] In some embodiments, the cover is removed from the body before arranging the cable component and the body concentrically.

[0027] In some embodiments, the one of the first or second fastening portion is heated before arranging the cable component and the body concentrically. Thus, the heated fastening portion is dilated and can be then arranged or fitted in or with the other fastening portion.

[0028] In some embodiments, the one of the first or second fastening portion is heated subsequently the ar-

rangement of the cable component and the body concentrically. In such case, a press-fit is first realized. The subsequent heating ensure a correct setting.

[0029] The present invention is also directed to an electrical connection system comprising an electrical elongated component having a cylindrical body extending along a longitudinal axis, a first fastening portion and a securing portion, the securing portion being welded to a workpiece; a cable component having a second fastening portion adapted to face the first fastening portion; a heat source adapted to heat one of the first or second fastening portion; a cooling device adapted to cool the one of the first or second fastening portion.

[0030] In some embodiments, the system further comprises a measurement sensor. The measurement sensor is for example integrated in the cable component and adapted to measure a temperature or an electrical parameter.

[0031] In some embodiments, the heat source is an induction loop. As previously described, the induction loop is compact and easy to implement. In others embodiments, heat sources such as radiant warmers, resistance heating, lasers ... may be used as an alternative to the induction loop.

[0032] The present invention is finally directed to an electrical connection comprising an electrical elongated component having a cylindrical body extending along a longitudinal axis, a first fastening portion and a securing portion, wherein the securing portion is adapted to be welded to a workpiece and a cable component having a second fastening portion comprising a sleeve surrounding the first fastening portion, the sleeve being provided with an opening (or a hole), the second fastening segment extending in the opening (or hole), and wherein the first fastening portion is secured into the sleeve by retraction of the sleeve around the first fastening portion after heating.

[0033] Other characteristics and advantages of the invention will readily appear from the following description of embodiments, provided as non-limitative examples, in reference to the accompanying drawings.

[0034] In the drawings:

Fig. 1 schematically shows an electrical connection with a cable component and an elongated component according to a first embodiment of the present invention;

Fig. 2 schematically shows an electrical connection with a cable component and an elongated component according to a second embodiment of the present invention;

Fig. 3 schematically shows the cable component and the elongated component of Fig. 1 before their assembly;

Fig. 4 schematically shows the cable component of Fig. 1 arranged around the elongated component of Fig. 1 with a heat source;

Fig. 5 schematically shows the elongated component with a cover before the assembly with the cable component;

Fig. 6 schematically shows the assembly of a cable component and an elongated component according to a third embodiment with a heat source.

[0035] On the different figures, the same reference signs designate identical or similar elements.

[0036] Fig. 1 schematically shows an electrical connection 10 with an electrical elongated component 12 and a cable component 14. The elongated component 12 is attached to a workpiece 16. The workpiece 16 is for example a panel or an engine compartment of an automotive vehicle.

[0037] The elongated component 12 is for example welded to the workpiece 16. However, in other embodiments, other fastening method may be used to attach the elongated component 12 to the workpiece 16.

[0038] The elongated component 12 can be an electrically grounding weld stud. For instance, the elongated component 12 is a metallic member operable to conduct electricity. The elongated component is for example made from steel. Other materials such as aluminium may also be used. Different surface conditions of the elongated component 12 may also be considered. The elongated material 12 can be an integral single piece.

[0039] The elongated component 12 comprises a cylindrical body 18 extending along a longitudinal axis X, a first fastening portion 20 and a securing portion 22. The elongated component 12 is attached to the workpiece 16 by the securing portion 22. For example, the securing portion 22 is welded to the workpiece 16.

[0040] As represented in Fig. 1, in an embodiment, the elongated component 12 further comprises an enlarged flange 24 transversely larger than the fastening portion 20. The flange 24 is for example circular, and the diameter of the flange 24 is larger than the diameter of the body 18. The flange 24 extends between the body 18 and the securing portion 22. Alternatively, the securing portion may be a free end of the body 18, such that the elongated component does not comprise any flange.

[0041] The body 18 may have a circular cross section or a polygonal cross-section.

[0042] The first fastening portion 20 may be provided on the body 18. In other words, the first fastening portion 20 may be a segment of the body 18. Eventually the cross section proximate the first fastening portion 20 may be different from the cross section proximate the flange 24. As illustrated, the first fastening portion 20 has a circular cross-section.

[0043] In an embodiment (not represented) the first fastening portion 20 is provided with a pattern. The pattern may be of any kind and can consist in projection, threads ... The first fastening portion 20 may also be sensibly flat without any projection or particular pattern, as illustrated in the figures.

[0044] The first fastening portion 20 is facing a second fastening portion 26 of the cable component 14. More

particularly, as illustrated in the figures, the cable component 14 comprises an electric conductor which is preferably a wire 28. The wire 28 is for example made of a flexible copper inner wire surrounded by an insulated casing. An end of the wire 28 (for example a free end of the wire) is provided with the second fastening portion 26. Thus the wire 28 is electrically connected to the second fastening portion 26. The second fastening portion 26 is made from an electrically conductive material. For example, the second fastening portion 26 is made from aluminum or steel.

[0045] In a first embodiment, the second fastening portion 26 comprises, as visible in Fig. 1, a sleeve 30. The sleeve 30 is cylindrical and provided with a through hole 32 extending along a sleeve longitudinal axis X1. The sleeve 30 comprises a cylindrical wall with a first surface 34 and a second surface 36 opposite the first surface 34. The cylindrical wall defines the through hole. The second surface 36 is an internal surface and faces the through hole 32. The first surface 34 is connected to the wire 28.

[0046] The second surface 36 is designed to face the first fastening portion 20 and to surrounds the first fastening portion 20. The sleeve 30 (or more particularly the cylindrical wall) comprises a first and a second edge 38, 40. The second edge 40 extends opposite the first edge 38 and both first and second edges delimit the extremities of the through hole 32. The first edge 38 may be adapted to rest against a surface of the flange 34.

[0047] The wire 28 may be connected to the sleeve 30 in the vicinity of the first edge 38. Thus the wire extends proximate the workpiece 16, such that the risk of damaging the wire of the connection between the wire and the second fastening portion is reduced. In another embodiment, the wire 28 may be connected to the sleeve 30 in the vicinity of the second edge 40.

[0048] In the assembled state (or mounted state) of the cable component 14 and the elongated component 12, the sleeve 30 surrounds the first fastening portion 20, as visible in Fig. 1. More particularly the second fastening portion 22 surrounds and contacts the first fastening portion 20, such that electricity may be conducted between first and second fastening portions. The cable component 14 assembled with the elongated component 12 forms the electrical connection 10.

[0049] In a second embodiment, as illustrated in Fig. 2 the second fastening portion 26' comprises a closed cylindrical part with an aperture 37 surrounded by a cylindrical wall 42 and a bottom. In other words, the aperture 37 forms a blind hole provided in the second fastening portion 26'. The first fastening portion 20 is adapted to be inserted in the aperture 37 (or blind hole). The bottom 43 may abut against the free end of the body 18 opposite the flange 24 or the securing portion 22.

[0050] Eventually, an edge 38' of the second fastening portion 26' surrounding the aperture 37 may abut against the flange 24 of the elongated component 12.

[0051] Fig. 1 and Fig. 2 show the cable component 14 and the elongated component 12 after their assembly.

[0052] Fig. 3 shows the cable component 14 and the elongated component 12 before their assembly. More particularly, Fig. 3 shows the cable component 14 and the elongated component 12 of Fig. 1 before their assembly. However, the structure and relations of cable component 14 and elongated component 12 of Fig. 2 is similar to the one of Fig. 1 described below in relation to Fig. 3.

[0053] The through hole 32 (or the aperture or blind hole in the embodiment of Fig. 2) of the second fastening portion has a fastening diameter D1 which is smaller than the diameter of the body 18 and more particularly than the diameter D2 of the first fastening portion 20.

[0054] In order to attach the cable component 14 and the elongated component 12 together, the cable component 14 is press-fitted with the body 18. More precisely, the second fastening portion 26 is press-fitted with the first fastening portion 20. The hole 32 or opening 37 is cylindrical, but may also be conical. The body 18 is preferably cylindrical but may, in some embodiments also be conical. The second fastening portion 26 is arranged concentrically to the first fastening portion 20.

[0055] Once the first fastening portion 20 is arranged concentrically with the second fastening portion and press-fitted in the second fastening portion 26, a heat source 44 can be provided and arranged proximate or in the vicinity of the second fastening portion 26. More particularly, as illustrated in Fig. 4, the heat source surrounds the second fastening portion 26. The second fastening portion 26 itself surrounds the first fastening portion 20.

[0056] The heat source 44 is for example an induction loop. However, in other embodiments, the heat source 44 may be hot air, a heat resistance, radiant warmers, resistance heating, lasers.

[0057] The heat source 44 heats the second fastening portion 26. Under heat, the second fastening portion 26 dilates or expands, and the fastening diameter D1 becomes larger. For example the fastening diameter D1 becomes equal to or larger than the diameter D2 of the first fastening portion 20. Thus the second fastening portion 26 can be correctly arranged around the first fastening portion, and notably with low forces.

[0058] Once the second fastening portion 26 has been heated to the programmed temperature, the heat device 44 may be turned off and/or removed. The removal of the heat device 44 may occurs after or during the setting of the sleeve on the body 18.

[0059] The second fastening portion 26 is then cooled. The cooling of the second fastening portion 26 may occur at normal room temperature or a cooling device 46 may be provided. The cooling device 46 may for example release a cold air flow directed to the second fastening 26 portion for cooling it. In other embodiments, other cooling devices, such as heat exchangers, air cooling devices, fluid cooling devices, cooling elements or any combination thereof... may be used.

[0060] During the cooling, the second fastening portion 26 is retracted such that the second fastening portion 26

shrinks and "adheres" to the first fastening portion 20. More specifically, the material of the second fastening portion 26 retracts and by doing so adheres to the first fastening portion 20. Thus a robust assembly of the cable component 14 and elongated component 12 is obtained. The cable component 14 cannot be twisted around the elongated component 12 and the contact area between the two components correspond to the entire second fastening portion 26 and first fastening portion 20 and may be on the entire length along the longitudinal axis of the body 18.

[0061] The method for forming the electrical connection 10 may also comprise first heating the second fastening portion 26 before or during fitting it or setting it with the first fastening portion 20. In such case, the second fastening portion is arranged above the first fastening portion 20 such that the sleeve longitudinal axis X1 is coaxial with the longitudinal axis X. The second fastening portion is heated by the heat device and then or simultaneously translated in the direction of the first fastening portion 20 until it reaches its final predetermined position. As previously mentioned, the final pre-determined position may be with the second edge 38 of the sleeve 30 being in abutment with the flange 24. Alternatively, the final position might be at a pre-programmed distance from the securing portion 22 or from the workpiece 16.

[0062] The assembly of the elongated component 12 with the cable component 14 according to the second embodiment of the second fastening portion 26' illustrated in Fig. 2 is similar or identical to the assembly of the elongated component 12 with the cable component 14 according to the embodiment of the second fastening portion 26 illustrated in Fig. 1, Fig. 3 and Fig. 4.

[0063] More particularly, the aperture 37 has a diameter which is smaller than the diameter of the first fastening portion 20. The aperture 37 receives the first fastening portion 20 before or after being heated by the heat source 44. The heating allows the diameter of the aperture 37 to expand in order to encompass the first fastening portion 20. A cooling of the second fastening portion 26' (in other words of the cylindrical walls 42) allows the diameter of the aperture 37 to retracts and the second fastening portion 26'shrinks on the first fastening portion 20. The second fastening portion 26' of Fig. 2 allows to increase the contact area between the first fastening portion 20 and the second fastening portion 26', since the bottom 43 forms an additional contact surface which may abuts and contacts the first fastening portion 20.

[0064] As illustrated in Fig. 5, the elongated component 12, and more particularly the body 18 of the elongated component may be provided with a cover 48. The cover 48 encompasses the body 18 and more particularly the cover encompasses the first fastening portion 20. For example the cover 48 is cylindrical with a recess 50 adapted to receive the body 18 or the first fastening portion 20. The cover 48 may be made from a plastic material, but other material may also be envisaged. The cover 48 protects the first fastening portion 20 during a cathodic dip-paint coat (or E-coat and/or paint processes) and allows maintaining the electrical conductivity property of the external surface of the first fastening portion 20.

[0065] A possible process to form the electrical connection 10 arrangement is as follow. The elongated body 12 is first fastened to the workpiece 16. For example, the elongated body 12 is welded to the workpiece 16. The cover 48 may be arranged on the body 18 before or after the fastening of the elongated body 12 to the workpiece 16.

[0066] In a subsequent step, the workpiece 16 undergoes a coating or painting, the cover 48 protecting the first fastening portion 20 of the elongated portion 12 from the coating or painting, allowing the first fastening portion to keep its electrical conductivity properties.

[0067] In a third step, the cable component 14 is provided and its second fastening portion 26, 26' is arranged concentrically to the first fastening portion 20.

[0068] The second fastening portion 26, 26' is then press-fitted to surround the first fastening portion 20 before heating the second fastening portion 26, 26'. In an alternative embodiment, the second fastening portion 26, 26' is first heated and then arranged around the first fastening portion 20.

[0069] The second fastening portion 26, 26' undergoes in a subsequent step a cooling, such that the material of the second fastening portion 26, 26' retracts around the first fastening portion 20, forming thus the electrical connection 10 with the wire 28 of the cable component 14 electrically connected to the elongated component 12 through the first and second fastening portions 20, 26, 26'.

[0070] In another embodiment shown in Fig. 6. The electrical connection 10 may be designed such that the first fastening portion 20" surrounds the second fastening portion 26". In such embodiment, the elongated component 12" comprises the cylindrical body 18". The cylindrical body 18" is hollow and is provided with a body aperture 52 adapted to receive the second fastening portion 26" of the cable component 14". More particularly, the body 18" comprises a first surface 54 facing and delimiting the body aperture 52 and a second surface 56 opposite the first surface 54. The first surface 56 forms at least a portion of the first fastening portion 20". The body 18" comprises a bottom 58 having an internal surface delimiting the body aperture 52 and an external surface opposite the internal surface. The external surface may define the securing portion 22" of the elongated component 12" and may be fastened or welded to the workpiece 16.

[0071] The second fastening portion 26" of the cable component 14" is received in the body aperture 52. The second fastening portion 26" comprises for example a cylindrical main part. The diameter of the cylindrical main part is for example larger than the diameter of the body aperture 52 before the assembly of the first and second fastening portions 20", 26". For example the cylindrical main part comprises a first and a second bottom 60, 62.

The first bottom 60 is designed to be inserted in the body aperture 52 by a press-fit connection and/or by dilatation of the first fastening portion 20" as described above. The second bottom 62 may be connected to the wire 28 and may protrude from the body aperture 52.

[0072] The second fastening portion 26" is arranged coaxially with the body aperture 52 and is inserted in the body aperture 52 after and/or before and/or during heating the first fastening portion 20". The heat source 44 is provided surrounding the cylindrical body 18, and more particularly the second surface of the body 18". Heating the body 18" leads to a dilatation of the first fastening portion 20" and an augmentation of the diameter of the body aperture 52. The second fastening portion 26" can thus correctly be set in the body aperture 52. Once the second fastening portion 26" is correctly be set in the body aperture 52 with the second bottom 62 protruding outside of the body aperture 52, the first fastening portion 20" is cooled, either as already described by the room temperature or by a cooling device 46. The cooling of the first fastening portion 20" leads to the retraction of its material and a decrease of the body aperture's diameter. The second fastening portion 26" is then trapped in the aperture and the electrical connection 10 is realized.

[0073] The joining of the first and second fastening portions through retraction or shrinking allows a removable or detachable assembly. More particularly, in order to disassemble the cable component from the elongated component, the heat source is applied around the first fastening portion 20" or the second fastening portion 26, 26', which allows the first fastening portion 20" or the second fastening portion 26, 26' to be dilated, thus increasing the diameter of its hole or body aperture and allowing the second fastening portion 26, 26', 26" to be removed from the first fastening portion 20, 20". First and second fastening portions 20, 20", 26, 26', 26" may be attached together again through the above-mentioned method for forming the electrical connection.

[0074] A measurement sensor 64 may be integrated proximate to or in the second fastening portion 26, 26', 26" or the first fastening portion 20, 20". The measurement sensor is for example adapted to measure a temperature parameter or an electrical parameter. For instance, the measurement sensor may be integrated in the cable component or in the elongated component. For example, the measurement sensor 64 may be integrated in a recess of the second fastening portion 26" or may be attached (for example glued) on an external surface of the second fastening portion 26", such as illustrated in Fig. 6. The measurement sensor may also be provided into a recess or on the external surface of the second fastening portion 26, 26' or into a recess or on the external surface of the first fastening portion 20, 20".

Claims

1. Method for forming an electrical connection (10) comprising the steps:

a. Providing an electrical elongated component (12) having a cylindrical body (18, 18") extending along a longitudinal axis (X), a first fastening portion (20, 20") and a securing portion (22);
b. Attaching the securing portion (22) of the elongated component to a workpiece (16);
c. Providing a cable component (14) having a second fastening portion (26, 26', 26");
d. Arranging the cable component (14) and the body (18, 18") concentrically, such that one fastening portion (20, 20", 26, 26', 26") coaxially surrounds the other fastening portion (20, 20", 26, 26', 26") and the first fastening portion (20, 20") is facing the second fastening portion (26, 26', 26");
e. Providing a heat source (44);
f. Arranging the heat source around the first and second fastening portions (20, 20", 26, 26', 26");
g. Heating one of the first or second fastening portion (20, 20", 26, 26', 26") with the heat source;
h. Cooling the one of the first or second fastening portion such that the cable component (14) and the body (18) are secured together by shrinking of the one of the first or second fastening portion (20, 20", 26, 26', 26").

2. Method according to claim 1, wherein the heat source (44) is an induction loop adapted to be arrange surrounding the first and second fastening portions (20, 20", 26, 26', 26").

3. Method according to claim 1 or 2, wherein a cooling device (46) is provided, and wherein the one of the first or second fastening portion (20, 20", 26, 26', 26") is cooled by the cooling device.

4. Method according to any of claims 1 to 3, wherein the body (18) comprises an enlarged flange transversely larger than the first fastening portion and extending between the first fastening portion (20) and the securing portion (22), wherein the first fastening portion, the flange and the securing portion are parts of a single metallic member operable to conduct electricity, and wherein the securing portion (22) is welded to the workpiece (16).

5. Method according to any of the preceding claims, wherein the cable component (14) is provided with a measurement sensor (64), and wherein a temperature and/or electrical parameters are measured by the measurement sensor.

6. Method according to any of the preceding claims, wherein the second fastening portion (26, 26') comprises a sleeve (30) with a hole (32, 37) adapted to

receive the first fastening portion (20), wherein the sleeve is arranged surrounding the first fastening portion, and wherein the diameter of the hole (32), before arranging the cable component and the body member concentrically, is smaller than the diameter of the fastening portion of the body, such that the first fastening portion is press-fitted onto the hole (32).

7. Method according to claim 6, wherein the heat source (44) heats the second fastening portion (26, 26') such that the hole (32, 37) is dilated and the diameter of the hole (32) expands.

8. Method according to any of claims 1 to 5, wherein the body (18") comprises a body aperture (52), wherein the second fastening portion (26") of the cable component is arranged in the body aperture (52).

9. Method according to claim 8, wherein the heat source (44) heats the first fastening portion (20").

10. Method according to any of the preceding claims, wherein the elongated component (12) is provided with a cover (48) adapted to protect the first fastening portion during a cathodic dip-paint coat, and wherein the cover (48) is removed from the elongated component (12) before arranging the cable component and the body (18, 18") concentrically.

11. Method according to any of the preceding claims, wherein the one of the first or second fastening portion is heated before arranging the cable component (14) and the body (18, 18") concentrically.

12. Method according to any of claims 1 to 10, wherein the one of the first or second fastening portion is heated subsequently the arrangement of the cable component (14) and the body (18, 18") concentrically.

13. Electrical connection system comprising:

a. an electrical elongated component (12) having a cylindrical body (18) extending along a longitudinal axis (X), a first fastening portion and a securing portion, the securing portion being welded to a workpiece;
b. a cable component (14) having a second fastening portion adapted to face the first fastening portion;
c. a heat source (44) adapted to heat one of the first or second fastening portion;
d. a cooling device (46) adapted to cool the one of the first or second fastening portion with the heat source.

14. System according to claim 13, further comprising a measurement sensor (64), and wherein the heat source is an induction loop.

15. Electrical connection (10) comprising an electrical elongated component (12) having a cylindrical body (18) extending along a longitudinal axis, a first fastening portion and a securing portion, wherein the securing portion (22) is adapted to be welded to a workpiece (16) and a cable component (16) having a second fastening portion comprising a sleeve surrounding the first fastening portion, the sleeve being provided with a hole (32, 37), the second fastening segment extending in the hole (32, 37), and wherein the first fastening portion is secured into the sleeve by retraction of the sleeve around the first fastening portion after heating.

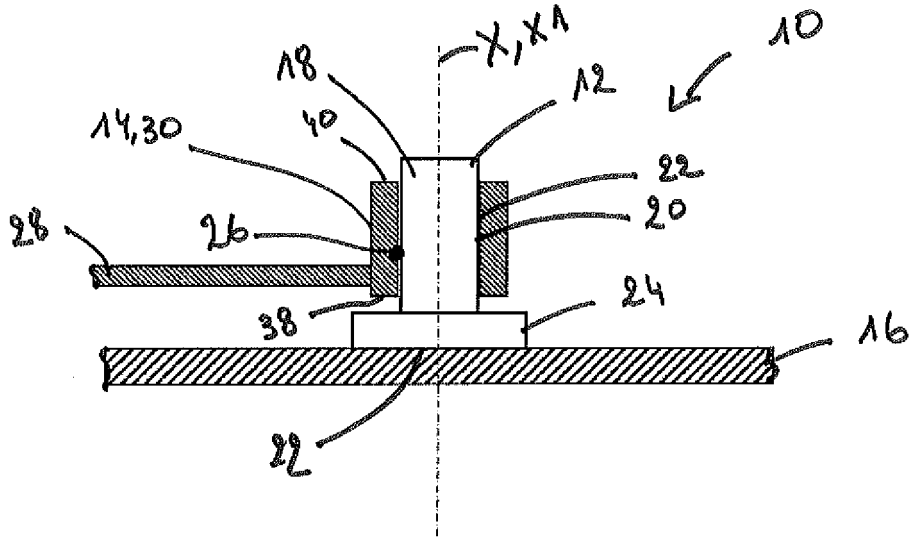
X, X1
10
18
12
14,30
40
22
20
28
26
24
38
16
22

Fig. 1

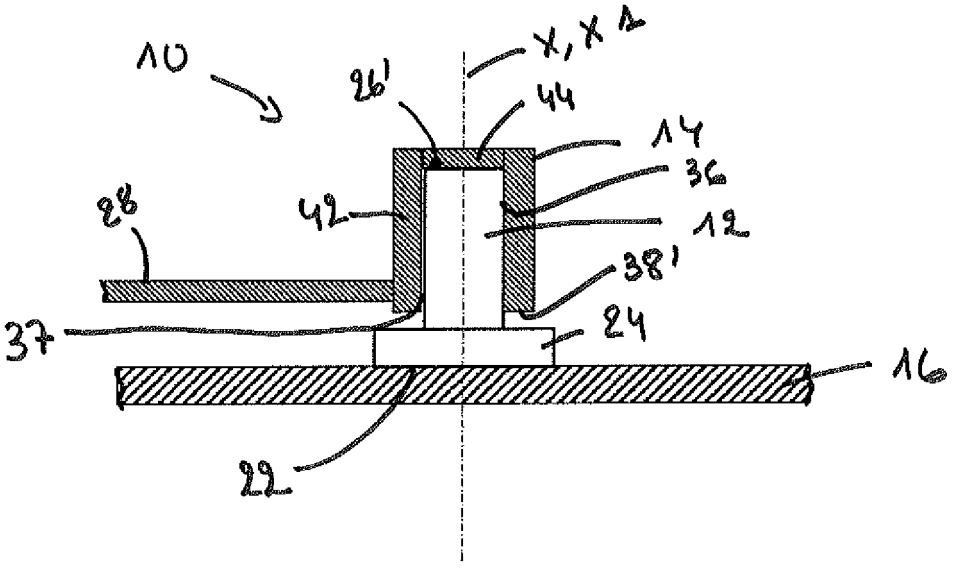
10
X, X1
26'
44
14
36
28
42
12
38'
37
24
16
22

Fig. 2

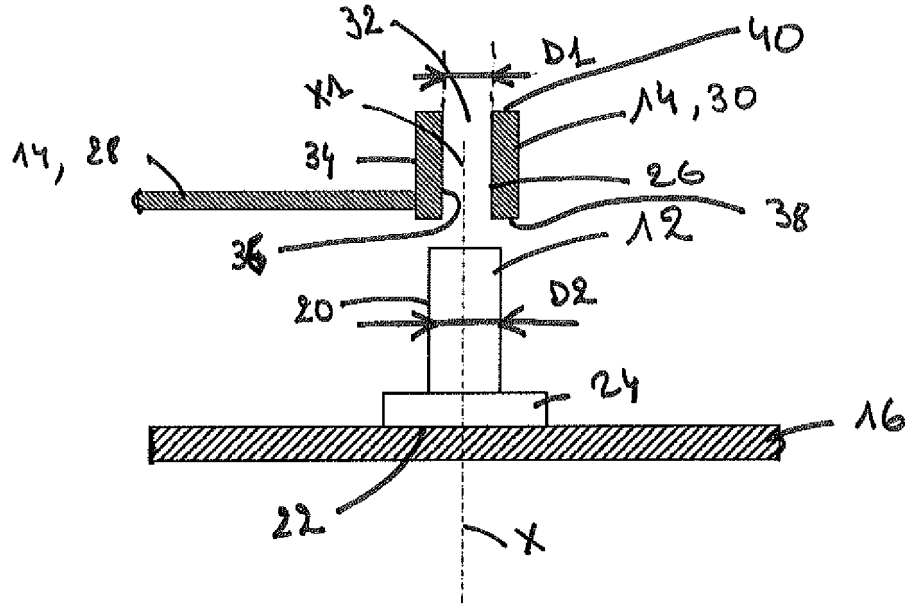
32
D1
40
14, 30
14, 28
34
26
38
36
12
20
D2
24
16
22
X

Fig. 3

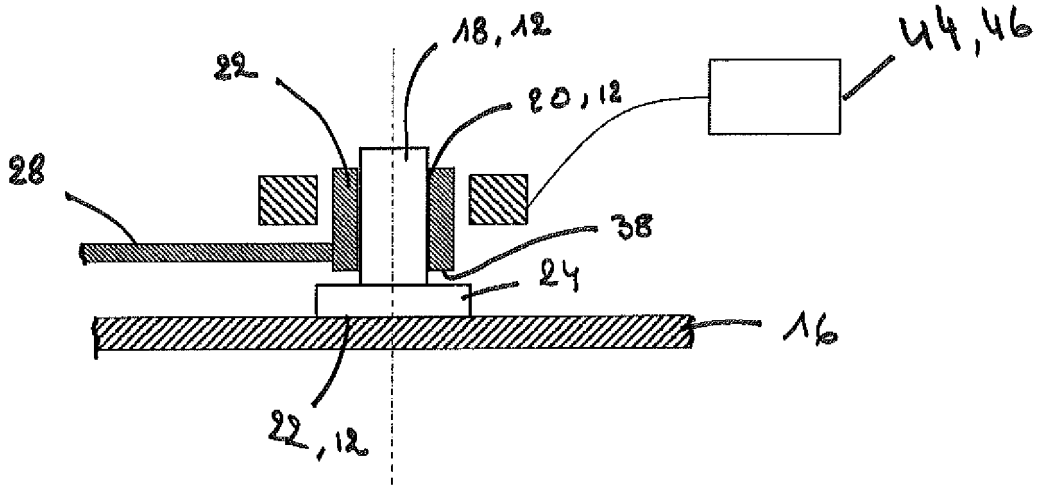
18, 12
44, 46
22
20, 12
28
38
24
16
22, 12

Fig. 4

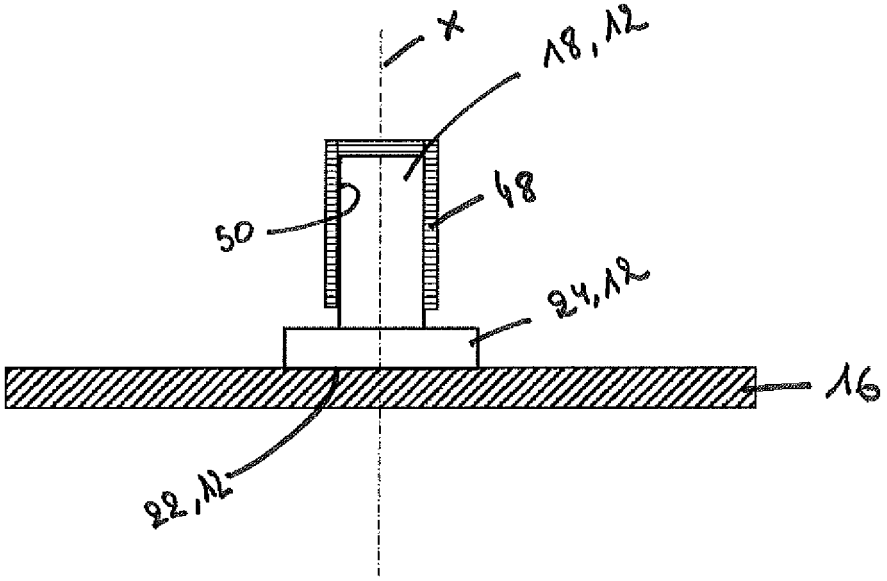
X
18,12
48
50
24,12
16
22,12

Fig. 5

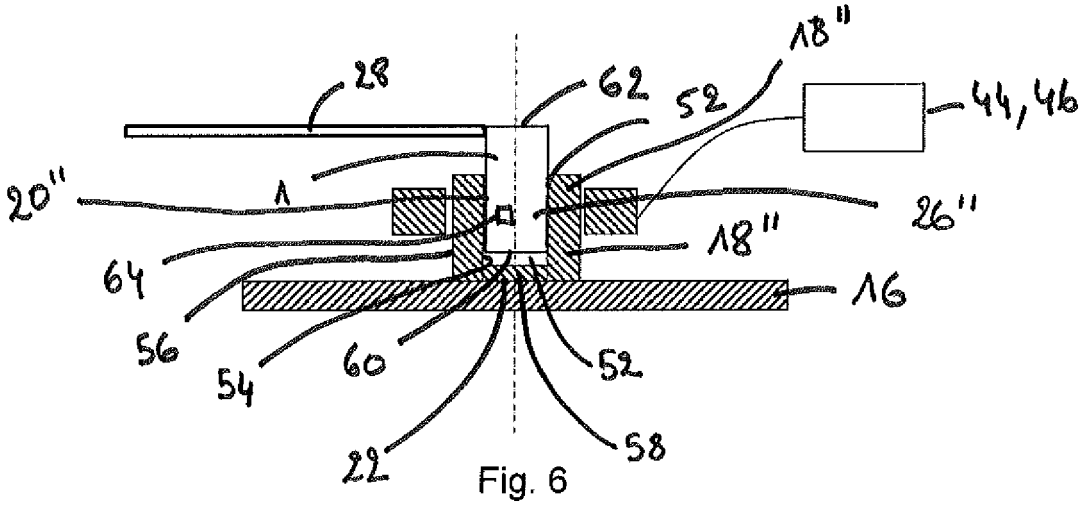
28
62
52
18"
44,46
20"
1
26"
18"
64
16
56
54
60
52
22
58

Fig. 6

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PARTIAL EUROPEAN SEARCH REPORT

under Rule 62a and/or 63 of the European Patent Convention. This report shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 17 18 9263

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 6 077 096 A (MORING ALLEN DALE [US] ET AL) 20 June 2000 (2000-06-20) * figures 2,6,7 * * column 3, line 53 - column 4, line 10 * * column 2, line 50 - column 3, line 4 *	1-12,15	INV. H01R4/01 H01R13/193 ADD. H01R4/64
Y	EP 2 889 965 A1 (CONTINENTAL AUTOMOTIVE SYSTEMS [US]) 1 July 2015 (2015-07-01) * paragraph [0014] - paragraph [0017] * * paragraph [0035] * * figures 1-3 *	1-12,15	H01R11/12
A	US 9 490 572 B2 (NEUMANN-HENNEBERG WOLF [DE]) 8 November 2016 (2016-11-08) * figures 1-2 * * abstract *	1-12,15	

TECHNICAL FIELDS SEARCHED (IPC)

H01R

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
The Hague	3 January 2018	Skaloumpakas, K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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INCOMPLETE SEARCH
SHEET C

Application Number
EP 17 18 9263

Claim(s) completely searchable:
1-12, 15

Claim(s) not searched:
13, 14

Reason for the limitation of the search:

Claims 13 and 14 were not searched as the applicant indicated in response to the invitation pursuant to rule 62a(1) that only Independent method claim 1 and independent apparatus claim 15 and the dependent to them claims are to be searched.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 18 9263

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03-01-2018

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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