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(54) Insulation displacement contact device

(57) The present invention relates to an insulation displacement contact device (IDC) having a contact slot provided with an insertion opening and wishes to provide such IDC having an improved capability of contacting conductors with a wider range of conductor diameter and/or number of strands forming the conductor. As a solution to the above problem, the contact slot (40) of the IDC device of the present invention is defined between blade surfaces (12; 22) of a first blade element (10) and a second blade element (20), wherein said first and second blade elements (10; 20) are physically separated from each other, movable relative to each other and biased against each other by spring means (30).

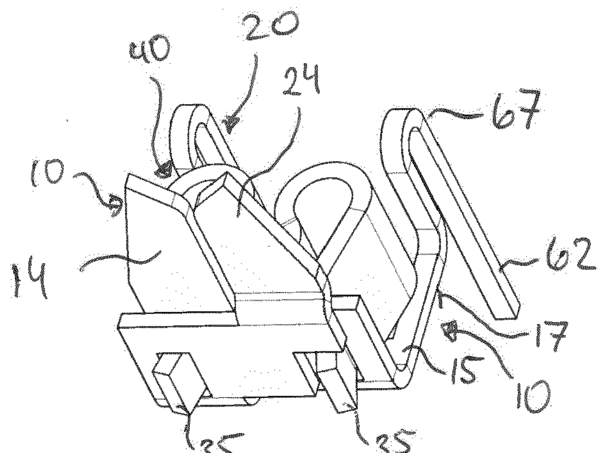


Fig.5a

EP 3 024 093 A1

Description

[0001] The present invention relates to an insulation displacement contact device which is suitable to provide an insulation displacement contact (IDC). IDC is also known as insulation piercing contact (IPC) and usually denotes an electrical connector designed to be connected to at least one conductor of an isolated cable by a connection process which forces a selectively sharpened blade or blades through the insulation, bypassing the need to strip the conductors of insulation before connection. If carried out properly, the connector blade cold-welds the conductor, thereby making a theoretically reliable gas-tied connection.

[0002] IDC contact design usually applies an IDC contact which is traditionally made of a single thin metal plate, wherein a copper alloy is usually preferred to make said metal plate, which is provided with a contact slot adapted to receive the at least one conductor of the cable. The mouth of said slot is usually designed to act as a blade to cut the insulation of the cable when the blade is inserted into the contact slot.

[0003] Examples of an IDC made of a single piece of thin metal plate are discussed e.g. in DE 90 06 417 U1, disclosing various configurations of the mouth and the contact slot within the metal plate adapted to receive the cable, and e.g. in EP 1 177 603 B1, EP 1 212 811 B1, EP 1 122 820 B1 or EP 0 893 845 B1, each disclosing an external clamping means adapted to force cooperating blade surfaces against each other to thereby press the blade surfaces against the cable received in the contact slot. Those additional clamping means are to secure a good contact between the at least one conductor of the cable and the cooperating surfaces of the contact slot. During use, shock or vibration may loosen the at least one conductor within the slot. Strain relief within the conductor or the material forming the IDC will likewise affect the electrical contact during the desired working lifetime of the IDC.

[0004] EP 0 435 292 B1 discloses an IDC providing improved flexibility performance. This prior art discloses an IDC made of a single piece of metal by cutting and bending. The contact slot is provided between two blade sections, which blade sections are defined at free ends of a basically U-cut sheet metal piece, which U-cut sheet metal piece is bent in a U-form to form blade sections parallel to a foot section with a bridge section extending perpendicular to the foot and the blade sections and interdisposed there between. The blade sections are not directly connected to each other. The only direct connection is provided by the foot section at the end opposite to the blade section. The foot section is provided with a hole adapted to receive and hold the cable to be contacted with the IDC by encompassing the insulation thereof and grasping the cable within the IDC. Due to the length of the bridge section, the IDC of this prior art provides increased flexibility and deflection capability.

[0005] Fig. 8 of the present application shows the behavior of prior art IDCs. With a "conventional IDC", the behavior of a single metal piece IDC essentially in accordance with DE 90 06 417 U1 or DE 10 2011 121 943 A1 is depicted. "Improved IDC" shows the behavior for an IDC in accordance with the aforementioned prior art EP 0 435 292 B1.

[0006] While said improved IDC design provides some advantages, some problems and restrictions with IDCs remain unresolved. Specifically, termination of considerably larger wires and/or wires with a high number of strands of a different design is hard to achieve. As derivable from enclosed Fig. 8, a conventional IDC can only connect a few wires of different size. If the conductor diameter is too small, the contact slot does not thoroughly contact the conductor of respective wire. If the diameter of the conductor is too large, plastic deformation of the IDC and/or the cable will negatively affect the elastic performance required to thoroughly contact the conductor within the IDC. With a longer beam as taught by EP 0 435 292 B1, the size range is enhanced.

[0007] In order to cope with the above problems, the present invention specifies an insulation displacement contact device having two blade surfaces defining the contact slot, wherein said blade surfaces are provided by a first blade element and a second blade element being physically separated from each other. The different blade elements are movable relative to each other and biased against each other by spring means. The first blade element provides the one and the second blade element provides the other of the two blade surfaces.

[0008] With the present invention, two physically separated blade elements are biased against each other by the spring means, thereby bringing the blade surfaces in contact against a conductor received within the contact slot. The spring force and the range allowing the blade elements to move relative to each other can be freely adjusted, thereby providing a high contact deflection range. Further, the IDC according to the present invention makes it possible to repeatedly repair the wire terminations by moving the blade surfaces away from each other against the force of the spring.

[0009] In conventional IDCs utilizing a single sheet metal and the inherent flexibility of the shape of the IDC, displacement of the blade surfaces is restricted even if a bridge section is realized as a beam in accordance with EP 0 435 292 B1. Physical properties, in particular elasticity and strength of the sheet material forming the IDC as well as creep resistance of the contact material, greatly limit the variety of cables connectable to a specific IDC made of a single sheet metal by cutting and bending.

[0010] With the present invention, however, the blade elements are usually provided movable in a translational fashion such that the blade surfaces defining the contact slot are provided within a single plane and strictly move within said plane in longitudinal direction, i.e. without tilting as the prior art blade elements do, wherein the blade sections are pivotally connected to a common base or foot section of the sheet material. By this translational movement, an exact geometry of the contact slot can be attained, thereby preventing the cable from moving out of the slot in longitudinal direction of said contact slot, which may happen in prior art due to creep and stress relaxation of the sheet metal forming the IDS and/or the material forming the conductor. Further, the material forming the blade elements can be selected to be a material providing a good electrical conductivity, such as copper and copper alloys. The elasticity and strength of the material is not an important parameter for the selection of an appropriate material for forming a blade element.

[0011] Further, the blade elements each can be made of different materials to e.g. provide blade surfaces made of a material having a good electrical conductivity and a low electrical transition resistance between the blade surface and the surface of the conductor, whereas the remaining parts of the blade elements can be made of a material selected to attain other required properties, such as e.g. the sliding properties for allowing relative movement of the first and the second blade elements relative to each other.

[0012] Nevertheless, in order to reduce manufacturing costs, each separate blade element is usually made of a single sheet of metal, preferably copper or a copper alloy, by cutting and bending. Naturally, a coating may be applied to the surface of such sheet of metal, in particular to the surface defining the contact slot.

[0013] The spring means can be made of any suitable material providing sufficient elasticity, including metal or plastic. The material defining the spring means does not necessarily have to be electrically conductive. Further, the spring means may be provided as a unitary portion of one of the first or the second blade elements.

[0014] The material and design of the spring means is selected in view of economical constraints and the desired flexibility and durability. The spring means can in particular be made of steel, in particular spring steel.

[0015] At least one of the blade elements is to provide means for electrically contacting the IDC to a substrate, e.g. a PCB or another conductive device like a cable or a connector or the like. For this, at least one of the first or the second blade elements defines a pin, usually made by cutting and bending sheet metal forming the respective blade elements, adapted to be received within a hole of a PCB, and electrically connected to a conductive path within said PCB.

[0016] According to a preferred embodiment of the present invention, the first blade element is formed by a terminal base element. A terminal base element in the meaning of this preferred embodiment provides at least one guide surface for guiding a movement of the second blade element relative to the first blade element. More preferably, the terminal base element provides all means for connecting the IDC to a support, such as a PCB, whereas the second blade element is slidably held only by the first blade element, i.e. the terminal base element.

[0017] According to a preferred embodiment, the first and the second blade elements each define a further blade section adapted to define there between a second slot adapted to either clamp the insulation or to contact the conductor of a cable. In other words, the first and the second blade elements define two separate slots, one of which is a contact slot adapted to electrically contact the at least one conductor of the cable, whereas the other slot may provide additional electrical contact to the conductor of said cable by likewise contacting said conductor or mechanical clamping of the cable within the IDC by clamping the insulation of the cable. The driving force of the blade sections against the outer circumference of the cable, i.e. the insulation thereof or the conductor, is usually triggered by the same spring means, preferably a single spring element.

[0018] According to a preferred embodiment of the present invention, the first blade element is a bent sheet metal piece providing a first biasing arm. The second blade element is likewise a bent sheet metal piece providing a second biasing arm. Those first and second biasing arms usually extend essentially parallel to the longitudinal direction of the contact slot to thereby define an abutment face suitable to receive the spring force of a spring element. A respective spring element is preferably arranged between the first and the second biasing arm. By making each of the first and the second blade element out of a single cut and bent piece of metal sheet, respective preferred IDC can be manufactured economically. Preferably, the IDC is defined of only two, at most three individual parts, i.e. the first and the second blade elements, and the spring element.

[0019] In a further preferred embodiment of the present invention, the first biasing arm is arranged below the second blade surface in extension direction of the contact slot and the second biasing arm is arranged below the first blade element in respective extension direction of the contact slot. Thus, a rather compact IDC is provided with a reduced lateral extension which is predominantly influenced by the width of blade sections defining the blade surfaces and/or the length of the spring element.

[0020] The blade surfaces defining the contact slot do not necessarily have to be provided with a sharpened edge throughout their entire length to cut the insulation of the cable. However, on a regular basis, the blade surfaces define a chamfered mouth defining a cutting section and leading to the contact slot. Here, the insulation is usually perforated and cut such that the blade surfaces can directly contact the conductor of the cable upon insertion thereof into the contact slot.

[0021] According to a preferred embodiment, the IDS comprises a spring element which is used to secure, i.e. hold, the first and second blade elements. For this, the spring element usually has a first fastening arm segment which is attached to the first element and a second fastening arm segment which is attached to the second blade element. Preferably, the spring element according to this constitution is made of a metal sheet which in turn is made of spring steel. Holding of the two blade elements is preferably attained by a form fit between the blade elements and the spring element. For this, the blade elements may have holes formed by cutting of the sheet metal defining the blade elements and projected by a fastening projection. This fastening projection may be the free end of the spring arms of the spring element. The fastening projections may have smaller dimensions than the dimension of the respective spring arm.

[0022] According to a further preferred embodiment, the spring element is provided with a mounting projection. This mounting projection is e.g. adapted to be received in a mounting hole of a support, such as a PCB, to mechanically secure the spring element to said support. The mounting projection does not form part of the electrical path on a regular basis. Thus, the mounting hole of the PCB is not electrically connected to the conductive paths of said PCB.

[0023] In this constitution, the blade elements are of course electrically connected to the PCB and the conductive paths thereof. While electrical contact between one of the first and the second blade elements and the PCB will be sufficient and can be embodied according to the present invention, two electrical contacts are usually and preferably selected such that both of the first and the second blade elements are both contacted with an electric path of the substrate. However, as the spring element supports the first and second blade elements, the mechanical support between those blade elements and the substrate can be weak. In fact, an elastic support of the first and second blade elements relative to said substrate is preferred to allow relative movement of the blade elements. At least one of the first and the second blade elements define an elastic section arranged between a pin provided by respective blade element and the blade surface such that the blade surface is allowed to move relative to the substrate/PCB. The elastic section can e.g. be provided by a very thin but straight leg or beam made by cutting the sheet metal forming the blade element. However, the elastic section may have a meandering or curved constitution to improve relative movement of the blade surfaces of the two blade elements relative to each other to cope with varying sizes of the cables to be inserted.

[0024] According to a further preferred embodiment of the present invention, the spring element is only secured to the substrate via the first and the second blade elements. In other words, the spring element is just a connection for connecting the separate blade elements with each other in an elastic way such that they can move relative to each other to define a varying contact slot adapted to receive cables of different size. Mounting of the IDC and, thus, securing of the entire IDC to the substrate/PCB is attained by at least one pin provided by at least one of the first and the second blade elements and received in a hole of the substrate/PCB. One of the blade elements can be arranged fixed relative to the substrate/PCB. The other blade element can be movable and pretensioned against the first blade element and does not need to be connected to the substrate/PCB.

[0025] According to a further preferred embodiment of the present invention, at least one of the first and the second blade element defines a guiding surface extending essentially perpendicular to a pin. This guiding surface is adapted to be guided on the surface of the substrate/PCB such that the movement of the two blade elements relative to each other is achieved against the pretension of the spring element connecting the two elements with each other in an elastic way while further alignment of the two elements is provided by the guiding surface and, thus, the surface of the plain PCB. At least one of the first and the second blade element is portably received within a receiving hole of the substrate/PCB. For this, the respective blade element has a pin which extends essentially perpendicular to the guiding surface and is received within the hole of the substrate/PCB. The spring element may only be secured to the first and the second blade elements and not the PCB or another substrate. In this preferred embodiment, the IDC device may only be connected to the substrate via one and only one pin received within the hole. However, preferably both blade elements are provided with a pin to be received in respective holes of the substrate/PCB for electrical and/or mechanical connection thereto.

[0026] As derivable from the above general description, the present invention provides an IDC device adapted to receive a wider range of cables. The IDC device of the present invention is able to terminate considerably larger wires and/or wires with a high number of strands of different design. The coupling of the connector to the IDC device is not limited by the material properties of the bent sheet material forming the IDC. Instead, movability is largely achieved by the spring performance of spring means bypassing two individually movable and physically separated blade elements against each other to thereby define a contact slot with blade surfaces limiting said contact slot, movable relative to each other to a great extent and pressed against each other by the force of the spring means.

[0027] The high contact deflection range provided by the inventive solution also makes repeated repairs of the wire terminations possible.

[0028] Further advantages and features of the present invention will be evident from the following description of preferred embodiments in connection with the drawing, in which

Fig. 1a, 1b	are schematic representations of a first embodiment of the present invention before the insertion of a cable (Fig. 1 a) and after that;
Fig. 2a to 2e	are perspective views of a second embodiment of the present invention and parts thereof;
Fig. 3a to 3c	are perspective views of a third embod-

iment of the present invention and parts thereof;

Fig. 4a to 4c are perspective views of a fourth embodiment of the present invention and parts thereof;

Fig. 5a, 5b are perspective views of a further embodiment of the present invention and the parts thereof in a exploded view;

Fig. 6a, 6b are side views of a modified embodiment to the embodiment of figures 2 and an enlarged section of the blade surfaces thereof (Fig 6b).

Fig. 7 is a diagram showing a comparison of force deflection in the present invention and the prior art; and

Fig. 8 is a force deflection diagram for known IDCs.

[0029] Fig. 1a and 1b illustrate the principle of the insulation displacement contact device according to the present invention consisting of a first blade element 10, a second blade element 20 and spring means 30 interdisposed between a first biasing arm 11 of the first blade element 10 and a second biasing arm 21 of the second blade element 20. Each blade element 10, 20 has blade surfaces 12, 22 facing each other and defining a contact slot 40 adapted to receive a cable 50 in a fashion depicted in Fig. 1 b.

[0030] The free end of the blade surfaces 12, 22 are diverging outwardly to define cutting sections 13, 23. In an initial stage, which is depicted in Fig. 1a, those diverging cutting sections 13, 23 define a funnel-shaped insertion opening into the contact slot 20 for the cable 50 to be inserted.

[0031] Both blade elements 10, 20 are made of sheet metal, which is cut and bent. The first blade element 10 is made of a first piece of sheet metal; the second blade element 20 is made of another piece of sheet metal. Thus, the two blade elements 10, 20 are physically separated from each other. In the schematic drawing of Figures 1a, 1b, a blade section 24 of the second blade element 20 is depicted to be arranged above a first transverse beam of the first blade element 10 extending transverse to the longitudinal extension of the contact slot 40 and identified with reference numeral 15. The assigned transverse beam 25 of the second blade element 20 is thus guided by an upper surface of the first transverse beam 15 to allow a sliding movement of the first blade element 10 relative to the second blade element 20. From the lateral ends of the transverse beams 15, 25, the biasing arms 11, 21 extend in a direction parallel to the extension direction of the contact slot 40.

[0032] When inserting the cable 50 into the IDC device depicted in Fig. 1, the cable abuts against the cutting sections 13, 23 and is usually cut such that a gap is formed in an insulating material 51 of the cable 50 to thereby expose multiple strands 52 providing the conductor of the cable 50. As the cable 50 is further advanced in longitudinal direction of the contact slot 40 towards a base of the IDC device, the blade surfaces 12, 22 are biased against the strands 52 to make electrical contact between the first and second blade elements 10, 20 and the conductor 52 of the cable 50. The force with which the blade surfaces 12, 22 abut against the conductor 52 depends on the force of the spring element 30, which force can be varied as required for providing the desired force, i.e. pressure, to electrically clamp the conductor 52 between the blade surfaces 12, 22.

[0033] Figures 2a to 2e elucidate a second embodiment of the present invention essentially embodying the blade sections 14, 24 of the first schematic embodiment of Figures 1a, 1b. In the second embodiment, a unitary cut and bent sheet metal piece provides for a terminal base element identified with reference numeral 10 having a frame-shaped base section 16 of rectangular form. From parallel lateral end faces of said frame, two blade sections 14 project. Those blade sections 14 have identical geometry and lateral position. An underside of the base section 16 opposite to the blade sections 14 is projected by four securing lugs 61 adapted to be inserted into an assigned fastening hole of a printed circuit board. At least one of those lugs 61 defines a pin 62 for electrically contacting the terminal base element 10 to a conductive path of the PCB. Naturally, all lugs 61 can be pins, provided that all respective fastening holes of the PCB are connected to electric paths of the PCB. By means of the lugs/pins 61/62, the terminal base element 10 is secured and electrically connected to the PCB.

[0034] As in particular evident from Fig. 2c, the blade sections 14 are slightly bent inwardly toward the inner space of the frame to slightly project an inner circumferential surface of the rectangular base section 16 defining a first guide surface 63. A bent foot transition in an area where the blade section 14 merges into the base section 16 provides a roof-shaped cover above said first guide surface 63 and thereby a second guide surface 64, which will be described in further detail hereinafter.

[0035] Figure 2e elucidates the second blade element 20 of the second embodiment having two blade sections 24 projecting from a U-shaped base section 26. Parallel arms thereof provide for transverse beams 25 already described in principle with reference to Fig. 1. Extending between those transverse beams 25 and perpendicular to the longitudinal extension of those transverse beams 25, there is provided a second biasing arm 21. The two second transverse beams 25 and the one second biasing beam 21 interdisposed there between provide the U-shaped geometry of the base section 26.

[0036] By cutting from the unitary sheet material and bending, four spring retaining arms 65 are formed, which extend parallel to each other and parallel to the transverse beams 25. A pair of spring retaining arms 65 encompasses a space essentially corresponding to the height of the base section 26 and adapted to receive a spring element 30 depicted in Fig. 2d. This spring element 30 is biased against the second biasing arm 21 of the second blade element 20 and a first biasing arm 11 formed by one beam of the rectangular base section 16.

[0037] For assembly, the spring element 30 is introduced between the spring retaining arms 65 (cf. Fig. 2b). Then, the preassembled second blade element 20 is introduced into the base section 16 of the first blade element 10 to assume the assembled state depicted in Fig. 1a. Figure 1a shows the initial position of both blade elements 10 and 20, in which the blade sections 14, 24 are in close vicinity to each other. In this assembled state, the transverse beam 25 of the second blade element 20 is arranged below the second guide surface 64 and thereby prevented from slipping out of the frame-shaped base section 16. Usually, the embodiment is arranged on top of the surface of a substrate, such as e.g. a PCB. Thus, the position of the first blade element 10 is fixed via the lugs/pins 61, 62, whereas the second blade element 20 is slidably held on the surface of the PCB. Thus, end surfaces of the U-shaped base section 26 provide guiding surfaces 27 to guide the translational movement of the second blade element 20 within the base section 16 of the first blade element. Those guiding surfaces 27 extend perpendicular to the pins/lugs 61/62 of the first blade element 10, i.e. perpendicular to the longitudinal extension of both contact slots 40 defined between the blade sections 14, 24. Outwardly bent projections 71 of the first and second blade element 10, 20 provide further guide surfaces 64 for the sliding movement.

[0038] When a cable is inserted into those contact slots 40, the blade section 24 of the second blade element 20 are urged away from the assigned blade sections 14 of the first blade element 10, thereby increasing the width of the contact slot to finally contact the conductor of the inserted cable. The insulation thereof is cut in the course of the introduction, as already described in principle with respect to Figs. 1a, 1b. As derivable from Fig. 2a, the blade surfaces 12, 22 of respective blade sections 14, 24 face each other. The blade sections 14, 24 extend parallel to each other and within a single common plane. Thus, the conductor sandwiched between the biased blade sections 14, 24 is pressed between the blade surfaces 12, 22 to make a solid electrical contact. Any creep or reorientation of multiple strands 52 forming the conductor will be compensated by partial release of the elastic force of the spring element 30 caused by the blade surfaces 12, 22 advancing towards each other.

[0039] In the embodiment described in Figs. 2a-2e, the second blade element 20 is only movable in a translational fashion relative to the first blade element 10. The guide surfaces 63, 64 prevent any rotational movement. The movement is a purely linear movement.

[0040] Figures 3a-3c depict an alternate embodiment. The blade elements 10, 20 are essentially designed as previously described. However, the second blade element 20 does not have the spring retaining arms 65. In the third embodiment of Figs. 3a-3c, four U-shaped spring elements are received within the rectangular base section 16 and biased between the biasing arm 11 of the first blade element 10 and the biasing arm 21 of the second blade element 20. Those four spring elements are identified with reference numeral 30 and define an example of spring means in the meaning of the present application.

[0041] The underside view depicted in Fig. 3b elucidates that the second transverse beam 25 of the second spring element 20 is shorter than the extension of the assigned first transverse beam 15 of the first blade element 10 to allow movement of the second blade element 24 away from the first blade element 14 upon introduction of a cable into the contact slot 40, thereby compressing the spring elements 30.

[0042] In the embodiment of Figs. 4a-4c, a spring element 30 is made of a cut and bent sheet metal piece of a spring metal material. By bending and cutting, a mounting projection 31 is cut free, which projects various spring arms projecting from a common spring base 32 and identified with reference numerals 33 and 34. The spring element 30 of said embodiment has a pair of first and second spring arms 33, 34 which extend parallel to each other and which are unitarily connected by the spring base 32. Those spring arms provide for an enhanced contact deflection range by means of the fairly long total effective spring length allowing the two arms 33, 34 to flex about the spring base 34 and an access which is parallel to the access of the spring mounting projection 31.

[0043] The free end of the second spring arms 34 is cut to define a male form fit element 35. By cutting, the free end of the second spring arms 34 also provide abutment faces 36 which extend perpendicular to the longitudinal extension of the spring arms 34.

[0044] The two blade elements 10, 20 of the fourth embodiment are depicted in Fig. 4c. The blade elements 10, 20 are identical, allowing economical manufacturing of this embodiment. The blade sections 14, 24 are provided with rectangular form fit holes 66 adapted to receive to the male form fit elements 35. When connected to the spring element 30, the blade elements 10, 20 contact the abutment faces 36. Then, the spring arm segments embody first and second fastening arm segments of the present invention. From each blade section 14, 24, a rod section extends. The fee end thereof provides for the pin 62 to electrically connect the blade elements 10, 20 to a PCB. An area between those pins 62 and the assigned blade section 14, 24 is bent in a meandering fashion to provide an elastic section 67, allowing the blade section 14, 24 to follow a movement of the second spring arm 34, while keeping the pins 62 in place within the PCB.

[0045] The embodiment according to Figs. 4a-4c is secured to the PCB by means of the mounting projection 31. The pins 62 are to electrically connect the blade elements 10, 20 to the conductive paths of the substrate/PCB.

[0046] Figures 5a and 5b elucidate a further embodiment, in which a spring element 30 is bent in a meandering fashion with three curves. The free ends of the spring element 30 provides male form fit elements 35 adapted to be received within rectangular form fit hole 66 of the two blade elements 10, 20, essentially as described with respect to the previous embodiment. However, the spring element 30 of this embodiment is only secured to the blade elements 10, 20 and not to a substrate. Fixing of the blade elements 10, 20 to such substrate is attained by the lugs 61. As in the previous embodiment, all portions of the blade elements 10, 20 are made by cutting and bending from a sheet metal piece. The first blade element 10 is provided with guide surfaces 63, 64, essentially as described with respect to the second embodiment (Figs. 2a-2e). The second blade section 24 and an assigned base thereof is flat and abuts against the first guide surface 63 and is slidably held by the spring element 30 there against. A cut-out 68 allows the second spring element 20 to slide over the spring arm 34 secured to the first blade element 10 and vice versa.

[0047] Reference numerals 15 and 25 identify transverse beams which extend perpendicular to the blade sections 14, 24 and provide guiding surfaces 27 abutting with a PCB, to which the pins 62 are secured via holes drilled into the PCB. As in the previous embodiment, elastic sections 67 are provided for each of the blade elements 10, 20, between the pins 62 and the blade sections 14, 24 by the rod-shaped extension terminating into the pin 62 and the geometric configuration with a U-shaped projection essentially providing elasticity within the elastic section 67.

[0048] Figures 6a and 6b depict the specific geometry of the blade section 14, 24 of both blade elements 10, 20 of a further embodiment. The geometry is such that the blade surfaces define outwardly diverging outer cutting sections 13, 23. Those cutting sections 13, 23 terminate into a constriction 69 defined by a boss 18, 28 arranged above a prismatic receptacle 70 adapted to receive the conductor of a cable. For this, the blade surface 12 is inclined to define a first blade surface segment 12.1 diverging outwardly and a second blade surface section 12.2 diverging inwardly and toward the base section 16. Above the first blade surface section 12.1, a third blade section 12.3 is provided, which extends essentially parallel to the longitudinal extension of the contact slot 40. The two blade surface sections 12.1 and 12.2 intersect with a butt angle to thereby provide the geometry of the receptacle. A maximum distance within said receptacle 70, identified with reference numeral A in Fig. 6b, is larger than a distance B between the bosses 18, 28. The correlation A/B is preferably in a range of between 1.6 through 3.2.

[0049] Figure 7 shows a graph essentially in accordance with Figure 8 discussed in the introductory part of the present application. The lower left section of said graph elucidates the performance of the known IDCs in accordance with Figure 8. Due to the enhanced flexibility of the IDC device provided by the present invention, a wider range of wire sizes can be used by a single IDC of the present invention. Thus, thicker cable applied in the high-current range with an effective area of e.g. 6 mm^2 can be connected. The embodiment of Figs. 2a-2c is in particular suitable for connecting wires with a conductor thickness of between 1.5 through 6 mm^2. The fourth and the fifth embodiments will provide capability of connecting of connecting a thinner cable with an effective diameter of between 0.2 and 1.5 mm^2 of the conductor. In case of a multiple strand conductor, the effective diameter provided by the entirety of all strands is meant.

REFERENCE **SIGNS**

[0050]

10	first blade element / terminal blade element
11	first biasing arm
12	first blade surface
13	first cutting section
14	first blade section
15	first transverse beam
16	first base section
17	first guiding surface
18	first boss
20	second base element /terminal base element
21	second biasing arm
22	second blade surface
23	second cutting section
24	second blade section
25	second transverse beam
26	second base section
27	second guiding surface
28	second boss
30	spring element
31	mounting projection
32	spring base
33	first spring arm
34	second spring arm
35	male form fit element
36	abutment face
40	contact slot
50	cable
51	insulation
52	strands / conductor
61	lug
62	pin
63	first guide surface
64	second guide surface
65	spring retaining arm
66	form fit hole
67	elastic section
68	cut-out
69	constriction
70	receptacle

71 projection

Claims

1. An insulation displacement contact device having a contact slot (40) provided with an insertion opening **characterized in that**
the contact slot (40) is defined between blade surfaces (12; 22) of a first blade element (10) and a second blade element (20), said first and second blade elements (10; 20) being physically separated, movable relative to each other and biased against each other by spring means (30).

2. The insulation displacement contact device of claim 1, **characterized in that** the first blade element is formed by a terminal base element (10), providing at least one guide surface (63, 64) for guiding a movement of the second blade element (20) relative to the first blade element (10).

3. The insulation displacement contact device of claim 1 or 2, **characterized in that** the first blade element (10) is a bent sheet metal piece providing a first biasing arm (11), that the second blade element is a bent sheet metal piece providing a second biasing arm (21) and that a spring element (30) is arranged between the first and the second biasing arm (11, 21).

4. The insulation displacement contact device of claim 3, **characterized in that** the first biasing arm (11) is arranged below the second blade surface (22) in the extension direction of the contact slot (40) and that the second biasing arm (21) is arranged below the first blade surface (12) in the extension direction of the contact slot (40).

5. The insulation displacement contact device as defined in any of the preceding claims, **characterized in that** the first and the second blade elements (10, 20) each define a further blade section adapted to define there between a second slot (40) adapted to clamp the insulation or to contact the conductor of a cable.

6. The insulation displacement contact device of any of the preceding claims, **characterized by** a spring element (30) having a first fastening arm segment (34), which is attached to the first blade element (10), and a second fastening arm segment (34), which is attached to the second blade element (20).

7. The insulation displacement contact device of any of the preceding claims, **characterized in that** the spring element (30) is a unitary cut and bent sheet metal piece and has at least one of a fastening projection (35), provided at at least one of the first or second fastening arm segment (34; 34) and positively fitting with the assigned blade element (10; 20), and a mounting projection (31), adapted to mount the spring element (30) on a PCB.

8. The insulation displacement contact device of any of the preceding claims, **characterized in that** at least one of the first or second blade element (10; 20) defines a pin (62) adapted to be received in a hole of a PCB and having an elastic section (67) arranged between the blade surface (12) and the pin (62).

9. The insulation displacement contact device of any of the preceding claims, **characterized in that** at least one of the first or second blade element (10; 20) defines a guiding surface (27) extending essentially perpendicular to a pin (62), which is adapted to be received in a hole of a PCB and to cooperate with the surface of the PCB, and that the spring element (30) is adapted to be secured to the PCB only via the at least one blade element (10, 20).

10. The insulation displacement contact device according to any of the preceding claims, **characterized in that** the blade surfaces (12, 22) define outwardly diverging outer cutting sections (13, 23), terminating into a constriction (69) with a width (B) smaller than a width (A) in an outer region of the contact slot (40).

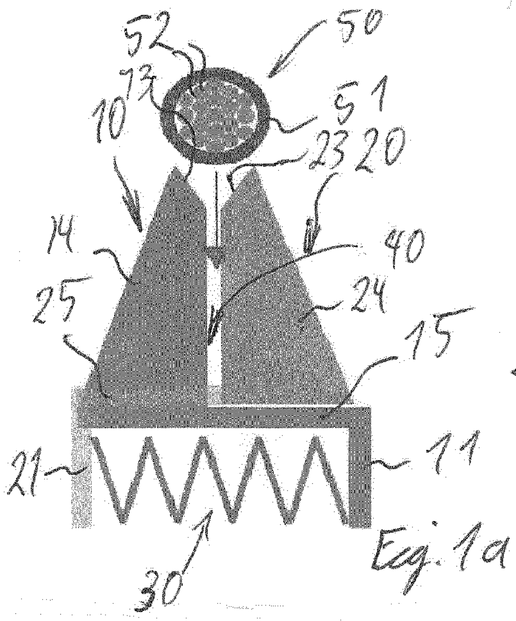


Fig. 1a

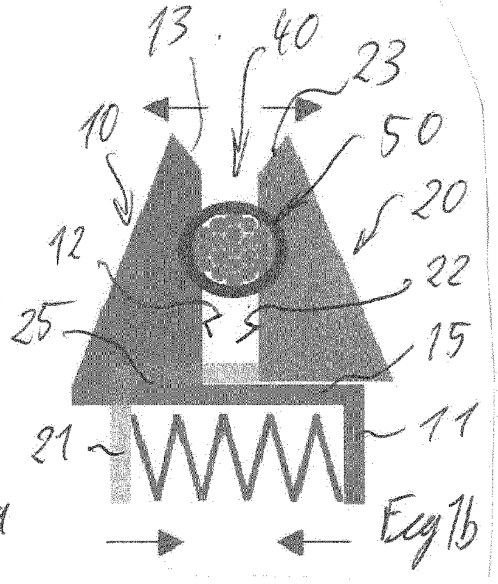


Fig. 1b

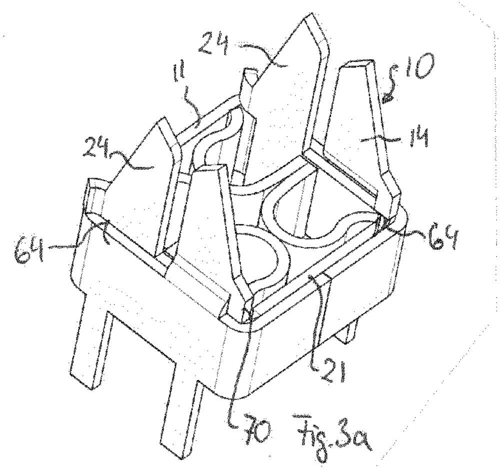


Fig. 3a

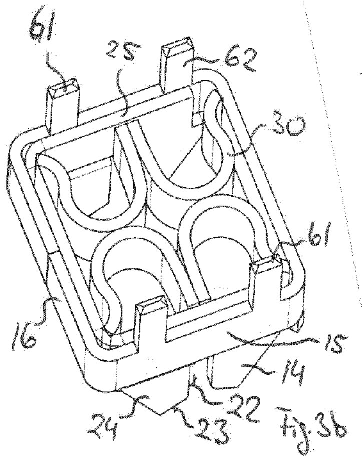


Fig. 3b

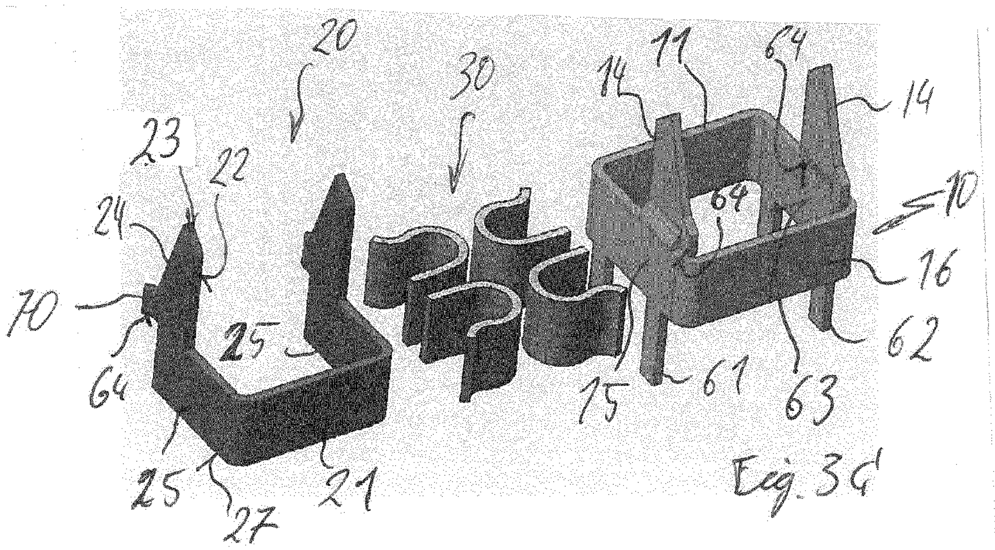


Fig. 3c

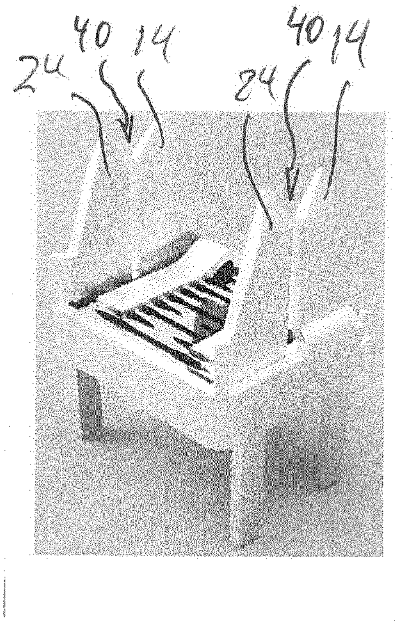


Fig. 2a

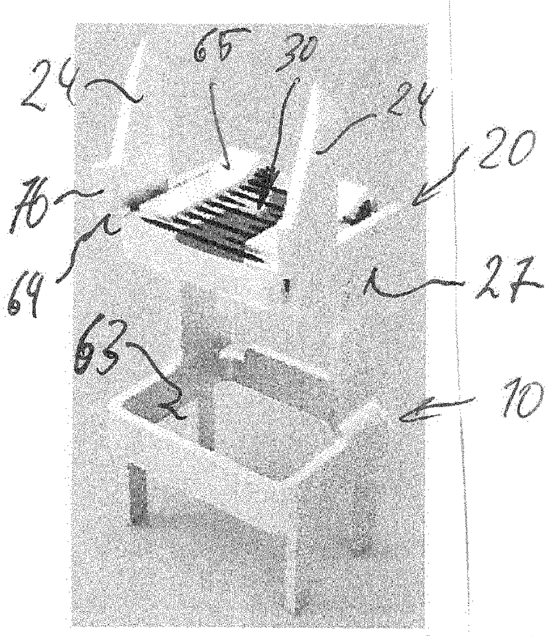
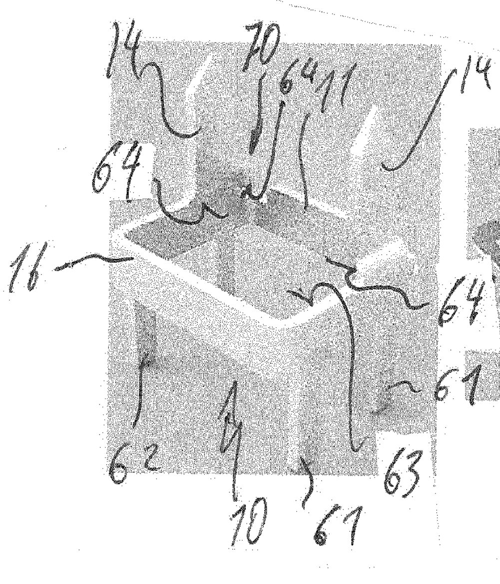


Fig. 2b

Fig 2c



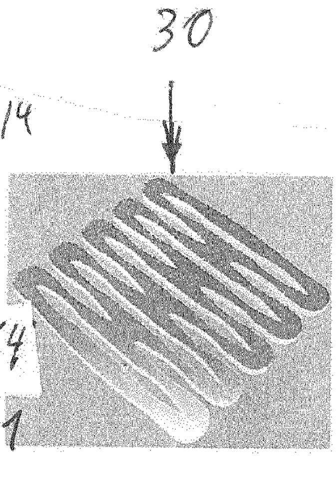
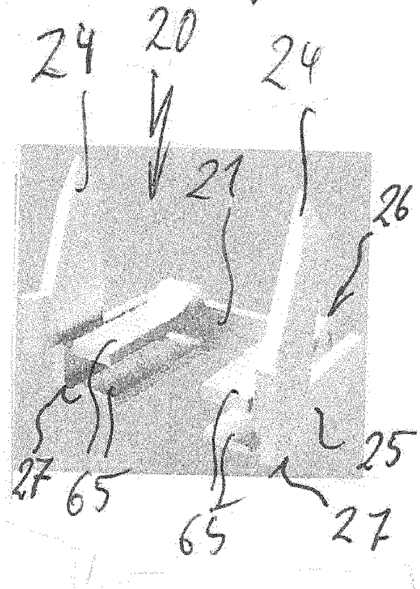


Fig. 2d

Fig. 2e



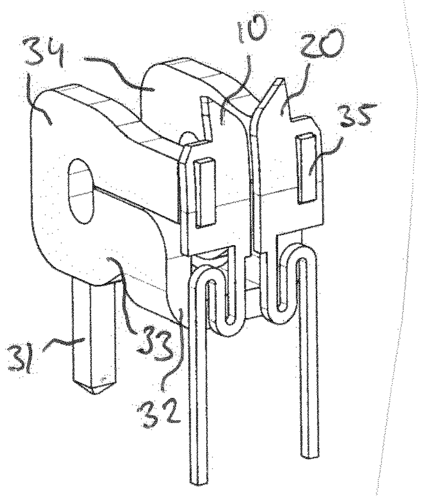


Fig.4a

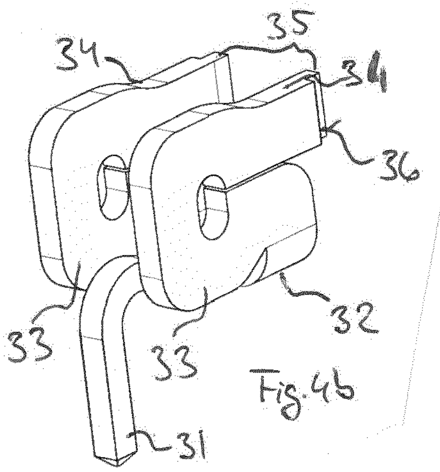


Fig.4b

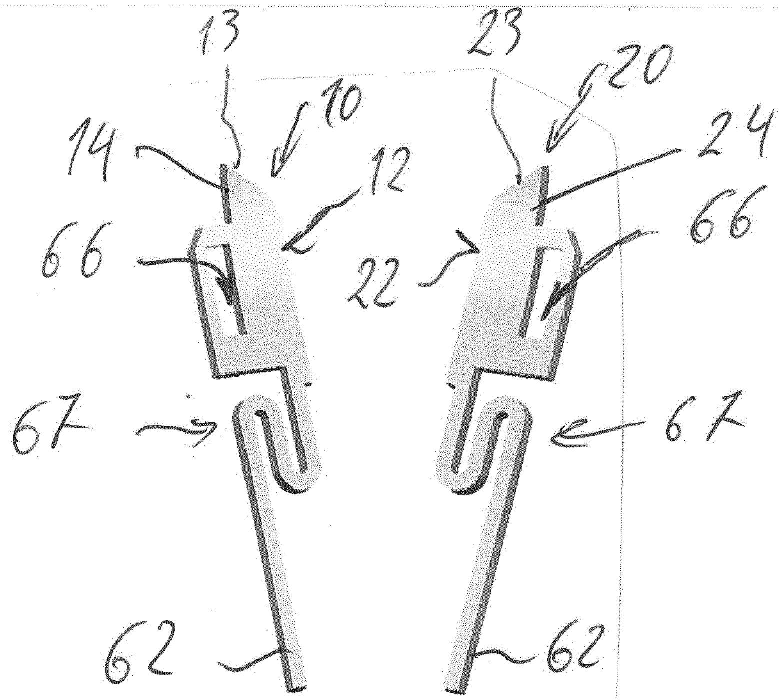
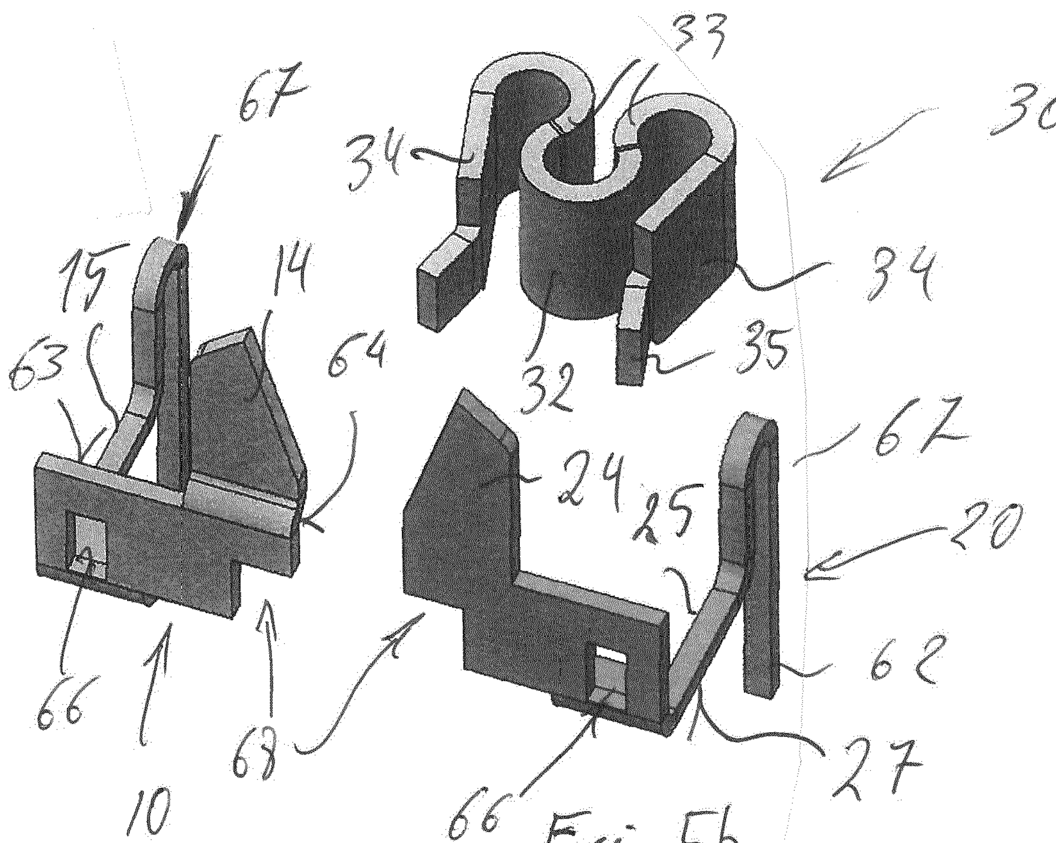


Fig. 4a'



33
30
67
34
34
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14
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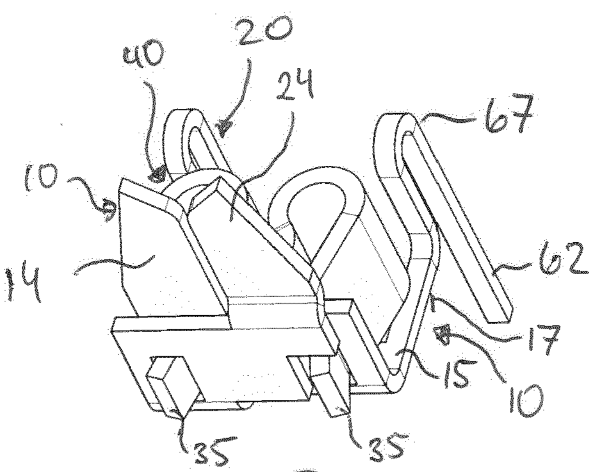
35
24
67
25
20
62
66
10
68
27
66

Fig. 5b



40
20
24
67
10
14
62
17
15
10
35
35

Fig.5a

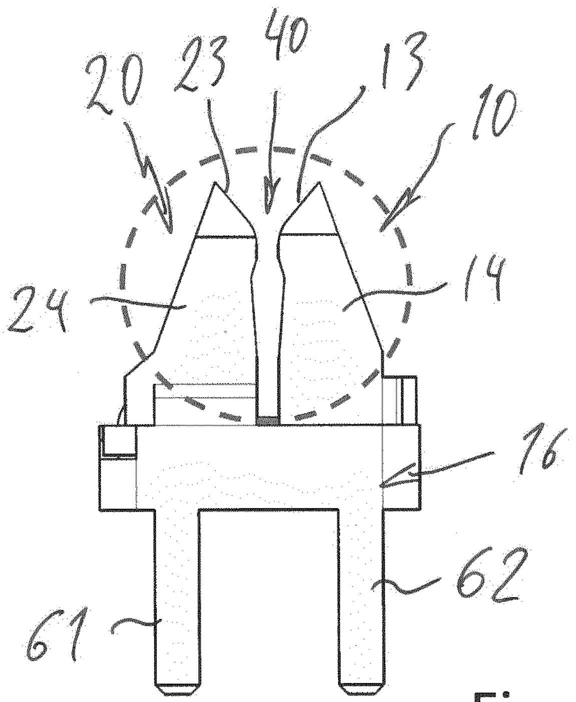


Fig. 6a

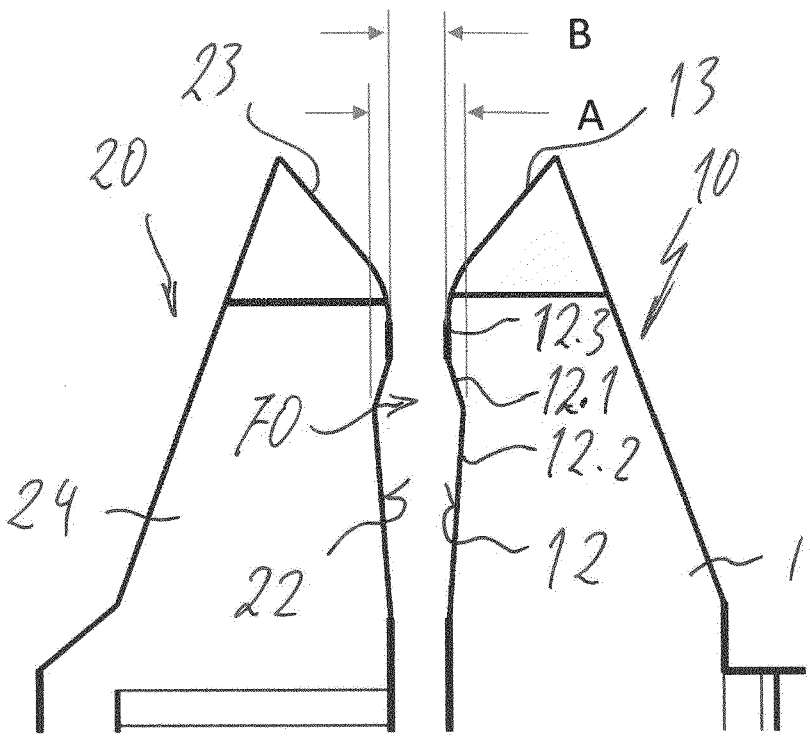


Fig. 6b

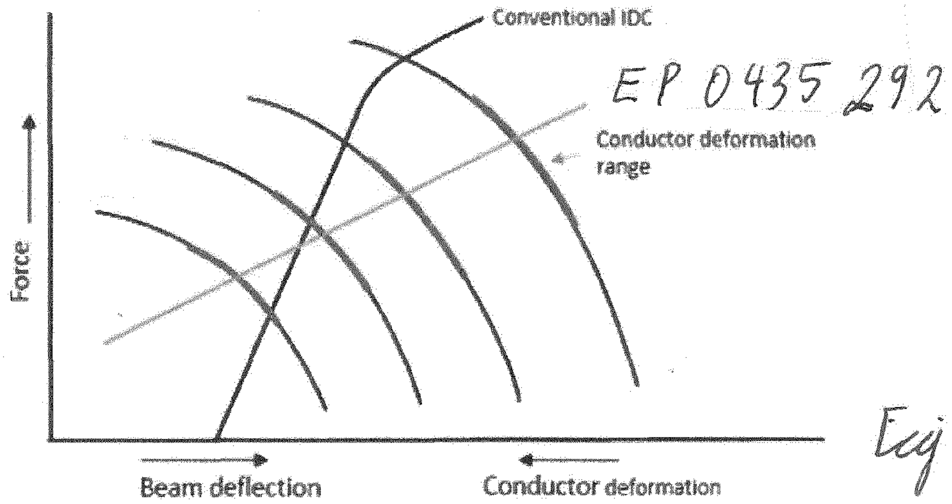


Fig 8

Force-deflection curve of different conductor sizes of conventional IDC terminals

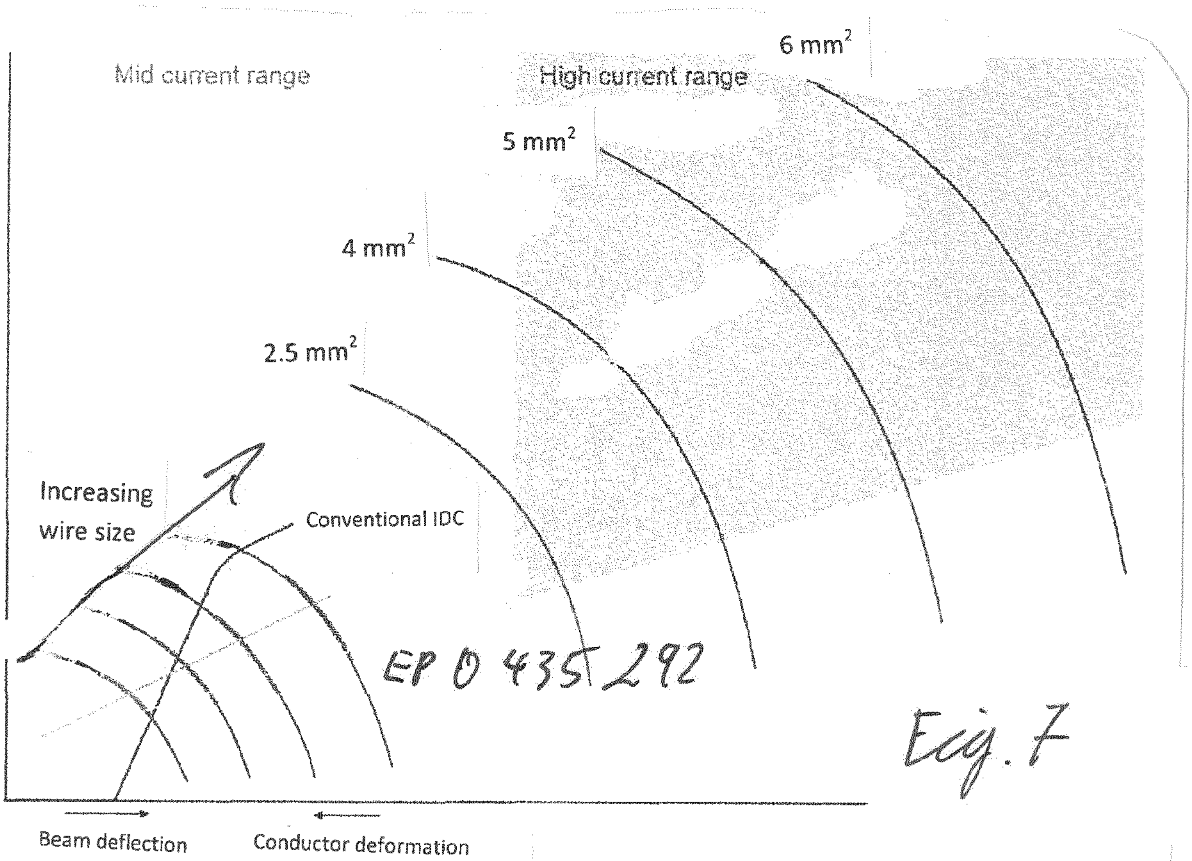


Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 4295

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H01R

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	24 April 2015	Ferreira, João

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