(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 610 970 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.07.2013 Bulletin 2013/27

(51) Int Cl.:
H01R 12/58 *(2011.01)*

(21) Application number: **12199794.4**

(22) Date of filing: **31.12.2012**

(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

(30) Priority: **30.12.2011 IT TO20111245**

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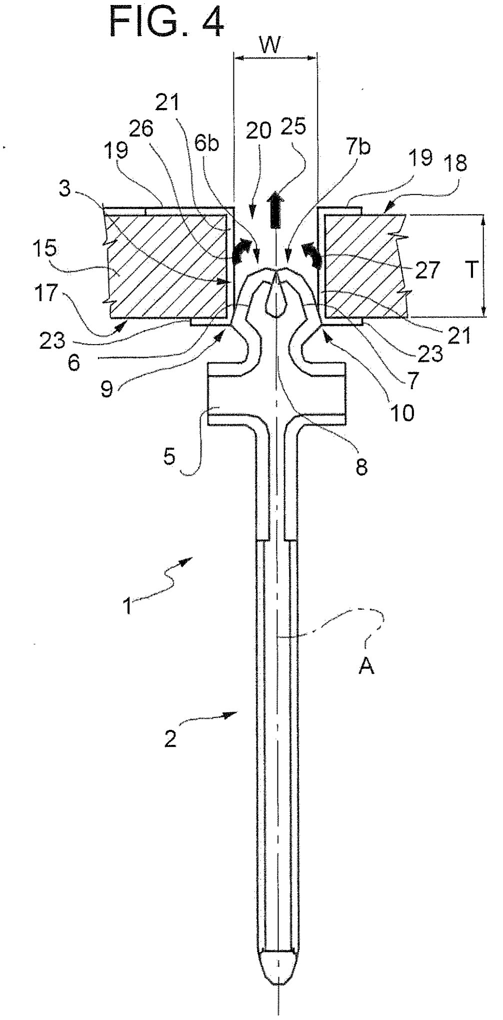
(54) **Solderable contact pin for printed circuit boards and process for manufacturing an electronic device**

(57) A solderable contact pin for printed circuit boards includes a terminal (2) and a mechanical coupling portion (3), extending along an axis (A). The mechanical coupling portion (3) has a length (L) less than the thickness (T) of a printed circuit board (15) and includes two elastic elements (6, 7), forming a fork along the axis (A) and provided with respective hooking elements (9, 10). The elastic elements (6, 7) are shaped so that, following the insertion of the mechanical coupling portion (3) in an opening with a width (W) less than a maximum distance (D) between respective outer edges (6a, 7a) of the elastic elements (6, 7), respective free ends (6b, 7b) of the elastic elements (6, 7) are rotated towards each other and the hooking elements (9, 10) are turned outwards to prevent the extraction of the mechanical coupling portion (3) from the opening.

FIG. 4



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Description

[0001] The present invention relates to a solderable contact pin for printed circuit boards and a process for manufacturing an electronic device.

[0002] As is known, printed circuit devices comprise printed circuit boards on which various types of components are mounted. Printed circuit boards have metal tracks and contact pads on one or both surfaces and through-holes, usually internally coated with a metallization layer, for mounting and electrically connecting components and, if necessary, for electrical connection between the opposite faces of the boards.

[0003] Among the components normally used in printed circuit devices, there are also contact pins, which normally serve as terminals for the electrical connection of external devices.

[0004] Known contact pins are made for being mounted by press fitting or soldering in the holes of printed circuit boards.

[0005] Pins of the first type are provided with rather complex connection mechanisms, which must ensure sufficient force to retain the contact pins in their respective seats for the life of the devices. At the same time, in order to avoid damage to the hole's metallization layer and consequent loss of reliability in the electrical contact, the forces must not be excessive. In production, ensuring this balance between the mounting force and that for pin retention is expensive and critical, as it is necessary to use materials with high mechanical performance and more precise production tools and controls. In addition, the electrical properties of the contacts made in this way are sub-optimal. In particular, the resistance of the contact can be quite high, as the connection area between hole and pin is limited to the edges in contact and is subject to possible oxidation because it is not protected.

[0006] Solderable pins are simpler to make and guarantee contacts with optimal electrical properties, due to both the larger extension of the contact area and because the level of conduction is not significantly altered by possible oxidation (which at most is limited to just the surface of the solder joint). On the other hand, the positioning of the contact pins is critical and requires special machines being introduced on the soldering lines. In fact, until soldering is completed, the pins are unsteady and the transfer from a machine outside the soldering line would be highly likely to cause them to come out or, in and case, to move.

[0007] However, soldering lines of this type are not very flexible and can only be used for a limited range of printed circuit devices. Their high cost is only justified if the few types of printed circuit devices are produced in sufficient volumes to saturate the production capacity, as the lines cannot be shared with other devices.

[0008] The object of the present invention is therefore to provide a solderable contact pin for printed circuit boards and a process for manufacturing an electronic device that enables the described limitations to be overcome.

[0009] According to the present invention, a solderable contact pin for printed circuit boards and a process for manufacturing an electronic device are provided as defined in claims 1 and 14, respectively.

[0010] The present invention will now be described with reference to the attached drawings, which illustrate some non-limitative embodiments, wherein:

- Figure 1 is a front view of a contact pin for printed circuit boards in accordance with one embodiment of the present invention;
- Figure 2 is a side view of the contact pin in Figure 1;
- Figure 3 shows an enlarged detail of the view in Figure 1;
- Figure 4 is a front view of the pin in Figure 1 in the step of insertion in a printed circuit board;
- Figure 5 is a front view of the pin in Figure 1 fastened in a printed circuit board to form a printed circuit device;
- Figure 6 is a simplified block diagram regarding a process for manufacturing an electronic device in accordance with one embodiment of the present invention;
- Figure 7 is a front view of a contact pin for printed circuit boards in accordance with a different embodiment of the present invention; and
- Figure 8 is a front view of the pin in Figure 7 fastened in a printed circuit board to form a printed circuit device.

[0011] With reference to Figures 1-3, a solderable contact pin for printed circuit boards is indicated as a whole by reference numeral 1.

[0012] The pin 1 is obtained by shearing from a thin flat sheet of metal and comprises a terminal 2 and a mechanical coupling portion 3, which extend along an axis A, on opposite sides of a base 5. In turn, the base 5 comprises two facing arms, transversal to axis A and defining a seat for mounting the pin 1 on a printed circuit board (not shown in Figures 1-3).

[0013] The mechanical coupling portion 3 comprises two elastic elements 6 and 7 on opposite sides with respect to axis A and has a length L that is less than the thickness of a printed circuit board on which the pin 1 is intended to be mounted (the length L of the coupling portion is understood as defined between the side of the base 5 from which the mechanical coupling portion 3 projects and a longitudinal extremity, along axis A, of the mechanical coupling portion 3). The elastic elements 6 and 7 form a fork along axis A and are shaped so that, following the insertion of the mechanical coupling portion 3 in an opening (such as a hole of a printed circuit board) with a width less than a maximum distance D between respective outer edges 6a and 7a of the elastic elements 6 and 7, respective free ends 6b and 7b of the elastic elements 6 are rotated towards each other (as shown in Figures 4 and 5, and which shall be described hereinafter).

[0014] More precisely, the elastic elements 6 and 7 have respective contact sections 6c and 7c and respective guide sections 6d and 7d.

[0015] The contact sections 6c and 7c of the mechanical coupling portion 3 project in the opposite direction with respect to terminal 2 and are connected to the base 5 by a connecting portion 8, which forms a narrowing between the base 5 and the mechanical coupling portion 3. Along the contact sections 6c and 7c, the outer edges 6a and 7a of the elastic elements 6 and 7 are substantially straight and parallel to axis A. The contact sections 6c and 7c of the elastic elements 6 and 7 also form respective hooking elements 9 and 10 with a connecting portion. In particular, the hooking elements 9 and 10 are defined by sharp edges at the connection between the respective outer edges 6a and 7a of the elastic elements 6 and 7 and respective edges 11 and 12 of the connecting portion 8. In addition, the angles α formed by the outer edges 6a and 7a and the respective edges 11 and 12 of the connecting portion are less than 135°, preferably between 45° and 90°. The sharp edges that define the hooking elements 9 and 10 extend in a perpendicular direction to the outer edges 6a and 7a.

[0016] The guide sections 6d and 7d are shaped so as to facilitate the rotation of the elastic elements 6 and 7 towards each other following the introduction of the mechanical coupling portion in an opening having a width less than the distance between the outer edges. In the embodiment described herein, in the guide sections 6d and 7d, the outer edges 6a and 7a of the elastic elements 6 and 7 are curvilinear and converge towards each other at the respective free ends 6b and 7b, which are spaced from each other in absence of stress.

[0017] In practice, the elastic elements 6 and 7 are shaped so that the hooking elements 9 and 10 are turned outwards to prevent the extraction of the mechanical coupling portion 3 from an opening in which it has been inserted, thus ensuring temporary locking of the pin 1.

[0018] Figure 4 shows a step of press fitting the pin 1 into a printed circuit board 15 to manufacture an electronic device 16, part of which is visible in Figure 5. The operation is performed by a specially provided press-fitting machine 30, of a type in itself known (Figure 6).

[0019] The printed circuit board 15 has a thickness T that is greater than the length L of the mechanical coupling portion 3 of the pin 1 and has two opposite faces 17 and 18 parallel to each other, on which the conductive tracks 19 are arranged, these being produced, for example, by lamination of a copper layer with subsequent definition via a spark erosion process. The printed circuit board 15 also has through-holes 20 (only one is visible in Figure 4 and to which reference will be made). The through-hole 20 is internally coated with a metallization layer 21, for example, electroplated copper. In the described embodiment, in particular, the metallization layer 21 is connected to a contact pad 23 on face 17 and to one of the tracks 19 on face 18. The clear width W of the through-hole 20 is less than the distance D between the outer edges 6a and 7a of the elastic elements 6 and 7.

[0020] When the mechanical coupling portion 3 is inserted in the through-hole 20 through face 17 of the printed circuit board 15 (in the direction indicated by arrow 25), the shape of the guide sections 6d and 7d causes the rotation of the free ends 6b and 7b of the elastic elements 6 and 7 towards each other and towards axis A (arrows 26 and 27). In this way, the contact sections 6c and 7c exert an elastic reaction against the walls of the through-hole 20. Furthermore, the hooking elements 9 and 10, which are turned outwards due to the rotation of the elastic elements 6 and 7, cut into the metallization layer 21 and remain embedded, obstructing the extraction of the mechanical coupling portion 3 from the through-hole 20. The mechanical coupling portion 3 ensures that the pin 1 is temporarily centred and locked to the printed circuit board 15 before further processing steps are performed.

[0021] Furthermore, given that the length L is less than the thickness T, the mechanical coupling portion 3 is completely contained between the faces 17 and 18 of the printed circuit board 15 and does not protrude from face 18. The grip offered by the mechanical coupling portion 3 is not sufficient to ensure correct functionality in use, because the contact with the walls of the through-hole 20 is only partially exploited. Nevertheless, the coupling is stable enough to enable transport of the printed circuit board 15 without significant risks of the pins coming out before final soldering.

[0022] The printed circuit board 15, with the pin 1 pressed in and temporarily retained in the through-hole 20, is then moved from the press-fitting machine 30 to an SMT soldering line 31, which comprises a depositing station 32 and an oven 33 (Figure 6). At the depositing station 32, particles of solder material are deposited on the printed circuit board 15 around the through-hole on the side of the pad 19 and where it is required for manufacturing the electronic device 16. It should be noted that SMT soldering is possible because the length L of the mechanical coupling portion 3 is such that no part of the pin 1 protrudes from face 18. The depositing step normally also provides for the removal of excess solder material by means of a doctor blade, which could not be used with normal protruding press-fit pins.

[0023] The printed circuit board 15 is then transferred to the oven 33 for fusion. The molten solder material penetrates into the through-hole 20 by capillarity, filling it and forming a solder meniscus on both the side with pad 19 and the side with pad 23. The electronic device 16, part of which is shown in Figure 5 (where the solder material and the meniscus are respectively indicated by reference numerals 28 and 29), is thus obtained.

[0024] In an alternative embodiment that is not shown, the soldering line is of the wave type. The solder material is thus transferred to the printed circuit board 15 by contact with a crest of a wave in the liquid state that laps the pad 19 and penetrates the metallized hole 20, filling it and creating the solder meniscuses on both sides of the printed circuit board 15.

[0025] The electronic device 16 can be used both as a simple connector and as a true processing board, if equipped with further analogue and/or digital components.

[0026] Since the contact pin 1 is fastened, albeit in a temporary manner, to printed circuit board 15 by the mechanical coupling portion 3, transfer from the press-fitting machine 30 to the soldering line 31 is not critical and the risk of altering the position of the contact pin 1 is reduced to acceptable limits. Therefore, press fitting may be carried out externally to the soldering line and the available machines may be exploited in a flexible manner to make a wide variety of printed circuit devices.

[0027] The invention therefore enables making high-quality soldered contacts (it should be noted that the entire mechanical coupling portion also accomplishes the function of electrical connection to the printed circuit board through the solder material), but without the costs of soldering lines with dedicated press-fitting machines.

[0028] Furthermore, the mechanical coupling portion of the contact pins may be made in a very simple manner, using ordinary and not special materials, and does not require complex mechanisms with critical details like press-fit pins. In particular, the open fork shaped enables exerting sufficient force for temporarily retaining the pins seated in the soldering position. The constructional simplicity results in a low number of production rejects and consequently in high output.

[0029] According to a different embodiment of the invention, shown in Figures 7 and 8, a solderable contact pin 100 for printed circuit boards comprises a terminal 102 with an output along an axis C at 90° with respect to the press-fitting axes A and B, a mechanical coupling portion 103 and a base 105.

[0030] The base 105, which in the described embodiment has a substantially quadrangular frame shape, defines a contact position for mounting the pin 100 on a printed circuit board (Figure 8).

[0031] The mechanical coupling portion 103 extends from the base 105 along axis A and comprises two elastic elements 106 and 107, which form a fork and are provided with respective hooking elements 109 and 110, substantially as already described with reference to Figures 1-5. In particular, the mechanical coupling portion 103 has a length L' that is less than the thickness of a printed circuit board on which the pin 1 is destined to be mounted (Figure 8).

[0032] A centering pin 104 protrudes from the base 105 along axis B, which is parallel to axis A of the mechanical coupling portion 103.

[0033] The terminal 102 extends from the base 105 transversally to axis A of the mechanical coupling portion 103, in particular along axis C, which is perpendicular to axis A.

[0034] In Figure 8, the pin 100 is mounted on a printed circuit board 115 to manufacture an electronic device 116.

[0035] The printed circuit board 115, which has a thickness T' greater than the length L' of the mechanical coupling portion 3 of pin 1, has a through-hole 120, provided with a metallization layer 121 and connected to a track 119 and a pad 123, and an auxiliary hole 120' that, in one embodiment, is devoid of metallization to avoid an excessive increase in the press-fit force.

The pin 100 is mounted with the mechanical coupling portion 103 inserted and soldered in the through-hole 120, with axis A perpendicular to the faces 117 and 118 of the printed circuit board 120, while the centering pin 104 is inserted in the auxiliary hole 120' without soldering. Optionally, the centering pin 104 can also be soldered. The soldering can be of the SMT or wave type in this case as well.

[0036] In the described embodiment, the terminal 102 is therefore substantially parallel to the faces of the printed circuit board 115.

[0037] Finally, it is clear that modification and changes can be made to the described contact pin and process without leaving the scope of the present invention, as defined in the appended claims.

Claims

1. A solderable contact pin for printed circuit boards, comprising a terminal (2; 102) and a mechanical coupling portion (3; 103), extending along an axis (A); wherein the mechanical coupling portion (3; 103) has a length (L; L') less than the thickness (T; T') of a printed circuit board (15) and comprises two elastic elements (6, 7; 106, 107), forming a fork along the axis (A) and provided with respective hooking elements (9, 10; 109, 110); and wherein the elastic elements (6, 7; 106, 107) are shaped so that, following the insertion of the mechanical coupling portion (3; 103) in an opening having a width (W) less than a maximum distance (D) between respective outer edges (6a, 7a) of the elastic elements (6, 7; 106, 107), respective free ends (6b, 7b) of the elastic elements (6, 7; 106, 107) are rotated towards each other and the hooking elements (9, 10; 109, 110) are turned outwards to prevent the extraction of the mechanical coupling portion (3; 103) from the opening.

2. A pin according to claim 1, wherein the elastic elements (6, 7; 106, 107) have respective contact sections (6c, 7c) and respective guide sections (6d, 7d), and wherein the guide sections (6d, 7d) are shaped so as to facilitate the rotation of the elastic elements (6, 7; 106, 107) towards each other following the introduction of the mechanical coupling portion (3; 103) in an opening having a width (W) less than the distance (D) between the outer edges (6a, 7a).

3. The pin according to claim 2, wherein the hooking elements (9, 10; 109, 110) are defined by sharp edges transverse to the outer edges (6a, 7a) of the elastic elements (6, 7; 106, 107) in the contact sections (6c, 7c), at the ends of the outer edges (6a, 7a) opposite to the free ends (6b, 7b).

4. The pin according to any of the preceding claims, wherein the mechanical coupling portion (3; 103) is connected to the terminal (2; 102) by a connecting portion (8) and the hooking elements (9, 10; 109, 110) are defined by respective outer edges (6a, 7a) and by respective edges of the connecting portion (8).

5. The pin according to claim 4, wherein the outer edges (6a, 7a) of the mechanical coupling portion (3; 103) and the respective edges of the connecting portion (8) form angles (α) of less than 135°, preferably between 45° and 90°.

6. The pin according to any of the preceding claims, wherein the free ends (6b, 7b) of the elastic elements (6, 7; 106, 107) are spaced from each other in absence of stress.

7. An electronic device comprising a printed circuit board (15; 115), having at least one hole (20; 120) and a contact pin (1; 100) according to any of the preceding claims.

8. A device according to claim 7, having the mechanical coupling portion (3; 103) soldered into the hole (20; 120).

9. The device according to claim 7 or 8, wherein the printed circuit board (15; 115) has a thickness (T; T') greater than the length (L; L') of the mechanical coupling portion (3; 103).

10. The device according to claim 9, wherein the mechanical coupling portion (3; 103) is completely contained between the opposite faces (17, 18; 117, 118) of the printed circuit board (15; 115).

11. The device according to claim 10, wherein the hole (20; 120) defines an opening having a width (W) less than the maximum distance (D) between the outer edges (6a, 7a) of the elastic elements (6, 7; 106, 107).

12. The device according to claim 10 or 11, wherein the hole (20; 120) is internally coated with a metallization layer (21; 121).

13. The device according to claim 12, wherein the metallization layer (21; 121) is cut into by the hooking elements (9, 10; 109, 110) of the mechanical coupling portion (3; 103).

14. A process of manufacturing an electronic device, comprising the steps of:

providing a contact pin (1; 100) having a terminal (2; 102) and a mechanical coupling portion (3; 103), extending along an axis (A); wherein the mechanical coupling portion (3; 103) comprises two elastic elements (6, 7; 106, 107), forming a fork along the axis (A) and provided with respective hooking elements (9, 10; 109, 110); and wherein the elastic elements (6, 7; 106, 107) are shaped so that, following the insertion of the mechanical coupling portion (3; 103) in an opening with a width (W) less than a maximum distance (D) between respective outer edges (6a, 7a) of the elastic elements (6, 7; 106, 107), respective free ends (6b, 7b) of the elastic elements (6, 7; 106, 107) are rotated towards each other and the hooking elements (9, 10; 109, 110) are turned outwards to prevent the extraction of the mechanical coupling portion (3; 103) from the opening;
providing a printed circuit board (15; 115), having at least one hole (20; 120) with a width (W) less than the maximum distance (D) between the respective outer edges (6a, 7a) of the elastic elements (6, 7; 106, 107), the length (L; L') of the mechanical coupling portion (3; 103) being less than the thickness (T; T') of the printed circuit board (5; 105);
press-fitting the mechanical coupling portion (3; 103) of the contact pin (1; 100) into the hole (20; 120); and
soldering the mechanical coupling portion (3; 103) of the contact pin (1; 100) in the hole (20; 120).

15. A process according to claim 14, comprising depositing a solder material (28) after the step of press-fitting and before the step of soldering.

FIG. 1

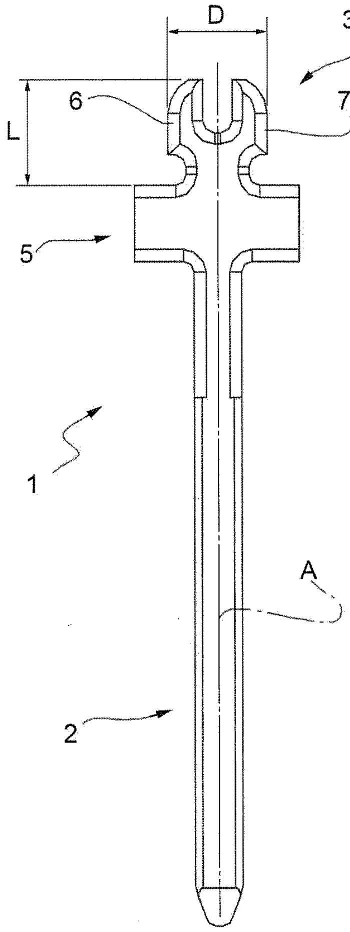


FIG. 2

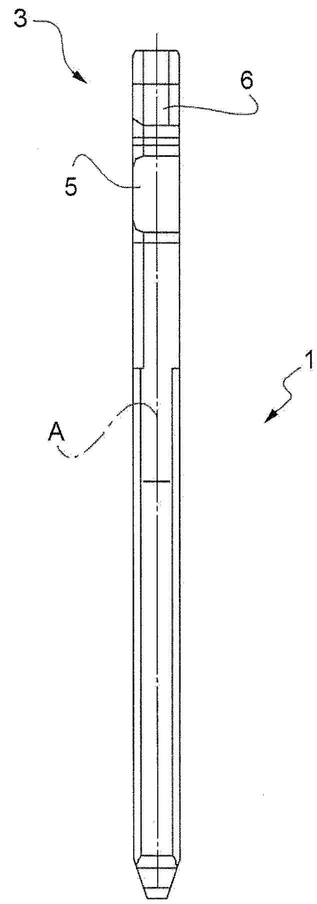


FIG. 3

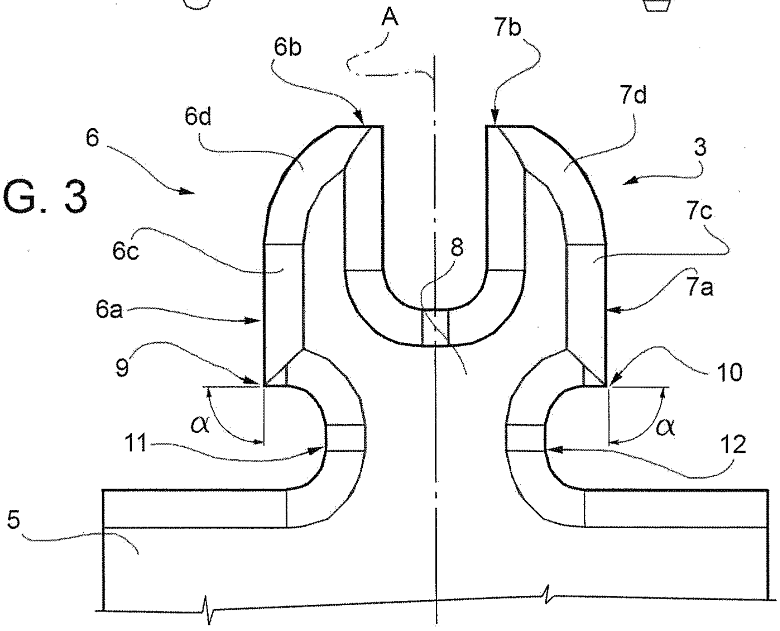


FIG. 4

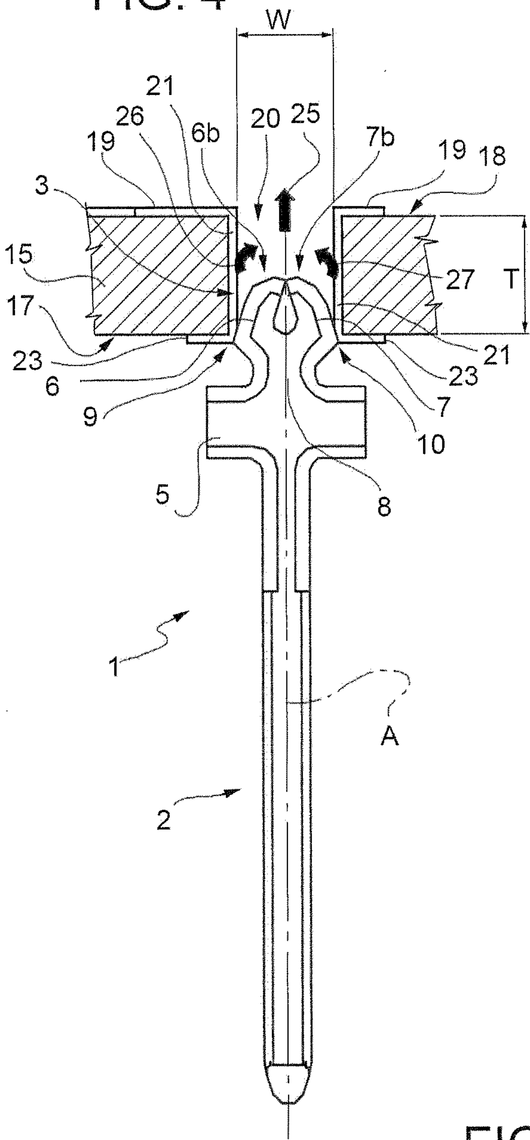


FIG. 5

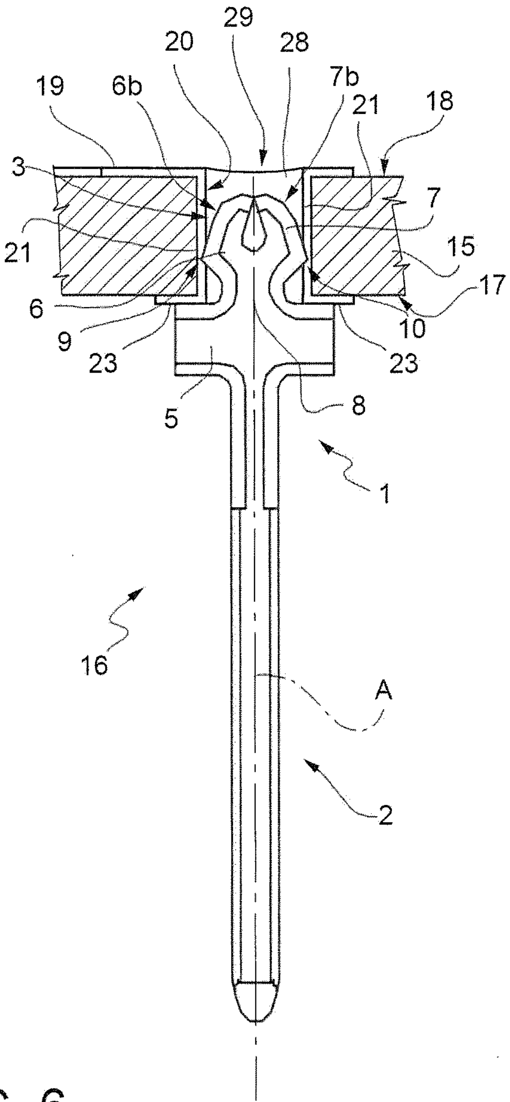


FIG. 6

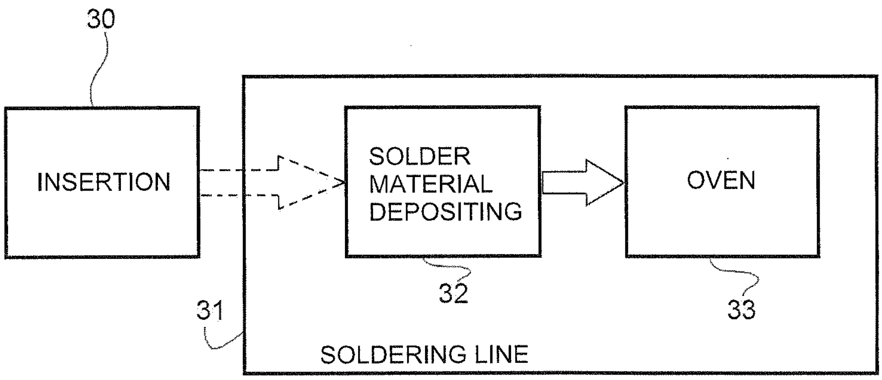


FIG. 7

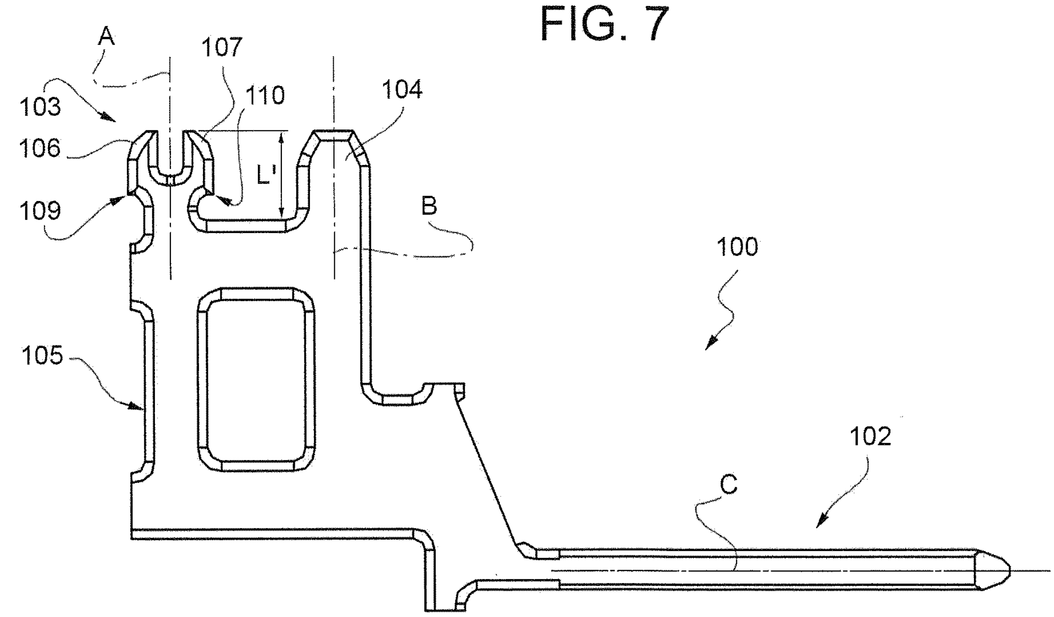
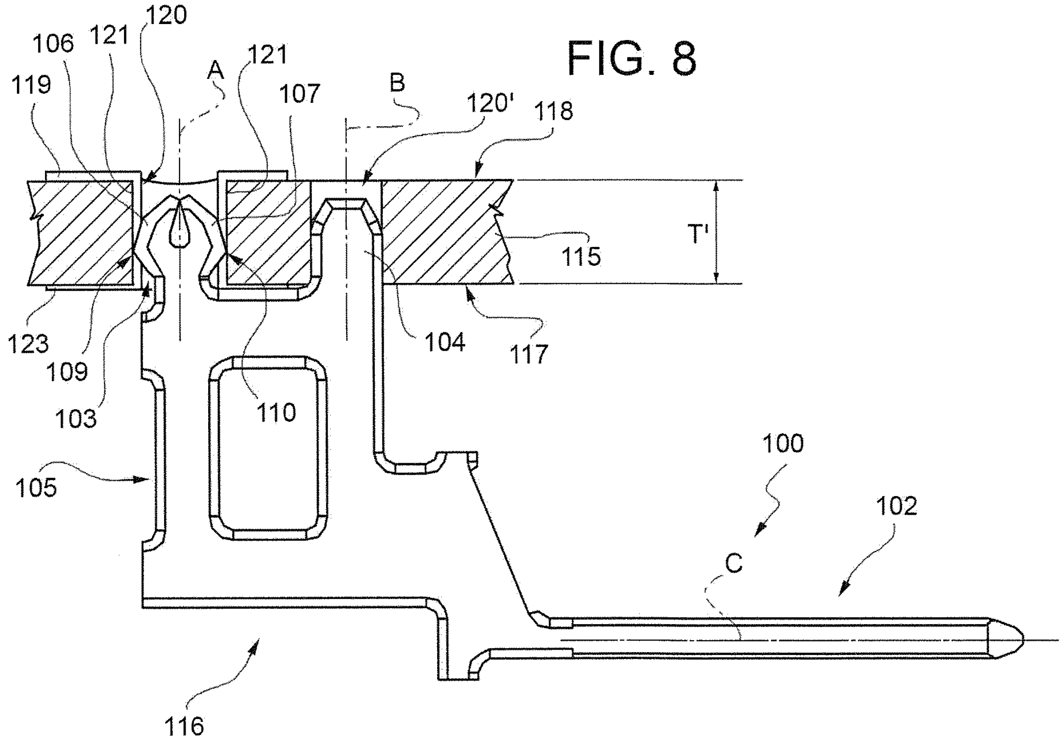

A
107
103
110
104
106
L'
109
B
100
105
102
C

FIG. 8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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 9794

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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X	US 3 428 934 A (REIDER GEORGE SYLVESTER JR ET AL) 18 February 1969 (1969-02-18) * column 2, line 27 - column 2, line 55 * * figures 1-5 *	1-15	
X	GB 2 121 620 A (OXLEY DEV CO LTD) 21 December 1983 (1983-12-21) * the whole document *	1-15	
A	US 2004/154907 A1 (BLOSSFELD MIKE [US] ET AL) 12 August 2004 (2004-08-12) * figures 7C,8C * * paragraph [0068] - paragraph [0068] *	1-15	TECHNICAL FIELDS SEARCHED (IPC): H01R H05K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2013	Pugliese, Sandro

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1

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14-03-2013

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