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(54) **Press-fit pin with unsymmetrical protrusions**

(57) The present invention relates to a press-fit pin (1) for, in particular, electrical plug-in connectors (15), comprising a plurality of protrusions (5a, 5b) protruding from the press-fit pin (1) in a direction essentially perpendicular to a height direction (L) of the press-fit pin, whereby the two protrusions (5a, 5b) that are located closest to each other are arranged on opposing sides (6a, 6b) of the press-fit pin. Further, the invention relates to an electrical connector (15) comprising a plurality of press-fit pins (1), the plurality of press-fit pins (1) comprising at least one pair of press-fit pins (1) mounted adjacent to and at a predetermined distance (s) from each other, each of the press-fit pins (1) of said pair comprising at least two protrusions (5a, 5b) sticking out from different sides (6a, 6b) of the respective press-fit pin (1). For providing a press-fit pin (1) which enables a further miniaturization of electrical elements, such as connectors (15), while at least maintaining the stability and capabilities in comparison with the prior art, the present invention provides that the protrusions (5a, 5b) of the pin (1) that are closest to each other are distanced from each other in the height direction (L), and that within the electrical connector (15) at the most one protrusion (5a, 5b) is arranged between the press-fit pins (1) of said pair at any given height of the press-fit pins (1).

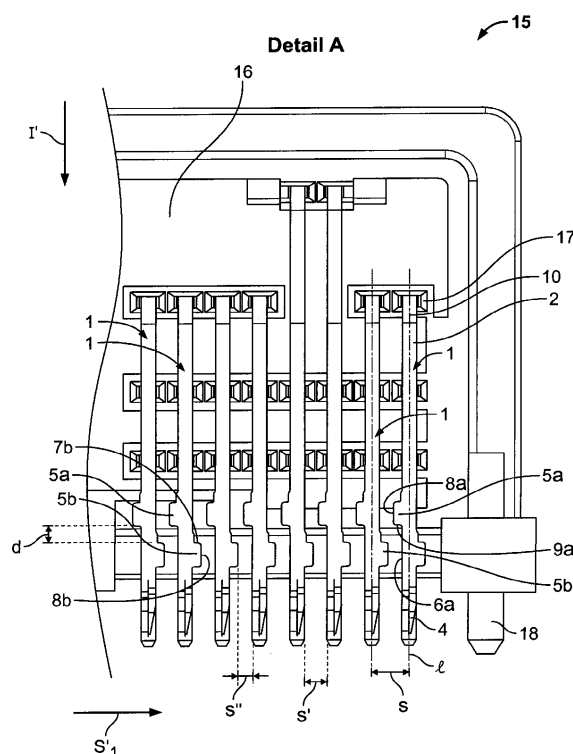


Fig. 3

Description

[0001] The present invention relates to a press-fit pin for, in particular, electrical plug-in connectors, comprising a plurality of protrusions protruding from the press-fit pin in a direction essentially perpendicular to a height direction of the press-fit pin, whereby the protrusions that are closest to each other are arranged on opposing sides of the press-fit pin.

[0002] Further, the present invention relates to an electrical connector comprising a plurality of press-fit pins, the plurality of press-fit pins comprising at least one pair of press-fit pins mounted adjacent to and at a predetermined distance from each other, each of the press-fit pins of said pair comprising at least two protrusions sticking out from different sides of the respective press-fit pin.

[0003] Press-fit pins are known and are pressed into printed circuit boards (PCB) for being used as a part of a plug-in connector for example. For pressing the press-fit pins into dies or sockets of the respective elements, a tool must exert high press-in forces on the pin. Therefore, the tools are often supported at so called press-in shoulders which protrude symmetrically from opposing sides of the press-fit pin. The press-in shoulders constitute pressing planes facing in the height direction of the pin for supporting the tool.

[0004] A press-fit pin according to the prior art is described in US-patent application US 200710010139 A1 for example. This press-fit pin includes a shoulder portion constituted by two protrusions symmetrically sticking out from opposite sides of the pin. Hence, the pin is significantly wider in the area of the protrusions than the rest of the pin-leg.

[0005] In an electrical connector, the distance, i.e. pitch, between the press-fit pins being used as plug contacts arranged in a row is usually 2.5 to 2.54 mm. This very small distance is reduced even further in areas where protrusions symmetrically sticking out from the sides of adjacent different pins are opposing each other. A further miniaturization of electrical elements such as the electrical connectors mentioned above is impossible because this would mean to reduce the distance between the pins and their protrusions which would then have too close geometries. These may lead to short circuits especially in cases of a presence of metallic particles. Moreover, due to the too close geometries of the pins it is difficult to reliably handle them with the press-in tools and design both the pins and the tools in a way that they will be stable enough and capable for industrial application.

[0006] In view of the disadvantages of the prior art mentioned above, an object underlying the invention is to provide a press-fit pin which enables a further miniaturization of electrical elements, such as connectors, while at least maintaining the stability and capabilities in comparison with the prior art.

[0007] This object is achieved according to the invention for the press-fit pin mentioned in the beginning of the introduction in that the protrusions that are closest to each

other are distanced from each other in the height direction.

[0008] For an electrical contact mentioned in the beginning of the description, the object is achieved according to the invention in that at the most one protrusion is arranged between the press-fit pins of said pair at any given height of the press-fit pins.

[0009] These simple solutions provide that the protrusions are unsymmetrical and do not overlap with another protrusion in a direction perpendicular to the height direction of the pin. Regarding a connector, the protrusions next to each other protruding from opposing sides of adjacent press-fit pins are spaced from each other in the height direction. In this way, the distance between the geometries or contours of adjacent pins with smaller distances has nearly the same proportion as between symmetrical contacts with bigger distances, i.e. pitches. In other words, according to the invention, while keeping the narrowest required distance between the pin-geometries, the overall pitch may be reduced. Hence, an advantage of the invention over the prior art is that any components and units comprising press-fit pins according to the invention may have smaller sizes and consequently help saving material and installation place. Above that, the present invention helps to lower the risk of short circuits between adjacent pins and thereby has lower requirements to cleanliness in view of (metallic) particles, compared to the prior art. Further advantages arising therefrom are a realisability of a compliant-contact-technology (press-fit-technology) for narrow pitches with at most the same requirements to tooling and processing as in the prior art. Tools for production and subsequent processing may be designed as same solid as for the existing processes.

[0010] The solution according to the invention can be combined as desired and further improved by the following, further embodiments that are advantageous on their own in each case.

[0011] According to a first possible further embodiment of the invention, at least one of the plurality of protrusions may comprise a pressing plane or surface of which the normal runs essentially parallel to a longitudinal direction of the press-fit pin or the height direction. A tool for exerting a press-in force to the pin may easily be supported at the pressing surface or the pressing surface may be used as a stop when inserting the pin into a socket.

[0012] According to another further possible configuration, at least one of the protrusions sticks out from a side of the press-fit pin. This enables to provide stable press-in-shoulders for example, of which the left and the right halves are placed in different heights on the respective sides of the pin and upon which the press-in force may be applied. The opposite sides of the shoulders may be designed in a similar way, with a distance to the shoulder on the other side of the contact and accordingly the shoulder of an adjacent contact.

[0013] According to another possible further embodiment the handling of a press-fit pin according to the in-

vention is facilitated when the pressing surface is substantially rectangular. Thereby, the area of the pressing surface may be maximized while minimizing the height of the protrusion with which it sticks out from the side of the pin. The outer edge of the substantially rectangular pressing surface sharply delimits the contour of the press-fit pin and facilitates to arrange a plurality of press-fit pins such that their contours interleave while keeping a desired minimal distance between adjacent pins in any height along their height direction.

[0014] According to another possible embodiment of the invention it is possible that a cross-sectional area of the press-fit pin at least in a region comprising one of the protrusions is of substantially rectangular shape. The cross-sectional area lies in a plane having a right angle to the longitudinal axis of the pin. It is also advantageous, when the cross-sectional area in a direction perpendicular to the height direction of the press-fit pin in the region of the protrusions is larger than the cross-sectional area in a region where no protrusion protrudes from one of the sides of the press-fit pin. Thereby, the stability of the press-fit pin in the region of the protrusion is increased in relation to other regions or portions of the pin which have a smaller cross-sectional area. When the protrusions are used as press-in-shoulders for example, it is possible to apply high press-in forces to the pin which has a high stability in the region of the shoulders due to the larger cross-sectional area.

[0015] According to another possible advantageous embodiment, the press-fit pin may be constituted of solid metal material. Thereby, the pin has a high stability and may take up higher forces than a pin having a hollow profile for example.

[0016] A press-fit pin according to the invention may be easily produced if the press-fit pin is stamped from plate material. However, the pin may also be produced from wire for example.

[0017] The invention will be described in more detail by way of example hereinafter using advantageous embodiments and with reference to the drawings. The described embodiments are only possible configurations in which the individual features may however, as described above, be implemented independently of each other or be omitted. Equal elements illustrated in the drawings are provided with equal reference signs. Redundant descriptions of equal elements within different drawings are left out.

In the drawings:

[0018]

Fig. 1 is a front view of a plurality of press-fit pins designed according to the invention which are arranged as a stamped strip of contacts,

Fig. 2 is a rear view of an electrical connector according to the invention comprising a plurality of

press-fit pins according to the invention,

Fig. 3 is an enlarged view of detail A of the connector shown in Fig. 2;

Fig. 4 is a perspective view of the electrical connector shown in Fig. 2,

Fig. 5 is a front view of a plurality of press-fit pins according to the prior art,

Fig. 6 is a rear view of an electrical connector comprising a plurality of press-fit pins according to the prior art.

Fig. 7 is an enlarged view of detail B of the connector shown in Fig. 6

[0019] The construction of a press-fit pin configured according to the invention will firstly be described in the following with reference to Fig. 1 which shows a front view of a plurality of press-fit pins 1. The press-fit pins 1 have a longitudinal body portion 2 running in a longitudinal direction or height direction L and having a longitudinal axis I as well as a width w. In the region of a lower tip 3 each pin 1 is provided with a press-in zone 4 constituting a press-in head to be inserted into openings in a counterpart e.g. press-in sockets or press-in holes for contacts on PCBs or the like. The press-in zone 4 is structured such that it provides a good hold of the pin 1 when the pin 1 is inserted into a respective socket, cavity, hole, opening or die.

[0020] For exerting a press-in force on the pins 1 or for other operations or functions, each pin 1 is provided with a pair of protrusions 5a and 5b. Each of the protrusions 5a and 5b protrudes from a respective side 6a and 6b of each pin 1. As the sides 6a, 6b are facing in opposite directions being substantially perpendicular to the longitudinal axis I of the pins 1, the protrusions 5a, 5b stick out from the respective sides 6a, 6b in opposite directions substantially perpendicular to the longitudinal axis I. By sticking out from the sides 6a, 6b, the protrusions 5a, 5b each form a shoulder element having an upper edge or corner. The shoulder elements constitute pressing surface 7a, 7b having a plane of which the normal at least partially runs parallel to the height direction L of each press-fit pin 1. The pressing planes 7a, 7b are facing in a direction opposite to an insertion direction I of the pins 1. Hence, the pressing surfaces 7a, 7b on the protrusions 5a, 5b facilitate to exert a press-in force on the pins 1 with the help of a press-in tool (not shown).

[0021] In the embodiment of the pins 1 shown in Fig. 1, the protrusions 5a, 5b have a rectangular shape with a height h in a direction perpendicular to the longitudinal axis I. The height h adds to the width w of the pin. Sides 8a, 8b of the respective protrusions 5a, 5b are running substantially parallel to the longitudinal axis I of the pins 1 like the sides 6a, 6b of the body portion 2 of each pin

1. As the protrusions 5a, 5b stick out from the sides 6a, 6b and have a rectangular shape, the protrusions 5a, 5b each constitute an additional shoulder element having a pressing surface 9a, 9b at a respective lower edge or corner of the protrusions 5a, 5b. The additional pressing surfaces 9a, 9b at least partially form a plane of which the normal also runs substantially parallel to the height direction L.

[0022] In the present invention it is an essential feature that the protrusions 5a, 5b which may be regarded as shoulders are spaced in the height direction L such that they have a certain distance d. Thereby, the protrusions 5a, 5b are offset or displaced along the opposing sides 6a, 6b of the pins, such that they are arranged at different heights of the height direction L which is always parallel to the longitudinal axis I in the present case. Hence, the protrusions 5a, 5b are asymmetrically in respect to the longitudinal axis I. As will be discussed in greater detail below, the asymmetrical arrangement of the protrusions 5a, 5b enables to arrange a plurality of press-fit pins 1 in a connector in such a way that the protrusions 5a, 5b of different pins 1 do not oppose each other in a direction perpendicular to the height direction L. The protrusions 5a, 5b are out of their way such that they may be regarded as interleaved for keeping a desired distance between their sides 8a, 8b and pressing planes 7a, 7b and 9a, 9b in any case according to the embodiment of the pins shown in Fig. 1.

[0023] Further, according to the embodiment of the pins 1 shown in Fig. 1, the body portion 2 of the pins 1 may be provided with one or more bending zones 10. In the area of the bending zone 10, the pins 1 may be bent such that they have a 90° kink for example. The pins 1 are provided with a punched out contact strip 11 as in the present embodiment, the pins 1 are stamped contacts made from strip or plate material. The contact strip 11 may advantageously be used as a carrier strip or holding member for feeding a plurality of press-fit pins 1 into a processing machine. The contact strip 11 can be removed before, during or after processing the press-fit pins 1. Alternatively, the pins may also be formed from wire material for example. The protrusions 5a, 5b may also be welded or soldered to the pins 1 or may be formed as several bends or by compressing the pins in the height direction L.

[0024] Above the contact strip 11, the pins 1 are provided with a retaining element 12. The retaining element 12 helps to securely fix the pins 1 to a connector, a housing, or similar elements or may be used as another press-in shoulder for example. The retaining element 12 is constituted by lance like edges symmetrically protruding from the sides 6a, 6b of the pins 1 and is much smaller than the protrusions 5a, 5b. Hence, the retaining element 12 is not of particular interest. Between the retaining element 12 and a sharpened upper tip 13, the pins 1 are provided with a contact zone 14. The contact zone 14 and the upper tip 13 constitute a pin contact when the press-fit pin 1 is inserted into an electrical connector.

[0025] Fig. 2 shows a rear view of an electrical connector 15 comprising a plurality of press-fit pins 1 according to the present invention. The pins 1 are similar to the press-fit pins 1 described above. The electrical connector 15 has a housing 16 which is provided with a plurality of cavities 17 in the form of sockets for accommodating a press-fit pin 1 each.

[0026] Fig. 3 is an enlarged view of the detail A of the electrical connector 15 shown in Fig. 2. The press-fit pins 1 are bent in the area of their bending zones 10 with a square angle. In an end position of the pins 1 shown in Fig. 3 an upper portion of the pins 1 reaching from their upper tip 13 to their retaining element 12 is fully inserted into a respective cavity 17. A lower portion of the pin from the bending zone 10 down to the press-in zone 4 has an insertion direction I and runs parallel to an insertion direction I' of the connector 15.

[0027] The connector 15 is provided with retaining taps 18. The retaining taps 18 and the press-in zones 4 of the pins 1 are protruding from the connector 15 in the insertion directions I, I'.

[0028] Hence, the connector 15 together with the pins 1 may be pressed into a PCB having respective cavities or press-in sockets for example, by carrying out a single press-in operation.

[0029] In a first spacing direction S_1 , centers of the cavities 17 are spaced with a distance s. Commonly, there is an equal spacing, i.e. distance s, between the centers of the cavities 17. In case of an equal spacing, the distance s may be regarded as a common pitch of the cavities 17 and therefore also of pins 1 within the electrical connector 16. The sides 6a, 6b of adjacent, i.e. neighboring pins 1 facing each other have a maximal distance s' being the distance s less the width w of the pins 1. A minimal distance s'' between opposing surfaces of the sides 6a, 6b and 8a, 8b of two adjacent or neighboring pins 1 is the distance s' between their respective sides 6a, 6b less the height h of the protrusions 5a, 5b protruding from the respective opposing sides 6a, 6b belonging to adjacent pins.

[0030] As the protrusions 5a, 5b of each pin 1 are spaced with the distance d in a direction parallel to the longitudinal axis I of the pins, the minimal distance s'' between the sides 6a, 6b of adjacent pins 1 is always kept. In other words, the asymmetrical arrangement of the protrusions 5a, 5b help to interleave the protrusions 5a, 5b on opposing sides 6a, 6b of neighboring pins 1 such that the outer contours of the pins are matched in order to keep a certain distance, i.e. the minimal distance s''. Sides 8a, 8b of protrusions 5a, 5b and sides 6a, 6b of the body portions 2 of the pin are always kept at the minimal distance s'', while the distance between opposing protrusions 5a, 5b or their opposing upper and lower shoulder elements 9a, 9b are spaced by the distance d between the protrusions 5a, 5b.

[0031] Fig. 4 shows a perspective view of the connector 15 shown in Fig. 2. In Fig. 3 it becomes obvious that press-fit pins 1 are not only aligned in a row in the first

spacing direction S_1 but also in another row in a second spacing direction S_2 . The protrusions 5a, 5b protrude from the press-fit pins 1 in parallel to the first spacing direction S_1 . Any protrusions protruding from the pins 1 in the second spacing direction S_2 could also be displaced along the height direction L of the pins such that a minimal distance s'' between the pins 1 is always kept.

[0032] Fig. 5 shows a plurality of press-fit pins 21 according to the prior art. The pins 21 have a body portion 22. Protrusions 25a, 25b are protruding from opposite sides 26a, 26b of the body portion 22. The protrusions 25a, 25b also have a height h in a direction perpendicular to a longitudinal axis I of the pins 21 and adding to their width w. The height h of the protrusions 25a, 25b of the pins 21 according to the prior art is similar to the height h of the protrusions 5a, 5b of the pins 1 according to the present invention.

[0033] Fig. 6 shows a rear view of an electrical connector 35 according to the prior art comprising a plurality of press-fit pins 21 according to the prior art. The pins 21 are similar to the press-fit pins 21 described above in relation to Fig. 5. The electrical connector 35 has a housing 36 which is provided with a plurality of cavities 37 for accommodating the pins 21. In an end position of the pins 21 shown in Fig. 6, an upper portion of the pins 21 is fully inserted into a respective cavity 37.

[0034] Fig. 7 is an enlarged detail B of the connector 35 according to the prior art illustrated in Fig. 6. As the protrusions 25a, 25b protruding from opposing sides 26a, 26b of neighboring pins 21 according to the prior art are not offset, i.e. distanced along the height direction L of the pins 21, the protrusions 25a, 25b are arranged symmetrically in respect to the longitudinal axis I. Hence, in the end position of the pins 21 according to the prior art shown in Fig. 7, a minimal distance s''' between the protrusions 25a, 25b in the spacing direction S_1 is smaller than the minimal distance s'' according to the present invention. This is because according to the prior art the distance s''' is the distance s between the centers of the cavities 37 less the width w of the pins and less two times the height h of the protrusions 25a, 25b. Hence, according to the prior art, a minimal achievable distance s'_{min} , i.e. a minimal pitch, between the centers of the sockets 37 is larger than the minimal achievable distance s_{min} according to the present invention. Consequently, asymmetrically arranged protrusions 5a, 5b according to the present invention have a decisive advantage over the symmetrically arranged protrusions 25a, 25b according to the prior art because the invention allows a smaller minimal distance, i.e. pitch, between the cavities 37 of a connector and therefore a larger density of the pins 1 inserted therein. This enables a further miniaturization of electrical components such as connectors.

[0035] Deviations from the above-described embodiments are possible within the inventive idea. The protrusions 5a, 5b could e.g. have a triangular or any other shape. In case it is desired that the protrusions 5a, 5b form shoulder elements having pressing surfaces 7a, 7b

in order to be utilized as press-in shoulders, the protrusions 5a, 5b should have an upper surface, edge or corner. However, the protrusions 5a, 5b could also have different shapes and may be used for another functionality, e.g. as stitch-shoulders and other contact-features that are wider than the very functional areas such as mating and PCB-connection areas because the application of the press-fit pins 1 is not limited to electrical connectors. The present invention may be used wherever at minimum two first objects or pins 1 are to be inserted parallel to each other and with a relatively narrow distance between each other into a second object which may be an electrical connector 15 as described herein.

[0036] The first objects needing thereby a minimum of support in the insertion direction I and possibly a guiding along the insertion direction I. Hence, the sides 8a, 8b of the protrusions 5a, 5b do not have to be running parallel to the longitudinal axis I of the pin. The sides 8a, 8b may serve as lateral guiding surfaces which may be beveled such that they help to guide and center the pin 1 within a respective hole or cavity.

Claims

1. Press-fit pin (1) for, in particular, electrical plug-in connectors (15), comprising a plurality of protrusions (5a, 5b) protruding from the press-fit pin (1) in a direction essentially perpendicular to a height direction (L) of the press-fit pin, whereby the two protrusions (5a, 5b) that are located closest to each other are arranged on opposing sides (6a, 6b) of the press-fit pin **characterized in that** the protrusions (5a, 5b) that are closest to each other are distanced from each other in the height direction (L).
2. Press-fit pin (1) according to claim 1, **characterized in that** at least one of the plurality of protrusions (5a, 5b) comprises a pressing surface (7a, 7b, 9a, 9b) of which the normal runs essentially parallel to the height direction (L).
3. Press-fit pin (1) according to any one of claims 1 or 2, **characterized in that** at least one of the protrusions (5a, 5b) sticks out from the side (6a, 6b) of the press-fit pin (1).
4. Press-fit pin (1) according to claims 2 or 3, **characterized in that** the pressing surface (7a, 7b, 9a, 9b) is substantially rectangular.
5. Press-fit pin according to any one of claims 1 to 3, **characterized in that** a cross-sectional area of the press-fit pin (1) at least in a region comprising one of the protrusions (5a, 5b) is of substantially rectangular shape.
6. Press-fit pin (1) according to any one of claims 1 to

5, **characterized in that** a cross-sectional area of the press-fit pin (1) in a region of the protrusions (5a, 5b) is larger than the cross-sectional area in a region where no protrusion (5a, 5b) protrudes from one of the sides (6a, 6b) of the press-fit pin (1).

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7. Press-fit pin (1) according to any one of claims 1 to 6, **characterized in that** the press-fit pin (1) is constituted of solid metal material.

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8. Press-fit pin (1) according to any one of claims 1 to 7, **characterized in that** the press-fit pin (1) is stamped from plate material.

9. Electrical connector (15) comprising a plurality of press-fit pins (1), the plurality of press-fit pins (1) comprising at least one pair of press-fit pins (1) mounted adjacent to and at a predetermined distance (s) from each other, each of the press-fit pins (1) of said pair comprising at least two protrusions (5a, 5b) sticking out from different sides (6a, 6b) of the respective press-fit pin (1), **characterized in that** at the most one protrusion (5a, 5b) is arranged between the press-fit pins (1) of said pair at any given height of the press-fit pins (1).

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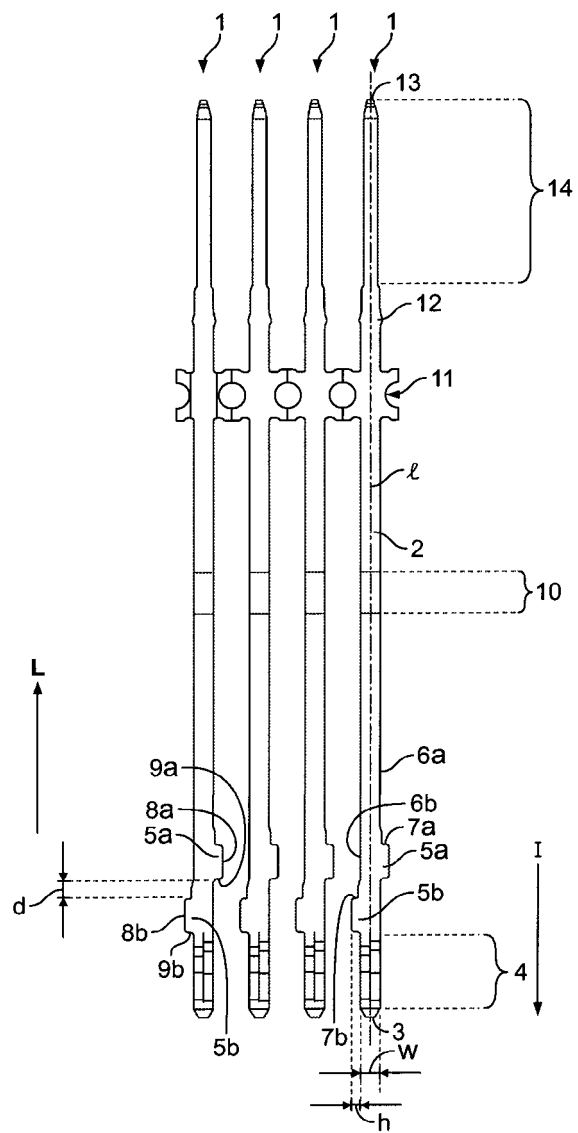


Fig. 1

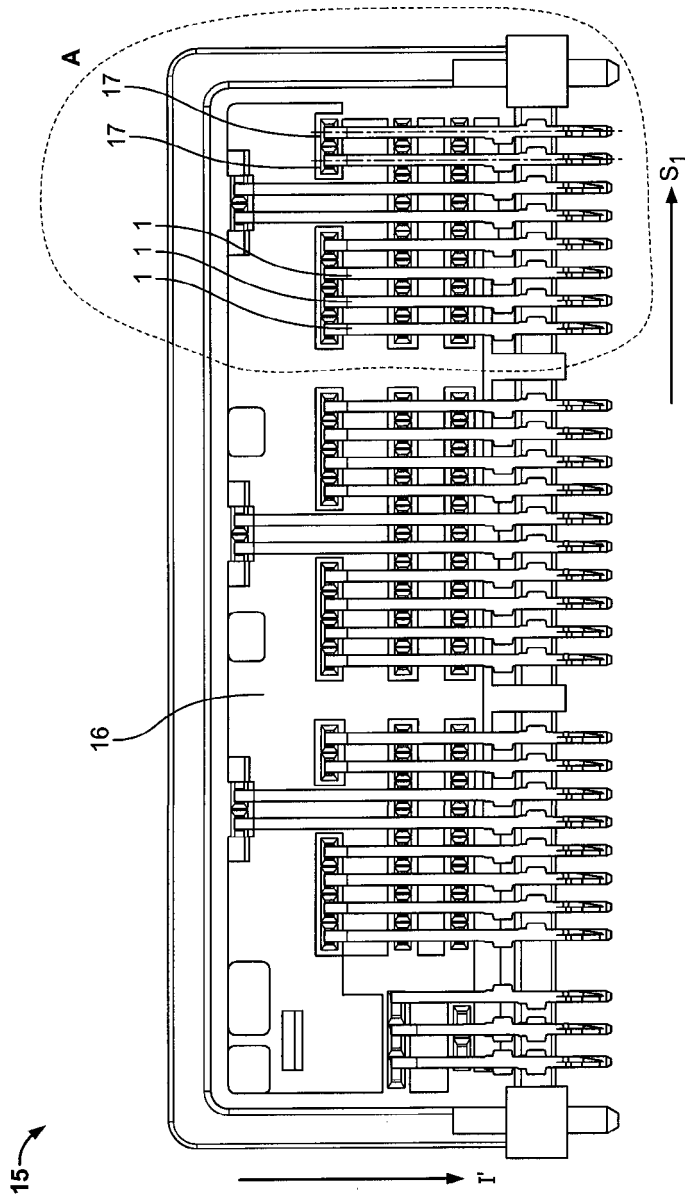


Fig. 2

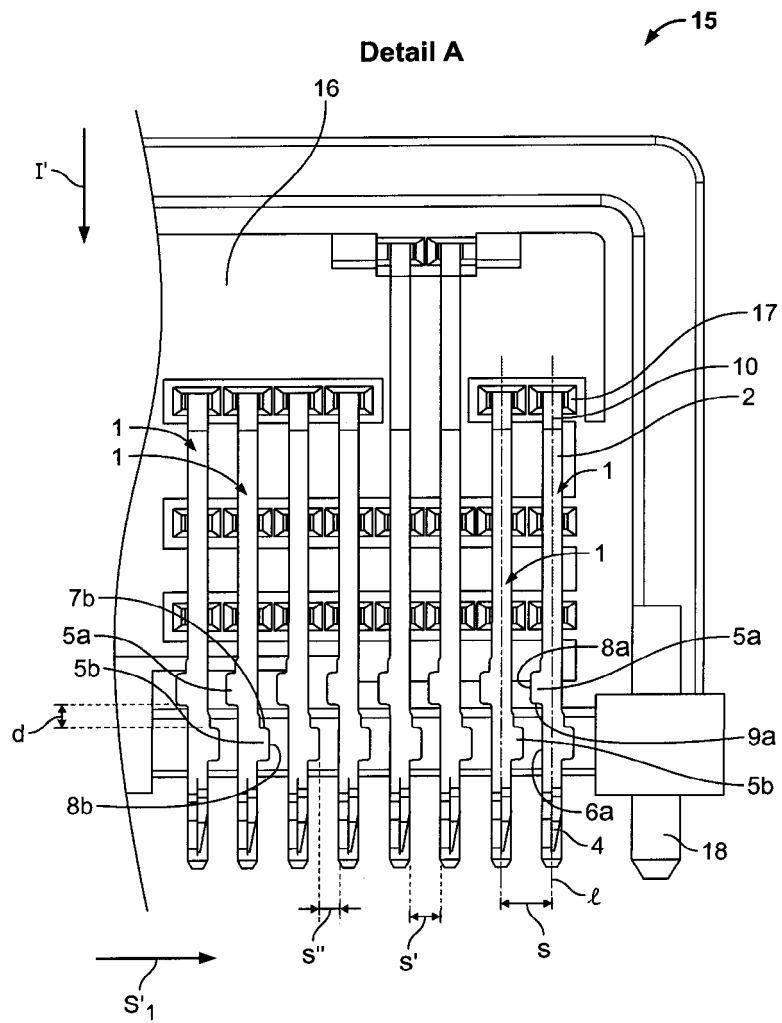


Fig. 3

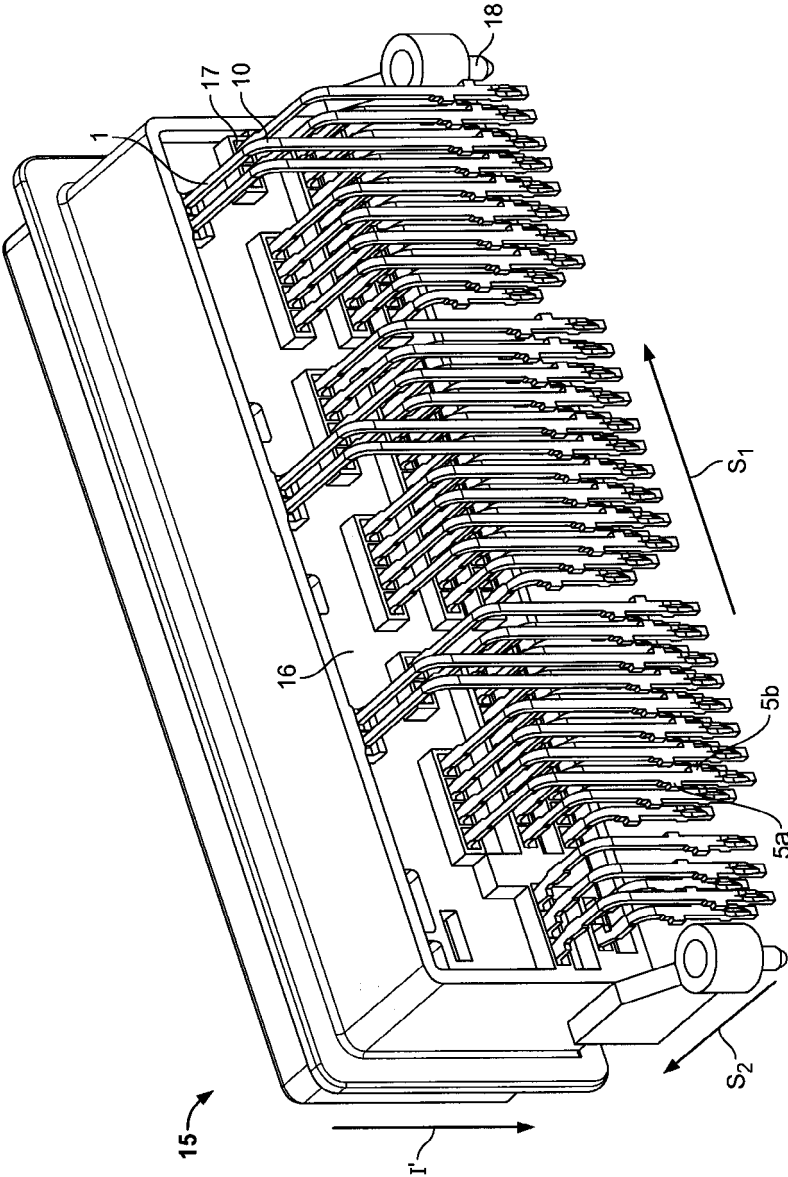


FIG. 4

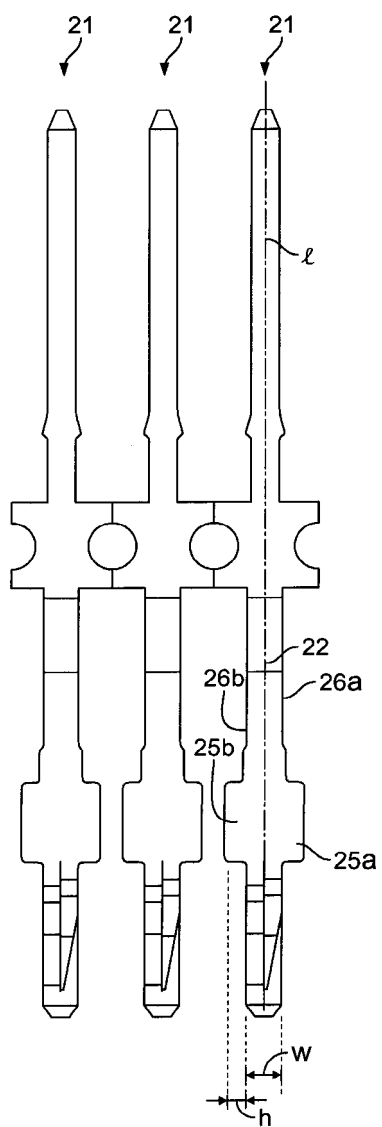


Fig. 5
(Prior Art)

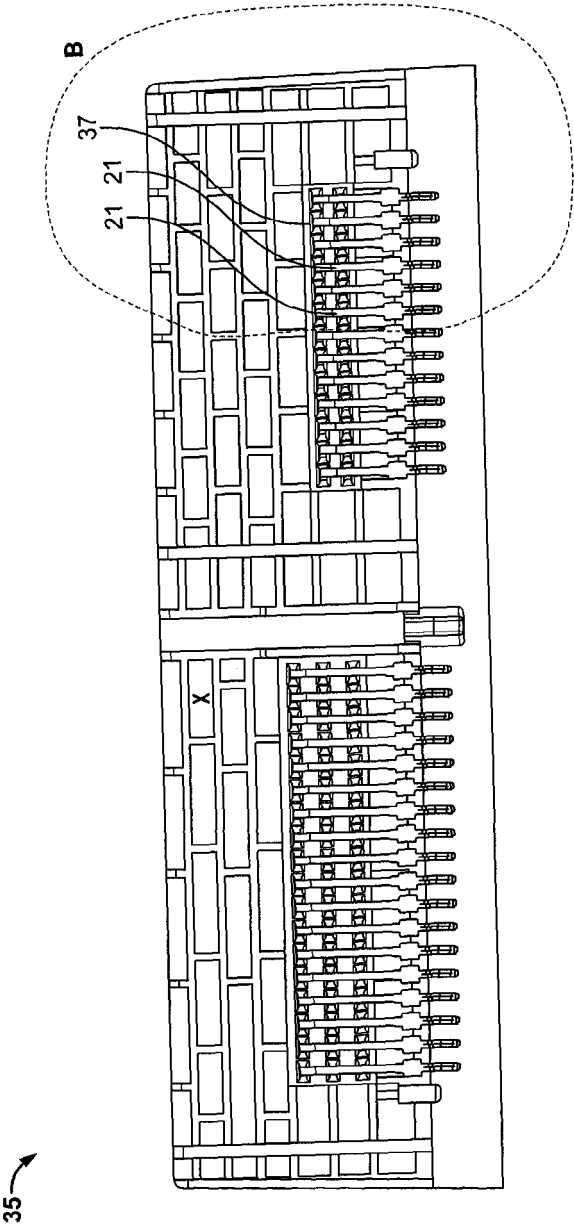


Fig. 6
(Prior Art)

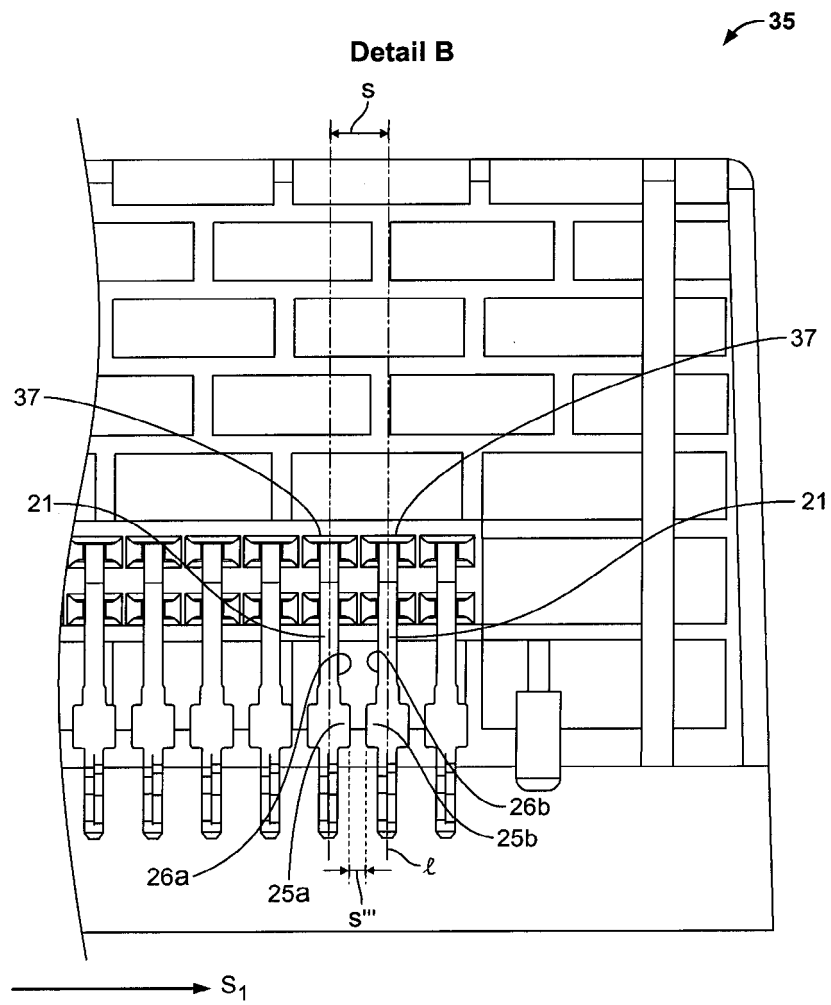


Fig. 7
(Prior Art)



EUROPEAN SEARCH REPORT

Application Number
EP 08 01 8735

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 0 271 357 A (NIPPON ELECTRIC CO [JP]) 15 June 1988 (1988-06-15) * column 1, lines 42-49 - column 2, lines 5-13; figures 6,7 *	1-9	INV. H01R12/32
D,A	US 2007/010139 A1 (CHEN PING [US]) 11 January 2007 (2007-01-11)	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 30 March 2009	Examiner Corrales, Daniel
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EPO FORM 1503 03.82 (P04C01)

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

EP 08 01 8735

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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30-03-2009

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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