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(54) **MODULAR ELECTRICAL CONNECTOR**

MODULARER ELEKTRISCHER STECKVERBINDER

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Description

[0001] The present invention relates to an electrical plug-element comprising at least one socket module with a receptacle for a mating plug-element, the receptacle opens towards a plug-direction of the plug-element, is formed between at least two wall sections of the socket module which extend essentially in parallel to a length direction of the plug-element, and accommodates at least one contact support area which extends along the length direction and at least partially faces into the plug-direction, wherein the receptacle of the socket module is laterally open through at least two recesses each extending along a width direction of the socket module between the at least two wall sections, the width direction extending perpendicularly to the length direction and the plug-direction, wherein the at least one contact support area is located at a bottom portion of the receptacle, the bottom portion faces into the plug-direction, and wherein the recesses extend down to the bottom portion and/or essentially along a distance measured in parallel to the width direction between the wall sections.

[0002] Plug-elements and methods for equipping substrates in electrical devices, e.g. printed circuit boards (PCB), with plug-elements are well-known from the prior art. The plug-elements normally comprise housings which are made of molded plastic material and are provided with means for mounting the plug-elements to the substrate. As an example for a connector series comprising plug-elements according to the prior art, the applicant offers the Micro Quad-lock System (MQS).

[0003] Document US 2010/0216340 A1 describes an electrical connector including an insulative housing, a shielding shell surrounding the housing, a mounting module and a set of contacts retained to the housing.

[0004] The housing, the electrical contact arrangement within the housing and any means for mounting the housing are usually adapted according to certain customer demands.

[0005] The plug-element and any electrical contacts therein may be mounted to the substrate by e.g. through-hole technology (THT) or surface mount technology (SMT). Hence, numerous designs of the plug-elements and approaches for their mounting have to be developed by the manufacturers of the plug-elements. The design procedure, development, and manufacturing of the plug-elements may, however, be cumbersome and inefficient in case only small quantities of a certain plug-element are demanded.

[0006] In view of these disadvantages of the prior art, an object underlying the invention is to provide a plug-element which may cover the market needs and embrace as much as possible new opportunities and demands arising in the market.

[0007] This object is achieved according to the invention for the electrical plug-element mentioned in the beginning of the description by at least two mounting modules each having a holding section attached to a lateral

side of the socket module, the lateral side extending essentially in parallel to the plug-direction, and a mounting section provided with a mounting organ adapted to be fastened to a substrate, wherein the mounting modules at least partially close the recesses. This solution provides that the electrical plug-element may be formed of at least one socket module and at least two mounting modules according to customer demands on the contact arrangement and mounting technology of the plug-element. The receptacle is laterally open as if some of its side walls are missing. The missing side walls may be replaced by the mounting module or any other modular element according to certain demands. This helps in making the socket module even more versatile. In other words, the socket module and the mounting module may be combined such that a certain customer's demands on the plug-element are met, yet the modules themselves may be produced in large numbers as they are interchangeable. The receptacle may be extended at the recess according to certain demands. Hence, in the area of the recess, the material constituting the socket module may be saved.

[0008] The present invention provides a modular system for electrical connectors and the plug-elements comprised thereof. Within this modular system, numerous socket modules and mounting modules may be provided. The socket modules may comprise modules of different sizes and different contact arrangements. The wall sections of the socket modules may provide guiding organs, coding organs, and latching or locking organs for a mating plug-element. Different mounting modules may be provided which mounting organs which may comprise mounting elements in the form of a pin, a latch, a hook, a catch, a lug, or a clamp in order to enable a desired way of mounting the plug-element without the need of adapting the socket modules. The lateral sides may be any wall sections, side walls and lateral edges of the mounting module.

[0009] Thus, the socket modules and the mounting modules according to the present invention may be individually adapted to the market needs and the specific customer demands without the need of redesigning an entire plug-element. Consequently, the present invention helps to minimize design and manufacturing costs and provides a versatile system of plug-elements.

[0010] The solutions according to the invention can be combined as desired and further improved by the following further embodiments that are advantages on their own in each case:

According to the invention, closing the recess of the module is easily achieved in that the holding section of the mounting module comprises a wall portion which at least partially closes the recess of the socket module. The mounting module thereby fulfills a double function in that it closes the recess and provides mounting facilities. By closing the recess, the mounting module forms a part of the receptacle.

[0011] According to another possible embodiment, a lateral edge of each of the wall sections and/or of a base of the socket module may be provided with at least one fixing element for affixing each of the mounting modules at the socket module. These fixing elements may be standardized such that numerous different mounting modules may be attached to the socket module. The mounting module may be attachable to the socket module without any further auxiliary parts necessary. In turn, the holding section of the mounting module may be provided with at least one counter-fixing element interacting with the at least one fixing element. Thereby, the mounting module may be rigidly and securely attached to the socket module. The mounting module may be provided with at least two mounting organs protruding from the mounting module in at least two different mounting angles of the socket module with respect to the substrate. The plug-element may thereby be mounted in different angles with respect to the substrate without the need of exchanging the socket module or the mounting module. Hence, the socket modules and the mounting modules may be produced in high numbers without the need of providing different modules for different mounting angles.

[0012] According to another possible embodiment of the plug-element according to the invention, a thickness of the holding section of the mounting module may be below 0.5 millimeter. Hence, the other dimensions of the plug-element may be held rather small. This facilitates miniaturization of electrical devices comprising the plug-element.

[0013] Versatility and durability of the plug-element according to the present invention may be further improved in that the socket module may be formed of plastic material. The socket module may be a plastic molded part whereas the mounting modules are made of stamped sheet material. Thereby, the socket module may be lightweight and can consist of electrically insulating material. The metal sheet material forming the mounting module may provide high stability and resiliency.

[0014] According to another possible embodiment, the at least one contact support area may comprise at least one row of contact supports, the at least one row of contact supports may run longitudinally essentially in parallel to the length direction. Hence, the socket modules may be selected according to a desired length of a required number of rows of contact supports.

[0015] Socket modules of different length may be laterally terminated by mounting modules of the same type and may be designed according to a certain wire range and pitch. A standard pitch, i.e. a distance between several contact supports arranged in rows or several rows forming a grid, may be 2.54 mm x 2.54 mm for wire ranges with cross sections from 0.22 to 0.5 mm². A plug-element comprising two rows of contacts supports with three contact supports each, i.e. overall 6 contact supports, could cover an area of approximately 968 mm² which is a standard size of the micro quad lock system.

[0016] The present invention facilitates to miniaturize

known plug-elements in that a pitch of 1.8 x 1.8 mm may be selected for wire ranges with cross sections from 0.13 to 0.35 mm². Hence, an area covered by the plug-element could be approximately 548 mm² which enables a reduction of the area covered by the plug-element in comparison to the 2.54 x 2.54 mm pitch of approximately -44 %. A further degree of miniaturization may be realized with the plug-element according to the invention in that a pitch of 1.8 x 1.6 mm for a wire range with cross-sections of 0.13 to 0.22 mm² is selected. This could lead to an area covered by the plug-element of 513 mm² which would enable to reduce the area covered by the plug-element in comparison with a plug-element of 2.54 x 2.54 mm pitch by approximately -47%.

[0017] The socket module may be selected amongst a plurality of different socket module types according to a desired number and arrangement of electrical contacts to be accommodated in the plug-element, and the mounting module may be selected amongst a plurality of different types of mounting modules according to a desired way of mounting the plug-element to the substrate. Different types of socket modules and mounting modules may be interchangeably combined. Thus, the different socket module types and mounting module types may constitute a versatile modular system for customizing plug-elements.

[0018] The invention will be described in more detail by way of example hereinafter using advantageous embodiments and with reference to the accompanying drawings. The described embodiments are only possible configurations. Corresponding elements illustrated in the drawings are provided with the same reference signs. Parts of the description relating to the same elements illustrated in different drawings are omitted.

[0019] In the drawings:

Fig. 1 is a schematic perspective view of a plug-element according to an embodiment of the present invention;

Fig. 2 is another schematic perspective view of the plug-element shown in Fig. 1;

Fig. 3 is a schematic back view of a socket module according to an embodiment of the present invention;

Fig. 4 is a schematic side view of the socket module shown in Fig. 3;

Fig. 5 is a schematic front view of the socket module shown in Fig. 3 and 4;

Fig. 6 is a schematic perspective view of a plug-element according to another embodiment of the present invention;

Fig. 7 is another schematic perspective view of the plug-element shown in Fig. 6;

Fig. 8 is a schematic back view of a socket module according to another embodiment of the present invention;

Fig. 9 is a schematic side view of the socket module shown in Fig. 8;

Fig. 10 is a schematic front view of the socket module shown in Figs. 8 and 9;

Fig. 11 is a schematic side view of a mounting module according to another embodiment of the present invention;

Fig. 12 is a schematic front view of the mounting module shown in Fig. 11;

Fig. 13 is a schematic front view of a mounting module according to another embodiment of the present invention;

Fig. 14 is a schematic front view of a mounting module according to another embodiment of the present invention;

Fig. 15 is a schematic front view of a mounting module according to another embodiment of the present invention;

Fig. 16 is a schematic front view of a mounting organ of a mounting module according to an embodiment of the present invention;

Fig. 17 is a cross-sectional view of the mounting organ shown in Fig. 16 along the cross-sectional line A-A illustrated therein;

Fig. 18 shows a mounting organ of a mounting module according to an embodiment of the present invention;

Fig. 19 is a schematic cross-sectional view of the mounting organ shown in Fig. 18 along the cross-sectional line B-B illustrated therein;

Fig. 20 is a schematic front view of a mounting organ of a mounting module according to another embodiment of the present invention;

Fig. 21 is a schematic side view of the mounting organ shown in Fig. 20;

Fig. 22 is a schematic perspective view of a socket module and a mounting module arranged to be affixed to the socket module;

Fig. 23 is a schematic perspective view of a detail of the socket module and the mounting module shown in Fig. 22 as they are assembled;

Fig. 24 is another schematic perspective view of a detail of the socket module and the mounting module shown in Figs. 22 and 23, the mounting module and the socket module being joined together;

Fig. 25 is a schematic side view of the socket module and the mounting module shown in Figs. 22 to 24;

Fig. 26 is a schematic perspective view of a plug-element in a 90°-mounting position;

Fig. 27 is a schematic perspective view of the plug-element shown in Fig. 26 in a 180°-mounting position;

Fig. 28 is a schematic front view of a mounting module;

Fig. 29 is a schematic side view of a mounting module shown in Fig. 28;

Fig. 30 is a schematic front view of several mounting modules shown in Fig. 28 and 29 joined together such that they are packaged on a reel;

Fig. 31 is a schematic perspective view of a plug-

element;

Fig. 32 is another schematic perspective view of the plug-element shown in Fig. 31;

Fig. 33 is a schematic perspective view of a plug-element according to another embodiment of the present invention;

Fig. 34 is another schematic perspective view of the plug-element shown in Fig. 33;

Fig. 35 a cross-sectional side view of the plug-element shown in Figs. 33 and 34;

Fig. 36 is a schematic perspective view of the plug-element shown in Figs. 33 to 35 mounted to a substrate.

[0020] It is to be noted that the embodiments shown in Figs. 22 to 29 do not form part of the invention. As shown in Fig. 1, a plug-element 1a according to the present invention may comprise a socket module 2a and two mounting modules 3a.

[0021] The socket module 2a has two wall sections 4, 4' which run essentially in parallel with a plug-direction Z and a length direction X of the plug-element 1a. The wall sections 4, 4' are distanced from each other in a width direction Y of the plug-element and form a receptacle 5 between them. The width direction Y runs perpendicularly to length direction X as well as to the plug-direction Z.

[0022] The wall section 4 is provided with a guiding organ 6 and a latching organ comprising a latching element 7 in the form of a nib and a latching element 7' in the form of a latching recess which are adapted to snap behind a counter-latching element (not shown) of a mating plug-element (not shown). The wall section 4' is further provided with a guiding organ 8 in form of a notch extending along the plug-in direction Z. Outer edges (not yet shown) of the wall sections 4, 4' and a base (not yet shown) of the socket module 2a are provided with fixing elements 9a, 9b, 9c, 9d, respectively, which enable attaching the mounting modules 3a to the socket module 2a. The fixing elements 9a to 9d are formed as lugs which engage with counter-fixing elements 10a, 10b, 10c, 10d, respectively, formed at an outer rim 11 of the mounting modules 3a, respectively. The counter-fixing elements 10a to 10d are formed as recesses. A further fixing element 9e on the lateral edge of the base (not yet shown) of the socket module 2a is formed as a protrusion and interacts with another counter-fixing element 10e which is formed at a wall portion 12 of the mounting modules 3a.

[0023] The wall portions 12 of the mounting modules 3a close an open lateral side, i.e. a recess (not yet shown) of the socket module 2a, respectively. Upper rims 13 of the wall portions 12 of the mounting modules 3a and front edges 14, 14', respectively, of the wall sections 4, 4' of the socket module 2a together define a plug opening 15 through which the receptacle 5 is accessible.

[0024] Further, the mounting modules 3a are each provided with a mounting section 16a which protrudes from the mounting modules 3a and therefore from the plug

element 1 against the plug-direction Z. A mounting organ 17a is formed at each of the mounting sections 16a. The mounting organ 17a is adapted to engage with a substrate (not yet shown) in order to attach the plug-element 1a to a substrate which may be a PCB of an electronic device.

[0025] Fig. 2 shows the plug-element 1a in another schematic perspective view. The base 18 of the socket module 2a is on its backside provided with a protuberance 19 which protrudes from the backside against the plug-direction Z. Contact supports 20 extend through the protuberance 19. The protuberance 19 helps to form and reinforce the contact supports 20 such that they may rigidly and securely hold electrical contact elements (not yet shown). The mounting sections 16a at the mounting modules 3a, respectively, flank the protuberance 19 at its lateral sides (not yet shown).

[0026] Further, at the backside of the base 18 in the area of the protuberance 19, the socket module 2a is provided with an indentation 21. The indentation 21 may serve as a coding keyway facilitating handling the plug-element as well as an access facilitating a detachment of the counter-fixing element 10e from the fixing element 9e.

[0027] Fig. 3 is a back view of the socket module 2a shown in Fig. 1 and 2. Here it becomes evident that the fixing elements 9a to 9e laterally protrude from the side walls 4, 4' and the base 18, respectively, in parallel to the length direction X.

[0028] Fig. 4 is a schematic side view of the socket module shown in Fig. 3. Here it becomes evident that the fixing elements 9a, 9b on the side walls 4, 4' are formed at lateral edges 22, 22', of the side walls 4, 4', respectively. The fixing elements 9c, 9d, and 9e are formed at a lateral edge, i.e. side face 23 of the base 18.

[0029] Between opposing inner sides 24, 24' of the wall sections 4, 4', respectively, and a bottom 25 of the receptacle 5, a recess 26 is formed. The socket module 2a is laterally open through the recess 26 in parallel to the length direction X. In other words, side walls closing the receptacle 5 in the length direction X are missing.

Further, a contact support area 27 is formed at the bottom 25 of the receptacle 5. The contact support area 27 slightly protrudes from the bottom 25 in the plug-direction Z.

[0030] Fig. 5 is a schematic front view of the socket module 2a shown in Figs. 3 and 4. Fig. 5 allows a view straight into the receptacle 5 formed between the opposing inner sides 24, 24' of the wall sections 4, 4'.

[0031] The contact supports 20 are arranged in two rows 28, 28' which run in parallel with the length direction X. Each of the rows 28, 28' of contact supports 20 is provided with identifiers 29 in the form of numbers which help to identify the individual contact supports 20 in order correctly equip the contact supports 20 with electrical contacts (not yet shown).

[0032] Figs. 6 and 7 analogously to Figs. 1 and 2 show a plug-element 1b according to an embodiment of the present invention. Indistinct from the plug-element 1a,

the plug-element 1b is provided with a socket module 2b, which is elongated in the length direction X relative to the socket module 2a. Like the plug-element 1a, the plug-element 1b is provided with mounting modules 3a.

[0033] Figs. 8 to 10 analogously to Figs. 3 to 5 show the socket module 2b in a schematic back view, side view and front view, respectively. In comparison to the socket module 2a, the socket module 2b is elongated in the length direction X. The rows 28, 28' each comprise ten contact supports 20. Hence, the socket module 2b provides twenty contact supports 20.

[0034] The wall section 4 of the module 2b is provided with the guiding organ 6, running centrally with respect to the receptacle 5 in the plug-direction Z. Further guiding organs 6' in the form of notches extending in parallel with the plug-direction Z, are provided in the vicinity of the lateral side or side face 23 at the lateral edges 22, 22' on the wall sections 4, 4', respectively, of the socket module 2b.

[0035] As a further distinction from the socket module 2a, the coding organ 8 having the form of a notch extending in parallel to the plug-direction Z is located differently to the notch 8 on the wall section 4' of the socket module 2a. Hence, even if socket modules 2a and 2b had a similar arrangement of contact supports 20, their respective receptacle 5 would still provide a proper distinction between the socket modules 2a and 2b in that they are provided with different guiding organs 6, 6' and coding organs 8.

[0036] Fig. 11 is a schematic side view of the mounting module 3a. The mounting module 3a may be formed of metal sheet material which could be shaped in a stamping process, for example, in order to obtain the desired design.

[0037] The mounting module 3a has a thickness d. The thickness d may be selected such, that it is less than a length of the fixing elements 9a to 9e measured in the length direction X. Thus, the thickness of the mounting module 3a does not add to the overall length of the plug-element 1a, 1b measured in length direction X. The thickness d may be less than 1 mm. Most preferably, the thickness d is less than 0.5 mm. For example, the thickness d may be 0.4 mm or less.

Fig. 12 shows the mounting module 3a in a schematic front view. A middle axis W of the mounting module 3a extends in parallel to the plug-direction Z. The mounting organ 17a on the mounting section 16a of the mounting module 3a is arranged coaxially to the middle axis W such, that a mounting direction M running towards the plug-direction Z and the middle axis W run in parallel. Hence, a mounting angle α between the axis W and the mounting direction M is 180° . The mounting section 16a with the mounting organ 17a is thereby adapted to be used for 180° THT mounting or to be soldered to the substrate.

[0038] Further, the mounting module 3a comprises a holding section 30 which includes the counter fixing elements 10a to 10b and the wall portion 12. The holding section 30 enables affixing securely the mounting module

3a to the socket module 2a, 2b.

[0039] Fig. 13 is a schematic front view of a mounting module 3b according to another embodiment of the present invention. In distinction from the mounting module 3a, the mounting module 3b is provided with a mounting section 16b having a mounting organ 17b which are designed such, that they enable a 90° THT mounting or soldering of the mounting module 3b. The middle axis W of the mounting module 3b runs in parallel to the plug-direction Z. The mounting direction M of the mounting module 3b runs in parallel to the width direction Y. Thus, a mounting angle α' between the middle axis W and the mounting direction M of the mounting module 3b is 90°.

[0040] The holding section 30 of the mounting module 3b is designed similarly to the holding section of the mounting module 3a. The mounting modules 3a and 3b may be interchangeably mounted to the socket modules 2a, 2b, depending on the desired mounting angle α or α' of the plug-element 1a, 1b.

[0041] Fig. 14 is a schematic front view of a mounting module 3c according to another embodiment of the present invention. The holding section 30 of the mounting module 3c is similar to the holding section 30 of the mounting modules 3a and 3b. A mounting section 16c of the mounting module 3c is provided with a mounting organ 17c which is shaped such, that the mounting module 3c is adapted for a 180° press-fit mounting on the substrate. The middle axis W and the mounting direction M of the mounting module 3c run parallel to the plug-in direction and define a mounting angle α of 180° between each other.

[0042] Fig. 15 is a schematic front view of a mounting module 3d according to another embodiment of the present invention. Similarly to the holding sections 30 of the mounting module 3a to 3c, the holding section 30 of the mounting module 3d is adapted to be affixed to the socket modules 2a or 2b such, that the socket modules 2a or 2b are held firmly by the holding section 30.

[0043] A mounting section 16d providing a mounting organ 17d of the mounting module 3d is shaped such, that the mounting module 3d is adapted for a 90° press-fit mounting on the substrate. The middle axis W of the mounting module 3d runs in parallel with the plug-direction Z. The mounting direction M defined by the mounting section 16d runs in parallel with the width direction Y. Hence, the middle axis W and the mounting direction M define a mounting angle α' of 90° between each other.

[0044] Fig. 16 is a schematic front view of a mounting section 16 having a mounting organ 17e which may be provided to a mounting module 3a to 3d according to an embodiment of the present invention. The mounting organ 17e may be used, for example, in order to affix the mounting section 16e at a mounting angle α of 90° with respect to a substrate.

[0045] Fig. 17 is a schematic cross-sectional view of the mounting section 16e shown in Fig. 16 along the cross-sectional line A-A illustrated therein. As can be seen in Fig. 17, the mounting organ 17e has the form of

a lug which has a curved cross-section. Thereby, the mounting organ 17e may be inserted into a through-hole of a substrate, for example, in order to hold the mounting section 16e tightly in a positive, form-fit, and/or traction fit manner.

[0046] Fig. 18 is a schematic front view of a mounting section 16f which is provided with a mounting organ 17f. The mounting section 16f could be implemented at any mounting module 3a, 3b according to an embodiment of the present invention. The mounting section 16f is adapted for through-hole mounting on a substrate at a mounting angle α of 180° with respect to the substrate since both the mounting direction M and the middle axis W of the mounting section 16f run in parallel to the plug-in direction.

[0047] Fig. 19 is a schematic cross-sectional view of the mounting section 16f shown in Fig. 18 along the cross-sectional line B-B illustrated therein. As can be seen in Fig. 19, the mounting organ 17f on the mounting section 16f has the form of a kink which allows affixing of a mounting module 3a, 3b equipped with the mounting section 16f to a substrate in a positive, form-fit and/or traction fit manner.

[0048] Fig. 20 is a schematic front view of a mounting section 16g which is provided with a mounting organ 17g. The mounting section 16g may be formed at any mounting module 3a, 3b according to an embodiment of the present invention. The middle axis W and the mounting direction M of the mounting section 16g both extend in parallel to the plug-in direction. Hence, the middle axis W and the mounting direction M define a mounting angle α of 90° between each other.

[0049] Fig. 21 is a schematic side view of the mounting section 16g shown in Fig. 20. As can be seen in Fig. 21, the mounting organ 17g on the mounting section 16g is hook-shaped such, that it may be inserted into a through-hole or any attaching facility on a substrate in order to firmly hold a mounting module 3a, 3b equipped with the mounting section 16g in a form-fit, positive fit and/or traction fit manner.

[0050] Fig. 22 is a schematic perspective view of an exemplary plug-element 1c which does not form part of the present invention. The plug-element 1c comprises a socket module 2c and two mounting modules 3e. In Fig. 22, the plug-element 1c is illustrated in a pre-assembled state P, wherein the mounting modules 3e are arranged to be affixed to the socket module 2c by pushing them towards the socket module 2c in the length direction X such, that fixing elements 9f to 9h having the form of cylindrical studs jut into counter-fixing elements 10f to 10h, respectively of the mounting module 3e which have the form of through-holes. The fixing elements 9f to 9h are provided on a sidewall 31, the socket module 2c.

Two of the sidewalls 31 and the wall sections 4 and 4' of the socket module 1c form the receptacle 5 and the plug opening 15 to the receptacle 5 of the socket module 1c. The receptacle 5 is provided with latching elements 7, 7' formed at the wall section 4 and guiding organs 6 as well

as a coding organ 8 having the form of notches running parallel to the plug-direction on the wall section 4' of the socket module 1c.

[0051] Fig. 23 is a schematic perspective view of a detail of the plug-element 1c in an assembled state Q. In the assembled state Q, the fixing elements 9f to 9h jut through the counter fixing elements 10f to 10h, respectively.

[0052] The counter fixing elements 10f and 10g each comprise a through-hole 32 and a lug 33. The lug 33 of the counter fixing element 10f extends in parallel to the width direction Y such, that the fixing element 9f is jammed and therefore firmly held in the direction Y. The lug 33 of the counter fixing element 10g extends in the plug-direction Z such, that the fixing element 9g is jammed therefore firmly held in the plug-direction Z.

[0053] Further, in the assembled state Q, the fixing element 9h having a slightly smaller diameter than the counter fixing element 10h still allows for a movement of the mounting module 3e in the length direction X. Therefore, any production tolerance of the socket module 2c and the mounting module 3e may be compensated.

[0054] Fig. 24 is a schematic perspective view of the plug-element 1c shown in Figs. 22 and 23 in a joined state R. In the joined state R, the fixing element 9h has been treated such that it sits within the counter fixing element 10h in a form-fit manner. For example, the fixing element 9h may be treated, for example, in an ultrasonic or laser welding process. The fixing element 9h may also be designed as a rivet. In the joint state R, the fixing element 9h may protrude out of the counter fixing element 10h such, that it overlaps with the mounting module 3e in order to prevent any movement of the mounting module 3e with respect to the socket module 2c in the length direction X. Hence, in the joined state R, the mounting module 3e and the socket module 2c are joined together such, that they are firmly mounted to each other and form the plug-element 1c.

Fig. 25 is a schematic side view of the plug-element 1c comprising the socket module 2c and the mounting module 3e. As can be seen in Fig. 25, the mounting module 3e has two branches 33'. On these branches 33', the counter fixing elements 10f to 10h are arranged such, that they form an isosceles triangle having a square angle between the legs a. The branches 33' have a breadth E. The counter fixing elements 10f to 10h have a diameter D. In each case, an overlap O is provided with which the mounting module 3e may overlap the edges of the sidewalls 31 of the socket module 2c such, that the socket module 2c may be held in a proper distance to the substrate in order to enable enough freedom for SMT, THT press-fit and/or soldering.

[0055] Fig. 26 is a detail of a schematic perspective view of an exemplary plug element 1d which does not form part of the present invention. The sidewall 31 of the socket module 2d is provided with fixing elements 9h to 9k having the form of studs which protrude laterally from the sidewall 31 in parallel to the length direction X.

The fixing elements 9h to 9k jut through counter fixing elements 10h to 10k formed at the mounting module 3f. The fixing elements 9h and 9k have a bigger diameter than the fixing element 9i. The counter fixing elements 10h and 10k accommodating the fixing elements 9h and 9k, respectively each comprise a through-hole 32 and a lug 33. The lugs 33 of the counter fixing element 10h and 10k point in opposite directions in a plane of the width direction Y and plug-direction Z. Thereby the lugs 33 of the counter fixing elements 10h and 10k act as metal claws which dig into the fixing elements 9h and 9k, respectively in order to pre-fix the holding section 30 of the mounting module 3f comprising the counter fixing elements 10h to 10k at the socket module 2d.

The fixing element 9i has a smaller diameter than the fixing elements 9h and 9k and is arranged on a middle point of a straight line between the fixing elements 9h and 9k such, that it constitutes a pivot point of the holding section 30. The fixing element 9i may be treated by ultrasonic or laser welding in order to deform it such, that it overlaps with the mounting module 3f in the length direction X in order to tie the mounting module 3f to the socket module 2d such, that they are inextricably linked with each other.

The mounting module 3f is provided with two mounting sections 16f, 16f' which comprise mounting organs 17f and 17f', respectively. The mounting sections 16f and 16f' protrude from the holding section 30 of the mounting module 3f in different directions under an angle of 90° between each other. Hence, by pivoting the mounting module 3f around the fixing element 9i and/or flipping the mounting module 3f, the different mounting sections 16f, 16f' may be selected for a desired way of mounting the plug-element 1d to the substrate with respect to a desired mounting angle between the plug-element 1d and a substrate as well as a desired mounting technology.

The mounting section 16f is provided with a mounting organ 17f having the form of a lug which may be used for through-hole mounting or soldering, for example. The two mounting organs 17f' of the mounting section 16f' are shaped as resiliently displaceable hooks which oppose each other and thereby enable snapping the mounting section 16f' into a through-hole on a substrate in order to enable a form-fit and/or traction fit.

Further, the socket module 2d is provided with a mark 34 having the form of an arrow which may indicate the mounting direction M of the plug-element 1d which is selected according to the rotary position of the mounting module 3f. As can be seen in Fig. 26, the selected rotary position of the mounting module 3f is a 90°-mounting because when using the mounting organ 17f, the mounting direction M and the plug-direction Z define a mounting angle α of 90°.

Fig. 27 is a schematic perspective view of a detail of the plug-element 1d shown in Fig. 26. In distinction from the arrangement of the socket module 2d and the mounting module 3f shown in Fig. 26, the socket module 2d and the mounting module 3f illustrated in Fig. 27 are arranged

such that the mounting organs 17f' of the mounting section 16f' allow for a mounting of the plug-element 1c under a mounting angle α of 180° with respect to the substrate. In other words, the mounting angle α between the plug-direction Z predefined by the receptacle 5 and the mounting direction M given by the mounting section 16f' is 180° .

[0056] Fig. 28 is a schematic front view of an exemplary mounting module 3g which does not form part of the present invention. The mounting module 3g is provided with counter fixing elements 10k to 10p in the form of through-holes. The counter fixing elements 10l, 10m, 10n and 10o are arranged around the counter fixing element 10p which may be used as a pivot point for pivoting the mounting module 3g on a respective fixing element (not shown) adapted to affix the mounting module 3g in different rotary positions in order to enable different mounting angles α , α' .

[0057] The mounting module 3g is provided with a mounting section 16g which comprises a mounting organ 17g in the form of a slit which may be used to attach the mounting module 3g to the substrate, e.g. by letting a bracket of the substrate (not shown) engage with the mounting organ 17g.

[0058] Fig. 29 is a schematic side view of the mounting module 3g shown in Fig. 28. The mounting module 3g has a thickness d which may be selected such that it does not add to the length of a plug-element 1a to 1d as explained above.

[0059] Fig. 30 is a schematic front view of several mounting modules 3g which are combined as a reel 50. By attaching the mounting modules 3g to each other the form the reel 50, the mounting modules 3g may be easily fed to an automatic manufacturing or assembling device which assembles the plug elements 1a to 1d by joining the socket modules 2a to 2d with the mounting modules 3a to 3g.

[0060] Fig. 31 is a schematic perspective view of a plug-element 1e according to an embodiment of the present invention. The plug-element 1e comprises a socket module 2e and two mounting modules 3h. The contact supports 20 in the protuberance 19 in the back-side of the base 18 of the socket module 2e are each equipped with an electrical contact 35 in the form of a press-fit pin which is press-fitted into the respective contact support 20.

The socket module 2e is equipped with fixing elements 9q to 9s on the lateral side faces 22, 22' of the wall sections 4, 4', respectively. The fixing elements 9q and 9r are formed as brackets, the tips of which point towards each other in parallel to the width direction Y. The fixing element 22s has the form of a clamp or bail spanning a distance between the wall sections 4, 4' in the vicinity of their respective front edges 14, 14'.

[0061] The mounting module 3h is slid underneath the fixing elements 9q to 9s in the plug-direction Z such that the fixing elements 9q and 9r engage with respective counter fixing elements 10q and 10r in the form of notches on the side faces of the mounting modules 3h. The front

edge of the mounting module 3h is slid underneath the fixing element 9s. Hence, the mounting module 3h is firmly held at its holding section 30 by the socket module 2e.

[0062] Further, the mounting module 3h is provided with a mounting section 16h which comprises a mounting organ 17h in the form of a pin protruding from the mounting module 3h in the mounting direction M against the plug-direction Z and an auxiliary mounting organ 17h' in the form of a latch laterally protruding from the mounting module 3h such that it allows for latching the plug-element 1e at a substrate or holder. The mounting organ 17h is arranged such that it allows for a mounting angle α between the plug-direction Z and the mounting direction M of 180° .

[0063] Fig. 32 is another schematic perspective view of the plug-element 1e illustrated in Fig. 31. Fig. 32 allows an inspection of the receptacle 5 through the plug opening 15 of the plug-element 1e. Within the receptacle 5, the electrical contacts 20 protrude from the base 18 of the socket module 2e in the plug direction Z. The wall section 4 of the socket module 2e is provided with a guiding organ 6 having the form of a notch running parallel to the plug-direction Z and a latching organ 7 in the form of a catch as well as a latching organ 7' in the form of a through-hole which are adapted to engage with a mating plug-element (not shown). The wall section 4' of the socket module 2e is provided with guiding organs 6' in the vicinity of the lateral edges 22 and 22' of the wall sections 4 and 4', respectively, in the form of notches running in the plug-direction Z. A coding organ 8 in the form of a notch running in the plug-direction Z is also provided on the wall section 4'.

[0064] Further, the wall sections 4 and 4' as well as the portions 12 of the mounting modules 3h define a contour of the receptacle 5. The socket module 2e is not provided with lateral side walls, the mounting modules 3h close the respective recesses left open at the sides of the socket module 2e in the length direction X.

[0065] Fig. 33 is a schematic perspective view of the plug-element 1e according to another embodiment of the present invention. The plug-element 1e comprises the socket module 2e previously known from Figs. 31 and 32 and a mounting module 3i. In distinction to the mounting module 3h, the mounting module 3i is provided with a mounting section 16i which comprises a mounting organ 17i and a mounting organ 17i'. The mounting organ 17i' is similar to the mounting organ 17h', of the mounting module 3h.

[0066] The mounting organ 17i in the form of a pin is arranged such that it protrudes from the mounting module 3i perpendicularly to the plug-direction Z and thereby defines a mounting direction M of the plug-element 1e which allows for a 90° -mounting of the plug-element 1e with respect to the substrate. In other words, the mounting angle α between the plug-direction Z and the mounting direction M is 90° .

[0067] Fig. 34 is another schematic perspective view of the plug-element 1e illustrated in Fig. 30. Fig. 34 allows

for a view into the receptacle 5 of the plug-element 1e. Within the receptacle 5, the electrical contact elements 35 are arranged in two rows 28, 28' in their contact support area 27 on the bottom 25 of the receptacle 5 of the plug-element 1e.

[0068] Fig. 35 is a schematic cross-sectional view taken along a plane spreading parallelly to the width direction Y and the plug-direction Z through the electrical contacts 35 in their respective contact supports 20 of the rows 28 and 28', respectively. The inner sides 24, 24' of the wall sections 4, 4', respectively, of the socket module 2e and the wall portions 12 of the mounting modules 3i define between themselves the receptacle 5. Hence, the holding section 30 of the mounting modules 3i forms a part of the receptacle 5.

[0069] Further, in Fig. 35 it becomes evident that the mounting angle α' between the mounting direction M defined by the mounting organ 17i and the plug-direction Z allows for a 90°-mounting of the plug-element 1e with respect to the substrate. Fig. 36 is a schematic perspective view of the plug-element 1e which is mounted to a substrate 100 in the form of a PCB. The plug-element 1e is mounted to the substrate 100, with a mounting angle α' of 90°. The mounting organs 17i of the mounting modules 3i jut into respective mounting elements 101 in the form of cavities in the substrate 100. Further, the electrical contacts 35 protruding from the plug-element 1e against the plug-direction Z are angled such that their rear ends which run parallel to the mounting direction M are sitting within respective mating contact supports 102 in the form of through-holes for a press-fit in the substrate 100.

[0070] Deviations from the above described embodiments of the plug-elements 1a, 1b, 1e according to the invention are possible within the inventive idea:

The socket modules 2a, 2b, 2e may be provided with wall sections 4, 4' being equipped however desired with guiding organs 6, 6', latching elements 7, 7', coding organs 8, fixing elements 9a to 9s, front edges 14, 14', bases 18, protuberances 19, contact supports 20, indentations 21, lateral edges 22, 22', side faces 23, inner sides 24, 24', bottoms 25 of the receptacles 5, recesses 26 between the wall sections 4, 4', contact support areas 27, rows of contact supports 28, 28', identifiers 29, and marks 34 however desired for forming a receptacle 5, an opening to the receptacle 15 and the desired possibilities for attaching at least one of the mounting modules 3a-3i to the socket modules 2a-2e.

[0071] The mounting modules 3a - 3d, 3h, 3i may be shaped as desired in order to have holding sections 30 which may be attached to the socket modules 2a, 2b, 2e, possibly in a complementary manner such that the mounting modules 3a - 3d, 3h, 3i form a part of the receptacles 5. In order to affix the mounting modules 3a - 3d, 3h, 3i to the socket modules 2a-2e, they may be pro-

vided with counter fixing elements 10a-10s, outer rims 11, wall portions 12, upper rims 13, mounting sections 16a-16i, mounting organs 17a-17i, through-holes 32, locks 33 and branches 33' in whatever shape and form desired in order to attach the mounting modules 3a - 3d, 3h, 3i to the socket modules 2a, 2b, 2e and to enable a mounting of the plug-elements 1a, 1b, 1e to the substrate 100 in a desired way and angle α , α' .

[0072] It should be understood that the angles α , α' are not limited to mounting angles of 180° and 90° but may be any desired angle. Further, the mounting modules 3a - 3d, 3h, 3i may

be provided with as many counter fixing elements 10a-10s and mounting sections 16a-16i in order to enable multiple ways of mounting the plug-elements 1a-1e with a single combination of a type of selected socket module 2a-2e and a type mounting module 3a-3i.

Claims

1. Electrical plug-element (1a, 1b, 1e) comprising at least one socket module (2a, 2b, 2e) with a receptacle (5) for a mating plug-element, the receptacle (5) opens towards a plug-direction (Z) of the plug-element (1a, 1b, 1e), is formed between at least two wall sections (4, 4') of the socket module (2a, 2b, 2e) which extend essentially in parallel to a length direction (X) of the plug-element (1a, 1b, 1e), and accommodates at least one contact support area (27) which extends along the length direction (X) and at least partially faces into the plug-direction (Z), wherein the receptacle (5) is laterally open through at least two recesses (26) each extending along a width direction (Y) of the socket module (2a, 2b, 2e) between the at least two wall sections (4, 4'), the width direction (Y) extends perpendicularly to the length direction (X) and the plug-direction (Z), wherein the at least one contact support area (27) is located at a bottom portion (25) of the receptacle (5), the bottom portion (25) facing into the plug-direction (Z), and wherein the recesses (26) extend down to the bottom portion (25) and/or essentially along a distance measured in parallel to the width direction (Y) between the wall sections (4, 4'), **characterised by** at least two mounting modules (3a-3d, 3h, 3i) each having a holding section (30) attached to a lateral side of the socket module (2a, 2b, 2e), the lateral side extending essentially in parallel to the plug-direction (Z), and a mounting section (16a-16d, 16h, 16i) providing a mounting organ (17a-17d, 17h, 17i) adapted to be fastened to a substrate (100), wherein the mounting modules (3a-3d, 3h, 3i) at least partially close the recesses (26).
2. Plug-element (1a, 1b, 1e) according to claim 1, **characterised in that** the holding section (30) of each of the mounting modules (3a-3d, 3h, 3i) comprises a

wall portion (12) which at least partially closes the recess (26) of the socket module (2a, 2b, 2e).

3. Plug-element (1a, 1b, 1e) according to claim 1 or 2, **characterised in that** a lateral edge (22, 22') of each of the wall sections (4, 4') and/or of a base (18) of the socket module (2a-2i) is provided with at least one fixing element (9a-9s) for affixing each of the mounting modules (3a-3d, 3h, 3i) at the socket module (2a, 2b, 2e).
4. Plug-element (1a, 1b, 1e) according to any one of claims 1 to 3, **characterised in that** the holding section (30) of each of the mounting modules (3a-3d, 3h, 3i) is provided with at least one counter fixing element (10a-10s) interacting with the at least one fixing element (9a-9s).
5. Plug-element (1a, 1b, 1e) according to one of claims 1 to 4, **characterised in that** a thickness (d) of the holding section (30) of at least one of the mounting modules (3a-3d, 3h, 3i) is below 0,5 mm.
6. Plug-element (1a, 1b, 1e) according to one of claims 1 to 5, **characterised in that** the socket module (2a, 2b, 2e) is formed of plastic material and/or the mounting modules (3a-3d, 3h, 3i) are formed of metal sheet material.
7. Plug-element (1a, 1b, 1e) according to one of claims 1 to 6, **characterised in that** the at least one contact support area (27) comprises at least one row (28, 28') of contact supports, the at least one row (28, 28') of contact supports (20) runs longitudinally essentially in parallel to the length direction (X).

Patentansprüche

1. Elektrisches Stecker-Element (1a, 1b, 1e), das umfasst:

wenigstens ein Buchsen-Modul (2a, 2b) mit einer Fassung (5) für ein passendes Stecker-Element, wobei sich die Fassung (5) in einer Einsteckrichtung (Z) des Stecker-Elementes (1a, 1b, 1e) öffnet, zwischen wenigstens zwei Wand-Teilabschnitten (4, 4') des Buchsen-Moduls (2a, 2b, 2e) ausgebildet ist, die sich im Wesentlichen parallel zu einer Längsrichtung (X) des Stecker-Elementes (1a, 1b, 1e) erstrecken, und sie wenigstens einen Kontaktauflage-Bereich (27) aufnimmt, der sich in der Längsrichtung (X) erstreckt und wenigstens teilweise in der Einsteckrichtung (Z) ausgerichtet ist, wobei die Fassung (5) seitlich über wenigstens zwei Aussparungen (26) offen ist, die sich jeweils in einer Breitenrichtung (Y) des Buchsen-Moduls

(2a, 2b, 2e) zwischen den wenigstens zwei Wand-Teilabschnitten (4, 4') erstrecken, die Breitenrichtung (Y) senkrecht zu der Längsrichtung (X) und der Einsteckrichtung (Z) verläuft, sich der wenigstens eine Kontaktauflage-Bereich (27) an einem Bodenabschnitt (25) der Fassung (5) befindet, der Bodenabschnitt (25) in der Einsteckrichtung (Z) ausgerichtet ist und sich die Aussparungen (26) bis zu dem Bodenabschnitt (25) und/oder im Wesentlichen über eine Ausdehnung, gemessen parallel zu der Breitenrichtung (Y) zwischen den Wand-Teilabschnitten (4, 4'), erstrecken, **gekennzeichnet durch** wenigstens zwei Anbringungs-Module (3a-3d, 3h, 3i), die jeweils einen Halte-Teilabschnitt (30) aufweisen, der an einer Querseite des Buchsen-Moduls (2a, 2b, 2e) angebracht ist, wobei sich die Querseite im Wesentlichen parallel zu der Einsteckrichtung (Z) erstreckt, sowie einen Anbringungs-Teilabschnitt (16a-16b, 16h, 16i), der ein Anbringungselement (17a-17b, 17h, 17i) bildet, das zum Befestigen an einem Träger (100) eingerichtet ist, und die Anbringungs-Module (3a-3d, 3h, 3i) die Aussparungen (26) wenigstens teilweise verschließen.

2. Stecker-Element (1a, 1b, 1e) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Halte-Teilabschnitt (30) jedes der Anbringungs-Module (3a-3d, 3h, 3i) einen Wandabschnitt (12) umfasst, der die Aussparung (26) des Buchsen-Moduls (2a, 2b, 2e) wenigstens teilweise verschließt.
3. Stecker-Element (1a, 1b, 1e) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** eine Querkante (22, 22') jedes der Wand-Teilabschnitte (4, 4') und/oder einer Basis (18) des Buchsen-Moduls (2a-2i) mit wenigstens einem Befestigungselement (9a-9s) zum Befestigen jedes der Anbringungs-Module (3a-3d, 3h, 3i) an dem Buchsen-Modul (2a, 2b, 2e) versehen ist.
4. Stecker-Element (1a, 1b, 1e) nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Halte-Teilabschnitt (30) jedes der Anbringungs-Module (3a-3d, 3h, 3i) mit wenigstens einem Gegen-Befestigungselement (10a-10s) versehen ist, das in Wechselwirkung mit dem wenigstens einen Befestigungselement (9a-9s) ist.
5. Stecker-Element (1a, 1b, 1e) nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** eine Dicke (b) des Halte-Teilabschnitts (30) wenigstens eines der Anbringungs-Module (3a-3d, 3h, 3i) weniger als 0,5 mm beträgt.
6. Stecker-Element (1a, 1b, 1e) nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass**

das Buchsen-Modul (2a, 2b, 2e) aus Kunststoffmaterial besteht und/oder die Anbringungs-Module (3a-3d, 3h, 3i) aus einem Blechmaterial bestehen.

7. Stecker-Element (1a, 1b, 1e) nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** der wenigstens eine Kontaktauflage-Bereich (27) wenigstens eine Reihe (28, 28') von Kontaktauflagen umfasst, wobei die Längsachse der wenigstens einen Reihe (28, 28') von Kontaktauflagen (20) im Wesentlichen parallel zu der Längsrichtung (X) verläuft.

Revendications

1. Élément enfichable électrique (1a, 1b, 1e) comprenant:

au moins un module de douille (2a, 2b, 2e) avec un réceptacle (5) pour un élément enfichable de connexion, le réceptacle (5) s'ouvre vers une direction d'enfichage (Z) de l'élément enfichable électrique (1a, 1b, 1e), est formé entre au moins deux sections de paroi (4, 4') du module de douille (2a, 2b, 2e) qui se prolongent essentiellement parallèlement au sens de la longueur (X) de l'élément enfichable électrique (1a, 1b, 1e), et loge au moins une zone de support de contact (27) qui se prolonge dans le sens de la longueur (X) et fait face au moins partiellement au sens d'enfichage (Z), le réceptacle (5) s'ouvrant latéralement à travers au moins deux évidements (26) se prolongeant chacun dans le sens de la largeur (Y) du module de douille (2a, 2b, 2e) entre lesdites au moins deux sections de paroi (4, 4'), le sens de la largeur (Y) se prolonge perpendiculairement au sens de la longueur (X) et au sens d'enfichage (Z), dans laquelle ladite au moins une zone de support de contact (27) est située sur une partie inférieure (25) du réceptacle (5), la partie inférieure (25) faisant face au sens d'enfichage (Z), et dans lequel les évidements (26) se prolongent vers le bas vers la partie inférieure (25) et/ou sensiblement le long d'une distance mesurée parallèlement au sens de la largeur (Y) entre les sections de paroi (4, 4'), **caractérisé par** au moins deux modules de montage (3a-3d, 3h, 3i) ayant chacun une section de maintien (30) fixée sur un côté latéral du module de douille (2a, 2b, 2e), le côté latéral se prolongeant essentiellement parallèlement au sens d'enfichage (Z) et une section de montage (16a-16d, 16h, 16i) constituant un organe de montage (17a-17d, 17h, 17i) prévu pour se fixer à un substrat (100), dans lequel les modules de montage (3a-3d, 3h, 3i) renferment au moins partiellement les évidements (26).

2. Élément enfichable électrique (1a, 1b, 1e) selon la revendication 1, **caractérisé en ce que** la section de maintien (30) de chacun des modules de montage (3a-3d, 3h, 3i) comprend une partie de paroi (12) qui renferme au moins partiellement l'évidement (26) du module de douille (2a, 2b, 2e).

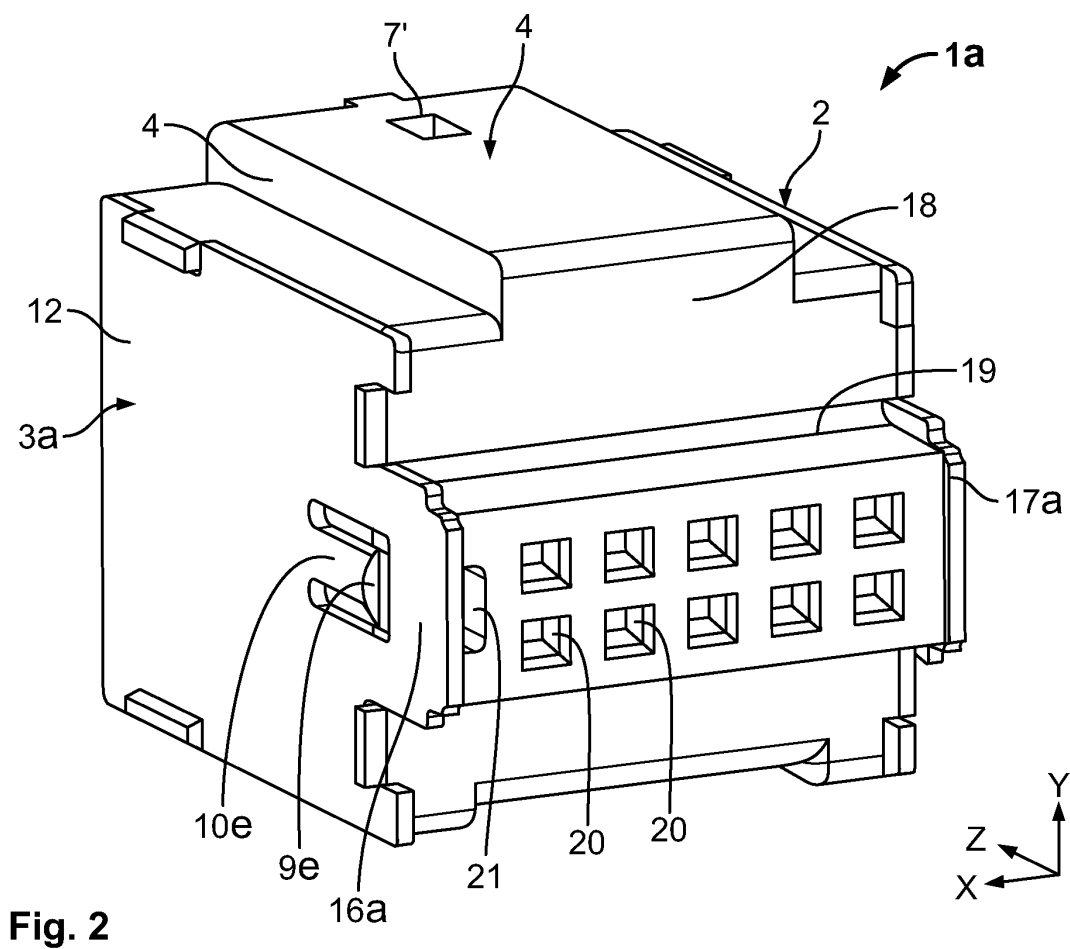
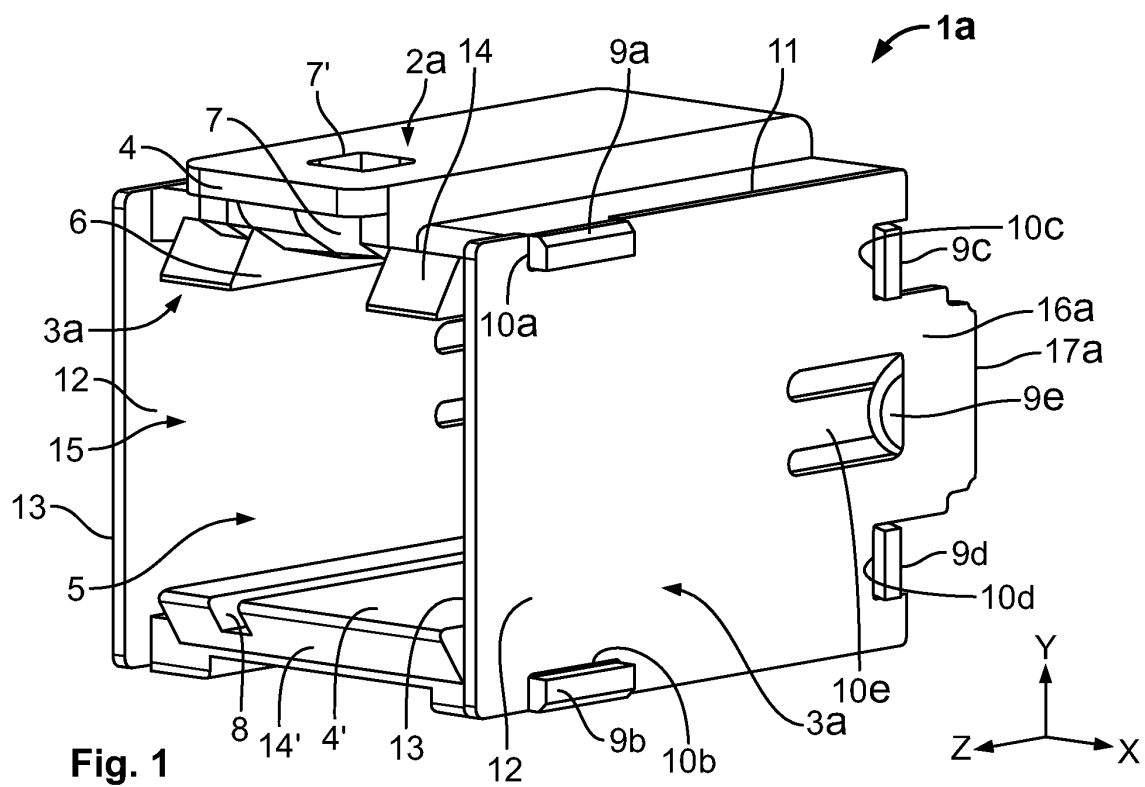
3. Élément enfichable électrique (1a, 1b, 1e) selon la revendication 1 ou la revendication 2, **caractérisé en ce qu'un** bord latéral (22, 22') de chacune des sections de paroi (4, 4') et/ou d'une base (18) du module de douille (2a-2i) est muni d'au moins un élément de fixation (9a-9s) pour fixer à demeure chacun des modules de montage (3a-3d, 3h, 3i) sur le module de douille (2a, 2b, 2e).

4. Élément enfichable électrique (1a, 1b, 1e) selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** la section de maintien (30) de chacun des modules de montage (3a-3d, 3h, 3i) est munie d'au moins un élément de contre-fixation (10a-10s) coopérant avec ledit au moins un élément de fixation (9a-9s).

5. Élément enfichable (1a, 1b, 1e) selon l'une quelconque des revendications 1 à 4, **caractérisé en ce qu'une** épaisseur (d) de la section de maintien (30) d'au moins l'un des modules de montage (3a-3d, 3h, 3i) est inférieure à 0,5 mm.

6. Élément enfichable (1a, 1b, 1e) selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** le module de douille (2a, 2b, 2e) est en matière plastique et/ou que les modules de montage (3a-3d, 3h, 3i) sont formés de matériau en feuille de métal.

7. Élément enfichable (1a, 1b, 1e) selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** ladite au moins une zone de support de contact (27) comprend au moins une rangée (28, 28') de supports de contact, ladite au moins une rangée (28, 28') de supports de contact (20) se prolonge longitudinalement et plus ou moins parallèle au sens de la longueur (X).



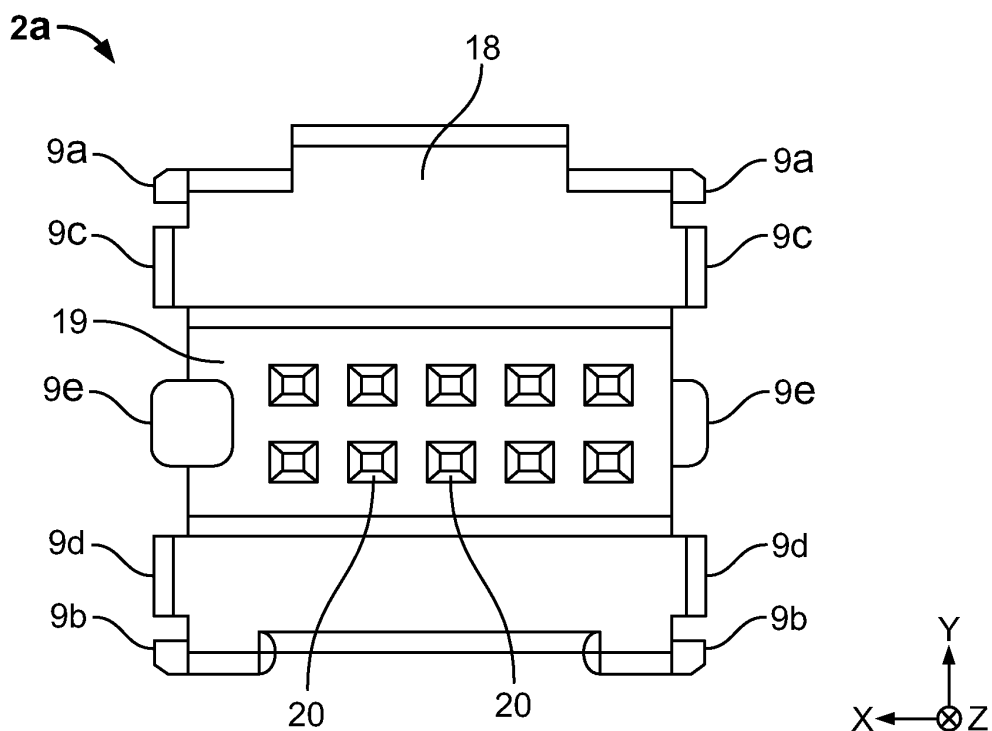


Fig. 3

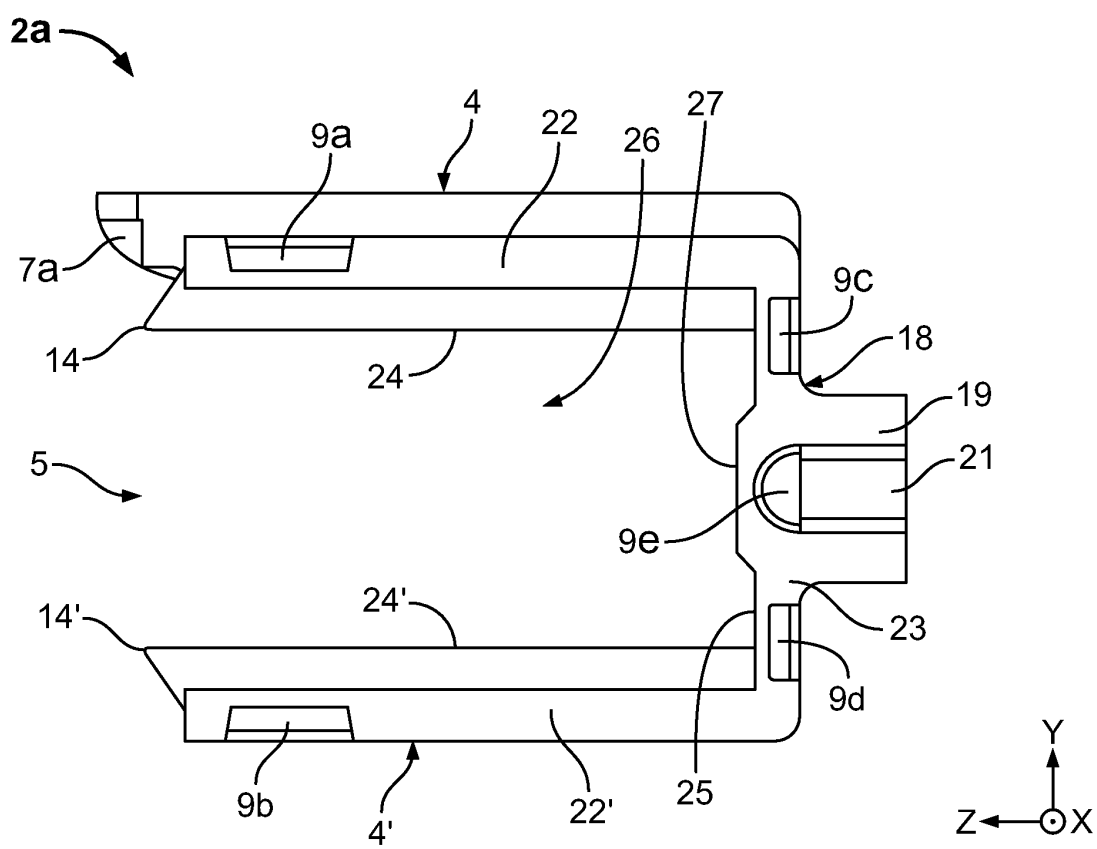


Fig. 4

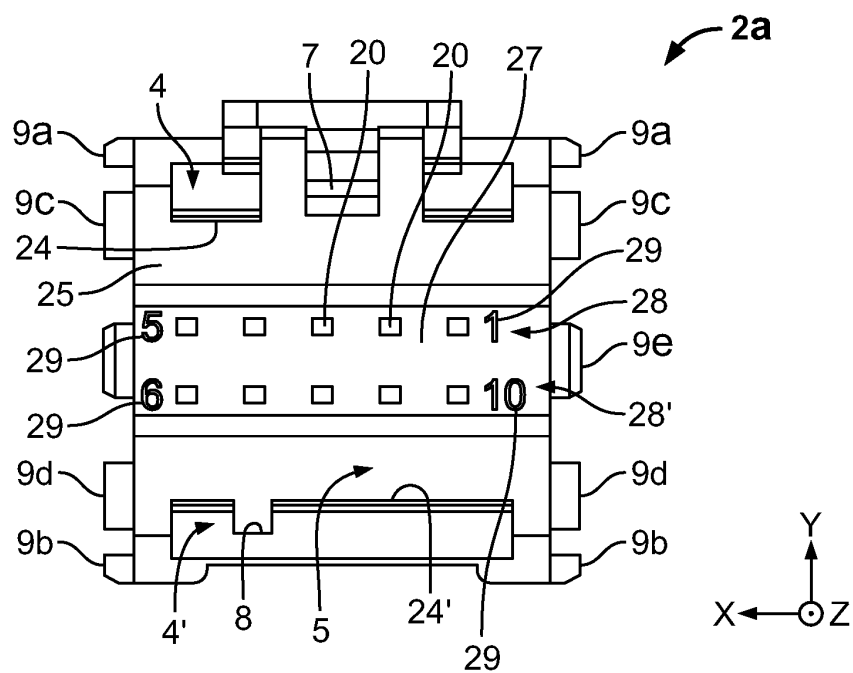


Fig. 5

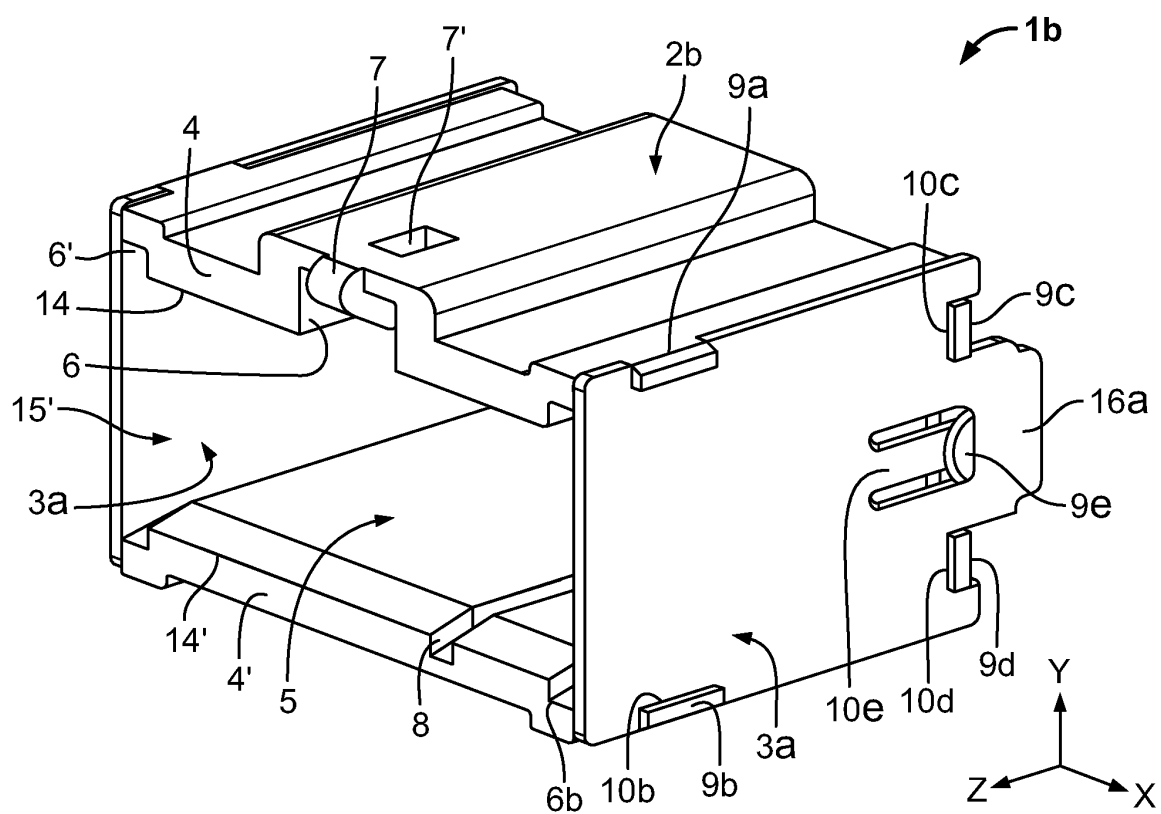


Fig. 6

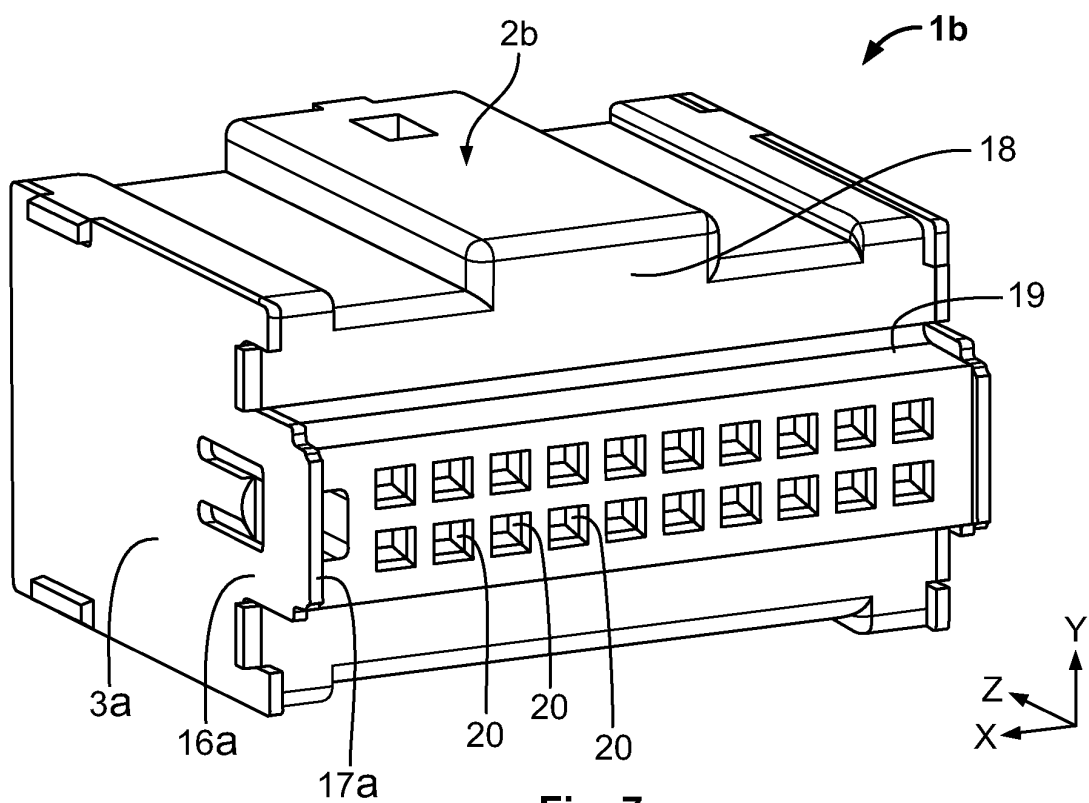


Fig. 7

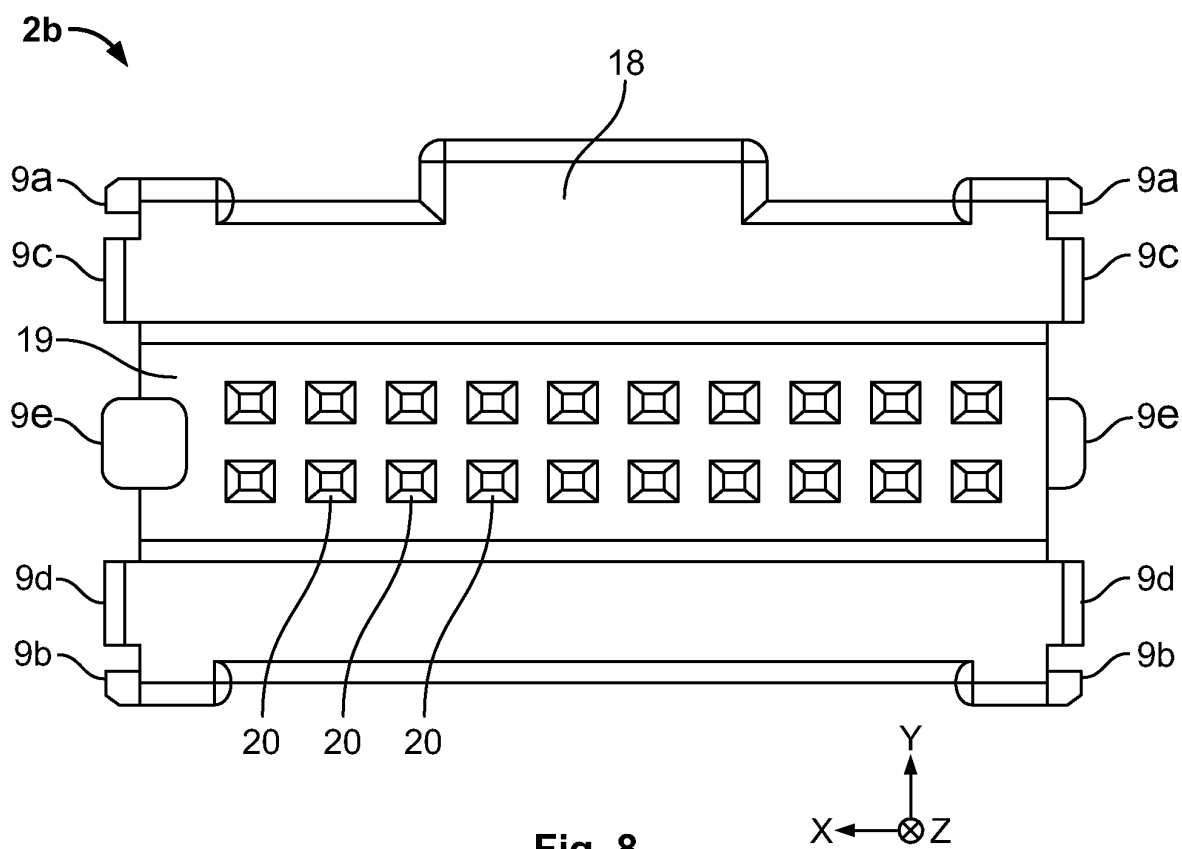


Fig. 8

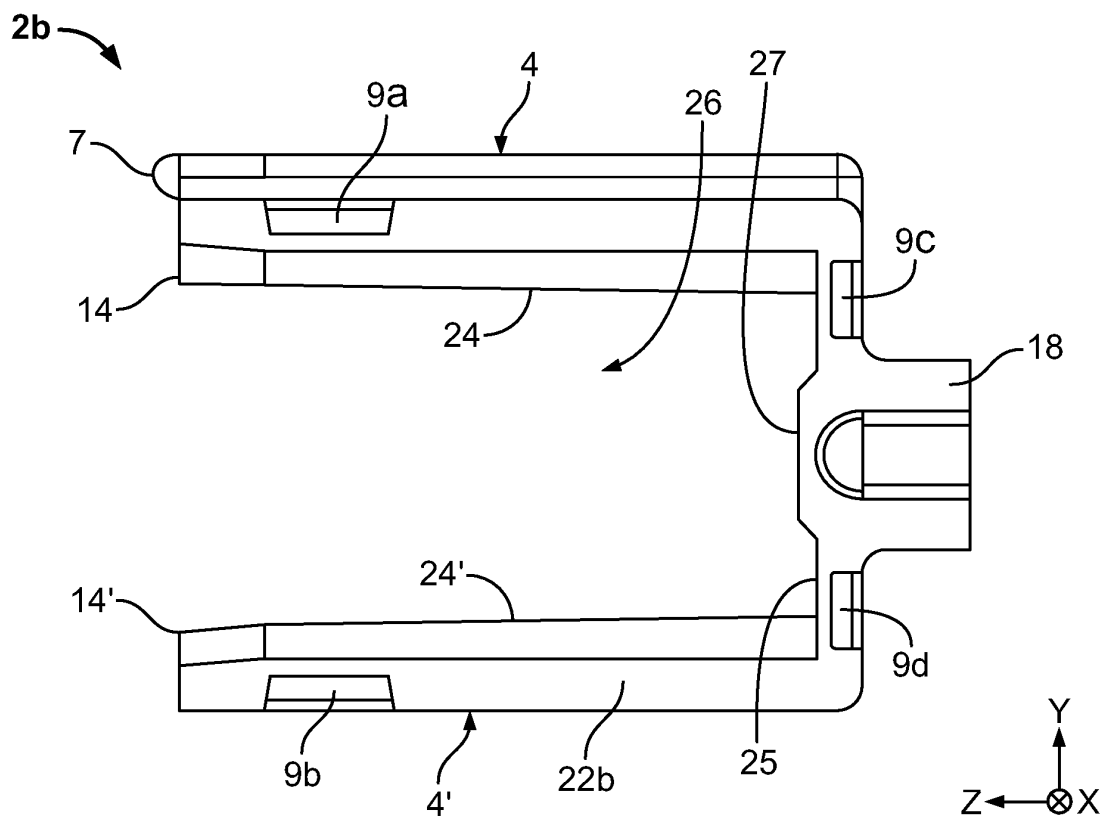


Fig. 9

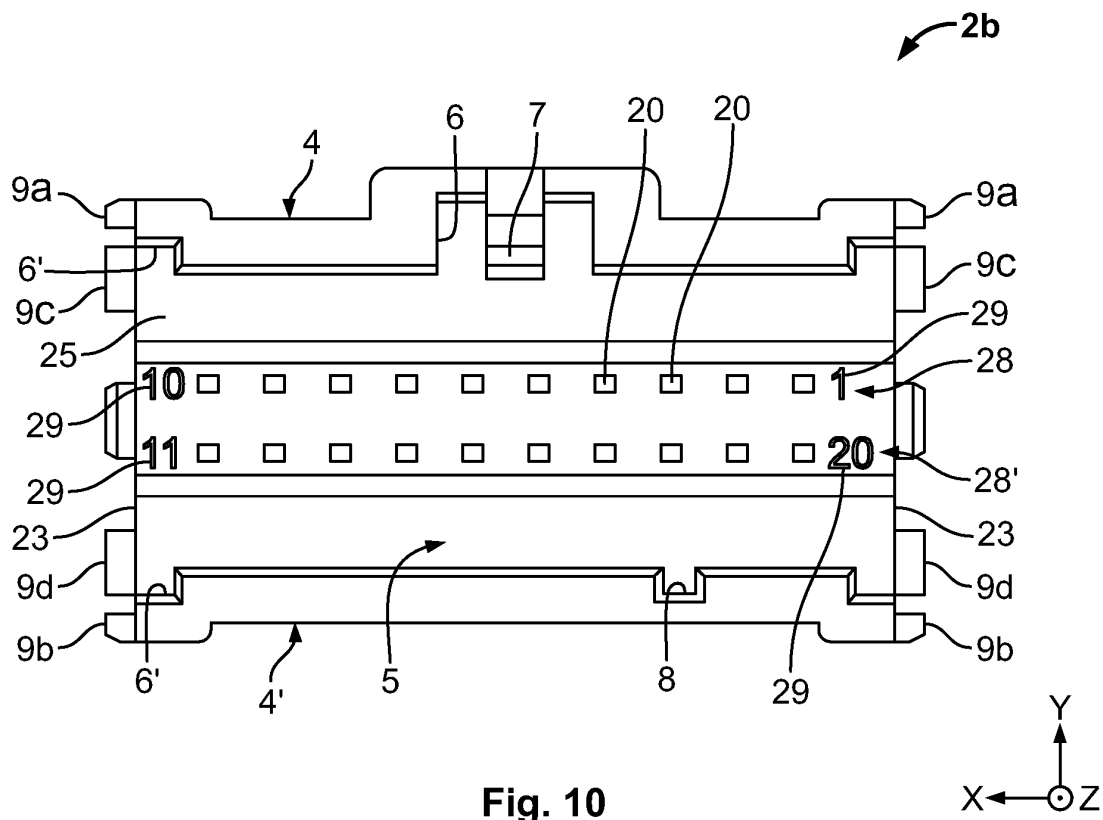


Fig. 10

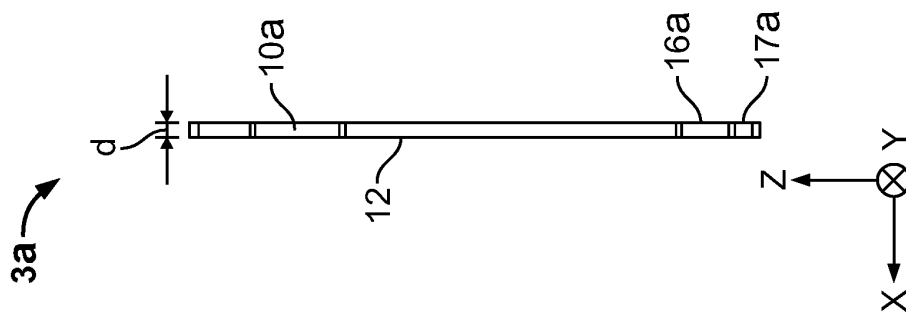


Fig. 11

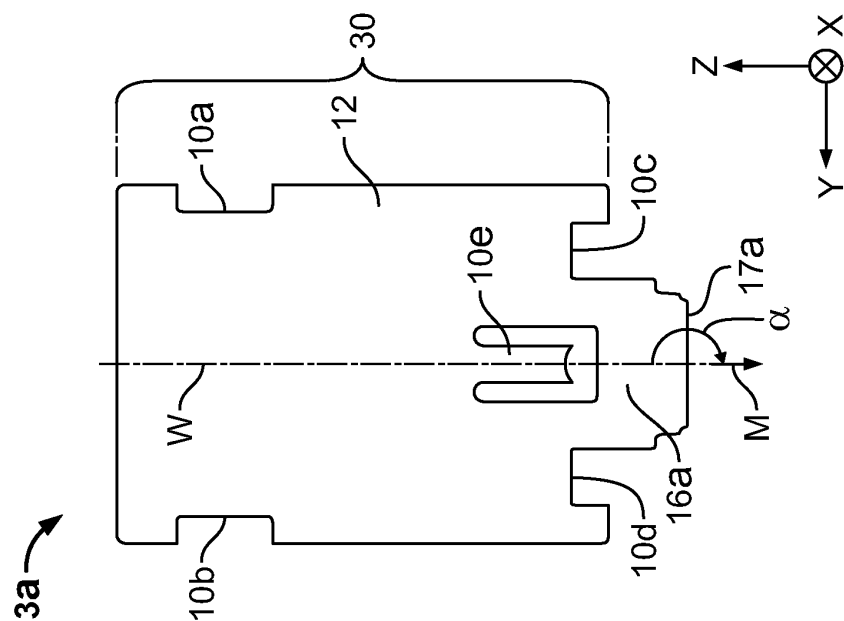


Fig. 12

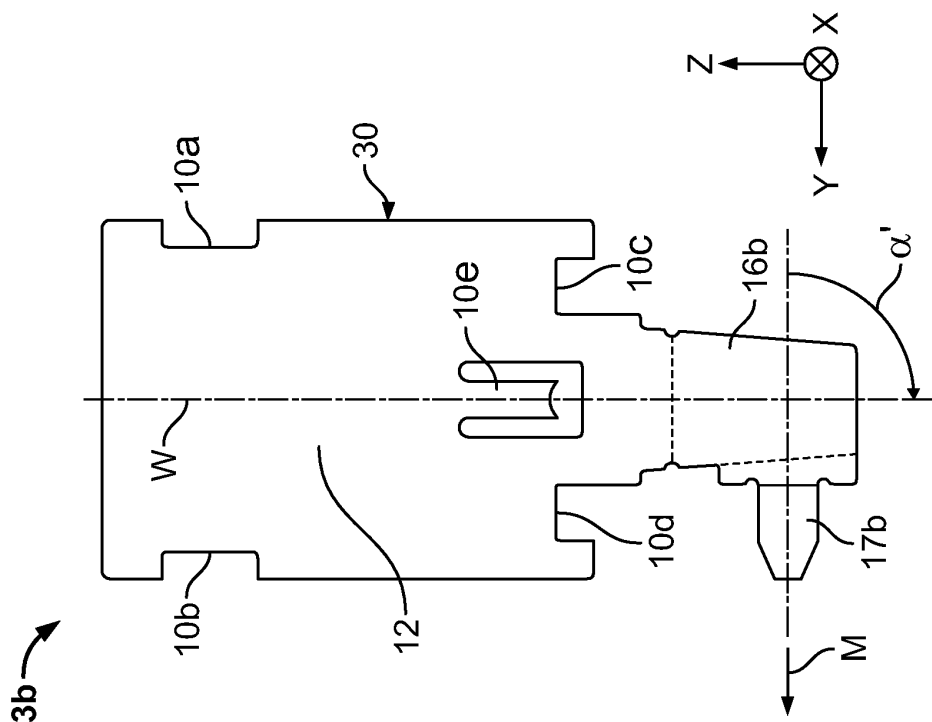


Fig. 13

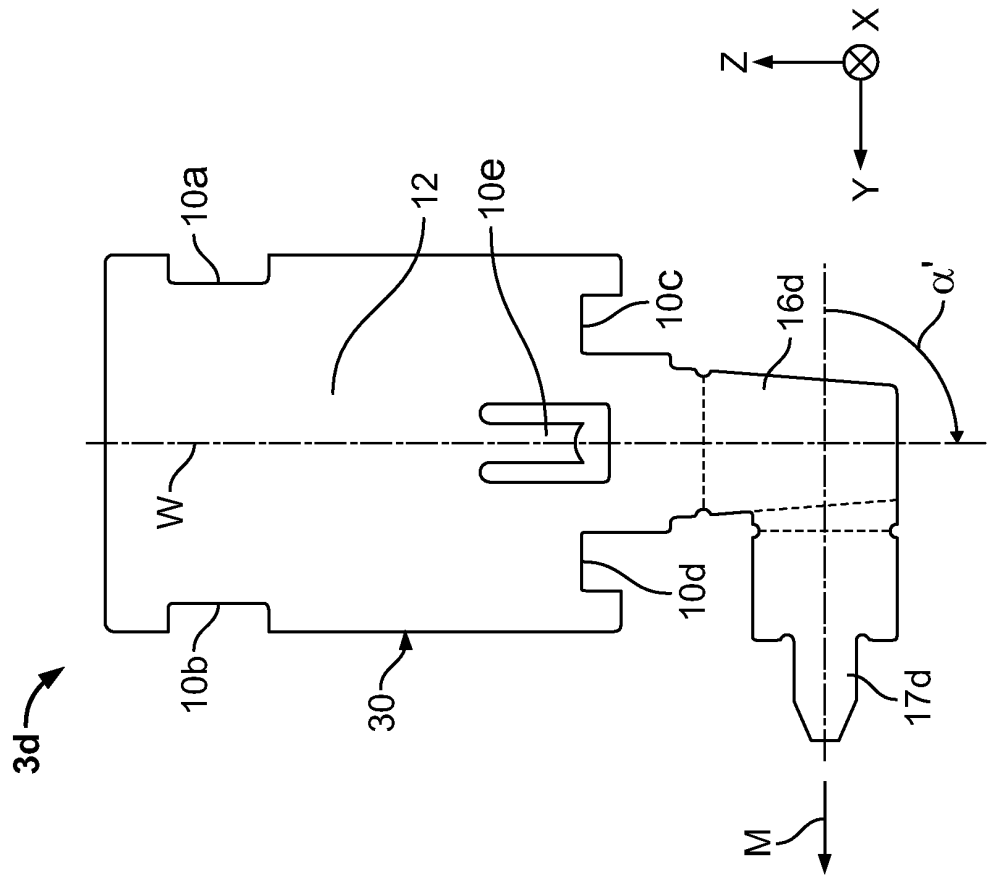


Fig. 15

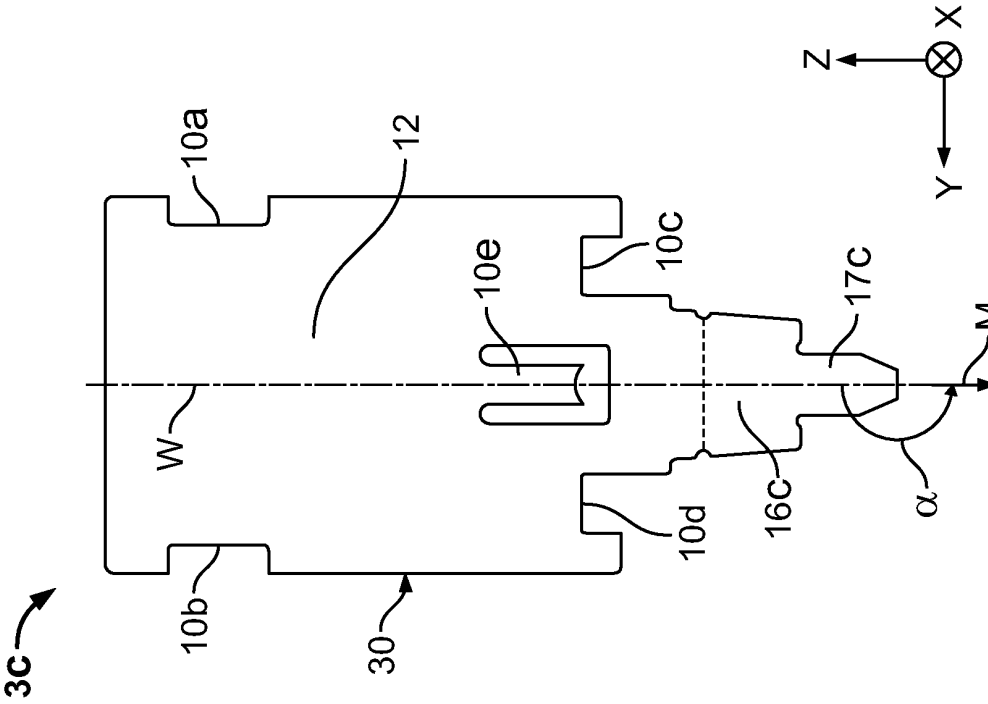


Fig. 14

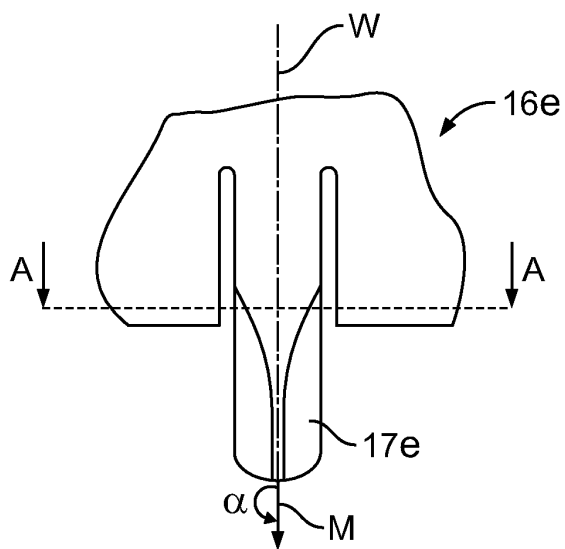


Fig. 16

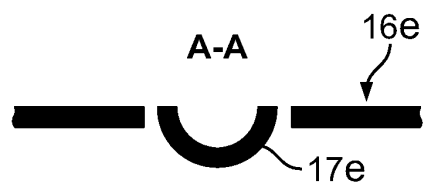


Fig. 17

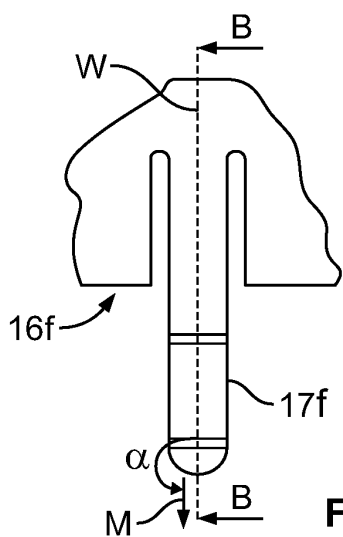


Fig. 18

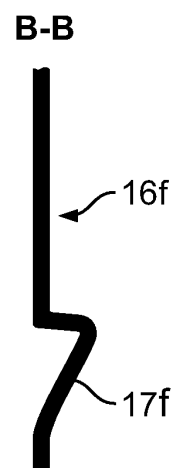


Fig. 19

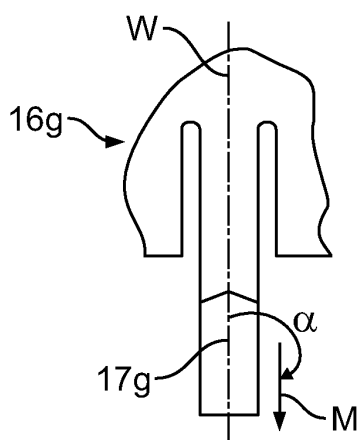


Fig. 20

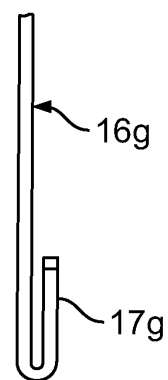
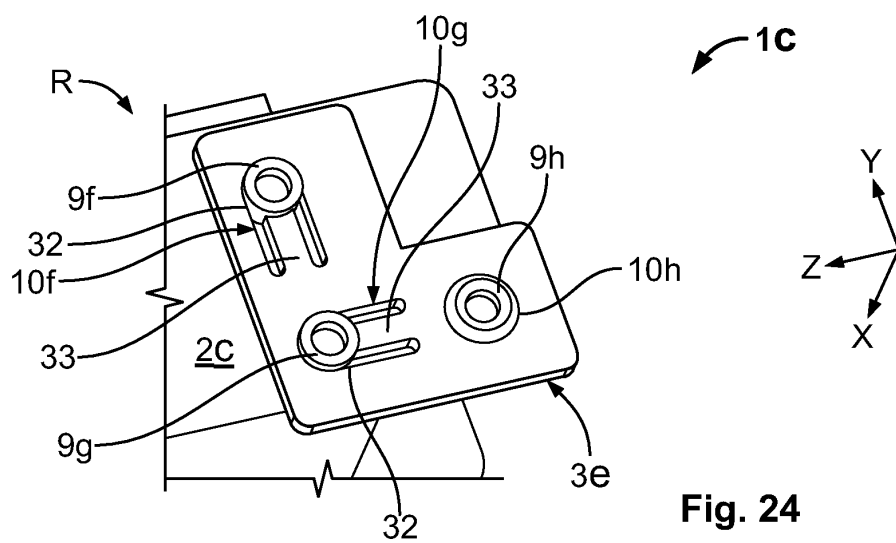
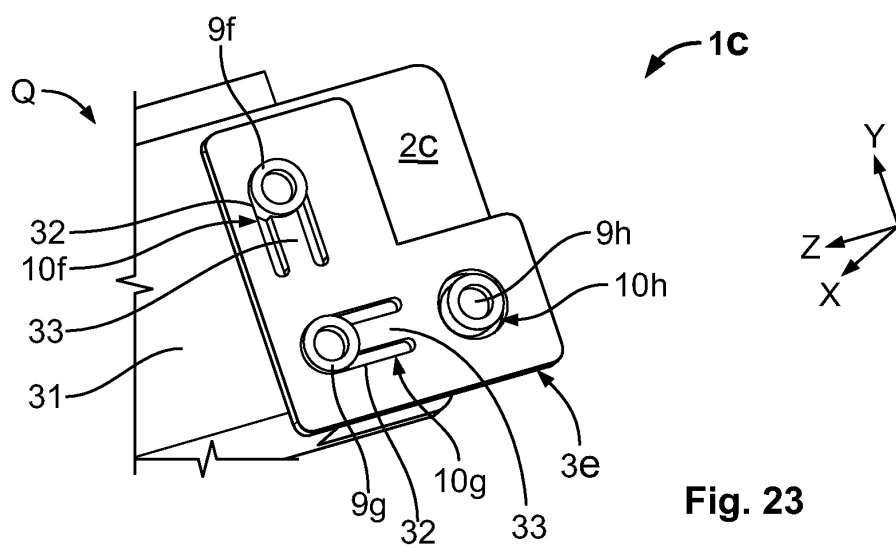
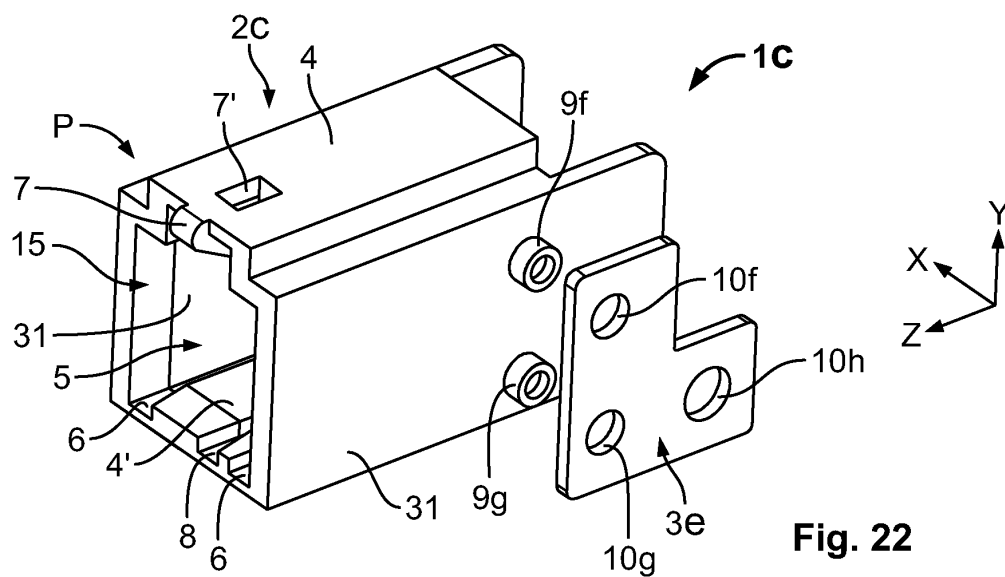


Fig. 21



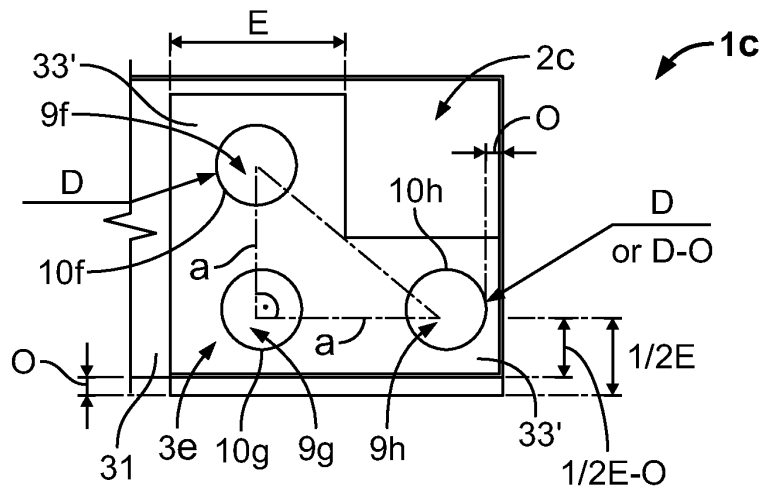


Fig. 25

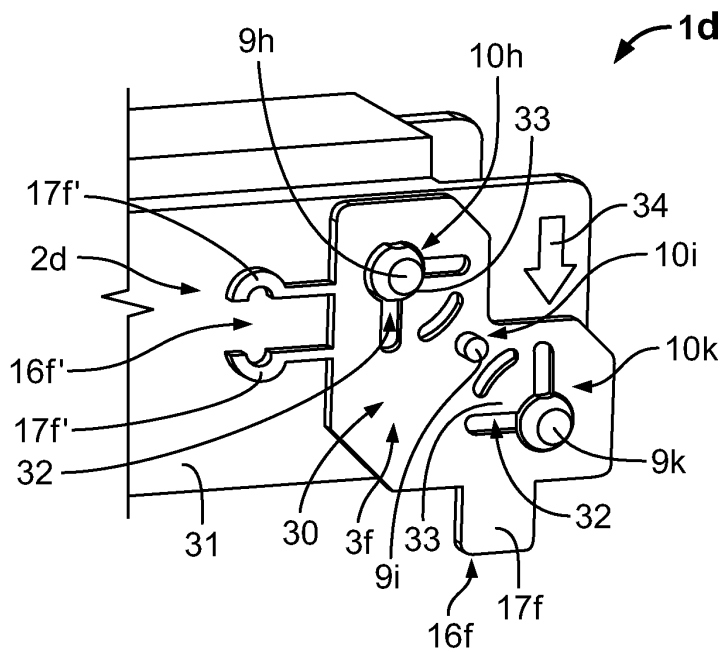


Fig. 26

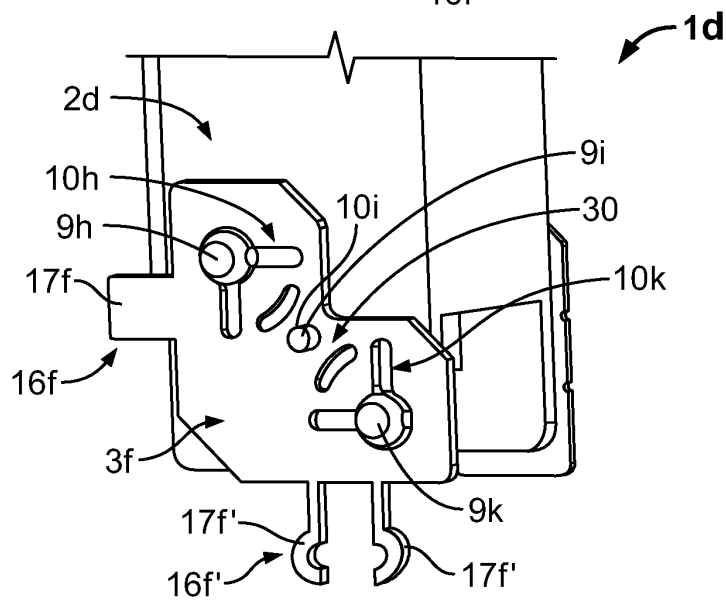


Fig. 27

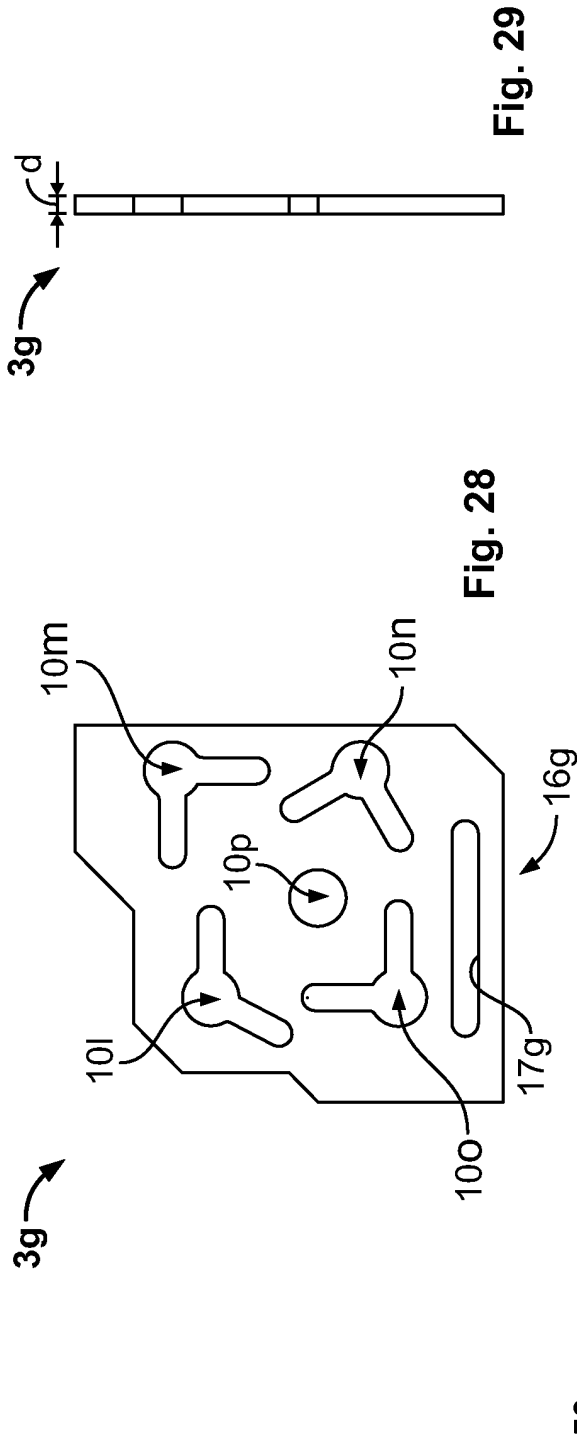


Fig. 29

Fig. 28

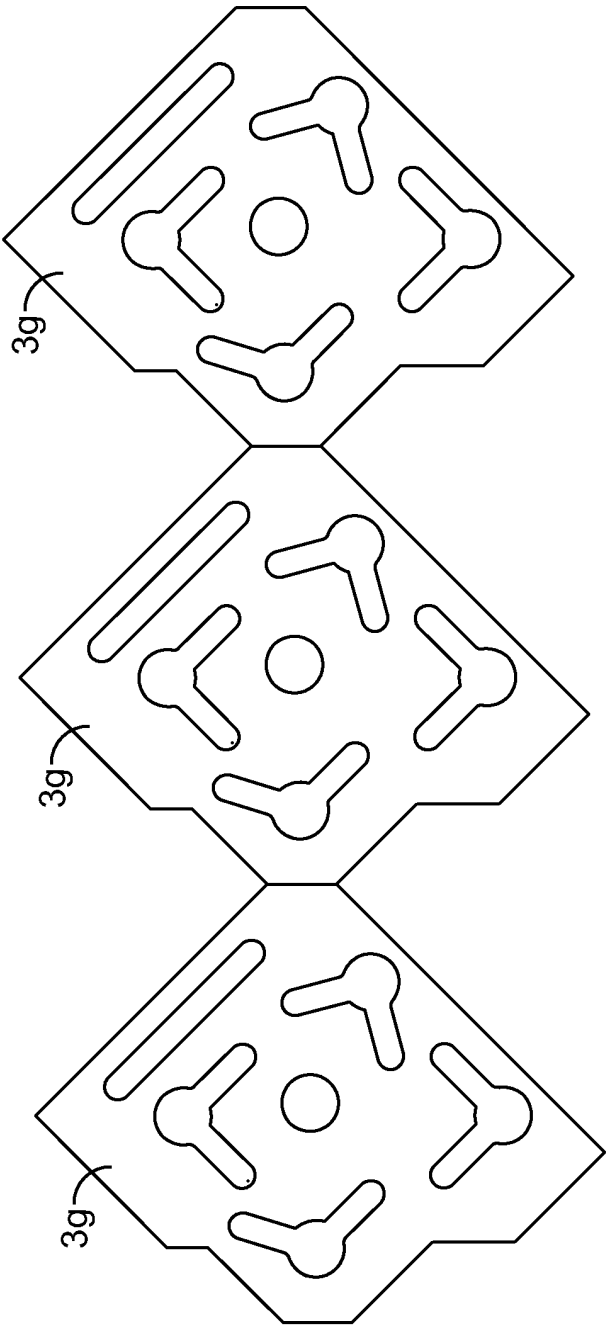


Fig. 30

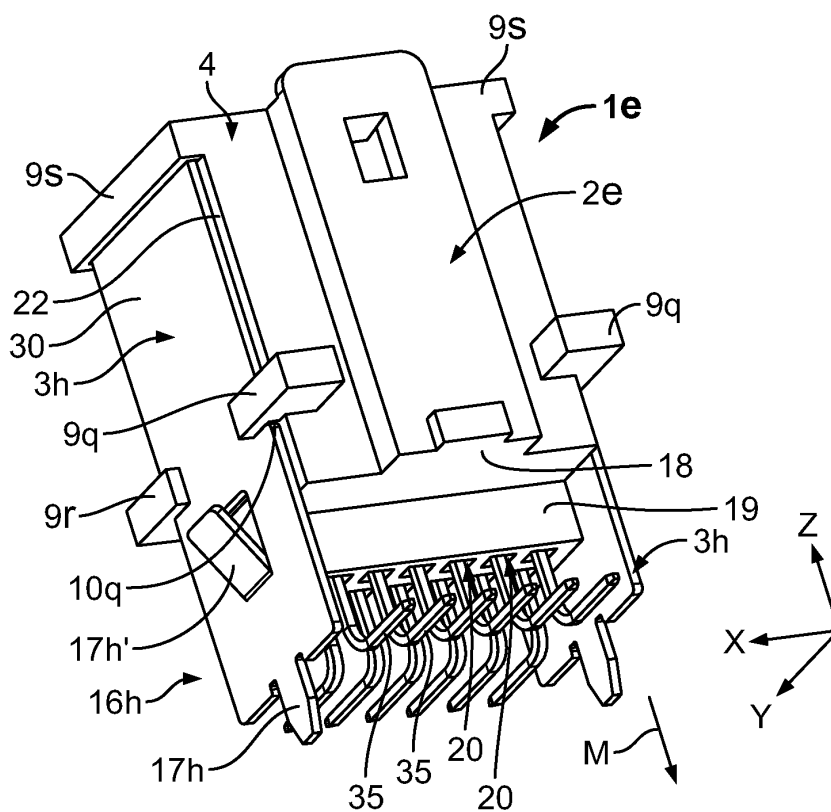


Fig. 31

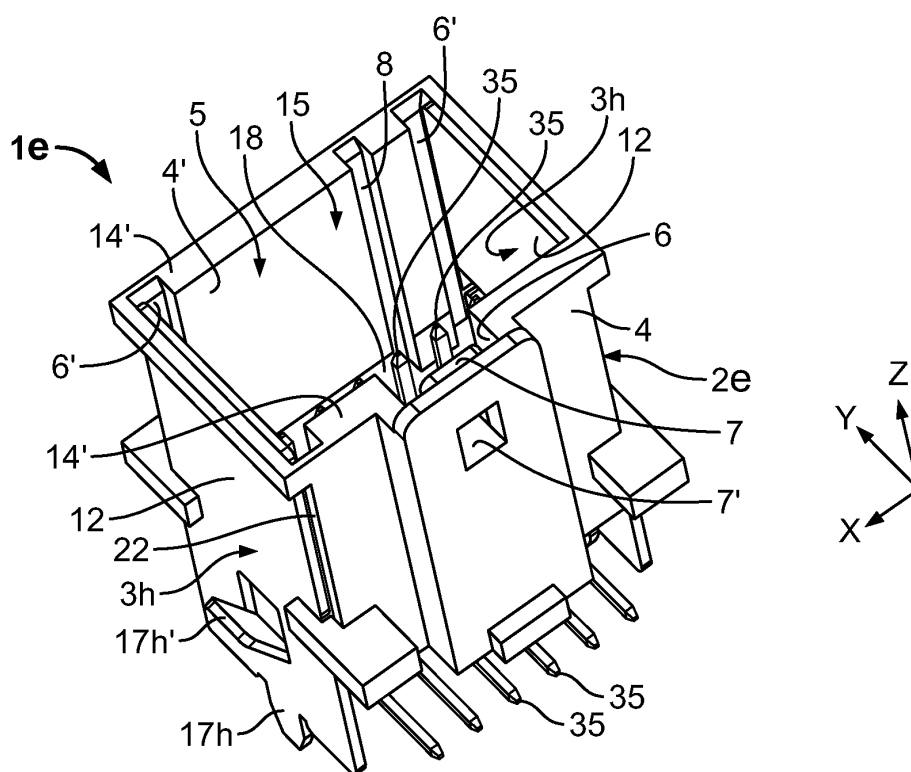
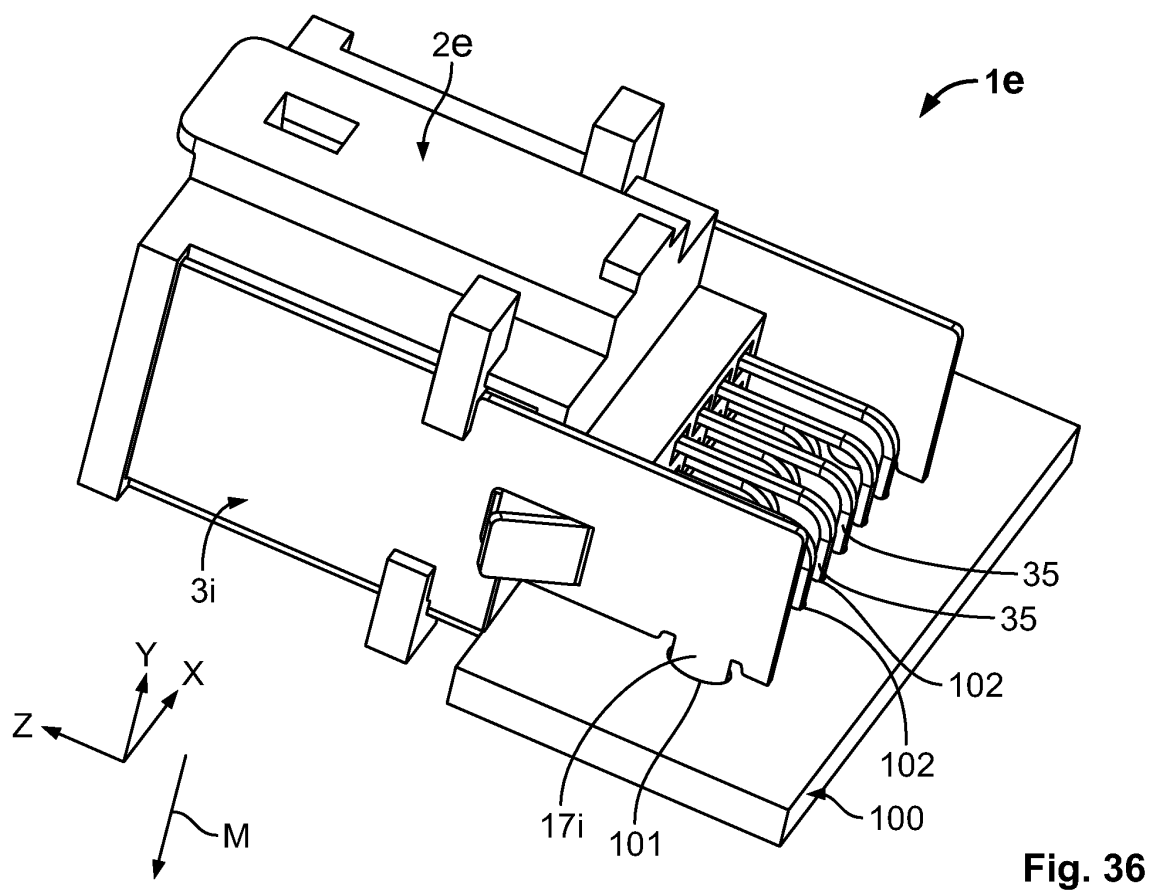
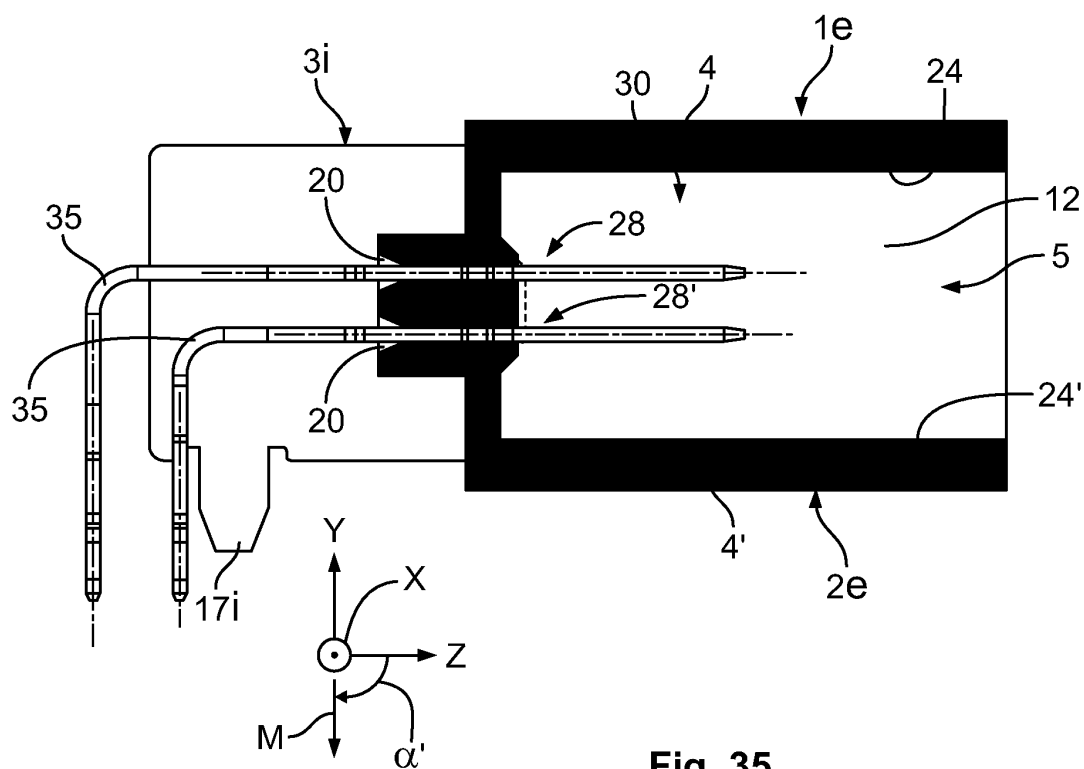


Fig. 32



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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