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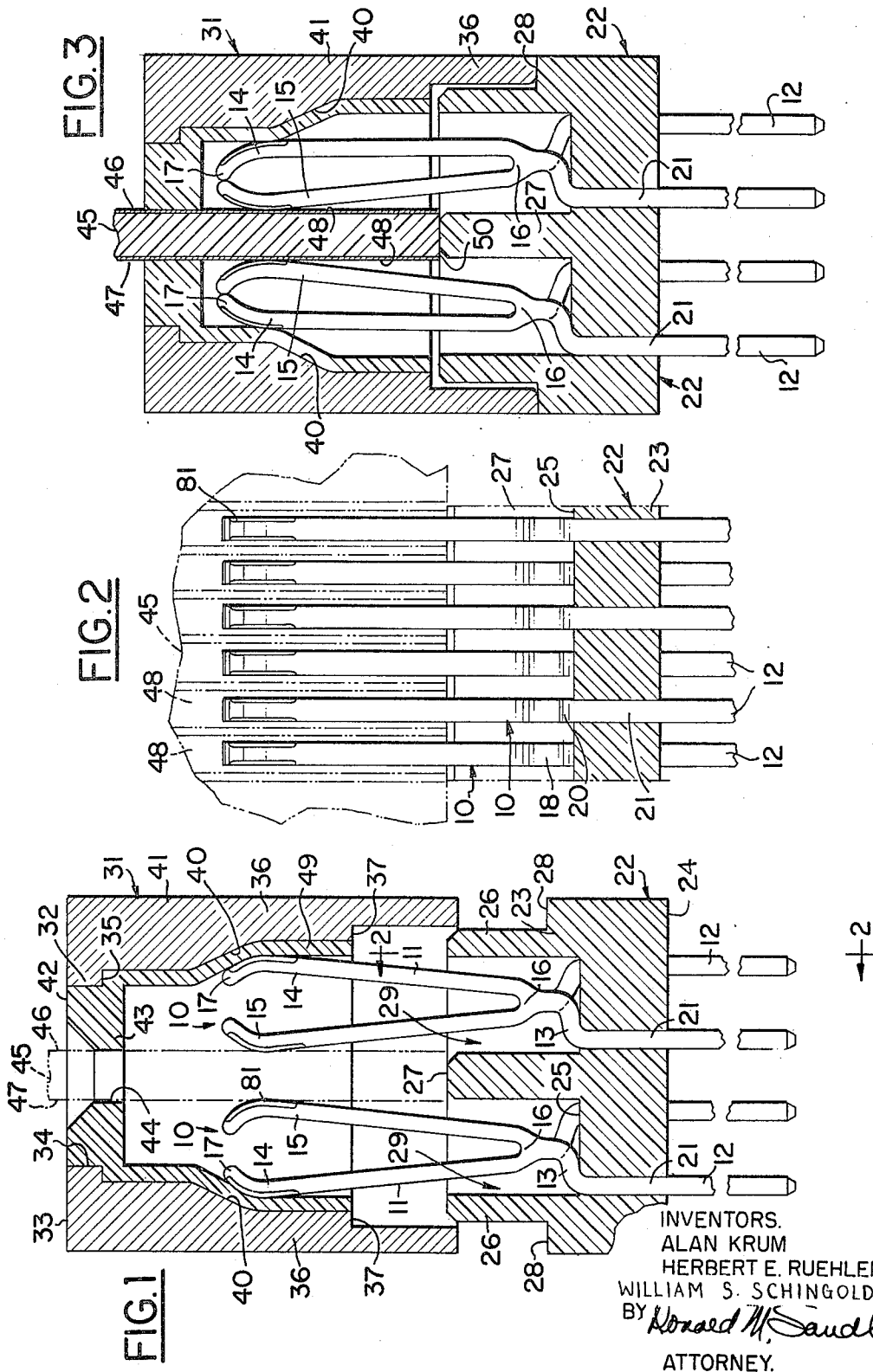
A. KRUM ETAL

3,474,387

ZERO INSERTION FORCE CONNECTOR AND CONTACT THEREFOR

Filed April 13, 1967

2 Sheets-Sheet 1



Oct. 21, 1969

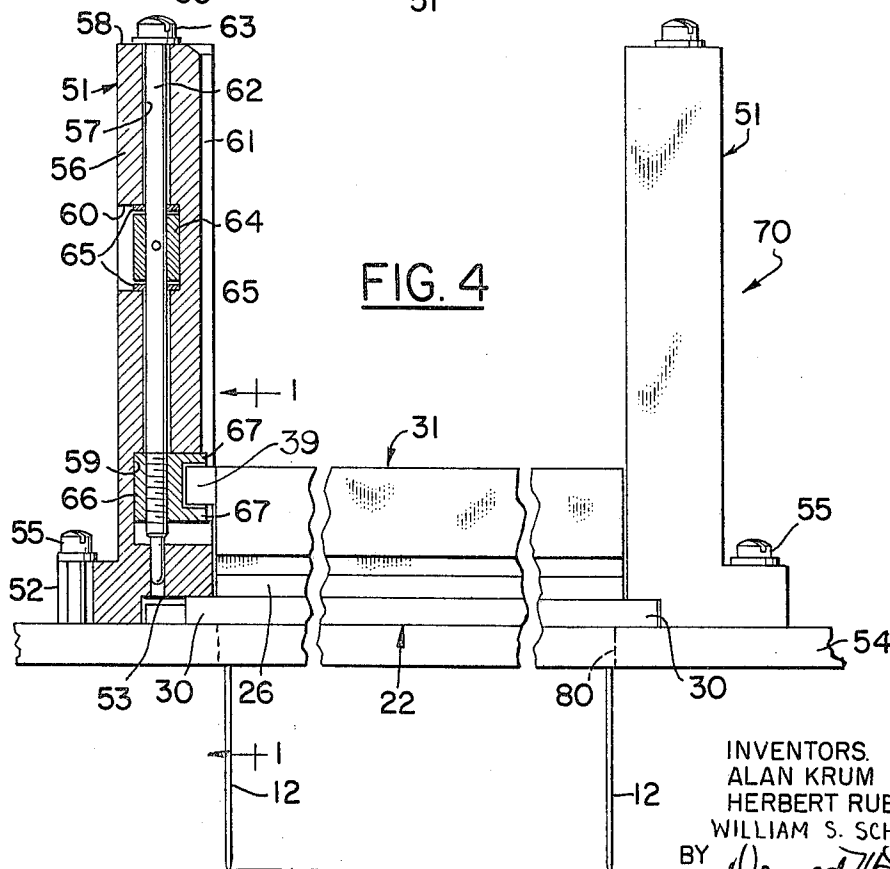
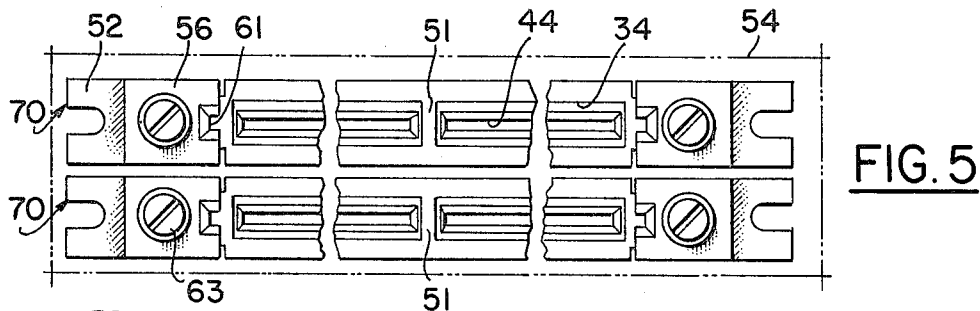
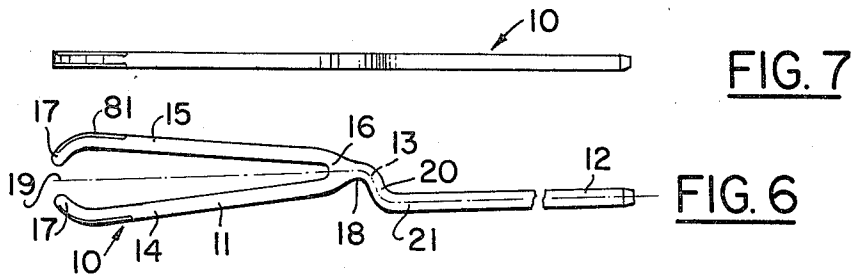
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2 Sheets-Sheet 2



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ZERO INSERTION FORCE CONNECTOR AND CONTACT THEREFOR

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Filed Apr. 13, 1967, Ser. No. 630,610

Int. Cl. H01r 13/54, 13/46; H05k 1/04

U.S. Cl. 339—75

6 Claims

ABSTRACT OF THE DISCLOSURE

A zero insertion force connector has an upper connector body translatable toward and away from a lower connector body in the same directions that a printed circuit board is inserted into or removed from the connector. The lower connector body has a stop against which a printed circuit board can rest when it is freely inserted through a slot in the upper connector body. Mounted in the lower connector body are a plurality of aligned contacts, each of which has a symmetrical U-shaped nose section defining a plane perpendicular to the printed circuit board with a first leg of the nose section being spaced from the printed circuit board and the second leg adjacent thereto. The movement of the upper connector body toward the lower connector body causes a cam surface on the upper connector body to engage the free end of the first leg of each contact and deflect such leg toward its symmetry axis. The deflection of the first leg is coupled through the web between the legs into the second leg causing it to be urged away from the symmetry axis and into electrical and mechanical engagement with a printed circuit board thereby retaining the latter in the connector.

This invention relates to a zero insertion force connector and to a contact therefor.

A zero insertion force connector is one designed to freely accept a printed circuit board without requiring the contacts mounted in the connector to mate with the respective conductive pads on the edge of the printed circuit board inserted into the connector. Thus, there is no force exerted on the printed circuit board to effect its entry into the connector and its movement to final position relative to the connector. Following insertion of the printed circuit board into the connector, mating of the contacts with the respective conductive pads is achieved by actuation of operable means effective to move the nose sections of the contacts in a plane normal to the printed circuit board into electrical and mechanical engagement therewith. At this stage, the printed circuit board is securely retained in the connector, and electrical continuity is established between the various conductive pads and the contacts.

Connectors of the type described known to the prior art generally utilize contacts whose nose sections are in the form of deflectable simple beams, and operable means in the form of a cam eccentrically mounted relative to the center line of the connector and rotatable about an axis normal to the plane within which the nose sections are deflectable. One end of the nose section of each contact is built into an insulated support, and the free end is engageable with the printed circuit board. The eccentric cam, upon rotation, engages the nose section and deflects it until the desired electrical and mechanical engagement takes place between the free end of the nose section and the printed circuit board. There are three main problems with this arrangement: (1) the cam must be approached from the lengthwise end of the connector; (2) the spring arm between the point of engagement of the cam and the free end is so short that very high stresses are

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induced in the spring arm when used with a printed circuit board whose thickness is at the maximum tolerance value; and (3) the engagement between the cam and contacts may load the bearings supporting the cam to such an extent that the cam must be supported between its ends thus limiting how closely adjacent printed circuit boards can be positioned in an installation requiring a plurality of boards.

The primary objects of the present invention, therefore, are to provide a zero insertion force connector in which the operable means for moving the nose sections of the contact is accessible from the same direction in which a printed circuit board is inserted into or removed from the connector thus eliminating the requirement for endwise access to an installation, and to provide a contact for a connector of the type described which is more effective, insofar as stresses and loading of the operable means is concerned, than conventional contacts used heretofore.

Briefly, the zero insertion force connector of the present invention has an upper connector body translatable toward and away from a lower connector body in the same directions that a printed circuit board is inserted into or removed from the connector. The lower connector body has a stop against which a printed circuit board can rest when it is freely inserted through a slot in the upper connector body. Mounted in the lower connector body are a plurality of aligned contacts, each of which has a symmetrical U-shaped nose section defining a plane perpendicular to the printed circuit board with a first leg of the nose section being spaced from the printed circuit board and the second leg adjacent thereto. The movement of the upper connector body toward the lower connector body causes a cam surface on the upper connector body to engage the free end of the first leg of each contact and deflect such leg toward its symmetry axis. The deflection of the first leg is coupled through the web between the legs into the second leg causing it to be urged away from the symmetry axis and into electrical and mechanical engagement with a printed circuit board thereby retaining the latter in the connector. Translation of the upper connector body relative to the lower connector body is effected by a screw thread arrangement mounted in the end guides of the connector with the result that the screw thread arrangement can be actuated from the top of the connector where the printed circuit board is inserted into or withdrawn from the connector.

The more important features of this invention have thus been outlined rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will also form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for designing other structures for carrying out the several purposes of this invention. It is important, therefore, that the claims to be granted herein shall be of sufficient breadth to prevent the appropriation of this invention by those skilled in the art.

The invention is described by way of example with reference to the accompanying drawing, in which:

FIG. 1 is a sectional view of a zero insertion force connector made in accordance with the present invention, and showing in phantom, a printed circuit board inserted into the connector;

FIG. 2 is a view taken generally along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view similar to FIG. 1 except the operating means has been actuated and the printed circuit board is mechanically attached to the connector by

the engagement of the contacts with the printed circuit board;

FIG. 4 is a side view of a complete zero insertion force connector with one end guide shown in section for the purpose of illustrating the operation of the invention;

FIG. 5 is a top view of a number of zero insertion force connectors illustrating how closely together the connectors can be mounted;

FIG. 6 is a plan view of an unstrained contact made in accordance with the principles of the present invention; and

FIG. 7 is a side view of the contact shown in FIG. 6.

Referring now to FIGS. 1 and 6, a contact constructed in accordance with the present invention is designated by reference numeral 10 and comprises nose section 11 interconnected to tail section 12 by body section 13. Nose section 11 is symmetrical about axis 19, and is U-shaped with a pair of legs 14 and 15 connected at one end by web 16. The free ends 17 of the lugs are curved inwardly toward each other but terminate short of engagement when the legs are unstrained. The normal or no-load position of the legs are thus shown in FIGS. 1 and 6. Integral with web 16 is body section 13 in the form of an S-shaped member, a first portion 18 of which extends away from web 16 in a direction opposite to the direction in which legs 14 and 15 extend from the web. More particularly, portion 18 is co-axial with the symmetry axis 19 of the nose section of the contact. Second portion 20 of the body section of the contact extends normal to portion 18; and third portion 21 of the body section extends parallel to portion 18 in a direction opposite to legs 14 and 15 and laterally displaced from symmetry axis 19. An extension to portion 21 forms the tail section 12 of the contact.

Preferably, the cross-section of legs 14 and 15, web 16, and portions 18, 20, and 21 of the body section and tail section 12 itself are square with the result that the contact can be stamped from a sheet of material whose thickness is the same as the tail size. The tail section, being quite long relative to its lateral dimensions and having sharp corners, is ideally suited for solderless-wrapped terminations. However, the principles of the present invention are not limited in application to square-sectioned material, or even single stage material, since the essence of the invention involves the plan configuration of the nose section of the contact as shown in FIGS. 1 and 6 plus the nature of the connector with which it is used as will be explained in more detail. The reason for the off-set nature of the tail section relative to the axis of symmetry of the nose section will also be explained in detail after the operation of the device is explained.

Contacts 10 as shown in FIG. 1 are used in combination with lower connector body 22 which has elongated base 23, the bottom surface 24 of which is plane, and the top surface 25 of which has a pair of longitudinally extending upstanding vertical walls 26 and a medial wall 27, all of which extend the length of the base but terminate short of its ends 30 (see FIG. 4). Walls 26 are indented from the lateral sides of base 23 to define steps 28, with the result that the walls 26 and 27 define a pair of side-by-side troughs 29. Rows of contacts 10 are mounted in each of these troughs with nose sections 11 projecting upwardly from top surface 25 of the base so that the free ends 17 extend above the free edge of medial wall 27. More particularly, the third portion 21 of body section 13 is embedded in base 23 of the lower connector body which, preferably, is thermoplastic insulating material such as glass-filled nylon, for example. Base 23, for this purpose, may be provided with square-holes slightly smaller than the cross-section of portion 21 of the contacts so that tail sections 12 can be forced into the holes from upper surface 25. The interference between the body section of a contact and the hole in the lower connector body serves to securely retain the contact in place. Other insulating materials and other arrange-

ments for holding the contacts to the connector body, of course, can be used without departing from the scope of the invention.

As indicated in FIGS. 1 and 2, adjacent contacts in a trough are arranged "opposite hand" which is to say that the axes of the tail sections of adjacent contacts are off-set on different sides of the axis of symmetry 19. This arrangement results in the tails of adjacent contacts being staggered to permit the connector to accommodate a printed circuit board having conductive tracks on centers only twice the thickness of the contacts. The significance of this lies in need to terminate glass or ceramic boards on which integrated circuits or memory discs are deposited. Many such boards have conductive tracks on 0.050 inch centers, and since 0.025 inch square tails are standard for making solderless-wrapped connections, this combination of dimensions would provide only 0.025 inch of clearance between adjacent tails if adjacent tails were aligned. This clearance is too small to permit conventional wrapping tools to be used on the tails. By off-setting the tail section of a contact 0.050 from the axis of symmetry of the nose section, the tails of adjacent contacts on the same side of the printed circuit board have a clearance of about 0.081 inch, corner-to-corner, even though the tails of every other contact are aligned and are located a distance of 0.100 inch apart providing a clearance of 0.075 inch. Furthermore, this arrangement, plus the symmetrical nature of the nose section, permits a single contact configuration to be used for adjacent contact locations, the change in "hand" of the contacts being accomplished by the expedient of merely turning over the contact. Thus, only one contact configuration need be stamped from a strip and this conserves inventory and facilitates fabrication.

Mounted for translatable movement toward and away from lower connector body 22 is upper connector body 31 which comprises outer shell 41 and inner shell 42. Shell 41 has an elongated base 32, the top surface 33 of which is plane and provided with closed slots 34 passing through base 32 and interconnecting top surface 33 with interior surface 35. Base 32 is provided with a pair of spaced longitudinally extending depending vertical walls 36 that are indented at their free ends on their opposite interior surfaces to define steps 37. Walls 36 terminate short of extremity 39 of base 32 (see FIG. 4). The height of walls 36 above step 37 is slightly more than the height of walls 26 above step 28 in the lower connector body for a reason to be explained.

Between step 37 and interior surface 35, the thickness of walls 36 increase to define a downwardly facing ramp 40 that extends the length of the walls 36. Preferably, shell 41 is metallic and may be, for example, an aluminum extrusion of even a die casting. Inner shell 42, on the other hand is of insulating material such as glass filled nylon or the like. Shell 42 includes base 43 which is slotted as at 44 to freely receive the edge of printed circuit board 45 on opposite surfaces 46 and 47 of which are located conductive tracks 48 which may be on centers as close as 0.050 inch as suggested in FIG. 2. Closely fitting against the interior surface of walls 36 of shell 41 are walls 49 integrally depending from base 43. The portion of walls 49 overlying ramps 40 define cam surfaces which operatively engage the free end 17 of a first leg 14 of the nose section 11 of each contact.

In the "open" position of body 31 shown in FIG. 1, printed circuit board 45 can be freely inserted into slot 44 until the edge 50 rests on the free end of medial wall 27 which acts as a stop for the printed circuit board. In such position, the free end 17 of a second leg 15 of the nose section 11 of each contact is adjacent a surface of the printed circuit board, so that when body 31 is moved to the "closed" position shown in FIG. 3 where the free ends of walls 36 abut step 28, the cam surfaces act upon free ends 17 and first legs 14 deflecting them toward their

respective axes of symmetry. This deflection of leg 14 in a contact is coupled through web 16 to leg 15 causing the latter to be urged away from the axis of symmetry and into engagement with a surface of the printed circuit board. The corners of the portion of the leg 15 engageable with the printed circuit board may be coined as shown at 81 to prevent burring of the conductive track. Since the contacts can be arranged "opposite hand," the corners of legs 14 are also coined. The geometric parameters of the nose section and portions 18 and 20 of the body section, such as the ratio of the distance of the web 16 from the built-in portion 21 of the body section to the distance of the free end 17 from the built-in portion, the total displacement of the leg 14 due to the action of ramp 40, and the cross-section of the contact material, permit a contact to be designed that will provide adequate mechanical retention of the printed circuit board, and low electrical resistance.

Because of the large tolerance values on the thickness of nominal printed circuit boards, the connector must accommodate a range of boards whose thicknesses may vary as much as 0.014 inches. For the thickest board available in the nominal size for which the connector is designed, the contact is designed so that when body 31 is "closed," the free ends 17 of the contact do not interfere with each other (see FIG. 3). The total lateral force exerted by legs 14 on walls 36 becomes considerable when a large number of contacts are involved and for this reason, shell 41 is made of metal and is provided with one or more stiffeners 51 that bridge slots 34 as shown in FIG. 5 and which function as polarizing means for the printed circuit boards. Walls 36 are further stiffened by providing the portion thereof extending beyond step 37. In this manner, the overall width of the connector is reduced to a minimum providing a capability for high-density packing of printed circuit boards.

To mount and operate the upper connector body 31, the screw thread arrangement shown in FIG. 4 is used. FIG. 4 shows a completed zero insertion force connector 70 comprising lower connector body 22, upper connector body 31 and a pair of end guides 51. The end guides are identical, and include mounting foot 52 having recess 53 which receives end 30 of body 22 and retains the latter secured to support plate 54 when bolts 55 are tightened. Plate 54 may have a slot 80 to provide clearance for tail sections 12. Extending upwardly from mounting foot 52 is post 56 provided with an axial hole 57 that extends from the free end 58 of the post to recess 53. Post 56 is also provided with actuating screw recess 59 adjacent recess 53 and thrust bearing recess 60 intermediate the ends. Card-guide groove 61 is provided in one surface of the post for receiving a lengthwise edge of a printed board and guiding the same into slot 44.

Operating screw shaft 62 contained in hole 57 has screw head 63 accessible from the top of the connector and extends through recesses 59 and 60. Collar 64, mounted in recess 60 between a pair of thrust washers 65 is pinned to shaft 62 which is threaded in the region of recess 59 and engaged with nut 66 mounted therein. Nut 66 travels upwardly or downwardly in recess 59 in response to rotation of shaft 62, and has carrier arms 67 engaged over end 39 on upper connector body 31.

To operate connector 70, a tool is inserted in screw head 63, which is accessible from the top of the connector as shown in FIG. 5, and shaft 62 is rotated until upper body 31 is translated to its "open" position spaced from lower body 22. At this stage, contacts 10 occupy their unstrained position as shown in FIG. 1, and a printed circuit board can be inserted into slot 44 in the upper body 31. There is no resistance to insertion of printed circuit board 45 whose edge 50 will rest on the free end of medial wall 27. Shaft 62 is now rotated to translate body 31 toward body 22, all of the load to accomplish this movement being taken up in posts 56 without exerting any force on the printed circuit board

or on plate 54. Rotation of shaft 62 continues until the free ends of walls 36 about step 28 at which time the bodies 22 and 31 are "closed," and contacts 10 occupy the position shown in FIG. 3.

While the nose of contact 10 is the same thickness as tail 12, it should be understood that in some applications, the nose may be thinner than the tail, in which case the contact can be stamped out of two-stage material. In addition, free ends 17 of the nose section of a contact preferably do not engage each other when a board of maximum thickness is used and body 31 is in "closed" position.

What is claimed is:

1. A zero-insertion force connector comprising:

(a) an upper and lower connector body mounted for movement toward and away from each other in the same directions that a printed circuit board is adapted to be inserted into or removed from said connector; (b) said upper connector body having a longitudinal slot large enough to freely receive an edge of a printed circuit board;

(c) a plurality of contacts, each having a symmetrical U-shaped nose portion defined by a pair of legs connected by a web;

(d) said contacts being mounted in said lower connector body so that the nose portions of said contacts lie in parallel, spaced planes, perpendicular to the printed circuit board when the latter is received in said slot; and

(e) means on said upper connector body cooperable with one leg of each pair of legs of said contacts, when the connector bodies move toward each other, for deflecting said one leg of each pair of legs whereby the other leg of each pair of legs is deflected into electrical and mechanical engagement with said printed circuit board.

2. A zero-insertion force connector comprising:

(a) a lower connector body adapted to receive an edge of a printed circuit board;

(b) a plurality of contacts, each with a symmetrical U-shaped nose portion having a pair of legs connected by a web;

(c) the free ends of the legs of each contact being curved inwardly toward one another but terminating short of engagement when the legs are unstrained;

(d) each contact having a body section connected to the web and extending away therefrom in a direction opposite to the direction in which said legs extend from the web;

(e) said contacts being mounted by the body section thereof in said lower connector body so that the nose portions of said contacts lie in parallel, spaced planes, perpendicular to the printed circuit board when the latter is received in said lower connector body, and one leg of each contact is remote from, and the other leg of each contact is adjacent to, the printed circuit board; and

(f) operable means for selectively deflecting said one leg of each contact in a direction toward the axis of symmetry whereby the deflection of said one leg is coupled through the web to the other leg causing the latter to be urged away from said axis of symmetry and into engagement with the printed circuit board.

3. The combination of claim 2 wherein said contact includes an elongated sharp-cornered tail section whose axis is displaced from the axis of symmetry, said combination including a second contact identical to the first mentioned contact attached to the lower connector body so that the axis of symmetry of the contacts define a symmetry plane and the respective axes of the tail section are located on opposite sides of said symmetry plane.

4. The combination of claim 2 wherein said operable means includes:

(a) an upper connector body mounted for movement toward and away from said lower connector body in

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the same directions that a printed circuit board is adapted to be inserted into or removed from said lower connector body; and

(b) cam means on said upper connector body engaged with said first leg when the bodies are apart from each other, whereby movement of the bodies together causes said cam means to deflect said first leg toward the axis of symmetry.

5. The combination of claim 4, including an end guide having a free end into which an edge of a printed circuit board is adapted to be inserted for guiding the latter when it is inserted into the combination until another edge rests on said stop, said end guide having actuating means accessible from the direction of the free end of said end guide for operating said operable means.

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6. The combination of claim 4 wherein upper connector body comprises an outer metallic shell and an inner insulating shell that engages said contact, and said actuating means including a screw-thread arrangement.

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