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Occhipinti et al.

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[54] **ELECTRICAL CONNECTOR**

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[52] **U.S. Cl.** ... **339/156 R**, 339/151 B, 339/176 MP

[51] **Int. Cl.** **H05k 1/07**

[58] **Field of Search** ..... 339/18 R, 18 C, 108 TP, 339/149 P, 150 B, 151 B, 156, 176 MF, 176 MP, 17 R, 17 E, 17 F, 17 L, 17 LC, 17 LM, 17 M

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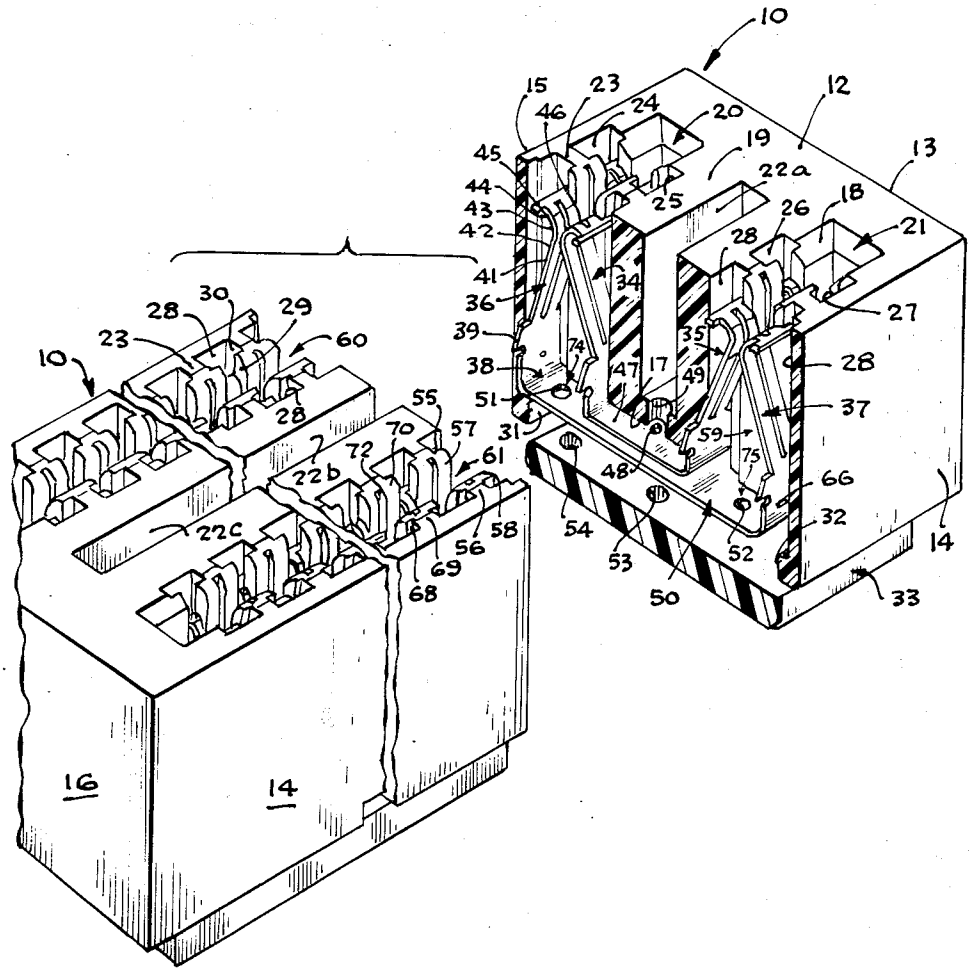
[57] **ABSTRACT**

An electrical connector for flat circuit bearing elements such as printed circuit boards is provided and includes an insulating housing with exterior surfaces including front and rear faces and a pair of elongated channels extending from the front face rearwardly into the housing for receiving the printed circuit boards, the rear face of the housing including a plurality of apertures extending into the housing for electrical access to the interior of the housing, and a plurality of metallic contacts including active portions spaced along and extending into the channels for engagement with conductive elements on the printed circuit boards and bridging portions interconnecting pairs of active portions in the housing, with at least one bridging portion overlying a second bridging portion with respect to the rear face and including an aperture aligned with one of the apertures from the rear face to provide electrical access to the underlying bridging portion.

9 Claims, 9 Drawing Figures



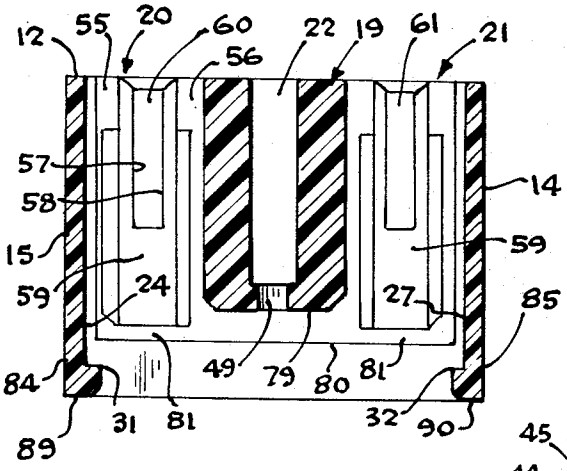


Fig.2

Fig.1

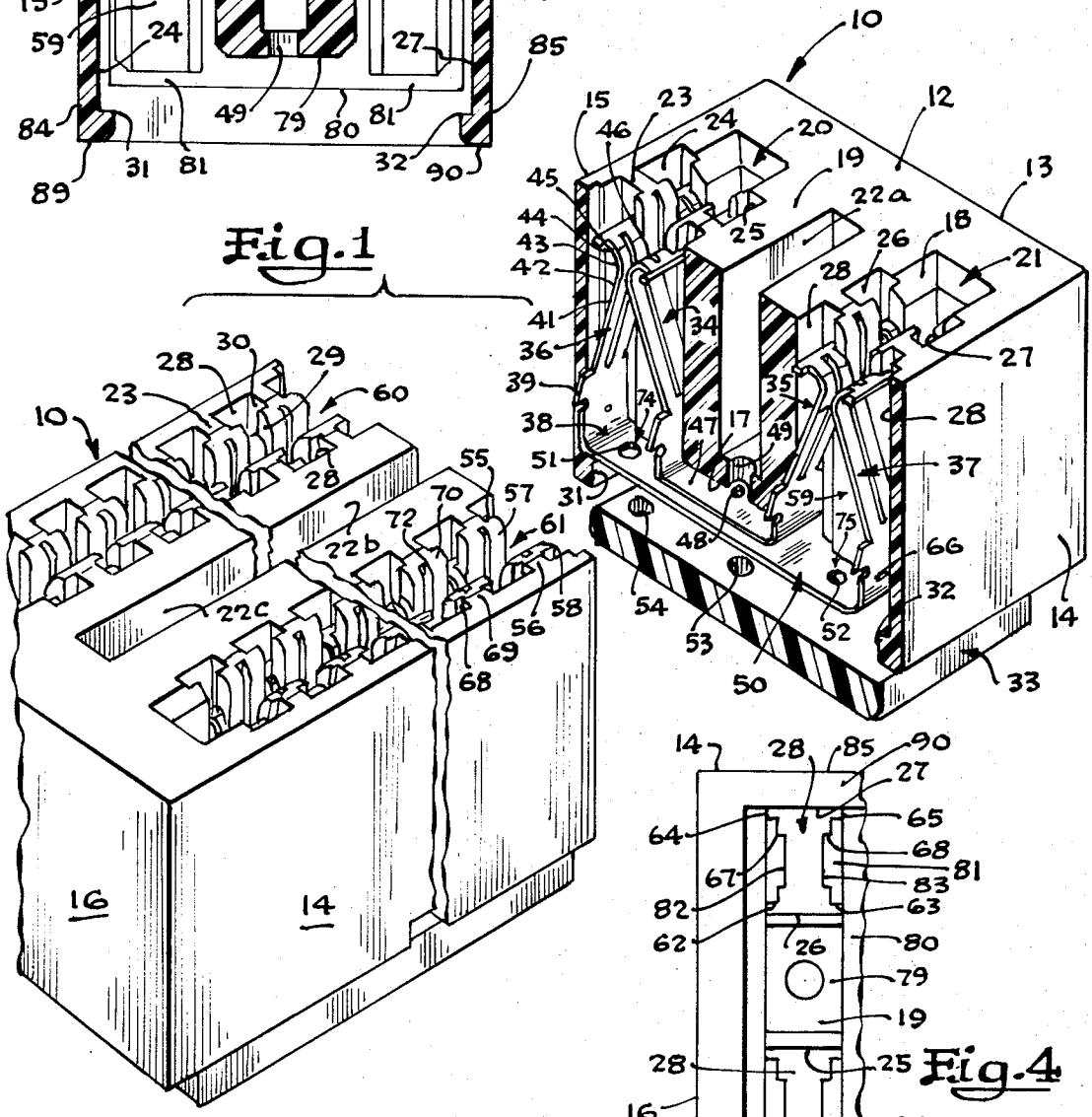


Fig.4

Fig.3

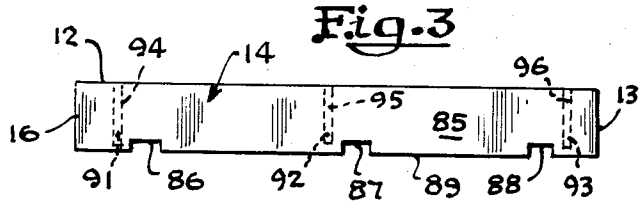
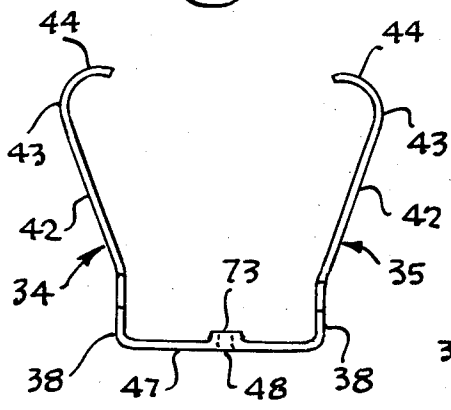


Fig.5



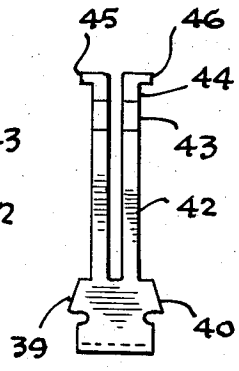


Fig.6

Fig.7

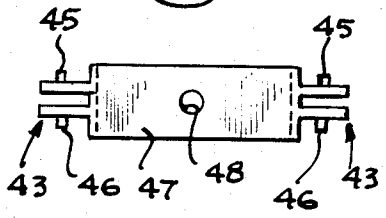
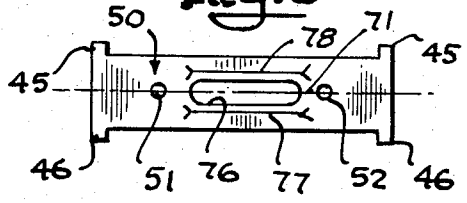


Fig.8



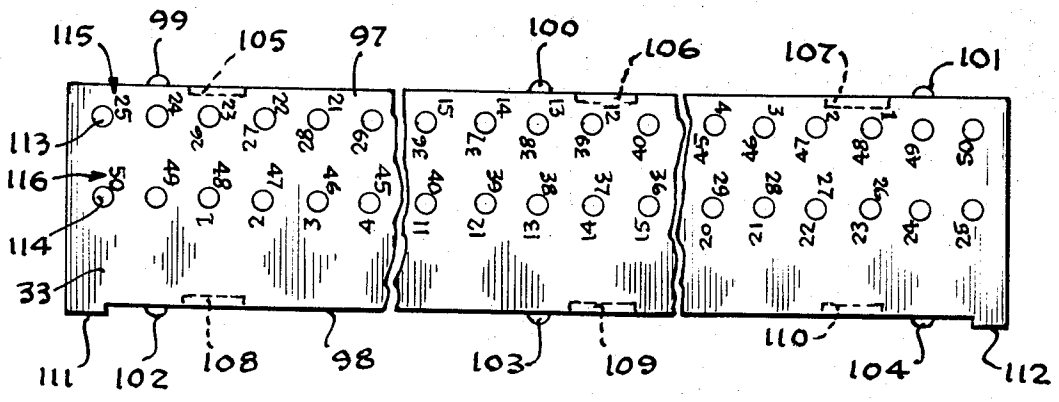


Fig.9

ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

Electrical connectors for flat circuit bearing elements such as printed circuit boards having a plurality of conductive pads commonly are constructed of an insulating housing with one or more long, narrow channels on a front face and a plurality of metallic contacts with mounting portions rearwardly disposed internally in the housing. Active portions on the contacts are spaced along one or both sides of each of the channels to electrically engage conductive pads spaced along one or more edges of the printed circuit board when inserted into the channels.

In those connectors having a pair of parallel channels extending longitudinally between opposite external sidewalls, the contacts are often arranged along both sides of the channels so as to form two centrally located inner rows and two laterally separated, oppositely disposed outer rows of contacts. With respect to one or more adjacent exterior longitudinal side surfaces, the outer contacts cover or overlie corresponding portions of the inner contacts. Although generally satisfactory for many purposes, this arrangement of contacts limits electrical accessibility to the underlying inner contacts from those exterior surfaces, thereby reducing the usefulness of the connectors for test and other purposes.

In addition, it has been desirable in the multichanneled connectors to electrically interconnect various combinations of oppositely positioned contacts in the same channel or different channels without first removing the printed circuit boards. While these connections can be made through the use of external conductors, internal interconnection can be an advantage with respect to cost, insulative protection, and other factors. However, if other contacts are in the direct path between those contacts to be interconnected, maintaining the insulative protection of the intermediate contacts becomes a problem.

A further problem with these electrical connector involves the sometimes conflicting requirements of adequate mounting of the contacts in the insulative housing and adequate interconnecting of opposed contacts. Frequently, the contact mounting portion is constructed of a thin, narrow metallic strip and is rigidly secured in the connector to support a movable cantilever beam in the active portion. If the width of a contact mounting portion is reduced to permit opposite contacts to be interconnected, the effectiveness of this mounting portion as a rigid support for the movable beam can be significantly limited.

As the above factors are considered in the construction of the connector, other problems are encountered. These relate to the desirability of constructing an insulative housing of a limited number of parts while providing ease in mounting the contacts and advantageously providing interconnections between contacts prior to their mounting in the connector. In some instances, it is also desirable to provide limited accessibility to the inner contacts for test and other purposes while permitting increased accessibility under other circumstances.

In view of the above, it is desirable to provide new electrical connectors with features providing one or more of the advantages described herein.

SUMMARY OF THE INVENTION

This invention relates to an electrical connector in which portions of one or more contacts overlie portions of other contacts in respect to an exterior surface of the connector and electrical access is provided to the underlying portions without electrically engaging the overlying contacts. More particularly, the invention relates to an electrical connector provided with a multiplicity of electrical contacts arranged along opposite sides of two or more long, narrow channels adapted to receive flat circuit bearing elements and in which at least a portion of the electrical contacts are interconnected internally in the housing.

The connector includes an insulating housing with exterior surfaces including a front face provided with a cavity formed as one or more channels to receive one or more printed circuit boards in a conventional manner. A plurality of metallic contacts are carried by the housing and include active portions arranged along each channel to engage conductive elements on a printed circuit board during insertion into the channel. At least two of the contacts include portions disposed within the housing with one of the contact portions overlying the other with respect to an adjacent exterior surface.

The adjacent exterior surface of the housing includes a plurality of apertures extending transversely from the surface into the housing to provide electrical access to contact portions for test or other purposes. Preferably, the overlying contact portion includes an access portion with an aperture aligned with one of the apertures in the housing to permit access to the underlying contact portion. Preferably, the aperture in the contact portion is a size larger than the aperture in the housing to prevent inadvertent simultaneous electrical engagement with both contact portions.

Advantageously, the connector is constructed to include these four contacts arranged in two pair of contacts, with each pair being interconnected by an electrical bridge. One of the bridges is arranged to overlie the other and contains an aperture of sufficient size and formed to align with one of the apertures in the housing to provide electrical access to the underlying bridge portion of the contact pair.

Advantageously, the overlying bridge forms part of a one-piece electrical element which includes a pair of spaced-apart metallic contacts with active portions for engagement with conductive elements on a printed circuit board, and interconnecting bridge portion providing an electrical path between the active portions, and an access portion with an aperture in an arrangement and of sufficient size to permit electrical access to the underlying portion of another conductive element in the housing.

Preferably, the one-piece electrical element also includes a plurality of spaced-apart mounting means which coact in rigidly securing each of the two contacts in the insulative housing. Guide means are also provided in the insulative housing through which the contacts can be inserted and their action portions biased in respect to the cavity forming the channels.

The electrical connector of the invention includes a number of advantages. A plurality of printed circuit boards can be mounted in the connector and portions of their circuits can be internally interconnected. In addition, electrical access is individually provided to the

inner and outer contacts from exterior surfaces in which the outer contacts essentially cover substantial portions of the inner contacts. Also, each of the pairs of contacts can be electrically bridged prior to being assembled in the connector by the use of the one-piece electrical element. A further advantage is that a plurality of mounting means are provided on each bridged pair of contacts and coact to securely position the contacts in the connector. Guide tracks are also provided to guide the active portions of the contacts frontwardly in the connector during rear mounting of the contacts.

In addition to the above advantages, the connector includes a releasable cover which provides both limited and increased electrical accessibility to the bridged inner and outer contacts. The cover also includes indicia in association with a plurality of access apertures to identify the contacts accessible by the apertures. A further advantage of the cover construction is its recessed surfaces in alignment with openings in the connector through which a wedge-like tool can be inserted for removing the cover from the insulative housing.

DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view partially in cross section of an electrical connector of the invention.

FIG. 2 is the cross-sectional view in FIG. 1 without the interconnected pairs of contacts being positioned in the connector.

FIG. 3 is a reduced side view of the electrical connector of FIG. 1.

FIG. 4 is a partial view of the underside of the connector of FIG. 1.

FIG. 5 is a side view of a bridged pair of inner contacts shown in FIG. 1.

FIG. 6 is an end view of the contacts shown in FIG. 5.

FIG. 7 is a rear view of the contacts shown in FIG. 5.

FIG. 8 is a rear view of a bridged pair of outer contacts shown in FIG. 1.

FIG. 9 is a rear view of a rear cover plate with apertures and indicia to identify underlying contacts.

DETAILED DESCRIPTION

The electrical connector of the invention comprises an insulating housing having exterior surfaces including front and rear faces and a pair of elongated channels extending from the front face rearwardly into the housing for receiving printed circuit boards. The rear face includes a plurality of apertures extending into the housing for electrical access to the interior and with a plurality of metallic contacts mounted therein. Active portions are provided on the metallic contacts and are arranged to extend into each channel for engagement with conductive elements on the printed circuit board.

More specifically, the connector includes a plurality of long, narrow channels which are open at the front face of the insulating housing and extend rearwardly into the housing. A plurality of metallic contacts are mounted internally in the housing and include active portions spaced along each of the longitudinal sides of the channels. Advantageously, each pair of the metallic contacts is interconnected by an electrical bridge portion which is disposed rearwardly in the connector housing, extends laterally between contacts in a direction parallel to the front face of the housing, and combines with active portions to form a one-piece electrical element.

An insulating cover is provided on the housing to protect portions of the electrical bridges from accidental electrical connection by external conductors. However, access to the protected electrical bridges is obtained by a pattern of apertures arranged on the rear cover with adjacent indicia to enable electrical access to individual electrical bridges in the connector and to identify those contacts. While the cover is adapted to be securely fastened in the insulating housing, recessed surfaces in the cover are aligned with adjacent cutout wall sections of the insulating housing to enable the release of the cover at appropriate times. Advantageously, these form slits adaptable to receive a wedge-like tool to force the cover means away from the insulating housing.

Metallic contacts are rearwardly mounted in the housing and are secured by inwardly tapered barbs on each of the mounting portions of the contacts. The mounting portions are disposed rearwardly in the housing and extend frontwardly therefrom in a direction generally normal to the front face. Advantageously, they are forwardly disposed in respect to the electrical bridge portion and securely fasten the interconnected contacts in the housing. The active portion on each contact extends frontwardly from the mounting portion and comprises a bifurcated, yieldable, free-standing bow interconnected to the mounting portion by a bifurcated ribbon inclined rearwardly from the bow to position the bow either inwardly or outwardly in respect to the mounting portion depending on whether the contact will be inserted in the inner or outer longitudinal sides of the channels. Frontwardly extending from the free-standing bow is a bifurcated free-ended flat tip with opposite coplanar ears adapted to bear against shoulders in the contact pockets to preload the bow in respect to its associated channel.

The connector includes a plurality of spaced-apart, U-shaped barrier walls aligned longitudinally along each channel with cutout portions aligned longitudinally to form a central slot. The surfaces of the barrier walls adjacent the slot extend laterally therefrom to form with surfaces of adjacent barrier walls, contact-receiving pockets in which the contacts are mounted and loaded. Opposite surfaces of each pocket are stepped to form a plurality of guide tracks to guide the active portion into the connector during assembly of the contacts. The pockets extend rearwardly in the connector housing and serve to receive the previously interconnected pairs of contacts. Each pair of interconnected contacts is advantageously rearwardly mounted in the insulating housing in which a dummy printed circuit board has been previously inserted.

In the mounting operation, the active portions of each pair of contacts are inserted in guide tracks of their respective oppositely disposed pockets and forced frontwardly. The free-standing bow bears against the dummy board which prevents the bow from laterally entering into its associated slot. In the rear portion of each pocket are provided mounting surfaces laterally separated from the slot adjacent a flat side of a channel which serves as a support wall for the barbed mounting portion. As the active portion becomes frontwardly disposed in the connector, the barbs bite into the mounting surfaces and secure each interconnected pair of contacts in the connector housing. The dummy board

is then removed causing the bows to spring into the slots a distance determined by the ears which bear against shoulders oppositely disposed in their associated slot.

The relationship of the various features may be understood upon reference to FIGS. 1–9. As illustrated, in FIGS. 1–4, the connector comprises an insulating housing 10 with exterior surfaces 12-17 which includes front face 12, rear face 17, and sidewall sections 13-16 enclosing cavity 18. Cavity 18 is divided by bar 19 which longitudinally extends internally between walls 13 and 16 and from front face 12 to rear surface 17 to divide cavity 18 into channels 20 and 21. Openings 22 provide equivalent cooling of each side of channels 20 and 21 to limit internal stresses.

Also provided in the insulating housing 10 are a plurality of spaced-apart, U-shaped barrier walls 23 disposed longitudinally along sidewalls 24-25 of channel 20 and sidewalls 26–27 of channel 21 and extending inwardly therefrom in opposite directions. As illustrated, adjacent barrier walls 23 form oppositely disposed contact pockets 28 with parts of guide tracks 29 and 30. The extremities of wall sections 14–15 are provided with internal undercut sections 31 and 32 adapted to fasten rear cover 33 over rear surface 17 of housing 10.

A plurality of spaced-apart contacts are disposed along each of the sidewalls 24–27 and include pairs of opposed inner contacts 34–35 and pairs of opposed outer contacts 36–37. Each of the contacts 34–37 include a mounting portion with a central web 38 and coplanar oppositely disposed mounting barbs 39–40 (more clearly illustrated in FIGS. 5–6). Extending frontwardly from each mounting portion is an active portion 41 which includes a bifurcated inclined ribbon 42, bow 43 and upper tip 44 with oppositely disposed coplanar ears 45–46.

Inner contacts 34–35 include an interconnecting electrical bridge 47 illustrated as a flat strip apertured at 48 and aligned with opening 49 in bar 19 to provide support for a test probe (not illustrated). Outer contacts 36–37 are also interconnected by rearwardly disposed electrical bridge 50 apertured at 51–52 to similarly provide support for test probes (not illustrated). Electrical bridge 50 is separated from and overlies inner bridge 47 with respect to rear surface 17. Cover 33 includes apertures 53-54 respectively positioned to aligned relationship over apertures 48 and 51 to provide electrical access thereto. In FIG. 1, cover 33 is not apertured over aperture 52 since bridge 50 is accessible by aperture 54.

U-shaped barrier wall3 23 are of stepped construction to provide guide tracks 29–30 for bow sections 43 and upper tips 44 of the contacts. Each of the barrier walls includes two legs 55–56 with inner surfaces 57-58 and a central web 59 forming the U-shape. Surfaces 57–58 and web 59 of each of barrier walls 23 form cutout portions aligned longitudinally in channels 20 and 21 to form element-engaging slots 60–61.

In assembling contacts 34–37 in housing 10, the inner pair of contacts 34–35 with integral electrical bridge 47 are rearwardly inserted in guide tracks 29–30 with bow sections 43 being restrained from entering slots 60–61 by the presence of a dummy circuit board (not illustrated). Barbs 39–40 are forced forwardly and bite into adjacent surfaces 62–63 to rigidly secure the contacts in pockets 28. Channel sides 24–27 adjoin webs 38 to prevent their radial movement in pockets 28.

Outer pair of contacts 36–37 with electrical bridge 50 is then inserted in outer pockets 28 with barbs 39–40 similarly engaging adjacent surfaces 64–65. As illustrated, outer contacts 36-37 include an extended mounting portion 66 causing electrical bridge 50 to be rearwardly disposed and electrically separated from inner electrical bridge 47. The dummy board is then removed causing bow sections 43 to resiliently move into slots 60 and 61 and be biased inwardly in respect thereto by ears 45–46 which bear against shoulders 67 and 68 on adjacent barrier walls 23. As illustrated in FIG. 1, each leg of a U-shaped barrier wall 23 is generally T-shaped with the stem 69 extending from sidewall 14 with cross member 70 forming the side of the slot and tightly tapered at the front face 12 of housing 10 to guide the printed circuit board into slot 61. Grooves 72 extend from front face 12 on cross member 70 rearwardly on each opposite pair of leg sections to provide a receptacle for insertion of a polarizing key (not shown).

FIGS. 5–7 are illustrations of side, end, and rear views respectively of the pair of inner contacts 34–35 with electrical bridge 47. Each of the contacts 34–35 and included electrical bridge portion 47 are constructed of a nickel alloy commonly identified as "nickel silver". As illustrated, bridge 47 is provided with extrusion 73 for support of an external probe (not illustrated). Contact 35 includes a mounting portion with barbs 39–40 for rigidly securing the contact in housing 10 and an active portion with an outwardly inclined ribbon 42 forming a lower leg of bow 43 and upper tip 44 with oppositely disposed coplanar ears 45–46. As illustrated, barbs 39–40 laterally extend beyond ears 45–46 to permit the insertion of the active portion into the contact pocket 28 with wall sections 62–63 of the pocket providing mounting surfaces for the contact.

Electrical bridge 50 as illustrated in FIG. 8 includes apertures 51-52 and frontwardly directed extrusions 74–75 (illustrated in FIG. 1) for insertion and support of test probes. As illustrated in FIG. 1, apertures 51–52 are positioned in cavity 18 between adjacent barrier walls 23 and therefore no additional openings are required in housing 10. While electrical bridge 50 is rearwardly separated from bridge 47, electrical access to the frontwardly disposed bridge 47 is provided by access aperture 76 which is considerably larger than test probe apertures 48 and 51–52. In this manner, a test probe can be rearwardly inserted into the connector housing 10, pass through aperture 76 without electrically contacting bridge 50, and reach aperture 48, thereby contacting bridge 47 and associated contacts 34–35. Since access aperture 76 extends laterally across a substantial portion of bridge 50, strengthening ribs 77–78 extending parallel to longitudinal axis 79 are provided to resist flexural movement of bridge 50.

The test probe features of FIGS. 1 and 8 can also be utilized where separate tabs are provided in place of bridge 47 for contacts 34–35; in which event, separate apertures corresponding to aperture 48 are provided in each tab with each aperture aligned with access aperture 76.

The support arrangement for bridges 47 and 50 is illustrated in FIGS. 1–2 and 4. For support of bridge 47, central bar 19 is provided with rear surface 79 parallel to front face 12 and extending longitudinally along sides 25–26 of channels 20–21. Adjoining bridges 47

are separated by ridges **80** extending laterally between channel sides **24** and **27** and rearwardly raised from rear surface **79**. In the molding of housing **10**, ridges **80** are integrally formed with central bar **19** and U-shaped barrier walls **23**. In channels **20–21**, ridge **80** is rearwardly raised from the rearward extremity **81** of central webs **59** which include shoulders **82–83** as mounting surfaces for supporting electrical bridge **50**. Shoulders **82–83** are slightly rearwardly disposed in respect to rear surface **79** of central bar **19** to provide electrical separation between bridges **47** and **50** while ridge **80** provides electrical insulation between adjoining bridges **50**.

Extending rearwardly from barrier walls **23** are wall sections **84-85** as illustrated in FIGS. **3–4** with rear edges **89–90**. In FIG. **3**, wall section **85** is provided with notches **86–88** with wall section **84** being similarly notched for access to cover **33**.

Adjacent to each of the notches **86–88** are undercut portions **91–93** which are conveniently provided in the molding operation by grooves **94–96** extending rearwardly from front face **12** of housing **10**. Insulating cover **33** is disposed within wall sections **84–85** and provides protection against accidental external electrical connection ridges **47** and **50**. As illustrated in FIG. **9**, cover **33** includes along each of its longitudinal edges **97–98** nibs **99–101** and **102–104** to snap into undercut portions **91–93** (FIG. **3**) and corresponding undercut portions on wall section **84**. Longitudinal edges **97–98** are also provided with recesses **105–107** and **108–110** which align with notches **86–88** and corresponding notches in wall section **84**. Projections **111–112** are provided on edge **98** to properly orient cover **33** in housing **10**, although nibs **102–104** on edge **98** can be located in a different pattern than that of nibs **99–101** on edge **97** to provide the desired orientation of cover **33**. When cover **33** is properly positioned within wall sections **84–85**, the recesses are aligned with corresponding notches and permit the insertion of a wedge-like tool into the recesses to release cover **33** in the event that inspection is desired of the electrical bridges. This feature also permits replacement of one or more pairs of contacts.

As further illustrated in FIG. **9**, cover **33** includes two parallel rows of apertures **113–114** and adjacent indicia **115–116**, the latter serving to identify each bridged pair of electrical contacts in respect to the other contacts. When cover **33** is inserted in the housing, apertures **113** are aligned with apertures **52** of bridge **50** while apertures **114** are aligned with apertures **48** on bridges **47**. In respect to cover **33**, ridges **79** serve to separate cover **33** slightly from bridges **50**.

The foregoing description of the present invention is only illustrative of an exemplary form which the invention may take. Still other modifications and variations will suggest themselves to persons skilled in the art. It is intended, therefore, that the foregoing detailed description be considered as exemplary only and that the scope of the invention be ascertained from the following claims.

We claim:

1. An electrical connector adapted to receive external electrical elements in electrical engage-ment and comprising

an insulating housing including exterior surfaces,

a plurality of metallic contacts carried by said housing and arranged to engage said elements,

at least four of said contacts being arranged in first and second contact pairs with respective first and second electrical bridges, said bridges being spaced apart within said housing and in overlying relationship with respect to one of said surfaces, said first bridge being close to said one surface and including a first aperture extending through said bridge, and

said housing including a second aperture extending transversely from said one surface to said first aperture and beyond to said second bridge providing electrical access to said second pair of contacts.

2. The electrical connector of claim **1** wherein said first aperture is larger than said second aperture.

3. The electrical connector of claim **1** wherein said housing includes at least one cavity extending from a second of said surfaces into said housing and providing access to said contacts by said external electrical elements.

4. The electrical connector of claim **1** wherein said exterior surfaces include front and rear faces, said housing includes a cavity extending from said front face rearwardly into the housing and bar means dividing and separating said cavity into two channels, and said contacts include active portions extending into said channels for engagement with said external electrical elements.

5. The electrical connector of Claim **4** wherein said insulating housing includes

wall sections extending between said front and rear faces and enclosing said cavity with said bar means longitudinally extending between opposite wall sections and from said front face rearwardly to a rear surface in said cavity to form said two channels,

a plurality of spaced-apart barrier walls disposed longitudinally along each channel and laterally interconnecting said bar means and one of said wall sections in each channel, said barrier walls in said two channels including longitudinally aligned cutout portions to define two slots adapted to receive a flat circuit bearing element, said barrier walls extending between front face of said cavity rearwardly a distance beyond said rear surface of said cavity and having rear mounting surfaces,

a plurality of said first and second pairs of contacts mounted in the housing with said second bridge of each second pair being disposed on said rear surface of said bar means and said first bridge of each first pair being disposed on said rear mounting surfaces of adjacent barrier walls and overlying one of said second bridges, said wall sections extending rearwardly from said barrier walls and having rear edges with a plurality of notches extending from said edges frontwardly, and

an insulating cover including a plurality of said second apertures and said insulating cover disposed within said wall sections, said cover having recesses aligned with said notches and adapted to receive a wedge-like tool inserted through said notches to release said cover from said connector.

6. A one-piece electrical element for insertion into an electrical connector for engagement with external electrical elements, said connector including an insulating housing with exterior surfaces and a plurality of conductive elements, said one-piece electrical element constructed to overlie a portion of at least one of said

conductive elements with respect to one of said exterior surfaces and comprising

a pair of spaced-apart metallic contacts including active portions arranged to engage said external conductive elements

an interconnecting bridge portion providing an electrical path between said active portions and including an access portion with at least one aperture extending through the access portion and of sufficient size to permit electrical access from said one exterior surface through said aperture to said conductive element, said bridge portion in-cluding reinforcing ribs adjacent said aperture.

7. The electrical element of claim **6** wherein each contact has a mounting portion including a flat ribbon with opposite coplanar inwardly tapered barbs adapted to mount rearwardly in said connector and each of said active portions include a yieldable free-standing bow and a flat tip oppositely disposed in respect to said mounting portion.

8. The electrical connector of claim **1** wherein said first bridge includes at least one test aperture laterally disposed from said first aperture for receiving a test probe and said second bridge also includes at least one test aperture.

9. The electrical element of claim **6** wherein said bridge portion includes at least one test aperture laterally disposed from said one aperture for receiving a test probe.

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