

PATENT SPECIFICATION

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(54) ELECTRICAL CONNECTOR

(71) We, AMP INCORPORATED, a corporation organised and existing under the laws of the State of New Jersey, United States of America, of Eisenhower Boulevard, Harrisburg, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an electrical connector and to an electrical contact arrangement therefor, and particularly to an electrical connector and contact arrangement for interconnecting conductors on two spaced, substantially planar, substantially parallel substrates.

Such connectors are used in the mounting of substrates carrying electronic components and associated circuitry on, for example, printed circuit boards, and also for providing connections between two printed circuit boards.

Often such connectors must be of very small size, say for providing connections between conductors on a board, having 1.15 mm centre line spacing, and thus there is a need for a connector which is of simple construction, is easy to manufacture, but which nevertheless provides an adequately high contact force between the contact members of the connector and the contacted substrate conductors.

According to the invention there is provided an electrical connector for interconnecting conductors on two spaced, substantially planar, substantially parallel substrates, comprising an electrically insulating body member carrying a plurality of contact members each providing two contact points for contacting the conductors on the two substrates respectively, characterised in that the contact members are parts of a structure consisting of a plurality of individual metal spring contact members carried in spaced relationship by, and extending substantially parallel across, a common sheet of electrically insulating material, edge portions of the

sheet at the ends of the contact members being secured to the body member with the sheet turning through substantially 180° with the contact members on the outer surface thereof.

The invention will now be described by way of example with reference to the drawings, in which:—

Figure 1 is an exploded perspective view of a connector according to the invention;

Figure 2 is a cross-section through the connector of Figure 1 in an assembled state;

Figure 3 is a cross-section through part of a modified form of the connector of Figure 1;

Figure 4 is a perspective view of part of a contact member structure as used in the connector of Figure 1 and Figure 3;

Figure 5 is an exploded perspective view, with parts broken away, of another connector according to the invention;

Figure 6 is a cross-section through the connector of Figure 5 in an assembled state;

Figure 7 is a plan view of part of the contact member structure used in the connector of Figure 5, prior to bending into its operative state;

Figure 8 is a perspective view of a third connector according to the invention;

Figure 9 is a cross-section through the connector of Figure 8;

Figure 10 is a view similar to Figure 9 but with the connector in an operative condition; and

Figure 11 is a plan view of part of the contact member structure of the connector of Figures 8 to 10, prior to bending into its operative state.

Referring to Figures 1 and 2, the connector here shown comprises a first rectangular frame member 1 of electrically insulating material, which is shaped to be received in a second frame member 2 of electrically insulating material, which second member 2 is provided with holes 3 at its corners whereby it can be secured to a substrate 4, for example a printed circuit board, by means of

bolts 5 secured in the substrate 4 and cooperating nuts 6. The first member 1 also has holes 7 therein which receive pegs 8 on the substrate 4 thereby accurately to position the first member 1 on the substrate 4.

Mounted on each side of the first member 1 is a contact member structure 9 (only one shown in Figure 1) which will be described in detail later.

The first member 1 is also shaped to receive a second substrate 10, for example an insulating substrate carrying integrated electronic circuitry and components, with a peripheral portion 11 of the substrate 10 extending over the contact member structures 9.

The first and second frame members 1 and 2 and the substrates 4 and 10 are held together in their assembled state by means of a clamp frame member 12 formed with holes 13 at its corners, which holes 13 will receive the bolts 5, and with depending peripheral portions 14 which are received in grooves 15 in the second frame member 2.

Thus, with the bolts 5 on the substrate 4 extending through the holes 3 in the second member 2 and the holes 13 in the clamp member 12, with the first member 1 carrying the contact member structures 9 and the substrate 10 positioned in the second member 2, the connector and substrates can be secured together by means of the nuts 6 on the bolts 5, as shown in Figure 2.

As shown in Figure 2, in the assembled state of the connector portions of the contact member structures 9 contact the substrate 4 and the peripheral portions 11 of the substrate 10 and can thus provide electrical connections between contact pads (not shown) on the substrates 4 and 10 thereby to provide required connections between components on the substrates 4 and 10.

In the modified form of the connector shown in Figure 3, the contact member structures 9 are located on the inwardly facing surfaces of the first frame member 1, and the first frame member 1 fits closely within the second frame member 2, and has a peripheral flange 16 which is received in a groove 17 of a downwardly (towards the substrate 4) facing surface of the second frame member 2, thereby to position the first frame member 1 and thus the contact member structures 9 as required on the substrate 4.

Thus, the pegs 8 and holes 7 of the arrangement of Figures 1 and 2 are omitted in this modified form of the connector.

Further, in the connector of Figure 3, because of the relative positions of the first frame member 1 and the contact member structures 9 points on the structures 9 remote from the first frame member 1 contact the substrate 10, while points on the structures 9 adjacent the first frame member 1 contact the substrate 4, this being the op-

posite arrangement to that of the connector of Figures 1 and 2. However, as can be seen in the drawings, the contact member structures 9 are the same shape in the two connectors.

A contact member structure 9 as used in the connector of Figures 1 and 2 will now be described with reference to Figure 4 which is a perspective view of part thereof.

The structure 9 comprises a plurality of individual metal spring contact members 18 carried in spaced relationship by, and extending substantially parallel across, a common sheet 19 of electrically insulating, for example polymeric, material. Each of the contact members 18 is bent four times whereby the structure 9 has a cross-section in the shape of a parallelogram having three complete sides and a fourth side defined by two inwardly directed edge portions 20. Each of the contact members 18 is formed with a contact pipe 21 at a corner remote from the open side of the structure 9.

Each contact structure 9 is secured to the first frame member 1 by engagement of the edge portions 20 thereof in grooves 22 in the member 1 as shown in Figures 2 and 3, the resilience of the contact members 18 serving to retain the edge portions 20 in the grooves. The two contact points on each contact member 18 are then the pip 21 and the opposite corner 23 adjacent the open side of the structure 9.

Contact structures 9 as described above can be manufactured in many sizes, and in one practical application of the present invention the sheet 19 was of polymeric material 0.025 mm thick, and the contact members 18 were of phosphor bronze 0.175 mm thick with the centre lines of the contact members 18 being at 1.15 mm spacing.

As clearly shown in Figure 4, a central portion of each contact member 18 is of constant width, while the remaining end portions taper towards their free ends, thus giving the contact structure 9 advantageous deflection characteristics in that the stresses occurring in the tapered portions during use are evenly distributed therealong, thereby resulting in uniform deflection of these portions. As shown, the central portion of each contact member 18 extends substantially normally of the substrates 4 and 10, as does the open side of the contact structure, and thus the contact structure acts as a parallelepiped with oppositely directed forces acting in the planes of the central portions of the contact members 18 and the open side of the structure 9. Thus, the central portion of each contact member 18 remains substantially planar while the tapered portions deflect uniformly as described.

Referring now to Figures 5, 6 and 7, the connector here shown comprises a single rectangular frame member 24 of electrically

insulating material, having a longitudinally extending central bar 25 formed with two upstanding bosses 26. The side members 27 of the frame member 24 are each formed with an upstanding wall 28 and with a row of through holes 29 which give access to within the bounds of the frame member 24.

The central bar 25 of the frame member 24 carries two contact member structures 30 each formed similarly to that described with reference to Figure 4 but with a six-sided cross-section as shown in Figure 6. Edge portions 31 of the structures 30 are similarly received in grooves 32 in the central bar 25 to secure the structures 30 to the frame member 24.

For use the frame member 24 carrying the contact structures 30 is positioned on a first substrate 33, for example a printed circuit board, and a second substrate 34 is then positioned on the frame member 24, guided into position by the walls 28 which have appropriately sloped surfaces for this purpose, and located by the bosses 26 engaging in recesses 35 provided in the ends of the substrate 34.

A clamp member 36 is then positioned over the substrate 34, and bolts 37 then passed through holes 38 in the clamp member 36 and aligned holes 39 in the substrate 33 to be secured by nuts 40.

The connector is thus assembled to the two substrates 33 and 34 as shown in Figure 6, with the contact structures 30 resiliently compressed to provide connections between the conductors on the two substrates 33 and 34 as do the corresponding structures of the connectors of Figures 1 to 4.

Since the clamp member 36 engages the upper surface of the substrate 34, the clamp member 36 can be of metal and can thus serve to dissipate heat from the circuitry and components on the substrate 34.

Figure 7 shows part of one of the contact member structures 30 prior to being bent into the required shape. The structure comprises a sheet 41 of electrically insulating polymeric material carrying individual contact members 42. Each contact member 42 is formed with two contact pips 43 which in use will contact conductors on the substrates 33 and 34. Further, each contact member 42 consists of a constant width central portion and tapering end portions and intermediate portions which serve to ensure uniform stress distribution throughout the contact member 42 and transmission of the stresses to the central bar 25 of the frame member 24.

Referring now to Figures 8 to 11, the connector here shown comprises a body member 44 of electrically insulating material, and a contact member structure 45 of the type described above with reference

to Figures 1 to 7, mounted on the body member 44.

The body member 44 is formed with two holes 46 whereby the connector can be clamped between two substrates 47 and 48, for example printed circuit boards, by means of bolts 49 and nuts (not shown), the bolts passing through holes 57 in the substrates 47 and 48, and through the holes 46 in the body member 44.

As shown in Figure 9, contact points 50 of the contact member structure 45 initially project beyond the surfaces 51 of the body member 44, but when the substrates 47 and 48 are clamped to the body member 44 against the surfaces 51 as shown in Figure 10, the contact member structure 45 is resiliently deformed and thereafter provides electrical connections between conductors on the two substrates 47 and 48.

As shown in Figures 9 and 10, the contact member structure 45 is mounted on the body member 44, by reversely bent edge portions 52 thereof being received in recesses 53 in the body member 44.

As shown in Figure 11, the contact member structure 45 consists of a sheet 54 carrying individual contact members 55 each comprising a constant width central portion and tapering end and intermediate portions as found in the contact member structure of the embodiments previously described. It will be noted that the contact points 50 of each contact member 55 are constituted by relatively narrow portions, this ensuring a high contact force by providing a small contact area. Otherwise contact pips as described for the contact member structure shown in Figure 7 can be provided.

On initial compression of the contact member structure the free edges of the contact member structure 45 each engage an edge of the recess 53 in which they are located, and thus the contact member structure 45 is held in contact with the corners 56 of the body member 44 about which the structure passes, this helping to provide a high contact pressure at the contact points 50.

As previously described the tapered portions of each contact member serve to ensure a uniform stress distribution along these portions, and from this an advantageous maximum deflection.

As can be seen from Figure 10, this maximum deflection together with the contact between the contact member structure 45 and the body member 44 at the corners 56 results in deflection of the central portion of each contact member 55, this deflection adding to the contact force available at each of the contact points 50 of each contact member 55.

Thus, the arrangement of Figures 8 to 11 ensures high contact forces between the con-

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5 tact members 55 and the substrates 47 and 48, together with a large possible deflection of the contact members 55 while maintaining a high contact force, satisfactory connections therefore being provided even when the facing surfaces of the substrates 47 and 48 are not truly parallel.

10 Contact member structures like those described above, for use in connectors according to the present invention, can be manufactured by first laminating a suitable polymeric sheet with a metal foil, and then etching away, in known manner, portions of the metal foil to leave only the required contact members on the polymeric sheet.

WHAT WE CLAIM IS:—

20 1. An electrical connector for interconnecting conductors on two spaced, substantially planar, substantially parallel substrates, comprising an electrically insulating body member carrying a plurality of contact members each providing two contact points for contacting the conductors on the two substrates respectively, in which the contact members are parts of a structure consisting of a plurality of individual metal spring contact members carried in spaced relationship by, and extending substantially parallel across, a common sheet of electrically insulating material, edge portions of the sheet at the ends of the contact members being secured to the body member with the sheet turning through substantially 180° with the contact members on the outer surface thereof.

40 2. A connector as claimed in Claim 1, in which the sheet forms three sides of a parallelepiped with contact points at diagonally opposite corners, and with the central side formed by the sheet extending, during use, substantially at right-angles to the two substrates.

45 3. A connector as claimed in Claim 2, in which each contact member consists of a constant width central portion extending across said central side formed by the sheet, and outwardly tapering end portions extending from the central portion to the edges of the sheet.

50 4. A connector as claimed in any preceding claim, in which the body member is in the form of a rectangular frame and carries a contact member structure as specified on the outer side of each of the four members of the frame.

55 5. A connector as claimed in any one of Claims 1 to 3, in which the body member is in the form of a rectangular frame and carries a contact member structure as specified on the inner side of one or more of the four members of the frame.

60 6. A connector as claimed in Claim 4 or Claim 5, including a second rectangular frame adapted to be secured to a first sub-

strate and to receive the first frame carrying the contact structure or structures within its periphery, and a clamp member adapted to be secured to the second frame to hold a second substrate against the first frame with the contact members of the contact structure providing connections between conductors on the two substrates.

70 7. A connector as claimed in Claim 1, in which the sheet forms five sides of a six-sided figure having opposed sides parallel, and with the central side formed by the sheet extending, during use, substantially at right-angles to the two substrates.

80 8. A connector as claimed in Claim 7, in which each contact member consists of a substantially constant width central portion extending across said central side formed by the sheet, inwardly tapering intermediate portions extending across the intermediate sides formed by the sheet, and outwardly tapering end portions extending from the intermediate portions to the edges of the sheet, contact points being provided at the junctions between the intermediate portions and the end portions of the contact members.

95 9. A connector as claimed in Claim 7 or Claim 8, in which the body member is in the form of a rectangular frame having a longitudinally extending central bar member carrying a contact structure as specified on each of its sides facing an edge member of the frame.

100 10. A connector as claimed in Claim 9, including a clamp member adapted to be secured to a first substrate with the frame carrying the contact structures and a second substrate, positioned therebetween, with the contact members providing connections between conductors on the two substrates.

115 11. A connector as claimed in Claim 1, in which the body member comprises a bar adapted to be secured between two substrates, the contact member structure being substantially U-shaped in cross-section and being engaged about three sides of the body member and having contact points intermediate the ends of the arms of each contact member.

120 13. A connector as claimed in Claim 11, in which each contact member comprises a constant width central portion which constitutes the base of the U-section, an intermediate portion which tapers inwardly from both ends to a relatively narrow contact point, and an outwardly tapering end portion.

125 13. A connector as claimed in Claim 12, in which the contact structure is mounted on the body member, and is shaped such that in use the junctions between the base and the arms of the U-section engage corners of the body member such that on compression of the intermediate portions of each con-

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tact members 55 and the substrates 47 and 48, together with a large possible deflection of the contact members 55 while maintaining a high contact force, satisfactory connections therefore being provided even when the facing surfaces of the substrates 47 and 48 are not truly parallel.

Contact member structures like those described above, for use in connectors according to the present invention, can be manufactured by first laminating a suitable polymeric sheet with a metal foil, and then etching away, in known manner, portions of the metal foil to leave only the required contact members on the polymeric sheet.

WHAT WE CLAIM IS:—

20 1. An electrical connector for interconnecting conductors on two spaced, substantially planar, substantially parallel substrates, comprising an electrically insulating body member carrying a plurality of contact members each providing two contact points for contacting the conductors on the two
25 substrates respectively, in which the contact members are parts of a structure consisting of a plurality of individual metal spring contact members carried in spaced relationship by, and extending substantially
30 parallel across, a common sheet of electrically insulating material, edge portions of the sheet at the ends of the contact members being secured to the body member with the sheet turning through substantially 180°
35 with the contact members on the outer surface thereof.

40 2. A connector as claimed in Claim 1, in which the sheet forms three sides of a parallelepiped with contact points at diagonally opposite corners, and with the central side formed by the sheet extending, during use, substantially at right-angles to the two substrates.

45 3. A connector as claimed in Claim 2, in which each contact member consists of a constant width central portion extending across said central side formed by the sheet, and outwardly tapering end portions extending from the central portion to the edges of
50 the sheet.

55 4. A connector as claimed in any preceding claim, in which the body member is in the form of a rectangular frame and carries a contact member structure as specified on the outer side of each of the four members of the frame.

60 5. A connector as claimed in any one of Claims 1 to 3, in which the body member is in the form of a rectangular frame and carries a contact member structure as specified on the inner side of one or more of the four members of the frame.

65 6. A connector as claimed in Claim 4 or Claim 5, including a second rectangular frame adapted to be secured to a first sub-

strate and to receive the first frame carrying the contact structure or structures within its periphery, and a clamp member adapted to be secured to the second frame to hold a second substrate against the first frame
70 with the contact members of the contact structure providing connections between conductors on the two substrates.

75 7. A connector as claimed in Claim 1, in which the sheet forms five sides of a six-sided figure having opposed sides parallel, and with the central side formed by the sheet extending, during use, substantially at right-angles to the two substrates.

80 8. A connector as claimed in Claim 7, in which each contact member consists of a substantially constant width central portion extending across said central side formed by the sheet, inwardly tapering intermediate portions extending across the intermediate
85 sides formed by the sheet, and outwardly tapering end portions extending from the intermediate portions to the edges of the sheet, contact points being provided at the junctions between the intermediate portions and the end portions of the contact members.

90 9. A connector as claimed in Claim 7 or Claim 8, in which the body member is in the form of a rectangular frame having a longitudinally extending central bar member carrying a contact structure as specified on each of its sides facing an edge member of the frame.

95 10. A connector as claimed in Claim 9, including a clamp member adapted to be secured to a first substrate with the frame carrying the contact structures and a second substrate, positioned therebetween, with the contact members providing connections between
100 conductors on the two substrates.

105 11. A connector as claimed in Claim 1, in which the body member comprises a bar adapted to be secured between two substrates, the contact member structure being substantially U-shaped in cross-section and being engaged about three sides of the body member and having contact points intermediate the ends of the arms of each contact member.
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115 12. A connector as claimed in Claim 11, in which each contact member comprises a constant width central portion which constitutes the base of the U-section, an intermediate portion which tapers inwardly from both ends to a relatively narrow contact point, and an outwardly tapering end portion.
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125 13. A connector as claimed in Claim 12, in which the contact structure is mounted on the body member, and is shaped such that in use the junctions between the base and the arms of the U-section engage corners of the body member such that on compression of the intermediate portions of each con-
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tact member towards the body member the central portion of the contact member is bowed away from the body member.

14. A connector as claimed in any preceding claim, in which the or each contact member structure is secured to the body member by the edge portions thereof being received in grooves in the body member.

15. An electrical connector substantially as hereinbefore described with reference to

Figures 1 to 4, or Figures 5 to 7, or Figures 8 to 11 of the drawings.

16. A contact member structure substantially as hereinbefore described with reference to Figure 4, Figures 6 and 7, or Figures 8 to 11 of the drawings.

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