

PATENT SPECIFICATION

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(54) AN ELECTRICAL CONNECTOR AND ITS METHOD OF MANUFACTURE

(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 concerns an electrical connector and its method of manufacture and is particularly concerned with matrix connectors of the kind described in our Patent Application No. 30105/74, Serial No. 1,427,494.

In our Patent Application No. 30105/74, Serial No. 1,427,494, we disclosed and claimed a matrix connector comprising an elastomer body presenting a pair of opposite contact surfaces at each of which is disposed a multiplicity of spaced contacts, the contacts of the opposite faces being interconnected by conductors extending through the body, characterised by the contacts being defined by folds of the conductors extending through the elastomeric mass convex portions of the folds being exposed at the opposite faces.

We also disclosed and claimed a method of forming a matrix connector comprising an elastomer body presenting a pair of opposite contact surfaces at each of which is disposed a multiplicity of spaced contacts, the contacts of the opposite faces being interconnected by conductors extending through the body, in which a lamina flexible printed circuit is formed with sets of conductive strips on opposite sides with portions of sets at opposite sides overlapping and forming apertures in the insulating lamina of the printed circuit, interconnecting the overlapping portions through holes in the insulating lamina of the printed

circuit, folding the printed circuit in concertina fashion with sets of conductive strips extending externally around the folds of the concertina, spacing adjacent limbs of the concertina form with strip-like partially cured elastomer material and compressing the concertina longitudinally to effect extrusion of the elastomer through the apertures in the printed circuit lamina and into troughs of the concertina form, and curing the elastomer to a homogeneous mass.

It is an object of the invention to provide an improved connector according to our earlier application which may more easily and economically be manufactured.

In a connector according to Claim 1 of our Patent Application No. 30105/74, Serial No. 1,427,494, according to the present invention the conductors are flat metal strips which strips extend through the elastomeric body to interconnect the contacts at the opposite surfaces, the contacts are arranged in rows and individual rows of contacts and their associated conductors are formed as circuit paths on respective laminar flexible printed circuits of strip-like form, each strip-like printed circuit lamina having the circuit paths on one side only of the strip, and extending substantially to the side edges of the strip, side edge portions of the strip being folded over to face the side devoid of the circuits and the conductors extending externally around the folded side edge portions, a plurality of such strip-like printed circuits being disposed in generally parallel spaced relationship within the body of elastomeric material, the folded conductor portions being exposed to opposite faces of the elastomer body to define the spaced contacts.

A method of manufacture of such a connector according to the present invention comprises forming a plurality of strip-like flexible laminar printed circuits, each strip-like printed circuit lamina having

circuit paths on one side only, the circuit paths comprising conductive strips spaced longitudinally of the strip-like lamina and each extending transversely substantially to

5 opposite side edge portions of the strip, forming apertures in the insulating lamina, folding over the opposite side edge portions of each strip to face the side of the lamina devoid of circuit paths so that the trans-
10 verse conductive strips extend externally of the folds of the side edge portions disposing between the opposite folds of each strip-like printed circuit lamina and adjacent the side devoid of circuit paths a first strip of partially cured or thermoplastic elastomeric
15 insulating material, positioning the assemblies of printed circuit laminae and first elastomeric strips in a stack alternating with second strips of elastomeric insulating
20 material, compressing the stack to effect extrusion of the first and second elastomeric strips through the apertures of the printed circuit laminae and into troughs within the folded side edge portions, and curing the
25 elastomer into a homogeneous body encasing the printed circuit laminae with convex portions of the folded conductors exposed at opposite faces of the elastomeric body.

30 The invention will now be described by way of example with reference to the accompanying partly diagrammatic drawings, in which:

Figure 1 is a fragmentary plan view of an
35 end portion of a strip-like flat-flexible printed circuit for use in a connector manufacture according to the invention;

Figure 2 is a fragmentary end perspective view of the circuit member of Figure
40 1 after a first stage of further manufacture;

Figure 3 is a view similar to that of Figure 1 of a further stage of manufacture;

Figure 4 is an end view of the circuit member in the Figure 3 stage;

45 Figure 5 is a view similar to Figure 3 of a plurality of circuit members in yet further stage of manufacture;

Figure 6 is an end view of the assembly of Figure 5; and

50 Figure 7 is a fragmentary partly sectioned perspective view of a matrix connector in a final stage of manufacture.

The flat flexible printed circuit member of Figure 1 comprises a lamina 1 of flexible
55 insulating material and of strip-like form having a uniform width between parallel side edges 2, 3 and extending longitudinally.

The insulating member 1 is formed on one side only with printed circuit conductors 4 to form a flexible printed circuit member, the conductors 4 extending transversely of the strip 1 between the side edges 2, 3 at uniform intervals along the strip 1. Each
60 conductor 4 is of generally rectangular section and strip-like form and has a chevron-

shaped central portion 5 comprising arms which diverge from the longitudinal axis of the strip 1 to aligned end portions 6 which extend normally to the side edges 2, 3.

The insulating strip member 1 is formed
70 intermediate adjacent conductor portions 5 with chevron-shaped apertures 7 having arms parallel to those of the chevron portions 5 and terminating short of the side
75 edges 2, 3. Further apertures 8 of generally rectangular form, are formed between adjacent conductor end portions 6 and between the side edges 2, 3 of the insulating strip
80 and outer extremities of the chevron apertures 7.

Apertures 7' and 8' are formed at the end of the strip 1 to terminate the strip 1 in a straight end.

In a first forming stage, the side edge
85 portions 2, 3 of the flexible printed circuit member are folded over as shown in Figure 2 to face the side of the insulating member devoid of conductive strips 4, to define
90 folds 9, 10 intersecting the apertures 8 and the conductor portions 6 which extend externally of the folds in convex manner.

In a second forming stage as shown in Figures 3 and 4 a strip 11 of partially cured
95 elastomeric material is disposed between the folds 9, 10 and adjacent the side of the insulating member 1 devoid of conductors 4.

The steps of Figures 2 and 3 may be carried out simultaneously by feeding the
100 elastomer strip 11 between the folds 9, 10 as the folds are progressively formed.

Following the step of Figures 3 and 4, several flexible printed circuit members 1, 4 in association with elastomer strips 11 are
105 stacked side-by-side as shown in Figures 5 and 6 with alternate further strips of elastomer 12 which is suitably of the same nature as that of strips 11. The stack may be of a number of layers selected according
110 to the size of connector required and, as shown in Figure 6 is provided with layers 12 of elastomer at both ends of the stack. The strips of elastomer 11 and 12 extend
115 beyond the ends of the printed circuit members.

The assembly of Figures 5 and 6 is then suitably compressed between ends of the stack to effect extrusion of the elastomer
120 11, 12 through the apertures 7 and into the folds 9, 10 and apertures 8. The compression is suitably carried out within a confined chamber, not shown, having plates, not shown, registering with the upper and lower side faces 13, 14 of the stack as seen
125 in Figure 6 and engaging the convexly curved conductive portions 6. The pressure of the extruded elastomer within the folds 9, 10 serves to hold the conductor portions 6 against the plates and prevent flow of
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elastomer through apertures 8 from encasing the conductor portions 6.

The compressed elastomer 11, 12 is then suitably cured to a homogeneous mass 15 as shown in Figure 7 with the arcuate conductor portions 6 exposed at intervals in grid array across the upper and lower surfaces 13, 14 to define contacts interconnected in pairs of opposite contacts by the conductive chevron portions 5.

The flexible printed circuit may comprise a lamina 1 of polyester such as MYLAR, registered trade mark, formed with copper conductive tracks 4 overplated with contact metal such as gold. Examples of suitable elastomeric material for use in the manufacture described in a partially cured state are Butyl Rubber, B-stage polyurethane and other partly cured rubbers embodying a cross-linking agent.

As an alternative to the use of partially cured elastomer, it is also practical to use thermoplastic rubbers for example Butadiene-Skyreen rubbers, which do not require curing. Bonding of the first and second strips of elastomer into a homogeneous mass is achieved under suitable temperature and pressure in a similar way.

WHAT WE CLAIM IS:

1. A matrix connector comprising an elastomer body presenting a pair of opposite contact surfaces at each of which is disposed a multiplicity of spaced contacts, the contacts of the opposite faces being interconnected by conductors extending through the body, the contacts being defined by folds of the conductors extending through the elastomeric mass, convex portions of the folds being exposed at the opposite faces, in which the conductors are flat metal strips, which strips extend through the elastomeric body to interconnect the contacts at the opposite surfaces, the contacts are arranged in rows and individual rows of contacts and their associated conductors are formed as circuit paths on respective laminar flexible printed circuits of strip-like form, each strip-like printed circuit lamina having the circuit paths on one side only of the strip and extending substantially to the side edges of the strip, side edge portions of the strip being folded over to face the side devoid of the circuits and the conductors extending externally around the folded side-edge portions, a plurality of such strip-like printed circuits, being disposed in generally parallel spaced relationship within the body of elastomeric material, the folded conductor portions being exposed at opposite faces of the elastomer body to define the spaced contacts.

2. A connector as claimed in Claim 1, in which the conductors on each printed circuit strip are of chevron-shape comprising a pair of arms extending in inclined manner from a central portion of the strip towards the side edge portions, slot-like apertures of chevron form in the printed circuit insulating lamina being disposed between adjacent conductors with limbs of the slots terminating short of the side edges, further apertures in the insulating lamina being disposed between marginal portions of adjacent conductors and outwardly of extremities of the chevron slots, the further apertures bridging the folds of the strip side portions at the opposite faces of the elastomer body.

3. A method of manufacture of a connector as claimed in Claim 1 comprising the steps of forming a plurality of strip-like flexible laminar printed circuits, each strip-like printed circuit lamina having circuit paths on one side only, the circuit paths comprising conductive strips spaced longitudinally of the strip-like lamina and each extending transversely substantially to opposite side edge portions of the strip, forming apertures in the insulating lamina, folding over the opposite side edge portions of each strip to face the side of the lamina devoid of circuit paths so that the transverse conductive strips extend externally of the folds of the side edge portions, disposing between the opposite folds of each strip-like printed circuit lamina and adjacent the side devoid of circuit paths, a first strip of partially cured or thermoplastic elastomeric insulating material, positioning the assemblies of printed circuit laminae and first elastomeric strips in a stack alternating with second strips of elastomeric insulating material, compressing the stack to effect extrusion of the first and second elastomeric strips through the apertures of the printed circuit laminae and into troughs within the folded side edge portions and curing the elastomer into a homogeneous body encasing the printed circuit laminae with convex portions of the folded conductors exposed at opposite faces of the elastomeric body.

4. A connector as claimed in Claim 1 and substantially as described with reference to the accompanying drawings

5. A method as claimed in Claim 3 and substantially as described with reference to the accompanying drawings.

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elastomer through apertures 8 from encasing the conductor portions 6.

The compressed elastomer 11, 12 is then suitably cured to a homogeneous mass 15 as shown in Figure 7 with the arcuate conductor portions 6 exposed at intervals in grid array across the upper and lower surfaces 13, 14 to define contacts interconnected in pairs of opposite contacts by the 10 conductive chevron portions 5.

The flexible printed circuit may comprise a lamina 1 of polyester such as MYLAR, registered trade mark, formed with copper 15 conductive tracks 4 overplated with contact metal such as gold. Examples of suitable elastomeric material for use in the manufacture described in a partially cured state are Butyl Rubber, B-stage polyurethane and other partly cured rubbers embodying a 20 cross-linking agent.

As an alternative to the use of partially cured elastomer, it is also practical to use thermoplastic rubbers for example Butadiene-Skyreen rubbers, which do not 25 require curing. Bonding of the first and second strips of elastomer into a homogeneous mass is achieved under suitable temperature and pressure in a similar way.

WHAT WE CLAIM IS:

30 1. A matrix connector comprising an elastomer body presenting a pair of opposite contact surfaces at each of which is disposed a multiplicity of spaced contacts, the contacts of the opposite faces being 35 interconnected by conductors extending through the body, the contacts being defined by folds of the conductors extending through the elastomeric mass, convex portions of the folds being exposed at the 40 opposite faces, in which the conductors are flat metal strips, which strips extend through the elastomeric body to interconnect the contacts at the opposite surfaces, the contacts are arranged in rows and individual 45 rows of contacts and their associated conductors are formed as circuit paths on respective laminar flexible printed circuits of strip-like form, each strip-like printed circuit lamina having the circuit paths on one side 50 only of the strip and extending substantially to the side edges of the strip, side edge portions of the strip being folded over to face the side devoid of the circuits and the conductors extending externally around the 55 folded side-edge portions, a plurality of such strip-like printed circuits, being disposed in generally parallel spaced relationship within the body of elastomeric material, the folded conductor portions being exposed at 60 opposite faces of the elastomer body to define the spaced contacts.

2. A connector as claimed in Claim 1, in which the conductors on each printed circuit strip are of chevron-shape comprising a pair of arms extending in inclined 65 manner from a central portion of the strip towards the side edge portions, slot-like apertures of chevron form in the printed circuit insulating lamina being disposed between adjacent conductors with limbs of 70 the slots terminating short of the side edges, further apertures in the insulating lamina being disposed between marginal portions of adjacent conductors and outwardly of extremities of the chevron slots, the further 75 apertures bridging the folds of the strip side portions at the opposite faces of the elastomer body.

3. A method of manufacture of a connector as claimed in Claim 1 comprising 80 the steps of forming a plurality of strip-like flexible laminar printed circuits, each strip-like printed circuit lamina having circuit paths on one side only, the circuit paths 85 comprising conductive strips spaced longitudinally of the strip-like lamina and each extending transversely substantially to opposite side edge portions of the strip, forming apertures in the insulating lamina, folding over the opposite side edge portions 90 of each strip to face the side of the lamina devoid of circuit paths so that the transverse conductive strips extend externally of the folds of the side edge portions, disposing between the opposite folds of each strip-like 95 printed circuit lamina and adjacent the side devoid of circuit paths, a first strip of partially cured or thermoplastic elastomeric insulating material, positioning the assemblies of printed circuit laminae and first 100 elastomeric strips in a stack alternating with second strips of elastomeric insulating material, compressing the stack to effect extrusion of the first and second elastomeric strips through the apertures of the printed 105 circuit laminae and into troughs within the folded side edge portions and curing the elastomer into a homogeneous body encasing the printed circuit laminae with convex portions of the folded conductors exposed at opposite faces of the elastomeric 110 body.

4. A connector as claimed in Claim 1 and substantially as described with reference to the accompanying drawings 115

5. A method as claimed in Claim 3 and substantially as described with reference to the accompanying drawings.

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