

PATENT SPECIFICATION

(11)

1 489 075

(21) Application No. 53874/74 (22) Filed 12 Dec. 1974
(31) Convention Application Nos.

432 121 (32) Filed 9 Jan. 1974 (19)
504 579 9 Sept. 1974 in

(33) United States of America (US)
(44) Complete Specification published 19 Oct. 1977
(51) INT. CL.² H01R 31/08 43/00 // 13/02

H05K 3/36

(52) Index at acceptance
B3A 26 49U 78B
B3E 10E3 1H1 CC
H2E 3B6 3C2A 3C2B 3C2C 3D4 3E7

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(54) IMPROVEMENTS RELATING TO ELECTRICAL CONNECTORS

(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:—

The invention relates to electrical connectors and methods of making such connectors.

15 A multi-contact electrical connector according to the invention comprises a series of strip-like contacts bonded to a continuous web of flexible insulating material so that the contacts extend across and are spaced-apart longitudinally of the web the contacts being roll-formed to provide one or more bent contact portions on each contact.

20 A method of making a multi-contact electrical connector according to the invention comprises the steps of stamping or severing a series of strip-like contact blanks from a continuous sheet or strip of metal, bonding the contact blanks to a continuous web of flexible insulating material so that the contact blanks extend across and are spaced-apart longitudinally of the web and roll-forming the contact blanks to define one or more bent contact portions on each contact.

Specific examples of the invention will now be described with reference to the accompanying drawings in which:—

40 Figure 1 is a perspective view of a portion of a connector according to the invention connected to two printed circuit boards;

Figure 2 is an end view of the connector;

45 Figure 3 is a schematic view of apparatus used in a first method of manufacturing the connector;

Figure 4, 5 and 6 are side views of the working surfaces of forming rollers for successive stages of forming the connector;

Figure 7 is a cross-sectional view of the working surfaces of rollers used in the final stage of forming the connector;

Figures 8, 9 and 10 are end views of the connector after forming by the rollers of Figures 4, 5 and 6 respectively;

Figure 11 is a perspective view of second examples of connector according to the invention;

Figure 12 is a perspective view of a portion of a third example of connector according to the invention; and,

Figure 13 is a schematic view of apparatus used in a second method of manufacturing the connector.

The connector 1 comprises a series of strip-like contacts 3 bonded to a continuous web 4 of flexible plastics material so that the contacts extend across and are spaced apart longitudinally of the web.

The contacts are roll-formed so that each contact includes a planar central portion 5 and, at opposite ends, bent contact portions defining loops 6 having opposed straight arms 7 which firstly converge to define a throat 8 of restricted size and then diverge to define a mouth 11. The free ends 12 of the contact are returned.

In use of the connector, a printed circuit board can be inserted through the mouth into each loop. The arms of the loop resiliently grip and effect connection to the conductive paths 9 of the printed circuit board. The web is sufficiently flexible to permit individual flexure of the contacts to accommodate variations in thickness and warpage of the printed circuit boards. Freedom of movement of the outer legs 7 of the loops is ensured as the web is bonded only to a central portion of the con-

tacts. Nevertheless, the web can be sufficiently stiff to provide a self-supporting connector structure.

Apparatus for manufacturing the connector includes a stamping station 15, a subsequent laminating station 16 having a web feed reel 18 and a final rolling station 17 from which the finished connector emerges in continuous strip form.

The elements of each station will now be described with reference to the method of manufacture.

A continuous strip of sheet metal 74 is fed between stamping dies in station 15 in conventional manner to produce a ladder strip 75 the cross members 76 of which constitute the precursors of the contacts 3. At the laminating station 16, a continuous strip 77 of plastics material such as MYLAR (Trade Mark) is overlaid and bonded to a central portion of the strip 75 by application of a suitable adhesive such as E. I. Dupont Nos. 49000 or 49002 adhesives. Alternatively, KAPTON or NOMAX (Trade Marks) plastics strip may be bonded with E. I. Dupont WA adhesive.

The laminated strip is then fed to the rolling station 17 which includes four pairs of forming rollers shown in Figures 4, 5, 6 and 7 respectively used for forming the contact shapes shown in Figures 8, 9, 10 and 12.

The primary formation stage includes upper and lower rollers 21, 22 respectively formed with a central annular groove 23 and a complementary annular projection 24 received in the groove and provided with chamfers 25. A clearance 27 to accommodate the stock thickness of the contacts is provided between the faces of the rollers by a step 26 on roller 22, which is further stepped at 28 defining grooves 29 providing an increased clearance 30 to accommodate the combined thicknesses of the web and contacts. In this stage the loop consists of the planar portion 5 and leg 11 formed by the rollers.

At the second stage, the rollers 31 and 32 have complementary frusto conical surfaces 33, 35 and 34, 36 respectively. Junctions of the surfaces 33 and 35, and 34 and 36 define complementary annular grooves and projections 41, 39 and 42, 43 which form the precursors 79 and 81 of the outer portions of the loops. The surface 36 is stepped at 37 defining annular recess 38 which provides the clearance 30 to accommodate the combined web and contact thickness.

In the third stage, rollers 45, 46 have frusto-conical surfaces arranged in an opposite sense to that of the rollers 31 and 32 and which terminate in interdigitating grooves and projections 51 and 52, and 54

and 55. The projection 52 is chamfered at 53. These projections and grooves form the precursors of the loops 6 and returned portions 12 of the contacts. The groove 55 is stepped at 56 to provide the increased clearance between the rollers to accommodate the laminated portion of the contacts.

In a final stage (Figure 7) relatively little forming occurs and the rollers 61 and 62 do not co-operate fully. Roller 62 is divided into three, the side rollers each being provided with an inclined forming surface 72 to pivot the legs of each loop together to define the throat of the loop. The projections 73 are relatively narrower than the projections 54 of the previous stage to permit such pivotal movement. By using a final pivotal stage it is possible to provide a substantially closed loop which would not ordinarily be possible by old forming techniques. The carrier 82 can be removed prior or after passage through the forming station. The connector strip can then be cut to the desired length.

It should be noted that, in practice, a large number of roller stages will be required to produce sufficiently gradual progressive forming stages.

It is possible to make contacts of relatively small size using the above-described method. For example, the stock can be No. 725 Copper Association copper having a thickness of .01 ins, the height of the loops can be .91 ins, and the plastics sheet can be .005 ins.

In an alternative example of connector 83, a series of contacts 84 are bonded at spaced-apart locations along a plastics (or paper) web 85. A post-form end of each contact can be received in an aperture in a printed circuit board 86 while the other, bent, end 87 can effect connection to conductive paths 88 on the printed circuit board. The connector may advantageously be applied to the board with the carrier strip 89 attached to facilitate alignment of the contacts with their respective apertures and the carrier removed subsequently. Two opposed connectors can be mounted on the printed circuit board 86 and a printed circuit board plugged in between them as shown schematically in Figure 11.

In a third example of connector 91 shown in Figure 12, a series of contacts 92 are bonded at spaced-apart intervals to separate parallel webs 93. In all examples the contacts can be preplated, plated after forming or spot plated to provide the desired contact surface.

In a second method of manufacturing the connector, a continuous web 97 of plastics material is fed from a supply station 94 to a severing station 95 which severs individual contact lengths 99 from a

continuous strip 98 and deposits them on the strip which can be pretreated with a suitable adhesive to accomplish bonding. Bonding may also be accomplished by pressure, heat or a suitable combination of these techniques. The web with the contact lengths bonded thereon is then passed through a rolling station 96.

- It should be emphasised that forming the contacts by rolling compares advantageously with previous stamping techniques as the repeated impact of the stamping dies causes rapid die wear and frequent replacement is required, particularly when small dimensional tolerances are required. In contrast, the effective life of the rollers is relatively long. The co-operating roller surfaces are also more easily tooled than stamping dies. Role forming may also be a relatively fast operation.

WHAT WE CLAIM IS:—

1. A method of making a multi-contact electrical connector comprising the steps of stamping or severing a series of strip-like contact blanks from a continuous strip of metal, bonding the contact blanks to a continuous web of flexible insulating material so that the contact blanks extend across and are spaced-apart longitudinally of the web, and roll-forming the contact blanks to define one or more bent contact portions on each contact.

2. A method of making a multi contact electrical connector according to Claim 1 in which the contact blanks are stamped as cross-members of a ladder-strip.

3. A method of making a multi-contact electrical connector according to Claim 1

in which the bent contact portions define resilient loops at one or both ends of each contact adapted to grip a complementary electrical contact.

4. A method of making a multi-contact electrical connector substantially as described with reference to Figure 3 of the accompanying drawings.

5. A method of making a multi-contact electrical connector substantially as described with reference to Figure 13 of the accompanying drawings.

6. A multi-contact electrical connector comprising a series of strip-like contacts bonded to a continuous web of flexible insulating material so that the contacts extend across and are spaced-apart longitudinally of the web, the contacts having been roll-formed with one or more bent contact portions on each contact.

7. A multi-contact electrical connector according to Claim 6 in which the bent contact portions define loops at one or both ends of each contact adapted to grip a complementary contact when inserted in the or each loop.

8. A multi-contact electrical connector substantially as described with reference to Figure 2 of the accompanying drawings.

9. A multi-contact electrical connector substantially as described with reference to Figure 11 of the accompanying drawings.

10. A multi-contact electrical connector substantially as described with reference to Figure 12 of the accompanying drawings.

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continuous strip 98 and deposits them on the strip which can be pretreated with a suitable adhesive to accomplish bonding. Bonding may also be accomplished by pressure, heat or a suitable combination of these techniques. The web with the contact lengths bonded thereon is then passed through a rolling station 96.

It should be emphasised that forming the contacts by rolling compares advantageously with previous stamping techniques as the repeated impact of the stamping dies causes rapid die wear and frequent replacement is required, particularly when small dimensional tolerances are required. In contrast, the effective life of the rollers is relatively long. The co-operating roller surfaces are also more easily tooled than stamping dies. Role forming may also be a relatively fast operation.

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1. A method of making a multi-contact electrical connector comprising the steps of stamping or severing a series of strip-like contact blanks from a continuous strip of metal, bonding the contact blanks to a continuous web of flexible insulating material so that the contact blanks extend across and are spaced-apart longitudinally of the web, and roll-forming the contact blanks to define one or more bent contact portions on each contact.

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