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(54) ELECTRICAL CONNECTIONS TO FLAT CONDUCTOR CABLE

(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 present invention relates to electrical contacts and electrical connections between flat conductors of flat conductor cable and electrical contacts.

Throughout this specification, the term "flat conductor cable" is intended in a generic sense to include both a flat flexible cable in which a flat ribbon-like strip of conductive material is embedded between layers of insulating material and flat flexible circuitry. The conductors in a flat flexible cable are usually of uniform width and extend parallel to each other throughout the length of the cable while the conductors in flat flexible circuitry can extend along irregular paths and may have enlarged portions at some locations to which electrical components may be connected.

According to one aspect of the present invention, in a electrical connection between a flat conductor of a flat conductor cable and an electrical contact including a deformable leg having a free end and a braking member co-operating with the leg, the leg passes from a first to a second opposite side surface of the cable and is curled so that the free end pierces the cable from the second side surface and engages the conductor and the backing member having a backing surface engaging the first side surface of the cable in alignment with the conductor, the free end of the leg being in overlapping relationship to the backing surface so that any relaxation of the leg after circling, is resisted by the backing member.

The present invention also relates to an electrical contact formed from sheet material for use in the electrical connection defined above.

Embodiments of the invention will now be described, by way of example, reference being made to the Figures of the accompanying diagrammatic drawings in which:—

Figure 1 is a perspective view of electrical contacts connected to and about to be connected to flat conductor cable;

Figure 2 is a cross-section on the line 2-2 of Figure 1;

Figure 3 is a partial cross-section similar to Figure 2 but including a die for use during a curling operation;

Figure 4 is an enlarged cross-section of the connection shown in Figure 2;

Figure 5 is a view similar to that of Figure 4 showing an alternative connection configuration;

Figure 6 is a perspective view of another embodiment of electrical contact;

Figure 7 is a sectional side view of the electrical contact of Figure 6 and an associated pair of dies;

Figure 8 is a sectional side view similar to Figure 7 but showing the electrical contact connected to a cable;

Figure 9 is a perspective view of still another embodiment of electrical contact;

Figure 10 is a sectional side view of the electrical contact of Figure 9 and an associated pair of dies;

Figure 11 is a sectional side view similar to Figure 10 showing the electrical contact prior to complete connection;

Figure 12 is a sectional side view similar to Figure 11 but showing the electrical contact after connection;

Figure 13 is a perspective view of yet another embodiment of electrical contact;

Figure 14 is a sectional side view of the electrical contact of Figure 13 and an associated pair of dies; and

Figure 15 is a sectional side view of the electrical contact similar to Figure 14, after connection.

As shown in Figure 1, an electrical contact 20 shown on the left is connected to a flat conductor cable 22 to electrically engage a flat conductor 24 while the electrical contact

20 on the right is shown prior to its being connected to the cable 22.

The cable 22 includes the flat conductor 24 with first and second insulating layers 26 and 28 disposed on opposite sides thereof. The layers 26 and 28 are of plastics material such as polyethylene terephthalate to provide a tough and durable protective insulation for the conductor 24. In preparation for the connection of an electrical contact 20 to the cable 22, an opening 30 is provided in the cable 22 which pierces the flat conductor 24.

Referring also to Figures 2 to 4, the electrical contact 20 is stamped and formed from sheet metal and includes a contact portion 36. The contact portion 36 has a pair of spaced, resilient side walls 38, the side walls being interconnected along their upper edges (as shown in Figure 1) by spaced bights 40 to define an inverted channel-shaped tab receptacle. The side walls 38 are curved inwardly so that the contact portion 36 maintains mechanical and electrical contact with a tab (not shown) when extended through the opening 30 and between the side walls 38.

A backing member 42 extends laterally outwardly from the free edge of each side wall 38 and is folded over on itself to define a double thickness flange having a backing surface 49. As best seen in Figure 3, immediately prior to connection, each backing member 42 is disposed adjacent the cable 22 so that the backing surface 49 engages the first insulating layer 26 and is in alignment with the flat conductor 24. A deformable leg 44 depends from each backing member 42, each leg 44 being connected to its respective backing member by a root portion 46. Each leg 44 extends through the opening 30 passing from a first to a second opposite side surface of the cable 22. The legs 44 initially extend towards each other but their free ends 48 are turned outwardly away from each other.

As seen in Figure 3, a pair of dies 50 and 52 are utilised to curl the contact 20 against the cable 22. The die 50 is stationary and supports the contact portion 36 and the backing members 42 against the first insulating layer 26 of the cable 22. The die 52 is aligned with the die 50 to deform each of the legs 44 by curling them outwardly and then back toward their respective backing members 42. The free ends 48 pierce the cable 22 from the second side surface, engage the conductor 24 and converge toward their respective backing members 42 at an angle A as shown.

Complete deformation of each leg 44, as shown in Figure 4, causes the free ends 48 and the respective backing surfaces 49 to be disposed in an overlapping relationship as indicated at 54. The ends 48 are deformed

by the resistance of the backing members 42 so that they are disposed generally parallel with the backing members 42.

Since both curled portions of the contact 20 are the same, only one will be discussed with reference to Figure 4. It can be seen that the end 48 has pierced the second insulating layer 28 and penetrated the flat conductor 24 to provide a substantial area of electrical contact at 56 and 58. The natural tendency towards relaxation of the leg 44 after curling will be in a direction of the arrow B as the leg 44 attempts to uncurl. The overlapping relationship of the end 48 and the backing surface 49 causes the end 48 to be restricted by the backing member 42 to maintain electrical contact with the conductor 24 at 56 and 58.

The free end 48 initially makes contact with the conductor 24 and converges toward the backing member 42 at a location more spaced from the root portion 46 of the leg 44 than its location after complete curling. The final deformation of the end 48 causes it to move toward the root portion 46 as it slides along the backing surface 49. The movement of the end 48 toward the root portion 46 of the leg 44 elastically deforms the cable 22 as it is confined between the leg 44 and the backing member 42. The natural relaxation of the deformed cable 22 applies an expansive force to the leg 44 indicated generally at arrow C. However, movement of the end 48 is again resisted by the backing member 42 as with the tendency towards relaxation of the leg 44, and there is no detrimental effect on the electrical or mechanical connection. Further, since the expansive forces are also in a direction as indicated by the arrow D, the overall electrical connection between the electrical contact 20 and the conductor 24 is enhanced.

A different result is obtained with the electrical contact 20' shown in Figure 5. By altering the structure of the flat conductor 24' of a cable 22' or free end 48' of a leg 44', the end 48' does not penetrate the flat conductor 24'. For example, the end 48' may be weakened so that it is not sufficiently rigid and will therefore bend under the resistance of a thicker conductor 24'. However, the overlapping relationship of the free end 48' and the backing surface 49' still resists relaxation of the leg 44'. Further, since the relaxation is in a direction indicated by the arrow E, the electrical contact with the flat conductor 24' at 70 is enhanced as the conductor 24' is pressed between the free end 48' and the backing surface 49' of the backing member 42'.

It can be further seen, that by making the surface 49' of the backing member 42' abrasive, such as by the introduction of an electrically conductive grit, the sliding movement of the cable 22' along the backing

surface 49' will cause the insulating layer 26' to be worn away to allow the backing member 42' to make electrical contact with the flat conductor 24', which contact will also be enhanced by the force E.

Another embodiment of electrical contact 76 is shown in Figures 6 to 8. The contact 76 includes a contact portion 78 in the form of a double thickness tab, a backing member 80 having a backing surface 83 extending laterally outwardly from a free edge of the contact portion 78 and a deformable leg 82 extending in the opposite direction to the contact portion 78. The leg 82 is straight and has a free end 84 which is tapered to facilitate initial piercing of a flat conductor cable 86. The backing member 80 has a part 85 which is inclined to the remainder of the backing member 80 to define a deflector surface portion 81 of the backing surface 83. The leg 82 is initially passed from the first to the second opposite side surface of the cable 86. The dies 90 and 92 curl the leg 82 to turn the free end 84 through 190° so that the free end 84 penetrates an insulating layer 94 and makes electrical contact with the flat conductor layer 96 of the cable 86. The free end 84 finally pierces the cable 86 and engages the deflector surface portion 81 and slides down the surface portion 81 (as shown in Figure 8). The free end 84 in the final connection is in overlapping relationship to the deflector surface portion 81 of the backing surface 83.

Another electrical contact 102 is shown in Figures 9 to 12 and includes a contact portion 104 in the form of a double thickness tab, a backing member 106 having a backing surface 107 and a deformable leg 108. The leg 108 is straight and has a free end 109 which is tapered to facilitate initial piercing of a flat conductor cable 110. An upper die 114, shown in Figure 10, is like the die 92 shown in Figure 7. However, the lower die 116 includes a concave recess 118. The leg 108 is initially passed from a first to a second opposite side surface of the cable 110 via a preformed hole 112. On connection the die 114 initially curls the free end 109 of the leg 108 so that it approaches the backing surface 107 of the backing member 106 at right angles as shown in Figure 11. Further deformation, as shown in Figure 12, causes the end 109 to pierce the cable 110 and press the backing member 106 into the concave recess 118 of the lower die 116. As shown, the free end 109 in the final connection is in overlapping relationship to the backing surface 107 of the backing member 106.

Still another electrical contact 122 is shown in Figure 13 which can be connected to a free end of a flat conductor cable 126. The electrical contact 122 includes a contact portion 128 in the form of a tab, a backing

member 130 (extending laterally outwardly from one end of the contact portion 128 and having a backing surface 131 and a deformable leg 132 extending from the backing member 130 in a direction opposed to the contact portion 128). The leg 132 has a free end 133 which is tapered to facilitate initial piercing of the cable 126. The leg 132 is initially passed from a first to a second opposite side surface of the cable 126 across the free end of the cable. During a connecting operation, an upper die 134 approaches the backing member 130 and the cable 126 at an angle as shown in Figure 14. As a result, a curved portion 138 of the die face of the upper die 134 initially directs the free end 133 of the leg 132 at an angle toward the backing member 130. The final deformation of the leg 132 again causes the free end 133 to be deformed by the backing member 130 to assume an overlapping relationship with the backing surface 131 of the backing member 130.

WHAT WE CLAIM IS:—

1. An electrical connection between a flat conductor of a flat conductor cable and an electrical contact including a deformable leg having a free end and a backing member co-operating with the leg, the leg passing from a first to a second opposite side surface of the cable and being curled so that the free end pierces the cable from the second side surface and engages the conductor and the backing member having a backing surface engaging the first side surface of the cable in alignment with the conductor, the free end of the leg being in overlapping relationship to the backing surface so that any relaxation of the leg after curling, is resisted by the backing member.

2. An electrical contact formed from sheet material for use in the electrical connection claimed in claim 1, comprising a contact portion having spaced, resilient side walls interconnected by a bight to define a channel-shaped tab receptacle, a backing member extending laterally outwardly from the free edge of each side wall, each backing member being folded over on itself to define a double thickness flange having a backing surface, and a deformable leg extending from each backing member in a direction opposed to the contact portion, the legs converging towards each other except at their free ends which are turned outwardly away from each other.

3. An electrical contact formed from sheet material for use in the electrical connector claimed in claim 1, comprising a contact portion in the form of a double thickness tab, a backing member having a backing surface extending laterally outwardly from a free edge of the contact portion and a deformable leg extending in the opposite

surface 49' will cause the insulating layer 26' to be worn away to allow the backing member 42' to make electrical contact with the flat conductor 24', which contact will also be enhanced by the force E.

Another embodiment of electrical contact 76 is shown in Figures 6 to 8. The contact 76 includes a contact portion 78 in the form of a double thickness tab, a backing member 80 having a backing surface 83 extending laterally outwardly from a free edge of the contact portion 78 and a deformable leg 82 extending in the opposite direction to the contact portion 78. The leg 82 is straight and has a free end 84 which is tapered to facilitate initial piercing of a flat conductor cable 86. The backing member 80 has a part 85 which is inclined to the remainder of the backing member 80 to define a deflector surface portion 81 of the backing surface 83. The leg 82 is initially passed from the first to the second opposite side surface of the cable 86. The dies 90 and 92 curl the leg 82 to turn the free end 84 through 190° so that the free end 84 penetrates an insulating layer 94 and makes electrical contact with the flat conductor layer 96 of the cable 86. The free end 84 finally pierces the cable 86 and engages the deflector surface portion 81 and slides down the surface portion 81 (as shown in Figure 8). The free end 84 in the final connection is in overlapping relationship to the deflector surface portion 81 of the backing surface 83.

Another electrical contact 102 is shown in Figures 9 to 12 and includes a contact portion 104 in the form of a double thickness tab, a backing member 106 having a backing surface 107 and a deformable leg 108. The leg 108 is straight and has a free end 109 which is tapered to facilitate initial piercing of a flat conductor cable 110. An upper die 114, shown in Figure 10, is like the die 92 shown in Figure 7. However, the lower die 116 includes a concave recess 118. The leg 108 is initially passed from a first to a second opposite side surface of the cable 110 via a preformed hole 112. On connection the die 114 initially curls the free end 109 of the leg 108 so that it approaches the backing surface 107 of the backing member 106 at right angles as shown in Figure 11. Further deformation, as shown in Figure 12, causes the end 109 to pierce the cable 110 and press the backing member 106 into the concave recess 118 of the lower die 116. As shown, the free end 109 in the final connection is in overlapping relationship to the backing surface 107 of the backing member 106.

Still another electrical contact 122 is shown in Figure 13 which can be connected to a free end of a flat conductor cable 126. The electrical contact 122 includes a contact portion 128 in the form of a tab, a backing

member 130 (extending laterally outwardly from one end of the contact portion 128 and having a backing surface 131 and a deformable leg 132 extending from the backing member 130 in a direction opposed to the contact portion 128). The leg 132 has a free end 133 which is tapered to facilitate initial piercing of the cable 126. The leg 132 is initially passed from a first to a second opposite side surface of the cable 126 across the free end of the cable. During a connecting operation, an upper die 134 approaches the backing member 130 and the cable 126 at an angle as shown in Figure 14. As a result, a curved portion 138 of the die face of the upper die 134 initially directs the free end 133 of the leg 132 at an angle toward the backing member 130. The final deformation of the leg 132 again causes the free end 133 to be deformed by the backing member 130 to assume an overlapping relationship with the backing surface 131 of the backing member 130.

WHAT WE CLAIM IS:—

1. An electrical connection between a flat conductor of a flat conductor cable and an electrical contact including a deformable leg having a free end and a backing member co-operating with the leg, the leg passing from a first to a second opposite side surface of the cable and being curled so that the free end pierces the cable from the second side surface and engages the conductor and the backing member having a backing surface engaging the first side surface of the cable in alignment with the conductor, the free end of the leg being in overlapping relationship to the backing surface so that any relaxation of the leg after curling, is resisted by the backing member.

2. An electrical contact formed from sheet material for use in the electrical connection claimed in claim 1, comprising a contact portion having spaced, resilient side walls interconnected by a bight to define a channel-shaped tab receptacle, a backing member extending laterally outwardly from the free edge of each side wall, each backing member being folded over on itself to define a double thickness flange having a backing surface, and a deformable leg extending from each backing member in a direction opposed to the contact portion, the legs converging towards each other except at their free ends which are turned outwardly away from each other.

3. An electrical contact formed from sheet material for use in the electrical connector claimed in claim 1, comprising a contact portion in the form of a double thickness tab, a backing member having a backing surface extending laterally outwardly from a free edge of the contact portion and a deformable leg extending in the opposite



direction from the contact portion, the leg having a free end which is tapered.

4. An electrical contact as claimed in claim 3, in which the backing member has a part which is inclined to the remainder of the backing member to define a deflective surface portion of the backing surface.

5. An electrical contact formed from sheet material for use in the electrical connection claimed in claim 1, comprising a contact portion in the form of a tab, a backing member extending laterally outwardly from one end of the contact portion, the backing member having a backing surface and a deformable leg extending from the backing member in a direction opposed

to the contact portion, the leg having a free end which is tapered.

6. An electrical connection between a flat conductor of a flat conductor cable and an electrical contact, constructed and arranged, substantially as described with reference to and as illustrated in Figures 2 and 4 or 5 or 8 or 12 or 15.

7. An electrical contact constructed and arranged substantially as described with reference to and as illustrated in Figures 1 to 4 or 5 or 6 to 8 or 9 to 12 or 13 to 15.

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