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# PATENT SPECIFICATION

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## (54) CABLE CONNECTING

- (71) We, E.I. DU PONT DE NEMOURS AND COMPANY, a corporation organised and existing under the laws of the State of Delaware, located at Wilmington, State of Delaware, 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:—
- 10 The present invention relates to an electrical connector and method for termination of a multi-conductor transmission cable.
- Electrical connectors for multi-conductor flat cables are well known in the electronic packaging arts. One such connector particularly adapted for use in jumper interconnecting of dual in-line sockets is described in U.S. Patent 3,731,254. The connector described in this patent includes an insulating body having a plurality of terminals mounted therein for soldering to a corresponding plurality of conductors in a multi-conductor cable. However, in order to accommodate the increased speeds of electronic data processing equipment and reduce cross-talk between adjacent conductors in a multi-conductor cable, shielded multi-conductor cables having characteristic impedances have been developed. Electrical connectors for such cables are described in U.S. Patents 3,634,806 and 3,907,396. In the connectors described in both of these patents, a multi-conductor cable includes a plurality of signal conductors and an even number of drain or shield conductors.
- 35 The insulation is stripped from the ends of the conductors, which are then separated and alternate signal and drain or shield conductors are terminated at opposite surfaces of a substrate. This type of connector requires the fanning of alternate conductors on opposite surfaces of a substrate and individual termination of each drain or shield conductor. Although this type of connector is generally suitable where the multi-conductor shielded cable includes an even number of signal and shield conductors, it is unsuitable for terminating the more recently developed multi-conductor shielded cable including a pair of juxtaposed shield conductors on each side of each signal conductor. Additionally, the connectors described in these patents require an individual terminal in the connector for each shield conductor greatly reducing the interconnection density for the signal conductors in the connector.
- 50 According to one aspect of the present invention there is provided an electrical connector for a flat, insulated, multi-conductor transmission cable having a plurality of signal conductors and one or more shield conductors for each signal conductor, comprising an electrically insulating body having a cable terminating end and a mating end, a plurality of terminals mounted in said body extending from said cable terminating end to said mating end, and a bus strip engageable with said shield conductors at said cable terminating end, said cable terminating end of said body having a face including a ribbed section comprising a plurality of spaced ribs, a tail of each terminal extending between an adjacent pair of ribs and means on said face adjacent said ribbed section for receiving a plurality of signal conductors of a said transmission cable and for separating the shield conductors in the cable from the signal conductors during termination of the cable.
- 55 In another aspect, the invention provides a method of terminating a flat, insulated, multi-conductor transmission cable having a plurality of signal conductors and one or more shield conductors for each signal conductor, comprising severing an end portion of the insulating sheath of said cable, sliding the severed end portion of the sheath along the conductors to expose a segment of the conductors, engaging each exposed signal conductor with one of a plurality of terminals mounted in an electrically insulating body having a cable terminating end and a mating end, said terminals extending from said cable terminating end to said mating end, said cable terminating end of said body
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having a face including a ribbed section comprising a plurality of spaced ribs, a tail of each terminal extending between an adjacent pair of ribs, separating said shield conductors from said signal conductors using means on said face adjacent said ribbed section for receiving said plurality of signal conductors and for separating said shield conductors during termination, engaging a bus strip over an insulated segment of the cable adjacent the end of the sheath from which said end portion has been severed, severing each signal conductor of said cable, and folding the insulated end of the cable back along the cable to engage the shield conductors with the bus strip.

Two embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of an embodiment of a connector according to the invention.

Figure 2 is a front elevation view of the embodiment of Figure 1.

Figure 3 is a plan view of a face of the connector body of Figure 2.

Figure 4 is a side in section taken along line 4-4 of Figure 3.

Figure 5 is a side view similar to Figure 4.

Figure 6 is a side view similar to Figures 4 and 5 illustrating an assembled connector embodying the invention.

Figure 7 is a side view in partial section along line 7-7 of Figure 8 of an alternative embodiment of a connector according to the invention.

Figure 8 is a plan view of a face of the connector body of Figure 7.

Figure 9 is a front view of the embodiment of the connector of Figure 7.

One embodiment of a connector 10 according to the invention is illustrated in Figures 1-6. The connector 10 comprises an insulating body 12, a grounding bus 14 engageable with the insulating body 12, and a cover 16 engageable with the body 12 to provide protection and strain relief for a transmission cable.

The insulating body 12 of the connector 10 is generally rectangular and includes a transmission cable terminating end 18, and a mating end 20, laterally extending side walls 22, 23 and end walls 24. The transmission cable terminating end 18 of the body 12 comprises a face 26 having a laterally extending surface 28 for receiving an insulated segment of the cable, and a surface 30 including a plurality of spaced ribs 32. A pair of staggered rows of slots 34 is provided in face 30 and the slots extend into the body 12. Face 26 also includes a surface 38 raised from surface 30 adjacent each end of body 12.

A parapet 40 extends from face 26 between each end wall 24 adjacent side wall 23. Parapet 40 is recessed from side wall 23 and includes a plurality of raised portions separated by V-shaped grooves 44. Each groove 44 terminates

on surface 30 between a pair of ribs 32. A scalloped top surface 46 is provided on each of the raised portions of parapet 40 adjacent each groove 44.

An opening 48 extending into the body 12 is provided in each surface 38 for receiving a leg of bus 14. A pair of latch receiving members 50 are provided on each end of body 12. Each member 50 includes a cam surface 52 and a latch surface 54. Two rows of terminal-receiving cavities 56 extend between the cable terminating end 18 and mating end 20 of insulating body 12. A female terminal 58 is mounted in each cavity. A tail 59 of each terminal 58 extends through each slot 34 and includes an L-shaped bend to position tail 59 on surface 30 between a pair of ribs 32.

The grounding bus 14 comprises a laterally extending segment 60, a leg 61 at each end of segment 60 and a pair of fingers 62 adjacent each leg 61.

The cover 16 includes a central, laterally-extending section 64 and a latch arm 66 extending from each end of section 64. Each arm 66 includes a widened latch member 68 at the free end of arm 66. Each latch member 68 includes a cam surface 70 and a pair of latch surfaces 72.

The method of terminating a transmission line according to the invention will now be described below with reference to the attached drawings, particularly Figures 1, 4 and 5.

A transmission cable 74 includes an insulating sheath 75 and a plurality of signal conductors 76 and shield conductors 77 encased in the sheath 75. An end portion 78 of the insulated sheath 75 is served and slid forward along the conductors to expose an intermediate segment of the conductors adjacent the end of the transmission cable. The exposed segment of the conductors is engaged against the face 26 of insulating body 12 and the bus strip 14 is engaged with the face 26 with each leg 61 providing an interference fit in hole 48 at each surface 38 and segment 60 clamping the insulated sheath 75 against surface 28. Each signal conductor 76 is received in a groove 44 in parapet 40. Each shield conductor 77 is separated from the signal conductor 76 by the scalloped surface 46 adjacent each V-shaped groove. A knife selectively severs each signal conductor 76 and stuffs the conductor 76 in each groove 44 adjacent surface 30 of face 26 of body 12. Each signal conductor 76 is held in each groove 44 in contact with a terminal tail 59 between spaced ribs 32. The insulated end of the transmission cable is folded back on itself and the shield conductors 77 are engaged with section 60 of ground bus 14. The folded end of the cable sheath is secured along itself, e.g. by taping. The transmission cable is terminated by heating the terminal tails 59 and ground bus to flow a layer of solder thereon, e.g. by infra-red heating lamps, and then cooled to establish a soldered connection between each

signal conductor 76 and terminal tail 59, each shield conductor 77 and the ground bus 14, and each finger 62 of the ground bus with a terminal tail 59. The shield conductors 77 are then severed adjacent the stripped insulated end of the transmission cable. The insulated transmission cable away from the terminated ends is then folded back over the face 26 of the terminating end and the cover 16 engaged with the body 12 to protect the termination and provide a strain relief for the termination transmission cable.

Each signal conductor 76 in the cable 74 is permanently electrically and mechanically connected by a soldered connection to a female terminal 58 mounted in the insulating body 12. Each shield conductor 77 is permanently electrically and mechanically connected by a soldered connection to the bus strip 14. The bus strip is permanently electrically and mechanically connected to one or more female terminals 58 by a soldered connection between each finger 62 of the bus strip 14 and a tail 59 of a female terminal 58 mounted in the insulating body 12.

In another embodiment, shown in figures 7, 8 and 9, a connector 80 for the termination of two cables according to the invention comprises an insulating base 82, a pair of grounding buses 84 and a cover 86.

The insulating base 82 of the connector 80 is generally rectangular and includes a transmission cable terminating end 88, a mating end 90, laterally extending side walls 92, and end walls 94. The transmission cable terminating end 88 comprises a face 96 having a laterally extending surface 98 adjacent each side wall 92, and a central surface 100 including a pair of rows of spaced ribs 102. A row of slots 103 is provided in surface 100 between each pair of ribs 102.

A parapet 110 is provided adjacent the interior ends of each row of ribs 102. Each parapet 110 includes a plurality of raised portions separated by V-shaped grooves 114. Each groove 114 terminates on surface 100 between a pair of ribs 102. A scalloped surface 116 is provided along the top of each of the raised portions of the parapet adjacent each groove 114.

An opening 118 extends into the base 82 in surface 100 adjacent each end of recessed surface 98 for receiving a leg of the ground bus 84. Latch members 120 are provided at each corner of the base 82. Each member 120 includes a cam surface 122 and a latch surface 124. A terminal 128 mounted in each slot 103 and includes an L-shaped tail between a pair of ribs 102, and a contact 129 adjacent one side wall 92 on the mating end 90 of base 82.

A grounding pad 130 is provided on the mating end 90 of base 82 and includes a leg 132 extending into each opening 118 in base 82. Each bus strip 84 comprises a laterally extending segment 140 and a leg 142 at each end of the segment 140. Each leg 142 is engageable

in hole 118 providing an interference fit.

An abutment 104, of generally triangular cross-section, is provided in the centre of the surface 100 to assist location of the cables which enter the connector normal to the surface.

The cover 86 is generally rectangular and includes a latch surface 142 at each corner for engagement by each latch member 120 at each corner of the base 82.

A pair of flat, multi-conductor transmission cables may be terminated on the face 96 of the base 82 according to the method of the invention described above with reference to the embodiment of the connector illustrated in Figures 1-6. In the latter embodiment, each signal and shield conductor of the cable is terminated as in the former embodiment, e.g. by reflow soldering, and the bus strip is permanently electrically and mechanically connected to the grounding pads 130 by a soldered connection between each leg 132 of the grounding pad 130 and each leg 142 of the bus strip 84.

In each embodiment 10, 82 of the connector, the terminals and bus strip are formed of a suitable metal, e.g. cupro-nickel, brass or copper and plated with gold or tin/lead to provide improved conductivity and/or corrosion resistance. Preferably, each terminal tail and bus strip is provided with an adherent layer of solder of sufficient thickness to provide the required permanent electrical and mechanical connections when the solder layer is heated and reflowed. Alternatively, such connections may be provided for example by wave or dip soldering.

The former embodiment of the connector is particularly useful for interconnecting a cable to a circuit board having a plurality of circuit board pins mounted in holes therein in a pattern corresponding to the terminals in the insulating body. The latter embodiment is particularly useful for providing jumper interconnection on one or more circuit boards between connector blocks for leadless integrated circuit packages.

It will then be appreciated that the present invention can provide for termination of the shield conductors of a cable to a common bus strip and common termination of the bus strip. Additionally, termination of the signal conductors and shield conductors may be accomplished on a common surface of the connector obviating the requirement for separating and fanning the alternate signal and shield conductors.

WHAT WE CLAIM IS:-

1. An electrical connector for a flat, insulated, multi-conductor transmission cable having a plurality of signal conductors and one or more shield conductors for each signal conductor, comprising an electrically insulating body having a cable terminating end and a mating end, a plurality of terminals mounted



signal conductor 76 and terminal tail 59, each shield conductor 77 and the ground bus 14, and each finger 62 of the ground bus with a terminal tail 59. The shield conductors 77 are then severed adjacent the stripped insulated end of the transmission cable. The insulated transmission cable away from the terminated ends is then folded back over the face 26 of the terminating end and the cover 16 engaged with the body 12 to protect the termination and provide a strain relief for the termination transmission cable.

Each signal conductor 76 in the cable 74 is permanently electrically and mechanically connected by a soldered connection to a female terminal 58 mounted in the insulating body 12. Each shield conductor 77 is permanently electrically and mechanically connected by a soldered connection to the bus strip 14. The bus strip is permanently electrically and mechanically connected to one or more female terminals 58 by a soldered connection between each finger 62 of the bus strip 14 and a tail 59 of a female terminal 58 mounted in the insulating body 12.

In another embodiment, shown in figures 7, 8 and 9, a connector 80 for the termination of two cables according to the invention comprises an insulating base 82, a pair of grounding buses 84 and a cover 86.

The insulating base 82 of the connector 80 is generally rectangular and includes a transmission cable terminating end 88, a mating end 90, laterally extending side walls 92, and end walls 94. The transmission cable terminating end 88 comprises a face 96 having a laterally extending surface 98 adjacent each side wall 92, and a central surface 100 including a pair of rows of spaced ribs 102. A row of slots 103 is provided in surface 100 between each pair of ribs 102.

A parapet 110 is provided adjacent the interior ends of each row of ribs 102. Each parapet 110 includes a plurality of raised portions separated by V-shaped grooves 114. Each groove 114 terminates on surface 100 between a pair of ribs 102. A scalloped surface 116 is provided along the top of each of the raised portions of the parapet adjacent each groove 114.

An opening 118 extends into the base 82 in surface 100 adjacent each end of recessed surface 98 for receiving a leg of the ground bus 84. Latch members 120 are provided at each corner of the base 82. Each member 120 includes a cam surface 122 and a latch surface 124. A terminal 128 mounted in each slot 103 and includes an L-shaped tail between a pair of ribs 102, and a contact 129 adjacent one side wall 92 on the mating end 90 of base 82.

A grounding pad 130 is provided on the mating end 90 of base 82 and includes a leg 132 extending into each opening 118 in base 82. Each bus strip 84 comprises a laterally extending segment 140 and a leg 142 at each end of the segment 140. Each leg 142 is engageable

in hole 118 providing an interference fit.

An abutment 104, of generally triangular cross-section, is provided in the centre of the surface 100 to assist location of the cables which enter the connector normal to the surface.

The cover 86 is generally rectangular and includes a latch surface 142 at each corner for engagement by each latch member 120 at each corner of the base 82.

A pair of flat, multi-conductor transmission cables may be terminated on the face 96 of the base 82 according to the method of the invention described above with reference to the embodiment of the connector illustrated in Figures 1-6. In the latter embodiment, each signal and shield conductor of the cable is terminated as in the former embodiment, e.g. by reflow soldering, and the bus strip is permanently electrically and mechanically connected to the grounding pads 130 by a soldered connection between each leg 132 of the grounding pad 130 and each leg 142 of the bus strip 84.

In each embodiment 10, 82 of the connector, the terminals and bus strip are formed of a suitable metal, e.g. cupro-nickel, brass or copper and plated with gold or tin/lead to provide improved conductivity and/or corrosion resistance. Preferably, each terminal tail and bus strip is provided with an adherent layer of solder of sufficient thickness to provide the required permanent electrical and mechanical connections when the solder layer is heated and reflowed. Alternatively, such connections may be provided for example by wave or dip soldering.

The former embodiment of the connector is particularly useful for interconnecting a cable to a circuit board having a plurality of circuit board pins mounted in holes therein in a pattern corresponding to the terminals in the insulating body. The latter embodiment is particularly useful for providing jumper interconnection on one or more circuit boards between connector blocks for leadless integrated circuit packages.

It will then be appreciated that the present invention can provide for termination of the shield conductors of a cable to a common bus strip and common termination of the bus strip. Additionally, termination of the signal conductors and shield conductors may be accomplished on a common surface of the connector obviating the requirement for separating and fanning the alternate signal and shield conductors.

WHAT WE CLAIM IS:—

1. An electrical connector for a flat, insulated, multi-conductor transmission cable having a plurality of signal conductors and one or more shield conductors for each signal conductor, comprising an electrically insulating body having a cable terminating end and a mating end, a plurality of terminals mounted

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- in said body extending from said cable terminating end to said mating end, and a bus strip engageable with said shield conductors at said cable terminating end, said cable terminating end of said body having a face including a ribbed section comprising a plurality of spaced ribs, a tail of each terminal extending between an adjacent pair of ribs, and means on said face adjacent said ribbed section for receiving a plurality of signal conductors of a said transmission cable and for separating the shield conductors in the cable from the signal conductors during termination of the cable.
2. A connector according to claim 1, wherein said means on said face comprises a parapet including V-shaped grooves for receiving the signal conductors, the upstanding portions between the grooves having scalloped tops for receiving the shield conductors.
3. A connector according to claim 1 or 2, said bus strip including at least one finger engageable with a tail of a further terminal mounted in said body.
4. A connector according to claim 1 or 2, additionally comprising a grounding pad on said mating end of the insulating body, said bus strip being engageable with said grounding pad.
5. A connector according to any one of claims 2 to 4, wherein each V-shaped groove terminates on said face of said insulating body in alignment with the space between a pair of spaced ribs.
6. A connector according to any one of the preceding claims, further comprising a cover engageable with said insulating body.
7. An electrical connector assembly comprising a flat, insulated, multi-conductor transmission cable having a plurality of signal conductor and one or more shield conductors for each signal conductor, an electrically insulating body having a cable terminating end and a mating end, a plurality of terminals mounted in said body extending from said cable terminating end to said mating end, a bus strip engaged with said shield conductors at said cable terminating end over an insulated end of said cable, and a cover engaged with said insulating body; said cable terminating end of said body having a face including a ribbed section comprising a plurality of spaced ribs, a tail of each terminal extending between an adjacent pair of ribs, a parapet extending from said face adjacent said ribbed section, said parapet including a plurality of V-shaped grooves, each V-shaped groove having a signal conductor positioned therein and the upstanding portions between the grooves having scalloped tops for receiving the shield conductors so as to separate the shield conductors from the signal conductors during termination of the cable, each shield conductor being bent back along the cable in engagement with the bus strip and soldered to said bus strip, and each signal conductor being soldered to a terminal tail position along said face of said insulating body.
8. A connector assembly according to claim 7, said bus strip including at least one finger soldered to a tail of a terminal mounted in said body.
9. A connector assembly according to claim 7, additionally comprising a grounding pad on the mating end of the insulating body, said bus strip being connected with said grounding pad.
10. A connector assembly according to claim 7, additionally comprising a cover engaged with said insulating body over said terminals and said bus strip.
11. A method of terminating a flat, insulated, multi-conductor transmission cable having a plurality of signal conductors and one or more shield conductors for each signal conductor, comprising severing an end portion of the insulating sheath of said cable, sliding the severed end portion of the sheath along the conductors to expose a segment of the conductors, engaging each exposed signal conductor with one of a plurality of terminals mounted in an electrically insulating body having a cable terminating end and a mating end, said terminals extending from said cable terminating end to said mating end, said cable terminating end of said body having a face including a ribbed section comprising a plurality of spaced ribs, a tail of each terminal extending between an adjacent pair of ribs, separating said shield conductors from said signal conductors using means on said face adjacent said ribbed section for receiving said plurality of signal conductors and for separating said shield conductors during termination, engaging a bus strip over an insulated segment of the cable adjacent the end of the sheath from which said end portion has been severed, severing each signal conductor of said cable, and folding the insulated end of the cable back along the cable to engage the shield conductors with the bus strip.
12. A method according to claim 11, additionally comprising soldering each signal conductor to a terminal positioned along said face of said insulating body and each shield conductor to said bus strip.
13. A method according to claim 12, wherein said soldering comprises heating a layer of solder adherent to each terminal and said bus strip to reflow the layer of solder.
14. An electrical connector substantially as herein described with reference to figures 1 to 6 of the accompanying drawings.
15. An electrical connector substantially as herein described with reference to figures 7, 8 and 9 of the accompanying drawings.
16. A method of terminating a cable substantially as herein described.
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