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(72) Inventors JAMES EARL FLEISCHHACKER,
HENRY GEORGE WASSERLEIN, Jr. and
JAMES ALBERT KLOTH



(54) ELECTRICAL TERMINAL AND MODULAR ELECTRICAL CONNECTOR ASSEMBLY

(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, U.S.A., 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 terminal and to a modular electrical connector assembly.

According to one aspect of the invention an electrical terminal which has been stamped and formed from a single piece of sheet metal stock comprises a first plate having a first rectilinear slot opening into a free edge of the plate and into which slot an electrical wire can be forced, to make electrical connection between the wire and the first plate, and second plates connected to an edge of the first plate opposite to the edge thereof into which the first slot opens, each second plate having a second slot opening into a free edge of the second plate, in the opposite direction to that in which the first slot opens, the first and second plates being relatively angularly displaced from one another about an axis extending in the direction of the first slot, the second slots being adapted to receive a further plate, so that opposed wall portions of each second slot resiliently engage such further plate between them.

According to another aspect of the invention, a modular electrical connector assembly for connecting a first plurality of wires to a second plurality of wires comprises a base, an intermediate body, and a cap, the body being of insulating material and having oppositely directed first and second faces, a plurality of first electrical terminals mounted

in the body, each first terminal having a wire-receiving portion and a receptacle portion, the wire-receiving portion being adapted to make electrical contact with a wire upon movement of the wire laterally of its axis and into the wire-receiving portion, the receptacle portion having slots each of which is open at one end, the wire-receiving portion and the receptacle portion of each first terminal each having a free end and an inner end, the inner ends being formed integrally with one another, the wire-receiving portions extending from the first face, the receptacle portions extending from the second face, the base having an internal face which is opposed to the second face, and second electrical terminals mounted on, and extending from, such internal face, the second terminals having wire receiving portions each dimensioned to be received in the slots of a receptacle portion of a first terminal, the receptacle portion and the wire receiving portion of each first terminal being relatively angularly displaced in such a way that when wires are received in the wire receiving portions of the first and second terminals and when the second terminals are received in the slots of the receptacle portions of the first terminals, the wires extend in the same direction.

For a better understanding of the invention reference will now be made by way of example to the accompanying drawings in which:—

Figure 1 is an enlarged exploded perspective view of a modular electrical connector assembly for making a splice connection;

Figure 2 is a perspective view of the assembly when assembled to connect the wires of two electrical cables;

Figure 3 is an enlarged perspective view showing two electrical terminals, in association with an electrical wire;

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Figure 4 is an enlarged perspective view showing the terminals engaged with one another and connecting two wires;

Figure 5 is an enlarged exploded elevational view of a terminal used in an intermediate body of the connector assembly and a terminal used in a base of the assembly, each terminal being connected to a wire;

Figure 6 is an enlarged exploded cross-sectional view of the connector assembly;

Figure 7 is a view taken on the lines VII—VII of Figure 2;

Figure 8 is a view taken on the lines VIII—VIII of Figure 7;

Figure 9 is an exploded view of an electrical connector assembly for making a tap connection;

Figure 10 is a perspective view of the connector assembly of Figure 9 when assembled to connect the wires of three electrical cables;

Figures 11 and 12 are views similar to those of Figures 1 and 2, respectively, but showing a modified version of the assembly of Figures 1 and 2; and

Figures 13 and 14 are views similar to those of Figures 1 and 2, respectively, but showing a further modification of the assembly of Figures 1 and 2.

As shown in Figures 1 and 2, a modular electrical connector assembly is adapted to connect the wires of a bundle of insulated wires 4 of a telephone cable 6 to corresponding wires of a bundle of insulated wires 4¹ of a telephone cable 6¹. The connector assembly comprises a base 8, an intermediate body 10 and a cap 12, all being advantageously moulded in thermo-plastic material, for example a glass filled nylon or polyester, and being of elongate substantially rectangular shape.

The base 8 has end walls 14 and 16, side walls 18 and 20, and external bottom surface 22, and an internal upwardly facing (as seen in Figure 1) face 24. A plurality of electrical terminals 25 are mounted in, and extend upwardly from, the face 24 and are arranged in two parallel rows as shown. The terminals of one row are staggered with respect to those of the other so that the terminals of the row which is remote from the side wall 20, as well as the terminals of the row nearest the side wall 20, can receive wires extending through openings 40 in that side wall.

In practice, since each cable has twenty five wires the terminals 25 are twenty-five in number. As best seen in Figure 5, each terminal 25 is in the form of a stamped metal plate 26 having a free end 28 into which a wire receiving slot 30 extends, the width of this slot being less than the diameter of the electrically conductive core of the wire to be received in the slot, so that when the wire is forced into the slot, electrical contact is

established between the wire core and the terminal as shown in Figure 6.

As shown in Figures 1, 6 and 8 a plurality of rectangular wire support bosses 32, extend upwardly from the face 24, the terminals 25 being received in grooves which extend from the upper surfaces 38 of the bosses 32 and into the base 8, each terminal 25 being positioned closer to the lefthand face 34 of its associated boss 32 than it is to the righthand face 36, as best seen in Figure 6. As shown in Figure 8, each boss 32 is of a width slightly less than the distance between side walls 60 of electrical terminals 46 described below, which are mounted in the intermediate body 10.

The openings 40 in the side wall 20 of the base 8 are in the form of spaced apart wire receiving notches the bases of which are semi-circular and are positioned at the same level as the upper surfaces 38 of the bosses 32 so that a fully inserted wire is supported on the surfaces 38. The side wall 20 has internal ledges 44 into which the openings 40 extend.

Parts of the intermediate body 10 which correspond to those described above with reference to the base 8 bear the same reference numerals as the corresponding parts of the base 8, with the addition of a prime symbol, and will not be described in detail, such corresponding parts of the cap 12 also bearing the same reference numerals as the corresponding parts of the base 8 or body 10, but with the addition of a double prime symbol.

The terminals 46 (best seen in Figures 3 and 5) mounted in the body 10 each have a wire-receiving portion 48 similar to the terminal 25 and having a wire-receiving slot 54 extending inwardly from its free end 52, the lower end of the portion 48 being connected by a neck 56 to a receptacle portion 50 having a web 58 from which depend the side walls 60 mentioned above which are in the form of parallel plates. The portions 48 may have pointed tips as shown in Figures 1, 11 and 13, or blunt tips as shown in Figures 3 to 5. The side walls 60 have inwardly extending aligned slots 62 which are constricted at their open ends by rounded projections 64. The slots 62 of each terminal 46 are dimensioned to receive a terminal 25 or the portion 48 of another terminal 46 so that the terminals 46 can be electrically coupled to the terminals 25, or to each other as shown in Figure 4 in the assembly of Figure 10, described below with the portion 48 of the lower terminal extending into the slots 62 in the side walls 60 of the upper terminal. The portion 48 is angularly displaced, to the extent of 90°, from the side walls 60 about an axis A (Figure 5) extending in the direction of the slot 54 and through the neck 56, whereby the planes of the portion 48 and

side walls 60 are perpendicular to one another.

As shown in Figure 6, the bottom surface 22¹ of the body 10 has recesses 68 each receiving the portion 50 of one of the terminals 46, the portion 48 of the terminal extending upwardly through a slot in the body 10, which communicates with the recess 68. The terminals 46 are of the same number as the terminals 25 and are likewise arranged in two staggered rows. The surface 22¹ also has transversely extending ribs 66 separating adjacent portions 50 of the terminals of the two rows, to increase the electrical creepage paths between adjacent terminals, the surface 22¹ also having longitudinally extending recessed marginal shoulders 45¹ to receive the side walls 40.

From the bottom surface 22¹¹ of the cap 12 project spaced ribs 66¹¹ positioned so as to lie between adjacent portions 48 extending from the surface 24¹ of the body 10 when the cap 12 is mounted on the body 10.

When the wires 4 are to be connected to the wires 4¹ by means of the connector assembly described above, the wires 4¹ are dressed along the side 20 of the base 8 and positioned in the slots 30 of the upstanding terminals 25 (see Figure 5) one wire of each pair to be connected to a corresponding pair of the wires 4 being positioned in a terminal 25 which is proximate to the side wall 18 and the other wire of the pair of wires 4¹ being positioned in the adjacent terminal in the row which is proximate to the side wall 20, as shown in Figure 1.

When all of the wires 4¹ of the bundle 6¹ have been connected to the terminals 25 in the base 8, the body 10 is assembled to the base 8 and the wires of the bundle 4 are similarly located in the slots 54 of the portions 48 of the terminals 46 extending from the face 24¹ of the body 10 (see Figure 5). Finally, the cap 12 is assembled to the body 10 and so that the assembly is complete (Figures 2, 7 and 8). Corner portions 72 and 74 of the base 8, 72¹ and 74¹ of the body 10 and 72¹¹ and 74¹¹ of the 12 have locating means in the form of circular cross-section openings and pins on the corner portions 72, 72¹ and 72¹¹ and rectangular cross-section openings and pins on the corner portions 74, 74¹ and 74¹¹ so that the parts of the assembly can only be mated with the correct orientations.

As the body 10 is mated with the base 8, the plates 26 of the terminals 25 are received in the slots 62 of the side walls 60 of the terminals 46 so that each wire of each pair of the wires 4¹ is electrically connected to the corresponding wire of a pair of the wires 4. A waterproof grease may be applied to the surfaces 24 and 24¹ prior to the assembly operation described above, to restrain the

ingress of moisture into the connector assembly.

When the wires of a third cable 6¹¹ are to be connected to the wires 4 and 4¹ a so called "bridging" splice can be made by connecting the wires of the cable 6¹¹ to an additional body 10a, identical with the body 10, positioned between the body 10 and the cap 12, as shown in Figures 9 and 10. In this case, the terminals 46 of the bodies 10 and 10a mate as illustrated in Figures 3 and 4.

When it is desired to tap into a pre-existing cable with a branch or tap cable, the pre-existing cable may be severed, and the wires of the severed ends connected to each other and to the wires of the tap cable in the manner described above with reference to Figures 9 and 10.

Figures 11 and 12 show a modified assembly for making such a branch or tap connection where the through cable must not be severed (in order to avoid interruption of service). A modified base 80 is provided which is similar to the base 8 excepting that the side wall 118 is provided with notches 82 aligned with the openings 40. To effect the tap connection, the wires 86 of the through cable 87 are inserted, without severing them, into the slots 30 of the terminals 25 of the base 80 so as to extend through the notches 82. A body 10 is then assembled to the base 80 and the wires 84 of the tap cable 85 are inserted into the slots 54 of the terminals 46 of the body 10.

Figures 13 and 14 show a modification for the purpose of making two tap connections to the wires 88 of a through cable 90, the base 80 being used in conjunction with an intermediate body 96 having notches 98 in its side wall 118¹. The two tap connections are made by connecting the wires 88 to the terminals 25 of the base 80 and then connecting the terminals 46 in the body 96 to intermediate portions of the wires 92 of a tap cable 94.

Although the connector assemblies described above are of particular use in the telephone industry, such as a connector assembly can be otherwise used for example as a junction block for making common electrical connections among a plurality of wires extending from diverse locations.

The wires may be connected to the terminals by means of a tool of the general kind described in United States Patent Specification No. 3,859,724.

Since the plates 26 and 48 are identical and are arranged in the same positions and orientations with respect to the side and end walls of the base and the body or bodies, respectively, of the connector assembly, the same tool for loading all the plates 26 with wire simultaneously can be used for loading

all the plates 48 with wire simultaneously and *vice versa*.

WHAT WE CLAIM IS:—

1. An electrical terminal which has been stamped and formed from a single piece of sheet metal stock and which comprises a first plate having a first rectilinear slot opening into a free edge of the plate and into which slot an electrical wire can be forced, to make electrical connection between the wire and the first plate, and second plates connected to an edge of the first plate opposite to the edge thereof into which the first slot opens, each second plate having a second slot opening into a free edge of the second plate, in the opposite direction to that in which the first slot opens, the first and second plates being relatively angularly displaced from one another about an axis extending in the direction of the first slot, the second slots being adapted to receive a further plate, so that opposed wall portions of each second slot resiliently engage such further plate between them.

2. A terminal according to Claim 1, in which the plates are flat, the second plates being parallel to one another, and the first and second plates lie in planes which are relatively displaced by 90° about the axis.

3. A terminal according to Claim 1 or 2, in which the second plates are connected by a web from which the first plate extends at right angles.

4. A modular electrical connector assembly comprising a base and a connector body each made of an electrically insulating material, and each having first and second opposite faces, a plurality of electrical terminals according to Claim 1, 2 or 3, being mounted in the body, with the first plates of these terminals projecting from the first face of the body and the second plates of the terminals projecting from the second face of the body in the same direction and in parallel spaced relationship, the base comprising a plurality of the further plates projecting in parallel spaced relationship from the first face of the base and each having a slot opening into a free edge of such plate remote from the base into which slot an electrical wire can be forced, to make electrical connection between the wire and the further plate, the body and the base being mateable, with the first face of the base facing the second face of the body, the second plates of the terminals of the body and the further plates of the base, being so relatively disposed that each further plate is received in the slots of a pair of the second plates when the body is mated with the base.

5. An assembly according to Claim 4, which includes an insulating cap adapted to be mounted over the first face of the body, the first face of the body being surrounded

by side walls and end walls, the first face of the base also being surrounded by side walls and end walls, one of the side walls of each of the body and the base being provided with wire receiving notches, each aligned with a respective one of the slots of the plates of the body and the base, the plates on the first face of each of the body and the base being arranged in rows, the plates in which rows are offset from one another longitudinally of the rows so that each slot is disposed opposite to one of the notches.

6. An assembly according to Claim 5, in which the other side wall of the base also has wire receiving notches each such notch being in alignment with a respective notch of the one side wall.

7. An assembly according to Claim 6, in which the other side wall of the body has wire receiving notches each such notch being in alignment with a respective notch of the one side wall.

8. An assembly according to Claim 5, 6 or 7, in which the cap has ribs which separate adjacent plates of the first face of the body when the cap is mounted on the body, the second face of the body having ribs which extend between adjacent plates of the base when the body is mounted on the base.

9. An assembly according to Claim 4 or 5, comprising a further body similar to the first mentioned body and the slots of the second plates of which further body receive the first plates of the first mentioned body when the further body is interposed between the first mentioned body and the cap in the completed assembly.

10. A modular electrical connector assembly for connecting a first plurality of wires to a second plurality of wires, such assembly comprising a base, an intermediate body and a cap, the body being of insulating material and having oppositely directed first and second faces, a plurality of first electrical terminals mounted in the body, each first terminal having a wire-receiving portion and a receptacle portion, the wire-receiving portion being adapted to make electrical contact with a wire upon movement of the wire laterally of its axis and into the wire-receiving portion, the receptacle portion having slots each of which is open at one end, the wire receiving portion and the receptacle portion of each first terminal each having a free end and an inner end, the inner ends being formed integrally with one another, the wire-receiving portions extending from the first face, the receptacle portions extending from the second face, the base having an internal face which is opposed to the second face, and second electrical terminals mounted on, and extending from, such internal face, the second terminals having wire receiving portions each dimensioned to be received in the slots of a

all the plates 48 with wire simultaneously and *vice versa*.

WHAT WE CLAIM IS:—

5 1. An electrical terminal which has been stamped and formed from a single piece of sheet metal stock and which comprises a first plate having a first rectilinear slot opening into a free edge of the plate and into which slot an electrical wire can be forced, to make electrical connection between the wire and the first plate, and second plates connected to an edge of the first plate opposite to the edge thereof into which the first slot opens, each second plate having a second slot opening into a free edge of the second plate, in the opposite direction to that in which the first slot opens, the first and second plates being relatively angularly displaced from one another about an axis extending in the direction of the first slot, the second slots being adapted to receive a further plate, so that opposed wall portions of each second slot resiliently engage such further plate between them.

2. A terminal according to Claim 1, in which the plates are flat, the second plates being parallel to one another, and the first and second plates lie in planes which are relatively displaced by 90° about the axis.

3. A terminal according to Claim 1 or 2, in which the second plates are connected by a web from which the first plate extends at right angles.

35 4. A modular electrical connector assembly comprising a base and a connector body each made of an electrically insulating material, and each having first and second opposite faces, a plurality of electrical terminals according to Claim 1, 2 or 3, being mounted in the body, with the first plates of these terminals projecting from the first face of the body and the second plates of the terminals projecting from the second face of the body in the same direction and in parallel spaced relationship, the base comprising a plurality of the further plates projecting in parallel spaced relationship from the first face of the base and each having a slot opening into a free edge of such plate remote from the base into which slot an electrical wire can be forced, to make electrical connection between the wire and the further plate, the body and the base being mateable, with the first face of the base facing the second face of the body, the second plates of the terminals of the body and the further plates of the base, being so relatively disposed that each further plate is received in the slots of a pair of the second plates when the body is mated with the base.

5. An assembly according to Claim 4, which includes an insulating cap adapted to be mounted over the first face of the body, the first face of the body being surrounded

by side walls and end walls, the first face of the base also being surrounded by side walls and end walls, one of the side walls of each of the body and the base being provided with wire receiving notches, each aligned with a respective one of the slots of the plates of the body and the base, the plates on the first face of each of the body and the base being arranged in rows, the plates in which rows are offset from one another longitudinally of the rows so that each slot is disposed opposite to one of the notches.

6. An assembly according to Claim 5, in which the other side wall of the base also has wire receiving notches each such notch being in alignment with a respective notch of the one side wall.

7. An assembly according to Claim 6, in which the other side wall of the body has wire receiving notches each such notch being in alignment with a respective notch of the one side wall.

8. An assembly according to Claim 5, 6 or 7, in which the cap has ribs which separate adjacent plates of the first face of the body when the cap is mounted on the body, the second face of the body having ribs which extend between adjacent plates of the base when the body is mounted on the base.

9. An assembly according to Claim 4 or 5, comprising a further body similar to the first mentioned body and the slots of the second plates of which further body receive the first plates of the first mentioned body when the further body is interposed between the first mentioned body and the cap in the completed assembly.

10. A modular electrical connector assembly for connecting a first plurality of wires to a second plurality of wires, such assembly comprising a base, an intermediate body and a cap, the body being of insulating material and having oppositely directed first and second faces, a plurality of first electrical terminals mounted in the body, each first terminal having a wire-receiving portion and a receptacle portion, the wire-receiving portion being adapted to make electrical contact with a wire upon movement of the wire laterally of its axis and into the wire-receiving portion, the receptacle portion having slots each of which is open at one end, the wire receiving portion and the receptacle portion of each first terminal each having a free end and an inner end, the inner ends being formed integrally with one another, the wire-receiving portions extending from the first face, the receptacle portions extending from the second face, the base having an internal face which is opposed to the second face, and second electrical terminals mounted on, and extending from, such internal face, the second terminals having wire receiving portions each dimensioned to be received in the slots of a



receptacle portion of a first terminal, the receptacle portion and the wire receiving portion of each first terminal being relatively angularly displaced in such a way that when
5 wires are received in the wire receiving portions of the first and second terminals and when the second terminals are received in the slots of the receptacle portions of the first terminals, the wires extend in the same
10 direction.

11. An electrical terminal as claimed in

Claim 1, substantially as hereinbefore described with reference to Figures 3 to 5 of the accompanying drawings.

12. A modular electrical connector assembly substantially as hereinbefore described with reference to the accompanying drawings. 15

For the Applicants:
R. G. STUART-PRINCE,
Chartered Patent Agent.

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