MULTI-CONTACT CONNECTOR AND CONTACT TERMINAL FOR FLAT CABLE

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ABSTRACT

Multi-contact connector for flat cable comprises base member and cap piece which are assembled to the cable. Wire-in-slot type electrical contact terminals mounted in the base member engage the conductors of the cable and establish electrical contact therewith. Contact terminals each provide redundant contact to the conductors and engage the cap member in a manner which maintains electrical contact and secures the cap member to the connector.

14 Claims, 12 Drawing Figures
MULTI-CONTACT CONNECTOR AND CONTACT TERMINAL FOR FLAT CABLE

BACKGROUND OF THE INVENTION

This invention relates to multi-contact electrical connectors adapted for use on flat cables of the type having a plurality of conductors contained in a web of insulating material.

It is generally known to use electrical connectors for flat cables having wire-in-slot type contact terminals wherein puncture the cable in a manner such that each conductor of the cable is moved into the slot of one of the contact terminals, see for example, U.S. Pat. Nos. 3,189,863, 3,444,506, and 3,225,833. The instant invention is particularly directed to embodiments in flat cable connectors which permit inspection of the cable and contacts prior to assembly of the cap piece to the base member of the connector, to improve contact terminals for flat conductor cable connectors, and to a connector having improved means for holding the cap piece in assembled relationship to the base member.

It is accordingly an object of the invention to provide an improved multi-contact connector for use with a flat cable. A further object is to provide an improved contact terminal for use with flat cables which establishes redundant electrical contacts with the conductors of the cables. A further object is to provide a contact terminal having improved spring characteristics for maintaining electrical contact with the conductor. A further object is to provide a contact terminal adapted for use with flat cable which will accept a range of conductor sizes.

These and other objects of the invention are achieved in a preferred embodiment thereof, which is briefly described in the foregoing abstract, which is described in detail below, and which is shown in the accompanying drawing in which:

FIG. 1 is a perspective view of a connector in accordance with the invention, the base member being exploded from the cap member in this view.

FIG. 2 is a perspective view of a connector in accordance with the invention installed on one end of a flat cable.

FIGS. 3 and 4 are views taken along the lines 3—3 and 4—4 of FIG. 2.

FIG. 5 is a plan view of a portion of a flat cable of the type for which the disclosed embodiment of the invention is intended.

FIG. 6 is a view taken along the lines 6—6 of FIG. 5.

FIG. 7 is a fragmentary perspective view of an apparatus for assembling a cable to the base section of a connector in accordance with the invention and forcing the conductors of the cable into the slots of the contact terminals of the connector.

FIG. 8 is a view taken along the lines 8—8 of FIG. 7 and showing the underside of the cable insertion die.

FIG. 9 is a fragmentary cross-sectional view showing a portion of the cable insertion die and the base portion of a connector, this view illustrating the initial movement of the cable connectors into the slots of the contact terminals.

FIG. 10 is a view similar to FIG. 9 but showing the positions of the parts at the conclusion of the cable insertion process.

FIG. 11 is a perspective view of a contact terminal in accordance with the invention.

FIG. 12 is a view of the contact terminal showing the side thereof which is opposite to the side shown in FIG. 11.

Referring first to FIGS. 5 and 6, a widely used form of flat cable 4 comprises a plurality of parallel conductors 2, which may be either solid or stranded, contained in a continuous web 6 of plastic insulation. The underside 8 of the cable has parallel arcuate surface sections which are symmetrically located with respect to the conductors 2 and which intersect each other to form grooves or depressions 10. The upper surface 11 is substantially flat but may have shallow grooves 12 between adjacent conductors and in alignment with the grooves 10. Cables of the type shown in FIGS. 5 and 6 are made with varying numbers of conductors and with conductors of varying sizes. One widely used size or type has its conductors 2 spaced apart by 0.050 inch, the conductors being AWG 28 or 30 wires.

A connector assembly in accordance with the invention, FIGS. 1 and 2, comprises a cap member 16 and a base member 18, the base member containing a plurality of electrical contact terminals 20 arranged in two parallel rows extending along the sides of the base member. Each contact terminal, FIGS. 11 and 12, have a yoke portion 22 intermediate its ends comprised of a pair of parallel plate sections 24, 26 which are connected to each other by a vertically extending bight 25. A mounting post 28 extends downwardly from plate section 26 and is enlarged adjacent to the plate section, a dimple 30 being formed on this enlarged section to retain the terminal in a housing as will be described below.

A pair of arms 32 extend upwardly from the plate section 26 and are spaced apart to define a first wire receiving slot 36. The upper portions of the opposed edges of the slot 36 diverge so that the upper portion of the slot is of increasing width. The outwardly facing edge 38 of the arms are tapered gently towards each other in the intermediate portions of the arms and are relatively sharply tapered at the upper ends as shown at 39. The upper or free ends of the arms are thus sharply pointed to facilitate penetration of the cable during installation.

A similar pair of arms 40 extend upwardly from the plate section 24 and have divergent opposed edges 41 which define a second wire receiving slot 42. The outwardly facing edges 44 of the arms 40 are also tapered towards each other and the upper or free ends 46 have laterally extending barsbs which provide downwardly facing shoulders 43. The arms 32, 40 are thus substantially the same excepting for the provision of the barsbs on the upper ends 46 of the arms 40. It should also be noted that the arms 40 are inclined towards the arms 32 (which are planar extensions of the plate section 36) so that the free ends of the arms are closely adjacent to each other for reasons explained below.

Contact terminals as shown in FIG. 11 can be manufactured at any desired size for different sizes of conductors. A terminal which is suitable for the AWG 28 or 30 conductors of the cable described above is advantageously manufactured from metal stock having a thickness of 0.010 inch. It is desirable to manufacture the contact terminal of a metal having good spring characteristics such as a No. 4 hard phosphor bronze in order to permit use of one terminal having specific
dimensions with a range of wire sizes. As will be explained below, the manner of installing a connector in accordance with the invention on a cable and the structural features of the contact terminal permit the use of relatively thin sheet metal having good spring characteristics rather than a comparatively heavy gauge metal which is substantially stronger and less elastic than the No. 4 hard phosphor bronze referred to above.

The base member 18 comprises a block of insulating material having bosses 51 on its underside to support it on a printed circuit board. The contact terminals 20 are contained in two rows 52, 52' of cavities extending inwardly from its upper surface 53 along the opposite sides thereof. The cavities 52 have a ledge or shelf 54 recessed from the upper surface of the base member and have a relatively smaller opening 56 extending through to the underside 58 of the base, the opening 56 being offset relative to the upper portions of the cavity so as to receive the offset post portions 28 of the terminals. As best shown in FIG. 4, the openings 56 receive the enlarged upper portions of the posts 28 in which the dimples 30 are provided and the lower edges of the yoke portion 22 are supported on the shelf 54 of each cavity. The cavities 52' are similar to the cavities 52 but the openings 56 are on the opposed ends of the cavities from the openings 56 of the cavities 52. This arrangement locates the wire receiving slots of the terminals in each row at intervals of 0.100 inch, the slots in the terminals in the one row being offset by a distance of 0.050 inch from the slots in the other row so that the contact terminals will engage the conductors at the indicated locations in FIG. 5.

Latching arms 60, 60' are provided at each end of the base member and have enlarged free ends 62. These latching arms are adapted to enter recess 64, 64' in the cap member, the recesses having suitable upwardly facing shoulders for engagement with the enlarged ends 62 of the latch arms. The upper ends of the latch arms are slightly above the upper ends of the terminals 20 mounted in the base 18 so that the conductor cable 4 can be located between the latch arms at the time of application of the connector to the cable.

The cap member 16 has two rows of openings 64 extending therethrough from its upper side 67 to its underside 68, these openings being so located as to receive the contact arms 32, 40 of the terminals. As best shown in FIG. 4, each opening has a conical portion 70 adjacent to the underside of the cap member, an intermediate cylindrical portion 73 which merges with the conical portion, and an enlarged upper portion, the inner end of which is defined by an upwardly facing shoulder 72. The diameter of the relatively short cylindrical portion 73 is advantageously slightly less than the distance between the oppositely directed edges of the arms 40 at the shoulders 43 so that the arms will be flexed inwardly towards each other by a slight amount by the cap member.

The cap member is advantageously provided with a shallow rectangular recess 67 on its underside as shown in FIG. 3. When the base member and cap member are clamped to the cable, the cable is clamped between the opposed surfaces of the base and cap member which surround the recess 67 and the plastic web material flows into this recess to a slight extent. The recess thus permits firm clamping of the cable between the base and cap members.

The connector is advantageously installed on the cable by means of an apparatus 74, FIG. 7 comprising a jig or workholder 76 which is supported between gibs 78 on a base plate 80 which in turn may be secured to the bed or platen of a suitable bench press. The jig 76 is removable from the base plate so that several jigs intended for different sizes of connectors can be used. Two rows of relatively small circular openings 82 are provided on the upper surface of the jig for the reception of the post portions 28 of the contact terminals in the base section 18 and two relatively large openings 84 are provided for the reception of bosses 51 on the underside of the base member. A pair of guide pins 86 are mounted in the jig to locate the cable with respect to the base member of a connector mounted on the jig. The cable is also located by means of a stop block 88 which has a surface 90 against which the end of the cable is located during installation. The stop block 88 is adjustably mounted as shown at 92 on a mounting block 94 which is secured to the base plate.

The cable is pressed downwardly onto the base member by means of a die block or pressing block 96 mounted on the end of the press ram 98. It will be understood that the block 96 and the base plate can be used with any suitable bench press. Block 96 is formed of three sections 100, 100' and 102, FIG. 8. The sections 100, 102 have recesses 108 provided on their sides which bear against the center section 102 to define rectangular openings extending into the underside of the block. The edges of these recesses are beveled inclined as shown at 105 to provide guiding surfaces for the edges of the terminals during the cable installation operation. The width of the recesses 108 is substantially equal to and slightly greater than, the distance between the outer ends of the barbs 46 of the arms 40 as is apparent from FIG. 9. Both pairs of arms can thus move freely into the recesses as shown in FIG. 9 but the arms are restrained against the flexure during movement of the wires into the slots. It should also be mentioned that the openings 108, 108' have a width which is slightly greater than the distance between the oppositely facing surfaces of the arms 32, 40 but not excessively greater in order to provide support for these arms against buckling.

The sections 100, 100' 102 are held in assembled relationship by suitable fasteners as shown. Openings 104, are provided on the underside of the die block for the latching arms 60, 60' of the base member 18 and a recess 106 is also provided for the projection 89 on the stop block 88.

When a cable 4 is to be assembled to a connector 14, the base section 18, is first positioned on the jig 76 with the post portions 28 of the terminals disposed in the holes 82. The end of the cable is then located between pins 86 with the cut end against the surface 90. The press is then cycled to move the insertion die 96 downwardly as shown in FIG. 9 until it reaches the position shown in FIG. 10. During such insertion, the upper ends of the arms of each contact terminal pierce the cable on each side of one of the conductors 2 and the upper ends of the terminals enter the openings 108 in the insertion die. As downward movement of the die proceeds, the conductors are forced into the inner ends of the slots 36, 42 until they are located in the portions of the narrow slots which extend into the yoke section 22 of the terminal.
As previously noted, the terminals are advantageously manufactured of relatively thin material having good spring characteristics and the arms are therefore flexed laterally outwardly by the wedging effect of the conductors as shown in FIG. 10. In fact, the upper ends of the arms are supported by the walls of the openings 108, against the outward flexure which they would otherwise undergo. In other words, the forces imposed on the terminal by the wire during its movement into the slots would cause a flexure of the arms beyond the position shown in FIG. 10 if they were not confined by the walls of the openings 108. By virtue of the fact that the arms are supported during installation of the cable, the individual conductors are deformed to a greater degree than would otherwise be the case and fresh surface is formed on these conductors for the electrical contact interface between the conductors and the edges of the slots. Since the conductors are of copper, they yield (i.e. they are permanently deformed) during installation of the cable and are not capable of forcing the arms apart when the block 96 is removed.

The block 96 also serves, during installation of the cable, to prevent buckling or other failure of the terminals as a result of compression and/or torsional stresses developed while the wires are being forced into the slots of the terminal. The terminals thus need not be of relatively thick metal in order to prevent buckling or torsional failure without added support. The support provided by the openings in the insertion block thus permits the use of a relatively thin material having good spring characteristics as noted above.

After the cable conductors have been fully inserted into the slots of the terminals, the insertion block is raised and the end of the cable is inspected for any improperly inserted conductors or other defects. Casual inspection of the electrical connections at this stage will reveal any defects such as improperly located conductors or insufficiently inserted conductors. While such defects are only rarely encountered and are usually a result of improper application technique, such as improper alignment of the cable in the jig, they nonetheless do occur on rare occasions and the fact that the cable can be inspected is an advantageous feature.

The cap member 16 is then assembled to the base member 18 by simply pushing it downwardly with the insertion block until the latch arms are seated in the recesses 64. The upper ends of the arms 32, 40 will be flexed inwardly during assembly of the cap and after passage of the hook-like upper ends 46 through the restricted cylindrical sections 73 of the openings 66, the arms will return partially to their normal positions and the shoulders 43 will be seated against the surfaces 72 as shown in FIG. 4. As previously noted, the diameter of the cylindrical portion 73 of each opening 66 is preferably such that the arms are flexed inwardly by a slight amount by the cap member.

Several of the advantageous features of a connector in accordance with the invention stem for the fact that the contact terminals can be produced of relatively thin stock material having good spring characteristics. In the assembled connector, as installed in the cable, the contact terminals have intentionally stored energy which resiliently urges the edges of their slots against the insertion wire. The use of thin stock metal in the terminals as described above is in turn permitted by virtue of the fact that the arms of the terminals are supported against failure by buckling during installation of the connector on the cable. Also, the provision of two sets of contact arms provides sufficient contact surface notwithstanding the thinness of the metal.

A further advantage of the invention is that four separate areas of contact are provided between each terminal and each conductor. These redundant contacts reduce the possibility of high resistance connections and/or open circuits. It is also advantageous that the individual contacts are held in a flexed condition by the cap member and engage the cap member to hold it against the upper surface of the cable. The interengagement of each contact with the cap member prevents any buckling or bowing of the cap with an accompanying relaxation of mechanical retention of the connector to the cable.

As described above, the contact terminal 20 is advantageously formed with the arms 40 inclined towards the arms 32. This slight inclination of the arms 40 is advantageous in that it locates the opposed edges of the slot in the arms 40 closely adjacent to the opposed edges of the slot in the arms 32, particularly at the upper ends of the arms. When the conductor is forced downwardly as, illustrated in FIG. 9, the insulation or the web material of the cable must be extruded from around the conductor and the extruded insulation can flow into the space between the opposed surfaces of the arms 40 and the arms 32. The gap between these opposed surfaces is smallest at the upper ends of the arms and increases as the lower ends of the arms (adjacent to the yoke 22) are approached. Therefore, as extrusion of flow of the insulation surrounding the conductor increases during movement of the conductor downwardly, an increasingly greater space is provided into which plastic material can flow. The extruded plastic does not, therefore, wedge itself between the opposed faces of the arms and force them apart.

Terminals in accordance with the invention are manufactured by blanking flat sheet metal and bending the blank along the bight 25 to bring the arms 32, 40 in substantial alignment with each other. It is advantageous if the arms are not perfectly aligned but are slightly offset with respect to each other so that the slots of the arms will be offset very slightly. The offset relationship of the slots gives rise to the imposition of tensile stresses in the conductor because of the fact that it is stretched and these tensile stresses further contribute to the stored energy in the contact system by means of which the electrical contact is assured.

In the foregoing description, the underside of the cable as viewed in FIG. 6 is positioned against the upper ends of the contacts. It should be mentioned that either side of the cable can be positioned against the upper ends of the terminals, the grooves 12 in the disclosed embodiment serving to locate the cable if the upper side is positioned against the contacts. Some commercially available flat cables do not have such grooves in which case the cable is located entirely by the latching arms 60, 60' or it may be located by the pins 86 of the application tooling.

A connector as shown in the drawing can be mounted on a printed circuit board and the post portions 28 soldered to conductors on the underside of the board or these post portions may be inserted into contact sockets or a complimentary connector. If desired, alternative forms of contact members can be substituted for the posts 28 such as contact sockets.
Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

What is claimed is:

1. A stamped and formed electrical contact terminal for forming an electrical connection with an insulated wire comprising:
   a pair of closely spaced, parallel, substantially planar plate sections which are connected by a bight, and
   bight extending along corresponding first sides of said plate sections,
   each plate section having a pair of spaced apart arms extending from second corresponding sides of said plate sections; and
   a contact member extending from a third side of at least one of said plate sections,
   said second corresponding sides being adjacent to said first corresponding sides, said arms having opposed edges, said edges defining a wire-receiving slot, said slots extending into said plate-sections whereby,
   upon movement of a conductor laterally of its axis into said slots, the edges of said slots pierce the insulation of said wire and establish electrical contact therewith.

2. A contact terminal as set forth in claim 1, said contact member comprising a post member.

3. A contact terminal as set forth in claim 1, said arms being of decreasing widths along their lengths and being stiffer flexible towards and away from each other.

4. A contact terminal as set forth in claim 3, the arms of at least one of said pairs having outwardly directed free ends of each arm of said one pair having a shoulder lying in the plane of said plate sections for latching engagement with one part of a two-part connector housing.

5. A contact terminal as set forth in claim 1, said slots extending in parallel laterally offset relationship to each other.

6. An electrical connecting device for forming electrical connections with the conductors of a multi-conductor flat cable of the type comprising a plurality of conductors in side-by-side parallel relationship, said conductors being contained in a web of plastic insulating material, said connecting device comprising:
   a base member of insulating material having a plurality of cavities extending therethrough from one side thereof to another side which is opposite to said one side,
   an electrical contact terminal in each of said cavities, each of said contact terminals having a wire-receiving portion comprising a pair of spaced-apart arms, said arms having opposed edges defining a wire-receiving slot, said arms extending normally beyond said one side of said base member,
   a cap member which is adapted to be assembled to said base member against said one side thereof, said cap member having openings extending therethrough for reception of said arms of said contact terminals, and
   interengaging means on said arms and said cap member for retaining said cap member on said base member whereby,
upon positioning said cable in spaced parallel relationship to said one side of said base member and upon movement of said cable towards said one side, said free ends of said contact terminals penetrate said cable and each of said conductors is forced into said slots in one of said contact terminals, and upon assembly of said cap member to said base member, said cable is clamped to said base member.

11. A multi-conductor flat cable having an electrical connecting device thereon, said cable comprising a plurality of conductors in side-by-side parallel relationship, said conductors being contained in a web of insulating material, said connecting means comprising:

a base member of insulating material having a plurality of cavities extending therethrough from one side thereof to another side which is opposite to said one side,
an electrical contact terminal in each of said cavities, each of said contact terminals having a wire-receiving portion comprising a pair of spaced-apart arms, said arms having opposed edges defining a wire-receiving slot, said arms extending normally beyond said one side of said base member, said cable being substantially against said one side of said base member, said arms extending through said cables and each of said conductors being in the said wire receiving slot of one of said contact terminals, a cap member assembled to said base member against said cable, said cap member having openings extending therethrough, said arms of said contact terminals extending into said openings, and interengageable means on said arms and said cap member, said interengaging means latching said cap member to said base member and maintaining said cap member and said base member in clamping engagement with said cable.

12. A multi-conductor flat cable and connecting means as set forth in claim 11 said base member and said cap member being on one end of said cable.

13. A multi-conductor cable and a connecting means as set forth in claim 12, said interengaging means comprising laterally outwardly directed free end portions on said arms, said free end portions having shoulders directed towards said one side of said base member, said shoulders being against surface portions of said cap member extending parallel to said one side of said base member.

14. A multi-conductor cable and a connecting means as set forth in claim 13, each of said contact terminals having a generally U-shaped yoke portion intermediate the ends thereof, said yoke portions comprising a bight and substantially parallel plate sections, said arms extending from one side of one of said plate sections which is adjacent to said bight, a second pair of arms extending from the other one of said plate sections, said second pair of arms providing a second wire-receiving slot.

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