ABSTRACT: A connector terminal including a cylindrically shaped, rolled, hollow body having an opening or separation extending the length thereof. A first, narrowed end of the body is received in an aperture in a printed circuit board and is soldered to a corresponding conductor printed on the latter. The second end of the terminal extends outwardly from the opposite surface of the printed circuit board and includes resilient means therein. A lead wire of an electrical component inserted into the second end of the body of the connector terminal is engaged by said resilient means electrically to interconnect the printed conductor and electrical component.
PRINTED CIRCUIT BOARD LEAD WIRE RECEPTACLE

BACKGROUND OF INVENTION

This invention relates generally to printed circuit board connectors and more particularly to connector devices for mounting electrical components on a printed circuit board.

Conventionally, electrically to connect a multilead electrical component, such as a solid state device such as a transistor, diode, or integrated circuit chip, to the copper conductors of a printed circuit board, holes are provided through the conductors and board for receipt therein of the leads of the component. After the leads have been inserted into the holes they are, usually by means of a wave soldering technique, connected to respective copper conductors on the board.

If it becomes necessary to replace the component, the leads thereof must be severed or they must be simultaneously heated and unsoldered, and the component must be removed from the board. This is not possible in some cases, in that often printed circuit boards are used in places where access thereto with a soldering iron, etc., is prevented. Furthermore, excessive heating of the component in an attempt to remove it from the board could cause damage thereto.

In some cases mounting devices are used to secure the leads to the conductors of the printed circuit board; however, these devices are expensive and still do not provide a satisfactory way of removing the component from the printed circuit board when such removal becomes necessary.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of this invention to provide a connector device for removably mounting an electrical component to a printed circuit board in an efficient, reliable manner.

It is another object of this invention to provide a printed circuit board connector device of the above-mentioned type which is inexpensive to produce and simple to use.

It is a more specific object of this invention to provide a terminal connector device for connecting an individual lead wire of an electrical component to a conductor of a printed circuit board from which the lead may be removed easily.

It is another object of this invention to provide an assembly of joined connector devices of the above described type which can be mounted simultaneously to a printed circuit for accommodating a plurality of easy to remove lead wires of an electrical component.

It is yet another object of this invention to provide a method for easily and quickly mounting a plurality of terminal connector devices on a printed circuit board.

Briefly, a preferred embodiment of a connector terminal mounting device according to the invention includes a cylindrical shaped hollow body, a first end of which is narrowed and which is received in an aperture in a printed circuit board. The first end of the terminal is soldered to a corresponding printed conductor of the printed circuit board, preferably by a wave soldering technique. The second end of the body extends outwardly from the opposite surface of the printed circuit board and includes therein a resilient contact portion. A single lead of an electrical component is received in the last-mentioned end and is engaged by the contact portion to make both a mechanical and electrical connection therewith. The connector terminal is constructed of a single piece of stamped metal which is rolled into a hollow, cylindrical shape.

A plurality of the connector terminal devices may be produced in chain form whereby a chain of terminals may be mounted simultaneously on the printed circuit board, or individual terminal devices may be severed from the chain and mounted on the board quickly and easily according to the invention.

DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention and its organization and construction may be had by referring to the description below taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of a multilead electrical component connected to the conductors of a printed circuit board by means of a plurality of connector terminals according to the invention.

FIG. 2 is an enlarged, partially sectioned isometric view of a single connector terminal according to the invention receiving a lead therein and being connected to a conductor of a printed circuit board.

FIG. 3 is an elevational view of the connector terminal of FIG. 2 with the printed circuit board in section.

FIG. 4 is an enlarged axial sectional view of a connector terminal according to the invention taken along the line 4—4 of FIG. 2, in the direction indicated.

FIG. 5 is a cross-sectional view of the connector terminal of FIG. 4 taken along the line 5—5 thereof running transversely to the axis of the connector terminal.

FIG. 6 is a perspective view of a plurality of connector terminals formed in a chain or strip being mounted on a printed circuit board in spaced-apart apertures therein according to the invention.

FIG. 7 is an end sectional view of the chains of terminal connectors of FIG. 6 taken along the line 7—7 thereof, illustrating the manner in which individual terminals are severed from the chains after they have been mounted in a printed circuit board.

FIGS. 8—10 illustrate the steps of a method for easily and quickly mounting a number of individual terminal connectors in apertures in a printed circuit board, according to the invention.

FIG. 11 is an elevational view of an alternate connector terminal constructed in accordance with the present invention and engaged in a printed circuit board, which is illustrated in section.

FIG. 12 is an enlarged sectional view of the terminal connector illustrated in FIG. 11.

FIG. 13 is a partial sectional view of a terminal connector of FIGS. 11 and 12 with a wire lead engaged therein.

FIG. 14 is a sectional view taken along the line 14—14 of FIG. 13 in the direction indicated.

FIG. 15 is an elevational view of a sheetlike blank that may be formed to provide the terminal connector of FIGS. 11—13.

FIG. 16 is a sectional view of the sheetlike blank of FIG. 15 after same has been rolled to provide a hollow cylindrical member, but before the bowed wall portions have been formed.

FIG. 17 is a sectional view similar to FIG. 16 and illustrating how dies may be employed to provide the terminal connector with arcuate inwardly bowed wall portions.

DETAILED DESCRIPTION

Referring now to the drawings in more detail, there is shown an electrical component 10 in FIG. 1 thereof, having a plurality of lead wires 12 extending therefrom. The lead wires 12 of the component 10 are connected, by means of a corresponding number of terminal connectors 18 according to the invention, to respective conductors 14 printed on the lower surface 28 of a printed circuit board 16. As can be seen in the figure, first ends 20 of the terminal connectors are received in apertures 22 in the board from the upper surface 24 thereof. The ends 20 extend through the board so that the extreme leading tips 26 thereof protrude beyond the opposite surface 28 and the printed conductors 14 to allow the terminal connectors to be soldered to the conductors 14. The lead wires 12 of the electrical component 10 are removably inserted into respective upper ends 30 of the terminal connectors wherein both a mechanical and electrical connection are made therebetween.

A single terminal connector 18 is shown in FIGS. 2—5 of the drawings. The terminal connector 18 is shown received in an aperture 22 in the printed circuit board 16 and includes a body 19 constructed of a single piece of resilient metal which
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is formed into a cylindrical or tubular shape by means of a rolling process of a known type to provide an internal bore or passageway 27. The extreme end or tip 26 of the body 19 is rounded or tapered to close off one end of said passageway 27, and to facilitate insertion of end 26 into aperture 22. The opposite end of the tubular connection 18 is open, as indicated at 29. The body 19, it will be noted, includes a seam opening or separation 32 running the length thereof. The separation 32, as it appears in aperture 22 in FIG. 2, is narrow at a first or leading end of the terminal 20 and widens as it extends toward a second or trailing end 30 of the terminal. Due to the resiliency of the metal from which the tubular terminal connector is constructed, the rolled connector terminal tends normally to open along the separation 32. Thus, after terminal end 20 is inserted in an aperture 22 in a printed circuit board, which is of a smaller diameter than the diameter of the end 20 in the normal state, the end 20 tending to open at the separation 32, provides a friction fit in the aperture 22. This assures good positioning of the terminal therein and prevents the terminal connector from being removed from the printed circuit board both prior and subsequent to soldering.

The end 20 of the terminal connector which extends less than half the length thereof has a diameter less than that of the trailing end 30. A shoulder 34 is provided at the juncture of the two ends 20 and 30, and serves to limit the insertion of the smaller leading end 20 into aperture 22 in the printed circuit board.

Trailing end 30 of the connector terminal 18 includes a resilient, tonguelike contact 36 which is stamped or cut from the body 19. The terminal connector 18 is so shaped from the free end 40 thereof, as can be seen in FIGS. 3 and 4 of the drawings, extends inwardly into bore 27 of the tubular body 19 and rests against the inner wall 42 of an indentation 38 formed opposite the contact 36 in the body of the connector terminal.

As can be seen in FIG. 3, the free end 40 of the contact 36 is curved and, as mentioned above, normally rests against the inner wall 42 of indented portion 38 to provide a restitution in bore 27. However, as shown in FIGS. 4 and 5, when an end 13 of a lead wire 12 of an electrical component is received in bore 27 through the open end 29 of trailing end 30, the resilient contact 36 is displaced and the wire 12 is gripped between said contact 36 and indentation 38; the curved end 40 of contact 36 acting as a cam surface to allow the lead wire to be inserted into the terminal.

Directly beneath contact 36 and wall 42 of indented portion 38, and extending inwardly into body 19 at shoulder 34 thereof, is a stop 44. The stop, as shown in FIGS. 4 and 5 of the drawings, limits the insertion of the end 13 of the lead wire 12 into trailing end 30 of the terminal connector. In addition, the stop prevents solder from entering end 30 of body 19 of the terminal connector 18 at the printed circuit board is run through a solder bath, or is manually soldered.

It will be noted, in FIGS. 2 through 4, that solder 48 has been applied about the end 20 of the terminal connector 18, causing printed circuit board conductor 14 and terminal end 20 to be joined, thereby to form a mechanical and electrical connection therebetween. The friction fit of ends 20 in apertures 22 is maintained with the soldered contact 18, and to the printed circuit conductor 14, providing adequate mechanical holding force to prevent the terminal connectors 18 from being pulled from the apertures 22 of the printed circuit board when it becomes necessary to withdraw the lead wires 12 from end 30 of the connectors.

For purposes of affording a more complete understanding of the invention, it is advantage to the mechanical and electrical connection therebetween. The friction fit of ends 20 in apertures 22 is maintained with the soldered contact 18, and to the printed circuit conductor 14, providing adequate mechanical holding force to prevent the terminal connectors 18 from being pulled from the apertures 22 of the printed circuit board when it becomes necessary to withdraw the lead wires 12 from end 30 of the connectors.

Initially a printed circuit board 16 is provided; the printed circuit board being of the usual type including a plurality of conductors 14 printed on one surface 28 thereof. A plurality of apertures or holes 22 having a predetermined diameter, extends through the board and conductors for accommodating a corresponding number of lead wires of an electrical component electrically and mechanically to connect the component to the conductors. Into each one of the above-mentioned holes, from the surface 24 of the printed circuit board opposite surface 28 thereof, there is inserted a terminal connector 18. Tip 26 of the terminal connector, which is tapered as shown in FIGS. 2-4 to provide easy insertion thereof, is first received in one of the holes 22. The tapered tip, upon entering the hole, causes the resilient, tonguelike shaped terminal connector to be closed at separation 32 thereof, so that end 20 may be pushed easily into the hole. Once within the hole in the printed circuit board, the effect of end 20 tending to unroll and assume its normal shape causes it to be forced against the printed circuit board surrounding the hole 22, thereby to securely hold the terminal connector in place in the latter. The end 20 of the terminal connector is able to be inserted in hole 22 only up to the shoulder portion 34 which separates ends 20 and 30 of the connector. End 20, however, extends beyond the tip 26 thereof extending outwardly from surface 28 and conductor 14. This procedure is repeated for each terminal connector to be used on the board.

When all of the terminal connectors are in place, the ends 20 are soldered to respective conductors 14 of the board 16 either manually or by a wave soldering technique which provides for quickly soldering the many connections. Being able to complete all the required soldering prior to the introduction of the electrical component avoids heating of the lead wires of the component which may be harmful to the latter.

After the above is completed, individual lead wires 12 of an electrical component 10 may be inserted into corresponding ones of the terminal connectors. The rounded or curved end of the contact 36 provides for easy entry and withdrawal of the end 13 of lead wire 12 into and out of engagement with the terminal connector.

As explained heretofore, the insertion of a lead wire into end 30 of the terminal connector forces the tonguelike, resilient contact 36 away from the wall 42 of indentation 38 (FIGS. 3 and 4). The force of the contact 36 and its tendency to return to its normal position against wall 42 serves to provide a satisfactory electrical and mechanical connection between the terminal connector and lead wire.

In FIGS. 11-17 there is illustrated an alternate embodiment of the present invention. The terminal connector of said FIGS. 11-17 is similar to that as previously discussed, except for the particular means employed to maintain the mechanical and electrical connection therebetween. Accordingly, said alternate embodiment will be designated 18', and said alternate embodiment will be designated 18'. Those structural features and elements similar to those previously identified with regard to the embodiment of FIGS. 1-5, will be given like reference characters, primed.

It should be noted that the terminal connector 18' is employed, with respect to the printed circuit board 16' and connector 14', in the same manner as discussed with respect to connector 18. Accordingly, a detailed discussion of the manner of using said connector 18' is deemed unnecessary, the prior discussion being incorporated herein by reference.

Turning now to FIGS. 11-13, terminal connector 18' differs from connector 18 in a number of respects, however, the only primary difference lies in the manner in which the electrical connections are being in the resilient means employed to affix the wire lead 12' thereto. As can be seen with reference to FIG. 12, the trailing portion 30' of said connector 18' is provided with a plurality of inwardly bowed wall sections 82. Each said section 82 is of an arcuate configuration both in the horizontal and vertical sectional planes. Thus, these bowed wall sections 82 cooperate to define an aforesaid tonguelike passageway 27' in the trailing portion 30' of said body 19'.

The tonguelike passageway 27' is of maximum radial dimension at the open end 29' of said terminal, and due to the arcuate configuration of said wall sections 82, said passageway 27' extends inwardly it narrows to a minimum radial dimension midway of the trailing end portion 30' and then widens again approximate entry into the first or leading
end portion 20'. In this regard, it should be noted that the term "radial dimension" as used above and hereinafter refers to a dimension taken from the center line of terminal connector 18' to the closest point on the surface of one of said arcuate wall portions 82. By way of example, the radial dimension referred to is represented by dimension "A" of FIG. 17. Accordingly, to insure firm gripping of the wire lead 12 the minimum radial dimension "A" of passageway 27' is selected to be less than the radius of the lead wire 12' to be engaged therein.

Directing attention to FIGS. 15-17, there is illustrated the manner in which said terminal connector 18' is constructed. Initially, a sheet metal blank 90 is formed with elliptical cutout portions 92 and correspondingly shaped arcuate notches 94 on the parallel edges 95. Next, the blank 90 is rolled into a cylindrical configuration with the edges 95 in engagement to provide a seam and the lower portion thereof crimped to provide the rounded or tapered tip 26'. After having been rolled, the blank 90 as shown in FIG. 16 now has three elliptical openings 97 therein, two provided by cutouts 92 and the third by the juxtaposed notches 94.

Accordingly, after the blank 90 has been rolled, FIG. 16, the wall portions 82 as viewed in section are arched radially outwardly, and do not bow inwardly, as is illustrated with regard to the finished product of FIG. 12. In addition, each of the respective wall portions is spaced from the adjacent portion by the elliptical openings 97. To provide the finished product, the rolled blank 90 of FIG. 16 is subjected to a forming operation, as illustrated in FIG. 17, which bows the wall portions 82 inwardly to bring the edges thereof into engagement, thereby eliminating the openings 97 as seen in FIG. 16. The result of this operation is to provide the rail 12' for the roller transport shown in FIG. 18. The rail 12' defined by the opening 27' of the roll 90 is adapted to be enclosed by the roll 90 as shown in FIG. 16.

As well as having the advantage of being produced quickly, the plurality of terminal connectors of the chain thereof may be inserted simultaneously into complementarily spaced-apart apertures, such as 54, in a printed circuit board 56, after which the plurality of terminals may be wave soldered to conductors printed on the lower surface 57 (FIG. 7) of the board, as explained heretofore.

Once the terminal connectors are in place, the strip 52 may be removed from each of the terminals, as shown in FIG. 7, wherein a pair of movable blades 58, 60, is used to snip or sever strip 52 from the extreme trailing ends 30 of the terminal connectors 18. The blades 58 and 60 are in opposing relation and in shearing engagement with each other, and are arranged for movement toward each other in the direction of the arrows to pass through the metal strip as shown.

FIGS. 8-10 illustrate the steps of a fast, easy method for mounting separately the terminal connectors of a chain 50 thereof in case the mounting of the terminal connectors should not be or are preferred not to be mounted simultaneously.

As shown in FIG. 8, a chain 50 of connector terminals has been formed as described above. The chain 50 passes along in the direction of arrow 62. The connector terminals are successively positioned directly above a first end 61 of a funnel-shaped guide tube 64, and are successively severed from the common linking strip 52 by means of a pair of shearing blades 66, 68 (FIG. 9) similar to blades 58, 60. After a connector terminal is severed as described it falls, due to gravity, into end 61 of tube 64.

Tube 64 is elongated as shown in FIG. 10, and the opposite end 65 thereof is connected to a pneumatic terminal mounting device 66, of a well-known type. The terminal mounting device 66 which is operated by means of air pressure, supplied through a tube 68 from a pressurized air supply (not shown), is placed over an aperture such as 70, in a printed circuit board 72. The operating switch 74 of the mounting device is moved to the "on" position and a surge of air is released automatically thereinto, to in turn propel a terminal 18 according to the invention into aperture 70. This process is continued, respectively moving device 66 and board 72 along from aperture to aperture on board 72. After all of the terminal connectors 18 required for a particular circuit configuration are mounted on board 72, the ends 76 thereof may be wave soldered to preprinted conductors 78 located on the lower surface 80 of the board.

Through this mounting technique, terminal connectors 18 can be mounted rapidly on printed circuit boards. This process which may be fully automated can speed the production of printed circuit boards, etc., which use terminal connectors of a type according to the invention.

While particular embodiments of the invention have been shown and described, it should be understood that the invention is not limited thereto, since many modifications may be made. It is therefore contemplated to cover by the present invention and all such modifications as fall within the true spirit and scope of the appended claims.

The invention is claimed as follows:

1. A terminal for electrically connecting a lead wire of an electrical component to a conductor of a printed circuit board having at least one aperture of a predetermined size extending through said board and conductor, said terminal comprising: an elongate hollow body defining an interior passageway and having a tubular leading and a tubular trailing end portion, said leading end portion having an annular tip of smooth contour to facilitate insertion of said leading end into said aperture for interconnecting said printed conductor and said terminal with said trailing end portion extending outwardly from said printed circuit board, a shoulder for limiting the insertion of said leading end portion into said printed circuit board, said trailing end portion including therein resilient means restricting said passageway, the free end of said trailing end portion being open for receiving said lead wire therein, whereby said lead wire will be engaged by said resilient means electrically to...
interconnect said conductor and said lead wire, the engagement of said wire by said resilient means permitting withdrawal of said lead wire through the open end of said trailing end portion.

2. A terminal as claimed in claim 1 wherein said body is cylindrically shaped, of a resilient electrically conductive metallic material and includes a separation therein extending the length of said body and wherein said leading end portion of said body is normally of a diameter larger than that of said predeterminately sized aperture in said printed circuit board, so that upon the insertion of said leading end portion into said aperture the former compresses, thereby at least partially to close said separation and to provide a friction fit of said leading end portion in said aperture.

3. A terminal as claimed in claim 2 wherein said trailing end portion is larger in diameter than said leading end portion and said aperture, wherein said body includes, at the juncture of said leading and trailing end portions, said shoulder portion.

4. A terminal as defined in claim 1, said resilient means including a tonguelike contact member struck from said elongate hollow body and extending inwardly of said interior passageway.

5. A terminal as claimed in claim 4, wherein said contact member includes an integrally formed strip, one end thereof being connected at the inner wall of said body and the other free end thereof extending into said passageway toward a diametrically opposed portion of said body, whereby upon the insertion of said lead wire into said trailing end portion, said lead wire forces said strip outwardly so that said strip mechanically and electrically engages said lead wire, holding the latter between said contact strip and the second side of said wall of said body.

6. A terminal as claimed in claim 5 wherein said trailing end portion includes, opposite the free end of said contact strip, an indented wall portion and wherein said free end of said strip is curved, and said curved end normally rests against said indented portion.

7. A terminal as claimed in claim 1 in combination with a printed circuit board having a conductor thereon and an aperture extending through said board and the conductor, wherein said conductor is printed on one surface of said printed circuit board and wherein said terminal is inserted from the opposite surface, and wherein said leading end portion is insertable completely through said printed circuit board and said conductor to extend outwardly therefrom so that said conductor and said leading end portion of said terminal may be interconnected thereat.

8. A terminal as defined in claim 1, said resilient means being defined by wall portions of said body which are bowed radially inward to restrict said passageway, said bowed wall portions being resilient and distendable upon introduction of a lead wire therein frictionally to grip said wire and thereby provide the requisite engagement therewith.

9. A terminal for removably connecting a lead wire of an electrical component to a conductor printed on a first surface of a printed circuit board having at least one aperture of a predetermined diameter extending through said board and conductor, said terminal comprising: a one-piece, metallic, cylindrically shaped hollow body having a separation extending the length thereof, said body having a leading end of a first diameter, normally larger than the diameter of said aperture, a trailing end of a second diameter, normally larger than the diameter of said leading end, and a shoulder separating said leading and trailing ends, said trailing end including a resilient contact member formed from the wall and extending inwardly thereinto, and an indented portion opposite said contact member, said first leading end being inserted into said aperture in said printed circuit board from the surface thereof opposite said first surface, whereby said separation is at least partially closed causing a friction fit between said terminal and said printed circuit board, said shoulder preventing said leading end from being inserted therebeyond into said aperture, the free end of said leading end extending outwardly from said first surface of said printed circuit board beyond said conductor for connecting the latter thereto, said trailing end of said terminal extending from a second surface of said printed circuit board opposite said first surface, and receiving therein a lead wire of said electrical component, wherein said lead wire is removably engaged between said resilient contact member and said indented portion to provide an electrical connection between said component and said printed conductor.

10. A terminal for removably connecting a lead wire or an electrical component to a conductor printed on a first surface of a printed circuit board having at least one aperture extending through said board and conductor, said terminal comprising: a one-piece, metallic hollow body having a separation extending the length thereof, said body having a leading end of a first diameter and a trailing end of a second diameter larger than said first diameter to provide a shoulder which in effect separates said leading and trailing ends, said trailing end including a plurality of wall sections bowed radially inward and cooperating to define a restricted passageway, the wall sections being arcuate in the radial and axial directions, said bowed wall sections being resilient such that a wire lead may be frictionally engaged in said terminal to distend said bowed wall sections and be frictionally engaged thereby, said leading end being insertable into said aperture in said printed circuit board with said shoulder acting as a stop to limit the extent of said insertion.