United States Patent [19]

Marks

[11] **3,778,755**

[45] **Dec. 11, 1973**

[54] **SELF-STAKING WIRE GRIP TERMINAL**

[75] Inventor: **Richard L. Marks**, Mechanicsburg, Pa.

[73] Assignee: **Berg Electronics, Inc.**, New Cumberland, Pa.

[22] Filed: **Nov. 6, 1972**

[21] Appl. No.: **304,090**

[52] **U.S. Cl.**..... **339/220 R**, 339/258 P, 339/276 R, 85/71

[51] **Int. Cl.**..... **H01r 9/08**

[58] **Field of Search**..... 339/217 R, 217 S, 339/217 PS, 217 JP, 220 R, 220 A, 220 C, 220 L, 220 T, 219 R, 219 F, 258 R, 258 A, 258 C, 258 F, 258 P, 258 S, 258 T, 258 TC, 256 R, 275 R, 275 A, 275 B, 275 C, 275 E, 275 R, 275 T, 252 P, 276 R, 276 A, 276 C, 276 D, 276 E, 276 F, 276 R, 258 RR; 29/203, 625, 626; 85/71, 37; 24/94, 73 D, 95, 96, 213, 219

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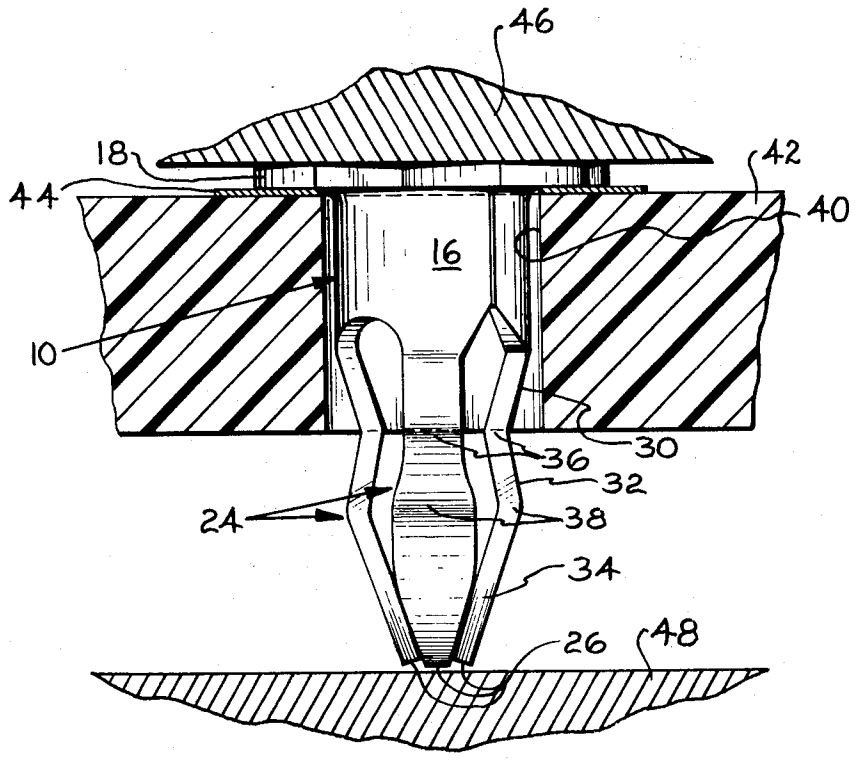
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Primary Examiner—Marvin A. Champion
Assistant Examiner—Robert A. Hafer
Attorney—Thomas Hooker

[57] **ABSTRACT**

A wire grip circuit board terminal having a cylindrical body, a circumferential flange on one end and collapsable fingers on the other end. The collapsable fingers permit staking of the terminals to circuit boards of different thicknesses. The terminals are staked to circuit boards without the necessity of special staking tooling for collapsing the fingers. The ends of the fingers grip wires inserted into the terminals.

6 Claims, 16 Drawing Figures



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SHEET 1 OF 2

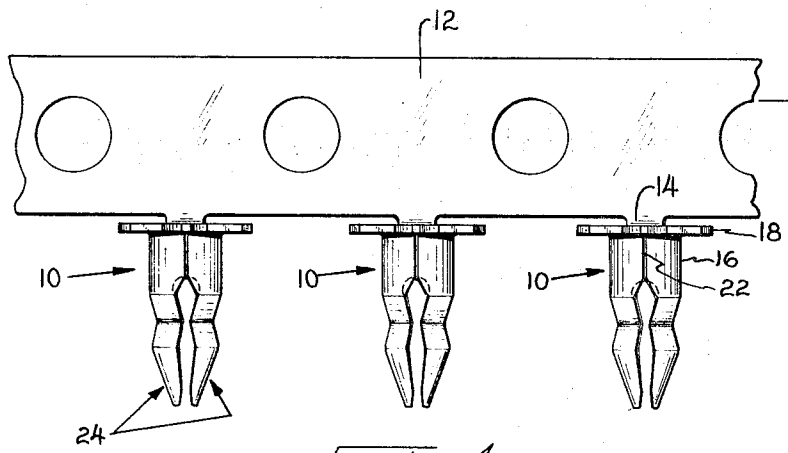


Fig. 1

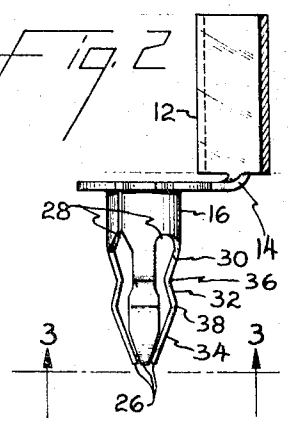


Fig. 2

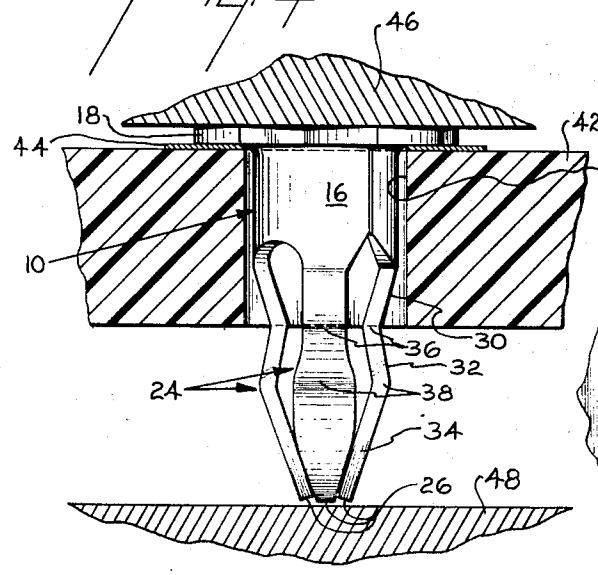


Fig. 4

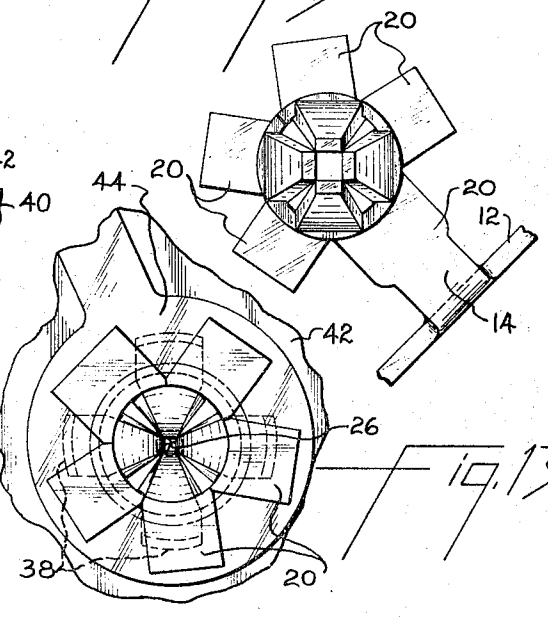


Fig. 3

Fig. 13

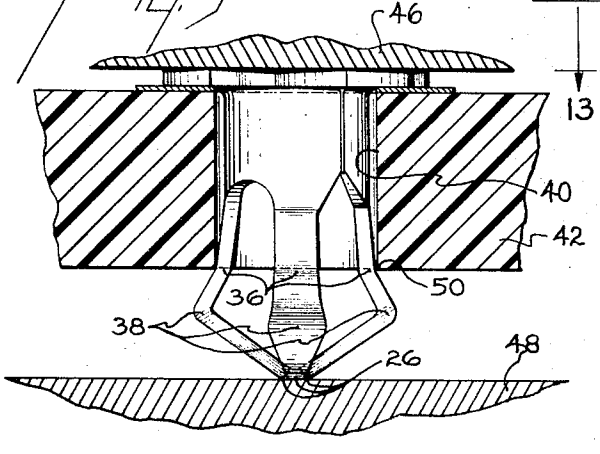


Fig. 5

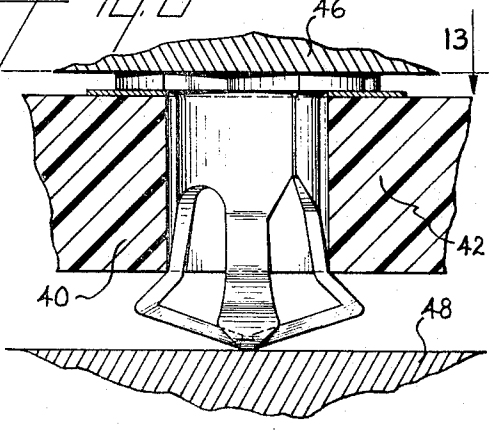


Fig. 6

Fig. 7

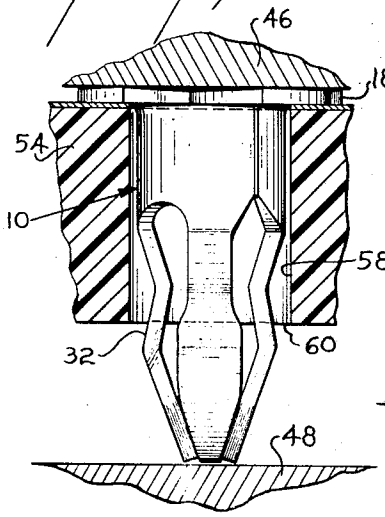


Fig. 8

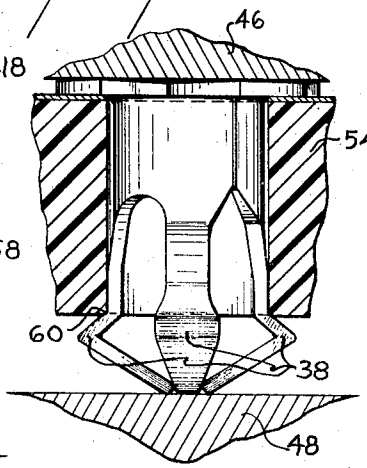


Fig. 9

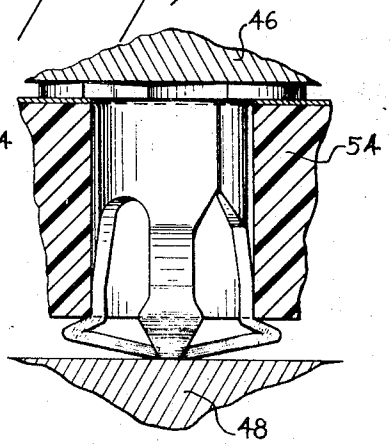


Fig. 10

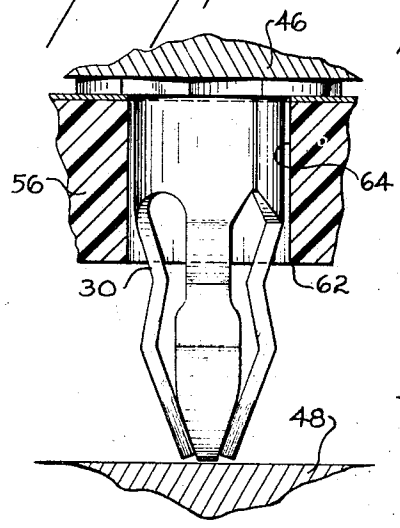


Fig. 11

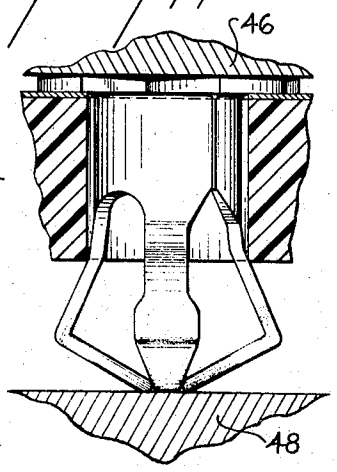


Fig. 12

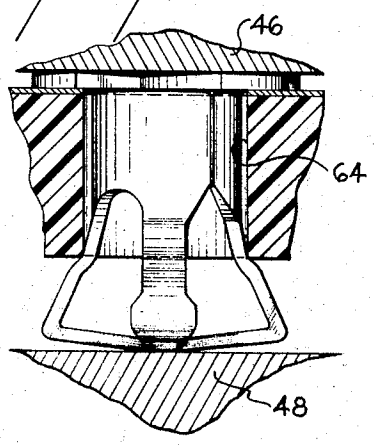


Fig. 14

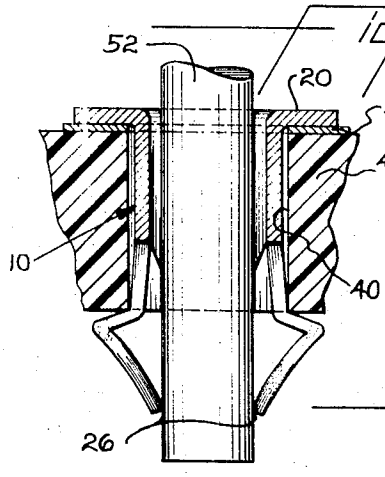


Fig. 16

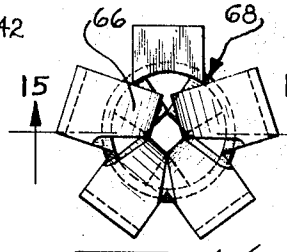
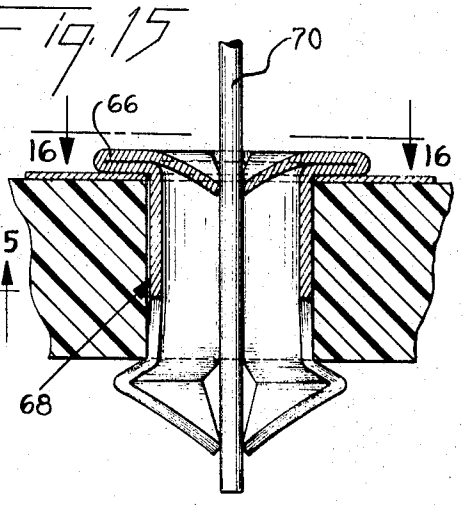


Fig. 15



SELF-STAKING WIRE GRIP TERMINAL

Wire grip circuit board eyelets of the type shown in U.S. Pat. Nos. 3,368,188 and 3,504,328 are well known in the art. These terminals include a cylindrical body, a circumferential flange at the upper end of the body and a circumferential flange member at the bottom of the body. The eyelets are inserted in holes formed through the thickness of the circuit board with the circumferential flange member extending outwardly of the board and are staked to the board by generally conical flaring tooling engageable with the circumferential flange member to flare it outwardly of the body about the lower corner of the circuit board hole. This staking operation is illustrated in U.S. Pat. Nos. 3,538,581, 3,571,924 and 3,574,935. All of the patents relating to the evelets per se and to staking of the eyelets to circuit boards are assigned to the assigner of the present invention. The circuit board eyelets may include wire grip fingers located generally within the thickness of the circuit board. U.S. Pat. No. 3,156,517 discloses a solder well terminal staked to a circuit board with wire grip fingers located in the well to one side of the circuit board.

The invention relates to an improved self staking wire grip terminal similar to the cylindrical circuit board eyelets of the type illustrated in U.S. Pat. Nos. 3,368,188 and 3,504,328. The eyelet includes a flange for engaging the top of the circuit board, a cylindrical body portion which fits into a circuit board hole, and a number of collapsable fingers extending downwardly from the body beyond the circuit board. During staking the circuit board is held against an upper flat staking surface so that the upper eyelet flanges are sandwiched between the surface and the top of the circuit board. A lower flat staking surface is then moved toward the upper surface so that it engages the free ends of the fingers. As the surfaces close the fingers buckle outwardly of the circuit board hole to engage the lower corner of the hole so that the eyelet is confined in the hole by the upper flange and the outwardly bent portion of the fingers. After staking the free ends of the fingers are close to each other and serve to hold a lead inserted into the eyelet in place prior to and during a soldering operation. If desired, additional wire grip fingers may be provided at the upper flange so that the eyelet includes two sets of wire grip fingers. After staking, leads are inserted in the eyelets and are held by the fingers. The circuit board may then be soldered to form electrical connections between the leads and circuit pads on the board.

During staking the eyelet fingers are deformed to attach the eyelet to the circuit board without the necessity of the conventional conical staking heads. This means that eyelets can be staked to a circuit board with improved reliability. In production, circuit board holes are formed through circuit boards with a relatively large tolerance concerning their location on the board. The conventional conical staking tooling is provided on the staking plate in alignment with the design or intended location of each circuit board hole. In actuality the circuit board hole may be shifted laterally on the board an appreciable distance from the design location. This means that during staking the lower cylindrical flange member is offset with respect to the staking tool and that the member is imperfectly deformed during staking. Eyelets staked in this manner are so imperfectly attached to the circuit board that they must be

replaced. This problem is eliminated with the present circuit board eyelet because the specialized staking tooling is not required.

The collapsable legs of the present eyelet enable the eyelet to be staked to circuit boards of different thicknesses without impairing the physical connection between the eyelet and the board. Also the wire grip ends of the fingers serve to retain leads in the eyelet without regard to the thickness of the board. This advantage is important since the thickness of mass produced circuit boards varies appreciably.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings illustrating the invention, of which there are two sheets.

IN THE DRAWINGS

FIG. **1** is a side view of a terminal strip illustrating a number of eyelets according to the invention;

FIG. **2** is a view similar to that of FIG. **1** illustrating an individual eyelet held by the strip;

FIG. **3** is a view taken along line **3—3** of FIG. **2**;

FIG. **4** is a partially broken away view illustrating a terminal in a circuit board hole between a pair of staking surfaces;

FIGS. **5** and **6** are views similar to FIG. **4** illustrating the staking operation;

FIGS. **7, 8** and **9** are similar to FIGS. **4, 5** and **6** but illustrate the staking operation on a circuit board of greater thickness than that of FIG. **4**;

FIGS. **10, 11** and **12** are also similar to FIGS. **4, 5** and **6** but illustrates the staking of an eyelet on a circuit board having a thickness less than the circuit board of FIG. **4**;

FIG. **13** is a view of the top of the eyelet taken along line **13—13** of FIG. **6**;

FIG. **14** is a sectional view taken through a staked eyelet illustrating a lead held therein by the ends of the staked fingers;

FIG. **15** is a view similar to that of FIG. **14** illustrating an embodiment of the invention in which the upper flange includes a number of wire grip fingers; and

FIG. **16** is a view taken along line **16—16** of FIG. **15** without the lead illustrating the upper wire grip fingers.

Circuit board eyelets **10** illustrated in FIG. **1** are preferably stamp formed from thin sheet metal stock and may be secured at regular intervals to a thin carrier strip **12** by severable connecting portions **14.** Each eyelet includes a cylindrical body **16** with a flange **18** on the end thereof adjacent the strip **12.** As illustrated in FIGS. **3** and **13,** flange **18** includes five tabs **20** arranged around the end of body **16.** Portion **14** connecting the eyelet to the strip **12** is an extension of one of the tabs **20.** A longitudinal seam **22** extends along the side of the body **16** away from tab **14.** The body **16** need not be cylindrical but may have a prismatic or other cross section.

Four collapsable fingers **24** extend from the end of the body **16** away from flange **18** with the free ends or finger tips **26** gripped closely together around the longitudinal axis of the terminal. The tips of the fingers may be slightly spaced from each other, as illustrated in FIG. **1** or may actually touch each other, as illustrated in FIG. **3.** The body **16** is cut away between adjacent fingers at **28** to facilitate bending of the fingers during staking of the terminal.

As illustrated at FIGS. 2 and 4, the fingers each include three generally flat sections 30, 32 and 34 interconnected by an inwardly directed or inner sharp bend 36 and an outwardly directed or outer sharp bend 38. Flat section 30 extends from body 16 to inner bend 36, flat section 32 extends from inner bend 36 to outer bend 38 and flat section 34 extends from an outer bend 38 to finger tip 26. Outer bend 38 is located approximately midway along the length of the finger and the inner bend 36 is located approximately midway along the length of the portion of finger extending between the body and the outer bend. Outer bend 38 is positioned to the outside of the axis of the finger and is further away from the axis than the inner bend 36. The axis of the finger is defined by a line extending from finger tip 26 to the junction between section 30 and body 16.

As illustrated best in FIG. 4, the width of the fingers 24 varies along the length thereof. The width remains constant from body 16 along flat portion 30 and approximately one half of flat portion 32. The width of the lower part of portion 32 increases to a maximum width just above bend 38. This width is maintained through approximately one half of portion 34 with the width of the free end of portion 34 decreasing to relatively narrow tips 26. This decrease in width permits close positioning of the tips adjacent each other in surrounding relationship to the longitudinal axis of the terminal.

Terminals 10 as described may be fitted within circuit board holes 40 formed through the thickness of circuit board 42, as illustrated best in FIG. 4. The flat upper flange 18 rests flush upon printed circuit pad 44 with the terminal body 16 within the hole and fingers 24 extending down from the body and out of the bottom of the hole. A circuit pad may be provided at the bottom of the hole. After the terminals 10 are positioned in holes 40 in the circuit board, the board is held against a flat upper staking plate 46 so that the flanges 18 are confined against the top of the circuit board. Staking is accomplished by raising a flat lower staking plate 48 up against the projecting ends of fingers 24 to collapse the same, as illustrated in FIGS. 5 and 6, and thereby stake the terminals to the circuit board.

In FIG. 4, staking surface 48 is below terminal tips 26. As the plate is raised it engages the tips and forces the same toward each other to assure that the tips engage each other and prevent further lateral movement of the tips. After the tips have been brought together, continued upward movement of plate 48 collapses the fingers 24 about outer corners 38. The outer corners bend because they are located outwardly of the finger axes. The inner corners 36 do not bend. With the collapse of the fingers resulting from bending at corners 38, the flat portions 30 and 32 are pivoted outwardly of the hole 40 about their juncture with terminal body 16.

Outward pivotal movement continues until the fingers engage the bottom corner of the hole 50 as illustrated in FIG. 5. The thickness of circuit board 42 is such that this engagement occurs at inner corner 36. After engagement between the fingers and corner 50, further upward movement of staking plate 48 collapses the portions of the fingers below the circuit board, as shown in FIG. 6 which illustrates the terminal fully staked to the circuit board. Staking plates 46 and 48 are then opened to permit removal of the circuit board 42 with staked terminals 20 thereon. Leads 52 may be inserted into the staked terminals as illustrated in FIG. 14. The leads force apart the wire grip ends of the fingers. The ends of the fingers securely hold the leads in place for a subsequent soldering operation. The soldering operation fills the eyelet bodies with solder to form a reliable electrical connection between the leads and the printed circuit pad on the circuit board. Eyelets 10 are particularly adapted for wave soldering in which case the bottom surface of the circuit board is exposed to a wave of molten solder which flows into the eyelet through openings between the fingers, up through the eyelet body and on to the circuit board pad at the top of the circuit board to form the desired solder joint. The fingers hold the lead in place and prevent lead movement during soldering.

The lower staking surface 48 is flat and does not require specialized tooling for staking the terminals. This means that the staking operation is carried out as desired and is not affected by off-center circuit board holes. Also the cost of staking tooling is appreciably reduced by eliminating the necessity of providing tooling in the lower plate for each individual eyelet in the circuit board. The tolerance for positioning circuit board holes may be decreased to permit location of a hole in a greater area on the circuit board without affecting the reliability of the staking operation. This represents a saving in circuit board costs.

The staking steps shown in FIGS. 4, 5 and 6 illustrate the staking of an eyelet 10 to a circuit board 42 having a nominal thickness for the eyelet. The eyelet may also be staked to circuit boards having a thickness less than that of the nominal thickness circuit board or to circuit boards having a thickness greater than that of the nominal thickness circuit board. FIGS. 7, 8 and 9 illustrate staking of an eyelet 10 to a circuit board 54 having a thickness greater than that of circuit baord 42. FIGS. 10, 11 and 12 illustrate staking of the same eyelet to a circuit board 56 having a thickness less than the thickness of circuit board 42.

Referring now to FIGS. 7, 8 and 9, a terminal 10 is positioned in a circuit board hole 58 extending through board 54 with the upper flange 18 held flush on the top of the board by upper staking plate 46. The lower flat staking plate 48 is raised to bring the finger tips 26 together. Further raising of the plate collapses the fingers 24 about outer bends 38 in a manner similar to the collapse during the initial staking of an eyelet 10 to circuit board 42. As flat portions 30 and 32 of each finger are bent outwardly away from body 16, portion 32 engages the lower corner 60 of hole 58. Further upward movement of staking plate 48 results in a collapse of the exposed portions of fingers 24. The staking operation is completed when the lower staking plate reaches the position of FIG. 9 and the portions of fingers 24 projecting outwardly of hole 58 are collapsed as illustrated. As in the staking operations illustrated in FIGS. 4 through 6 and FIGS. 10 through 12, the fingers are held tightly against the bottom corner of the circuit board hole during the final collapse of the exposed finger portions. After the staking tooling has opened and the board and terminals are removed from the staking apparatus, leads may be inserted into the terminal between the wire grip ends of the fingers prior to the soldering operation of the type previously described.

FIGS. 10, 11 and 12 illustrate staking a terminal 10 to a circuit board having a thickness less than that of

circuit board **32.** The staking operation is essentially the same as that previously described with the exception that during the initial staking step flat portion **30** is brought into engagement with the lower corner **62** of circuit board hole **64.** Further upward movement of the lower staking plate collapses the fingers about the corner **62,** as illustrated, in essentially the same manner as shown in FIGS. **6** and **9.** Again leads may be inserted into the staked eyelets on board **56** prior to a soldering operation.

During staking of a terminal **10** to any of circuit boards **42, 54** and **56** the outward bending of the legs brings the narrow width portion of the legs **24** into contact with the lower corner of the circuit board hole. This contact between the lower corner of the hole and the minimum width portion of the legs assures that the legs bend about the corner at the contact point to securely hold the eyelet to the circuit board. The legs are weakened at the contact point because of the reduced width in order to assure the desired bending at the lower hole corner during staking.

The movement of the staking tooling **46** and **48** in staking eyelets **10** to circuit board **42, 54** and **56** is identical. Thus, on a production run it is not necessary to alter the adjustment of the staking tooling to accomodate circuit boards of different thicknesses.

FIGS. **15** and **16** illustrate a further embodiment of the invention in which the upper flange **18** engages reverse bend wire grip fingers **66** which form extensions of tabs **20** bent back on top of the tabs and extending over the interior of body **16.** These fingers provide additional wire grip support for retaining a lead **70** in the eyelet. It is frequently desirable to secure a lead in place against possible lateral movement during soldering. This is assured by providing the spaced pair of wire grip fingers. With the exception of the additional wire grip fingers **66,** the eyelet **68** of FIGS. **15** and **16** is identical to eyelet **10.**

Circuit board holes are conventionally formed by either a drilling or a punching operation. In both these operations it is difficult to accurately control the diameter of the hole. The variation in circuit board hole diameter mades it difficult to stake conventional eyelets to circuit boards. Eyelets of the type disclosed herein represent an improvement over conventional eyelets in this regard since the staking legs **24** bend outwardly of the hole until they engage the edge of the hole. Thus, a tight staked joint is formed between the eyelet and the circuit board without regard to the diameter of the individual hole. The tight physical connection between the eyelet and the circuit board improves the subsequently formed solder connection.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are capable of modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

What I claim as my invention is:

1. A circuit board eyelet adapted to be staked in a circuit board hole comprising a hollow generally cylindrical body, flange means at one end of the body having a central longitudinal axis, and a plurality of spaced staking fingers extending away from the other end of the body with the free ends of the fingers grouped together in converging relation adjacent the axis of the eyelet, each finger including a sharp outer bend located between the body and the finger ends defining an apex facing generally inwardly toward said axis and a sharp inner bend defining an apex facing generally outwardly away from said axis located between the body and the outer bend, whereby during staking the portions of the fingers between the body and the outer bends are pivoted away from said axis and into contact with the adjacent edge of the circuit board hole, the ends of the fingers forming means for receiving and holding a lead inserted through the eyelet body.

2. A circuit board eyelet as in claim **1** wherein each finger includes a first flat portion extending from the body to said inner bend, a second flat portion extending from the inner bend to the outer bend and a third flat portion extending form the outer bend to the end of the finger.

3. A circuit board eyelet as in claim **2** wherein in each finger the outer bend is located further from a line extending from the tip of the finger to the junction between the finger and the body than the inner bend.

4. A circuit board eyelet as in claim **3** wherein the width of each finger at the inner bend is less than the width of the finger at the outer bend.

5. A circuit board eyelet comprising a generally cylindrical body having a central longitudinal axis, an outwardly extending flange at one end of the body, and a plurality of collapsable fingers extending from the other end of the body, each finger including a sharp outer bend located approximately midway along the length thereof defining an apex facing generally inwardly toward said axis and a sharp inner bend located approximately midway along the portion thereof between said body and said outer bend defining an apex facing generally outwardly, away from said axis, said outer bend being located further from a line extending from the tip of the finger to the junction between the finger and the body than said inner bend whereby upon axial collapse of the eyelet positioned in the circuit board hole said legs first collapse about said outer bend to move said leg portions outwardly against the circuit board hole to confine the eyelet in the hole.

6. A circuit board eyelet as in claim **5** wherein said eyelet includes a set of wire grip fingers extending from outer edges of said flange into the opening at one end of the body, the ends of such fingers being spaced closely together to receive and hold a lead inserted into the body.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,778,755 Dated December 11, 1973

Inventor(s) Richard L. Marks

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover page after "[73] Assignee:", "Berg Electronics, Inc., New Cumberland, Pa." should read --E. I. du Pont de Nemours & Company, Wilmington, Delaware--.

Signed and sealed this 9th day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

ORM PO-1050 (10-69)

USCOMM-DC 60376-P69
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