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(54) SELF-STAKING TERMINAL PIN

(71) We, E. I. DU PONT DE NEMOURS AND COMPANY, a corporation organized and existing under the laws of the State of Delaware, located at Wilmington, State of Delaware, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to self-staking terminal pins, for example, to terminal pins for mounting in holes extending through supports such as circuit boards and panels. A self-staking terminal pin may be moved towards the support from one side thereof, seated in the hole and be physically secured to the hole to prevent accidental dislodgement. The pin may be subsequently soldered to the support. The terminal pin is "self-staked" to the support, that is it is positively secured to the support without the use of tooling on the side of support opposite the insertion side.

Circuit board terminal pins are conventionally inserted into circuit board holes from one side of the board and staked therein by tooling which deforms the lead-in end of the pin as it projects below the board as illustrated in United States Patents Nos. 3,574,935 and 3,355,701. Circuit board components having legs with spring detents such that upon insertion into a circuit board hole the legs are bent inwardly and snap back on the other side of the board are shown in United States Patents Nos. 2,950,458; 3,506,942 and 3,786,402. United States Patent Number 3,777,303 discloses a circuit board hole liner having a latching member which is locked in the latch position upon insertion of a lead through the opening in the hole liner. United States Patent Number 3,596,236 discloses a circuit board contact member which is fitted in a hole through a circuit board and includes deformable members on

one side of the board which are connected to members on the other side of the board such that movement of the members on the other side of the board deforms the members on said one side of the board. Also see United States Patent Number 3,588,793 relating to a panel mount wedge connector used to form a ground connection, and United States Patent Numbers 2,333,930 and 2,660,084 relating to blind rivet type fasteners.

According to the present invention there is provided a self-staking terminal pin comprising an inner body within an elongate hollow outer body, said outer body having a collapsible portion which is collapsible in the direction of the longitudinal axis of the outer body, and an expandable portion at one end of said outer body for mounting in a hole, said inner body extending through said collapsible portion with a free end of said inner body adjacent said expandable portion, such that upon axial collapse of said collapsible portion said free end of said inner body engages the radially inner surface of said expandable means so as to deflect some radially outwardly.

Terminal pins of the present invention may be mounted in supports through the use of assembly apparatus which stakes a large number of pins in a support in one operation. Individual pins are automatically dropped into selected holes in the supports with the expandable portions fitted loosely within the holes and the collapsible portions seated against the top surface of the support to locate the pin in the hole. An upwardly projecting portion of the outer body joining the collapsible portion is then pushed towards the support to collapse the collapsible portion and move said inner body downwardly to engage said expandable portion whereby the expandable portion is deflected radially outwardly and engage into the inner surface of the support hole adjacent the bottom of the support. This engagement of the expandable

portion with the support stakes the contact to the support with the collapsed collapsible portion held in tight engagement against the top of the support. The result is a tight physical connection between the contact and the support.

Preferably the expandable portion comprises a plurality of inwardly dished petal elements each having a pair of corners on its radially outer surface for engagement with the inner body. The dishing, in combination with the width of the petal elements, provides an effective thickness greater than the thickness of the metal from which the petal elements are formed, thus assuring that the petal elements are bent outwardly sufficiently to force them into tight engagement with the circuit board.

Because the petals are positively pushed outwardly upon staking, the pin may be staked in circuit board holes having a range of diameters and lengths greater than the range tolerated by conventional elements which are staked to circuit boards by engagement with tooling on the side at which the staking occurs. This feature also allows the terminal pin to be staked to boards having holes sufficiently large so that the expandable portion can be loosely fitted into the hole prior to staking. Further, there is no injury to the pin or circuit board hole during fitting of the pin into the hole. Initial insertion force is reduced because the pin can fall into the hole.

In a preferred embodiment the pin also includes a continuous solder flow path extending from the bottom of the circuit board up through the height of the pin so that upon soldering of the board molten solder is drawn up past the collapsed collapsible portion and solder flow windows and into the elongate portion projecting above the board. Solder may also be drawn up the pin along an additional solder flow path defined by the interior surface of the expandable and projecting portions and the exterior surface of the inner body defining the first solder flow path. Solder flowing along the second solder flow path also flows out of windows in the collapsible or knuckle portion to form a solder joint between the pin and a contact pad on the top of the board, if there is such a pad. After soldering, the interior of the pin both above and below the circuit board is filled with solder, thus increasing the rigidity of the pin and also improving its electrical current-carrying capacity.

The pin is preferably stamp-formed from flat sheet metal stock and includes an upwardly extending tubular portion adapted to receive a female disconnect terminal. Undesirable raw edges are eliminated on the

surface of the pin so that corrosion products do not form on the pin and the female disconnectable terminals are not injured during insertion upon the pin. If desired, the free end of the pin may be tapered to facilitate mounting of the disconnectable socket terminal on the end. Preferably, the collapsible portion comprises a plurality of collapsible members spaced about the longitudinal axis of the outer body and extending radially outwardly beyond said expandable portion. Each collapsible member may be a "knuckle" formed from a pair of legs of equal length joined at an apex.

In a further preferred embodiment of the invention the terminal pin is adapted to be crimped to either an electrical or fibre optic conductor and staked to a circuit board or like support panel to form a physical connection between the conductor and the board or panel. Where the pin is crimped to an electrical conductor a subsequent soldering operation forms the desired electrical connection between the conductor and printed circuitry on the circuit board. The free end of the fibre optic conductor crimped within the connector is exposed on the non-insertion side of the board or panel to permit transmission of light to the fibre optic member to such side, or alternatively, from such side through the fibre optic member to a remote area.

The crimp-type contact is manufactured from strip stock in an open configuration to provide a U-shaped expandable portion such that the conductor, whether optically or electrically conductive, may be positioned within the contact prior to crimping. Following the crimping operation the pin is piloted into a circuit board hole or a hole in a support panel to seat the knuckles against one side of the board or panel following which continued movement toward the board or panel collapses the knuckles and moves the staking member against the petals to force them radially outwardly and physically secure the pin in place. In the case that the pin is crimped to a fibre optic member the edges of the pair of outwardly bowed strips forming the staking element abut each other to prevent undue radial pressure on the relatively delicate fibre optic member during collapse and staking to the terminal pin.

A heavy coating of solder may be provided on the outer surfaces of the collapsible knuckles so that following staking and heating the solder melts to form a soldered joint between the collapsed knuckles and printed circuitry on the insertion side of the board. In this way, the pin may be soldered to the circuitry on the insertion side of the board without the necessity of wave-solder-

ing the non-insertion side of the board. A solder coating may be provided on the inner surfaces of the staking strips forming the inner body to form a soldered joint between the strips and an electrical conductor positioned between the strips.

Embodiments of the present invention will hereinafter be described by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a side elevational view of a terminal pin of the invention;

Figures 2, 3, 4, and 5 are sectional views taken along lines 2-2, 3-3, 4-4, and 5-5 of Figure 1, 2, 3, 4, and 5 respectively;

Figure 6 is a view of the bottom of the pin illustrated in Figure 1 taken in the direction of arrow 6;

Figure 7 is a fragmentary illustration of a flat metal preform used in the manufacture of the pin;

Figures 8 and 9 are sectional views of the pin taken along line 8-8 of Figure 4 illustrating the pin positioned on a circuit board prior to and after staking to the board;

Figure 10 is a sectional view similar to Figure 9 after soldering of the pin to the board;

Figures 11 and 12 are sectional views taken along lines 11-11 and 12-12 respectively of Figure 10;

Figure 13 is a perspective view of a further embodiment of a pin of the invention;

Figure 14 is a sectional view taken along line 14-14 of Figure 13;

Figure 15 and 16 illustrate positioning of a pin in a punched circuit board hole with break out and subsequent staking of the pin in such hole;

Figures 17 and 18 are similar to Figures 8 and 9 and illustrate a further embodiment of the invention;

Figure 19 is a side elevational view of a crimp-type self-staking contact;

Figure 20 is a sectional view taken along line 20-20 of Figure 19;

Figure 21 is a partially broken away view of the contact of Figure 19 crimped to an electrical conductor and staked to a circuit board;

Figure 22 is a partially broken away view of a contact like that of Figure 19 crimped to a fibre optic member and staked to a support panel; and

Figure 23 is a sectional view taken along line 23-23 of Figure 22.

The self-staking terminal pin 10 is preferably stamp formed from a flat sheet metal preform 12 and includes an elongate tubular body 14 at one end of the pin, a tubular mounting portion 16 at the other end of the pin and a collapsible knuckle portion 18 joining the body and mounting

portions. The collapsible portion 18 includes four outwardly bent V-shaped knuckles spaced equally around the periphery of the pin to define four solder flow openings 22 between adjacent knuckles communicating the inside and outside of the pin as shown in Figure 4. Each knuckle includes a leg 24 extending from the tubular body 14 and a leg 26 extending from the mounting portion 16, with the legs joining at a relatively sharp apex 28. The free end 30 of tubular body 14 is inwardly tapered to facilitate mounting a female terminal on the end of the pin 10 after the pin has been staked and soldered on a circuit board.

Three circuit board engaging petals 32 are provided at the free end of the mounting portion 16 and extend radially inwardly toward the longitudinal axis 34 of the pin (see Figure 1). The petals 32 are inwardly dished so that when together they close the interior of the mounting portion. Each petal includes a pair of circuit board hole-engaging corners 36 located on the outside surface of the petal and a longitudinally extending camming surface 38 located midway between the edges of the petals on the inner surface. As shown in Figure 2, the camming surfaces 38 converge with each other adjacent the longitudinal axis 34.

Longitudinal seam 40 extends along the one side of body 14, through a solder flow opening 22, along one side of the mounting portion 16, and between a pair of petals 32. An inner tubular body 42 surrounded by the body 14, collapsible knuckle portion 18 and mounting portion 16 includes a pair of outwardly bowed elongate strips 44. Each strip 44 is joined to the body 14 at one side of seam 40 through a reverse bend portion 46 which extends along the body 14 from the collapsible portion 18 to free end 30. The strips 44 extend from body 14 past the collapsible portion 18 and into the mounting portion 16 with the free ends 48 of the strips positioned immediately above the camming surfaces 38 on the inner sides of the petals. The strips are radially outwardly bowed in planes transverse to the axis 34 so that their outer sides are adjacent and slightly spaced from the inner surface of the body 14. The inner concave surfaces of the strips 44 define a hollow continuous solder flow path 49 extending from the interior of the mounting portion 16, past the collapsible portion 18, and up to the free end 30 of body 14.

The blank 12 illustrated in Figure 7 includes two side portions 50, a central portion 52, four strips 54, and end portion 56 and three tabs 58. Slits are provided on each side of the tabs and strips. The right hand end of the preform 12 is broken away

to indicate that the central portion and side portions may be of a given length, depending upon the length of the pin above the collapsible portion. In the manufacturing operation used to form the pin 10 from the blank 12, the central portion 52 becomes body 14, side portions 50 become strips 44, strips 54 become knuckles 20, portion 56 becomes mounting portion 16, and strips 58 become petals 32.

The pin is mounted in and soldered to a circuit board as illustrated in Figures 8 to 12. The mounting portion is loosely fitted into a circuit board hole 60 extending through the thickness of circuit board 62, which may have printed contact pads 64 on both sides of the board. The loose fit of the mounting portion in the hole facilitates mounting of pins in mass pin assembly, as the pin may simply be dropped into the hole without the necessity of forcing the pin into the hole. Injury to the pin or hole during insertion is avoided, together with the problem of aligning the pin exactly with the hole.

The pin moves into the circuit board hole until the outwardly projecting knuckles 20 rest on the upper surface of the board, in this case the upper contact pad 64. The corners 36 of the petals 32 extend radially inwardly toward the free end 66 of the pin to provide lead-in for ease of entry into hole 60. As shown in Figure 8, the petals and corners may extend from within the hole 60 below the lower surface of the board 62.

The circuit board pin 10 is staked to board 62 as illustrated in Figure 9. Board 62 is positioned on a support 68 having an opening below circuit board hole 60. A staking tool 70 having a cylindrical bore slightly greater in diameter than the diameter of the body 14 is positioned over the body 14 so that the lower staking surface 72 of the tool engages the knuckles 20 and, with movement of the tool 70 toward the fixed board 62, collapses the legs of the knuckles flat against each other as illustrated. Legs 24 and 26 are of equal length, thus facilitating flat collapse of the knuckles. Collapse of the knuckles lowers the elongate tubular body 14 and the strips 44 which are integral therewith so that the free ends 48 of the strips are moved down with respect to the fixed mounting portion 16 and petals 32. This downward movement brings the ends into engagement with the camming surface 38 on the insides of the petals and forces the ends of the strips together, as shown in Figure 9, to collapse the seams 74 between the free ends of the strips as illustrated in Figures 9 and 12. Continued downward movement of the body 14 and strips bends the petals radially outwardly about their junctions with the

mounting portion 16 so that the circuit board engaging corners 36 bite into the circuit board at the lower end of the hole 60. See Figure 12 which shows the corners 36 embedded into the circuit board material. The inward dishing and width of the petals increases the effective radial thickness of the petals so that the corners are radially spaced a distance from the camming surfaces 38 greater than the thickness of the metal stock from which the petals are formed.

Engagement between the petals and the circuit board forms a tight staked connection which physically secures the pin to the circuit board. This assures that the pin is held to the board without movement prior to soldering and is important since the elongate tubular body 14 of pin 10 may extend above the surface of the board a relatively great distance so that accidental movement of the free end 30 of a staked pin exerts a high force on the connection between the pin and the board. As an example of the strength of the staked connection, a pin having a mounting portion with a diameter of 0.045 inch was staked in a circuit board hole of 0.055 inch in diameter extending through a 0.062 inch thick glass filled phenolic circuit board. The pin was formed from 0.008 inch thick $\frac{1}{2}$ hard brass stock. A force of ten pounds on the body portion 14 was required to pull the pin from the board. The tight physical connection between the staked pin and the board also assures that the connection is rigidly held on the board during soldering so that there is no relative movement between the pin and board during cooling of the molten solder.

Following staking of the pin to the board, molten solder is applied to the lower surface of the pin, conventionally by moving the board through a molten wave solder bath. The molten solder flows into the interior of the mounting portion 16 and wicks up the solder flow channel 76 between the strips 44 and the mounting portion to the solder flow windows 22 between adjacent collapsed knuckles. Solder flows through the windows and onto the adjacent pad 64 to form an electrical joint with the circuitry on the top of the board. Molten solder also continues to flow upwardly through the solder flow channel 76 to form a bond between the body 14 and the strips 44, thereby stiffening the pin.

At the same time, molten solder from the solder bath flows into the central solder flow path 49 between the outwardly bowed strips 44 and is drawn up the path into the portion of the pin above the board, thereby increasing the beam and torsional strength of the pin. Because the strips defining solder flow path 49 extend past the col-

lapsed knuckles and windows 22, the knuckles and windows do not disrupt the upward flow of solder in the path. Solder may not flow all the way up the pin to end 30. This is a function of pin length and soldering conditions. Without the continuous solder path 49, solder applied to the underside of the board would tend not to rise above the windows 22 so that it would not be possible to fill the interior of the pin above the circuit board with solder and a much weaker pin would result. The use of solder to stiffen the pin is relatively inexpensive as compared to the cost of providing sufficient metal in the stamped pin to achieve an equivalent stiffness. This expediency reduces the cost of the product by conserving pin metal.

As illustrated in Figures 10 and 11, solder fillets 78 and 79 are formed at the upper and lower circuit board contact pads 64 respectively. The fillets assure that a reliable interfacial connection is formed between the pin and each of the pads and between the pads themselves. While the pin is disclosed in connection with a double-sided circuit board, it is obvious that the pin may be staked to a circuit board having contact pads on but one side or, in certain circumstances, having no contact pads at the circuit board hole. In this situation, the pin may be used as a mounting terminal for forming an electrical connection between two disconnect sockets or other elements secured to the projecting body 14.

As illustrated in Figure 11, the stock forming the body 14 is bent into the interior of the body at the seam 40 by reverse bends 46. This assures that there are no raw edges on the outer or contact surface of the pin. Such raw edges are undesirable as corrosion products tend to collect on them and the sharp corners at the edges injure mating parts. Raw edges 80 of the strips 44 are located within the body 14 away from the outer surface of the body.

After soldering, circuit board pins 10 may be used for plug-in engagement with female terminals or other types of connectors. The current carrying capacity of the pin is greater than that of conventional single thickness circuit board pins because of the increased metal cross-sectional area of the pin due to the inner strips 44 and the solder within the pin. The solder and inner strips 44 in the pin 10 increase the current carrying capacity of the pin appreciably over that of a rolled single wall thickness pin.

As indicated in connection with the description of the blank 12, the length of the pin above the circuit board may be varied as described. A relatively short pin may be used or a relatively long pin, of the type illustrated, may be used. In each case, the

strips 44 are integral with the body 14 so that upon collapse of the knuckles the strips are lowered and the petals are forced outwardly to engage the sides of the circuit board hole.

Pin 10 may be staked in circuit board holes having a greater range of diameters than tolerated by components which are staked into circuit board holes by bending flanges around the corners of the hole. For instance, a pin 10 where the mounting portion 16 has a diameter of 0.045 inch can be staked in circuit board holes having a diameter ranging from 0.045 inch up to 0.055 inch. Also, the thickness of the circuit board may be increased from a minimum to a thickness such that the petals do not extend below the board. During staking of the pin to a thick board, the petals are forced outwardly against the circuit board wall so that the entire length of the cutting corners 36 engage the wall, resulting in a strong physical connection between the pin and the board.

Figures 13 and 14 illustrate an embodiment of the invention where pin 100 is identical to pin 10 with the exception that upper portion 102 of the pin is stamp-formed so that the ends of the body 14 and strips 44 are deformed and portion 102 is square in cross-section with a pyramidal lead-in 104 at the free end of the pin. Seam 106 extends from the collapsible knuckle portion 108 along a pin portion 110, which is identical to the corresponding portion 16 of pin 10, and thence along one corner of the square portion 102. As illustrated in Figure 14, the corners of pin portion 102 are relatively sharp to facilitate wire wrap connections. Alternatively, sockets may be mounted on the portion 102. The strong stake connection between the pin and the circuit board, together with the soldered joint with circuitry on the board, if any, assures that the pin is held securely despite the torque applied during wrapping wires about portion 102.

Figures 15 and 16 illustrate staking of a pin 118, similar to pin 10, into a hole through a single-sided circuit board formed by punching. Punched holes are subject to break-out on the side away from the circuitry so that the diameter of the hole on that side is appreciably larger than the diameter of the hole on the circuitry side. Hole 120 extending through board 122 is broken out on the top side of the board. Circuitry 124 is on the bottom of the board. Circuit board pin 118 is readily staked to such a hole. The petal end is positioned into the hole from the bottom out side so that the knuckle portion partially extends into the enlarged end of the hole. The pin may then be collapsed by pushing on the free end 126 while supporting the length

of the body 128 to prevent it from bending due to its long length. Lowering of the body 128 collapses the knuckles and forces the collapsed knuckles into the broken out portion of the hole as illustrated in Figure 16 while at the same time moving the strips 130 down into the hole to engage the petals and force them outwardly, thus securing the pin to the board as previously described. Because the upper end of the pin is held down against the upper surface of the board, the knuckles are seated tightly in the broken out end of the hole despite the increase in the diameter of the hole. Upon application of molten solder, solder would flow into the interior of the pin as previously described.

Figures 17 and 18 illustrate staking of a circuit board pin 140 to board 142. Pin 140 is identical to pin 10 with the exception that it is formed from sheet metal stock so that a thick layer of solder 144 is secured to the outer surfaces of knuckles 146. Because the solder stripe is continuous, thick layers of solder 148 are also provided on the inner surfaces of strips 150 located adjacent the knuckles.

Pin-receiving circuit board hole 152 extends through the thickness of board 142. A metallized circuit pad 154 surrounds the end of hole 152 on the insertion side of the board. The petals 156 and mounting portion 158 of pin 140 are moved into hole 152 from the pad or insertion side of the board until the knuckles 146 are seated against the pad. Continued movement of the outer tubular body 160 toward board 142 collapses the knuckles 146 against pad 154 and moves the free ends of strips 150 against the camming surfaces of petals 156 to rotate the petals outwardly of the hole and stake the pin to the board as previously described in connection with pin 10.

The desired soldered joint between the pin and pad 154 is formed after staking by heating the collapsed knuckles to melt the thick solder layers 144 so that upon cooling a soldered joint is formed between the collapsed knuckles and pad 154. See Figure 18. During reflow soldering the solder layers 148 on the interior surfaces of strips 150 melt and recombine on the strips. In some applications, this solder may be used to form a soldered connection between the pin and the bare end of a wire inserted into the interior of the inner tubular body 162 prior to reflow soldering. The wire may be inserted into the body through an opening in the end of the body away from board 142 or, alternatively, may be positioned in the body laterally before the longitudinal seam is closed. In this regard see the embodiment of Figures 20 and 21 described hereinafter.

By providing thick solder layers on the

outer surfaces of knuckles 146, it is possible to form reliable electrical connections between staked pins 140 and pads on the circuit board 142 by merely heating the portions of the pins adjacent the pads. The conventional soldering operation involving moving the board above a molten wave solder bath is eliminated. In the case that the inner thick solder layers 148 form soldered connections between a conductive wire and the pin, the reflow soldering operation provides a reliable electrical connection between the wire held in the pin and the circuitry on the board. As illustrated in Figure 18, during staking of the pin to the board the two strips 150 engage the petals 156 and are forced together thus forcing the interior solder layers 148 tightly against a wire previously inserted into the end of the inner body 162. In this way a tight physical connection is assured between the end of the wire and the strips 150 prior to heating of the pin and reflow soldering.

Figures 19, 20, and 21 illustrate a crimp-type self-staking contact 170 which includes a U-shaped wire crimp barrel 172, a U-shaped insulation crimp barrel 174, four collapsible knuckles 176, a U-shaped mounting portion 178 and three outwardly bendable circuit board-engaging petals 180. A pair of outwardly bowed longitudinal strips 182 extend along the length of the contact from the wire crimp barrel 172 past the knuckles and into the mounting portion 178. The strips 180 join the edges of wire crimp barrel 172 through reverse bends 184.

A stripped wire 186 is positioned within open contact 170 with the bare end 188 of the conductor located in barrel 184 between strips 182. Insulation crimp barrel 174 surrounds the end of the insulation on the wire. The open contact 170 is then crimped closed so that the open sides of the contact as illustrated in Figure 19 form a longitudinal seam 190 extending the length of the contact and the end of the wire is tightly confined in the closed barrels 174 and 172. During crimping the petals 180 are bent inwardly to permit movement of the petals and circular mounting portion 178 into a circuit board hole.

The lead end of the crimp contact secured to wire 186 is then positioned in circuit board hole 192 extending through the thickness of board 194 and, with further insertion, knuckles 176 are collapsed against a pad 196 on the insertion side of the board and the strips 182 forming the inner tubular body of contact 170 which surrounds wire end 188 are moved downwardly to engage the petals 180 to bend them radially outwardly for engagement with the side of hole 192. Following staking, the board 194 is soldered so that molten

solder flows into hole 192 to form a desired soldered joint between the contact and pads 196 and 198 on each side of board 194 and also a soldered connection between the contact and the stripped end 188 of wire 186. In this way, an interfacial connection is established between the wire and pads on both sides of the board. For certain applications contact 170 may be provided with thick solder layers on the outer surfaces of knuckles 176 and on the inner surfaces of strips 182. Following crimping of the contact onto a wire and staking of the contact and wire to a circuit board, the contact is heated to melt the solder layers and form soldered electrical connection between the knuckles and printed circuit pad on the insertion side of the board and between the wire and the strips defining the inner tubular body. In this case, the need for a separate soldering operation is eliminated.

Figures 22 and 23 illustrate a further embodiment of the invention in which a contact 200, similar to contact 170, is crimped to a fibre optic conductor 202 and then staked in a hole 204 extending through a suitable panel 206. The insulation crimp barrel 208 tightly surrounds the insulation of conductor 202 to hold the member to the support. The central fibre optic element 210 is located between the outwardly bowed strips 212 of contact 200 with edges 214 of the strips 212 engaging each other to assure that during crimping and staking of the contact fibre optic member 210 is not subjected to damaging compressive forces, see Figure 23.

Figure 22 illustrates the contact 200 secured to the panel 206 with the end of the fibre optic member 210 exposed on the lower or non-insertion side of the panel to either receive light from that side of the panel and transmit the light along the member 202 to a remote terminal or project a ray of light transmitted from a remote source through the fibre optic member to the lower side of the panel. While panel 206 is illustrated as being formed of a plastics material, obviously the contact 200 may be secured to other types of panels as desired. In some applications, the contact may be staked to a blind hole in a transparent material so that light carried by the fibre optic member illuminates the material.

WHAT WE CLAIM IS:—

1. A self-staking terminal pin comprising an inner body within an elongate hollow outer body, said outer body having a collapsible portion which is collapsible in the direction of the longitudinal axis of the outer body, and an expandable portion at one end of said outer body for mounting in a hole, said inner body extending through said collapsible portion with a free end of

said inner body adjacent said expandable portion, such that upon axial collapse of said collapsible portion said free end of said inner body engages the radially inner surface of said expandable portion so as to deflect same radially outwardly.

2. A terminal pin as claimed in Claim 1, wherein said collapsible portion comprises a plurality of collapsible members spaced about the longitudinal axis of the outer body and extending radially outwardly beyond the expandable portion.

3. A terminal pin as claimed in Claim 2, wherein each collapsible member comprises a pair of legs of equal length joined at an apex.

4. A terminal pin as claimed in Claim 2 or 3, wherein the collapsible portion has four collapsible members.

5. A terminal pin as claimed in any of Claims 2 to 4, wherein a layer of solder is adhered to the outer surface of each collapsible member.

6. A terminal pin as claimed in any preceding claim, wherein said expandable portion comprises a plurality of petal elements for engagement with said inner body free end, each extending from the free end of the expandable portion.

7. A terminal pin as claimed in Claim 6, wherein each petal element is inwardly dished and includes a pair of corners for engagement with the hole on its radially outer surface and a camming surface on its radially inner surface, the camming surfaces of the petal elements being adjacent the free end of the inner body.

8. A terminal pin as claimed in Claim 6 or 7, wherein the engaging means comprises three petal elements.

9. A terminal pin as claimed in any preceding claim, wherein a layer of solder is adhered to the inner surface of the inner body in the region of the collapsible portion.

10. A terminal pin as claimed in any preceding claim, wherein said inner body comprises a pair of elongate members.

11. A terminal pin as claimed in Claim 10, wherein each elongate member of said inner body is bowed in transverse cross-section.

12. A terminal pin as claimed in Claim 10 or 11, wherein said outer body has a longitudinal seam extending along the entire length thereof and each of said elongate members of the inner body are connected to said outer body at said seam.

13. A terminal pin as claimed in Claim 12 wherein said outer body has a tapered contact portion at the end of thereof remote from the expandable portion.

14. A terminal pin as claimed in Claim 13, wherein said contact portion has a rectangular cross-section.



solder flows into hole 192 to form a desired soldered joint between the contact and pads 196 and 198 on each side of board 194 and also a soldered connection between the contact and the stripped end 188 of wire 186. In this way, an interfacial connection is established between the wire and pads on both sides of the board. For certain applications contact 170 may be provided with thick solder layers on the outer surfaces of knuckles 176 and on the inner surfaces of strips 182. Following crimping of the contact onto a wire and staking of the contact and wire to a circuit board, the contact is heated to melt the solder layers and form soldered electrical connection between the knuckles and printed circuit pad on the insertion side of the board and between the wire and the strips defining the inner tubular body. In this case, the need for a separate soldering operation is eliminated.

Figures 22 and 23 illustrate a further embodiment of the invention in which a contact 200, similar to contact 170, is crimped to a fibre optic conductor 202 and then staked in a hole 204 extending through a suitable panel 206. The insulation crimp barrel 208 tightly surrounds the insulation of conductor 202 to hold the member to the support. The central fibre optic element 210 is located between the outwardly bowed strips 212 of contact 200 with edges 214 of the strips 212 engaging each other to assure that during crimping and staking of the contact fibre optic member 210 is not subjected to damaging compressive forces, see Figure 23.

Figure 22 illustrates the contact 200 secured to the panel 206 with the end of the fibre optic member 210 exposed on the lower or non-insertion side of the panel to either receive light from that side of the panel and transmit the light along the member 202 to a remote terminal or project a ray of light transmitted from a remote source through the fibre optic member to the lower side of the panel. While panel 206 is illustrated as being formed of a plastics material, obviously the contact 200 may be secured to other types of panels as desired. In some applications, the contact may be staked to a blind hole in a transparent material so that light carried by the fibre optic member illuminates the material.

WHAT WE CLAIM IS:—

1. A self-staking terminal pin comprising an inner body within an elongate hollow outer body, said outer body having a collapsible portion which is collapsible in the direction of the longitudinal axis of the outer body, and an expandable portion at one end of said outer body for mounting in a hole, said inner body extending through said collapsible portion with a free end of

said inner body adjacent said expandable portion, such that upon axial collapse of said collapsible portion said free end of said inner body engages the radially inner surface of said expandable portion so as to deflect same radially outwardly. 70

2. A terminal pin as claimed in Claim 1, wherein said collapsible portion comprises a plurality of collapsible members spaced about the longitudinal axis of the outer body and extending radially outwardly beyond the expandable portion. 75

3. A terminal pin as claimed in Claim 2, wherein each collapsible member comprises a pair of legs of equal length joined at an apex. 80

4. A terminal pin as claimed in Claim 2 or 3, wherein the collapsible portion has four collapsible members.

5. A terminal pin as claimed in any of Claims 2 to 4, wherein a layer of solder is adhered to the outer surface of each collapsible member. 85

6. A terminal pin as claimed in any preceding claim, wherein said expandable portion comprises a plurality of petal elements for engagement with said inner body free end, each extending from the free end of the expandable portion. 90

7. A terminal pin as claimed in Claim 6, wherein each petal element is inwardly dished and includes a pair of corners for engagement with the hole on its radially outer surface and a camming surface on its radially inner surface, the camming surfaces of the petal elements being adjacent the free end of the inner body. 95

8. A terminal pin as claimed in Claim 6 or 7, wherein the engaging means comprises three petal elements. 100

9. A terminal pin as claimed in any preceding claim, wherein a layer of solder is adhered to the inner surface of the inner body in the region of the collapsible portion. 105

10. A terminal pin as claimed in any preceding claim, wherein said inner body comprises a pair of elongate members. 110

11. A terminal pin as claimed in Claim 10, wherein each elongate member of said inner body is bowed in transverse cross-section. 115

12. A terminal pin as claimed in Claim 10 or 11, wherein said outer body has a longitudinal seam extending along the entire length thereof and each of said elongate members of the inner body are connected to said outer body at said seam. 120

13. A terminal pin as claimed in Claim 12 wherein said outer body has a tapered contact portion at the end of thereof remote from the expandable portion. 125

14. A terminal pin as claimed in Claim 13, wherein said contact portion has a rectangular cross-section. 130

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15. A terminal pin as claimed in Claim 10 or 11, wherein said outer body is substantially U-shaped and each of said elongate members of the inner body is connected with said outer body along a respective leg of the outer body.

16. A terminal pin as claimed in Claim 15, wherein said outer body has a tapered contact portion at the end thereof remote from the expandable portion.

17. A terminal pin as claimed in Claim 17, wherein said contact portion is substantially U-shaped.

18. A method of securing a terminal pin as claimed in any preceding claim in a hole in a panel comprising the steps of inserting said expandable portion in the hole and axially collapsing said collapsible portion against a surface of the panel whereby the free end of said inner body engages the radially inner surface of said expandable portion so as to deflect same radially outwardly to engage the panel and secure the terminal pin in the hole.

19. A method of securing an element to a panel comprising the steps of crimping the element in the U-shaped outer body of a terminal pin as claimed in any of Claims 15 to 17, inserting the mounting portion of the terminal pin in a hole in the panel and axially collapsing said collapsible portion against a surface of the panel whereby the free end of said inner body engages said inner surface of said expandable portion and deflects the expandable portion radially outwardly to engage the panel and secure the terminal pin in the hole.

20. A method as claimed in Claim 19, wherein said element is electrically conductive.

21. A method as claimed in Claim 19, wherein said element is a light-transmitting optical fibre element.

22. A panel having at least one hole therein and a terminal pin as claimed in any of Claims 1 to 17 secured in said hole.

23. A terminal pin substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 7 of the accompanying drawings.

24. A terminal pin substantially as hereinbefore described with reference to and as illustrated in Figs. 13 and 14.

25. A terminal pin substantially as hereinbefore described with reference to and as illustrated in Figs. 17 and 18.

26. A terminal pin substantially as hereinbefore described with reference to and illustrated in Figs. 19 and 20.

27. A method of securing a terminal pin in a hole in a panel substantially as hereinbefore described with reference to Figs. 8 to 12 of the accompanying drawings.

28. A method of securing a terminal pin in a hole in a panel substantially as hereinbefore described with reference to Figs. 15 and 16.

29. A method of securing a terminal pin in a hole in a panel substantially as hereinbefore described with reference to Figs. 17 and 18.

30. A method of securing a terminal pin in a hole in a panel substantially as hereinbefore described with reference to Fig. 21.

31. A method of securing a terminal pin in a hole in a panel substantially as hereinbefore described with reference to Figs. 22 and 23.

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