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(54) IMPROVEMENTS IN OR RELATING TO CIRCUIT BOARD PINS

(71) We, E. I. DU PONT DE NEMOURS AND COMPANY, a Corporation organized and existing under the laws of the State of Delaware, United States of America, of 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:—

This invention relates to circuit board pins adapted for mounting in holes in a circuit board.

Circuit board pins are well-known in the prior art, and are described in U.S. patent 2,994,057; and U.S. patent 3,223,960. A circuit board pin including three spring members disposed radially at approximately 120 degrees from each other is described in U.S. patent 3,634,819. A circuit board pin including four fins formed in a medial portion of the pin with each fin extending from a corner of the pin and with adjacent pairs of fins bent toward each other is described in U.S. patent 3,827,004. The circuit board pin described in this prior patent provides for seating the pin in a circuit board hole by collapsing each pair of fins toward each other. The circuit board pin of the present invention has only three fins, and reduces the possibility of damage to a conductive plating in the hole and connections between the plating and multi-layer circuitry. Additionally, the fin configuration provides for improved solder flow and insures a reliable solder connection between the pin and a plated hole.

Plug-in contacts for printed circuit boards including oppositely-bowed split tabs for insertion through a hole in a circuit board and retention of a contact assembly are described in U.S. patent 3,230,494. An electrical connector formed from a strip and including an elongate member which is slit to form transversely aligned peaks and valleys is described in U.S. patent 3,048,812. Electrical connector plugs including blade contact having longitudinal slits struck out to provide a pair of

outer sections and an intermediate section are described in U.S. patent 2,183,067 and U.S. patent 2,542,609. A circuit component lead having three radially extending fins swaged in the end of the lead is described in Dutch patent 109,516.

The circuit board pin of the present invention including the three longitudinally extending fins is readily distinguished structurally from the circuit board pins described in the above patents and other circuit board pins known in the art. The mounting portion adapted for insertion into a circuit board hole includes one fin extending in cross-section lengthwise radially from the central longitudinal axis of the pin and each of the other fins being offset from the central longitudinal axis and extending in cross-section lengthwise away from the first fin and the pin. The ends of the fins away from the pin provide contact surfaces lying substantially on the locus of a circle centered on the longitudinal axis of the pin. These structural features provide for minimizing damage to a hole in a circuit panel when the pin is inserted in the hole.

According to the present invention, a circuit board pin is provided for insertion in a hole in a circuit board, the pin including a mounting portion comprising three fins extending lengthwise of the pin, one of said fins extending, when viewed in transverse cross-section, radially from the central longitudinal axis of the pin and each of the other fins being, when viewed in transverse cross-section, laterally off-set from the central longitudinal axis and extending away from the first fin.

The offset fins may be parallel to one another (when viewed in transverse cross-section) or may be flared and diverge from one another to provide for uniform spacing of the edges of the fins and engaging the inside of a hole in a circuit board. The hole-engaging edges of the fins are preferably rounded to provide a hole-engaging surface on each fin which tangentially engages the inside of the circuit board hole. The adjacent interior end

portions of the three fins are preferably severed from one another. The interior edges of the radial fin and the offset fins may be spread apart by shearing to adapt the pin to various hole sizes and provide the desired spring properties for insertion and retention of the pin in a circuit board hole. This provides for insertion of a standard size pin in an oversized hole and for retention of the pin by spacing the interior edges of the fins to conform the hole-engaging surfaces to the oversized hole.

In a preferred embodiment, said pin is elongate and has a square transverse cross-section with opposed sides spaced apart a distance X and said mounting portion is located medially with respect to the ends of the pin, said three fins being integral with the ends of the pin, each fin having a transverse width of about $X/3$ and a transverse length of about X and including a longitudinally extending smooth hole-engaging surface on an edge thereof located outwardly from the longitudinal axis of the pin and a distance greater than

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one fin extending outwardly from the longitudinal axis of the pin in a direction perpendicular to one side of the pin, the other two fins being located on opposite sides of said one fin, the hole-engaging surfaces of said fins intersecting a plane perpendicular to the longitudinal axis of the pin at points approximately equidistant from said longitudinal axis.

In another aspect the invention provides a circuit board pin for insertion in a hole in a circuit board, the pin including a mounting portion comprising three fins extending lengthwise of the pin, the fins each extending transversely in a direction generally away from the central longitudinal axis of the pin whereby the ends of the fins remote from said central longitudinal axis are spaced apart, and wherein the transverse axis of at least one of the fins extends through the central longitudinal axis of the pin.

The above preferred features of the circuit board pin can provide a significant technical advance over the prior art pins by consistently locating the pins in the center of a hole in the circuit board. The hole-engaging surfaces may be at three points lying on the locus of a circle centred on the longitudinal axis of the pin. This provides predictable deformation of the fins on insertion in a hole in a circuit board. Additionally, choice of suitable spring properties for the fins provide for greater latitude in hole tolerance and plating tolerance of plated-through holes, as the fins will bend with only negligible damage to the hole or plating within the hole.

Also provided is a method of mounting the pins of the present invention in a circuit board, comprising inserting the mounting portion of the pin loosely in a hole in the circuit board, supporting one end of the pin on one side of the circuit board, and compressing the other end of the pin to expand the fins outwardly so that the fins engage the side of the hole and retain the pin in the hole.

The method of the present invention is particularly significant in inserting pins in multi-layer circuit boards. Multi-layer circuit boards may have many internal conductive layers internally connected by plated-through holes, and such circuit boards are expensive to produce and may be irreparably damaged in the final stage of fabrication during insertion of the pins in holes in the circuit board. The circuit board pins of the prior art are inserted to provide an interference fit in the circuit board holes. The pins may cut into the plating in the hole and destroy the internal interconnections rendering the board useless. The method of the present invention reduces this problem by inserting the pin loosely in the circuit board hole, and expanding the fins of the mounting portion of the pin. The tightness of fit can then be controlled by controlling the force under which the pin is compressed. This reduces the possibility of damage to the internal connections in a multi-layer circuit board.

Some embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a multi-layer circuit board with a number of pins according to the invention mounted thereon.

Figure 2 is a side view of an embodiment of the pin of the invention.

Figure 3 is a view of the pin along line 3—3 of Figure 2.

Figure 4 is a view in cross-section taken along line 4—4 of Figure 2.

Figure 5 is a partially broken-away sectional view showing a pin mounted in a plated-through circuit board hole in multi-layer circuit board.

Figure 6 is a partially broken-away sectional view similar to Figure 5 after solder dipping.

Figure 7 is a view in cross-section taken along line 7—7 of Figure 6.

Figure 8 is a view in cross-section of another embodiment of the invention similar to the section of Figure 4.

Figure 9 is a view in cross-section of another embodiment of a pin similar to Figure 4.

Figure 10 is a side view illustrating the method of the invention with the pin loosely inserted in a circuit board hole.

Figure 11 is a view similar to Figure 10 illustrating the expansion of the medial portion of the pin.

Figure 12 illustrates a female disconnect terminal inserted over the pin of the invention.

5 Figure 13 illustrates a female disconnect terminal integrally formed on an end of a pin according to the invention.

Figure 14 is a view in cross-section of another embodiment of the invention similar to Figure 8.

10 The pin 20 is adapted to be mounted in a hole extending into or through the thickness of a circuit board 22 or similar circuit panel. The ends 26 of pin 20 are preferably uniform in cross section e.g. square or round, and a mounting portion 24 is provided with a first longitudinally extending fin 28 extending, when viewed in transverse cross-section, radially away from the central longitudinal axis 34 of the pin 20, and a pair of longitudinally extending fins 30 offset from the central axis 34 extending, when viewed in transverse cross-section, away from the first fin 28. The fins 28 and 30 are substantially rectangular in transverse cross-section, having substantially planar sides and extend from opposite sides of the pin 20.

25 A rounded hole-engaging contact surface 32 is located on the edge of each fin furthest from axis 34. The surface 32 of each of the fins is tangential to a circle centered on the longitudinal axis 34 of the pin 20. Fins 30 may extend (viewed in transverse cross-section) parallel with each other and offset from the central axis 34 of the pin 20 or may be flared and diverge from each other, as illustrated in Figure 8.

30 The hole-engaging surfaces 32 of the fins are located so that when portion 24 is moved into a circuit board hole 42 and the surfaces 32 engage the sides of the hole, the radial inward forces exerted on each fin may resiliently bend or flex each fin to avoid damage to the hole 42. If the fins would not resiliently bend, they would dig into the plating in the hole and could damage any internal connection between the plating in the hole and conductive layers in the board. Shearing of the interior sides 31 of the fins 28, 30 allows for the fins to resiliently bend and uniformly and accurately locate the pins in the center of the hole in the circuit board. The interior edges 33 of the adjacent fins may overlap, as illustrated in Figures 4 and 8, or may be spread apart if the pin is to be mounted in an oversized hole in a circuit board.

35 The mounting portion 24 may be formed by a stamping operation which shears the pin 20 to form the adjacent fins and separates the fins from each other and the central longitudinal axis 34 of the pin 20. The distance the fins are separated may be varied to adapt the pins to various hole sizes or allow for a loose fit or an interference fit on insertion of the mounting portion 24 of the pin in a hole of a given size. The length of the fins

along the pin may be varied during manufacture to provide for insertion in holes in circuit boards of various thicknesses.

The fins 28 and 30 may have a longitudinal taper in order to facilitate moving portion 24 into a circuit board hole when an interference fit is desired.

In the embodiment shown in Figures 1 to 4, wherein the cross-section of the pin 20 is square, the transverse length of the fins is substantially three times the transverse width of the fins.

However, the cross-sectional width of the radial fin may be greater than the transverse width of each offset fin to balance the spring properties of the fins on opposite sides of the pin. The transverse width of the radial fin should not exceed the sum of the transverse widths of the two offset fins.

70 Ends 26 of the pin 20 extend freely into a plated circuit board hole 42 extending through the thickness of multi-layer circuit board 22. The locus of a circle defined by the hole-engaging surfaces 32 of fins 28 and 30, however, may have a greater radius from axis 34 than the radius of hole 42 to provide an interference fit. The pin 20 is positioned in the hole 42 by freely moving one end 26 therethrough and then inserting portion 24 in the hole 42. As the portion 24 is moved into the hole, surfaces 32 are brought into engagement with the plating 44 in the hole 42. With further insertion of the pin 20, each fin is resiliently bent inward toward the central longitudinal axis 34. The fins are resiliently bent toward each other so that the pin 20 is securely held in the hole 42. The resilient fins permit mounting the pin in circuit board holes of different diameters. This feature is preferred because it is difficult to assure that a number of circuit board holes are of the same diameter.

80 Insertion of pins 20 with the resilient fins does not injure the plating 44 in the holes 42. Thus the pins 20 are inserted into the holes 42 in the circuit board 22 without impairing any internal electrical connections between the plating 44 in the hole 42 and a conductive layer 46 in the circuit board. The insertion of conventional frictional press-fit type pins into plated holes may rupture the plating and destroy the electrical connections between the internal circuitry 46 and the plating 44 in the hole 42.

85 The pin 20 is not rotated during insertion because the fins resiliently flex toward each other. The pin 20 may be picked up by conventional insertion tooling in a given angular orientation and then mounted on a circuit board in the same orientation to assure that the flat surfaces of ends 26 are properly aligned as required. As an example, the angular orientation of the pins is important in the case where disconnect or pluggable terminals 56 or female sockets 58 are attached

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to the pins, as illustrated in Figures 12 and 13.

Figure 5 illustrates a pin 20 which has been seated in plated-through hole 42 through circuit board 22. The fins 28 and 30 have been resiliently bent and surfaces 32 engage the sides of the plated hole 42. After the pin 20 is seated in the hole the pin is soldered, either by hand or by a conventional type soldering method, in order to provide an electrical connection between the pin 20 and plated circuitry on board 22. Molten solder is applied to the pin at one side of the circuit board and flows along the three solder flow channels 48 (Figure 7) to the other side of the board. The three channels 48 improve solder flow through the circuit board hole 42 and provide for the escape of any gases which could interfere with the solder connection. Alternatively, solder may be preapplied selectively to portion 24 of pin 20 or the plated hole 42.

Figure 8 illustrates a modified pin 50 in which the offset fins are sheared and formed to provide flared or diverging fins with the hole-engaging surfaces 62 uniformly spaced from each other on the locus of a circle centered on the central longitudinal axis of the pin. This provides a somewhat more resilient connection between the pin and the circuit board hole by spacing the hole-engaging surfaces 62 equally about the central axis 64 of pin 50. With the exception of the diverging fins, pin 50 is identical to pin 20. Alternatively, the two offset fins may each include a twist 54 along its length to provide uniform spacing of the hole-engaging surfaces, as illustrated in Figure 14.

Figure 9 illustrates another embodiment of a pin according to the present invention, wherein the pin 64 includes a radial fin 68 and a pair of offset fins 70. The pin 64 is similar to pin 20 but the adjacent fins are integrally joined about the central longitudinal axis of the pin. In this embodiment of the pin, the radial fin 68 is rigid and the offset fins 70 are collapsible inwardly toward each other on insertion of the mounting portion 54. The offset fins 70 may be substantially parallel to each other, as illustrated or flared as in the embodiment illustrated in Figure 8, and the radial fin 68 may be shortened to provide for centering the ends of the pin with respect to the hole.

The method of mounting a pin in a hole in a circuit board is illustrated in Figures 10 and 11. The pin 20 is inserted loosely in an oversized hole in the circuit board by suitable insertion means 80 which grip one end 26 of pin 20. The other end is supported on the opposite side of the board by support means 84. The insertion means applies a force to compress the pin 20 and expand the fins 28 and 30 of the mounting portion 24 to provide an interference fit between contact surfaces 32 and the hole 42. The interference

fit holds the pin 20 snugly in the hole 42 for subsequent soldering, e.g. dip soldering or re-flow soldering of solder selectively applied to the pin or the plating 44 inside of the hole 42.

While the pins disclosed herein are preferably square in cross section, it is obvious that the invention may be used with pins having other cross sections in which it is desired to mount the pins in round circuit board holes. The invention is particularly useful in connection with mounting circuit board pins in plated circuit board holes, however, it may be used in connection with mounting pins in circuit board holes which are not plated. The pins may have two square ends 26, as illustrated, for conventional wire wrapping of wires or receiving a female disconnect terminal 56 (Figure 12) at at least one end 26, or may have a female disconnect-type terminal 58 integrally formed on one end or attached thereto and a square male terminal on the other end.

WHAT WE CLAIM IS:—

1. A circuit board pin for insertion in a hole in a circuit board, the pin including a mounting portion comprising three fins extending lengthwise of the pin, one of said fins extending, when viewed in transverse cross-section, radially from the central longitudinal axis of the pin and each of the other fins being, when viewed in transverse cross-section, laterally offset from said central longitudinal axis and extending away from said first fin.

2. A pin as claimed in claim 1 for insertion in a circular hole in a circuit board wherein the end of each fin remote from said central longitudinal axis is rounded to engage the interior of the hole and each of said remote ends lies substantially on the locus of a circle whose centre lies on the central longitudinal axis of the pin.

3. A pin as claimed in any preceding claim, wherein the offset fins extend, when viewed in transverse cross-section, substantially parallel to each other.

4. A pin as claimed in claim 1 or 2, wherein the offset fins are, when viewed in transverse cross-section, flared and diverge from each other.

5. A pin as claimed in any preceding claim, wherein the ends of the fins remote from the central longitudinal axis are uniformly circumferentially spaced from each other.

6. A pin as claimed in any preceding claim, wherein said offset fins are twisted along their length.

7. A pin as claimed in any of claims 1 to 5, wherein the mounting portion has a uniform cross-section.

8. A pin as claimed in any preceding claim, wherein the interior end portion of the radial



to the pins, as illustrated in Figures 12 and 13.

Figure 5 illustrates a pin 20 which has been seated in plated-through hole 42 through circuit board 22. The fins 28 and 30 have been resiliently bent and surfaces 32 engage the sides of the plated hole 42. After the pin 20 is seated in the hole the pin is soldered, either by hand or by a conventional type soldering method, in order to provide an electrical connection between the pin 20 and plated circuitry on board 22. Molten solder is applied to the pin at one side of the circuit board and flows along the three solder flow channels 48 (Figure 7) to the other side of the board. The three channels 48 improve solder flow through the circuit board hole 42 and provide for the escape of any gases which could interfere with the solder connection. Alternatively, solder may be preapplied selectively to portion 24 of pin 20 or the plated hole 42.

Figure 8 illustrates a modified pin 50 in which the offset fins are sheared and formed to provide flared or diverging fins with the hole-engaging surfaces 62 uniformly spaced from each other on the locus of a circle centered on the central longitudinal axis of the pin. This provides a somewhat more resilient connection between the pin and the circuit board hole by spacing the hole-engaging surfaces 62 equally about the central axis 64 of pin 50. With the exception of the diverging fins, pin 50 is identical to pin 20. Alternatively, the two offset fins may each include a twist 54 along its length to provide uniform spacing of the hole-engaging surfaces, as illustrated in Figure 14.

Figure 9 illustrates another embodiment of a pin according to the present invention, wherein the pin 64 includes a radial fin 68 and a pair of offset fins 70. The pin 64 is similar to pin 20 but the adjacent fins are integrally joined about the central longitudinal axis of the pin. In this embodiment of the pin, the radial fin 68 is rigid and the offset fins 70 are collapsible inwardly toward each other on insertion of the mounting portion 54. The offset fins 70 may be substantially parallel to each other, as illustrated or flared as in the embodiment illustrated in Figure 8, and the radial fin 68 may be shortened to provide for centering the ends of the pin with respect to the hole.

The method of mounting a pin in a hole in a circuit board is illustrated in Figures 10 and 11. The pin 20 is inserted loosely in an oversized hole in the circuit board by suitable insertion means 80 which grip one end 26 of pin 20. The other end is supported on the opposite side of the board by support means 84. The insertion means applies a force to compress the pin 20 and expand the fins 28 and 30 of the mounting portion 24 to provide an interference fit between contact surfaces 32 and the hole 42. The interference

fit holds the pin 20 snugly in the hole 42 for subsequent soldering, e.g. dip soldering or re-flow soldering of solder selectively applied to the pin or the plating 44 inside of the hole 42.

While the pins disclosed herein are preferably square in cross section, it is obvious that the invention may be used with pins having other cross sections in which it is desired to mount the pins in round circuit board holes. The invention is particularly useful in connection with mounting circuit board pins in plated circuit board holes, however, it may be used in connection with mounting pins in circuit board holes which are not plated. The pins may have two square ends 26, as illustrated, for conventional wire wrapping of wires or receiving a female disconnect terminal 56 (Figure 12) at at least one end 26, or may have a female disconnect-type terminal 58 integrally formed on one end or attached thereto and a square male terminal on the other end.

WHAT WE CLAIM IS:—

1. A circuit board pin for insertion in a hole in a circuit board, the pin including a mounting portion comprising three fins extending lengthwise of the pin, one of said fins extending, when viewed in transverse cross-section, radially from the central longitudinal axis of the pin and each of the other fins being, when viewed in transverse cross-section, laterally offset from said central longitudinal axis and extending away from said first fin.

2. A pin as claimed in claim 1 for insertion in a circular hole in a circuit board wherein the end of each fin remote from said central longitudinal axis is rounded to engage the interior of the hole and each of said remote ends lies substantially on the locus of a circle whose centre lies on the central longitudinal axis of the pin.

3. A pin as claimed in any preceding claim, wherein the offset fins extend, when viewed in transverse cross-section, substantially parallel to each other.

4. A pin as claimed in claim 1 or 2, wherein the offset fins are, when viewed in transverse cross-section, flared and diverge from each other.

5. A pin as claimed in any preceding claim, wherein the ends of the fins remote from the central longitudinal axis are uniformly circumferentially spaced from each other.

6. A pin as claimed in any preceding claim, wherein said offset fins are twisted along their length.

7. A pin as claimed in any of claims 1 to 5, wherein the mounting portion has a uniform cross-section.

8. A pin as claimed in any preceding claim, wherein the interior end portion of the radial



fin is between the interior end portions of the offset fins.

9. A pin as claimed in any preceding claim, wherein the interior end portion of said radial fin and the interior end portions of said offset fins are spaced apart.

10. A pin as claimed in any preceding claim, wherein the cross-sectional length of each fin is substantially three times the cross-sectional width of each fin.

11. A pin as claimed in any preceding claim, wherein each end of the pin is a substantially uniform cross section male terminal.

12. A pin as claimed in claim 11, additionally including a female disconnect terminal in engagement with at least one of said male terminals.

13. A pin as claimed in any of claims 1 to 12, wherein an end of said pin includes a female disconnect terminal.

14. A pin as claimed in claim 13, wherein said female disconnect terminal is integrally formed on said pin.

15. A pin as claimed in any preceding claim, wherein said pin includes a layer of solder selectively applied to the mounting portion of said pin.

16. A pin as claimed in any preceding claim, wherein said pin is elongate and has a square transverse cross-section with opposed sides spaced apart a distance X and said mounting portion is located medially with respect to the ends of the pin, said three fins being integral with the ends of the pin, each fin having a transverse width of about X/3 and a transverse length of about X and including a longitudinally extending smooth hole-engaging surface on an edge thereof located outwardly from the longitudinal axis of the pin a distance greater than

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one fin extending outwardly from the longitudinal axis of the pin in a direction perpendicular to one side of the pin, the other two fins being located on opposite sides of said one fin, the hole-engaging surfaces of said fins intersecting a plane perpendicular to the longitudinal axis of the pin at points approximately equidistant from said longitudinal axis.

17. A pin as claimed in any preceding claim, wherein the interior end portions of the fins adjacent the central longitudinal axis are severed from each other so that the fins may resiliently bend to provide an interference fit with a hole in a circuit board.

18. A pin as claimed in any of claims 1 to

8, or 10 to 16 when dependent thereon, wherein the interior end portions of said fins are joined to one another.

19. A pin as claimed in any preceding claim, wherein the sides of said fins are substantially planar.

20. A method of inserting a circuit board pin as claimed in any preceding claim, in a hole in a circuit board, comprising inserting the mounting portion of the pin loosely in the hole in the circuit board, supporting one end of the pin on one side of the circuit board, and compressing the other end of the pin to expand the fins outwardly so that the fins engage the side of the hole and retain the pin in said hole.

21. A circuit board having at least one hole extending through the thickness thereof and a circuit board pin mounted in said hole by a method as claimed in claim 20.

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

23. A circuit board pin substantially as hereinbefore described with reference to and as illustrated in Fig. 8 of the accompanying drawings.

24. A circuit board pin substantially as hereinbefore described with reference to and as illustrated in Fig. 9 of the accompanying drawings.

25. A circuit board pin substantially as hereinbefore described with reference to and as illustrated in Fig. 14 of the accompanying drawings.

26. A method of inserting a circuit board pin in a hole in a circuit board substantially as hereinbefore described with reference to and as illustrated in Figs. 10 and 11 of the accompanying drawings.

27. A circuit board pin for insertion in a hole in a circuit board, the pin including a mounting portion comprising three fins extending lengthwise of the pin, the fins each extending transversely in a direction generally away from the central longitudinal axis of the pin whereby the ends of the fins remote from said central longitudinal axis are spaced apart, and wherein the transverse axis of at least one of the fins extends through the central longitudinal axis of the pin.

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