United States Patent

[11] 3,601,750

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[73] Assignee **Berg Electronics, Inc.**
New Cumberland, Pa.
Continuation-in-part of application Ser. No. 749,694, Aug. 2, 1968.

[54] **CIRCUIT BOARD CONNECTOR**
16 Claims, 20 Drawing Figs.

[52] **U.S. Cl.** ..... **339/17 C,** 174/68.5, 174/94 R, 317/101 CC, 339/95 A, 339/220 T, 339/221 R, 339/275 R
[51] **Int. Cl.** **H01r 5/04,** H05k 1/00
[50] **Field of Search** ..... 339/17, 18, 95, 220, 221, 275; 317/101 B, 101 CC; 174/68.5, 94

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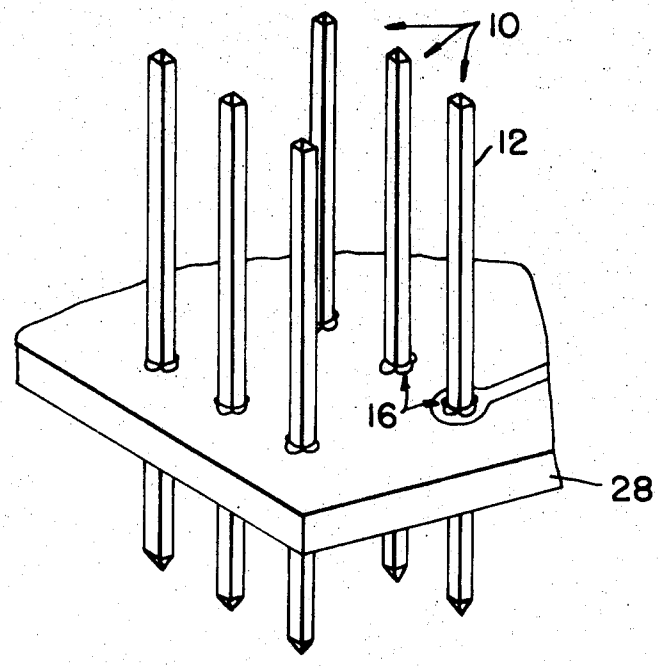
Primary Examiner—Stephen J. Novosad
Assistant Examiner—Terrell P. Lewis
Attorney—Thomas Hooker

ABSTRACT: A square pin with a cylindrical ferrule fitted around the medial portion and mechanically secured to the corners of the pin forms a circuit board through connector. A plurality of passages extend the length of the ferrule between the sides of the pin and the interior of the ferrule. The connector is fitted in a hole in a circuit board with the ends of the ferrule extending to either side of the circuit board, following which the ends of the ferrule are deformed to engage the circuit board and secure the connector to the circuit board.



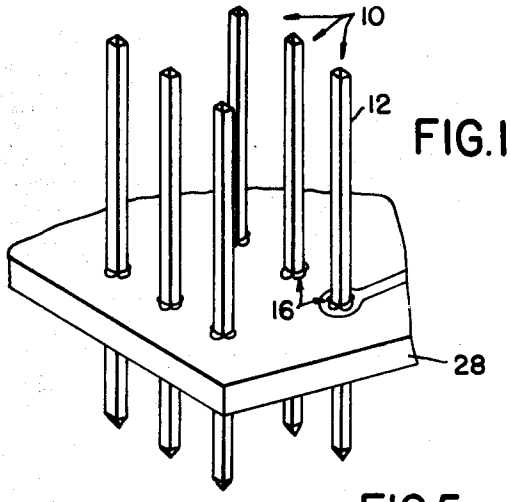


FIG.1

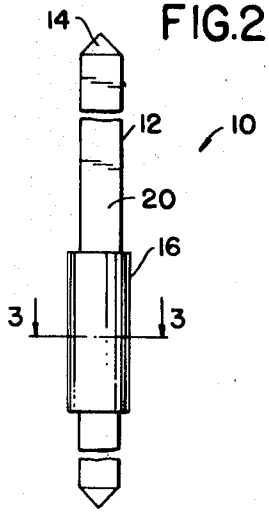


FIG.2

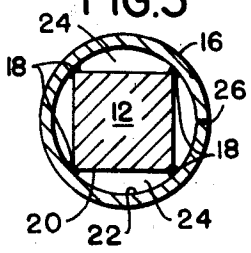


FIG.3

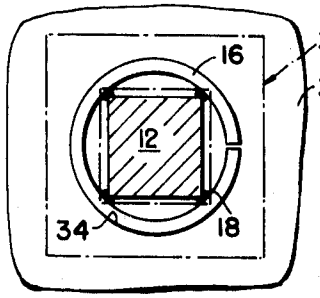


FIG.5

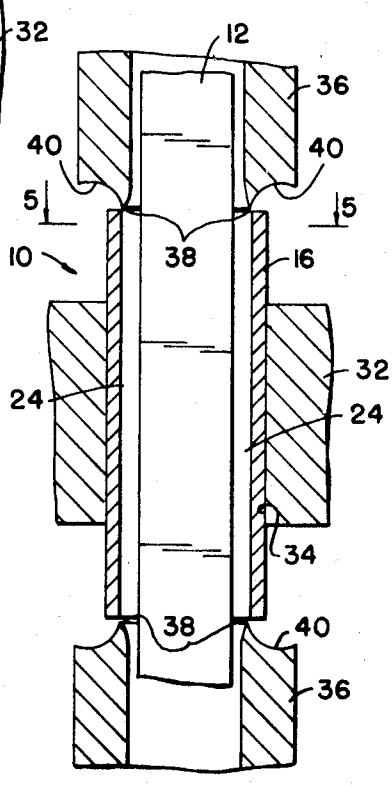


FIG.4

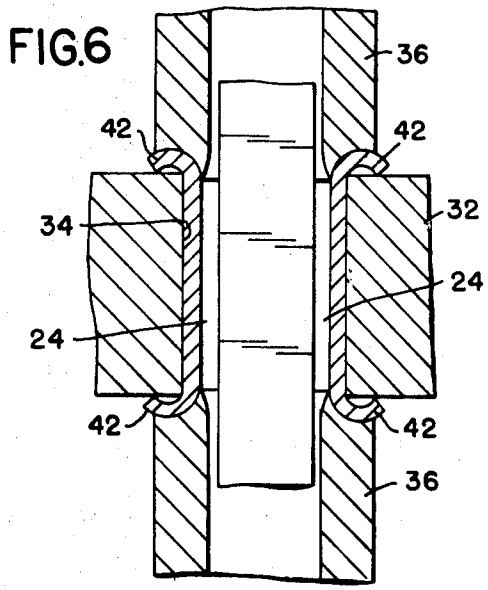


FIG.6

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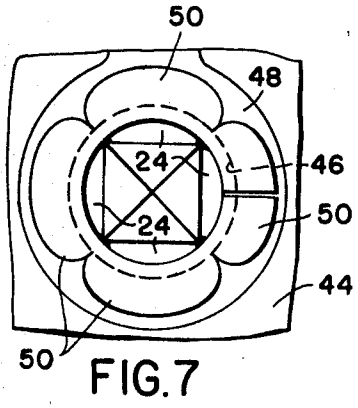

FIG.7

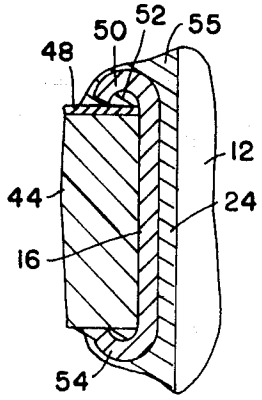

FIG.8

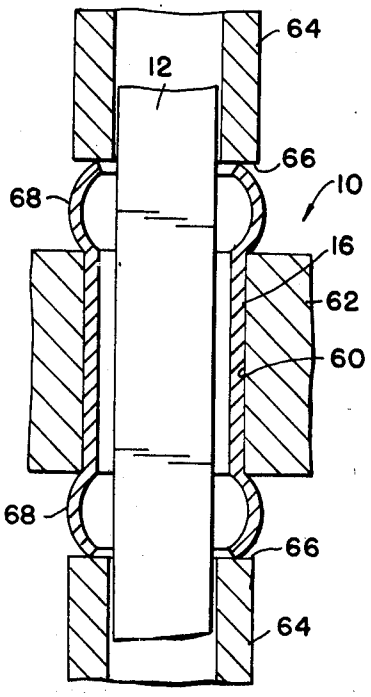

FIG.9

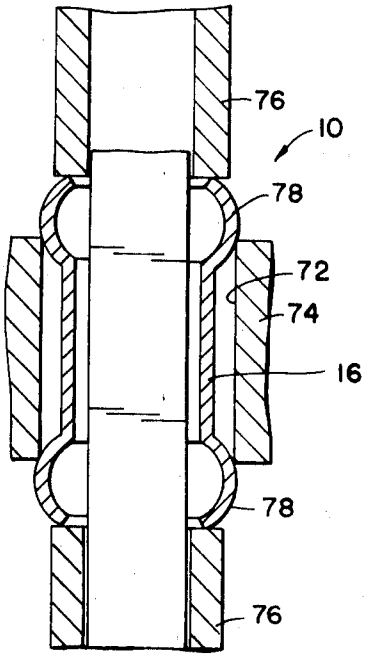

FIG.10

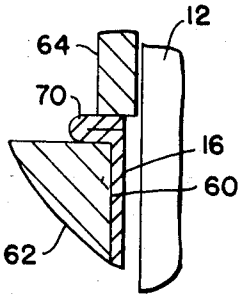

FIG.11

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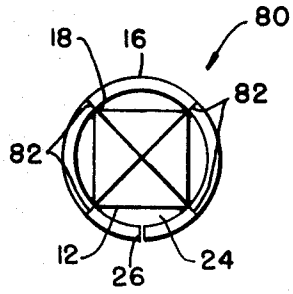


FIG.12

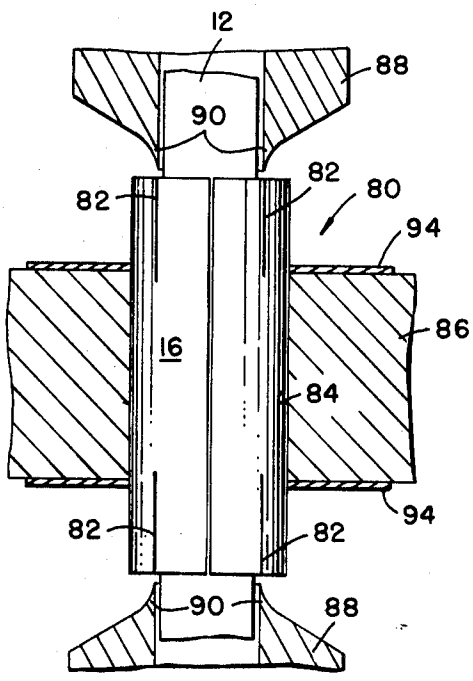
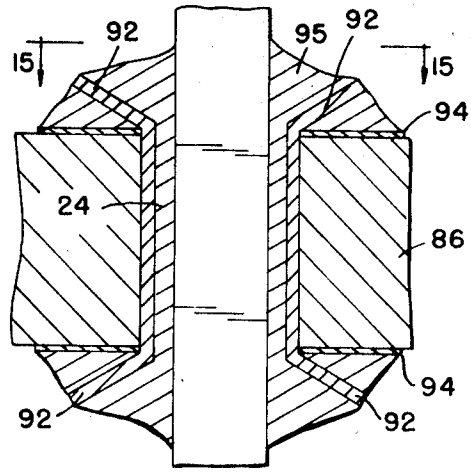


FIG.13

FIG.14



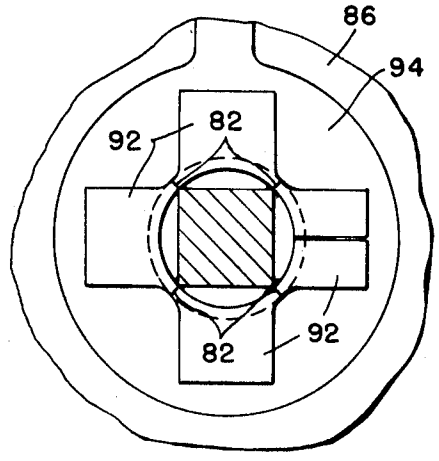


FIG.15

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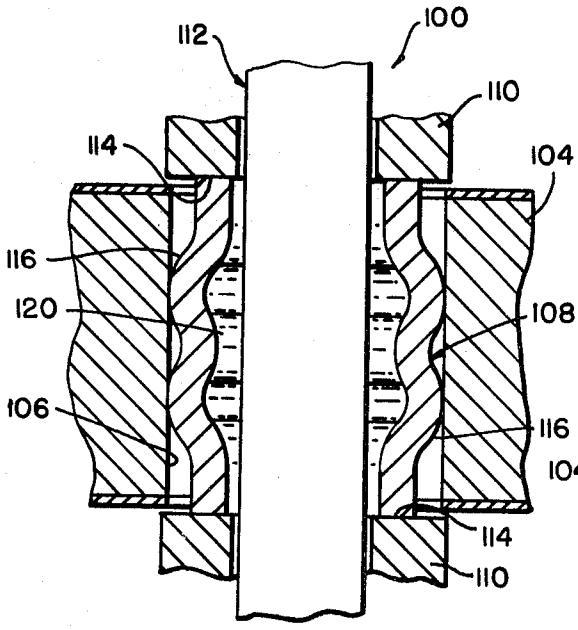

FIG.16

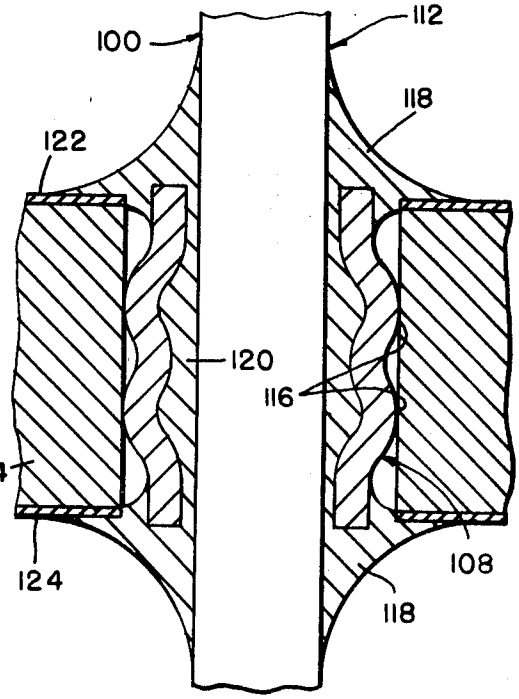

FIG.17

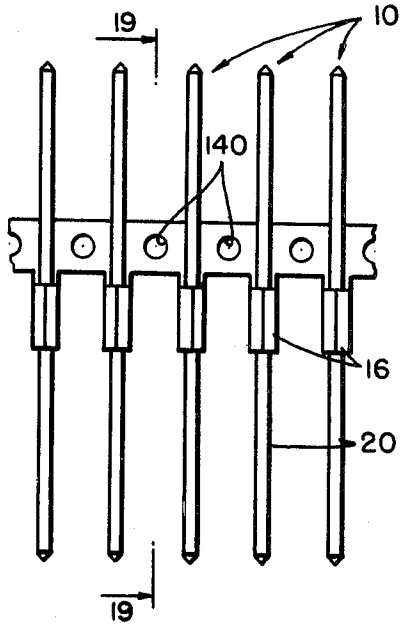

FIG.18

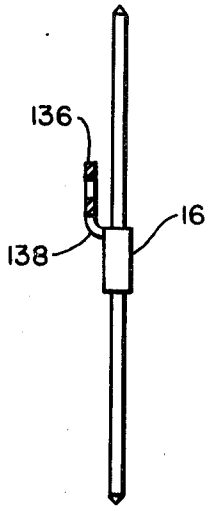

FIG.19

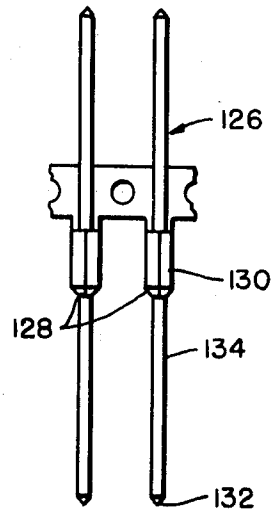

FIG.20

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CIRCUIT BOARD CONNECTOR

This application is a continuation-in-part of my copending application Ser. No. 749,694, for "Circuit Board Connector," filed in the Patent Office on Aug. 2, 1968.

Present electronic technology requires that circuit boards be provided with through connectors for establishing a circuit path through the thickness of the circuit board. One form of circuit board through connector utilized an elongate wire or pin which is fitted through a plated hole on the circuit board. The median portion of the wire which extends through the thickness of the circuit board is circular in cross section and is soldered to the plated hole to secure the pin in the board. The protruding ends of the wire are coined to a generally square cross section to facilitate wire wrapping or mounting of disconnects. The medial potion of the pin is cylindrical in order to facilitate soldering of the pin to a plated circuit board hole. Soldering of square pins to circuit boards is undesirable from an expense and reliability point of view.

The conventional type of through board connector has a number of disadvantages. It is hard to plate the interior of circuit board holes uniformly and economically. The coining of the ends of the pin, due to the small size of the pin, is difficult to control accurately so that the wore is formed to a square cross section. The disconnects of the type used on through board connectors are designed for establishing a reliable electrical connection with connectors of square cross section. Small dimensional changes in the through connectors affect the properties of the electrical connection with the disconnect.

The coining operation required to form the circular wire pin to a generally square configuration at its ends is not readily adapted to mass production operation. The loose wires are individually inserted in the circuit board holes and held therein during the soldering operation, usually dip soldering, which results in attachment of the pin to the circuit board. All of these steps require additional labor and increase the cost of the conventional through board connector.

A further problem relates to the size of the hole in the circuit board. It is difficult to punch holes for through board connectors in circuit boards so that the interior diameter of the hole conforms closely to the diameter of the medial round portion of the pin whereby soldering will accurately locate the connector in the circuit board. If the hole is too large, the pin may not be accurately located on the board and the reliability of the solder joint between the pin and the plating on the hole will be diminished. Irregularly shaped holes are difficult to plate.

The invention relates to a through board connector of an improved type having many advantages over conventional through board connectors. The connector is formed from a segment of drawn square wire of uniform cross section on which is positioned a cylindrical ferrule. The ferrule is secured to the pin at the corners thereof by strong mechanical reflow solder joints to define four passages extending along the length of the ferrule adjacent to the sides of the pin. The pin is positioned in the circuit board hole with the ferrule projecting to either side of the circuit board and is physically secured thereto by deforming the ends of the ferrule outwardly away from the pin so as to grip the circuit board. The mechanical joints between the pin and ferrule permit handling and staking of the connector as a unit.

When it is desired to establish a solder connection between the through board connector and printed circuitry on the top of the circuit board, the circuit board may be solder dipped and solder will wick from the bottom of the circuit board through the passages between the pin and the ferrule and onto the upper surface of the circuit board, thereby forming an electrical connection with printed circuitry on the board. Fore ease of handling, the through board connectors may be secured to a carrier strip with the pins mounted in parallel transverse orientation.

The through board connector may be secured to the circuit board a number of ways, depending upon the intended application. The connector can be used in oversize circuit board holes by radially expanding the ferrule sufficiently to engage the circuit board at each end of the hole therethrough. The invention eliminates the necessity for plating circuit board holes and, because the square wire is drawn to a uniform cross section, eliminates contact problems with disconnects. In the drawings:

FIG. 1 is a perspective view of a circuit board with a number of through board connectors according to the invention attached thereto.

FIG. 2 is a side view of a through connector;

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

FIG. 4 is a sectional view showing a through board connector mounted in a circuit board hole prior to staking thereof;

FIG. 5 is a horizontal sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a view like that of FIG. 4 after the through board connector has been secured to the circuit board;

FIG. 7 is a top view of the through board connector shown in FIG. 6;

FIG. 8 is a partially broken away sectional view of the through board connector of FIG. 7 after solder dipping;

FIGS. 9 and 10 are sectional views of a through board connector similar to FIG. 4 illustrating alternate ways of securing it to a circuit board;

FIG. 11 illustrates a further way to secure the connector to the circuit board;

FIG. 12 is a top view of a modified version of the through board connector;

FIG. 13 is a sectional view showing the through board connector of FIG. 12 prior to staking to the circuit board;

FIG. 14 is a view similar to FIG. 13 taken following staking and solder dipping of the through board connector;

FIG. 15 is a top view of the through board connector of FIG. 13 following staking to the circuit board;

FIG. 16 is a sectional view similar to FIGS. 9 and 10, illustrating a further way of securing the through board connector to a circuit board;

FIG. 17 is a view similar to FIG. 16, taken after staking and solder dipping of the through board connector;

FIG. 18 is a front view of a chain of through board connectors;

FIG. 19 is a sectional view taken along line 19—19 of FIG. 18; and

FIG. 20 is a view of a modified through board connector.

Through board connector 10 illustrated in FIG. 2 comprises a length of conductive square wire 12 which may be die drawn to assure a uniform cross section throughout its length. Pyramidal ends 14 are provided on the wire or pin 12 to facilitate insertion of disconnect contacts thereon.

Fitted about a medial portion of wire 12 is a cylindrical metal ferrule 16 having an interior diameter such that the ferrule fits snugly around the pin. Ferrule 16, wire 12, or both of them are preferably solder coated. After the ferrule is positioned on a pin in a desired location the assembly is heated and the solder coatings on the pin and ferrule are reflowed to form solder joints 18 at the corners of the pin, thereby mechanically securing the pin to the ferrule. Because of the snug fit of the ferrule around the pin the joints 18 extend along the pin corners the entire length of the ferrule.

With the ferrule secured to the pin, each side face 20 of the pin and the adjacent interior portion of the ferrule define a longitudinal channel 24 which extends the axial length of the ferrule. In a through board connector utilizing a square pin, four channels 24 are provided.

Ferrule 16 may be rolled from metal strip stock so that a longitudinal seam 26 is provided. It is desirable to position seam 26 midway between two corners of the pin 12 to assure that a reliable solder joint 18 is formed at each corner of the pin.

As shown in FIG. 1, through board connectors 10 may be secured to circuit board 28 by positioning the connectors in holes in the circuit board with the ferrule 16 extending to each side of the circuit board and then deforming the projecting ends of the ferrule to secure the connectors to the board. Through board connector 10 may be used to establish electrical contact with printed circuitry on double or single-sided circuit boards or may be used solely to provide a circuit path through a circuit board without establishing an electrical connection to any printed circuitry on the board.

When the connector 10 is mounted on the circuit board, the ends of the pin 12 extend away from the board and may be used to establish an electrical connection with a removable or disconnect type terminal or may be wire wrapped. The connector 10 may be solder dipped after attachment to the circuit board, depending upon whether or not the connector is used to establish a connection with printed circuitry on the board. In either case, the physical connections between the pin and the ferrule and the ferrule and the board are sufficient to withstand the torque the pin is subjected to during wire wrapping.

Connector 10 may be secured to the circuit board in a number of ways. FIGS. 4–6 are illustrative of one manner of securing the connector to a circuit board 32. The connector 10 is first positioned in a hole 34 in circuit board 32 as shown in FIG. 4 with the end portions of ferrule 16 extending outwardly of each side of the circuit board. The ferrule is deformed to secure the connector to the circuit board by a pair of axially opposed hollow square staking tools 36 which are fitted over the ends of the pin 12 as shown in dotted lines in FIG. 5. Four straight cutting edges 38 at the extremity of each tool 36 parallel and are spaced from the side faces 20 of the pin 12.

Staking of the connector to the circuit board is accomplished by moving the tools 36 toward each other to the position shown in FIG. 6. The cutting edges 38 sever the ferrule adjacent the corners of the pin and tool faces 40 flare the severed ferrule portions away from the pin to form reverse bend segments 42, the ends of which abut the circuit board outwardly of hole 34. During staking the solder joints 18 between the portions of the ferrule forming segments 42 and the pin 12 are broken. Staking of the connector 10 to a circuit board as described in connection with FIGS. 4–6 deforms the ferrule outwardly of the pin, thus preserving the longitudinal channels 24 which communicate each side of the circuit board. FIG. 7 is a top view of a through board connector 10 which has been staked to a circuit board 44 having a circuit board hole 46 formed therein with a printed circuit pad 48 surrounding the hole. Reverse bend ferrule segments 50 engage the printed circuit pad and provide a generally annular space 52 thereunder. When circuit board 44 is solder dipped, molten solder 55 flows from the bottom of the circuit board up longitudinal channels 24 by capillary action to the top of the circuit board and through the slots between adjacent segments to the annular space 52, thereby forming a reliable solder connection between the connector 10 and the printed circuit pad 48. The preferred solder coating of both the pin 12 and ferrule 16 facilitates flow of molten solder from the bottom of the circuit board through channels or passages 24 and around and under the segments 50.

FIG. 8 illustrates the solder connection formed after the staked through board connector of FIG. 7 is wave soldered or solder electrical connection deposit a mass of solder 55 in and around ferrule 16. It should be noted that during staking of the connector 10 to the circuit board, the bottom portion of ferrule 16 is deformed to form segments 54 which are similar to segments 50. These segments assure that a reliable solder connection may be formed between the connector 10 and printed circuitry provided on the bottom of board 44. Thus it will be seen that connector 10 may be used as a through board circuit path only, as a contact for establishing connection with circuitry on one side of the printed circuit board, or as a contact for establishing electrical connections with circuitry on both sides of the printed circuit board. The solder in channels 24 between the pin and ferrule assist in establishing a reliable electrical connection therebetween.

FIG. 9 illustrates a modified mounting of the connector 10 in a circuit board hole 60 formed in board 62. The exposed portions of the ferrule 16 are stripped away from the corners of pin 12 by staking tools 64 which, like tools 36, are fitted over the ends of pin 12. The hollow interiors of tools 64 are square and slightly larger than the cross section of the pin 12. The end or work surface 66 of each tool 64 is flat and lies in a plane transverse to the axis of the tool.

The connector 10 is secured to board 62 by moving the tools 64 together to engage the end surfaces of ferrule 16. Continued movement of the staking tools 63 toward each other strips the exposed portions of ferrule 16 from the corners of pin 12 and buckles these portions outwardly of the pin to form an outwardly bowed annular collar 68 at each end of the ferrule. Since the diameter of circuit board hole 60 is not appreciably greater than the outside diameter of ferrule 16, the collars 68 extend from each end of the ferrule to the adjacent circuit board surface and do not extend into the circuit board hole 60. Collars 68 engage the circuit board at each end of circuit board hole 60, and secure the connector 10 to the board 62. If desired, the tools 64 may be brought closer together to further collapse collar 68 as shown in FIG. 11 to form a flat double-thickness collar or flange 70 which extends circumferentially around each end of circuit board hole 60.

In FIG. 10 a connector 10 has been positioned in an oversized hole 72 in circuit board 74 following which staking tools 76, identical to tools 64 of FIG. 9, have been brought together to deform the end portions of the ferrule 16 thereby stripping away these portions of the ferrule from the pin to form outwardly bowed annular collars 78. Because the diameter of circuit board hole 72 is greater than the outside diameter of ferrule 16, collars 78 extend into the hole 72 a short distance. Ferrule 16 is deformed sufficiently so that the maximum diameter of the collar 78 is greater than the diameter of circuit board hole 72 and the collars engage the circuit board at the edges of the hole. Solder dipping or wave soldering of a connector 10 secured to a circuit board according to FIGS. 9–11 will result in solder flowing up through channels 24 to form a reliable electrical connection between the ferrule and the pin.

Through board connectors 10 may be secured to circuit board holes of different diameters by assuring that the stroke of the staking tools is sufficient to move the end portions of the ferrule 16 a distance from the pin sufficient that the outer diameter of the circuit board hole. Thus, by utilizing a through board connector in accordance with the invention it is not necessary that the diameter of the circuit board holes in which the connector is to be mounted be held to a close tolerance as presently required.

FIGs. 12–15 relate to a modified version 80 of the through board connector. As illustrated in FIGS. 12 and 13, connector 80 is identical to connector 10 with the exception that the end portions of ferrule 16 are provided with longitudinal slits 82 at the corners of the pin. Each slit 82 extends from an end of the ferrule a distance toward the other end of the ferrule. The slits 82 are preferably long enough to extend a distance into the circuit board hole when the connector is in position for staking.

With the connector 80 positioned in hole 84, it is secured to the circuit board 86 by moving staking tools 88 together to wedge prongs 90 into channels 24 and to split the end portions of ferrule 16 from pin 12. Further movement of the tools 88 toward each other flares the segmented end portions of the ferrule outwardly away from the pin 12 by opening slits 82 to form four outwardly extending locating flanges 92 which are spaced circumferentially around the connector 80. Because the slits 82 extend into the interior of circuit board hole 84, the staking operation assures that flanges 92 are in tight engagement with the edges of the circuit board hole 84 and tightly secure the connector 80 to board 86. This feature permits connector 80 to be mounted in oversized circuit board holes.

As illustrated in FIGS. 13–15, circuit board 86 is provided with printed circuit pads 94 which surround hole 84 on both sides of the board. Upon solder dipping or wave soldering of the circuit board 86, solder 95 wicks up through channels 24 to the upper surface of the board and fills the space between the upper printed circuit pad 94 and flanges 92 thereby establishing an electrical connection between the connector 80 and the upper printed circuit pad 94. A similar electrical connection is formed between the lower flanges 92 and the lower printed circuit pads 94.

While it is possible to secure through connectors to circuit boards as shown in FIGS. 10 and 14 where the circuit board hole is oversize, it is also possible to secure the through connector 10 to a circuit board having an oversize hole therein in the manner of FIG. 6. Segments 42 are bent back from the pin 12 and engage the surface of the circuit board at a distance from the body of the ferrule 16.

FIG. 16 illustrates a further way in which a through board connector 100 similar to the connector illustrated in FIG. 2 may be secured to a circuit board 104. The pin and ferrule are first positioned in circuit board hole 106 with the ferrule 108 within the hole. Staking tools 110 are positioned over the ends of pin 112 and are brought together to collapse the ferrule. The work surfaces 114 of tools 110 lie in a plane transverse to the axis of the pin so that as the tools are brought together the ferrule 108 is partially stripped from the pin and is collapsed within the circuit board hole.

When the pin 112 and ferrule 108 are staked as shown in FIG. 16, a pair of generally annular collars 116 are formed from the ferrule with one collar located adjacent each end of the circuit board hole 106. With the formation of the collars the ferrule is expanded away from the pin 112 and engages the surface of the circuit board hole to secure the through board connector 100 to the circuit board. By means of this way of staking the connector to the circuit board it is possible to secure through board connectors in circuit board holes without requiring that the circuit board holes be uniformly cylindrical or held to a close dimensional tolerance. If the circuit board holes formed in a given circuit board vary in interior diameter and in interior configuration, it will be possible to secure through board connectors 100 in such holes because during the staking the ferrule will expand to engage the interior surface of the hole. Depending upon the geometry of the circuit board hole, on e collar 116 may be larger than the other collar. This feature represents a marked improvement over conventional through board connectors where it is necessary that the holes formed in the circuit board be maintained to close tolerances. Circuit board connectors may be secured to circuit boards having punched circuit board holes. These holes usually have the shape approximating that of a truncated cone. If an electrical connection between the pin and circuitry on the board is not required, the soldering operation may be eliminated.

FIG. 17 illustrates a through board connector 100 after it has been staked to the circuit board 104 as in FIG. 16 and further has been solder dipped so that a solder connection has been formed between the connector 100 and printed circuitry on board 104. Solder will wick through the channels 120 between the ferrule 108 and pin 112 so that a solder joint will be formed between the pin 112 and printed circuit pad 122 located on the top surface of the circuit board 104 away from the molten solder bath in which the circuit board and through connector are dipped. A reliable solder connection is also formed between the pin and the printed circuit pad 124 located on the bottom of circuit board 104.

FIG. 20 illustrates a modification 126 of the through board connector. This modification is similar to the connector illustrated in FIG. 2 with the exception that a bevel 128 has been formed at one end of ferrule 130. Insertion of the through board connector into a circuit board hole is accomplished by first positioning tapered end 132 of pin 134 in the circuit board hole and then moving the connector 126 so that the ferrule is positioned in the hole. The bevel 128 together with the taper at the end 132 of pin 134 will reduce hanging up of the pin and ferrule on the edge of the circuit board hole during movement of the connector to position the ferrule in the circuit board hole. Due to the small size and close spacing of circuit board holes, these features speed up the mass production staking of through connectors to circuit boards.

FIGS. 18 and 19 illustrate a chain of through connectors of the type described. This chain includes a flat metal carrier strip 136 of indefinite length. A plurality of through board connectors 10 are secured to the strip at regular intervals along its length and are oriented with the axes of pins 20 extending transversely to the longitudinal axis of the strip. As shown in FIG. 19, ferrules 16 are formed from parts of strip 136. The connectors 10 are secured to the strip by metal interconnecting portions 138 which are integral with the strip and with the ferrules. Portions 138 are severed to remove connectors 10 from strip 136. The strip 136 is located slightly above ferrules 16 and is offset laterally from the connectors 10. A pilot hole 140 is formed in strip 136 between each connector 10 in order to facilitate movement of the chain in an applicator used for mounting the through connectors on a circuit board.

Through connectors disclosed herein have all used a four-sided or square pin. It is contemplated that a three-sided or triangular pin, or pins of other geometries could be used in through connectors according to the invention. In some applications where wire warp connections only will be made to the through connector, a triangular pin may be advantageous. In other cases other forms of pins may be desirable.

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 through connector for mounting in a hole extending through the thickness of a circuit board or the like comprising an elongate conductive pin having a square cross section with four flat longitudinally extending sides, and a cylindrical metal ferrule closely fitted around a medial portion of said pin and engaging the corners of said pin to provide four passages extending along the length of said ferrule, each passage defined by one of said sides and the adjacent inner surface of the ferrule, joint means of a displacement resistant nature extending along said corners for the length of the ferrule for securing said ferrule to said pin whereby part of the ferrule is deformable outwardly of the pin to engage the interior of the circuit board hole and secure the connector to the circuit board with said pin projecting outwardly of each side of the circuit board.

2. A through connector as in claim 1 wherein said joint means comprises fused joints between said pin and said ferrule.

3. A through connector as in claim 1 wherein said joint means comprises solder joints between said pin and said ferrule.

4. A through connector as in claim 2 wherein longitudinal slits are formed in said ferrule at each end thereof adjacent said side edges.

5. In a circuit board, a through connector comprising an elongate square conductive pin having four flat longitudinally extending sides, a generally cylindrical ferrule closely fitted around a medial portion of said pin and engaging said pin at the edges of said sides to provide four passages extending the length of said ferrule, each passage defined by one of said sides and the adjacent interior surface of the ferrule, joint means of a displacement resistant nature securing said ferrule to said pin at said edges, said pin and ferrule being positioned in a hole extending through the thickness of the circuit board with end portion of the pin projecting to either side of the circuit board and with the ferrule in the hole, the diameter of said hole being slightly greater than the outside diameter of the cylindrical part of said ferrule, and a noncylindrical part of said ferrule engaging the circuit board hole to secure the connector thereto.

6. A through connector as in claim 5 wherein said ferrule is collapsed to form at least one outwardly bowed generally annular ring, the outer surface of said ring engaging said circuit board.

7. A through connector as in claim 6 wherein two generally annular rings are formed in said ferrule and a portion of each of said rings extends into said circuit board hole and engages the surface thereof to permit securing of the pin and ferrule to a circuit board hole having a diameter greater than the outside diameter of said ferrule.

8. A through connector as in claim 7 wherein said rings are located within the thickness of said circuit board.

9. A circuit board connector assembly comprising a circuit board having a hole formed through the thickness thereof and a connector including an elongate square conductive pin having four flat longitudinally extending sides and a ferrule closely fitted around a portion of aid pin, said connector being positioned in said circuit board hole with at least one end of the pin projecting to one side of the circuit board and the ferrule fitted within the hole, at least one annular ring formed in said ferrule and projecting outwardly of said pin to engage the interior surface of said hole and secure the connector to the circuit board.

10. An assembly as in claim 9 including a second annular ring formed in said ferrule and spaced along the longitudinal axis of said pin from said first ring, both said rings projecting outwardly from the pin and engaging the interior surface of said circuit board hole to secure the connector to the circuit board.

11. An assembly as in claim 10 wherein both said rings are located within the thickness of said circuit board.

12. An assembly as in claim 11 including a number of passages each defined by one side of the pin and a portion of the interior surface of the ferrule, said passages extending through the thickness of the circuit board.

13. A circuit board connector assembly including a circuit board having a hole formed through the thickness thereof and a connector comprising an elongate square pin with a ferrule closely fitted around a portion thereof, said connector being positioned within the circuit board hole with one end of the pin projecting from one side of the circuit board and the ferrule fitted within the hole, a pair of generally annular rings formed in said ferrule and located within the thickness of the circuit board, said rings being spaced apart along the longitudinal axis of said pin and projecting outwardly of the pin to engage the interior surface of the circuit board hole to secure the connector to the circuit board.

14. A circuit board connector assembly including a circuit board having a hole formed through the thickness thereof and a connector, said connector including an elongate conductive pin of uniform cross section having a number of longitudinally extending flat sides intersection at longitudinally extending corners and a generally cylindrical ferrule closely fitted around said pin and secured thereto, said ferrule being positioned within said hole with one end of said pin projecting from one side of the circuit board, the outside diameter of the cylindrical portion of said ferrule being slightly less than the inside diameter of said hole, and noncylindrical holding means formed in said ferrule within the thickness of said circuit board and projecting outwardly of the cylindrical portion of the ferrule to engage the inner surface of the circuit board hole and thereby secure the connector to the circuit board.

15. A circuit board connector assembly including a circuit board having a hole formed through the thickness thereof and a connector positioned within said hole, said connector including an elongate conductive pin of uniform cross section having a number of longitudinally extending flat sides intersection at longitudinally extending corners and a generally cylindrical ferrule closely fitted around said pin and secured thereto, said ferrule being positioned within said hole with one end of said pin projecting from one side of the circuit board, the outside diameter of the cylindrical portion of said ferrule being slightly less than the inside diameter of said hole, and a pair of spaced generally annular rings formed in said ferrule and projecting outwardly of the cylindrical portion of the ferrule to engage the interior of the circuit board hole and secure the connector to the circuit board.

16. An assembly as in claim 15 wherein said pair of rings is located within the thickness of the circuit board.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,601,750 Dated August 24, 1971.

Inventor(s) Lloyd Mancini

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

Column 1, line 9, "utilized" should be --utilizes--

Column 1, line 25, "wore" should be --wire--

Column 1, line 72, "Fore" should be --for--

Column 3, line 65, "electrical connection" should be deleted and --dipped to-- inserted

Column 4, line 14, "63" should be --64--

Column 6, line 26, "warp" should be --wrap--

Column 8, lines 12 & 28, "intersection" should be --intersecting--

Signed and sealed this 22nd day of February 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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