Aug. 4, 1970 W. V. PAUZA 3,523,267

DISENGAGEABLE ELECTRICAL CONNECTOR

Filed Jan. 24, 1968

4 Sheets-Sheet 1

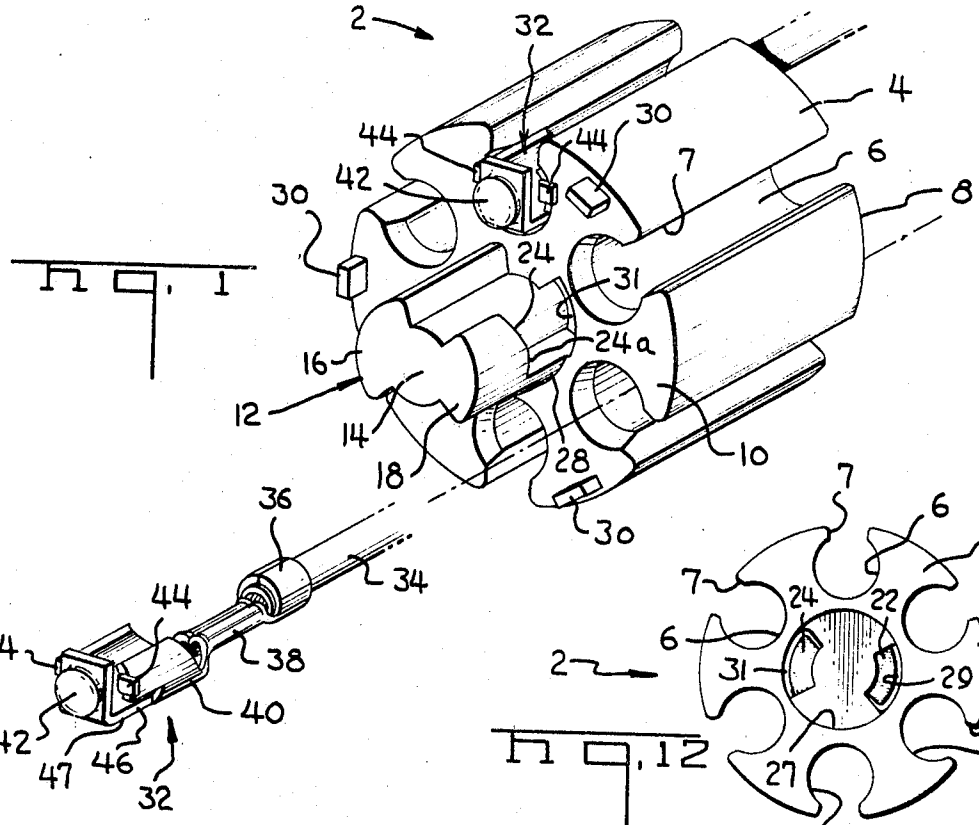


Fig. 1

Fig. 12

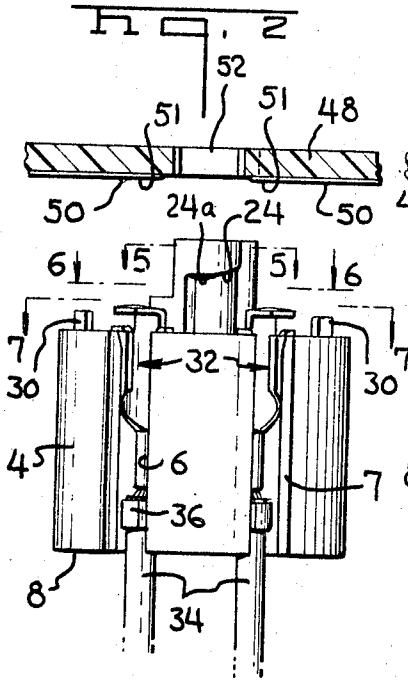


Fig. 2

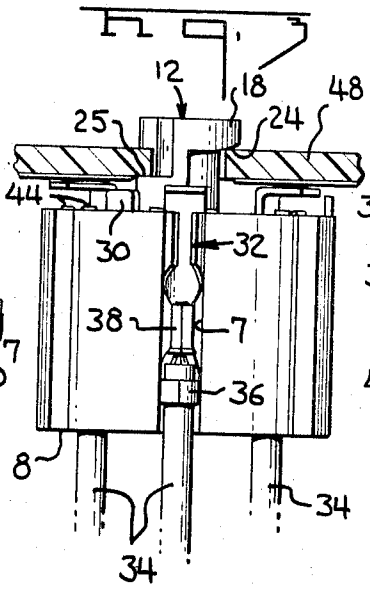


Fig. 3

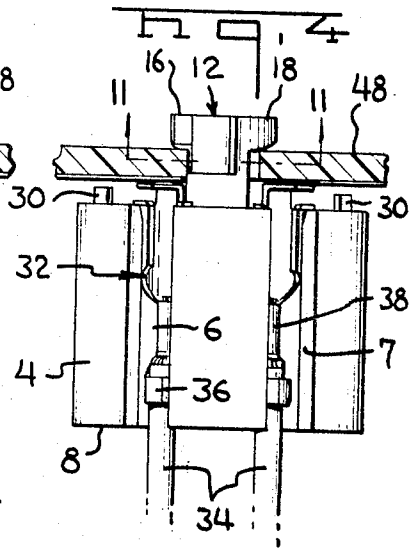


Fig. 4

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Fig. 5

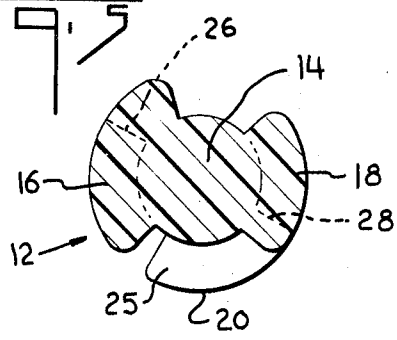


Fig. 9

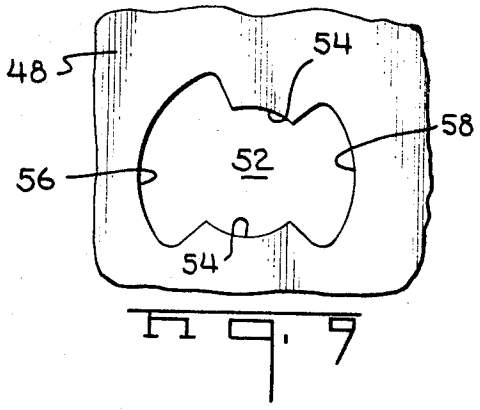


Fig. 6

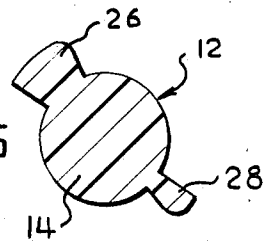


Fig. 10

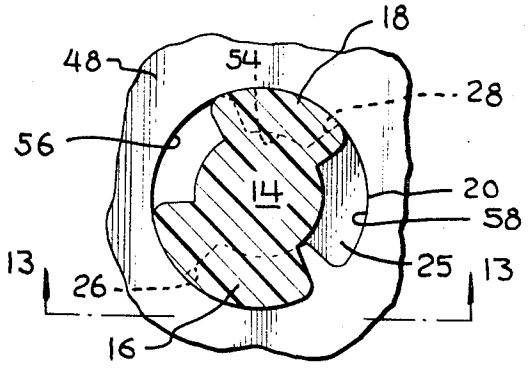


Fig. 7

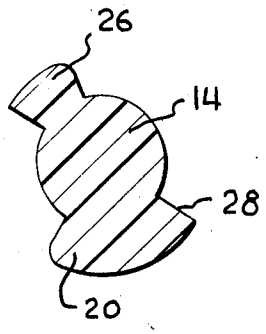


Fig. 11

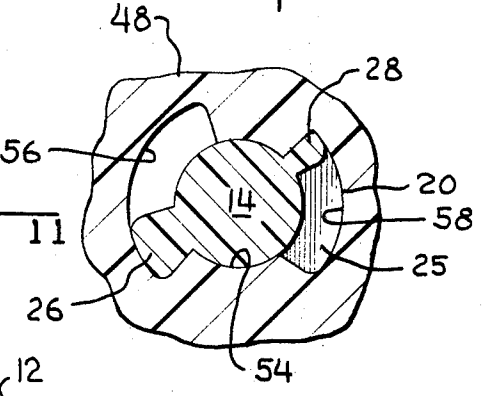


Fig. 8

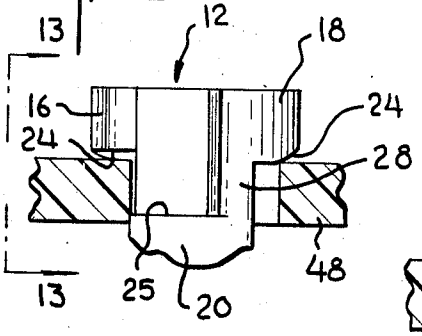
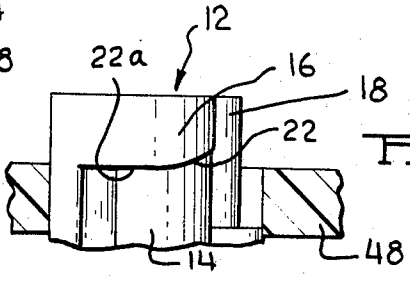


Fig. 13



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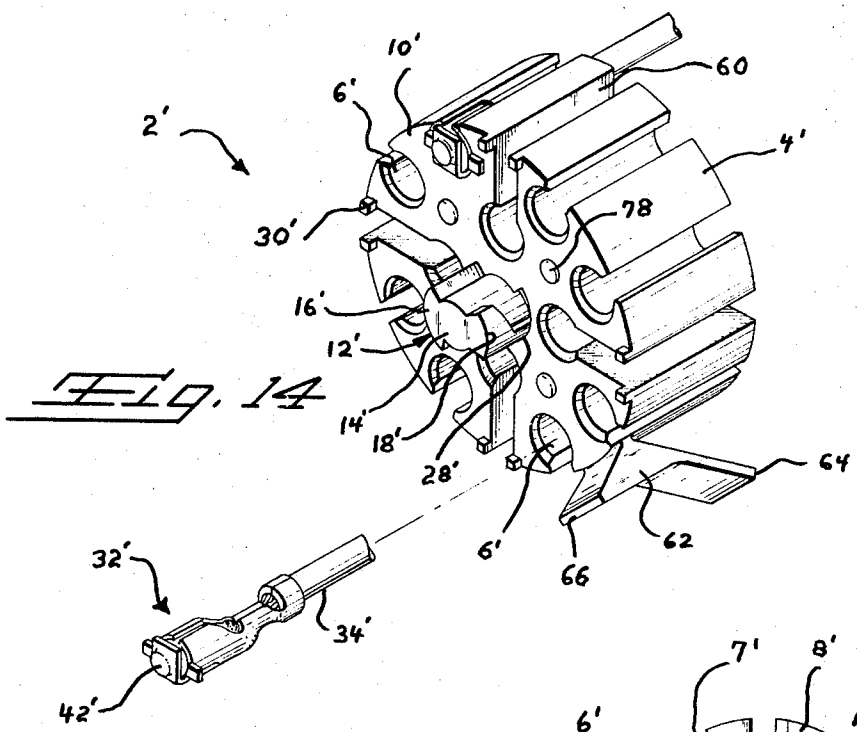


FIG. 14

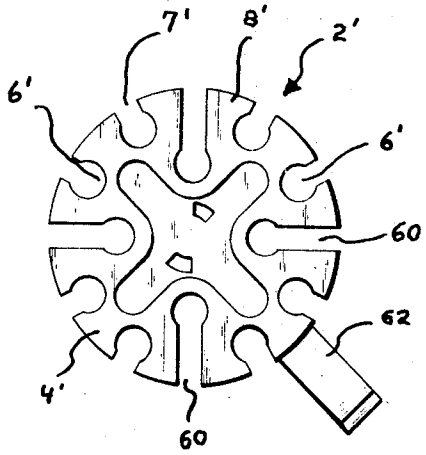


FIG. 15

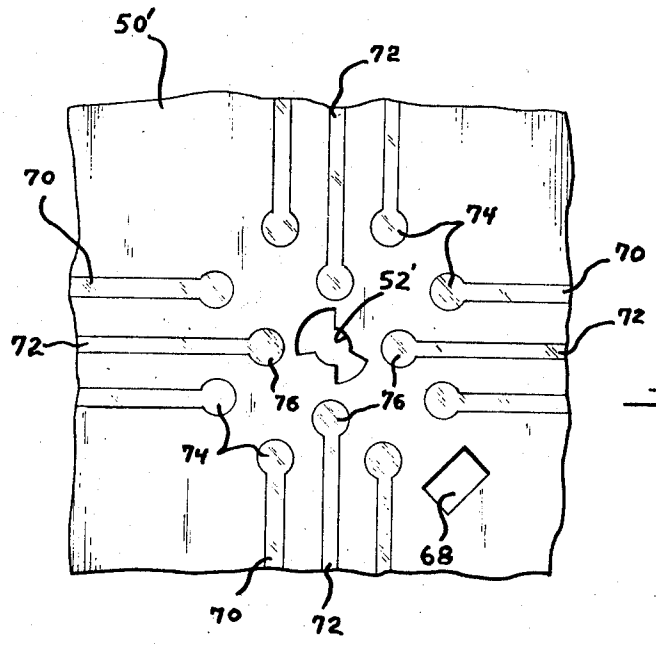


FIG. 16

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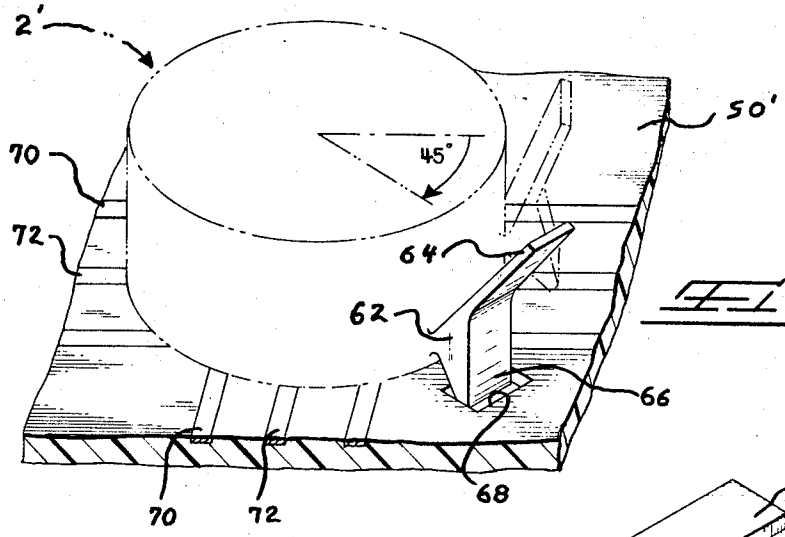


Fig. 17

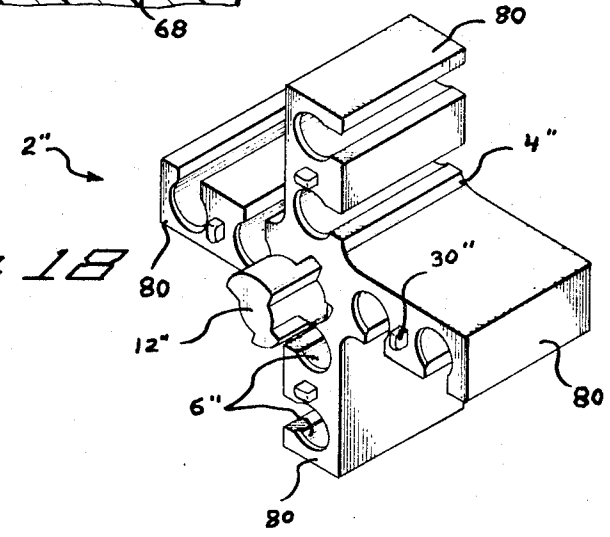


Fig. 18

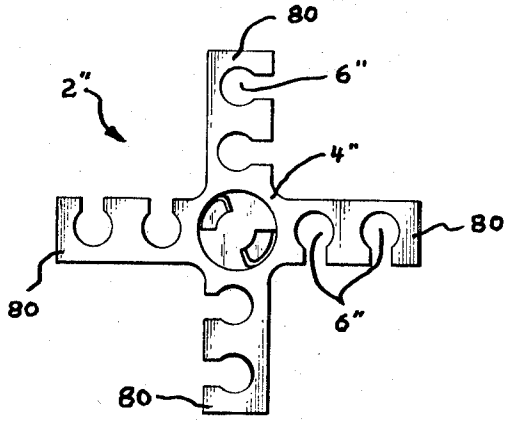


Fig. 19

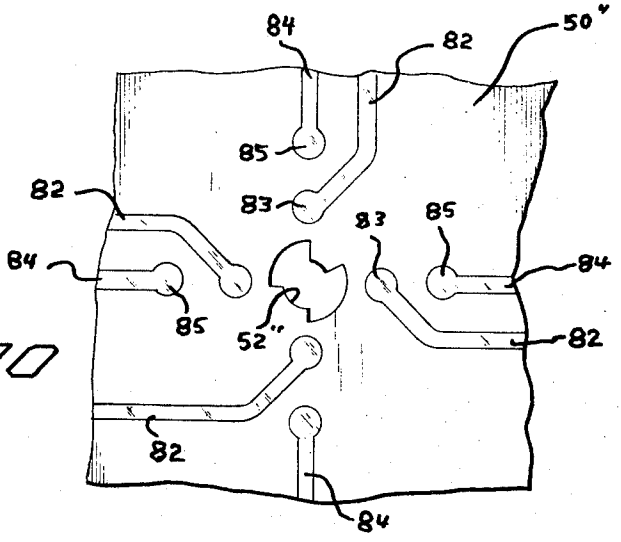


Fig. 20

United States Patent Office 3,523,267 Patented Aug. 4, 1970

3,523,267

DISENGAGEABLE ELECTRICAL CONNECTOR

William Vito Pauza, Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Continuation-in-part of application Ser. No. 626,252, Mar. 27, 1967. This application Jan. 24, 1968, Ser. No. 704,503

Int. Cl. H05k 1/00

U.S. Cl. 339—17 7 Claims

ABSTRACT OF THE DISCLOSURE

Disengageable electrical connector for use with a printed circuit board comprises insulating housing having locking boss extending centrally from one side. Contacts are mounted in the housing and have contact head portions adjacent to, and elevated from, one side in surrounding relationship to locking boss. Boss has bayonet-type detent mechanism thereon including means for latching boss in assembled relationship to board and controlling the engagement of the contact heads of the terminals with the conducting paths of the board.

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of my copending application Ser. No. 626,252, filed Mar. 27, 1967, and now abandoned.

The vast majority of the presently available disengageable connectors for printed circuit boards are adapted to be applied to the edge portions of the board. In common practice, the conductors on the board extend to the edge of the board and the disengageable connector has a plurality of contacts mounted therein in a manner such that when the connectors are mounted on the board, the contacts engage, and make electrical contact with, the conductors.

There is a substantial need for connectors which can be applied to the printed circuit board at locations remote from the edges rather than at the edges although only a limited amount of development work has been done on connectors of this type. The following U.S. patents show some of the previously proposed disengageable connectors which are adapted to be mounted at locations remote from the edge of a printed circuit board or the like: 3,209,308; 2,793,351; 2,911,610; and 2,774,949.

SUMMARY OF THE INVENTION

A preferred embodiment of the present invention comprises a housing of insulating material such as nylon having a centrally located locking boss extending from one side thereof. This locking boss has locking ears extending from its end, the shape of the ears being such that upon insertion of a locking boss through an irregularly shaped open in a printed circuit board and upon rotation of the housing relative to the board, the ears will prevent axial movement of the housing away from the printed circuit board. Additional locking means for locking the housing in its rotated position are provided either in the form of a locking lug mounted on the locking boss or in the form of a latch arm integral with the housing and engageable with a second opening in the printed circuit board.

The present invention also includes an improved contact terminal for the connector described above. The terminal has a generally cylindrical body portion with an integral flange on its end which extends normally of the axis of the body portion. A pair of axially extending slots are provided in the body portion on each side of the flange so that the contact flange pivots about the sections of the body portion which lies between the slots.

A plurality of contact terminals of this type are

mounted in suitable cavities in the housing and the conducting path on the printed circuit boards are located such that after rotation of the housing relative to the board, the contact buttons or ends of the terminals will be in engagement with the terminal or end portions of the printed circuit paths.

In the drawings:

FIG. 1 is a perspective view of a connector in accordance with the invention showing a contact terminal exploded from its contact receiving cavity;

FIG. 2 is a side view of the connector of FIG. 1 in alignment with a panel opening;

FIGS. 3 and 4 are similar to FIG. 2 but showing the manner in which the connector is assembled to the printed circuit board;

FIGS. 5, 6, and 7 are views taken along the lines **5—5**, **6—6**, and **7—7** of FIG. 2;

FIG. 8 is a side view of, on an enlarged scale, of the boss portion of the connector when it is mounted on a printed circuit board;

FIG. 9 is a plan view of a panel opening adapted to receive the connector of FIG. 1;

FIG. 10 is a view similar to FIG. 9 but showing the relationship of the locking boss to the panel opening after the connector has been mounted on the panel;

FIG. 11 is a view taken along the lines **11—11** of FIG. 4;

FIG. 12 is a top plan view of the connector block;

FIG. 13 is a view taken along the lines **13—13** of FIG. 8;

FIG. 14 is a perspective view of an alternative embodiment of the invention;

FIG. 15 is a top plan view of the housing of the connector of FIG. 14;

FIG. 16 is a plan view of a portion of a printed circuit board and showing the arrangement of the printed circuit paths around an opening which is adapted to receive the locking boss of the connector of FIG. 14;

FIG. 17 is a perspective view illustrating the mounting of the connector of FIG. 14 on a printed circuit board and the manner in which the connector is locked or secured to the board;

FIG. 18 is a perspective view of a further embodiment of the invention;

FIG. 19 is a top plan view of the connector housing of FIG. 18; and

FIG. 20 is a view similar to FIG. 16 showing the arrangement of conductor paths on a printed circuit board which is adapted to receive the connector of FIG. 18.

Referring first to FIG. 1, a connector **2** in accordance with the invention comprises a block **4** of suitable insulation material, such as a relatively firm nylon which can be injection molded, having a plurality of generally cylindrical cavities **6** extending therethrough from its upper or first side **8** to its lower or second side **10**. These cavities open into the side of the block as shown at **7** so that the terminated leads **32** can be moved laterally through the openings and into the cavities as illustrated in FIG. 1. The housing or block has a locking boss generally indicated at **12** extending centrally from its lower side **10**, this boss having a generally circular cross-section **14** and having a pair of diametrically opposed laterally extending ears **16**, **18** on opposite sides of its lower end. In addition, a locking lug **20** is provided adjacent to the side **10** of the housing and integral with this side and with the boss **12**. The lug **20** is circumferentially offset on the boss **12** with respect to the ears **16**, **18**; in other words, the lug is in axial alignment with a space between the ears.

The ear **16** has a shoulder **22** which is opposed to, and faces, the side **10** of the block **4** and the ear **18** has a similar shoulder **24**. These shoulders are helically in-

clined in a common direction towards the surface of the side **10** so that they have ends which are proximate to the surface of the side **10**. The helically inclined portions of the shoulders merge with flat portions **22***a*, **24***a* which define planes extending normally of the axis of the boss. The lug **20** defines a shoulder **25** which is opposed to the shoulders **22**, **24**. This shoulder **25** also defines a plane which extends normally of the axis of the boss **12**. Axial stops **26**, **28** in the form of axially extending ribs are provided on the boss, the stop **28** extending between one side or end of the lug **20** and the end portion **24***a* of the ear **18** while the stop **26** extends from the end portion **22***a* of the ear **16** to the surface of the side **10** of the block **4**.

The block **4** is provided with an axial cavity or bore **27**, FIG. 12, which extends downwardly from the upper side **8** to a location adjacent to the lower side of the block. Additionally, openings **29**, **31** are provided in the floor of this cavity which openings are in alignment with the ears **16**, **18**. The openings **27**, **29**, **31** permit the housing to be made by a relatively simple injection molding process with a single action mold. The openings **29**, **31** permit the movement of core pins through the mold cavity so that the shoulders **22**, **24** can be formed when the molding material, is injected into the mold. Connector blocks in accordance with the invention can thus be manufactured at high production rates and at an extremely low cost.

A plurality of supporting feet **30** are integral with the side **10** of the housing and project therefrom by an amount slightly less than the spacing between the surface of the shoulder **25** and the surface of the block **10**. These feet, as will be explained below, function to stabilize the block when it is mounted on the printed circuit board **48** and prevent overstressing of the contact portions of the terminals **42** as will be explained more fully below.

A preferred form of terminal **32** in accordance with the invention is crimped onto the stripped end of a wire **34** by means of a first crimp **36** and a second crimp connection **38**, the crimped connection **36** securing the terminal to the insulation of the wire and the crimped connection **38** securing the terminal to the conducting core of the wire. The terminal **32** extends axially from the wire end and has a generally cylindrical body portion **40**, the diameter of which is substantially equal to, and slightly greater than, the diameter of the cavities **6**. A contact button **42** is formed on the end of the terminal and bent rightwardly of the terminal axis, the shape of this contact button being advantageously spherical to facilitate its sliding motion over the board. Slots **46** extend inwardly from the end of the terminal to define a resilient arm **47** and retaining ears **44** extend radially outwardly from the end of the body portions. As illustrated in FIG. 1, when a terminal is positioned in a cavity, these ears project radially beyond the sides of the cavity and prevent further inward movement of the terminal and overstressing of the contact button **42**.

As will be explained below, the contact portion **42** is urged against the surface of the printed circuit board in use. Since the contact portion extends from the end of the arm **47** (which is defined by the slots **46**) the arm is flexed about its own end when pressure is applied to the contact portion **42**. In other words, the contact portion and the arm flex as a unit with respect to the inner end of the arm **47**. This arrangement is advantageous in that flexure of the contact portion with respect to the body portion of the terminal is substantially reduced or eliminated. Flexure of the latter type is undesirable for the reason that the sharp right angle bend will not withstand repeated flexing without failure.

The terminal is dimensioned, relative to the connector block such that when it is properly positioned in a cavity in the block, the surface of the contact button **42** is between the ends of the feet **30** and the plane defined by the shoulder **25** of the lug **20** as best shown in FIG. 2. As will be explained below, if these relationships between the surface of the button **42**, the surface of the shoulder **25**, and the ends of the feet **30** are maintained, the contact button portion **42** of the terminal will be protected from overstressing during assembly of the connector to the board and good contact pressure will be developed when the connector is in its assembled position.

The printed circuit board **48** which is adapted to receive a connector in accordance with the invention, has a plurality of conducting paths **50** which terminate in generally circular contact portions **51** disposed in a circular pattern around a panel opening **52** which is adapted to receive the boss **12** of the housing. This panel opening **52** (FIG. 9) has opposed edge portions **54** which have a diameter substantially equal to, and slightly greater than, the diameter of the circular cross-section of the boss. Diametrically opposed enlarged diameter portions **56**, **58** are provided which conform to the cross-section of the ears **16**, **18** on the end of the boss. It will be noted that these enlarged portions are of unequal arcuate extent and that the two ears **16**, **18** are similarly of unequal arcuate length. It should be noted also that the arcuate extent of the enlarged portion **56** is equal to the arcuate extent of the ear **16** plus the arcuate extent of stop **26**. Similarly, the arcuate extent of enlarged portion **58** is equal to the total arcuate extent of ear **18** and stop **28**. The entire boss can thus be inserted through the panel opening **52** until the shoulder **25** of lug **20** is against the surface of the board, see FIG. 3. The arcuate extent of the lug **20** is the same as the arcuate extent of the ear **18**, a relationship which gives rise to a detent device for latching the connector to the board as will be described below.

A further dimensional requirement of the preferred embodiment is that the spacing between the surface of the shoulder **25** and the surface of the proximate ends of the ears **16**, **18** is substantially equal to, and slightly less than, the thickness of the printed circuit board so that when the boss **12** is inserted through the panel opening **52**, the board, and rotated, the shoulders and ears will be slightly compressed and/or the board will be slightly compressed.

In use, appropriate wires and terminals are fitted in the cavity as illustrated in FIG. 1 to make connections to the appropriate ones of the conductors **50** of the board. The connector is thereafter positioned in alignment with the panel opening **52** and the boss is inserted through the opening until the shoulders **22**, **24** are on the opposite side of the panel. The conductors **50**, in FIGS. 2–4, are on the underside of the panel and the connector is assembled to the board from the underside. The conductors could be provided on the top of the panel and the connector inserted from above. The block or housing is thereafter rotated through an angle of about 75° in the preferred embodiment until the flat portions **22***a*, **24***a* of the shoulders **22**, **24** are disposed above the surface of the board and the lug **20** in alignment with the enlarged portion **58** of the panel opening. As a result of the compression of the block or board, as explained above, which takes place during such rotation, the lug **20** moves a short distance into the panel opening portion **58**; in other words, the compression of the ears **16**, **18** and the compression of the lug **20** is partially relieved when this lug is in a position to move partially into the panel opening portion **58**. This arrangement has the effect of a detent mechanism which latches the connector to the board thereby preventing accidental removal and preventing loosening of the connector under the influence of vibration or other accidental effects.

As previously noted, the surface **42** of the contact terminal is spaced from the surface of the side **10** a distance slightly less than the spacing between the surface of the shoulder **25** and the surface **10**. By virtue of this arrangement, the contact surface **42** of the terminal is held slightly spaced from the surface of the board during assembly of the connector to the board, but after the lug **20** is in alignment with the panel opening portion **58**,

the connector housing moves slightly towards the board and the contact portions 42 of the terminals are brought into engagement with the ends of the printed circuit paths 50.

FIGS. 14–17 show an alternative embodiment of the invention which is similar to the previously described embodiment in many respects but which differs therefrom in particular respects pointed out below. The same reference numerals, differentiated by prime marks, are used to identify corresponding structural parts of the embodiment of FIG. 1 and the embodiment of FIG. 14 where appropriate. Structural features of the embodiment of FIG. 14 which do not appear in the embodiment of FIG. 1 are identified by unprimed reference numerals.

The connector 2', FIG. 14, comprises a cylindrical housing 4' having a first plurality of contact receiving cavities 6' similar to the cavities 6 of the previously described embodiment. It will be noted that the cavities 6' are located relatively close to the surface of the housing 4' and are spaced-apart around the periphery of the housing. Additional cavities 60 are located at 90° intervals around the circumference of the housing with the cylindrical contact-receiving portions of these cavities 60 being located relatively close to the longitudinal axis of the housing. In the particular embodiment shown, there are provided four cavities 60 and eight cavities 6' so that a total of twelve contact terminals may be mounted in the housing. Housing 2' has supporting feet similar to the feet 30 of the FIG. 1 embodiment and has additional supporting bosses 78 in the center of each cluster of cavities 6', 60.

The connector 2' is adapted to be locked to the printed circuit board 50' upon insertion of the locking boss 12' through the opening 52' and rotating the housing 4' through an angle of 45° as indicated in FIG. 17. Locking of the housing in its rotated position is, in the case of this embodiment, achieved by means of a latch member 62 having a latching arm 66 which extends beyond the second side 10' of the housing and a lever arm 64 which extends relatively upwardly towards the first side. This latch arm is integral with the housing by means of a flexible hinge member so that the lever arm 64 can be depressed to move the latch arm 66. When the boss 12' is inserted through the opening 52' and the housing rotated through the required 45° angle, the latch arm 66 will enter an additional opening 68 adjacent to the opening 52' and lock the housing in its rotated position, and, therefore, to the printed circuit board. When it is desired to remove the connector from the printed circuit board, the upper end of the lever arm 64 is depressed thereby to move the latch arm 66 out of the opening 68 and permit counter rotation of the housing and removal of the locking boss 12' from the opening 52'.

The printed circuit board paths on the board 50' with which the contact terminals in the connector 2' are engaged are preferably arranged as shown in FIG. 16. Four of these paths 72, which extend at right angles to each other, have contact portions 76 at their ends which are located relatively close to the center of the opening 52'. The remaining conducting paths 70 on the printed circuit board 50' have contact portions 74 which are relatively remote from the center of the opening 52'. The contact terminals in the cavity 6' thus will make electrical contact with the ends of the conductors 70 while the contact terminals in the cavities 60 of the connector will make electrical contact with the conducting path 72.

It should be pointed out that when the connector is mounted on the printed circuit board and rotated, some of the contact terminals in the housing will pass over, and make momentary electrical contact with, conducting paths on the printed circuit board with which they do not make electrical contact in the final circuit arrangement. For this reason, it is desirable to use the connector 2' only under circumstances where such momentary electrical contact between lead wires secured to terminals in the connector 2' and some of the conductors on the printed circuit board 50' would not be harmful. Alternatively, any undesirable effects can be avoided by applying the connector to the printed circuit board and removing it from the printed circuit board only when no power is passing through the conductors 70, 72 of the printed circuit board.

FIGS. 18–20 show a further embodiment of the invention in which this crossing effect is completely avoided. In this embodiment, the connector 2'' has a central body portion 4'' from which four arms 80 extend radially at 90° intervals. Each arm is provided with a pair of side-by-side spaced-apart contact-receiving cavities 6'' which are adapted to receive electrical contact terminals of the type previously described. The embodiment of FIG. 18 may be provided with a locking boss 12'' and a locking lug as previously described with reference to the embodiment of FIG. 1 or may be provided with a separate latching member as described with reference to FIG. 14. In either event, the conductors 84, 82 on the printed circuit board 50'' are arranged as shown in FIG. 20. The conductors 84 thus have their contact pad portions 85 located relatively remote from the center of the opening 52'' so that these conductors will be contacted by the terminals located in the outer cavities 6'' of the four arms 80. The conductors 82 have their contact pad portions 83 located relatively close to the center of the opening 52'' and will make contact with the contact terminals disposed in the openings 6'' which are relatively adjacent to the axes of the connector housing. When the connector is applied to the printed circuit board and the boss 12'' is inserted through the opening 52'', the contact portions of the terminals will be located between the four groups of conductors shown in FIG. 20. Upon subsequent rotation of the housing through an angle of about 45°, the contact portion of the terminals will move onto the pad portions 83, 85 of the printed circuit paths and will not, during such movement, move over any other conductors on the board.

A salient advantage of the invention is that a positive lock between the connector and the board is achieved in all of the embodiments described above. The lock may take the form of the separate locking lug as described with reference to the embodiment of FIG. 1 or may take the form of a latch member as described with reference to FIG. 14. In either event, the connector cannot be removed from the board excepting by a premeditated and deliberate series of manual operations. It should also be noted that the connector housings described above can all be manufactured by injection molding processes which is to say that they could be rapidly and inexpensively produced and can be manufactured to the extremely close tolerances required in printed circuit board devices. The connectors shown above are all serviceable in that the contact terminals can be readily removed for circuit changes or for replacement when desired. Finally, it should be noted that in all of the embodiments described above, the locking bosses 12, 12', and 12'' are centrally disposed on the underside of the housing and occupy very little space. As a result, the peripheral portions of the connector housing, or the arms in the case of the embodiment of FIG. 18, are entirely available for contact cavities and contacts.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

What is claimed is:

1. An electrical connector adapted for use with a printed circuit board or the like comprising:

an insulating housing having a plurality of contact-receiving cavities extending therethrough from a first side to a second side,

a locking boss extending from said second side, said locking boss being centrally located on said second side and having laterally extending ear means thereon, said ear means comprising a pair of ears on opposite sides of said boss,

locking means for locking said housing in its rotated position to lock said connector in said rotated position, said locking means comprising a locking lug integral with said second side and integral with said boss, said lug having a cross-section which is substantially similar to the cross-section of one of said ears, said lug being spaced from said ears and being located, relative to the circumference of said boss, between said ears, said connector being adapted to be mounted on a printed circuit board having a thickness greater than the spacing between said ears and said lug and having an irregularly shaped opening which will admit said boss and said ears whereby, upon insertion of said boss and said ears through said opening and upon rotation of said connector, said ears are disposed against the side of said board which is opposite to the side on which said housing is mounted and said lug enters said opening to lock said connector to said board.

2. An electrical connector as set forth in claim 1 wherein said housing comprises a central body portion and a plurality of arms extending radially from said body portion, said boss extending from said body portion and said cavities extending through said arms.

3. An electrical connector as set forth in claim 2 wherein each of said arms has at least two of said cavities extending therethrough.

4. An electrical connector as set forth in claim 1 wherein said housing is cylindrical.

5. An electrical connector as set forth in claim 4 wherein said cavities are equidistant from the periphery of said housing.

6. An electrical connector as set forth in claim 4 wherein periodic cavities of said plurality of cavities are disposed relatively proximate to the axis of said housing, the remaining cavities of said plurality being relatively remote from said axis.

7. An electrical connector for use with a printed circuit board or the like comprising:

an insulating block having a locking boss extending from one side thereof,

said boss having a pair of laterally extending ears on opposite sides thereof,

said ears being spaced from said one side and defining first shoulders opposed to said one side, said first shoulders being generally helically inclined in one direction whereby said first shoulders have proximate ends with respect to said one side,

a locking lug integral with said housing and said boss, said lug defining a second shoulder opposed to said first shoulders, the spacing between the proximate ends of said first shoulders and said second shoulder being substantially equal to, and slightly less than, the thickness of the printed circuit board to which said connector is applied, said locking lug being offset from said ears relative to the circumference of said boss whereby, upon insertion of said boss through an opening in said printed circuit board conforming to the cross-section of said boss and said ears and upon partial rotation of said housing, until said first shoulders are disposed against surface portions of said printed circuit board and said lug is in alignment with a portion of said opening which received one of said ears, said lug moves relatively into said portion of said opening to lock said connector to said printed circuit board.

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