April 22, 1969 C. E. BAKER II, ET AL 3,440,597

ELECTRICAL CONNECTOR HAVING CONTACT TERMINALS WITH TERMINAL POSTS

Filed Oct. 9, 1967 Sheet 1 of 3

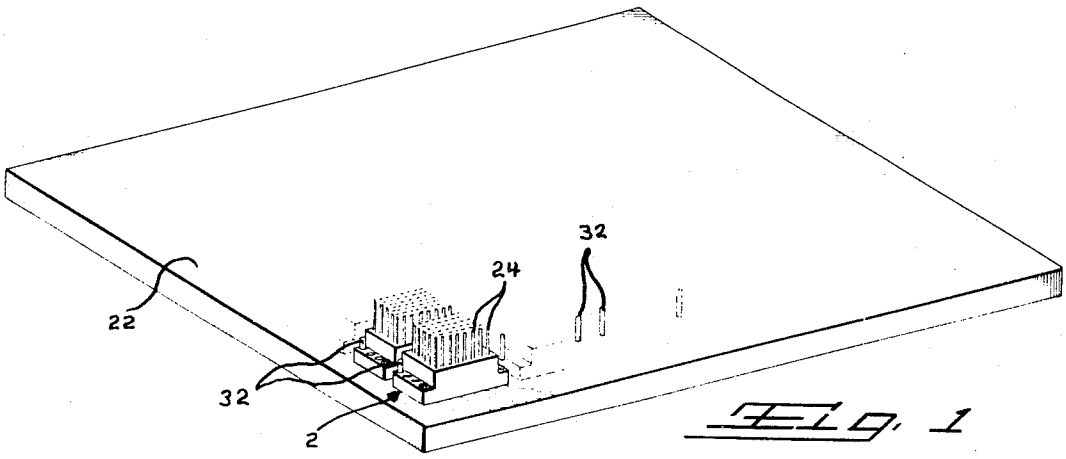


Fig. 1

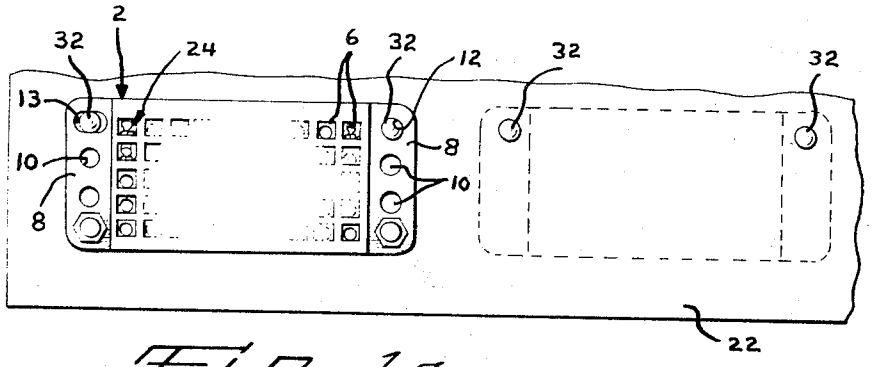


Fig. 1a

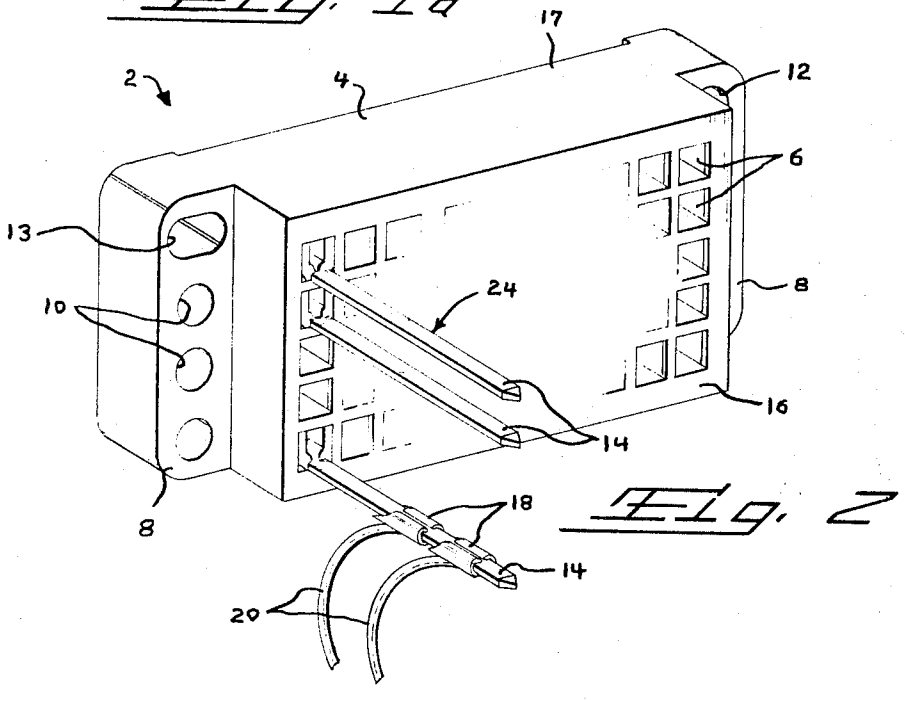


Fig. 2

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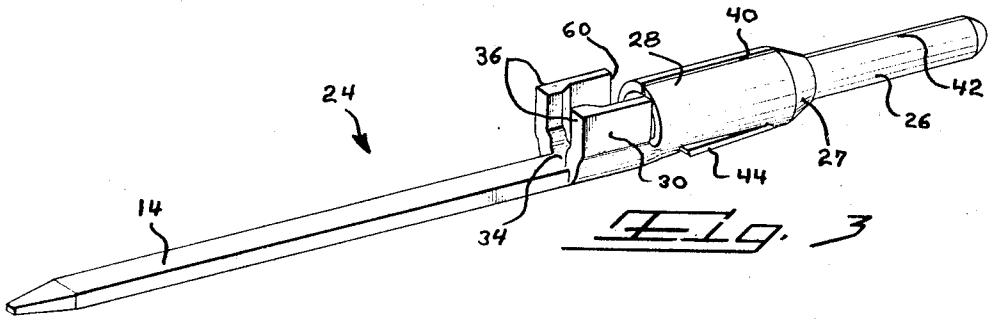



Fig. 3

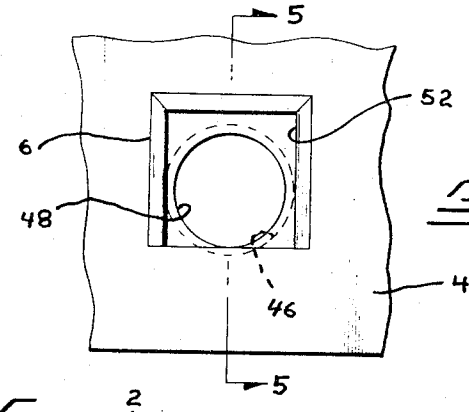
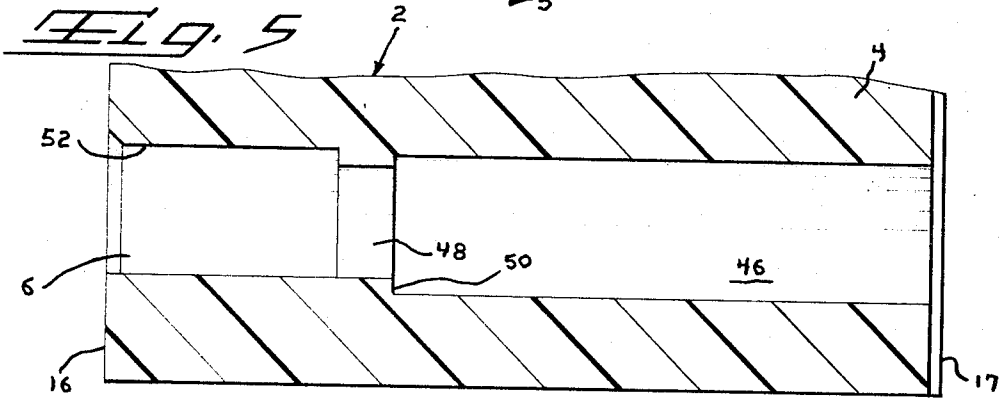



Fig. 4

Fig. 5



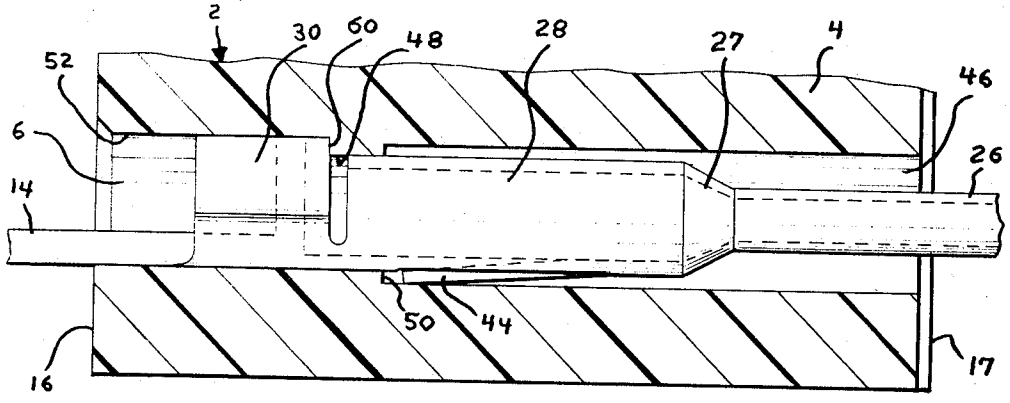




Fig. 6

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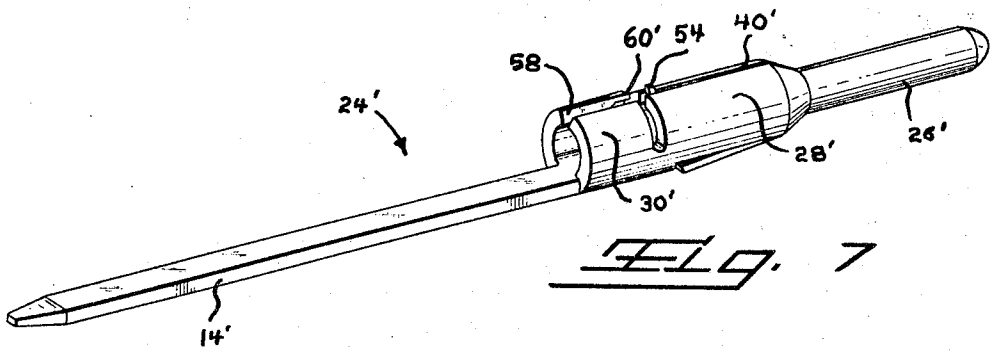


Fig. 7

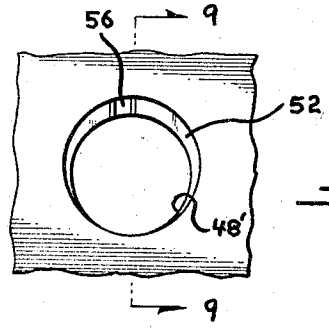


Fig. 8

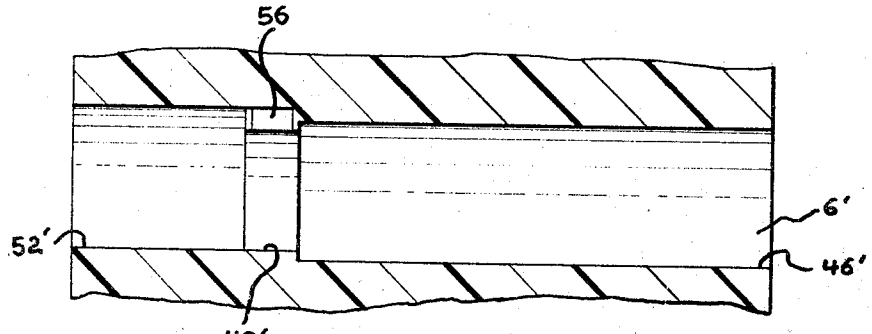


Fig. 9

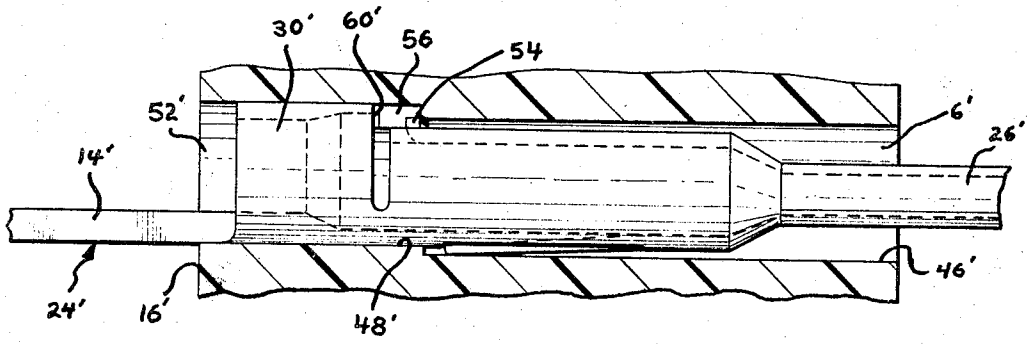


Fig. 10

United States Patent Office 3,440,597
Patented Apr. 22, 1969



3,440,597

# ELECTRICAL CONNECTOR HAVING CONTACT TERMINALS WITH TERMINAL POSTS

Charles Edward Baker II, Middletown, and Albert Casciotti, Hershey, Pa., assignors to Amp Incorporated, Harrisburg, Pa.

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Int. Cl. H01r 9/08, 5/00
U.S. Cl. 339—221
9 Claims

## ABSTRACT OF THE DISCLOSURE

Multi-contact electrical connector comprises connector block having cavities with pin and socket type contact terminals therein. Each terminal has a cylindrical contact end, an intermediate cylindrical portion, a force-fit portion, and a terminal post extending from the force-fit portion. The force-fit portion is laterally offset with respect to the axes of the intermediate cylindrical portion and the contact end portion. The contact-receiving cavities in the block have a constricted intermediate portion and an entrance portion through which the terminals are inserted. The entrance portion is offset with respect to the constricted intermediate portion so that the terminals can be inserted into the cavities when they are in only one orientation. The force-fit portions of the terminals have a force-fit in this entrance portion of the cavity so that the terminal posts which extend from the rearward side of the block are rigidly supported and accurately located. Because of this accurate location and rigid support of the terminal posts, the connector block can be automatically wired with clip-type or wrap-type connections made by an automatic wiring machine.

## BACKGROUND OF THE INVENTION

A commonly known type of multi-contact electrical connector comprises an insulating housing having a plurality of pin and socket types of contact terminals therein which are secured to the ends of wires. Such connectors are adapted to be engaged with, and disengaged from, a mating connector thereby to connect the individual wires to wires secured to the terminals in the mating connector. Connectors of this type are usually assembled by crimping individual contact terminals onto the wires and thereafter inserting the terminals into cavities in the housing. Operations of this type are generally time consuming, tedious, and expensive. The assembly of these connectors is usually not highly automated for reasons which will become apparent during a reading of this specification.

It has been common practice in the past to automatically or semi-automatically wire certain types of connecting devices (other than pin and socket connectors) by means of clip-type or wrap-type electrical connections. A clip-type electrical connection is made by means of a terminal clip which is mounted on a generally rectangular terminal post and which holds the wire against, and in electrical contact with, the surface of the post. Connections of this type may be made rapidly and at an extremely low cost by a suitable hand tool as disclosed, for example, in U.S. Patent 3,249,992, or by a fully automatic program controlled automatic wiring machine as disclosed in U.S. Patent 3,186,077. Wrap-type electrical connections are made by wrapping the stripped end of a wire around a terminal post and these connections can also be made by hand tools or by well known automatic wiring machines.

When wiring operations with clip-type or wrap-type connections are carried out by means of automatic wiring machines, the terminal posts to which the wires are connected must be very accurately and precisely located on a suitable work support which is placed beneath the head



of the wiring machine. Accurate location and positioning of the terminal posts is necessary in order to ensure that the particular post to which a connection is to be made is located beneath the head of the wiring machine when the machine is moved to a position above the post. Because of this requirement of accurate location of the terminal posts relative to the wiring head, it has heretofore been considered impractical to automatically wire certain types of multi-contact electrical connectors, particularly connectors of the pin and socket type.

The present invention is directed generally to the provision of an electrical connector which can be wired by an automatic wiring machine. The invention, as will be explained below, contemplates the use of improved contact terminal and an improved connector block having cavities which will receive terminals in only one orientation so that the terminal posts on the terminals will occupy a precisely predetermined location on the surface of the block. The construction of the terminal is, moreover, such that the post will be sturdy and rigid and capable of withstanding the stresses imposed during a wrap-type or clip-type wiring operation.

It is an object of the invention to provide an improved multi-contact electrical connector. It is a further object to provide an improved pin and socket type connector. It is a still further object to provide a pin and socket connector which is adapted to be wired by means of clip-type or wrap-type electrical connections. A still further object is the provision of a multi-contact electrical connector which can be automatically wired by means of an automatic wiring machine.

These and other objects of the invention are achieved in a preferred embodiment thereof comprising an insulating block having a plurality of cavities extending therethrough with contact terminals mounted in each of the cavities. The individual terminals are of the pin and socket type and have a contact end portion such as a pin portion or a socket portion, an intermediate cylindrical portion which is axially aligned with the contact end portion, a force-fit section immediately adjacent to, and behind the cylindrical portion and which offset with respect to the cylindrical intermediate portion and finally a terminal post extending from one side of the force-fit portion. The individual cavities in the connector block have an intermediate cylindrical constricted portion which is axially aligned with a frontal portion and which, on its opposite side, merges with an entrance portion extending inwardly from the rearward side of the block. The entrance portion is offset with respect to the intermediate constricted portions so that a terminal can be inserted into the cavity when it is in only one orientation. By virtue of this fact, the terminal posts will occupy a precisely predetermined location on the rearward side of the block. The block can be positioned on a suitable wiring fixture and a plurality of such blocks can be wired by means of an automatic wiring machine.

In the drawings:

FIGURE 1 is a perspective view of a wiring fixture adapted to hold a plurality of connector blocks during a wiring operation;

FIGURE 1*a* is a fragmentary plan view of the wiring fixture;

FIGURE 2 is a perspective view of a connector block in accordance with the invention and showing clip-type electrical connections between external conductors and some of the terminal posts extending from the block;

FIGURE 3 is a perspective view of a contact terminal in accordance with the invention;

FIGURE 4 is a plan view on an enlarged scale of a portion of the rearward side of a connector block showing the entrance portions of the contact cavities;

FIGURE 5 is a view taken along the lines 5—5 of FIGURE 4;

FIGURE 6 is a view similar to FIGURE 5 but showing a contact terminal mounted in the cavity;

FIGURE 7 is a perspective view of a contact terminal in accordance with an alternative embodiment of the invention;

FIGURE 8 is a plan view of the rearward side of a connector block showing the entrance portions of cavities adapted to receive terminals of the type shown in FIGURE 7;

FIGURE 9 is a view taken along the lines 9—9 of FIGURE 8; and

FIGURE 10 is a view similar to FIGURE 9 but showing a contact terminal mounted in the cavity.

Referring first to FIGURES 2, 4, and 5, a multi-contact electrical connector in accordance with the invention comprises an insulating block **4** of diallyl phthalate, phenolic, or similar firm plastic material having a plurality of cavities **6** extending therethrough from its rearward side **16** to its forward side **17**. The ends of the block **8** are provided with holes **10** which are adapted to receive jack screws or other hardware for connecting the block to a complementary block. Additional holes **12** and slots **13** may be provided in these ends to accurately locate the block on a wiring fixture which will be described below while it is being wired by an automatic wiring machine.

The contact terminals contained in the cavities **6** have terminal posts **14** extending from their ends and projecting normally from the surface of the rearward side **16** of the block. The external conductors **20** are connected to these posts by clip-type electrical connections as indicated at **18**. Electrical connections of this type are fully described in U.S. Patent 3,239,918 and need not be described in further detail here. It is sufficient to say that such connections can be made by an automatic wiring machine of the type disclosed in U.S. Patent 3,186,077, and that in the finished connection, the stripped end of the wire is held against, and in electrical contact with, the surface of the post by a terminal clip. Wrap-type electrical connections may also be made between the ends of the wires **20** and the post **14** by means of hand tools or automatic wiring machines for making wrap-type electrical connections.

At the time of assembly and wiring of the connector **2**, the individual contact terminals are inserted into the cavities **6** in the block and the connector is thereafter placed on a wiring fixture **22** (FIGURE 1). Wiring fixture **22** has a plurality of dowl pins **32** thereon which are adapted to extend through the tooling holes **12** of the individual blocks **10** and through a tooling slot **13** on the opposite end of the block. The purpose of these dowl pins is to accurately and precisely locate the individual connectors on the surface of the fixture so that when the fixture, in turn, is accurately positioned on the work table of a wiring machine, each of the terminal posts will occupy a precisely predetermined position with respect to the work table of the machine. It is, of course, necessary to accurately locate the individual terminal posts in the individual blocks, and, as will be explained below, the principles of the invention permit the achievement of such accurate positioning of the terminal posts.

Referring now to FIGURE 3, a contact pin **24** in accordance with the invention has a reduced diameter cylindrical contact end portion **26** which is adapted to enter a complementary contact socket, an intermediate enlarged cylindrical portion **28** which merges with the pin portion **26** by means of a conical transition section **27**, an enlarged force-fit section **30** of generally U-shaped cross-section, and a terminal post **14** which extends from the web or floor **34** of the force-fit section. The contact pin **24** is manufactured by stamping forming operations and, therefore, has an axial seam. This seam is slightly open as indicated at **40** in the intermediate cylindrical



section **28**. As will be explained below, the open portion **40** of this seam is partially closed when the contact terminal is inserted into a cavity thereby to assist in providing a force-fit of the terminal in the cavity and to accurately position the terminal post **14** with respect to the rearward side **16** of the terminal block. Advantageously, the terminal is manufactured from metal stock which is relatively thin at the forward end of the terminal and is relatively thicker in the post portion and part of the force-fit portion, the transition **38** of thin to thick stock occurring adjacent to the end of the force-fit portion. By virtue of this difference in the stock thickness along the length of the contact terminal, the forward cylindrical portions of the terminal can be drastically deformed during manufacture and the post portion **14** will be nonetheless sturdy and rigid when the terminal is mounted in the connector block. A retaining lance **44** is struck from the intermediate cylindrical portion **28** of the terminal member **24** and cooperates with a retaining shoulder in the cavity in which the terminal is mounted as will be described below.

As shown in FIGURES 4 and 5, each of the contact-receiving cavities **6** in the block **4** has a generally rectangular entrance portion **52**, an intermediate cylindrical constricted portion **48**, and a forward cylindrical portion **46**. The intermediate constricted cylindrical portion **48** is in axial alignment with the forward cylindrical portion **48** and has a diameter which is substantially equal to the diameter of the intermediate contact portion **28**. A forwardly facing shoulder **50** is defined by the diameter change between these two cylindrical cavity portions which is adapted to bear against the retaining lance **44** when the contact is inserted into the cavity as shown in FIGURE 6.

The entrance portion **52** of the cavity is rectangular and, in the disclosed embodiment, almost square having a height (as viewed in FIGURES 4 and 5) which is substantially equal to, but slightly less than, the height of the sidewalls **36** of the force-fit portion of the terminal member **24**. The geometric center of this entrance **52** is slightly offset with respect to the common axis of the cylindrical portions **48**, **46** of the cavity so that the constricted portion **48** of each cavity appears to be tangent to the lower side of the entrance portion of the cavity as viewed in FIGURE 4.

The contact terminal **24** is assembled to the connector block by inserting the contact terminal through the cavity from the left to the right as viewed in FIGURE 5 until the lance **44** passes through the constricted cavity portion **48** and lodges against the shoulder **50**. It is an important feature of the invention that the terminal **24** can be inserted fully into the cavity **6** only when it is in one orientation, that is, when the terminal is oriented such that the terminal post **14** is in alignment with the lower surface (as viewed in FIGURE 4) of the entrance portion **52** of the cavity. If an attempt is made to insert the terminal into the cavity when the terminal is in any other orientation, the leading edges **60** of the sidewalls **36** will extend beyond the confines of the entrance portion **52** and prevent movement of the terminal into the cavity beyond these leading edges. By virtue of this fact, the contact terminal posts **14** will always occupy a precisely predetermined position, within relatively narrow production tolerances, with respect to the cavities in which the terminals are located. The precise location of these cavities, in turn, permits the completed and assembled connector to be automatically wired by means of an automatic program controlled wiring machine when it is mounted on the mounting fixture **22**. The force-fit of the force-fit portion **36** of the terminal in the entrance portion **52** of the cavity moreover, assures that the terminal will be rigidly mounted in its accurately predetermined position and will not wobble to any substantial degree about its own axis.

FIGURES 7–10 show an alternative embodiment of the invention in which the force-fit portion **30'** of the terminal is cylindrical rather than U-shaped and has a substantial gap in its open seams as indicated at **58**. The post portion **14'** and the contact pin portion **26'** of the contact terminal **24'** of FIGURE 7 are substantially identical to corresponding parts of the terminal **24** of FIGURE 3. The intermediate cylindrical section **28'** of the terminal **24'** has a struck-up ear **54** extending outwardly from its rearward end. This ear assists in orientating the terminal in its cavity and preventing rotation as will be explained below.

The contact-receiving cavity **6'** which is adapted to receive the terminal **24'** has a forward cylindrical portion **46'**, an intermediate cylindrical constricted portion **48'**, and an entrance portion **52'**. The constricted cavity portion **48'** is in axial alignment with the cavity portion **46'** but the entrance portion **52'** is laterally offset with respect to the common axes of the forward cavity portions **48'**, **46'**. As shown in FIGURE 8, the constricted cavity portion **48'** appears to be tangent to the entrance cavity portion **50'** at one point by virtue of this offset relationship of the two cavity portions. A recess **56** may be provided in the upper side (as viewed in FIGURE 9) of the constricted cavity portion **48** to receive the upwardly struck ear **54** on the contact terminal. The diameter of the entrance **52'** of the cavity is slightly less than the diameter of the cylindrical force-fit portion **30'** of the terminal.

As will the previously described embodiment, the contact terminal **24'** can be inserted in the cavity **6'** only when the terminal is in an orientation such that the terminal post is in alignment with the lower side of the cavity as viewed in FIGURES 8 and 9. If it is attempted to insert the terminal into the cavity when it is in any other orientation, the leading edges **60'** of the cylindrical force-fit portion **30'** will move against the rearward side **16'** of the connector block and prevent complete insertion. When the terminal is properly oriented and inserted, the ear **54** will move into the recess **56** and assist in preventing rotational movement of the terminal in its cavity.

It should be mentioned that the ear **54** and the cavity **56** are not essential to the practice of the invention if the dimensions of the parts are judiciously selected and if the amount of the offset of the entrance portion **52** with respect to the cavity portion **48'** is adequate to prevent rotation of the terminal in its cavity.

After insertion of the contact terminal into the cavity, the terminal can not be rotated by virtue of the eccentric fit of the force-fit portion **30'** in the cavity portion **52'** with respect to the axes of the cavity portions **48'**, **46'**. The gap **58** in the seam of the cylindrical force-fit portion **30'** of the terminal is partially closed when the terminal is inserted by virtue of the fact that the diameter of this force-fit portion **30'** is slightly greater than the diameter of the entrance portion **52'** of the cavity. This arrangement allows liberal manufacturing tolerances in the terminal, but, at the same time, insures that the terminal can be inserted into the cavities in only one orientation so that the terminal posts will occupy the desired portions on the rearward sides of the connector block. The embodiment of FIGURES 7–10 permits mounting of the terminals on closer centers than the embodiment of FIGURES 3–6 by virtue of the cylindrical force-fit terminal portions **30'** of the terminals and the cylindrical cavity entrance portions **52'**.

While the invention has herein disclosed in an embodiment comprising a contact pin, it will be apparent that the principles of the invention are equally applicable to contact socket terminals having integral terminal posts of the type shown in **14**, **14'**. Pin and socket terminals ordinarily can be inserted into a connector block in any rotational orientation with respect to the block cavity. This characteristic of the pin and socket type contacts has, in the past, prevented the application of automatic wiring techniques to pre-assembled pin and socket connectors. It will be apparent that the principles of the present invention overcome this comparative disadvantage, for automatic wiring purposes of pin and socket type contacts, and permit the achievement of precisely locating terminal posts on the rearward side of a pin and socket connector part.

The invention is not limited to pin and socket type connectors which are adapted to be wired by means of automatic wiring machines. Clip-type and wrap-type electrical connections are frequently made, in fairly large numbers, with hand tools as noted above and a connector in accordance with the invention can, if desired, be wired with a hand tool. A distinct advantage of a connector in accordance with the invention which is important to the hand wiring of the terminal posts is that these posts are rigidly mounted in the connector block so that they are capable of withstanding the stress imposed by a hand wiring operation. Furthermore, the post should be accurately located on the rearward side of the connector for a hand wiring operation if the operation is to be carried out with maximum efficiency. The requirements of accurately located and rigidly supported posts are applicable for both hand wiring and automatic wiring methods but these requirements exist to a great degree for automatic wiring methods than is the case for hand wiring.

It should be mentioned that the wiring fixture **22** on which the connectors are mounted can be used as a permanent mounting panel for the connectors. In other words, the posts extending from the terminals can be interconnected by the automatic wiring machine and the fixture **22** can then be mounted on the equipment (e.g., a computer) being assembled. Mating connectors are then engaged with the connectors mounted on the panel, these mating connectors functioning to interconnect the components or units of the equipment.

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. The actual scope of the invention is intened to be defined in the following claims when viewed in their proper perspective against the prior art.

What is claimed is:

**1.** An electrical connector comprising an insulating block having a plurality of contact terminals extending therethrough, each of said contact terminals having disengageable connecting means of the pin and socket type at one end and having a terminal post at its other end, each of said terminals having a force-fit portion and a cylindrical portion intermediate its ends with said cylindrical portion being in axial alignment with, and merging with, said pin and socket type connecting means, said force-fit portion being laterally offset with respect to said cylindrical portion and having a maximum transverse dimension which is greater than the diameter of said cylindrical portion, each of said cavities having an entrance portion extending inwardly from one side of said block and having an intermediate cylindrical portion adapted to snugly receive said cylindrical contact portion, said entrance portion being offset with respect to said intermediate cavity portion and being dimensioned to receive said force-fit portion of one of said contact terminals with a force-fit whereby, said terminals can be inserted into said cavities in only one orientation and said terminal posts will occupy precisely predetermined positions on said one side of said insulating block, and the force-fit of said force-fit contact portion in said cavity entrance portion will hold said posts rigidly on said side.

**2.** A connector as set forth in claim **1** wherein said cavity entrance portion is generally rectangular and said force-fit portion is U-shaped in cross-section.

3. A connector as set forth in claim **1** wherein said cavity entrance portion is cylindrical and said force-fit portion of said contact is cylindrical and has an axially extending open seam, said seam being closable upon insertion of said contact into said cavity.

4. A contact terminal of the pin and socket type comprising a leading end portion, a cylindrical intermediate portion, said intermediate portion merging with a force-fit portion, and a terminal post extending from said force-fit portion, said cylindrical intermediate portion and said leading end portion being in axial alignment with each other and said force-fit portion being offset relative to said intermediate portions, and said force-fit portion having a maximum transverse dimension which is greater than the diameter of said cylindrical intermediate portion, said contact terminal being adapted to be inserted into a contact receiving cavity in an insulating block, said contact-receiving cavity having an entrance portion extending inwardly from one side and having a cylindrical intermediate portion merging with said entrance portion, said intermediate portion being offset with respect to said entrance portion and said entrance portion being dimensioned to snugly receive said force-fit portion whereby said terminal can be inserted into said cavity in only one orientation and said terminal post has a predetermined position and orientation on said one side of said block.

5. A contact terminal as set forth in claim **4** wherein said force-fit portion of said terminal has a U-shaped cross-section.

6. A contact terminal as set forth in claim **4** wherein said force-fit portion of said terminal has a cylindrical cross-section and has an axially extending open seam, said seam being closable upon insertion of said terminal into said cavity.

7. A connector block having a plurality of contact-receiving cavities extending therethrough from a first side to a second side, each of said cavities having an enlarged



entrance portion extending inwardly from said first side, said entrance portion adjoining a cylindrical intermediate portion, the longitudinal axis of said cylindrical intermediate portion being laterally offset to the axis of said entrance portion, each of said cavities being adapted to receive a contact terminal of the pin and socket type, each of said contact terminals having a cylindrical intermediate portion adapted to be inserted into said cylindrical cavity portion and having a force-fit portion adapted to be fitted into said enlarged cavity entrance portion, said terminals each having a terminal post extending from said force-fit portion, each of said terminals being insertable into said contact cavity when in only one orientation by virtue of said offset cylindrical cavity portions whereby, said terminal post occupies a predetermined location on said first side of said block and is rigidly held in said location by its force-fit portion.

8. A connector block as set forth in claim **7** wherein said entrance portion has a polygonal cross-section.

9. A connector block as set forth in claim **7** wherein said entrance portion has a cylindrical cross-section, said force-fit portions of said terminal being cylindrical and having an axis which is offset relative to said cylindrical intermediate portion.

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RICHARD E. MOORE, *Primary Examiner.*

U.S. Cl. X.R.

339—276

# U.S. DEPARTMENT OF COMMERCE

## PATENT OFFICE

## Washington, D.C. 20231

## UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,440,597 April 22, 1969

Charles Edward Baker II et al.

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

Column 6, line 49, after "therethrough," insert -- each of said terminals being disposed in a cavity extending through said block, --; line 62, after "receive" insert -- the --; same line 62, cancel "contact"; same line 62, after "portion" insert -- of one of said contact terminals --. Column 8, line 4, after "offset" insert -- with respect --.

Signed and sealed this 14th day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents