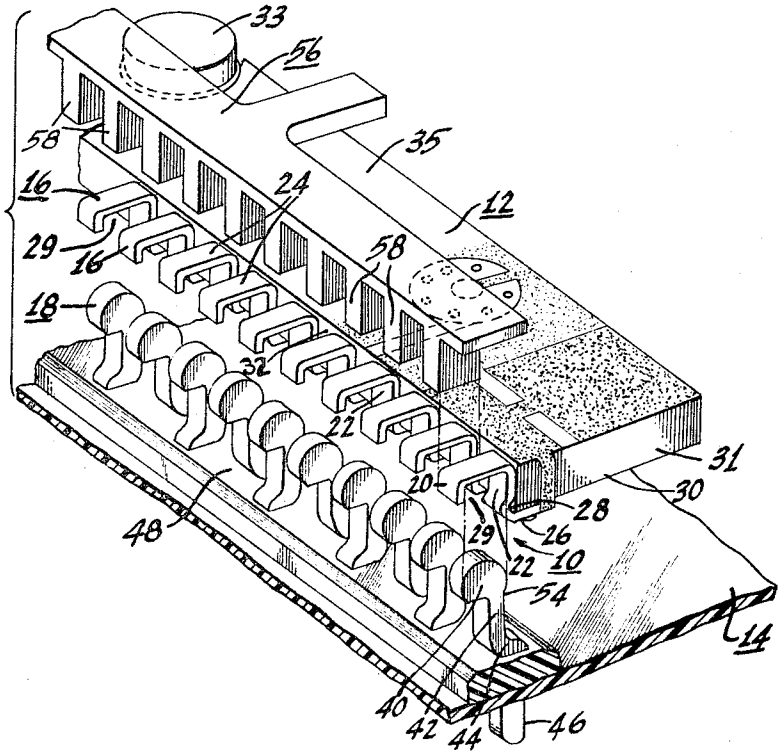
Aug. 23, 1966 M. SILVERBERG 3,268,849

ELECTRICAL CONNECTORS

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Fig. 1.



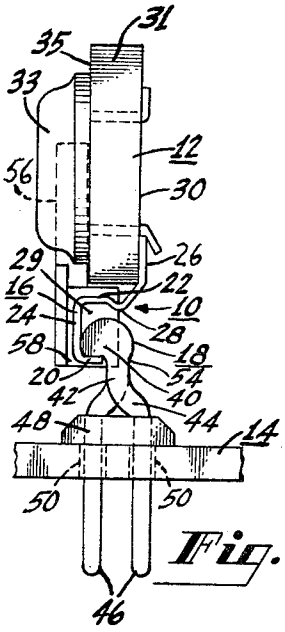


Fig. 2.

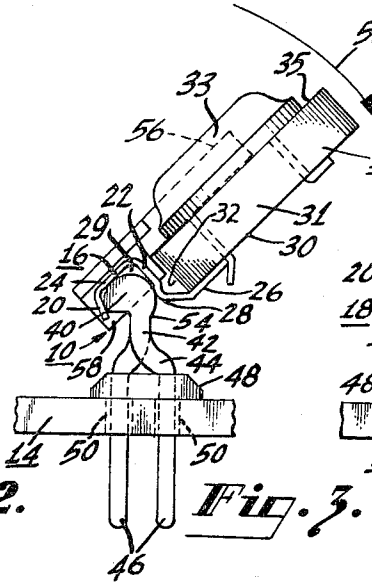


Fig. 3.

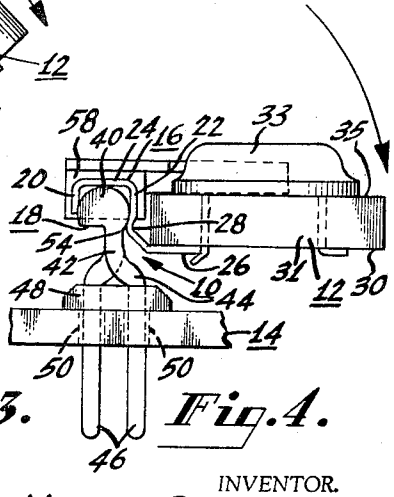


Fig. 4.

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ELECTRICAL CONNECTORS

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Fig. 5.

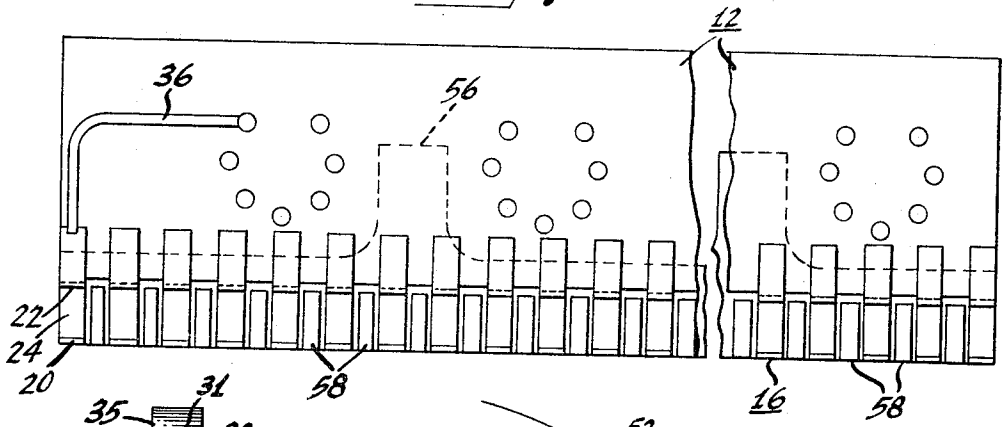


Fig. 6.

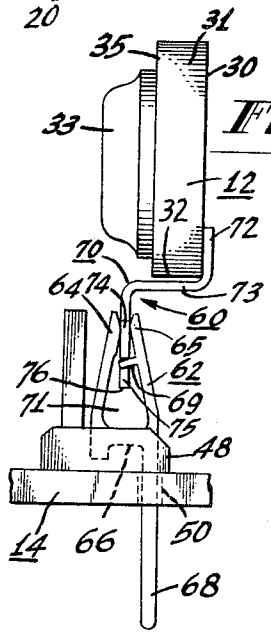


Fig. 7.

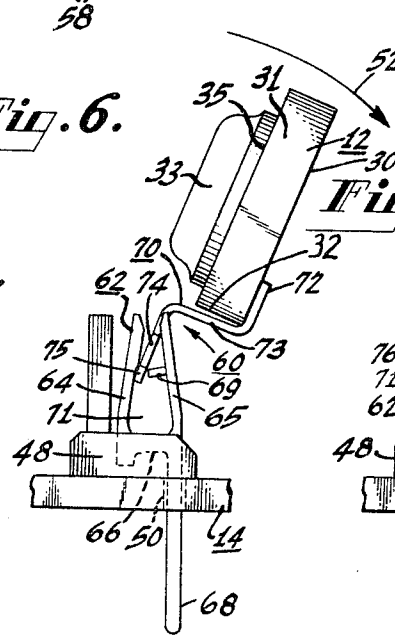


Fig. 8.

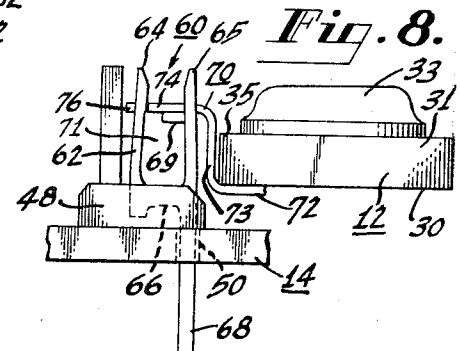
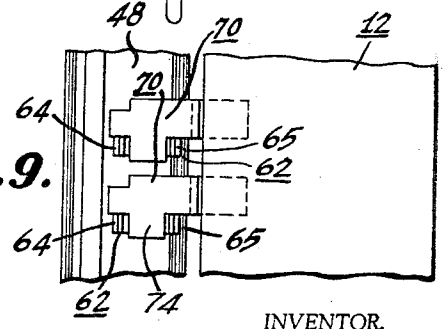


Fig. 9.



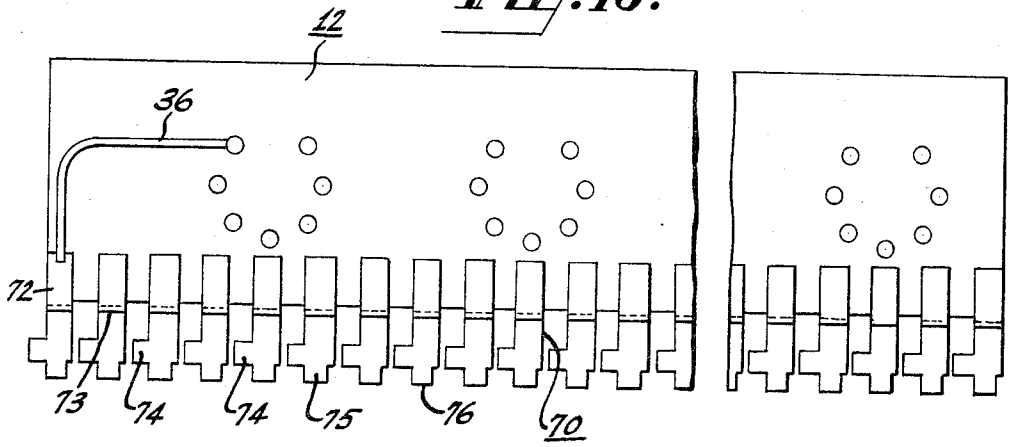
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ELECTRICAL CONNECTORS

Filed July 26, 1963 4 Sheets-Sheet 3

Fig. 10.



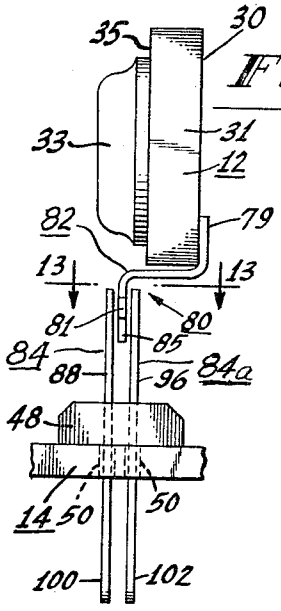


Fig. 11.

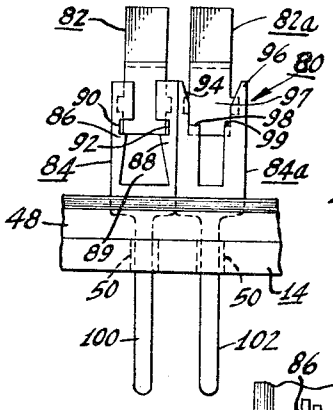


Fig. 12.

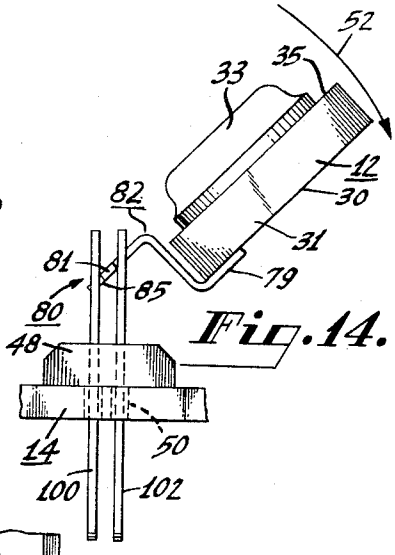


Fig. 14.

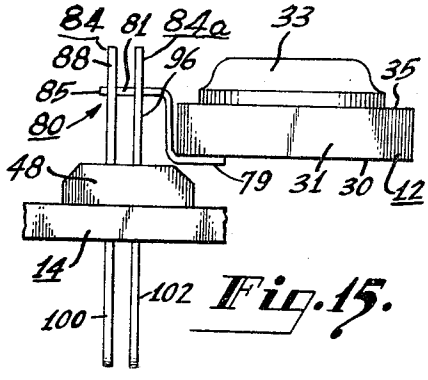


Fig. 15.

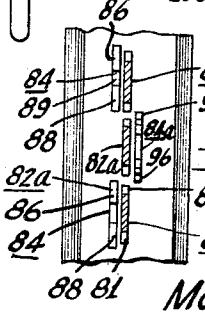


Fig. 13.

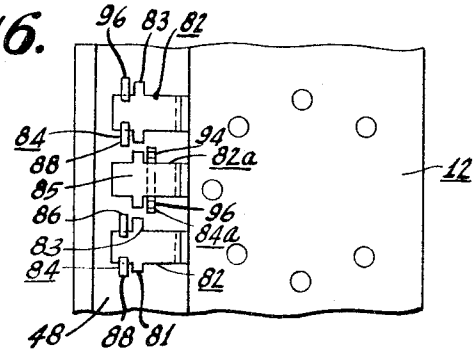
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ELECTRICAL CONNECTORS

Filed July 26, 1963 4 Sheets-Sheet 4

Fig. 16.



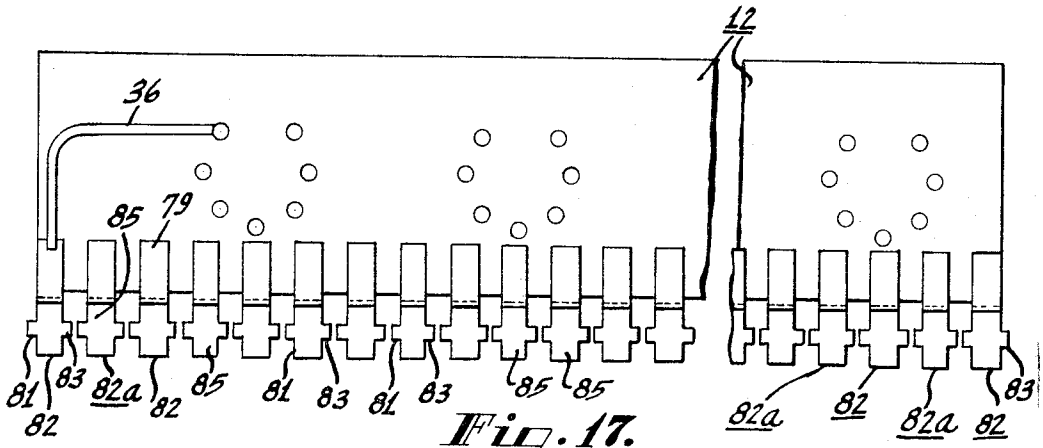


Fig. 17.

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3,268,849

ELECTRICAL CONNECTORS

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Filed July 26, 1963, Ser. No. 297,872
5 Claims. (Cl. 339—182)

This invention relates to electrical connectors that are especially useful with electronic modular structures, and more particularly to electrical connectors for connecting miniaturized electrical modules to printed circuit panels and the like with minimal space requirement.

It has been proposed to connect electrical modules to printed circuit boards by means of connectors of the plug-in type. These prior art connectors usually employ straight pins or rods that are adapted to be engaged within mating receptacles by a pushing action. Where, however, the number of connections to be made simultaneously is relatively large, the force required to make these connections may be considerable. Thus, it is frequently rather unwieldy to effect suitable connection by connectors of the prior art, since the mechanical advantage afforded by these connectors is relatively low. Similar difficulties are also experienced with these plug-in connectors in simultaneously disconnecting a plurality of pins from their mating receptacles.

It is an object of the present invention to provide improved electrical connectors that have a relatively higher mechanical advantage in making the connection than do conventional, prior art, plug-in-type connectors.

A further object of the present invention is to provide improved electrical connectors by means of which connection can be obtained by an easily effected, simple, rotational motion of one of the connector parts with respect to the other.

Another object of the present invention is to provide improved electrical connectors wherein good wiping action is obtained between mating contacts.

Still another object of the present invention is to provide improved electrical connectors that are especially suitable for easily mounting electrical modules to printed circuit boards.

A further object of the present invention is to provide improved electrical connectors that lend themselves to high packaging densities, as required in miniaturized equipment.

Still a further object of the present invention is to provide improved electrical connectors of the type described that are relatively simple in construction and operation, easy to manufacture, and yet highly reliable in use.

Briefly stated, each of the improved electrical connectors of the present invention comprises a cam contact and a resilient contact having a pair of opposite members or parts of which at least one is resilient. The opposite members of the resilient contact define a passageway within which a cam portion of the cam contact may be easily disposed when the latter is in a selected or desired position with respect to the resilient contact. When the cam contact is rotated with respect to the resilient contact, the cam portion of the cam contact cams the resilient members of the resilient contact apart, thereby making a good electrical connection with the resilient contact.

The novel features of the present invention, both as to its organization and method of operation, as well as additional objects and advantages thereof, will be more readily understood from the following description, when read in connection with the accompanying drawings, in which similar reference characters designate similar parts throughout, and in which:

FIG. 1 is a fragmentary, exploded view, in perspective, of one embodiment of electrical connectors according to the present invention for making electrical connections between an electrical module and a circuit board;

FIGS. 2, 3 and 4 are side elevational views of the electrical connector shown in FIG. 1, illustrating different positions of mating contacts in the process of connecting an electrical module to a printed circuit board;

FIG. 5 is a bottom view of the electrical module shown in FIGS. 1–4;

FIGS. 6, 7 and 8 are side elevational views of another embodiment of electrical connectors according to the present invention, illustrating different positions in the process of connecting a module to a printed circuit board;

FIG. 9 is a fragmentary plan view of the module and electrical connectors shown in FIG. 8;

FIG. 10 is a bottom view of the module shown in FIGS. 6–9;

FIG. 11 is a side elevational view of still another embodiment of electrical connectors according to the present invention, illustrating one of the positions in the process of electrically engaging a module to a printed circuit board;

FIG. 12 is a fragmentary, front elevational view of the electrical connectors shown in FIG. 11;

FIG. 13 is a fragmentary, cross-sectional view taken along the line **13—13** of FIG. 11;

FIGS. 14 and 15 are side elevational views of the electrical connectors shown in FIGS. 10–13, illustrating different positions of the mating contacts in the process of electrically connecting a module to a printed circuit board;

FIG. 16 is a fragmentary, plan view of the electrical connectors shown in FIG. 15; and

FIG. 17 is a bottom view of the module shown in FIGS. 11, 14, 15 and 16.

Referring, now, particularly to FIGS. 1, 2, 3, 4 and 5 of the drawings, there is shown one embodiment of a novel electrical connector **10** for connecting an electrical module **12** to a circuit board **14**, such as a printed circuit board. The electrical connector **10** consists of one or more U-shaped resilient contacts **16** affixed to the module **12**, and a corresponding number of relatively rigid cam contacts **18** affixed to the board **14**. The resilient contacts **16** and the cam contacts **18** are mating contacts that are adapted to make an electrical connection between them by a camming action of the cam contacts **18** within the respective resilient contacts **16**, as will be hereinafter explained.

Each resilient contact **16** may be made from an integral strip of resilient metal, such as beryllium copper, for example, and has a pair of opposed resilient members **20** and **22** that are integral with a connecting member **24**, forming a U-shaped contact therewith. The member **22** is also integral with a proximal end member **26**, the latter forming a bend or detent **28** with the member **22** in a direction which tends to narrow the passageway **29** defined by the opposed members **20** and **22**.

The resilient contacts **16** are attached to the lower surface **30** of the electrical module **12** by any suitable means, such as by soldering to a metalized surface of

the module, or by gluing, for example. A plurality of resilient contacts **16** may be attached to the module **12** adjacent to its front edge **32**, as shown in FIGS. 1 and 5, for connections to different parts of the circuitry of the module **12**. The module **12** comprises a base **31** of insulating material, such as a wafer of aluminum oxide. A plurality of electrical components, such as a transistor **33**, for example, can be supported on the upper surface **35** of the module and interconnected on the lower surface **30** to form a desired circuit. Since these interconnections need not be described for an understanding of the present invention, most of them are not shown in the drawings for the sake of clarity. A typical connection between one resilient contact **16** and a component on the module **12** is shown, by way of example, in FIG. 5, by a "printed" or painted conductor **36**.

Each rigid cam contact **18** comprises a head or cam portion **40**, a relatively narrow neck portion **42** extending from the cam portion **40**, and a shoulder portion **44** extending from the neck portion **42**. A straight, relatively narrow terminal portion **46** extends from the shoulder portion **44** and is adapted to function as a stud around which a wire (not shown) may be wrapped for connection thereto. The upper part of the terminal portion **46** is molded into a connector block **48**, and the lower part extends through a hole **50** in the circuit board **14**. The connector block **48** may be secured to the circuit board **14** by any suitable means, as by gluing. A plurality of cam contacts **18** are disposed linearly within the connector block **48**, as shown in FIG. 1, for engaging the resilient contacts **22** on the module **12**. The terminal portions **46** of adjacent cam contacts **18** are offset from each other in order to facilitate making wiring connections to them.

The cam portion **40** of each cam contact **18** has a greater dimension along one direction than along a transverse direction. As seen in FIGS. 1, 2 and 3, for example, the cam portion **40** is shown as having a greater overall width (in a horizontal direction as oriented in the drawing) than height (in a vertical direction). Also, it is eccentric with respect to the neck portion **42**. Because of this eccentricity, the cam portion **40** can be inserted easily into the passageway **29** bebtween the resilient members **20** and **22** of the resilient contact **16**, as shown in FIG. 2. To make a good electrical connection between the resilient contacts **16** and the cam contacts **18**, relative motion is produced between these contacts, as by rotating, for example, the resilient contacts **16** in the direction indicated by the arrow **52** (FIG. 3). This action cams the resilient members **20** and **22** apart. When the plane of the surface of the module **12** is parallel to the plane surface of the circuit board **14**, the detent **28** engages within a notch **54** between the cam portion **40** and the neck portion **42** of the cam contact **18**, as shown in FIG. 4. The resilient members **20** and **22** are thus spread apart by the widest part of the cam portion **40**, providing a good electrical connection between the resilient contact **16** and the cam contact **18**. While, in most cases, it is more convenient to rotate a relatively small module **12** with respect to a relatively larger circuit board **14** to make an electrical connection between their attached contacts **16** and **18**, respectively, it will be understood that the cam contact **18** may also be rotated with respect to the resilient contact **16** to obtain the desired electrical connection.

A comb **56** of plastic material is attached to the upper surface **35** of the module **12** by any suitable means, as by glue. The comb **56** is formed with teeth **58** that extend between adjacent resilient contacts **16** and function as guides for aligning the cam contacts **18** with respective resilient contacts **16**.

Referring, now, to FIGS. 6, 7, 8, 9 and 10, there is shown another embodiment of an electrical connector **60** in accordance with the present invention for connection of the module **12** to the circuit board **14**. The connector **60** comprises a resilient contact **62** having a pair of opposed resilient members **64** and **65** that form a U-shaped structure with a connecting member **66**. A terminal portion **68** of the resilient contact **62** is fixed in the terminal block **48** and extends through the hole **50** in the circuit board **14**, providing means to make electrical connections thereto. A stop tab **69** extends laterally from the member **65** into a passageway **71** defined between the resilient members **64** and **65**.

A cam contact **70** of the electrical connector **60** is formed from an integral, rigid strip of metal that has a proximal end portion **72** fixed to the lower surface **30** of the base **31** of the module **12** by any suitable means. The cam contact **70** has a middle portion **73** that is bent parallel to the front edge **32** of the base **31** and a distal end portion **75** that is bent away from the base **31** and parallel to the upper surface **35** of the base **31**. A cam portion **74** extends laterally from the distal end portion **75** near the distal end **76** of the cam contact **70**, as best seen in FIG. 9.

In order to make an electrical connection between the cam contact **70** and the resilient contact **62**, the cam contact **70** is inserted into the passageway **71** between the resilient members **64** and **65** until the cam portion **74** abuts the stop tab **69**, as shown in FIG. 6. When the module **12** is substantially perpendicular to the circuit board **14**, as shown in FIG. 6, the cam contact **70** fits easily within the U-shaped resilient contact **62**. A good electrical connection can now be made between these contacts by providing relative motion between them, as shown in FIGS. 7 and 8. Thus, by rotating the cam contact **70** in the direction of the arrow **52**, as shown in FIG. 7, the cam portion **74** wipes and spreads apart the resilient members **64** and **66**. When the module **12** is substantially parallel to the circuit board **14**, as shown in FIG. 8, the members **64** and **65** are cammed apart a maximum amount, and the contacts **62** and **70** make a good electrical connection between them.

Referring, now, to FIGS. 11 to 17, there is shown a further embodiment of a novel electrical connector **80** according to the present invention for making an electrical connection between the module **12** and the circuit board **14**. The connector **80** comprises a cam contact **82** that is connected at its proximal end portion **79** to the module **12** by any suitable means. The cam contact **82** has a pair of cross-like arms **81** and **83** extending laterally from its distal end portion **85**. The end portions **85** of the cam contacts **82** comprise cam portions for wiping and camming oppositely disposed resilient members of mating contacts in a manner hereinafter to be described. Alternate ones of the cam contacts **82** are designated with a subscript "*a*," as shown in FIG. 17. Adjacent cam contacts **82** and **82***a* are adapted to engage a pair of U-shaped resilient contacts **84** and **84***a*, respectively.

The resilient contact **84** is a U-shaped contact having a pair of opposed resilient members **86** and **88**. The members **86** and **88** are formed so as to define a passageway **89** therebetween, the lower portion of the passageway **89**, looking at FIG. 12, being wider than the upper portion thereof. The members **86** and **88** are formed with a pair of notches **90** and **92**, respectively, about their middle portions, serving to widen the tapered passageway **89** at the sites of these notches.

The resilient contact **84***a* is also a U-shaped resilient contact having opposed, resilient members **94** and **96**. The members **94** and **96** define a passageway **97** which is widest at the top, looking at FIG. 12, and tapers toward a pair of notches **98** and **99** in the sides of the members **94** and **96**, respectively. The notches **98** and **99** widen the tapered passageway **97** at their sites, and they are disposed at the same height from the connector block **48** as are the notches **90** and **92** in the members **86** and **88**, respectively.

The resilient contacts **84** and **84***a* are arranged in a

sequential, alternate, offset manner. The resilient contacts **84** are disposed in a linear alignment in the connector block **48**, as shown in FIGS. 13 and 16, for example. The resilient contacts **84***a* are also disposed in a linear alignment in the connector block **48**, but they are displaced from the linear alignment of the resilient contacts **84**. This offset arrangement makes it convenient to wrap wires around the terminal ends **100** and **102** of the resilient contacts **84** and **84***a*, respectively.

In order to make an electrical connection between a cam contact **82** and a resilient contact **84** and between a cam contact **82***a* and a resilient contact **84***a*, the cam contacts **82** and **82***a* are disposed between the two, parallel alignments of the two sets of resilient contacts **84** and **84***a*, as shown in FIGS. 11 and 13. In this position, the module **12** is substantially perpendicular to the circuit board **14**. The module **12** is now rotated about an imaginary axis passing through the cross-like arms **81** and **83** in the direction indicated by the arrow **52** in FIG. 14. The cam portion **85** to one side of the arms **81** and **83** of the cam contact **82** extends through, and moves upwardly in, the passageway **89**, cams the members **86** and **88** apart, and comes to rest within the notches **90** and **92**. Simultaneously with the latter action, the cam portion **85** to the other side of the arms **81** and **83** of the cam contact **82***a* enters the passageway **97** between the members **94** and **96** of the resilient contact **84***a*, spreads the members apart, and comes to rest within the notches **98** and **99**, as shown in FIGS. 15 and 16. In the latter position, the module **12** is substantially parallel to the circuit board **14**.

In order to remove the module **12** easily and quickly from the circuit board **14**, in each of the embodiments of the electrical connectors of the present invention, the module **12** is rotated in the direction opposite to that indicated by the arrow **52** until the module **12** is substantially perpendicular to the circuit board **14**. In the latter position, the resilient members of the resilient contacts are substantially unbiased and the module **12** is easily separated from the circuit board **14**, the mating contacts of the electrical connectors being substantially disconnected from each other.

From the foregoing description, it will be apparent that there has been provided a novel electrical connector for interconnecting components that may require a great number of mating connectors with a high mechanical advantage. While only a few examples of the novel electrical connectors have been described herein, variations in their structures and applications, all coming within the spirit of this invention, will, no doubt, readily suggest themselves to those skilled in the art. Hence, it is desired that the foregoing shall be considered as illustrative and not in a limiting sense.

What is claimed is:

1. A connector for electrically connecting a pair of parts comprising: a plurality of cam contacts each having a cam-head with a relatively narrow terminal portion depending from each of said cam-heads, said narrow terminal portions each being adaptable as a stud for wrapping a wire thereabout, a plurality of resilient U-shaped contacts each having a pair of opposed resilient members defining a passageway therebetween, said cam contacts being affixed to one of said parts and said U-shaped contacts being affixed to the second of said parts, each of said cam heads having an eccentric cam portion adapted, in one angular position of said one part with respect to said other part, to fit easily and freely into a separate one of said passageways, each of said cam portions being adapted, in a second angular position of said one part with respect to said other part, to cam said pair of members of that U-shaped contact in whose passageway it fits away from each other, thereby mating said parts.

2. A connector for electrically connecting a pair of parts comprising: a plurality of rigid cam contacts and a plurality of resilient, U-shaped contacts each having a pair of opposed, resilient members defining a passageway therebetween, said cam contacts being linearly affixed to one of said parts, and said U-shaped contacts being linearly affixed to the second of said parts, each of said cam contacts having an eccentric cam portion adapted, in one angular position of said one part with respect to said second part, to fit easily and freely into a separate one of said passageways, each of said cam portions being adapted, in a second angular position of said one part with respect to said second part, to cam said pair of members of that U-shaped contact in whose passageway it fits away from each other, and a comb member fixed to said second part and having teeth extending between said U-shaped contacts.

3. An electrical connector connecting first and second parts, said connector comprising a plurality of rigid cam contacts and a plurality of resilient contacts, each resilient contact being adapted to mate with a separate one of said cam contacts, each of said resilient contacts having a pair of opposed resilient members, each of said cam contacts being defined by two parallel planar surfaces, and edges, with said cam contacts being aligned on said first part and said resilient contacts being aligned on said second part in alignment with said cam contacts on said first part; said pair of members in each of said resilient contacts defining a passageway therebetween for easily receiving a separate one of said cam contacts therein when each of said cam contacts is disposed in a first position with respect to a mating one of said resilient contacts, portions of said edges of each of said cam contacts being formed to cam apart said pair of members in its mating resilient contact by rotation of the cam contact to a second position within said passageway of said mating resilient contact and to releasably and securably engage said members to hold said cam contacts in said second position.

4. An electrical connector connecting first and second parts, said connector comprising a plurality of rigid cam contacts, a plurality of resilient contacts, each resilient contact being adapted to mate with a separate one of said cam contacts, each of said resilient contacts having a pair of opposed resilient members, each of said cam contacts being defined by two parallel planar surfaces, and edges, with said cam contacts being aligned on said first part and said resilient contacts being aligned on said second part in alignment with said cam contacts on said first part; said pair of members in each of said resilient contacts defining a passageway therebetween for easily receiving a separate one of said cam contacts therein when each of said cam contacts is disposed in a first position with respect to a mating one of said resilient contacts, portions of said edges of each of said cam contacts being formed to cam apart said pair of members in its mating resilient contact by rotation of the cam contact to a second position within said passageway of said mating resilient contact and to releasably and securably engage said members to hold said cam contacts in said second position, and a comb member fixed to said second part, said comb member having teeth extending between said resilient contacts.

5. An electrical connector connecting first and second parts, said connector comprising a plurality of rigid cam contacts, a plurality of resilient contacts, each resilient contact being adapted to mate with a separate one of said cam contacts, each of said resilient contacts having a pair of opposed resilient members, each of said cam contacts being defined by two parallel planar surfaces, and edges, with said cam contacts being aligned on said first part and said resilient contacts being aligned on said second part in alignment with said cam contacts on said first part; said pair of members in each of said resilient contacts defining a passageway therebetween for easily receiving a separate one of said cam contacts therein when each of said cam contacts is disposed in a first

position with respect to a mating one of said resilient contacts, portions of said edges of each of said cam contacts being formed to cam a part said pair of members in its mating resilient contact by rotation of the cam contact to a second position within said passageway of said mating resilient contact and to releasably and securably engage said members to hold said cam contact in said second position, and a stop tab extending into said passageway from one of said resilient members intermediate the ends thereof to aid in releasably and securably engaging said members in said second position.

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