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Cutchaw

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[54] **ZERO INSERTION FORCE SOLDERLESS CONNECTOR**

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[52] **U.S. Cl.** ..... **339/75 MP;** 339/176 MP

[51] **Int. Cl.²** **H01R 13/54**

[58] **Field of Search**...339/74 R, 75 R, 75 M, 75 MP, 339/176 MP

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Assistant Examiner—James W. Davie
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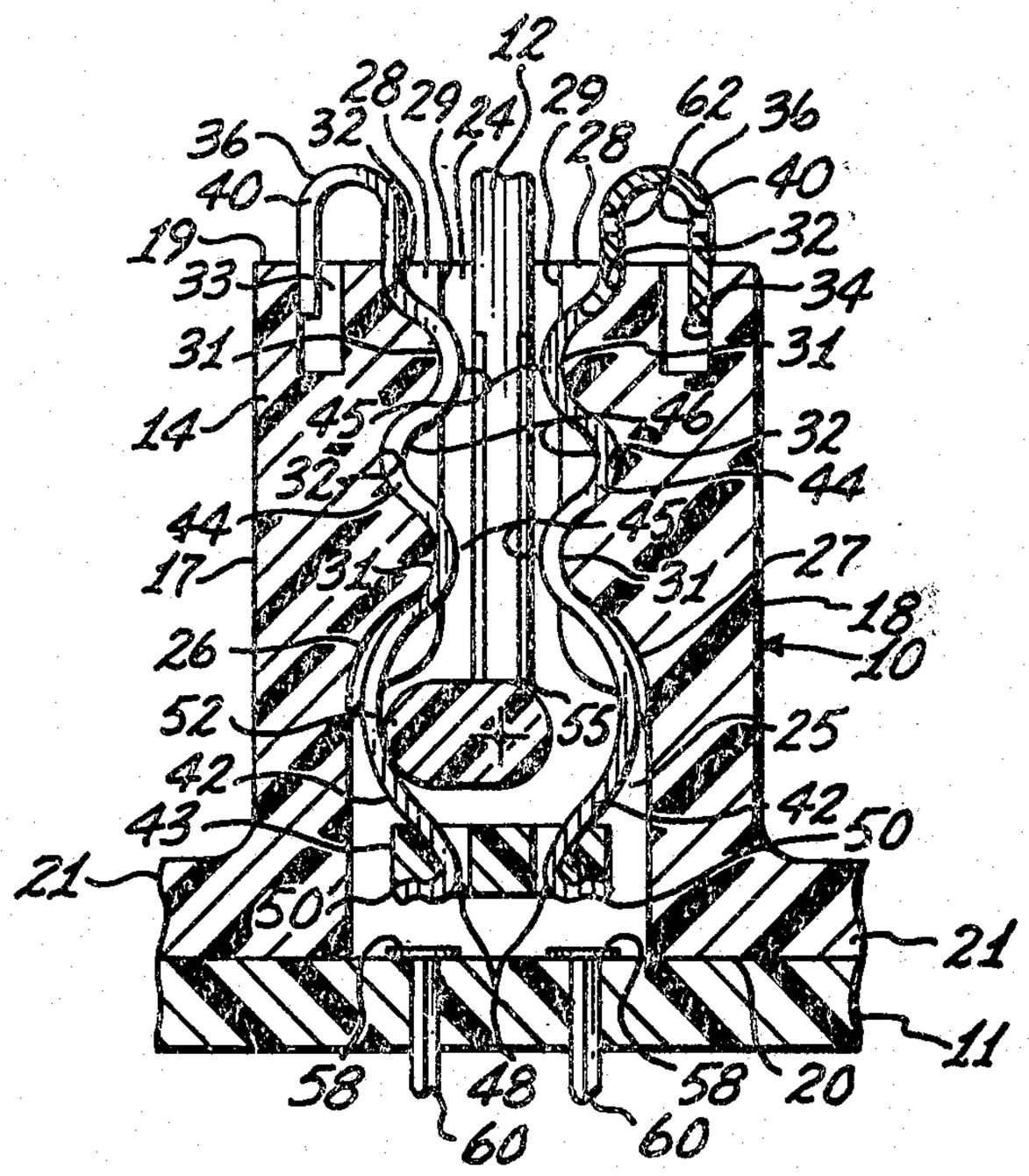
[57] **ABSTRACT**

A connector for electrically interconnecting the conductive terminals of flat electric structures such as circuit boards and backpanels. The connector includes a housing which is carried on the surface of a first one of the flat electric structures and is provided with a slot for demountably receiving one edge of the second electric structure. Interconnecting elements within the connector are in alignment with the conductive terminals of both of the electric structures, and these interconnecting elements are cam actuated between electrically engaged and disengaged positions so that little or no insertion or removal forces are required to plug the second electric structure into the connector and so that all the electrical interconnections are made in a solderless manner.

12 Claims, 7 Drawing Figures



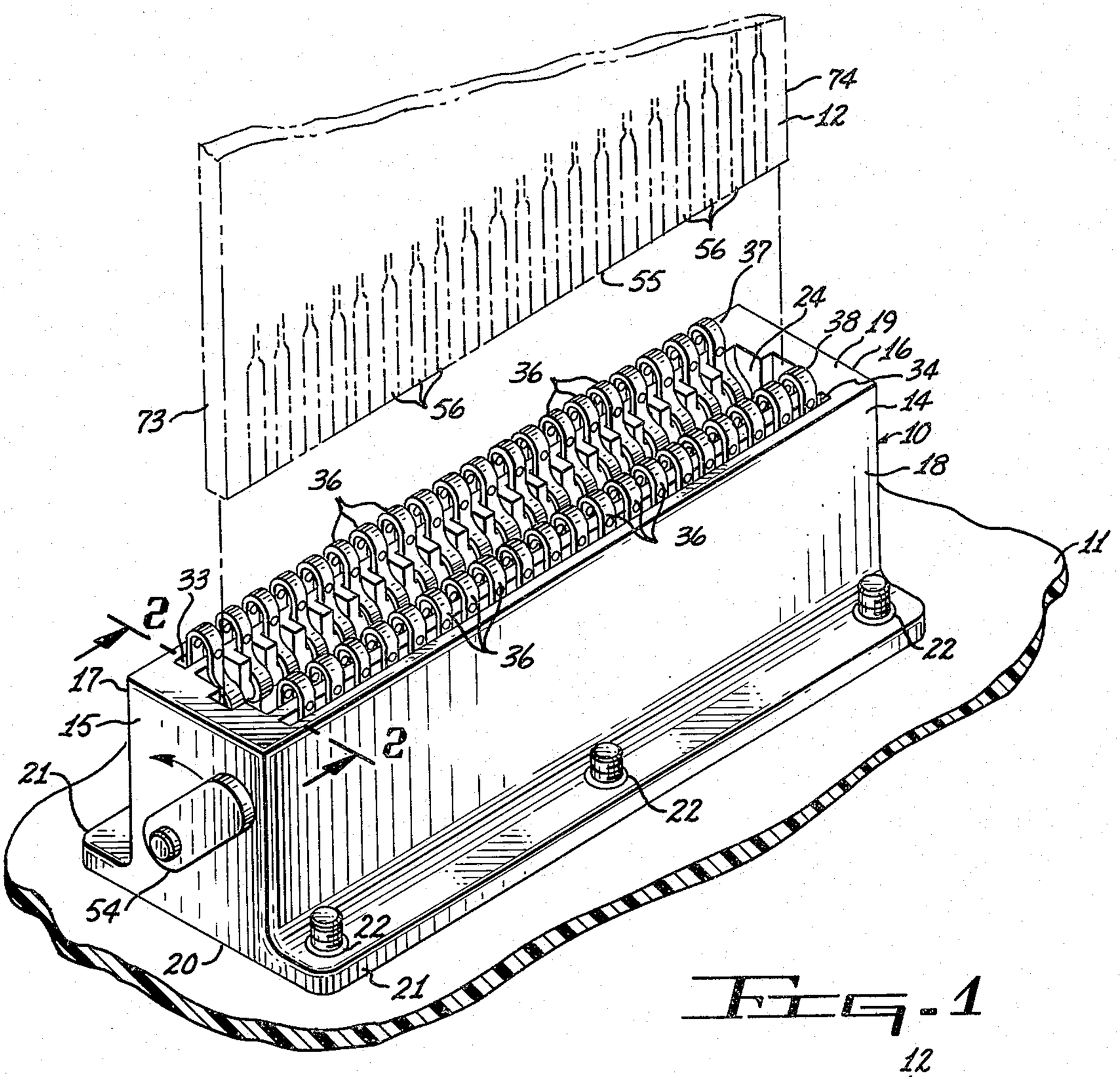


FIG-1

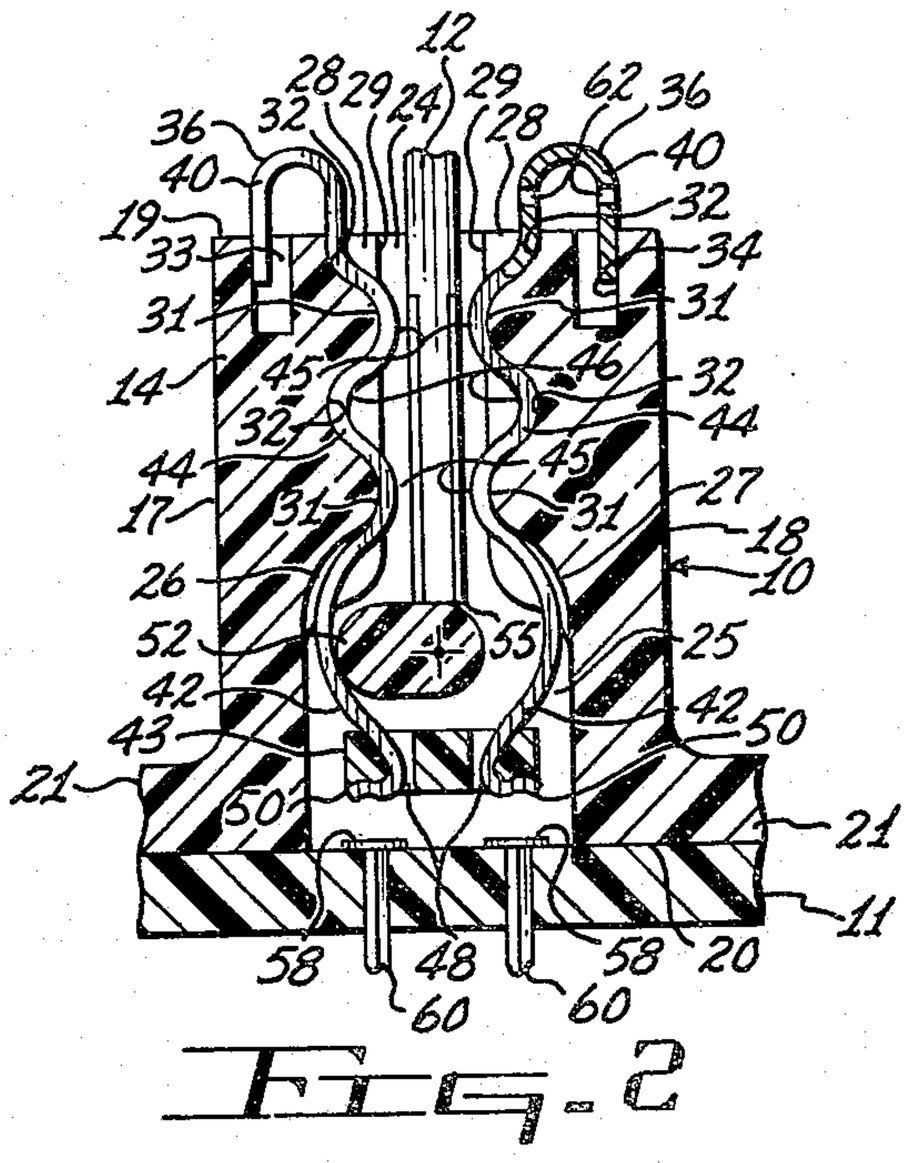


FIG-2

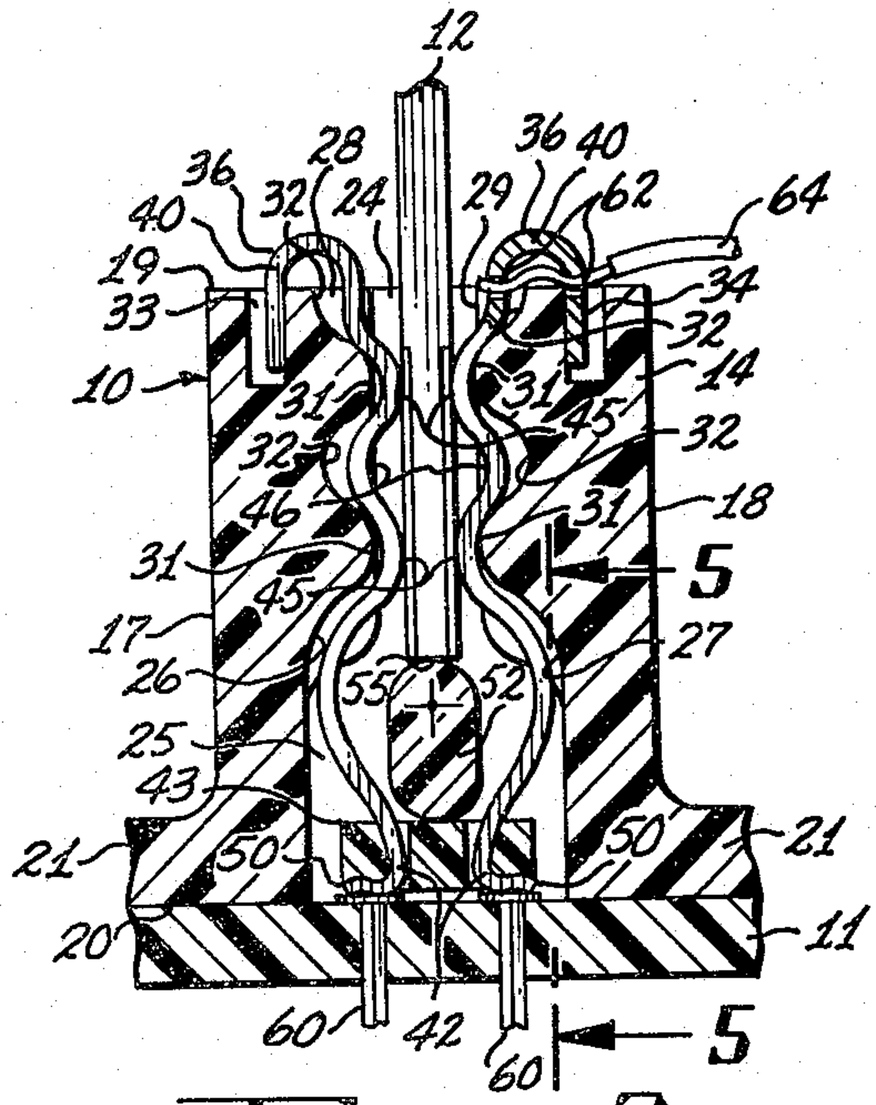


FIG-3

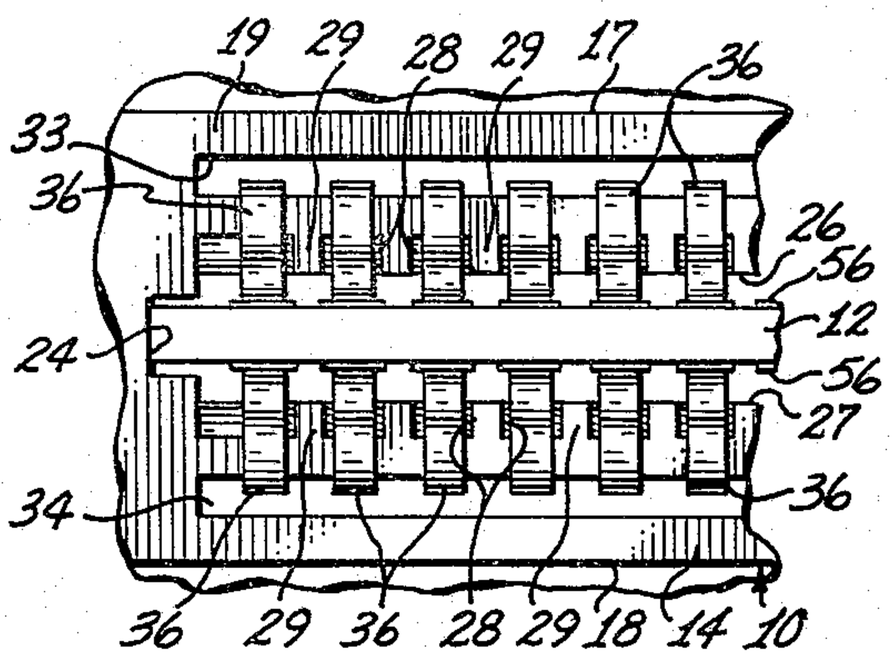


Fig. 4

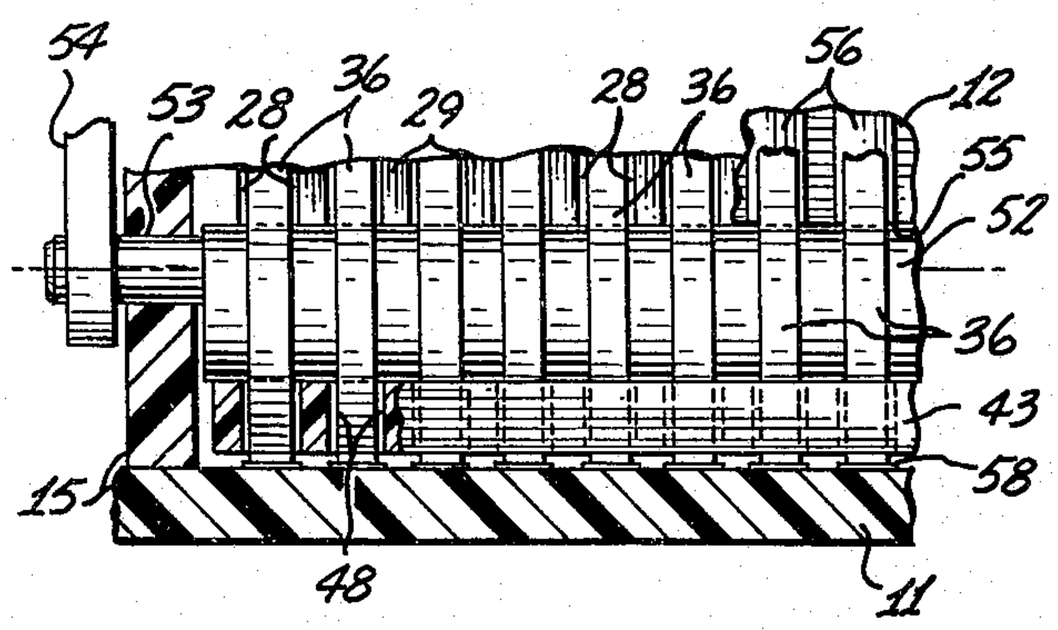


Fig. 5

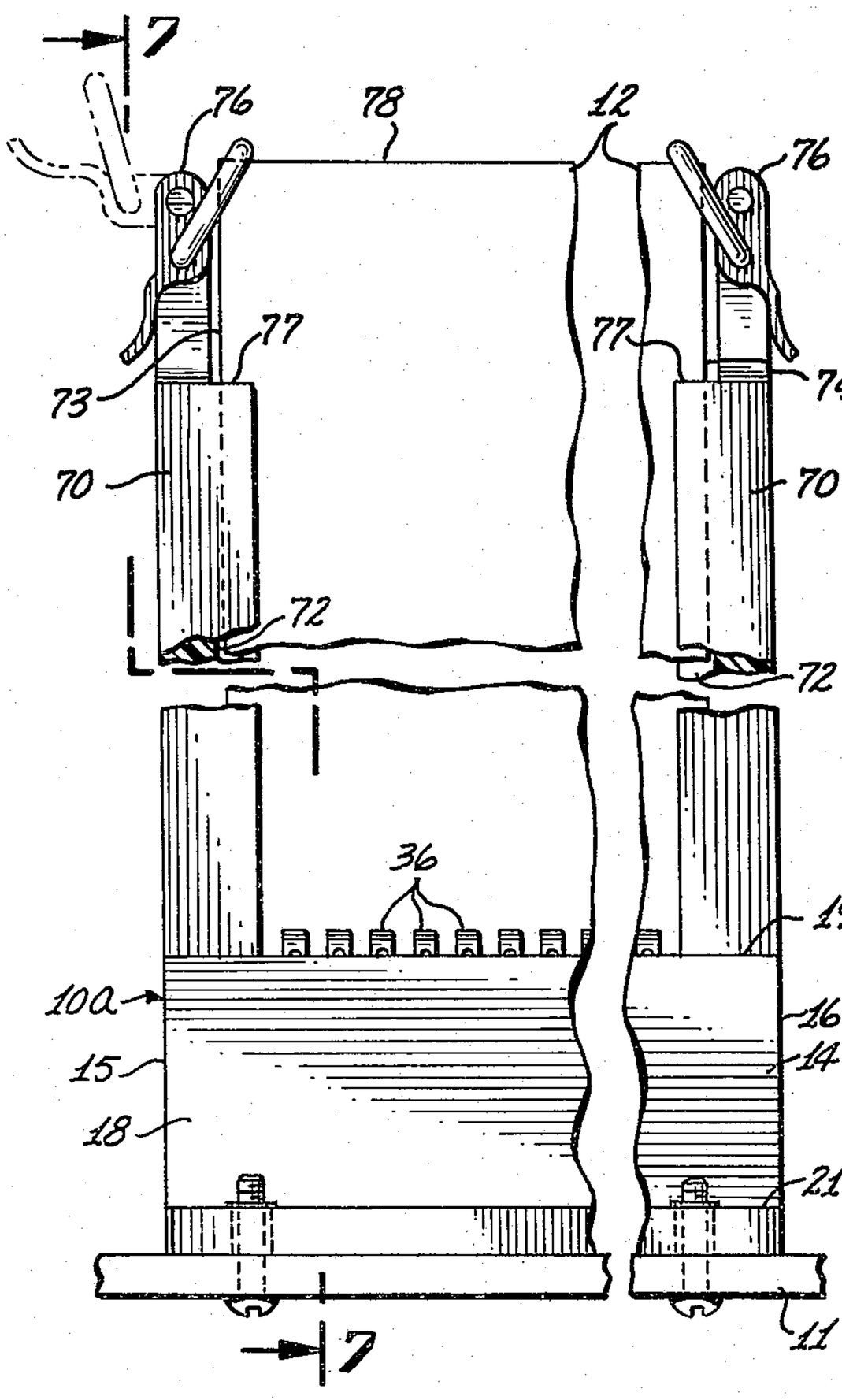


Fig. 6

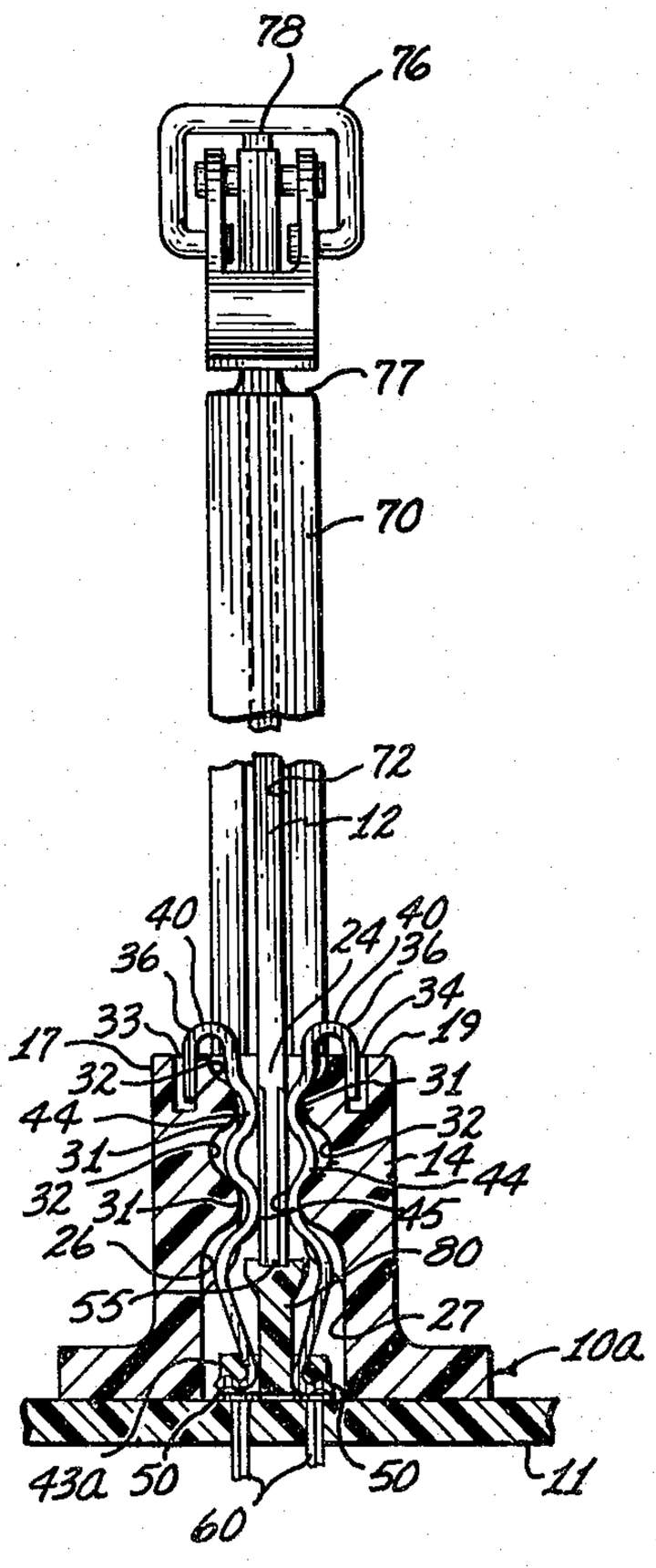


Fig. 7

ZERO INSERTION FORCE SOLDERLESS CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical connectors and more particularly to a zero insertion force connector for solderlessly interconnecting the conductive terminals of flat electric structures.

2. Description of the Prior Art

With the current trends toward miniaturization of electronic elements such as the components, circuitry, and interconnecting cables, many of these elements are now printed, deposited or otherwise formed on one or both sides of a board or other suitable substrate.

The miniaturization itself as well as the various technologies employed in achieving the miniaturization, have resulted in complex problems with regard to the electrical inteconnection of the miniaturized elements.

For example, the electrical interconnection of a printed circuit board and a backpanel is usually accomplished by a mechanism that is simply called a connector. These connectors are formed in various configurations and all serve to mechanically mount the printed circuit board on the backpanel and provide the electrical interconnections therebetween.

These connectors generally include a housing which is bolted or otherwise affixed to the backpanel, and the housing is formed with a longitudinal slot for receiving one edge of the circuit board therein. The connector is provided with a plurality of individual interconnection elements each of which is adapted to suitably contact the backpanel on one end thereof and to suitably contact the printed circuit board on the other end thereof. The electrical connections provided by these interconnection elements are formed in various well known manners with the connections to the backpanel being relatively permanent in comparison to the connections made with the printed circuit board.

In many connector configurations, the interconnection elements are formed so that one end of each element is a wire wrap pin, and these pins protrude through the backpanel and are soldered or otherwise fixed therein. In the case where the backpanel is in the form of printed circuitry, solder connections are made between the interconnection elements and terminal pads provided in the printed circuitry. This technique of forming relatively permanent connections between the connector and the backpanel can cause problems when and if it becomes necessary to replace a faulty or damaged connector. Extreme caution must be exercised when removing a connector affixed to the backpanel as described above so that the entire backpanel won't be ruined.

Connections between these prior art connectors and the printed circuit board are generally made by mechanically biasing the interconnection elements of the connector into engagement with the edge contacts of the printed circuit board. This mechanical biasing force serves two purposes with the first being to provide the electrical connections and the second being to grip the printed circuit board and thus hold the circuit board in the connector. It should be apparent that the biasing force exerted by the interconnecting elements must be relatively high to insure that good conductive contacts are made and maintained.

Techniques are continuously being improved which result in increased miniaturization, thus, more electrical connections are being made in less space than was heretofore possible. This requires that the contact areas of the edge contacts and the interconnection elements must be made smaller and this results in concentration of the contact pressure with the lowering of stress limits. While this concentrated force is desirable when the circuit board is in the connector, it can cause problems when the circuit board is being inserted and removed.

This insertion and removal problem has become so serious that special insertion and removal equipment is often needed so that the number of interconnecting elements won't have to be limited.

Another problem with these prior art connectors is that the contact areas of the edge contacts and the interconnecting elements will rub against each other with considerable force during insertion and removal of the printed circuit board. Since the edge contacts of a typical printed circuit board are only a few thousandths of an inch thick, this rubbing action which occurs during insertion and removal of the printed circuit board tends to wear away the edge contacts and may well ruin a circuit board after several insertions and removals. This rubbing action may also wear away precious metal on the surface of the interconnecting elements which invites corrosion and can result in hard to detect failures of the equipment.

In view of these above stated problems several attempts have been made to produce what has become known in the art as a zero insertion force connector. Generally, these zero insertion force connectors are provided with mechanical actuating mechanisms which move the contact areas of the interconnecting elements out of the insertion and removal path of the printed circuit board and allow the interconnecting elements to move into engagement with the edge contacts after the circuit board has been inserted.

These prior art zero insertion force connectors have not been too successful as many of these connectors employ complex actuating mechanisms which result in costly and bulky connectors. Not only do the connectors tend to defeat the purposes of miniaturization by their bulk, they also tend to be not too reliable. This unreliability stems in some instances from the complexity of the actuating mechanisms, and in other instances from the relatively great distances that the delicate cantilevered interconnecting elements are required to flex without sufficient support to protect them from damage, misalignment and the like.

Therefore, a need exists for a new and improved solderless zero insertion force connector which solves some of the problems of the prior art connectors.

SUMMARY OF THE INVENTION

In accordance with the present invertion, a new and improved solderless zero insertion force connector is disclosed for electrically interconnecting the conductive terminals of two electric structures. The connector includes an elongated housing having a longitudinally extending slot passing transversely therethrough. A plurality of conductive interconnecting elements are arranged within the slot to form two spaced apart parallel rows. The housing is adapted for mounting on the surface of one of the electric structures and to receive the edge of the other electric structure within the slot. The interconnecting elements are movable by means of

a cam actuated draw block. After insertion of the edge of the electric structure into the slot, the cam actuated draw block is manipulated to move the interconnecting elements into conductive contact with the terminals of both of the electric structures. The longitudinal walls of the slot and the interconnecting elements are especially configured so that proper movement of the interconnecting elements can be achieved with a minimum number of moving parts.

Accordingly, it is an object of the present invention to provide a new and improved connector for electrically interconnecting electric structures.

Another object of the present invention is to provide a new and improved solderless connector for electrically interconnecting electric structures.

Another object of the present invention is to provide a new and improved solderless zero insertion force connector for electrically interconnecting electric structures.

Still another object of the present invention is to provide a new and improved solderless zero insertion force connector which is constructed with a minimum number of moving parts.

The foregoing and other objects of the present invention, as well as the invention itself, may be more fully understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of the connector of the present invention having a fragmentary portion of an electric structure upon which the connector is supported and having a fragmentary portion of another electric structure exploded therefrom.

FIG. **2** is an enlarged sectional view taken on the line **2—2** of FIG. **1** and illustrating a first position of the connector of the present invention.

FIG. **3** is a sectional view of the connector of the present invention similar to FIG. **2** and showing a second position of the connector.

FIG. **4** is a fragmentary plan view of the connector of the present invention.

FIG. **5** is a fragmentary sectional view taken on the line **5—5** of FIG. **3.**

FIG. **6** is a front elevational view of a modification of the connector of the present invention.

FIG. **7** is a sectional view taken on the line **7—7** of FIG. **6.**

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in more detail, FIG. **1** shows the solderless zero insertion force connector of the present invention as being designated generally by the reference numeral **10.** In this same figure is shown the first electric structure **11** or back-panel upon which the connector **10** is carried and the second electric structure **12** or printed circuit board which is demountably attachable to the connector **10** as will hereinafter be described in detail.

The connector **10** comprises an elongated housing or connector body **14** formed of insulative material such as a suitable synthetic resin having an appropriate dielectric constant and having a high degree of dimensional stability.

The connector body **14** is formed with end walls **15** and **16,** longitudinal side walls **17** and **18,** a top wall **19** and a bottom wall **20.** Suitable mounting flanges **21** are

formed integral with the body **14** and extend laterally therefrom proximate the bottom of the body. It should be noted that the flanges **21** may be formed to extend as shown, or alternately may extend from the end walls **15** and **16** (not shown) and in either case may be provided with suitable nuts **22** captively embedded therein.

An elongated slot **24** is formed in the body **14** and extends along the length thereof. The slot **24** passes through the body **14** transversely with respect to the longitudinal axis from the top wall **19** to the bottom wall **20.** As best seen in FIGS. **2** and **3,** the slot **24** is enlarged proximate the bottom wall **20** to provide an enlarged cavity **25** which extends longitudinally of the housing. The side walls **26** and **27** of the slot **24** are each formed with a series of vertically disposed grooves **28** therein which are separated from each other by divider ribs **29.** The grooves **28** extend downwardly from the top wall **19** of the body **14** and terminate just above the enlarged cavity **25.** The inwardly facing surfaces which form the bottom of each of the grooves **28** is undulated to provide a vertically disposed alternating series of convex portions **31** and concave portions **32.**

The top wall **19** of the connector body **14** is provided with a pair of longitudinally extending shallow channels **33** and **34** which are disposed on opposite sides of the centrally located slot **24** and are parallel therewith.

A connector strip **36,** or interconnecting element, is positioned within each of the grooves **28** formed in the connector body **14** for electrically interconnecting the backpanel **11** and the printed circuit board **12** as will hereinafter be described in detail. The strips **36** may be formed of any suitable electrically conductive material such as copper plated spring steel, beryllium copper, phosphor bronze and the like, and may be gold plated to avoid difficulties due to corrosion and to assure low resistance electrical connections. Placement of one of the strips **36** within each of the grooves **28** may be seen in FIG. **1** to provide two longitudinally extending parallel rows **37** and **38** of the strips.

Each of the conductor strips **36** is formed with a hook shaped upper portion **40** which extends from the central slot **24** and curves outwardly and downwardly into the appropriate one of the shallow channels **33** or **34.** The opposite end **42** of each of the strips **36** is connected to a draw block **43** as will hereinafter be described in detail. Each of the connector strips **36** is configured intermediate the ends thereof into an undulating shank **44** which is of substantially the same configuration as the undulating surface of the grooves **28.** In other words, the shank **44** of each of the connector strips **36** is shaped to provide a vertically disposed alternating series of what may be referred to as contact areas **45** and recesses **46.**

The lower ends **42** of the connector strips **36** extend through apertures **48** provided in the draw block **43** and are curved outwardly to secure the strips **36** to the draw block **43** and also form dual contact terminal pads **50** which are movable into and out of contact with the backpanel **11** as will be described. The draw block **43** may be fabricated of an insulative material similar to the material previously described for use in the fabrication of the connector body **14,** and is an elongated structure having an aperture **48** formed therein which aligns with each of the connector strips **36.**

As best seen in FIGS. **2, 3,** and **5,** and actuating cam mechanism **52** is provided within the connector body **14** for moving the draw block **43** and connector strips

36. The cam **52** is suitably jounaled for rotation in the end walls **15** and **16** (one shown) as at **53** and is provided with an actuating lever **54** on one end thereof which extends through the end wall **15** so as to position the lever **54** externally of the connector body **14.** The cam mechanism **52** is rotatably movable through approximately 90° of rotation from a disengaged position shown in FIG. **2** to an engaged position shown in FIG. **3.**

In the disengaged position of the cam mechanism **52,** the draw block **43** will be in the up position and the undulatory shanks **44** of the connector strips **36** will be nestibly aligned in contiguous engagement with the undulatory surfaces of their respective ones of the grooves **28.** Thus, it may be seen that the distance between the rows **37** and **38** of connector strips **36** will be at a maximum, that is, the strips **36** are displaced from the center of the slot **24** so that the edge **55** of the printed circuit board **12** (FIG. **1**) may be inserted therebetween with what is referred to as zero insertion force.

After the edge **55** of the printed circuit board **12** is inserted centrally of the slot **24** between the rows **37** and **38** of the connector strips **36** so that the edge terminals or finger contacts **56** of the circuit board **12** are each in alignment with a particular one of the connector strips **36,** the cam mechanism **52** may be rotated to the engaged position shown in FIG. **3.** As is well known in the art, the finger contacts **36** are applied to one or both surfaces of the circuit board and are pretty much a standard throughout the industry. When actuated, the cam mechanism **52** will move into engagement with the draw block **43** and cause it to move downwardly in a direction toward the backpanel **11.** The downward movement of the draw block **43** simultaneously brings the connector strips into conductive contact with the printed circuit board **12** and the backpanel **11.**

The downward movement of the draw block **43** moves the dual contact pads **50** of the connector strips **36** into conductive contact with the terminals **58** provided on the backpanel **11.** These terminals **58** may be formed on the backpanel **11** in various ways well known in the art such as being integrally formed as part of printed circuitry (not shown) or as part of wire wrapping pins **60** shown in FIGS. **2** and **3.** The pads **50** are formed into dual contacts so as to ensure a redundant electric connection.

The downward movement of the draw block **43** will also move each of the connector strips **36** relative to the undulatory surface of their respective ones of the grooves **28,** so that the undulatory shanks **44** of the strips **36** will move out of the nesting engagement with the undulatory surfaces of the grooves **28.** Therefore, a misalignment of the undulatory shanks **44** with the undulatory surfaces occurs when the draw block **43** is moved down, and such misalignment produces a downwardly angularly inwardly directed resultant movement of the shanks **44** which brings the contact areas **45** thereof into conductive contact with the edge contacts **56** of the circuit board **12.**

It will be noted tht the undulatory configuration of the shanks **44** of strips **36** will result in at least two points of contact, that is, at least two contact areas **45** will be brought into engagement with the edge contacts of the printed circuit board, thus ensuring a good electric contact. Also, when the contact areas **45** are being brought into engagement with the edge contacts, a mild wiping action will occur due to the angular approach and thus, any corrosion or other contamination existing on either the finger contacts **56** or the contact areas **45** will be pushed aside to ensure a clean contact. This same type of mild wiping action will occur between the dual contact pads **50** of the connector strips **36** and the terminals **58** of the backpanel **11** due to the movements of the connector strips **36** when engaging the printed circuit board **12.**

As seen best in FIG. **2** and **3,** the hook shaped upper portions **40** of the connector strips **36** are provided with connector means which may take the form of a pair of aligning apertures **62.** One of these apertures **62** being formed in that portion of the hook **40** which extends upwardly out of the slot **34** with the other one of the apertures **62** being formed in that portion of the hook **40** which extends downwardly into the appropriate one of the shallow channels **33** or **34.** In the upwardly disposed position of the connector strips **36** as shown in FIG. **2,** the apertures **62** are spaced above the top wall **19** of the connector body **14.** In the actuated or downwardly disposed position of the connector strips **36,** the apertures **62** are positioned substantially even with or somewhat below the top wall **19.** Thus, as shown in FIG. **3,** a wire **64** or other suitable device for making a temporary connection, may be inserted through the apertures **62** and will become firmly clamped therein when the connector strips are moved into the down or engaged position. This may be considered an additional feature of the connector **10** of the present invention and may be employed as desired for test probe or circuit modification purposes.

Referring now to FIGS. **6** and **7** wherein a modified form of the connector of the present invention is shown and is indicated generally by the reference numeral **10a.** In this embodiment, the connector body **14** is provided with a guide standard **70** on each of its opposite ends. The standards **70** are formed with channels **72** therein for slidably receiving the opposite side edges **73** and **74** of the printed circuit board **12.** A clamp means **76** is provided on the extending end **77** of each of the standards **70** which is movable into or out of engagement with the top edge **78** of the printed circuit board **12** as shown in solid and dashed lines in FIG. **6.**

The draw block **43***a* provided within the enlarged cavity **25** of the connector body **14** is coupled to the conductor strips **36** as described in the previous embodiment and both the block **43***a* and the strips **36** function in the same manner. However, the draw block **43***a* is formed with centrally located upwardly extending pedestal **80** which extends along the length of the draw block **43***a*.

Therefore, insertion of the edge **55** of the printed circuit board **12** into the slot **24** between the rows **37** and **38** of the strips **36** will bring the edge **55** into engagement with the pedestal **80** and thus cause the draw block **43***a* to move downwardly. It may now be seen that the actuation of the connector **10***a* is accomplished by the circuit board itself, in combination with the clamping action provided by the clamp means **76,** and this combination will maintain the engaged position of the connector strips **36.**

While the principles of the invention have now been made clear in an illustrated embodiment, there will be immediately obvious to those skilled in the art, many modifications of structure, arrangements, proportions, the elements, materials, and components used in the practice of the invention, and otherwise, which are particularly adapted for specific environments and opera-

tion requirements without departing from those principles. The appended claims are therefore intended to cover and embrace any such modifications within the limits only of the true spirit and scope of the invention.

What I claim is:

1. A connector for electrically interconnecting a first and a second electric structures comprising:

a. an elongated body having a top wall and a bottom wall with a slot communicating therebetween, said body adapted for mounting on a surface of the first electric structure with the bottom wall substantially flush therewith, the slot in said body adapted to receive an edge of the second electric structure centrally therein, at least one of the side walls of the slot in said body being undulatory;

b. at least one conductive strip within the slot of said body and having an undulatory shank which is normally displaced from the center of the slot of said body in nestingly aligned contiguous engagement with the undulatory side wall thereof, said conductive strip having at least one pressure contact area of the undulatory shank thereof and a pressure terminal pad on the end thereof which is positioned adjacent the bottom wall of said elongated body; and

c. means within said body and coupled to said conductive strip for movement thereof toward the bottom wall of said body for moving the pressure terminal pad of said conductive strip into conductive pressure contact with the surface of the first electric structure mounted substantially flush therewith, and for simultaneously moving said conductive strip relative to the undulatory side wall of the slot of said body for moving the undulatory shank of said conductive strip out of its normal contiguous engagement with the undulatory side wall of the slot of said body toward the center of that slot for moving the pressure contact area of said conductive strip into conductive pressure contact with the edge of the second electric structure inserted therein.

2. A connector as claimed in claim **1** wherein the undulatory side wall of the slot of said body is formed in an alternating series of concave and convex portions extending from the top wall of said body at least part way to the bottom wall thereof.

3. A connector as claimed in claim **1** wherein the undulatory shank of said conductive strip is formed in an alternating series of at least one contact area and at least one recess area.

4. A connector as claimed in claim **1** wherein the undulatory shank of said conductive strip is formed in an alternating series of contact areas and recess areas with there being at least two contact areas.

5. A connector as claimed in claim **1** wherein said means comprises:

a. a draw block within the slot of said body adjacent the bottom wall thereof and movable in a direction between the top wall and bottom wall of said body, said draw block having means therein by which said conductive strip is attached thereto; and

b. a cam mechanism with the slot of said body adjacent said draw block, said cam mechanism journaled for rotation into and out of engagement with said draw block for movement thereof.

6. A connector for electrically interconnecting a first and a second electrical structures comprising:

a. an elongated body having a longitudinal slot formed therein which extends between a top wall and a bottom wall of said body, the top wall of said body having a shallow channel formed on each of the opposite sides of the slot and extending parallel therewith, the opposite longitudinal side walls of the slot of said body having an undulatory configuration, said body adapted for mounting on a surface of the first electric structure with the bottom wall substantially flush therewith and for receiving an edge of the second electrical structure centrally within the slot of said body;

b. at least one pair of oppositely positioned conductive strips within the slot of said body, each of said conductive strips having an undulatory shank which is normally nestingly aligned in contiguous engagement with its respective one of the undulatory side walls of the slot of said body for laterally displacing said pair of conductive strips from the center of the slot of said body, each of said pair of conductive strips is formed with a hook shaped member on one end thereof which extends from the slot of said body beyond the top wall thereof and curves outwardly and downwardly into one of said shallow channels, and transverse pressure terminal pads on the opposite ends thereof; and

c. means within the slot of said body and coupled to said pair of conductive strips for movement thereof toward the bottom wall of said body to move the terminal pads of said conductive strips into conductive contact with the surface of the first electric structure mounted substantially flush therewith and for simultaneously moving said pair of conductive strips relative to their respective ones of the side walls of the slot of said body so that the undulatory shanks of said pair of conductive strips will move out of nesting contiguous alignment with the undulatory side walls of the slot of said body toward the center of that slot for conductively contacting the edge of the second electric structure inserted therein.

7. A connector as claimed in claim **6** wherein the undulatory shank of each of said pair of conductive strips is positioned within a groove formed in its respective one of the longitudinal side walls of the slot of said body, each of the grooves extending from the top wall of said body at least part way to the bottom wall thereof, each of the grooves having a bottom surface which faces the center of the slot of said body in which the undulatory configuration of the respective one of the longitudinal side walls is formed.

8. A connector as claimed in claim **6** wherein the hook shaped member formed on one end of each of said conductive strips is provided with means thereon for gripping a temporary electrical connection device when said conductive strips have been moved out of their normal positions of lateral displacement from the center of the slot of said body.

9. A connector as claimed in claim **6** wherein the hook shaped member formed on one end of each of said conductive strips is provided with an aperture in that portion of the hook shaped member which extends from the slot of said body and with an aligning aperture formed in that portion of the hook shaped member which extends downwardly into said one of said shallow channels.

10. A connector as claimed in claim **6** wherein said means comprises:

a. a draw block within the slot of said body adjacent the bottom wall thereof and movable toward and away from the bottom wall of said body, said draw block having an aperture formed therein for each one of said pair of conductive strips; and

b. a cam mechanism within the slot of said body adjacent said draw block, said cam mechanism journaled for rotation into and out of engagement with said draw block for movement thereof.

11. A connector as claimed in claim **10** wherein one end of each of said pair of conductive strips passes through one of the apertures of said draw block and is bent to form the terminal pad which is substantially transverse to the undulatory shank of said conductive strip and is in engagemet with the surface of said draw block which is adjacent the bottom wall of said body for affixation of said conductive strip to said draw block.

12. A connector for electrically interconnecting a first and a second electrical structures comprising:

a. an elongated body having a top wall and a bottom wall with an elongated slot communicating therebetween, said body adapted for mounting on a surface of the first electric structure with the bottom wall substantially flush therewith, the slot in said body adapted to receive one edge of the second electric structure therein, the opposite longitudinal side walls of the slot of said body being undulatory;

b. at least one pair of oppositely positioned conductive strips within the slot of said body, each of said conductive strips having an undulatory shank which is normally nestingly aligned in contiguous engagement with its respective one of the undulatory side walls of the slot of said body for laterally displacing said pair of conductive strips from the center of the slot of said body, each of said conductive strips having a terminal pad formed on the one end thereof which is adjacent the bottom wall of said body, said terminal pads transverse with respect to their respective ones of said pair of conductive strips;

c. a draw block within the slot of said body adjacent the bottom wall thereof, said draw block having each of said pair of conductive strips affixed thereto so that the terminal pads thereof are in engagement with the surface of said draw block which is adjacent the bottom wall of said body said draw block adapted for movement toward the bottom wall of said body to bring the terminal pads of said pair of conductive strips into conductive contact with the surface of the first electric structure mounted substantially flush therewith and for simultaneously moving said pair of conductive strips relative to their respective ones of the side walls of the slot of said body so that the undulatory shanks of said pair of conductive strips will move out of nesting contiguous alignment with the undulatory side walls of the slot of said body toward the center of that slot for conductively contacting the edge of the second electric structure insertable therein;

d. a pair of standards each extending from a different one of the opposite ends of the top wall of said body, said standards adapted to slidingly engage the opposite side edges of the second electric structure for supportingly guiding that structure into the center of the slot of said body and into engagement with said draw block when the second electric structure is inserted therein; and

e. clamp means on the extending end of each of said standards for movement into and out of engagement with the second electric structure inserted within the slot of said body, said clamp means adapted to hold the second electric structure in engagement with said draw block for moving said draw block toward the bottom wall of said body.

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