United States Patent

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[15] **3,656,183**

[45] **Apr. 11, 1972**

[54] CONNECTOR ASSEMBLY

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[22] Filed: **Feb. 3, 1970**

[21] Appl. No.: **8,352**

[52] **U.S. Cl.** .....**339/17 CF,** 339/19, 339/92 M, 339/112 R, 339/174, 339/176 MP

[51] **Int. Cl.** **H01r 13/00,** H01r 13/54

[58] **Field of Search** .....339/17 C, 17 CF, 17 F, 17 L, 339/17 LC, 17 LM, 19 R, 22 B, 75 M, 75 MP, 91 R, 91 L, 92, 95, 112 R, 174, 176 M, 176 MF, 176 MP; 317/100, 101 A, 101 C, 101 CC, 101 OE; 174/DIG. 3, DIG. 5

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[57] **ABSTRACT**

Apparatus for enabling the rapid installation of dual-in-line type integrated circuit modules in an electronic system, including a male connector frame which fits into a female frame to hold a set of circuit modules between them, the female frame being easily connected to the electronic system. The male and female frames each have many corresponding recesses, and have resilient conductive elements in the recesses. The circuit modules are first installed on the male frame with their leads lying over the elements in the male frame recesses. When the male frame is inserted into the female frame, the module leads are trapped between the elements on the male and female frames. The male frame is constructed of plastic material, and the bodies of the circuit modules are held thereon between an elongated heat sink that lies close to the male frame and a retainer member on a side of the modules opposite the heat sink.

10 Claims, 11 Drawing Figures

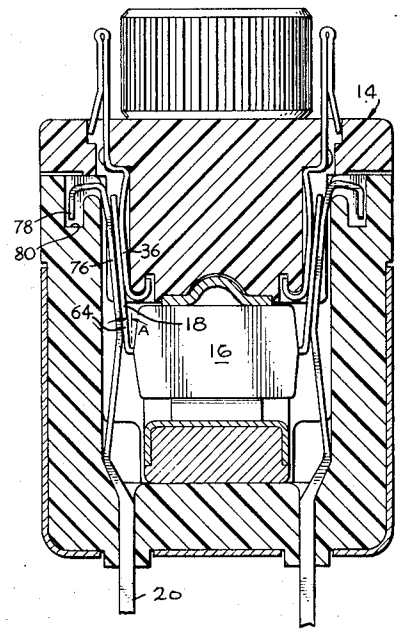


Fig. 1

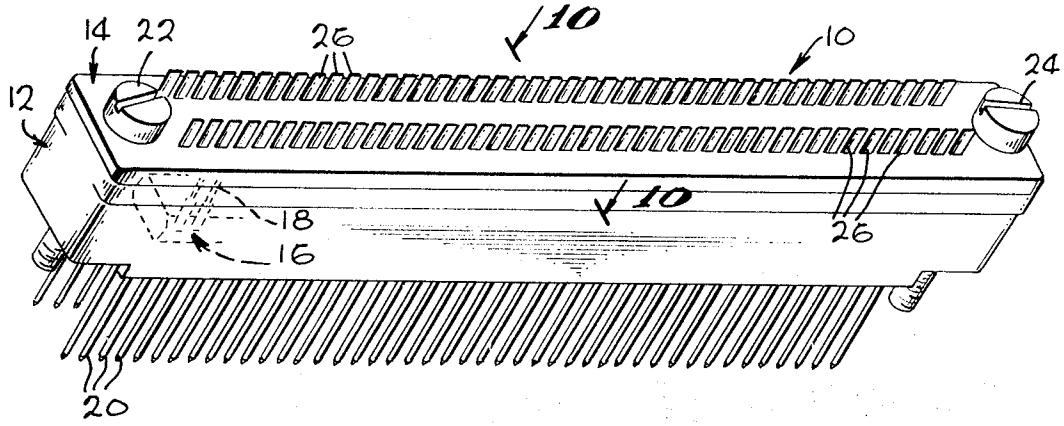
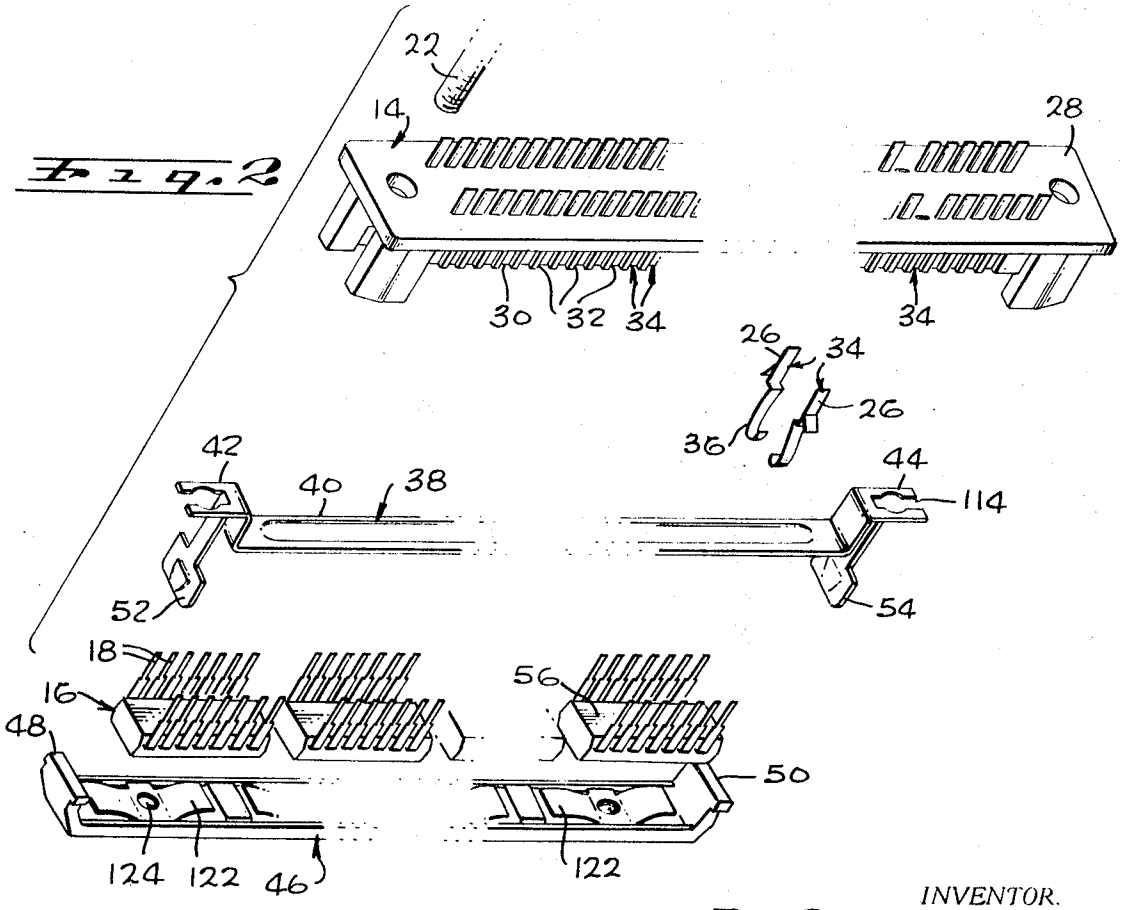
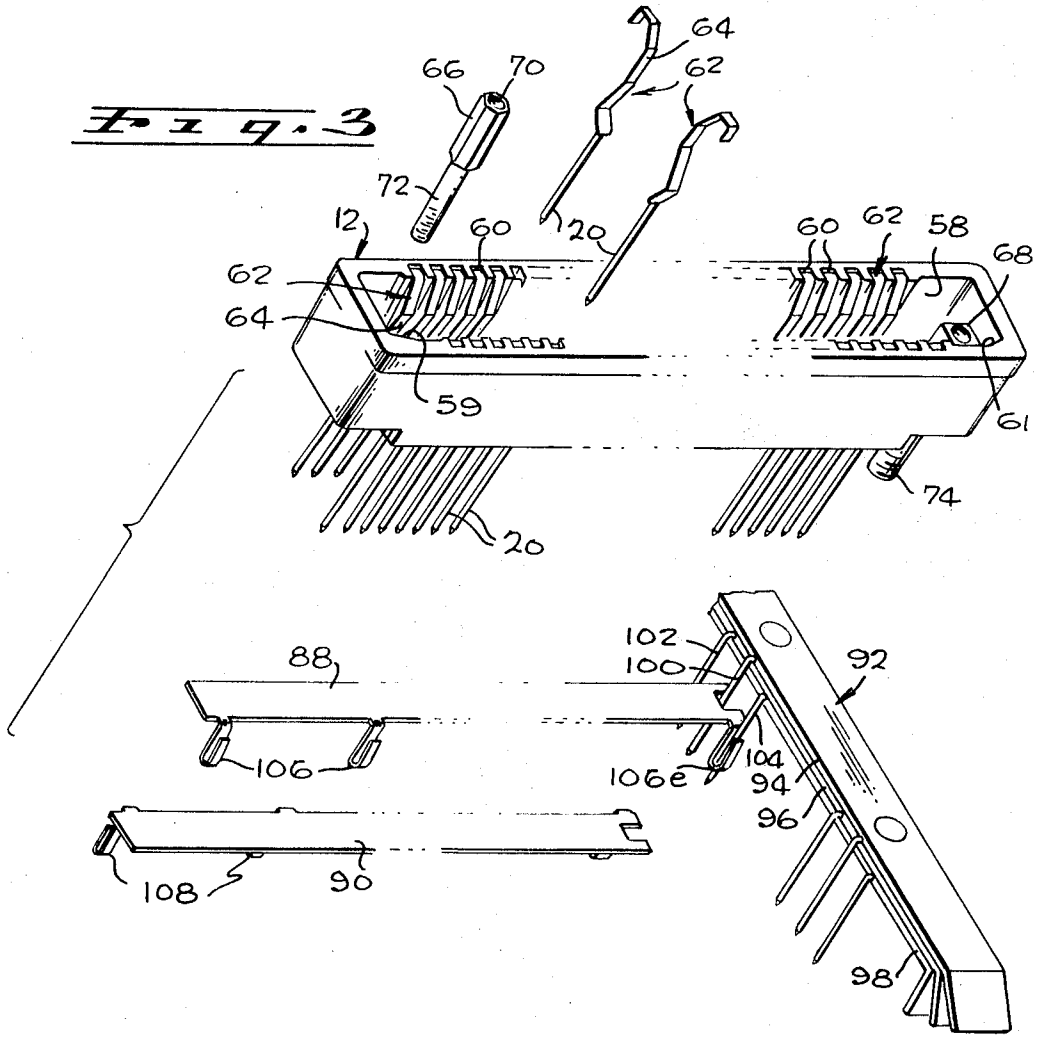


Fig. 2



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Fig. 3



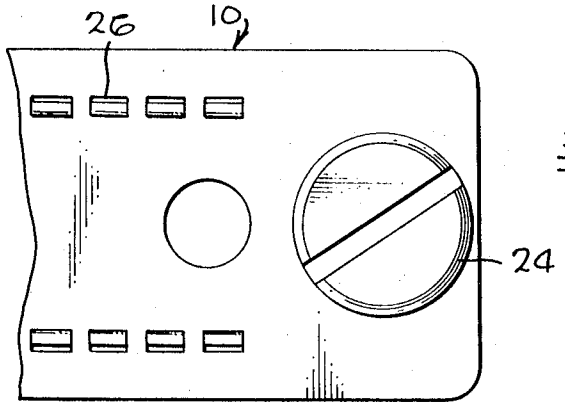


Fig. 4

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Fig. 5

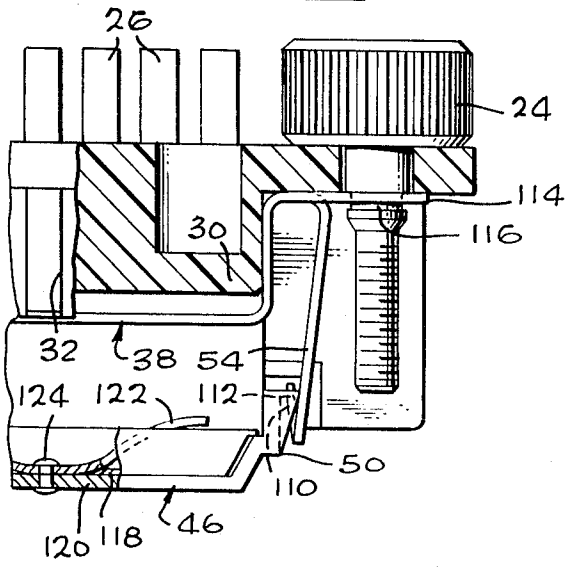


Fig. 8

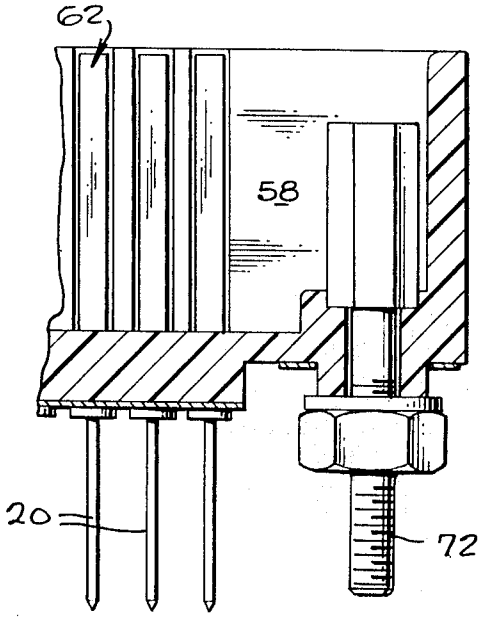


Fig. 6

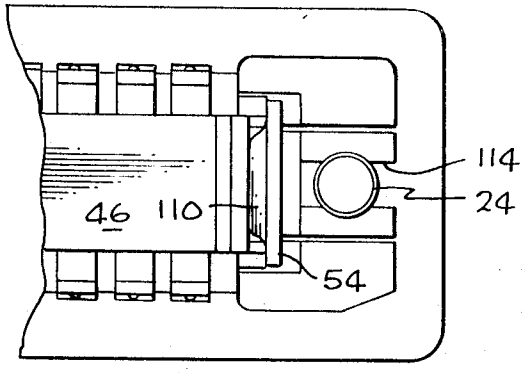


Fig. 9

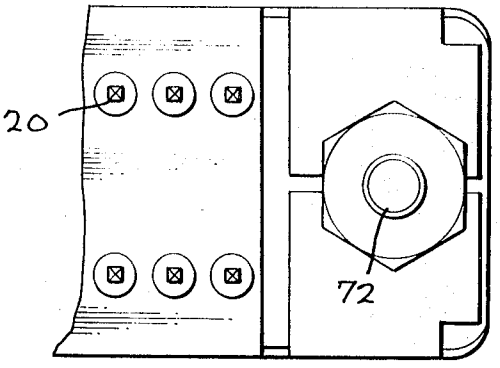
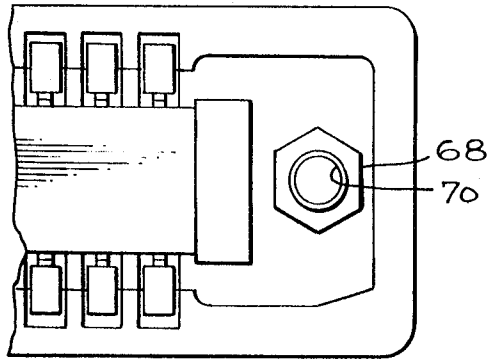


Fig. 7



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Fig. 11

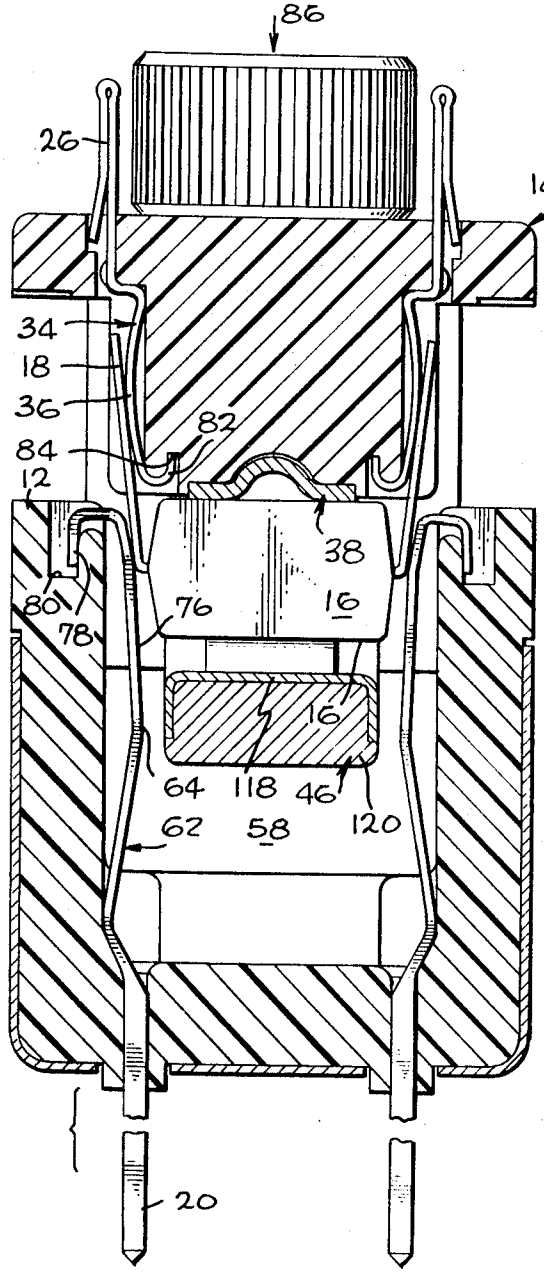
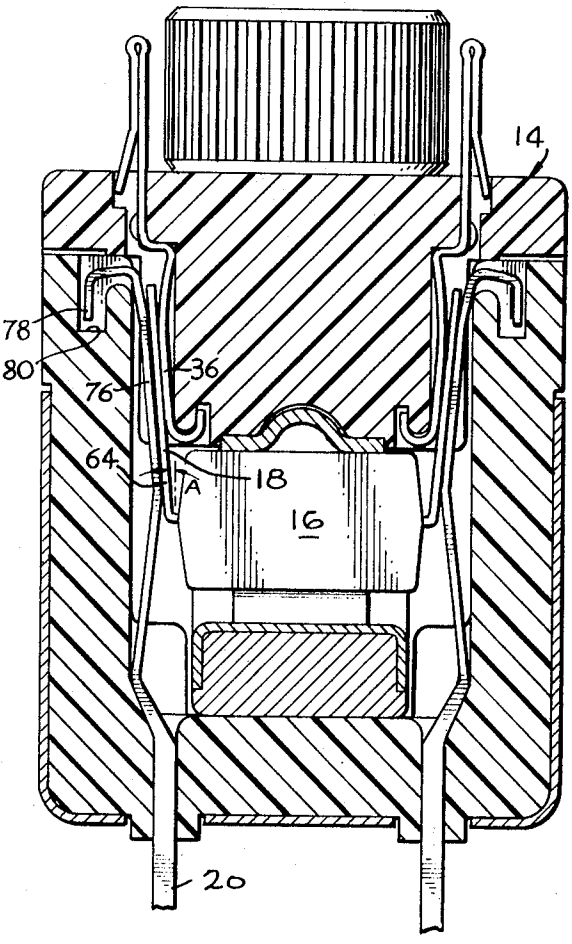


Fig. 10



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CONNECTOR ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to connector assemblies for facilitating the installation of integrated circuit modules in a complex electrical system.

2. Description of the Prior Art

Complex electrical apparatus, such as digital computers, are often constructed using integrated circuit modules. One common type of module form is the dual-in-line type wherein each module has a body and electrical leads extending above the upper face of the body. The circuit modules are generally constructed in a standard size and shape, although the thicknesses of different modules may vary somewhat. Inasmuch as a computer may utilize many of such modules, it is necessary to provide simple mounting apparatus for them to enable connection of the leads of the modules to each other and to various inputs and outputs of the electrical system.

One type of connector assembly includes male and female connector frames for trapping several circuit modules between them, with the leads of the module pressed against contact elements in the female frame. The contact elements have pins extending from the frame, which can be easily connected to the rest of the electrical system. A connector assembly typically holds up to five circuit modules, each module having either 14 or 16 leads, for a total of 70 to 80 leads that must be connected in the system. The complete electrical system may employ hundreds of such connector assemblies. In order to permit rapid installation and removal of the modules, no soldering or the like is employed. The ability to economically construct complex electrical systems using large numbers of such modules, depends upon the provision of connector assemblies which assure reliable, low resistance connections with modules which are merely laid in place.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention is to provide a highly reliable connector assembly for circuit modules.

Another object is to provide a connector assembly for circuit modules which reliably holds modules of a variety of thicknesses and effectively dissipates heat from the modules.

In accordance with one embodiment of the invention, a connector assembly is provided which includes female and male connector frames, for holding integrated circuit modules between them. The female frame has numerous recesses on its inner region and the male frame has corresponding recesses along the portion received in the female frame. A first group of resilient contact elements is disposed in the recesses of the female frame, and a second group of resilient contact elements is disposed in the recesses of the male frame. The male frame is constructed to hold a circuit module so that the leads lie over its contact elements. Thus, when the male frame is inserted into the female frame, the leads of the circuit module are held between the resilient elements of the two frames.

The resilient contact elements on the male and female frames have portions that extend to positions outside of the frames, which enables a functional test for contact between the circuit module leads and the contact elements. Such a test is made by measuring the resistance between portions of corresponding male and female contact elements that lie outside the frames. These same extending contact elements may be used for integrating discrete electrical components into the system or for additional connecting wiring.

A heat sink is provided on the male frame, the heat sink being a strip of thermally conductive material with its ends in contact with screws that hold the frames together and to a mounting panel. The circuits are mounted against the heat sink strip and are held thereto by a flexible retainer member that accommodates different thicknesses of circuit module bodies. The mounting of the upper surfaces of the module bodies against the heat sink strip, which is fixed with respect to the male frame, assures uniform location of the leads of modules of different thicknesses.

The novel features of the invention are set forth with particularity in the appended claims. The invention will be best understood from the following description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top perspective view of a connector assembly constructed in accordance with the invention;

FIG. **2** is an exploded perspective view of the male portion of the connector assembly of FIG. **1**;

FIG. **3** is an exploded perspective view of the female portion of the connector assembly of FIG. **1**, and of bus strips that can be used therewith;

FIG. **4** is a partial plan view of the male assembly portion of the assembly of FIG. **1**;

FIG. **5** is a sectional side view of the male assembly of FIG. **4**;

FIG. **6** is a bottom view of the male assembly of FIG. **4**;

FIG. **7** is a plan view of the female assembly portion of the assembly of FIG. **1**;

FIG. **8** is a side sectional view of the female assembly of FIG. **7**;

FIG. **9** is a bottom view of the female assembly of FIG. **7**;

FIG. **10** is a sectional view taken on the line **10—10** of FIG. **1**, showing the male and female assembly portions in a fully installed position; and

FIG. **11** is a view similar to FIG. **10**, but at the beginning of installation of the male assembly portion in the female portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** illustrates a connector assembly **10** which includes a female frame **12** which receives a male frame **14**. The purpose of the connector assembly is to receive an integrated circuit module **16** of the dual-in-line type and connect the rows of leads **18** extending from the module to corresponding pins **20** extending from the female frame **12** of the assembly. The entire assembly is designed to be mounted on a panel which holds many of such assemblies in a complex electrical device such as a digital computer. After the connector assembly is mounted on the panel along with other similar assemblies, wire wrap connections can be made from any of the pins **20** to any other pins on the same connector assembly or other assemblies on the panel.

The connector assembly is designed to facilitate the replacement of any of the circuit modules **16**. This can be accomplished by removing a pair of screws **22**, **24** that hold the male and female frames together, replacing the module on the male frame, and reinstalling the male frame in the female frame. The male connector assembly has test point regions **26** that extend from the top of the male frame, each test point region being electrically connected to one of the leads **18** of a circuit module installed in the assembly. Additional capacitors or other devices can be added to the module by connecting them across a pair of test point regions **26** to connect them to the leads of the circuit module. If there is doubt about the establishment of a satisfactory electrical contact between any lead of the circuit module **16** and one of the pins **20**, this can be tested by connecting an ohm-meter or any other selected testing apparatus between one or more test point regions **26** and/or a corresponding pin **20**.

FIGS. **2** and **3** are exploded views of the female and male assembly portions of the connector assembly. As shown in FIG. **2**, the male frame **14** has an upper bed portion **28** and a lower block portion **30**, the block or holding portion having numerous recesses **32** on either side. A male contact element **34** is provided for each recess, each contact element having a lower contacting portion **36** which lies in the recess, and an upper portion forming the test point region **26** for that element. The block **30** may have a large number of recesses such as 44 on each side, and it has a like number of male contact elements **34** disposed in the recesses.

The male assembly portion includes a heat sink member **38** to help dissipate heat from the circuit modules held in the connector assembly. The heat sink is desirable because the circuit modules generate heat in use and a means of distributing the heat over the maximum area facilitates its dissipation, particularly since the frames are constructed of a thermally insulative material. The heat sink member **38** includes a long strip portion **40** and a pair of end portions **42, 44**. The end portions **42, 44** are designed to receive the screws **22, 24** to hold the heat sink member in place against the bottom of the block **30**. A retainer member **46** is provided which holds the integrated circuit modules **16** against the heat sink member **38** and therefore in place on the frame **14**. The retainer member has ends **48, 50** which are held by tabs **52, 54** on the heat sink member. To mount one or more circuit modules **16** on the male assembly portion, the modules are placed with their upper surface **56** against the heat sink member **38**, and with their leads **18** extending along the recesses **32** in the block portion of the male frame. The retainer member **46** is then installed on the heat sink member to complete the assembly.

FIG. **3** illustrates the female assembly portion, showing the frame **12** and the inner region or cavity **58** therein which receives the male assembly. The walls of the cavity **58** are formed with many recesses **60** corresponding to the recesses in the male frame. A group of female frame contact elements **62** are provided, each having a connector portion or pin **20** and a contacting portion **64** which is disposed in one of the recesses **60**. A pair of fasteners **66, 68** is installed at either end of the female frame. Each fastener has an upper internal thread **70** for receiving one of the screws **22, 24** to enable the male and female frames to be held tightly together. Each fastener also has a threaded stud portion **72, 74** to facilitate fastening of the connector assembly to a bus bar or other elements of a complete panel.

The male assembly portion is installed in the female portion by merely pushing the male frame into the cavity **58** of the female frame and tightening the screws **22, 24**. Electrical connections are automatically made between the leads **18** of the circuit modules and the female frame contact elements **62**, to enable access to the circuit modules through the pins **20** of the female frame contact elements and/or the test points **26**. The female cavity has corners **59, 61** that have blocking portions, instead of being rounded like the other two corners. This allows the male frame to be installed in only one orientation, instead of either one of two orientations. The corners block improper male frame insertion before contact can be made between any female frame contact element and the leads of modules on the male frame.

FIGS. **11** and **10** illustrate the connector assembly prior to and after the installation of the male assembly portion in the female assembly portion. As shown in FIG. **11**, the upper or contacting portion **64** of the female frame contact element **62** has a bowed configuration along most of its length, one part **76** of the bowed portion being substantially straight. The upper end of the contacting portion **64** has a sharp U curve so that the outer end **78** lies in a well **80** formed in the female frame. The lower or contacting portion **36** of the male frame contact element **34** is also formed with a bowed configuration along most of its length, although this is a simple bow rather than one with straight portions. As with the female frame contact element, the outer portion is looped so that the outer end **82** lies in a well **84** formed in the block of the male frame. The lead **18** of the circuit module **16** extends upwardly along the bowed contacting portion **36** of the male frame contact element.

When the male assembly portion is moved down into the cavity **58** of the female frame **12**, the apparatus achieves the configuration shown in FIG. **10**. It can be seen that the bowed female frame contacting portion **64** has been outwardly deflected while the bowed male frame contacting portion **36** has been inwardly deflected, the circuit module lead **18** lying between them. If the male assembly portion is moved down in the vertical direction, indicated by arrow **86**, then the module lead **18** and the straight part **76** of the female element extend outwardly at an angle A of about 4° from the vertical direction. It can be seen that a large area of the lead **18** contacts the straight part **76** of the female contact element to provide for a low resistance contact between them. In addition, during sliding of the male connector assembly down into place, the surfaces of the lead **18** and straight portion **76** slide over one another. The sliding action prior to full installation tends to remove any insulative film on the surfaces to further lower the final contact resistance. The male frame contacting element **36** is thinner than the female frame element **64**, so that the male frame element **36** can be more easily deformed to push a large area of the lead **18** against the female element. Both contact elements **36, 64** are constructed of a flat strip of resilient conductive material such as beryllium copper, the male frame element **36** having a thickness such as 0.007 inch and the female frame element **64** having a thickness such as 0.010 inch.

Referring again to FIG. **2**, most of the integrated circuit modules **16** have at least two leads which are connected to a power supply. Thus, if five modules are mounted on a connector assembly, 10 of the pins **20** extending from the female frame must be connected to a power supply. While such a connection could be accomplished by using 10 wires leading from 10 pins of the connector assembly to two power leads on the panel which holds the assembly, this could add to the cost of connecting a panel. In accordance with the invention, special bus strips are provided to facilitate power connections. FIG. **3** illustrates a pair of bus strips **88, 90** which facilitate connection of a bus bar assembly **92**, which runs along the length of a frame which holds many connector modules **10**, to selected pins **20** of the connector assembly.

The bus bar assembly **92** has three bus bars **94, 96** and **98** which can carry current to circuit modules in the connector assemblies. Generally, only two bus bars **96, 98** are utilized, the other bar **94** generally being grounded to supply a ground where required. A group of pins **100, 102** and **104** extend from the bus bars at uniform spacings along the bus bar assembly. The pins are connected to the bus bars **94, 96** and **98**, respectively, to facilitate connection of the bus strips.

The first bus strip **88** has bus clips **106** spaced along its length, each designed to engage a pin and make electrical contact therewith. One clip **106***e* engages the pin **104** to connect the strip **88** to the bus bar **98**. The other clips on the strip **88** engage the pins **20** extending down from the female frame **12** to make electrical contact with those pins and to the circuit module leads connected thereto. In a similar manner, the other bus strip **90** has clips **108**, one of them designed to connect to the bus bar pin **102** and the other clips designed to couple to pins **20** extending from the female frame. By utilizing only two bus strips **88, 90**, ten pins **20** can be connected to two bus bars **96, 98** which carry current to energize the circuit modules.

Generally, all integrated circuit modules will have particular leads that must be supplied with power. Thus, almost every connector assembly in a complex electrical system can utilize a pair of bus strips identical to those shown at **88, 90** to supply power to the circuit modules. If it is desired to eliminate the connection between any clip **106** or **108** and one of the pins **20**, then that clip can be easily removed. The bus strips are generally supplied with an insulative coating on either face (but not on the clips) to insulate them from the surroundings. The use of the bus strips which lie against one another results in high capacitance between them to increase the speed of the circuit or provide other desirable characteristics. The high capacitance is an advantage which generally cannot be easily obtained with simple wire wrap connections.

FIGS. **4–9** illustrate some of the mechanical details of construction of the male and female assemblies. As shown in FIG. **5**, the tab **54** on the heat sink member **38** is lanced at its outer end to form a projection **110** which fits into an undercut region **112** formed in the end **50** of the retainer member **46**, to hold the retainer member in place. This enables the retainer

member **46** to be installed by merely pushing it up against the heat sink member after the circuit modules are in place. (Installation of the circuit modules is performed while the male frame is upside down from the position shown in the figures.) The heat sink member **38** has a screw receiving end portion **114** which is bifurcated to embrace a groove **116** formed in the screw **24**. The receiving end portion **114** can be installed by pushing it over the threaded part of the screw until the arms at end portion **114** separate in moving into the groove and then spring together when they are fully in the groove.

The fact that the receiving end portion **114** of the heat sink member is in contact with the screw **24**, enables the heat sink member to conduct heat to it. As mentioned above, the screw **24** fits into a fastening member on the female frame, that fastening member fitting into a panel which holds the entire connector assembly. The screw **24** and fastener member to which it is attached are constructed of thermally conductive material such as aluminum, so that a good thermal path is established between the heat sink member **38** and the frame of the electrical system. In addition, a good heat path is established between the retainer member **46** and the heat sink member **38** and to the panel which holds the connector assembly.

The retainer member **46** is composed of two parts, including a thin upper part **118** of resilient, thermally conductive material such as beryllium copper and a backing strip **120** of a cheaper material such as aluminum. The upper part or spring member **118** has spring tabs **122** punched out of it and formed in a curve to enable it to push against the body of a circuit module. The upper part **118** is held by rivets **124** to the backing strip **120**. The tabs **122** not only hold the circuit modules in place, but serve to conduct heat from them. The heat conductive material of tabs **122** can conduct substantial heat from the modules even with a low contact area. The tabs **122** carry this heat to the backing strip **120** which can carry it to the heat sink **38** for dissipation on the panel of the electrical system.

The placement of the retainer member **46** below the circuit modules serves to assure uniform placement of the leads **18** of the modules on the connector block **30**. The bodies of the integrated circuit modules may vary in thickness, but the leads generally extend from the bodies at a uniform distance from the upper surface **56** of the module body. In the present connector assembly, the upper surfaces **56** of the modules all lie at a known position, this being the lower surface of the heat sink member **38**. Accordingly, the leads generally extend a uniform distance along the recesses **32** in the block portion **30** of the male frame so that its position with respect to the female contact elements is known. If the body of the circuit module is thicker or thinner than normal, however, it is still held tightly in place by the resilient tabs **122** which lie on a side of the module bodies opposite the heat sink member **38**.

Thus, the invention provides a connector assembly which enables the rapid installation and removal of circuit modules from connection to an electrical system. The apparatus utilizes contact elements that assure a large area sliding contact between the leads of the module and connector pins of the assembly. In addition, the assembly provides for good heat dissipation from the modules. These features are provided using a relatively simple and reliable connector assembly.

Although particular embodiments of the invention have been described and illustrated herein, it is recognized that modifications and variations may readily occur to those skilled in the art and, consequently, it is intended that the claims be interpreted to cover such modifications and equivalents.

What is claimed is:

1. A connector assembly for receiving circuit modules with bodies of uniform width and variable thickness, and which have upwardly extending leads generally uniformly spaced from the upper face of the body, comprising:

a female frame constructed of electrically insulative material and having an inner region;

a male frame for reception in said female frame, said male frame constructed of electrically insulative material and having a plurality of recesses for receiving the leads of circuit modules;

an elongated heat sink member of high heat-conductive material mounted on said male frame on the side thereof which first enters said female frame; and

a retainer mounted on said male frame and spaced from said heat sink member so a circuit module body can be received between them, said retainer having resilient portions for pressing circuit module bodies of various thicknesses against said heat sink member.

2. The connector assembly described in claim **1** wherein:

said retainer member includes an elongated spring member of highly heat-conductive material with tabs formed therein having outer end portions for pressing against said circuit module bodies, and a substantially rigid backing member of heat-conductive material disposed against said spring member, said backing member having opposite ends held against said heat sink member.

3. A connector assembly for receiving circuit modules with leads thereon comprising:

a female connector frame having a cavity whose inner walls have a plurality of recesses;

a plurality of first electrical contact elements, each mounted on said female frame and having a portion within one of said recesses;

a male connector frame having a block portion for slidable reception in said cavity of said female frame, said block portion having a plurality of recesses on its outer walls;

a plurality of second electrical contact elements, each mounted on said male frame and having a portion within one of said recesses on said male frame, each of said first and second elements having a lead-contacting region located to lie adjacent to the lead-contacting region of a corresponding electrical contact of the other frame when the male frame is fully inserted into the female frame;

holding means for holding at least one of said circuit modules on said male frame with its leads lying over at least part of the lead-contacting region of some of said second elements, so that said leads lie between contacting regions of said first and second elements when said male frame is inserted into said female frame; and

means for fastening said holding means on said male connector frame independently of reception of said male frame in said female frame.

4. The connector assembly described in claim **3** wherein:

said lead-contacting region of each of said first contact elements has a substantially straight portion and each of said first elements is mounted so that said straight portion is maintained at a small outward angle from the direction of sliding of said male frame block portion into said female frame cavity when said male frame is fully inserted into said female frame cavity.

5. A connector assembly for receiving the body of a circuit module and facilitating connection of its leads to other circuits comprising:

a female connector frame having a plurality of recesses on either side of its inner region;

a plurality of first contact elements, each constructed of an electrically conductive material, and each having a connector portion fixed to said frame and a resilient contacting portion biased to a position spaced from the innermost wall of one of said recesses so it can deflect inwardly;

a male connector frame having a male holding portion with a plurality of recesses on either side, for reception in said female connector frame, to hold the body of said circuit module at a position between said holding portion and said female connector with the leads of said module received in said recesses of said holding portion, each of said frames being elongated and having opposite ends for receiving fasteners to hold it to the other frame;

a plurality of second contact elements, each having a contacting portion disposed in one of said recesses of said male connector frame at a position deeper therein than the positions at which said leads are received, and a test point portion extending to a position accessible outside of said frame when said male frame is in said female frame;

an elongated strip of material which is highly heat conductive extending substantially along the length of said male frame adjacent to the positions of circuit module bodies on said male frame, said strip positioned so it is between said male frame and the bodies of circuit modules thereon and having ends positioned to contact fasteners holding said frames together; and

a retainer member positioned on a side of circuit module bodies opposite said strip of heat conductive material for biasing said bodies towards said strip.

6. A connector assembly for receiving the body of a circuit module and facilitating connection of its leads to other circuits comprising:

a female connector frame having a plurality of recesses on either side of its inner region;

a plurality of first contact elements, each constructed of a conductive material, and having a connector portion fixed to said frame and a contacting portion at least partially disposed in one of said recesses of said female connector frame;

a male connector frame having a male holding portion with a plurality of recesses on either side, for reception in said female connector frame, to hold the body of said circuit module at a position between said holding portion and said female connector frame with the leads of said module received in said recesses of said holding portion;

a plurality of second contact elements mounted on said male connector frame, each of said second contact elements having a contacting portion disposed in one of said recesses of said male connector frame at a position deeper therein than the positions at which said leads are received; and

a circuit module having a body disposed between said holding portion of said male connector frame and said female connector frame, and having a plurality of electrical leads on either side, each lead extending between one of said first contact elements on said female frame and one of said second contact elements on said male connector frame.

7. The connector assembly described in claim **6** wherein:

said male frame is formed for reception in said female frame by sliding it therein, and said first and second contact elements have elongated contact regions for contacting said circuit module leads, said contact regions extending with a major directional component parallel to the direction of sliding of said male frame into said female frame, whereby to provide a large area of contact between a lead and each contact element.

8. Circuit module mounting and connecting apparatus for receiving the body of a circuit module and facilitating connection of its leads to other circuits comprising:

a circuit module having a body and leads;

a female connector frame having a plurality of recesses on either side of its inner region;

a plurality of first contact elements, each constructed of a conductive material and having a connector portion fixed to said frame and a resilient contacting portion biased to a position spaced from the innermost wall of one of said recesses so it can deflect inwardly;

a male connector frame having a male holding portion with a plurality of recesses on either side, said male holding portion received in said female frame inner region with the body of said circuit module between them and with the leads of said module received in said recesses of said holding portion; and

a plurality of second contact elements, each having a contacting portion disposed in one of said recesses of said male connector frame at a position deeper therein than the positions at which said leads are received, and an exposed test point portion on the outside of said male frame, whereby to enable testing for contact resistance between said first elements and each of said circuit module leads.

9. Circuit module mounting and connecting apparatus for receiving the body of a circuit module and facilitating connection of its leads to other circuits comprising:

an elongated female connector frame having a plurality of recesses on either side of its inner region and having opposite ends,

a plurality of first contact elements, each constructed of a conductive material and having a connector portion fixed to said frame and a resilient contacting portion biased to a position spaced from the innermost wall of one of said recesses so it can deflect inwardly;

an elongated male connector frame having a male holding portion with a plurality of recesses on either side, for reception in said female connector frame, the depth of said female frame inner region and of said male holding portion chosen to provide sufficient space between them, when said male frame is fully inserted into said female frame, to receive the body of said circuit module at a position between said holding portion and said female connector with the leads of said module received in said recesses of said holding portion, said male connector frame having opposite ends for receiving fasteners to hold it to said female frame;

a plurality of second contact elements, each having a contacting portion disposed in one of said recesses of said male connector frame at a position deeper therein than the positions at which said leads are received; and

an elongated strip of material which is highly heat conductive, said strip extending substantially along the length of said male frame adjacent to the positions of circuit module bodies on said male frame and lying between said opposite sides of said inner region of said female frame when said male frame is received in said female frame, said strip having ends positioned to contact fasteners holding said frames together, whereby to carry heat from said module bodies to said fasteners.

10. Circuit module mounting and connecting apparatus for receiving the body of a circuit module and facilitating connection of its leads to other circuits comprising:

a female connector frame having a plurality of recesses on either side of its inner region;

a plurality of first contact elements, each constructed of a conductive material and having a connector portion fixed to said frame and a resilient contacting portion biased to a position spaced from the innermost wall of one of said recesses so it can deflect inwardly, each contacting portion having an outwardly bowed part with an inner end substantially fixed in position and an outer end free to move inwardly, said bowed part having a substantially straight region near its outer end for contacting the leads of circuit modules, the substantially straight region being outwardly angled so that the straight regions of contact elements at opposite sides of said female frame inner region are progressively closer together at locations pregressively deeper within said inner region;

a male connector frame having a male holding portion with a plurality of recesses on either side, for reception in said female connector frame, the depth of said female frame inner region and of said male holding portion chosen to provide sufficient space between them, when said male frame is fully inserted into said female frame, to receive the body of said circuit module at a position between said holding portion and said female connector with the leads of said module received in said recesses of said holding portion; and

a plurality of second contact elements, each having a contacting portion disposed in one of said recesses of said

male connector frame at a position deeper therein than the positions at which said leads are received.

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