

[54] CONNECTOR

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[51] Int. Cl. **H01r 13/62**

[58] Field of Search **339/75, 95, 256, 258**

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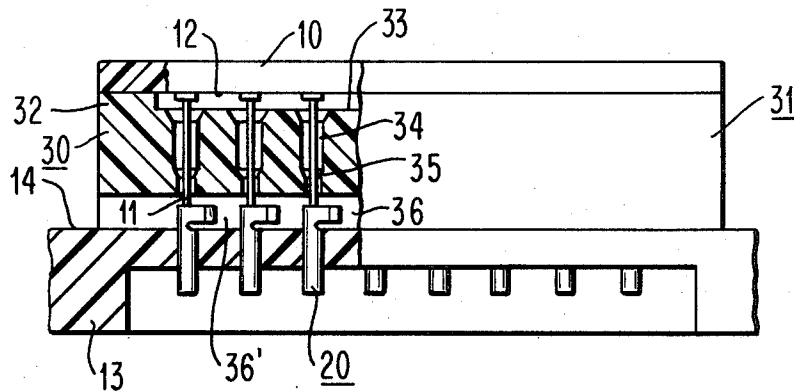
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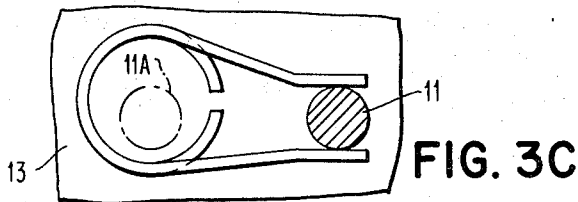
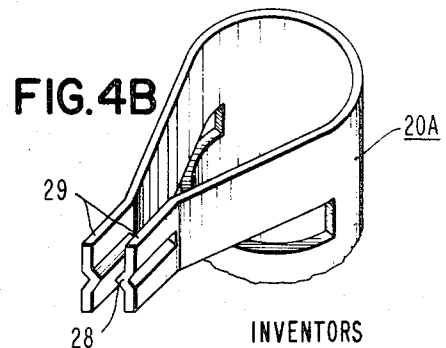
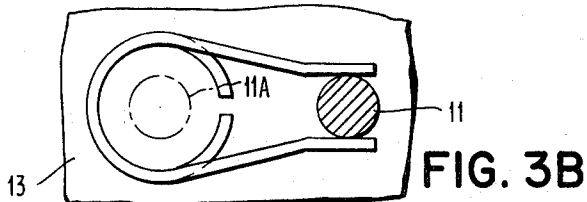
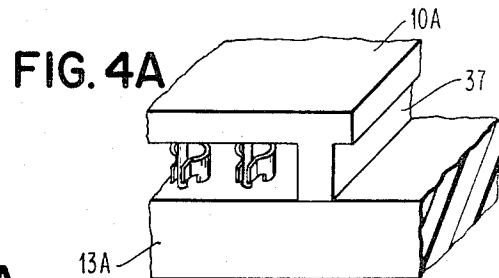
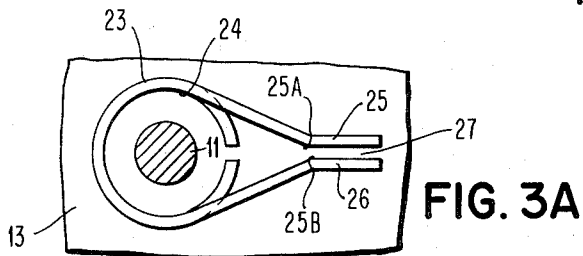
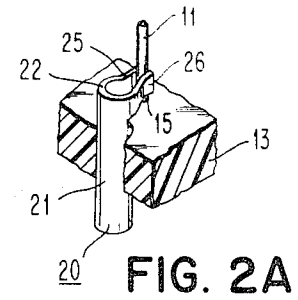
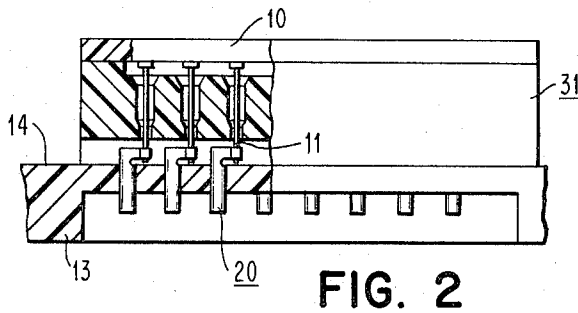
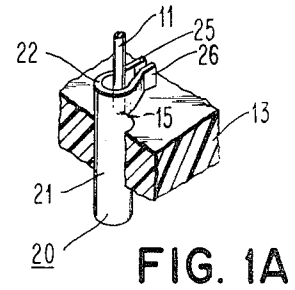
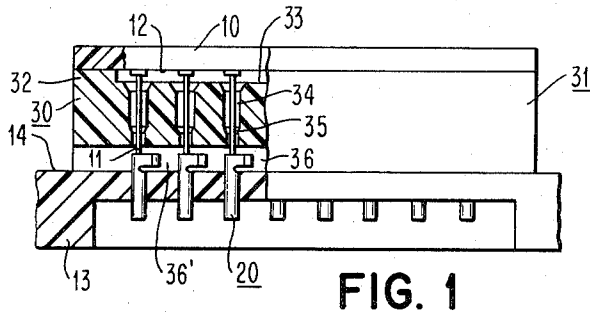
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ABSTRACT

A female connector for insertion into a printed circuit board and the like, the connector comprising an axially extending conductive tubular body portion having a loop-type receptacle at one terminal end of the body portion, the loop having a greater dimension than the diameter of a male connector-type pin so as to permit essentially zero axial force insertion of the pin into the receptacle. The receptacle includes a pair of resilient, radially projecting arms which converge from the receptacle and in conjunction with the receptacle define a converging path between the receptacle and the arms whereby relative lateral motion between the pin and female connector causes the pin to be engaged and retained by and between the pair of resilient arms. Also disclosed is apparatus for shifting one of or creating relative lateral movement between the pin and connector when the connectors are mounted respectively in a module element and a substrate element.

10 Claims, 13 Drawing Figures





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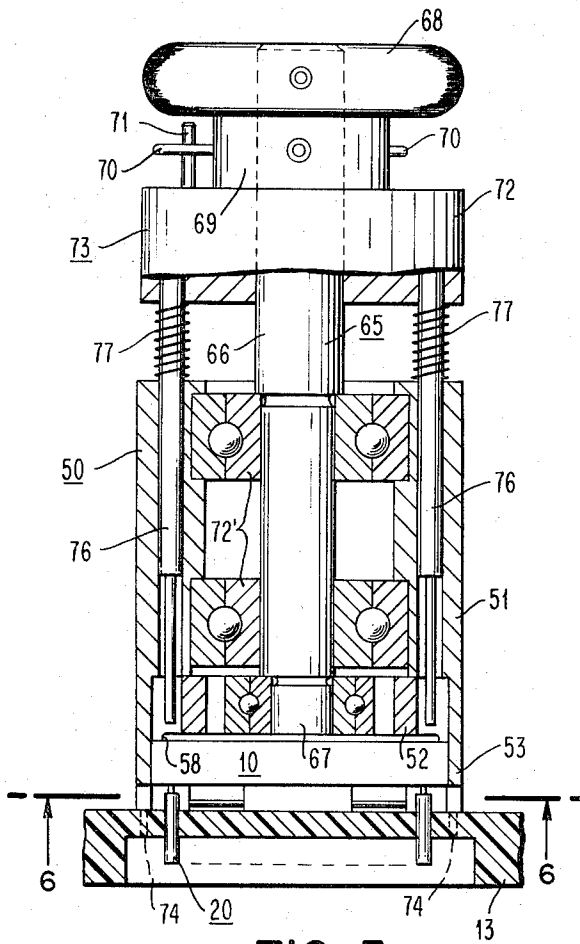


FIG. 5

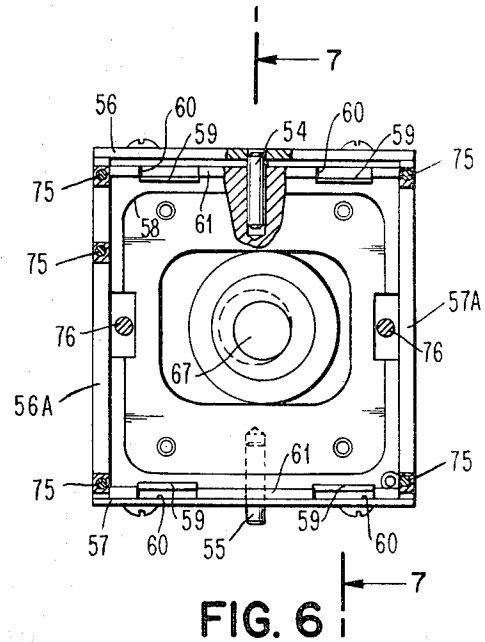


FIG. 6

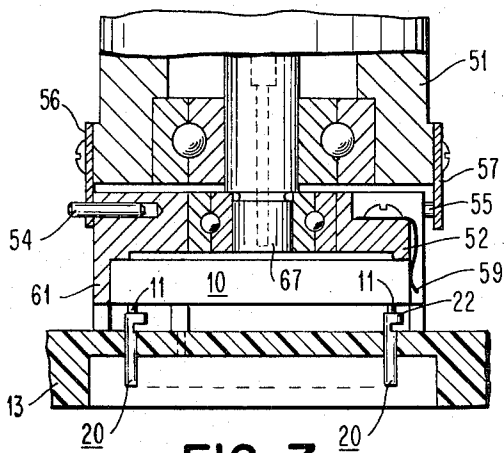


FIG. 7

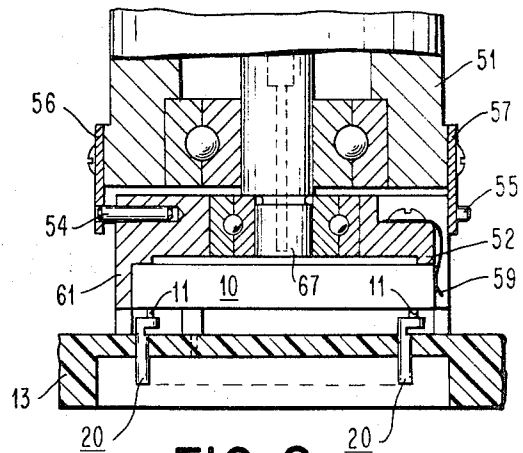


FIG. 8

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CONNECTOR

SUMMARY OF THE INVENTION AND STATE OF THE PRIOR ART

The present invention relates to connectors and more particularly to female connectors adapted to receive at least the pin portion of a male connector without creating axial stress on the male or female connectors.

In integrated circuit packaging, it is common practice to bond the connectors of the integrated circuit chip to a printed circuit pattern on, for example, a ceramic substrate. Connection to the printed circuit pattern is made by, for example, pins which pass through the substrate and are conductively connected to the pattern on one side of the substrate and project perpendicular to the plane of the substrate on its opposite side. As the number of devices per integrated circuit chip increases, and as the number of connections necessary increases, it is obvious that the number of external connections, e.g. pins on the substrate, must also increase. Insertion of the pins of the substrate into, for example, a socket on a circuit board is a problem because of the additional force required to insert a plurality of pins into friction-type female connectors. Additionally because of problems inherent with bent pins, misaligned female connectors and/or pins, and the possibility of bending pins during insertion, the use of sockets with friction fit female connectors is rarely used in high reliability electronic equipment such as computers. As a result it has been common practice to insert the substrate into apertures on the printed circuit board and solder the pins directly to the board. However, if during final test of the board it is discovered that the module is defective, time is lost in unsoldering, cleaning up the apertures and reinserting a new module. Additionally, in the field when a printed circuit card is found to contain a defective module, it is necessary to remove and replace the entire card and send the used one back for repair.

In view of the above it is a principal object of the present invention to provide a female connector for use in conjunction with a pin-type male connector, which female connector permits insertion of the pin with zero axial force on the pin and/or female connector.

Another object of the present invention is to provide a female connector which will permit of limited axial misalignment between itself and a male connector without imposing axial stress on either connector while permitting good engagement therebetween by providing a relative shift in a lateral direction between the connectors.

Still another object of the present invention is to provide novel apparatus for connecting a module element to a substrate element, one of the elements including novel female connectors constructed in accordance with the present invention and the other including a plurality of spaced male connectors having pin portions thereon.

Yet another object of the present invention is to provide a female connector which permits insertion of the pin portion of a male connector without axial stress being placed on either connector but which will lock the pin into interconnecting engagement as desired.

Still another object of the present invention is to provide a female connector which is reusable while maintaining, with minimum loss, its ability to frictionally engage and retain a male connector.

Another object of the present invention is to provide novel apparatus for shifting a module having a plurality of male or novel female connectors to effect interlocking engagement with a connector mounted on a circuit board or other substrate.

Still another object of the invention is to provide, in the shifting apparatus, means for releasably clamping a module so as to effect easy insertion and removal of the module from, for example, a circuit board.

Other objects and a fuller understanding of the invention may be had by referring to the following specification and claims taken in conjunction with the accompanying drawings in which:

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FIG. 1 is a fragmentary side elevational view illustrating a module having pin-type male connectors being inserted into female connectors constructed in accordance with the present invention;

FIG. 1A is a fragmentary enlarged perspective view illustrating the position of a male connector relative to a novel female connector shown in FIG. 1;

FIG. 2 is a fragmentary side elevational view similar to FIG. 1 but illustrating the male and female connectors in a second, or pin engagement position;

FIG. 2A is a fragmentary enlarged perspective view illustrating the position of the male connector relative to the novel female connector in FIG. 2;

FIGS. 3A, 3B and 3C are enlarged fragmentary plan views illustrating the typical relationship between the male and female connectors respectively upon registration, after lateral shifting, and under circumstance when there is limited axial misalignment between the connectors both in its inserted and shifted positions;

FIG. 4A is a fragmentary perspective view of a modified carrier module constructed in accordance with the present invention;

FIG. 4B is a fragmentary perspective view of another embodiment of the female connector of the present invention.

FIG. 5 is a fragmentary side elevational sectional view of a novel tool used for inserting a module and making the necessary connection between the female and male connectors.

FIG. 6 is a fragmentary sectional view taken along line 6—6 of FIG. 5;

FIG. 7 is a fragmentary sectional view taken along line 7—7 of FIG. 6 and as if FIG. 6 were rotated 90° into the plane of the paper; and

FIG. 8 is a fragmentary sectional view similar to FIG. 7 but illustrating the position of the male and female connectors in frictional engagement.

Referring now to the drawings and particularly FIG. 1 thereof, a module 10 having a plurality of male connectors 11, in the present instance including at least a pin portion spaced along and projecting from one surface 12 thereof, is shown inserted into novel female connectors 20 located in like spaced relation to the male connectors and positioned in a substrate 13. After insertion of the pins into the female connector 20, relative movement is effected between the module 10 and the substrate 13, in a manner which will be more fully explained hereinafter, creating a wiping and self-locking action between the pin and connector.

In accordance with the invention the female connector 20 is adapted to receive a pin 11 without axial stress on either the male or female connector and then, by effecting a relative lateral shift between the connectors, engagement and frictional locking of the male to the female is effected. To this end, the female connector 20 comprises an axially extending conductive body portion 21, in the present instance tubular in shape, including a receptacle 22, in the illustrated instance loop shaped, at one terminal end of the body portion 21. The receptacle includes upstanding wall means 23 extending from the tubular body portion 21, the wall means defining an opening 24 of greater dimension than the diameter of the pin 11 intended for use with the connector (see FIG. 3A). In this manner pins may be inserted into the receptacle without frictionally engaging the wall means 23 thereby permitting an essentially zero force insertion.

After insertion of the pin into the receptacle it is necessary to effect mechanical engagement of the pin by the female connector to lock the pin while insuring electrical continuity between the male and female connector. To this end, a pair of resilient, radially projecting arms 25 and 26 converge from the wall means 23 of the receptacle 22, defining a converging path between the receptacle and the arms. As shown, at least a portion of the arms 25 and 26 define a space 27 therebetween having a dimension less than the diameter of the pin 11, the opening 24 and the space 27 being in communication. As may be recognized, after the pin 11 has been inserted into the opening 24, lateral movement of the pin from the position il-

illustrated in FIG. 3A to the position shown in FIG. 3B causes the arms 25 and 26 to grasp or engage the pin insuring a good electrical connection between the connectors.

To prevent a reaction force which would tend to force a pin embraced or engaged and retained by the pair of resilient arms back towards the opening 24, it is desirable that at least one of the arms, in the illustrated instance, both, have a bow, concavity or curvature such that when the pin is in position in the space 27 intermediate the arms 25 and 26, that portion of the arm adjacent and in engagement with the pins is essentially parallel. The concavity or bow may be formed, as illustrated in the drawings, by providing a break 25A and 25B in the arms 25 and 26 respectively.

In the event that the pins or connectors are subject to heavy oxidation, connector 20A may include means for breaking through the oxide so as to insure a good electrical connection. To this end, and as illustrated in FIG. 4B, an inwardly projecting protrusion 28 may be provided in at least one of the arms 29, in the illustrated instance both of the arms, and extend axially thereof. The protrusion 28 having a smaller area, will effect a rupture of any oxide film on the pin by the high pressure exerted between the pin and the female connector.

As illustrated in FIGS. 1 and 2 the receptacle 22 of the connector 20 is spaced from a surface 14 of the substrate 13. Upon the pins being inserted into the receptacle and then shifted for firm embracing engagement between the arms 25 and 26, it is desirable that the terminal ends or tips 15 of the pins do not engage the surface 14 of the substrate 13 otherwise excessive frictional resistance occurs creating difficulty in effecting the relative lateral shift between the connectors. To this end, means are provided to inhibit engagement of at least some of the pins against the surface of the substrate element, in the illustrated instance a spacer means is positioned intermediate the body portion of the module 10 and the surface 14 of the substrate 13. As illustrated in FIGS. 1 and 2 the spacer means may include a carrier 31 having a body portion 32, a recessed upper surface 33 to accommodate the shank portion of the pins 11, and a plurality of apertures 34 at spaced apart locations coinciding with the pin spacing. The apertures 34 may include, as shown in FIGS. 1 and 2, a tapered portion 35 which acts as pin straighteners when the pins of the module 10 are inserted in the carrier 31. Along at least two of the edges of the carrier are rib portions 36 which form, intermediate the body portion and surface 14 of the substrate 13, a cavity 36'. The height H of the carrier is chosen such that with the module 10 in place resting on the spacer means 30, the terminal ends or tips 15 of the pins do not engage the surface 14 of the substrate 13.

It has been found that with modules having long pins, the carrier gives support to the pins and prevents bending when shifting one of the module or substrate for engagement of the pins intermediate the arms 25 and 26 of the female connectors. Additionally, the carrier may be firmly fixed and form a part of the module or may be free floating with respect to both the carrier and substrate.

It should be recognized that the important function of the specific spacer means is to inhibit engagement of at least some, and preferably all of the pins against the surface of the element carrying the female connectors. Thus in an alternate arrangement, the surface of the substrate may be recessed at the portions thereof underlying the arms 25 and 26. Additionally, with short pins and a decreased bending moment, or relatively thick and longer pins, the carrier or spacer means may comprise a simple rib-type standoff structure 37 such as shown in FIG. 4A. In this instance at least a pair of ribs having the necessary height to inhibit engagement of the pins against the surface of the substrate may be sufficient. As shown, the ribs may be connected (for stability purposes) to either the module 10A or the substrate 13A.

By forming the female connectors from a resilient material such as beryllium copper any misalignment of a pin relative to its associated connector 20 is automatically compensated. A typical instance of misalignment is illustrated in FIG. 3C

wherein a pin 11A is illustrated in phantom in the opening 24 but misaligned from the central axis of the receptacle 22. When the pin is moved to the right wherein it is embraced by the arms 25 and 26 of the female connector, one of the arms, in the illustrated instance arm 26, will deflect further or be offset from the central axis.

As the number of male and female connectors increases per module the amount of force required to effect relative motion between the connectors increases making necessary a tool for effecting relative lateral motion between the connectors. To this end and in accordance with another feature of the invention, apparatus for effecting a lateral movement of, in the illustrated instance, the module is illustrated in FIGS. 5-8. The apparatus 50 includes a tubular stand 51 having an element receiving housing 52 mounted at one end 53 of the stand 51. As shown best in FIGS. 7 and 8, the element receiving housing 52 is connected to guide means, in the illustrated instance a pair of guide pins 54, 55, which project through opposite side walls 56 and 57 of the stand 51. The element receiving housing 52 is reciprocable in the plane dictated by the guide means.

In order to hold the module 10 in the element receiving housing 52, the housing is formed with a recess or cavity 58 and provided with clamping means, in the present instance a plurality of module side engaging springs which serves to grasp the module 10 and retain the module in the housing. As best illustrated in FIG. 6 the clamping means includes four springs 59 which project inwardly toward the cavity 58 through recesses 60 in a retaining side wall 61 of the housing 52.

In order to shift the module 10 in the element receiving housing, actuator means 65 serve to effect oscillation along a path dictated by the guide means or pins 54 and 55. To this end, the actuator means 65 includes a shaft 66 which extends axially of the stand 51 and terminates in an eccentric 67 located in the housing 52. As illustrated best in FIG. 5, the opposite end of the shaft 66 is coupled to a knob 68 and a collar stop 69 immediately below the knob is provided with arcuately spaced rotational stops 70. The stops 70 limit the rotation of the shaft 66 by engaging a pin 71 which projects upwardly from a collar 72 associated with module ejector means 73. As shown in FIG. 5, the shaft is mounted in ball bearings 72' so as to facilitate rotation.

Inasmuch as the movement of the housing 52 is in one plane and reciprocable along one line of action, i.e. along the line of action of pins 54 and 55, it is necessary to insure that the stand 51 is accurately positioned superimposed of the connectors in the substrate 13 and movable in a direction to insure pin movement between the receptacle 22 and the arms 25, 26 of the female connector 20. Accordingly, the substrate may include locating apertures 74 adapted to receive locating pins 75 depending from walls 56A and 57A of the stand 51. As best shown in FIG. 6, one of the side walls of the stand, in the illustrated instance 56A, contains an extra locating pin 75 which registers with a similarly located aperture in the substrate to insure proper orientation of the module.

After the locating pins 75 are inserted in the locating holes 74 the pins 11 associated with the module 10 will nest in the receptacle 22 of the female connectors 20 (see FIG. 7). Rotation of the shaft 66 of the actuator means 65 will cause the module nested in the housing to shift until the pins 11 are disposed intermediate the resilient arms 25 and 26 of each of the female connectors (see FIG. 8). The clamping springs 59 are made so that although they clamp the module 10 in the cavity 58 of the housing, once the pins are embraced by the arms of the female connectors the module will be held fast in the connectors.

In the event that it is desired to remove the module from the element receiving housing, the reverse procedure is effected and the module is moved or shifted to the left (reference FIG. 8) to the position shown in FIG. 7 and then lifted out.

To facilitate easy removal of the module from the housing, the module ejector apparatus 73 is provided, this apparatus comprises the axially reciprocable collar 72 and a pair of

spaced apart push rods 76 which pass through the housing 51 and are held upwardly, so as to normally not engage the module, by biasing springs 77. When it is desired to eject the module from the cavity or element receiving housing 52, a downward motion of the collar causes the ends of the ejector rod 76 to impinge upon the lateral edges of the module and eject the same.

It should be recognized that it may be unnecessary to provide spacer means intermediate the module and substrate when utilizing the apparatus 50 and a module having relatively short pins, (i.e. no lateral support required for the pins). In this connection the depth of the cavity 58 should be chosen so that the tips of the pins do not engage the surface of the substrate or vice versa if the module contains the novel female connector of the present invention.

It should be recognized that in all of the examples heretofore given the pins and male and female connectors may be reversed such that the female connectors are on the module and the male connectors are on the substrate.

Thus the connector of the present invention permits of easy insertion of a pin while effecting a good electrical connection and locking of the pin merely by imposing lateral force on the pin. Additionally, the novel apparatus permits easy insertion and removal of modules without deleteriously affecting the reinsertability of the module and while in the field.

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be made without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A female connector comprising: an axially extending conductive body portion; a receptacle at one terminal end of said body portion; a pair of resilient, radially projecting arms converging from said receptacle, a concavity in at least one of said arms formed by providing a break in said one arm, said arms defining a converging path extending from said receptacle.
2. A connector in accordance with claim 1 including a protrusion in at least one of said arms and extending axially thereof.
3. A connector in accordance with claim 1 wherein said receptacle comprises a loop.
4. A connector for receiving and making electrical connec-

tion to a pin, said connector comprising: means defining a receptacle comprising upstanding wall means defining an opening of greater dimension than the diameter of the pin intended for use with said connector; a pair of resilient arms including a concavity in each of said arms formed by providing a break in each of said arms, said arms extending laterally from said wall means and defining a space therebetween having a dimension less than the diameter of said pin, said opening and said space being in communication whereby, upon insertion of said pin into said opening and lateral movement of said pin from said opening into said space causes said arms to grasp said pin in substantially parallel relation to each other.

5. A connector in accordance with claim 4 wherein said connector includes a tubular body portion extending axially from said receptacle.

6. A connector in accordance with claim 4 including an inwardly facing protrusion in both of said arms and extending axially thereof.

7. A module element releasably connected to a substrate element, one of said elements including a plurality of spaced female connectors and the other including a plurality of like spaced male connectors each including a pin portion; each of said female connectors comprising a receptacle including upstanding wall means defining an opening of greater dimension than the diameter of said pin portion on said associated male connector; a pair of resilient arms extending from said wall means and defining a space therebetween less than the diameter of said pin, said opening and said space being in communication; said pin portion of said male connectors being engaged intermediate said resilient arms of associated female connectors, and means to inhibit engagement of at least some of said pins against the surface of the element having said female connectors.

8. A module and substrate element in accordance with claim 7 wherein said means to inhibit engagement includes a spacer intermediate said elements to space said elements one from the other.

9. A module and substrate element in accordance with claim 8 wherein said spacer includes a body portion, and means defining a plurality of apertures in said body portion to permit pins to pass therethrough.

10. A module and substrate element in accordance with claim 9 wherein said apertures are tapered so as to effect straightening of said pins upon entry thereinto.

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