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Harwood et al.

[11] **3,858,957**

[45] **Jan. 7, 1975**

[54] **ELECTRICAL CONNECTING MEMBERS REQUIRING LOWER INSERTION AND RETRACTION FORCES AND PROVIDING FOR LOW CONTACT WEAR**

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[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

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[21] Appl. No.: **392,153**

[52] **U.S. Cl.** .... **339/17 L,** 339/176 MP, 339/273 R, 339/74 R

[51] **Int. Cl.**.... **H05k 1/07,** H01r 13/54, H01r 13/62

[58] **Field of Search** 339/17, 18, 61, 65, 66, 339/75, 91, 176, 273, 274, 74

[56] **References Cited**

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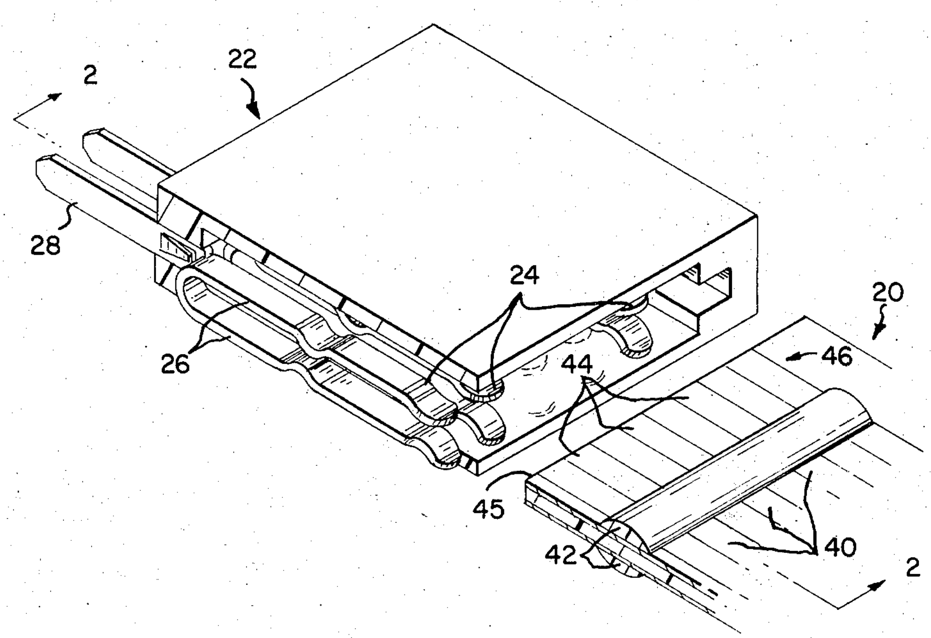
Primary Examiner—Roy D. Frazier
Assistant Examiner—Terrell P. Lewis

[57] **ABSTRACT**

The improved pair of mating electrical connecting members are incorporated into a variety of matable contacts, connectors and other electrical devices.

In one specific application, an improved edge board connector receives an improved printed circuit board and includes therein a plurality of contact members which are normally biased to a disengaged position and to provide a predetermined contact force against the mating conductor paths of the board when it is fully engaged with the connector. The improvements include surfaces on a free end of the contact member and on a cam bar on the board which surfaces cooperate during engagement and disengagement to perform a camming action to deflect the contact member against biasing to cause it to pivot about a fixed end to maintain a contact area on the member between the fixed and free ends away from the board unless they are fully engaged. The camming action is applied to the free end of the member so that the member is less resistant to deflection than it would be if applied at the contact area. As a result, the insertion force during engagement and the retraction force during disengagement are lessened by the fact that the frictional forces between the contact members and the board are being produced by normal forces at the free end of the member rather than by the contact force at the contact area.

2 Claims, 13 Drawing Figures



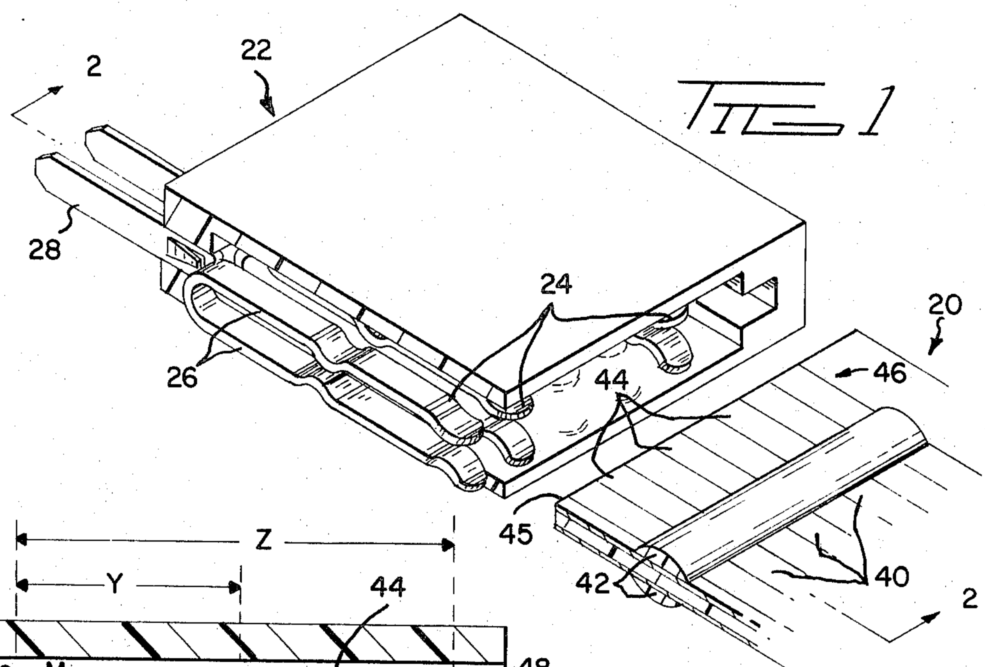


FIG 1

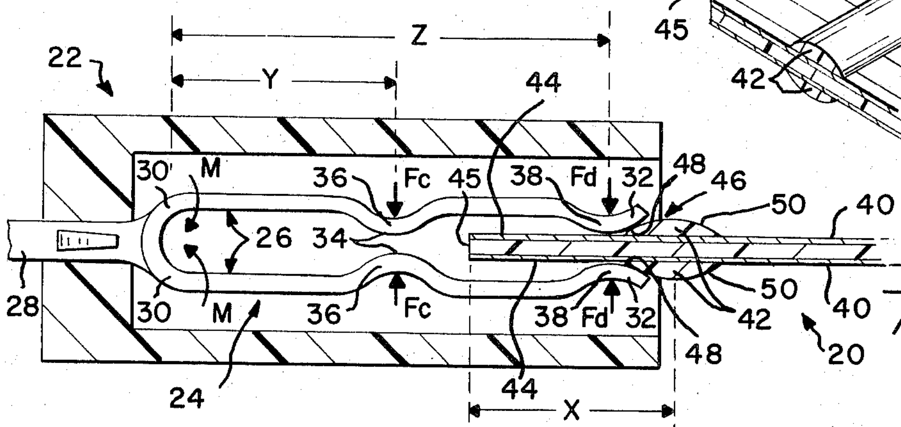


FIG 2

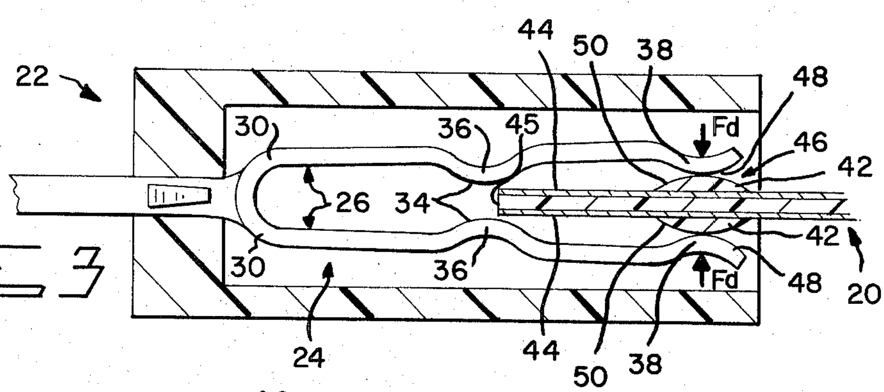


FIG 3

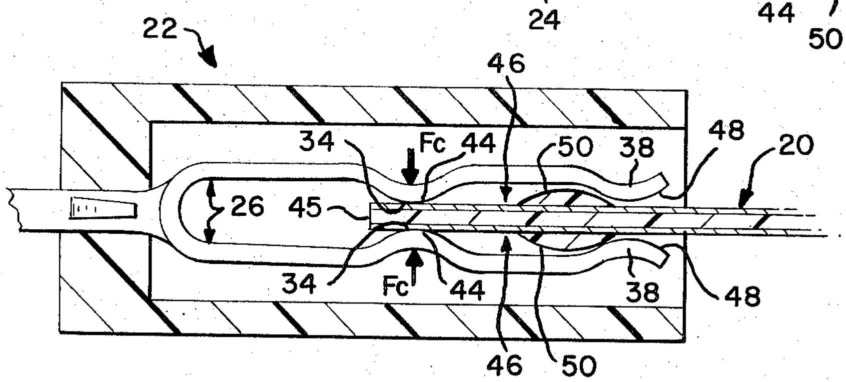


FIG 4

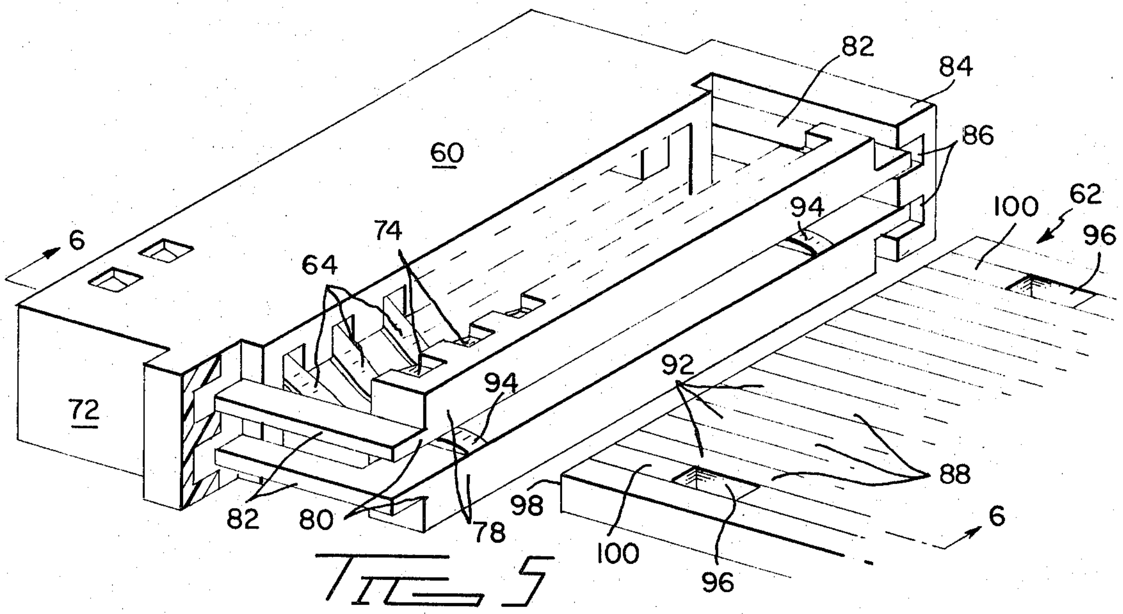


FIG. 5

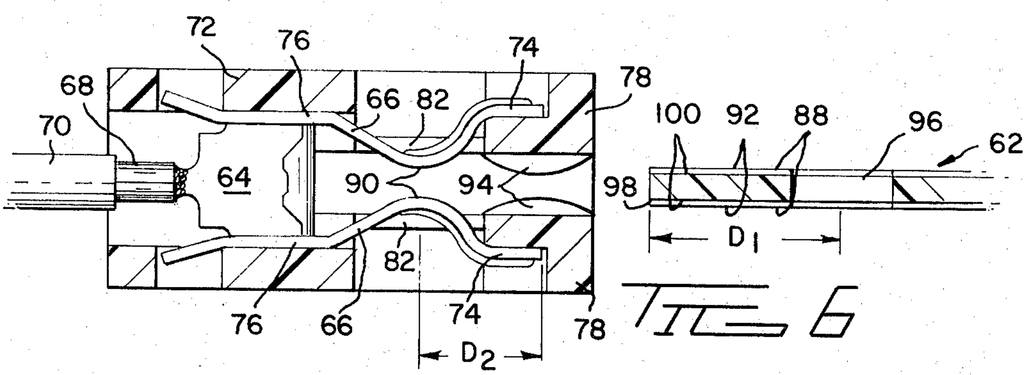
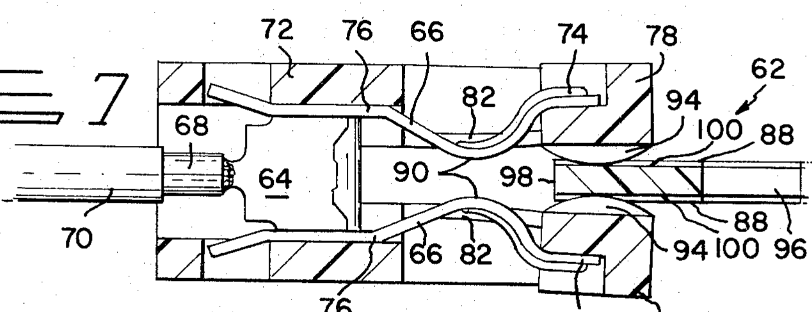


FIG. 6

FIG. 7



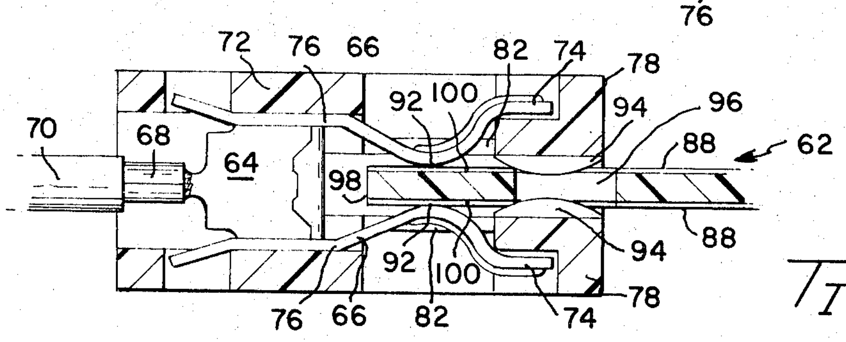
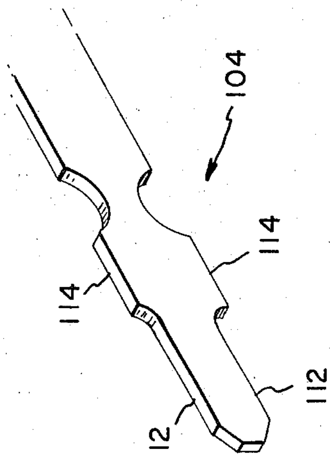


FIG. 8


104
114
114
112
112

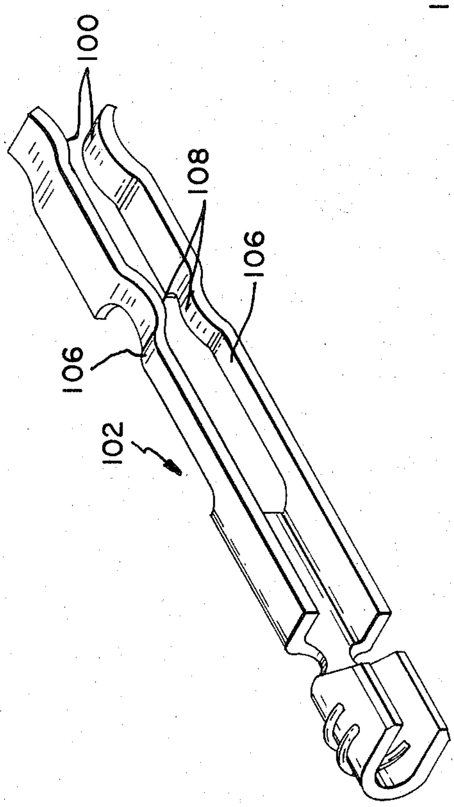

100
108
106
106
102

FIG. 9

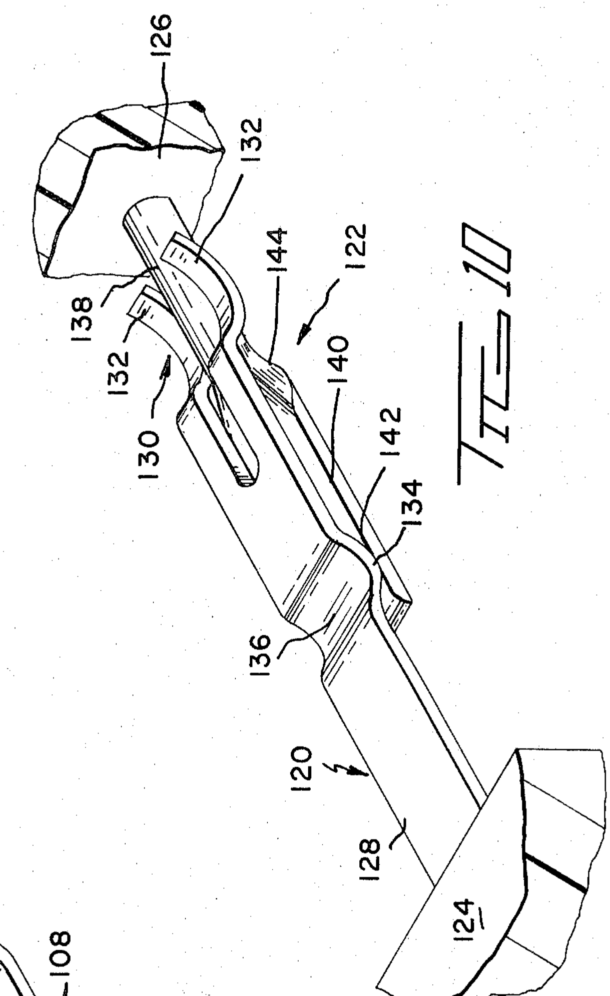

126
132
144
122
138
132
140
130
142
134
136
120
128
124

FIG. 10

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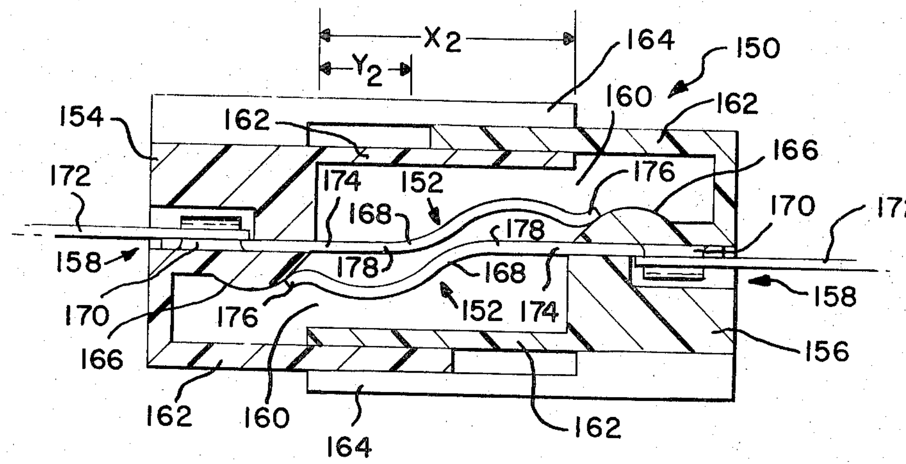

FIG. 11

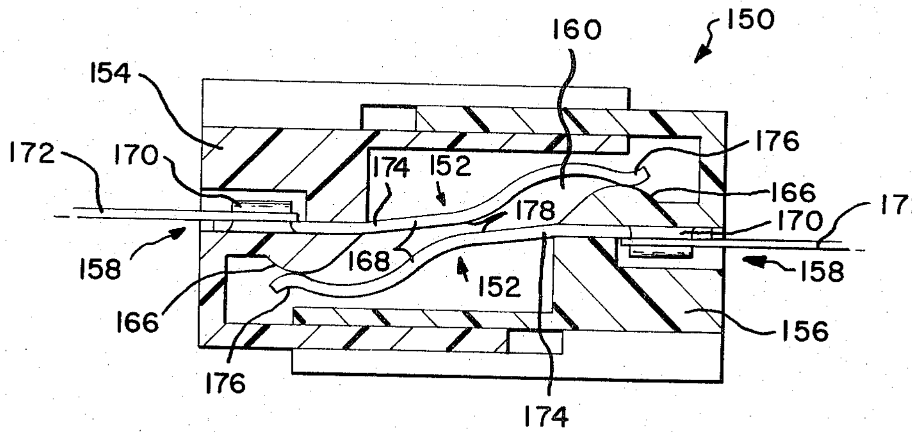

FIG. 12

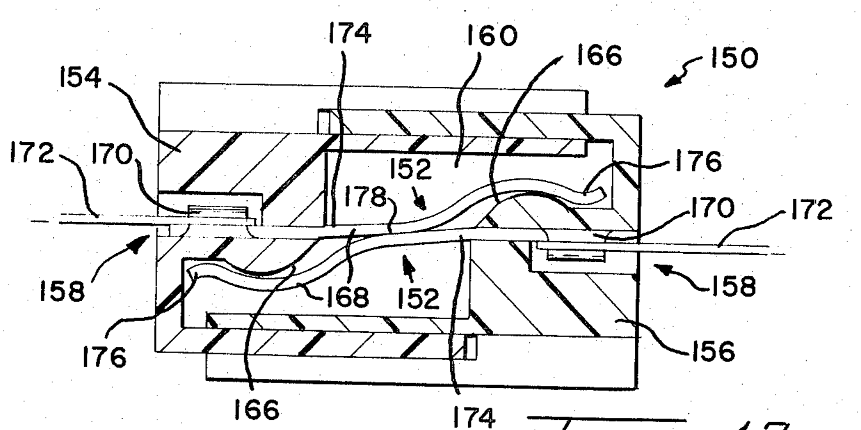

FIG. 13

ELECTRICAL CONNECTING MEMBERS REQUIRING LOWER INSERTION AND RETRACTION FORCES AND PROVIDING FOR LOW CONTACT WEAR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an improved pair of mating connecting members for inter-connecting electrical components and, more specifically, to a pair of connecting members having a configuration which makes them capable of providing a higher contact force therebetween while decreasing the resulting wear of their contact areas and requiring relatively low insertion force for their engagement and retraction force for their disengagement.

2. Description of the Prior Art

It has long been considered desirable to have a pair of mating, multicontact connectors which provide high contact force without producing excessive wear on the contact areas or requiring large insertion forces. A number of zero insertion force connectors have been offered which provide an element in addition to the basic connecting members within the connector to increase the contact force therebetween after insertion. The additional structure of these connectors makes them more complicated and thus more expensive to manufacture. In some cases, an additional manipulative step is also required for the connection to be fully completed.

A noteworthy class of prior art devices in the printed circuit field has provided connectors which particularly attempt to solve the wear problem without requiring an additional manipulation of the connectors to provide full engagement. U.S. Pat. Nos. 2,811,700; 3,140,907; 3,594,699; and 3,710,303 are in this class and teach the utilization of camming surfaces associated with an edge board connector and the printed circuit board which force the biased contacts of the edge connector apart by the movement of the board during insertion. Upon complete insertion, the biased contacts are released to make electrical contact with the connector paths on the board. Although some of the above-mentioned devices include features for ease of insertion of the board, they do not teach how to substantially reduce the insertion force of the board into an edge board connector, or any other type of multi-contact connector.

With the ever-increasing demand for more contacts per connector in the printed circuit board, flatflexible cable and individually insulated wire fields, an inexpensive, simple-to-operate, low insertion force connector continues to be highly desirable. Further, because of the increasing costs of gold plating, other materials such as tin are being utilized for some contact members causing a substantial increase in the required contact force with the attendent insertion force problems becoming even more acute. As a result, the above-mentioned devices each include features which tend to unnecessarily increase the insertion force required and thereby decrease their desirability when utilizing more contact members and/or higher contact forces.

It, therefore, appears that the prior art does not provide a pair of connecting members being equally applicable in conjunction with printed circuit boards, flat-flexible cable, or individual wires which members have a configuration for one-step engagement, are simple and inexpensive to produce but provide a high contact force while nevertheless insuring low wear in the contact areas and requiring relatively low insertion force during engagement and retraction force during disengagement.

SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide an improved pair of connecting members which are capable of satisfying the requirement for high contact force while being utilized in many types of multi-connectors in a variety of conductor fields.

A further object of the invention is to provide connecting members of the type described which have a configuration for simple, direct engagement that results in low wear in the contact area and requires relatively low insertion and retraction forces as compared with the contact force produced.

It is another object to provide connecting members of the type described which are inexpensive, uncomplicated, and simple to produce.

These and other objects of the invention are achieved in a preferred embodiment thereof which is an improved pair of mating connecting members each having contact areas for inter-connecting electrial components and are of a type capable of being individually mounted for engagement and disengagement along a path which is generally parallel with the longitudinal axis of the members. At least one of the members is normally biased to a disengaged position and to provide a predetermined contact force at the contact areas in a generally transverse direction when the members are engaged.

The improvement to the members includes surfaces associated with each member which cooperate during engagement to perform a camming action to deflect the one connecting member against the biasing to cause it to pivot about one end to maintain a first of the contact areas which is on the one member away from the other member until the members are substantially fully engaged. The camming action is applied to a region of the one member which is more remote from the one end than the first contact area. The biasing of the one member causes it to be more resistant to a deflecting force applied at the first contact area than at the region. Because of the improvements, the insertion force during engagement is lessened by causing the deflection force to be applied at the region rather than at the first contact area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary perspective view of a preferred embodiment of the invention with the connecting members disengaged;

FIG. 2 is a sectional side view of the embodiment of FIG. 1 as viewed generally along line 2—2 just prior to engagement of the members;

FIG. 3 is a view like that of FIG. 2 during engagement;

FIG. 4 is a view like that of FIG. 2 with the members engaged;

FIG. 5 is a fragmentary perspective view of an alternative embodiment of the invention with the connecting members disengaged;

FIG. 6 is a sectional side view of the embodiment of FIG. 5 as viewed generally along line 6—6 just prior to engagement of the members;

FIG. 7 is a view like that of FIG. 6 during engagement;

FIG. 8 is a view like that of FIG. 6 with the members engaged;

FIG. 9 is a perspective view of another alternative embodiment of the invention;

FIG. 10 is a perspective view of still another alternative embodiment;

FIG. 11 is a sectional side view of yet another alternative embodiment of the invention prior to engagement of the members;

FIG. 12 is a view like that of FIG. 11 during engagement; and

FIG. 13 is a view like that of FIG. 11 with the members engaged.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In order to more clearly explain and understand the invention, there are some observations and assumptions that should initially be discussed. It should first be noted that for the class of uncomplicated connecting members to which the improved connecting members have now been added, the insertion force during engagement and the retraction force during disengagement were generally found to be directly proportioned to the contact force between the connecting members after engagement. It is essential to recognize that the actual minimum insertion or retraction force required is that force which is required to overcome frictional forces between the members during engagement or disengagement respectively. The frictional forces between the members primarily depends upon the static and sliding coefficients of friction, which vary with the shapes, surface characteristics and basic materials of the members utilized, and upon the normal forces therebetween. It is assumed for this invention that any attempt to reduce the insertion or retraction force which relies upon a reduction of the static and/or sliding coefficients of friction would be equally applicable to all the members of the subject class of connecting members. However, the minimum normal force between all the unimproved connecting members of the class discussed hereinabove can be found to be equal to or greater than the contact force between the members when fully engaged. It is, therefore, the primary concern of this invention to disclose a concept whereby the normal force between the members during engagement and disengagement will be substantially less than the contact force when they are fully engaged. The resulting reduction in frictional forces this produces will in turn reduce the insertion and retraction force. It is with respect to these normal forces that the description hereinbelow is primarily directed to thereby provide a more simplified explanation of the invention.

It should further be noted that in the preferred embodiments discussed below, the deflectable connecting members are primarily presented in the form of cantilevers. However, since the normal forces resulting from the deflection on a cantilever throughout the anticipated operational ranges of the invention are substantially equal to those of a biased rigid beam, the later will generally be discussed and shown to simplify the disclosure. The primary difference between a cantilever and a rigid beam with regard to the invention is in the specific amount of deflection of each at various points along its length and it is felt that the disclosure below will sufficiently explain the significance of this deflection to enable one skilled in the art to properly practice the invention.

Referring to the drawings, FIGS. 1 through 4 show several views of a preferred printed circuit board 20 and edge board connector 22 which include various features of the invention. The edge board connector 22 includes a row of connecting elements 24 rigidly mounted therein. Only a selected number of elements 24 are shown in FIG. 1 to simplify the figure, but any number might be included in the connector 22 as desired without altering the basic invention.

Each connecting element 24 is stamped and formed from electrically conductive sheet metal and includes a pair of resiliently deflectable connecting members 26 and an external connecting portion 28, which in this instance is in the form of a post. The connecting portion 28 can be selected from a large variety of connecting means known in the art according to the particular desired application for the connector. Further, it will later become apparent that although being shown as having been formed from common material, the connecting members 26 might be physically separated and separately mounted within the connector 22 to satisfy a particular electrical configuration without altering their basic mechanical operation.

Each member 26 is rigidly supported within the connector 22 for pivotal deflection about a first end 30. As shown in FIG. 2, the member 26 is undeflected and maintained in a disengaged position, as it extends from the first end 30, by the natural resilience of the material from which the connecting element 24 is formed. The natural resilience of the member 26 is such that its deflection is opposed by a bending moment M around the end 30 which moment M remains substantially constant throughout the anticipated operational range of deflection of the member 26. Each member 26 further includes an extended end 32 and a contact area 34 which is located in an intermediate portion of the member 26. Curved portions 36 and 38 respectively at the end 32 and contact area 34 of the connecting member 26 will be discussed in detail hereinbelow.

The circuit board 20 to be received within the connector 22 includes a plurality of conductor paths 40 and a pair of cam bars 42. Each of the conductor paths 40 is arranged to mate with a corresponding connecting member 26 within the connector 22 with a contact area 44 on the path 40 aligned with the contact area 34 of the member 26. Each of the cam bars 42 is rigidly secured to its respective side of the board 20 at a predetermined distance X from the edge 45 of the board 22 as it extends transversely across the conductor paths 40 in an overlying manner without disturbing their electrical continuity. As a result of this configuration, each connecting member 26 has a mating connecting member 46 which includes a conductor path 40 and its corresponding portion of a cam bar 42.

To understand how the stated objectives of the invention are accomplished, the location of the curved portions 36 and 38 and their significance during insertion and as shown in FIGS. 2, 3 and 4, must be examined. The curved portion 36 locates the contact area 34 on the member 26 a distance Y from the pivoted end 30 so that the contact force Fc at the contact area 34 is equal to the moment M divided by the distance Y. The curved portion 38 is located at the extended end 32 to provide an interior surface 48 which is located about a distance Z from the end 30 which distance Z is substantially greater than Y and, in this preferred embodiment, approximately equal to twice the distance Y. A force F*d* opposing deflection of the member 26, if the deflecting force is applied at the surface 48, would equal the moment M divided by the distance Z. It is, therefore, apparent that the force F*d* is substantially less than the force F*c* and, in this preferred embodiment, approximately one-half of the force F*c*.

It is the purpose of the invention to provide structure to the connecting members 26 and 46 which result in a normal force therebetween which will equal the force F*d* during engagement and disengagement and will equal the force F*c* when they are fully engaged. As shown in FIGS. 2, 3 and 4 the alignment of the members 26 and 46 is such that the edge 45 of the printed circuit board 20 passes freely between the members 26 until a surface 50 of the cam bar 42 makes contact with the surface 48 of the curved portion 38 of the end 32. The distance X of the board 20 is sufficiently less than the distance between the curved portions 36 and 38, which generally equals distance Z minus distance Y, to insure that initial contact is made only at the surfaces 48 and 50. The limitation on the distance X becomes apparent when it is seen that the curved portion 36 extends into the potential path of the circuit board 20 when the connecting members 26 are in the disengaged position. Allowing initial contact at the surfaces 48 and 50 and then causing a deflection of the member 26 against the force F*d* by the relative movement of the cam bar 42 causes the curved portion 36 to be deflected out of the path of the board 20 so that the force F*c* is not applied to the member 46.

As the insertion causes the member 46 to approach the fully engaged position shown in FIG. 4, the surfaces 48 and 50 cooperate to decrease the deflection of the member 26 until the contact between the members 26 and 46 is transferred from the surfaces 48 and 50 to the contact areas 34 and 44. When fully engaged, the member 26 only makes contact with the member 46 at their respective contact areas 34 and 44 with a contact force F*c* therebetween. Since insertion continues only until the members 26 and 46 are fully engaged, the frictional forces therebetween which provide the opposition to the insertion force are a product of the force F*d* rather than the greater force F*c* which is necessary for a proper electrical connection between the members 26 and 46.

Although FIGS. 2, 3 and 4, are described as showing the connecting members during engagement, it can be seen that the nature and shape of the surfaces 48 and 50 are such that the description hereinabove for insertion is equally applicable for retraction. The retraction force applied to the board 20 will again be opposed by the frictional forces between the members 26 and 46. The slightest withdrawal of the board 20 will cause the contact between the members 26 and 46 to be transferred from the contact areas 34 and 44 to the surfaces 48 and 50. As a result, the attendant force between the members 26 and 46 is again force Fd rather than force F*c* to produce frictional opposition during disengagement which is generally equal to that encountered during engagement. With the curved portion 36 again withdrawn so that it no longer makes contact with the member 46, the retraction force is generally equal to that which had been required for insertion.

It should also be observed from the description above that while providing for lower insertion and retraction forces an attendant feature of the invention is a minimization of wear at the contact areas of the members. Providing means for shifting the normal force between the members from the contact areas during engagement and disengagement effectively limits the amount of surface wear at the contact areas which might otherwise decrease the effective life of the members.

An alternative embodiment of the invention is shown in FIGS. 5, 6, 7, and 8 in the form of an edge board connector 60 and a printed circuit board 62. Although any number of connecting elements 64 might be utilized in the connector 60, only a selected number are shown. Each element 64 includes a pair of connecting members 66 and an external connecting portion 68 in the form of a crimped ferrule in which the conductor of a wire 70 has been secured. As with connecting elements 24, the connecting members 66 of elements 64 might be separately formed and mounted as desirable for a particular electrical configuration.

The connecting element 64 is rigidly mounted within a base portion 72 of the connector 60 with an extended end 74 of each connecting member 66 extending outwardly therefrom. Each connecting member 66, like member 26 described above, is designed for biased, pivotal deflection about a fixed end 76. However, the corresponding extended ends 76 of each connecting element 64 rather then being free are respectively aligned with each of a pair of commoning bars 78. Each commoning bar 78 is capable of movement to collectively deflect each of the corresponding extended ends 74 of the members 66 from their normal disengaged position as shown in FIG. 6. Although it should be apparent that a commoning bar could be provided which is rigidly secured to all of the corresponding ends 74, a floating arrangement has been selected for the preferred connector 60. To maintain the commoning bar 78 in alignment with the ends 74 and to insure that there is no relative movement therebetween during deflection of the member 66 by the movement of the commoning bar 78, each of the commoning bars 78 is mounted at its opposite ends 80 a fixed distance from the base portion 72 by each of a pair of flexible spacers 82 extending therebetween. The spacers 82 are designed to resist movement of the commoning bar 78 in all directions except that which is transverse to the direction of insertion of the board 62. A guide means 84 is provided at each end of the connector 60 which rigidly extends from the base portion 72 to protect the spacers 82 and bars 78 and to limit their transverse travel by the notches 86 provided therein to that travel well within the expected range of deflection of the member 66.

The printed circuit board 62 which is intended to cooperate with the connector 60 includes a plurality of conductor paths 88 arranged so that each will be aligned with a corresponding connecting member 66. When the board 62 is fully inserted within the connector 60, a first contact area 90 on each member 66 makes electrical contact with the corresponding conductor path 88 at a second contact area 92.

To obtain the camming action required for the invention, the commoning bars 78 are provided with cam lugs 94 and the board 62 is provided with corresponding holes 96. Specifically, in this embodiment, each camming surface associated with the board 62 includes the edge **98**, the surface **100**, and the forward edge of a hole **96** which are all located between the conductor paths **88** of the board **62** to prevent contact therewith during engagement. The cam lugs **94** are located on the bars **78** in alignment with the holes **96** and the specific number of lugs **94** and holes **96** selected generally depends upon the length of the connector **60** and the number of elements **64** housed therein and the ability of the bars **78** to uniformly distribute the deflection force to the connecting members **66**. Although the actual normal force at each lug **94** will depend upon the number of deflected members **66** which proportionally act thereon, it can be adequately assumed for an analysis of the relative effects on friction that the connecting member **66** shown in FIGS. **6, 7** and **8** contributes its proportional share to the force at the lug **94** when it is deflected. As a result, in the analysis hereinbelow only this proportional share of the total force will be discussed while recognizing that the actual frictional forces encountered will be produced of all of the members **66** in the connector **60**.

Accordingly, it can be seen that the connecting member **66** shown in FIGS. **6, 7** and **8** is sufficiently similar to the member **26** described hereinabove to establish that the contact force at contact area **90** is about twice the proportional amount of force needed to deflect the member **66** if it is applied at the lug **94**. However, there are some differing features of the members **66** and **26** which are of significance. Unlike the extended end **38** of member **26**, the cam lug **94** must extend into the path of the board **62** in order to be properly aligned with the edge **98**, the leading portion of the camming surface associated with the board **62**. It should also be noted that the amount the lug **94** extends into the path of the board **62** when the member **66** is in the disengaged position, as seen in FIG. **6**, is greater than the extension of the contact area **90** into the path.

When the board **62** is moved into engagement with the connector **60**, the members **66** are deflected against biasing by the camming action of the board edge **98** acting on the lug **94**. The deflection remains substantially constant as the lug **94** is in sliding contact with the surface **100** as shown in FIG. **7**. The distance D_1 between the edge **98** and the hole **96** is greater than the distance D_2 between the lug **94** and the contact area **90** so that positioning the lug **94** at the hole **96** will cause the contact area **90** to overlie the board **62** for alignment with the contact area **92** of the corresponding conductor path **88**. Therefore, the extension of the contact area **90** into the path of the board **62** as compared with that of the lug **94** when the member **66** is in the disengaged position must be such that the area **90** is adequately withdrawn from the path during engagement to allow contact-free overlapping of the board **62** until the lug **94** is aligned with and positioned within the hole **96**. At complete engagement, the lug **94** extends into the hole **96** without making contact with its edges to shift the contact between the member **66** and the board **60** to the contact areas **90** and **92** with the attendant contact force being about twice the proportional force applied at the lug **94** as a consequence of the deflection of the member **66**. Disengagement again deflects the member **66** by a lifting movement on the lug **94** as a result of the camming by the forward edge of the hole **96** to again cause the lesser force to be applied to the board **62** and thereby limit the frictional forces in opposition to disengagement.

Since the embodiment shown in FIGS. **5** through **8** does not include a camming surface for the board in the form of a cam bar, there is some contact between the member and the board in a region which includes the conductor paths and their associated contact areas. However, by locating the camming surface associated with the member and the board in a common plane which is different from and not aligned with the plane in which the respective contact areas are located, the engagement and disengagement can be accomplished without producing sliding contact at the contact areas which would otherwise cause wear and thereby decrease their effectiveness.

In an effort to demonstrate the diversified application of the invention disclosed herein, alternative embodiments are shown in FIGS. **9** and **10** from which it can be seen that a wide variety of configurations could be utilized to provide multi-contact connectors providing high contact force but relatively low insertion force. For example, the embodiment shown in FIG. **9** includes a female contact **102** and a male contact **104** which could include any desired terminal end and could be mounted in any suitable manner to provide for their alignment during engagement. Female contact **102** includes a pair of resiliently deflectable connecting members **106** similar to those found in the connector **22** and also including a contact area **108** and an extended end **110** to provide a camming surface. The male contact **104** is a rigid member having a pair of contact areas **112** at opposite edges of its forward end and a pair of camming lugs **114** which act in a manner similar to the cam bar **42** of the board **20**. Providing the contacts **102** and **104** with relevant dimensions consistant with those utilized in the embodiment shown in FIGS. **1** through **4**, the camming action between the contact **102** and **104** satisfy low insertion force requirements during engagement and disengagement without detrimental wear at the contact areas **108** and **112** but with a relatively high contact force therebetween when fully engaged.

Although a two-sided configuration is shown, in FIG. **9**, it should be apparent that a multi-sided arrangement is equally applicable if desired. A stamped and formed or machine turned socket would provide the same function as the contact **102** by including a plurality of members such as member **106** arranged in a side-by-side manner to form a cylindrical receptacle while each retains the capability of independent deflection away from the central axis. The pin portion of the multi-sided configuration could be stamped and formed or machine turned to a cylindrical form while having a cross-sectional shape like that of contact **104**.

Still another alternative is shown in FIG. **10** which includes various features of the invention. Mating contact **120** and **122** are shown in the fully engaged position and are respectively mounted in supports **124** and **126** which are only partially shown but are intended to include sufficient structure to maintain the contacts **120** and **122** in the desired alignment during engagement. The terminal ends of contacts **120** and **122**, not shown in FIG. **10**, might again include any desired configuration selected from the large variety of electrical terminating means known in the art.

The contact **120** is resiliently deflectable and capable of pivotal movement about its end **128** mounted at the support **124**. A forked extended end **130** provides a pair of spaced-apart camming surfaces **132** similar to those provided by the lugs **94** described hereinabove.

A contact area **134** is located on a curved intermediate portion **136** of the contact **120**. The relevant dimensions and forces characteristic of the member **66** above are similarly applicable for the contact **120**.

The contact **122** is a rigid member extending outwardly of the support **126** from a U-shaped base portion **138** to a flat, extended end portion **140** with a contact area **142** at one side thereof. The contact has been formed to provide an intermediate portion **144** including the positive transition from the wide end portion **140** to the narrower base portion **138** which can be received between the camming surface **132** without making contact therewith.

Since the relevant dimensions of the contacts **120** and **122** are similar to those of the connecting members shown in FIGS. **5** through **8**, the normal force therebetween is again minimized during engagement. However, unlike those members described above, there is some sliding contact at the contact area **142** during engagement, but since it is limited to the marginal edges of the extended end **140**, there is an area therebetween free from contact prior to full engagement. This embodiment demonstrates how wiping, which is sometimes considered desirable, can be provided. Since the normal forces producing the wiping are less then the contact force, this configuration would be desirable if it was felt that the amount of wear produced by the contact force would be excessive. Further aspects of wiping with regard to the invention will be discussed below.

In the embodiments hereinabove, there is basically included a resiliently deflectable member and a mating rigid member. FIGS. **11, 12** and **13** show a hermaphroditic connector **150** having mating pairs of identical, resiliently deflectable connecting members **152** which include the various features of the invention.

Specifically, a pair of identical connector halves **154** and **156** form the connector **150**. Each half **154** and **156** has retention means **158** by which the connecting member **152** is supported and a cavity **160** into which the member **152** extends. The sidewalls **162** of each half **154** and **156** include a guide means **164** so that the sidewalls **162** and guide means **164** cooperate to insure accurate and reliable alignment of the connector halves throughout engagement and disengagement. A cam surface **166** adjacent the retention means **158** and projecting into the cavity **160** will be explained below.

Each connecting member **152** is stamped and formed to include a deflectable portion **168** and a terminal portion **170**. The terminal portion **170** is crimped or otherwise electrically and mechanically secured to a flat-flexible cable **172** and a corresponding conductor path therein. The terminal portion **170** is then secured to its respective connector half **154** or **156** by the retention means **158** so that the deflectable portion **168** extends into the cavity **160** to be capable of pivotal deflection therein about a point **174** at its supported end. An extended end **176** of the portion **168** is similar to the extended end **38** described hereinabove and a contact area **178** is located between the end **176** and the point **174**. In this embodiment, the distance X_2 between the point **174** and the end **176** is about three times the distance Y_2 between the point **174** and the contact area **178**. As a result, the deflecting force would be about one-third the contact force to provide a correspondingly reduced frictional opposition to engagement and disengagement.

In FIG. **11**, with the connector halves **154** and **156** are partially engaged, it can be seen the respective members **152** are in overlapping alignment when in an undeflected position such that continued engagement without an accompanying deflection would result in contact therebetween in the region of the contact areas **178**. However, with further engagement, as shown in FIG. **12**, each extended end **176** is cammed by the cam surface **166** of the other connector half **154** or **156** to thereby deflect the member **152** against the lesser normal force to withdraw the contact areas **178** and initially prevent their mutual engagement at the higher contact force. At full engagement, as shown in FIG. **13**, the contact between the member **152** and connector half **154** or **156** with which it mates is shifted to the contact areas **178** at full contact force to provide the desired electrical connection without excessive wear at the contact areas **178** or the need for excessive force for engagement. As in the embodiments previously presented, the advantages found during engagement are also present during disengagement.

While there has been shown and described various preferred embodiments of the invention, it will be obvious to those skilled in the art that changes and modifications may be made therein without departing from the claimed invention. For example, if it were felt desirable to alter the connection to resist rather then assist disengagement for a particular application, the coefficient of friction could be increased by altering the slope or character of the surfaces during disengagement to thereby increase the friction in opposition to the disengagement.

If, for another example, wiping of the contact area is felt essential but wear is not considered a problem, continued movement in the direction of engagement after full engagement on any of the embodiments above would wipe the contact areas. The small amount of travel necessary for this wiping could make the method acceptable even though the contact force would be present during the wiping.

If wear is considered a problem, the embodiment shown in FIG. **10** demonstrates how wiping could be obtained at a reduced normal force. If the reduced normal force would still cause too much wear, it would be possible to align the extended end of a cantilever member for sliding contact with the contact area of the rigid member at a deflection substantially less than the anticipated operational range utilized in the preferred embodiments. This reduced deflection of a cantilever would be at a normal force substantially less than any force previously discussed. During the engagement, the extended end would wipe the contact area of the rigid member at the lesser normal force and then a properly designed camming surface associated with the rigid member could further deflect the cantilever member in manner described hereinabove to allow the engagement while reducing the resistance to insertion.

What is claimed is:

1. An improved pair of mating connecting members each having contact areas for interconnecting electrical conductors; said members being of a type capable of being individually mounted for engagement and disengagement along a path which is generally parallel with the longitudinal axis of said members; at least one of said members being normally biased to a disengaged position and to provide a predetermined contact force at said contact areas in a generally transverse direction when said members are engaged; said improvement comprising:

surfaces associated with each of said members cooperating during engagement to perform a camming action to deflect said one of said connecting members against said biasing to cause it to pivot about one end of said one of said members to maintain a first of said contact areas which is on said one of said members disposed from the other of said members until said members are substantially fully engaged, said surfaces being aligned to maintain a second of said contact areas which is on said other of said members away from said one of said members until said members are substantially engaged, said surface associated with said other of said members being disposed along said axis of said other of said members at a location which is more remote from said one of said members than said second contact area so that during said engagement said one of said members generally overlies said second contact area without making contact therewith prior to any said deflection of said one of said members from said disengaged position,

said camming action being applied to a region of said one of said members which is more remote from said one end of said one of said members than said first contact area; and

said biasing of said one of said members causing said one of said members to be more resistent to a deflecting force applied at said first contact area than at said region,

said one of said connecting members comprising a metallic, electrically conductive cantilever with said biasing including natural resilience of said cantilever against deflection and said surface associated with said cantilever is located on its curved extended end which includes said region,

said other of said connecting members comprising a conductor path of a printed circuit board and said surface associated with said conductor path is a cam bar mounted on said board and extending transversely across said conductor path,

whereby the insertion force during engagement is lessened by causing said deflecting force to be applied at said region rather than at said first contact area.

2. An improved low insertion force edge connector for printed circuit boards and the like, said boards having a plurality of parallel spaced contact pads along at least one edge thereof and a cam bar fixed extending transversely across said pads parallel to but spaced from said edge, said connector comprising:

an elongated housing having an elongated circuit board receiving aperture in one side thereof, a plurality of contact passages extending from another side of said housing into said aperture,

a like plurality of contacts stamped and formed from electrically conductive sheet metal, each said contact comprising a terminal connecting portion adapted to pass through said contact passages to mount said contacts in said housing, and an integral U-shaped yoke portion comprising a pair of spaced apart cantilever members joined at the base of said yoke and biased to a preset position against deflection by the natural resilience of said metal, each said cantilever member having a cam surface on the free end thereof directed towards the other cantilever member and a contact surface intermediate the length of said cantilever member also directed towards the opposite cantilever member, said cam surfaces being spaced apart a distance greater than in the distance between said contact surfaces,

whereby upon insertion of a circuit board into said connector, said board initially passes between the free cam surface ends of said contacts without making substantially any contact therewith until said cam surfaces subsequently engage said cam bar causing said cantilever arms to spread apart against the inherent biasing of said metal, said spreading causing said contact surfaces to be spaced apart sufficiently to allow passage of said board therebetween until said cam surfaces pass over said cam bar at which time said cantilever arms are biased toward their preset position with said contact surfaces engaging said pads.

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