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S. STRAUS
DIGITAL CONNECTOR

3,395,377

Filed March 22, 1966

2 Sheets-Sheet 1

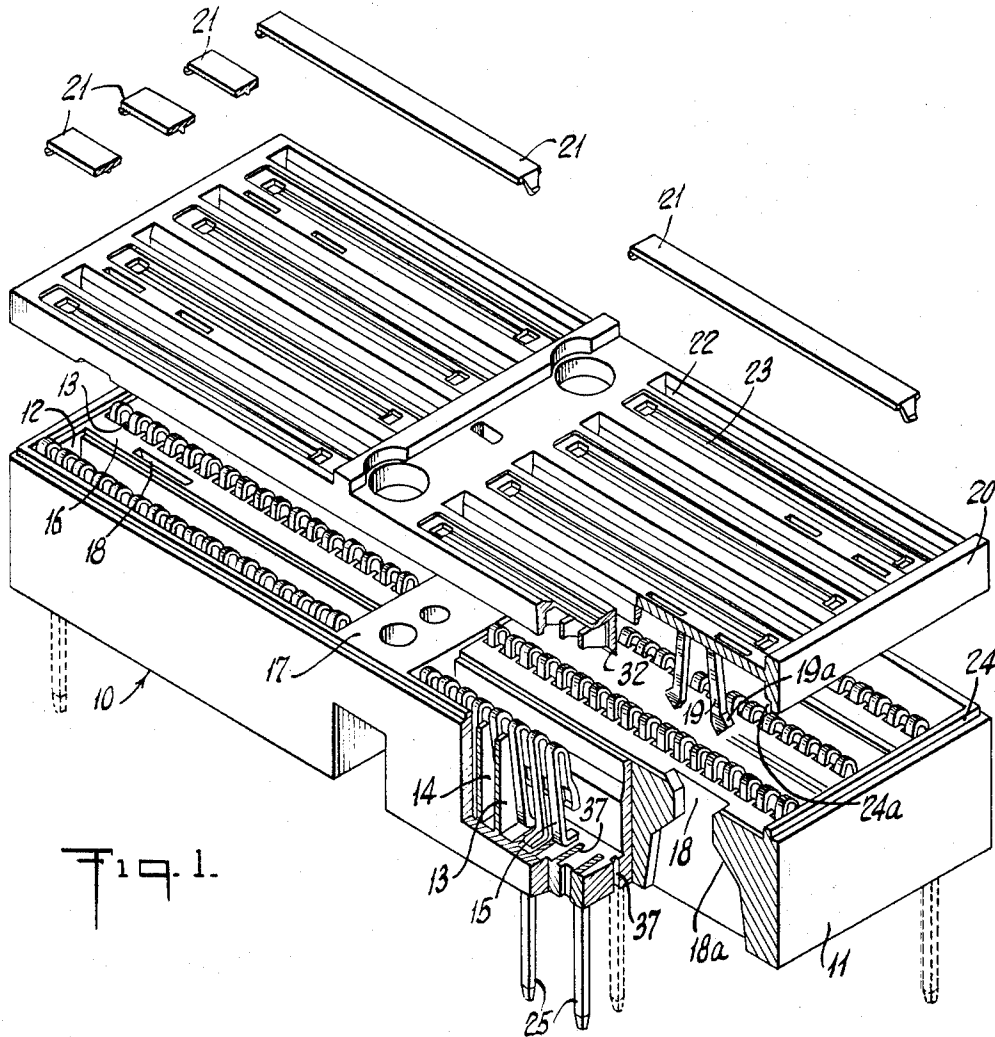


Fig. 1.

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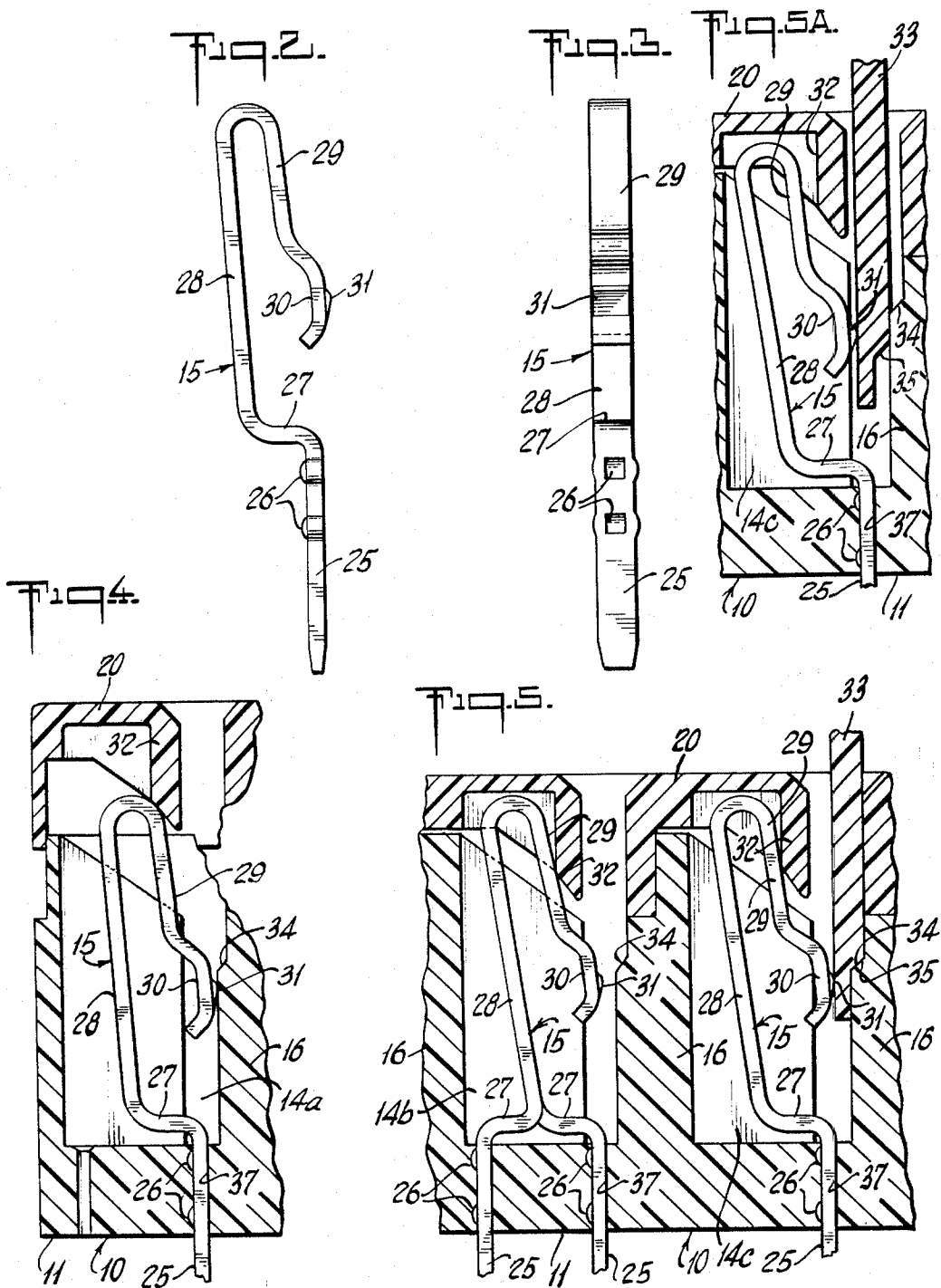
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ABSTRACT OF THE DISCLOSURE

An electrical connector for receiving a printed circuit board. The connector includes an insulated body which has an elongated slot disposed along the longitudinal axis thereof and a plurality of substantially equally spaced transverse walls which define a plurality of compartments within the slot. A spring contact is disposed in each of these compartments, and each spring contact has a portion extending from the surface of the insulated body and a hooked portion disposed within the compartment to be deflected to a given operating position by the printed circuit board. A preloading means is provided for preloading the hooked portions of the spring contacts, and the preloading means engages these hooked portions of the contacts for deflecting them part of the way toward their given operating position prior to insertion of the printed circuit board into the compartment, so that the extent to which the printed circuit board is required to deflect and stress the contacts until they reach their operating positions is diminished by the extent of deflection of the contacts by the preloading means.

The present invention relates to electrical connectors and in particular to a connector and an associated spring contact which is capable of making electrical connections with a printed circuit board having printed circuits on one side thereof.

As applications for digital techniques increase, greater emphasis is placed on equipment cost and reliability of operation, space requirements and ease of maintenance. The extent to which these objectives are achieved depends to a considerable degree on the mechanical packaging of the electronic circuitry. Not the least of these considerations is the printed circuit board connector. The connector must be designed so that it can be mass produced economically and yet operate with high reliability over a period of time commensurate with the capital investment of the user. Due to the large number of contacts and wire terminations in many digital systems, the connector becomes an important factor in the overall system reliability.

In such connectors it is essential that the connection be firmly and securely made; and furthermore it is essential that the connection once made be retained for long periods of use under severe environmental conditions.

It is also important in a connector of the type described, to control the insertion force of the printed circuit board into the connector in relation to the wiping action of the contact on the printed board. The insertion force should be held to a minimum commensurate with the number of contacts and the wiping pressure should be of a predetermined optimum value determined by the specific application. The withdrawal force should be substantially greater than the insertion force or the wiping force.

In presently known printed circuit board connectors, the initial insertion force is generally much greater than the wiping or withdrawal force. It is furthermore a problem of present printed circuit board connectors, that in the insertion of the boards into the connection, the inserting fiberglass edge of the board rubs against the con-

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tact area of the spring contact causing contamination of the contact areas of the spring contact and on the printed circuit board.

When the printed circuit boards are utilized in an atmosphere which is corrosive to metals, it is desirable to maintain an optimum pressure between the spring contact and conducting areas of the circuit board. If this pressure is too great, galling or a cold weld may result, and if the pressure is too low, an oxidizing film may form on the contact areas to thereby create a defective electrical connection between the spring contact and printed circuit board.

It is, therefore, an object of the present invention to provide an electrical connector for use with a printed circuit board in which the printed circuit board is firmly retained within the electrical connector once inserted therein.

It is a further object of the present invention to provide an electrical connector in which the force required to insert the printed circuit board into the connector is substantially reduced.

It is a further object of the present invention to provide an electrical connector for use with printed circuit board in which during the insertion of the printed circuit board into the connector, the fiberglass end of the board does not contact the contact area.

It is yet another object of the present invention to provide an electrical connector and associated spring contact in which the spring contact is preloaded, and in which the geometric configuration of the spring contact provides for an optimum force between the spring contact and the inserted printed circuit board.

It is a further object of the present invention to provide a printed circuit connector in which the spring contacts act as a self-energizing brake to retain the printed circuit board in the connector body.

It is also an object of the present invention to provide for extended life of the connector and the printed circuit board by providing optimum essential contact pressure and reduction of contact travel. This optimum contact pressure will also greatly reduce contamination of the contact point and the printed circuit board conducting areas.

In accordance with the above objects, the present invention provides an electrical connector in which spring contacts, having a predetermined geometric configuration, are placed within spaced compartments within the electrical connector. The interior surface of the connector body includes a ramp surface of size and configuration adapted to provide accurate location of the printed circuit board contact areas in relation to the spring contacts. The ramp surface of the connector, engages with a corresponding bevel in the printed circuit board profile during the insertion of the board into the connector, and provides a condition whereby the printed circuit board enters and makes contact with the spring contacts with a minimum force exerted on the spring contacts. This action eliminates the initial high insertion force and also reduces the friction between the spring contact and the connecting elements on the printed circuit board.

The printed circuit board is then further inserted within the connector cavity, at which time the mating camming surfaces on the board and connector are disengaged and the printed circuit board then exerts a force on a preloaded spring contact to obtain the wiping or conducting action between the spring contact and the conducting portion of the printed circuit board. At this point the only force acting upon the printed circuit board is the force exerted by the spring contact.

Upon a tendency of the printed circuit board to withdraw from the connector, the spring contact member by

virtue of the geometric configuration thereof, exerts a self-energizing braking action causing the spring contact to exhibit a high withdrawal force, thus automatically preventing vibration of the printed circuit board out of the contact area.

The wiping action forces are determined by the preloading feature of the design of both the spring contact and the connector mold. A cover is designed to snap onto the connector body after the spring contacts are placed into the connector. The cover includes a retainer lip which abuts the contact so that as a result of the geometry of the contact and the cover, the contact is pre-stressed or preloaded at a specific predetermined force prior to the insertion of the printed circuit board. Thus, the contact is initially deflected in this way through part of the distance toward the operating position it assumes when pressed against by the printed circuit board, so that the extent to which the latter need stress and deflect the contact is diminished by this amount of initial preloading and deflection of the contacts. The insertion of the printed circuit board permits unrestricted movement of the spring contact within certain specified pressures. The limits of this pressure are so designed as to prevent contamination on the conducting areas of the printed circuit, and to effect a wiping action between the printed circuit board and the spring contact. Furthermore, because of the preloading of the spring, the board enters the connector body without contacting the surface of the spring contact.

Another feature of the present invention is a button of gold, or other precious metal having high conductivity, welded upon the spring contact where it makes contact with a conductor of the printed circuit board in order to increase the conductivity of such contact connection.

Other objects of the present invention will become apparent from the following details description when read in conjunction with the attached drawings, in which:

FIG. 1 is an isometric view, partly broken away and partly in section, of a preferred embodiment of the present invention showing the connector body, the contacts and the snap-on cover, prior to the insertion of a printed circuit board within the connector;

FIG. 2 is a side elevational view of a spring contact according to the present invention;

FIG. 3 is a front elevational view of the spring contact viewed from the right hand side of the contact when viewed as in FIG. 2;

FIG. 4 is a cross sectional view of a portion of the connector illustrated in FIG. 1 prior to the insertion of the printed circuit board into the connector and prior to the placement of the snap-on cover onto the connector;

FIG. 5 is a view similar to FIG. 4 showing the snap-on cover in place on the connector, and showing the initial phase of the insertion of the printed circuit board; and

FIG. 5a is a view similar to FIGS. 4 and 5, showing the printed circuit board completely inserted into the connector.

Referring to the drawings, there is shown in FIG. 1 a preferred embodiment of the invention. Here a connector 10 comprises a rectangular body 11 which has eight elongated slots 12 formed therein. The slots 12 extend in the axial direction of body 11. Within each slot there are disposed a plurality of compartment defining walls 13 extending transversely of the slot in sequence along the length of each slot 12. A series of compartments 14 are defined by walls 13, each compartment being adapted to receive a spring contact 15 with a press fit therein. Slots 12 are separated by longitudinal walls 16 and a central dividing wall 17 extending transversely of the body 11. Inwardly expanding slots 18, which are disposed within the longitudinal walls 16, are adapted to receive divergent resilient legs 19 which extend from the lower surface of a snap-on cover 20. The inwardly expanding slots 18 are enlarged a short distance from their openings to form divergent ramp-like surfaces 18a for making holding contact with hooked end portions 19a

of the legs 19. Thus the resilient legs will hold the snap-on cover 20 upon the body 11; but the cover may be removed therefrom by applying sufficient force thereto.

Snap-on cover 20 also contains slots 23 for receiving color coding strips 21, one of said strips being placed over each of slots 23. The color of strips 21 indicates to the technician the nature of the printed circuit board (not shown) which is inserted through apertures 22 into connector 10. Connector body 11 also contains location ridges 24 for mating with an inner chamfer 24a on the rim of the snap-on cover 20 for precise positioning of the cover in relation to established reference points.

Body 11 contains a plurality of openings 37 at the bottom surface thereof, extending out of the compartments 14, through which terminals 25 of spring contacts 15 pass, to receive the external voltage or signal input.

The configuration of spring contact 15 is best shown in FIGS. 2 and 3.

A terminal end 25 of each spring contact 15 has bosses 26 formed thereon for mating with recesses within connector body 11 to help retain the spring contact in the body. A bend 27 is further formed in the spring contact 15 to form an offset portion 28 of the contact formed which is given a reverse bend to form an arm 29 thereof.

The arm 29 terminates in an arcuate portion 30 of the contact spring 15 which is bowed outwardly of the offset portion 28. Thus there is formed a hooked portion of the spring which is disposed within the compartment 14, as best shown in FIG. 4. Upon the convex surface of the arcuate portion 30 the button of gold 31 is disposed to form a contact of the spring 14. This contact preferably consists of a .003-inch thick 24-karat gold, of tear-drop shape, which is resistance welded to the arcuate portion 30.

It should be noted that the welded gold contact has several important advantages. The 24 karat material provides a substantially higher resistance to the formation of corrosion films than gold-silver alloy contacts and is free of pores. The tear-drop shape of the button of gold on bead 31 provides the necessary "plowing action" required to break through the oxidation formed on the printed circuit board contact surfaces and also to remove the residue of disrupted films, which is an important source of contact contamination. This residue, composed of minute fragments of broken (non-conducting) films, is created with each contact wipe in which a tarnish film is ruptured. With successive insertions in certain environments, the debris can accumulate on the contact surfaces to the point where it interferes with metallic contact, thus causing high and unstable contact resistance.

An important feature of snap-on cover 20 is a retaining lip 32 which will preload and retain contact spring 15 in such a manner as to permit the printed circuit board to be inserted partially before contact deflection occurs. This allows the printed circuit boards to be inserted by "feel" constituting a great improvement over the present designs. In addition to furnishing the pretensioning surface, snap-on cover 20 provides protection against air circulation past the contacts. Experience has demonstrated that contacts so protected are consistently less affected by corrosive atmospheres than if unprotected.

Referring now to FIG. 5A, connector 10 and contact member 15 are shown, illustrating the means by which a printed circuit board 33 is mounted into the connector 10 to make contact with spring contact 15.

In compartment 14a (FIG. 4), the connector is shown with a spring contact 15, placed in compartment 14a, prior to the placement of cover 20 thereover and, of course, prior to the insertion of the printed circuit board therein. It is seen that the non preloaded contact 15 abuts the surface of wall 16 of the adjacent compartment.

With reference now to compartment 14b (FIG. 5), there is shown a spring contact 15 placed in position therein, prior to the insertion of printed circuit board 33. The spring contact 15 is preloaded by the operation of

the retaining lip 32, which extends from snap-on cover 20. It is also within the scope of the invention to hingedly connect lip 32 to wall 16 of connector body 11. Lip 32 of cover 20 abuts against section 29 of spring contact 15 to preload the contact prior to the insertion of printed circuit board 33 within connector 10. Thus contact 15 is already in a preloaded, partially deflected state prior to the insertion of the printed circuit board, so that the extent to which the board must further deflect the contact 15 is diminished by the initial, partial deflection thereof by the lip 32. The contacting button 31 is now seen to be laterally displaced away from the wall of the adjoining compartment.

One side of wall 16 is formed into a ramp surface 34 having an angle of approximately 45°. Printed circuit board 33 is given a corresponding bevel surface 35 upon its connector-entering end, which bevel is formed to mate with ramp surface 34, upon insertion of the board into the connector 10. Thus, when the printed circuit board 33 is partially inserted into the connector 10, as in compartment 14c, (FIG. 5) the narrowed, leading end of the board does not contact the gold contact 31 until the bevel surface 35 encounters ramp surface 34 of the longitudinal wall 16. At the same time the printed face of the board makes initial contact with the button of gold 31 upon the spring contact 15 within the compartment 14. Further insertion of the board, as in compartment 14d, (FIG. 5a) into the compartment causes the bevel surface 35 on the board to slide over the ramp surface 34 and the board to slide and be deflected transversely of the compartment. Such transverse sliding brings the board into more forceful contact with the button of gold 31 and to move over the button with a wiping action. At the same time the spring contact 15 is further stressed to give more forceful contact between the printed circuit board 33 and the spring contact 15. It is noted that at this point of insertion, the lip 32 no longer contacts spring contact 15, and so the entire tensioning force on spring contact 15 is now exerted by the force of printed circuit board 33.

By virtue of the preloading of the spring contact by the cover and lip construction, and the camming action between surfaces 34 and 35, the board may be inserted into the connector and positioned against the spring contact with a minimum of force exerted on the spring contact. This operation therefore eliminates the initial high breakaway or insertion force required in known circuit board connectors.

The spring contact length and geometry are such as to obtain approximately 5 grams of pressure for .001" of deflection. This produces the desired 250 grams of pressure with a deflection of approximately .050". This spring, however, will be preloaded at approximately 190 grams by the lip 32 of the snap-on cover 20, leaving an additional deflection corresponding to 0.12" and an additional pressure of 60 grams to be imposed by printed circuit board 33. The additional deflection and the additional pressure will occur after printed circuit board 33 has entered the body of connector 10 and has passed contact button 31 of spring contact 15. This design eliminates the wear and contamination of spring contact 15 which is bound to occur with present designs of printed circuit boards when such boards pass over the gold button with considerable pressure. In the embodiment shown in FIG. 1, a total number of 144 of spring contacts 15 are assembled into a connector block to form the complete connector where the spring contacts are divided into eight groups of 18 contacts each. Within each group the spring contacts 15 are located on .125 inch centers. Alternate spring contacts are formed to provide .250 inch staggered grid spacing to facilitate wire wrapping operations. The connector end of the spring is machined-formed to the correct configuration of the proper spring action.

The spring contact is designed to provide 250 grams \pm 60 grams of force on the board at the gold contact button including all possible variations in the board, con-

necter body and spring contact material. There will be some degradation of the contact force with time, however, due principally to stress relaxation of the phosphor-bronze wire. It is important to insure against contact force exceeding 310 grams in order to avoid cold welds and galling between spring contact 15 and the contact surfaces on the board. Thus, the spring design force of 250 ± 60 grams will satisfy all requirements over the life of the connector.

The differences between insertion and withdrawal force is a function of the geometry of contact spring 15 and the preloading tension thereon. Upon insertion of the printed circuit board, the spring contact is deflected and the resistance to deflection is effected principally at the bend between the offset portion 28 and the arm 29 of the spring contact. Upon any tendency of the printed circuit board to withdraw from the connector, the friction of this resistance tends to act as a self-energizing brake, thereby retaining the printed circuit board within connector 10.

While I have shown a preferred embodiment of my invention, it is my intention that the scope of the invention be limited not to the embodiment shown, but rather by the scope of the claims which are appended claims.

What is claimed is:

1. An electrical connector for receiving a printed circuit board comprising, an insulated body having an elongated slot disposed along the longitudinal axis thereof, a plurality of substantially equally spaced transverse walls defining a plurality of compartments within said slot, a spring contact disposed in each of said compartments, each having a portion thereof extending from the surface of said insulated body and a hooked portion disposed within said compartment to be deflected to a given operating position by said printed circuit board, and each compartment having a wall portion at an elevation higher than said spring contact therein and preloading means extending downwardly from said wall portion for preloading the hooked portions of said contacts and engaging said hooked portions for deflecting them part of the way toward said operating position prior to insertion of said printed circuit board into said compartment, so that the extent to which the printed circuit board is required to deflect said contacts to said operating positions thereof is diminished by the extent of initial, partial deflection of said contacts by said preloading means.

2. An electrical connector assembly for receiving a printed circuit board comprising, an insulated receptacle, having a plurality of separated compartments, a spring contact of conducting material inserted into each of said compartments to be deflected by the printed circuit board to a given operating position, and a cover having a downwardly extending lip constituting means for preloading each of said spring contacts, said lip engaging and holding each of said spring contacts in a position partially deflected toward said operating position, so that the extent to which each contact is deflected by said printed circuit board is diminished by the initial extent of deflection thereof by said lip.

3. An electrical connector according to claim 2 wherein said spring contact comprises a strip of resilient metal shaped into a hook portion at the upper end thereof, and a bead of a highly conductive metal secured to the region of the lower end of said hook portion.

4. An electrical connector according to claim 2 wherein said receptacle comprises a plurality of upstanding longitudinal walls defining said compartments, each of said walls having an upper edge and below the latter a ramp formed therein at the elevation of a region of each contact which is engaged and deflected by the printed circuit board into said operating position, said ramp thus constituting means for laterally deflecting the printed circuit board during insertion thereof into said connector after initial engagement of each contact by said board.

5. An electrical connector according to claim 2 where-

in said receptacle further comprises a mounting ridge extending around the perimeter thereof, constituting means for positioning said cover into proper orientation with respect to said compartments.

6. An electrical connector according to claim 2 wherein said cover comprises downwardly extending resilient members, and said receptacle contains slots disposed therein for receiving said resilient members.

7. An electrical connector according to claim 6 wherein said resilient members contain a ramp section, and said slot has a projection formed at the upper section thereof mating with the ramp section of said resilient member.

8. In combination with a printed circuit board having electrical contact areas over one face thereof, a leading insertion end, and a bevel at an opposite face thereof spaced from said leading insertion end to provide said board with a thickness between said bevel and said insertion end thereof which is less than the thickness of said board at the side of said bevel opposite from said leading insertion end, an electrical connector comprising an insulated body having an elongated slot along the longitudinal axis thereof, a plurality of upstanding walls defining a plurality of compartments, a spring contact in each of said compartments and having a portion to be engaged by said printed circuit board at said one face of the latter, said wall having a ramp substantially at the elevation of said contact portion and of substantially the same inclination as said bevel on said opposite face of said printed circuit board so that said board will initially engage said portion of said contact at the thinner part of said board which extends from said bevel to said leading insertion end thereof and will then be deflected by coaction of said ramp and bevel further into pressing engagement with said contact, said ramp and bevel thus

comprising means for reducing the insertion force of said printed circuit board into said connector.

9. In combination with a printed circuit board according to claim 8 further comprising a cover fitted over said body having a slot therein for inserting said printed circuit board therethrough, and a lip downwardly extending from said cover and engaging and initially deflecting each contact part of the way toward the position to which the contact is thereafter deflected by said printed circuit board, said lip thus constituting means for preloading said spring contact prior to the insertion of the printed circuit board into said connector.

10. In combination with a printed circuit board according to claim 8 wherein said spring contact comprises a strip of resilient conductive metal having a hook portion formed at one end thereof and constituting said portion of said contact which is engaged by said board, and a gold bead welded to said hook portion.

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