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3,242,456

ELECTRICAL CONNECTOR WITH SPRING PIN CONTACT

Filed Oct. 7, 1963

FIG. 1.

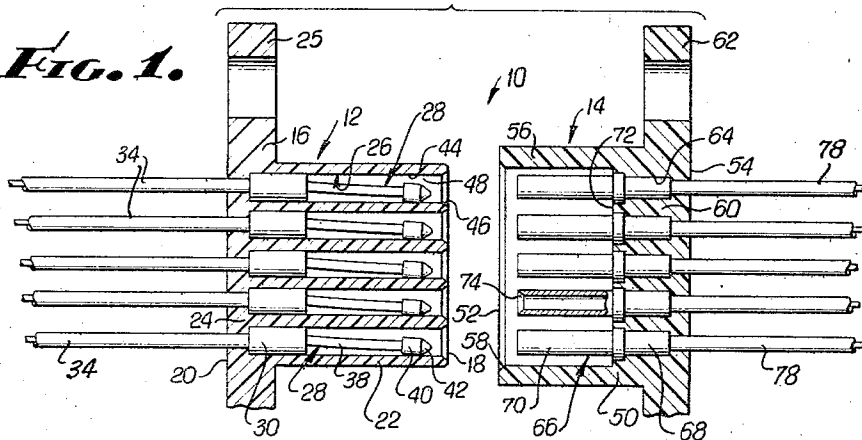


FIG. 2.

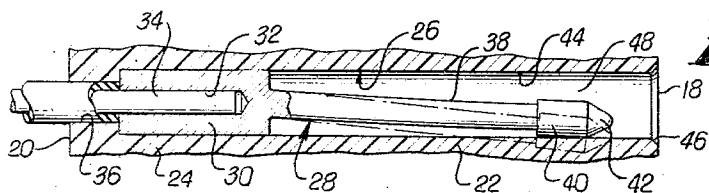


FIG. 3.

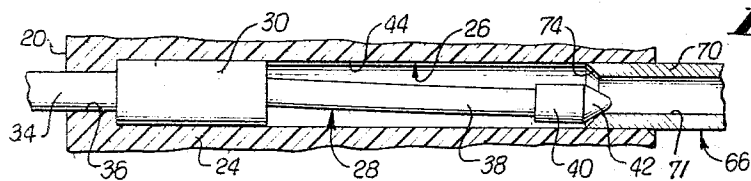


FIG. 4.

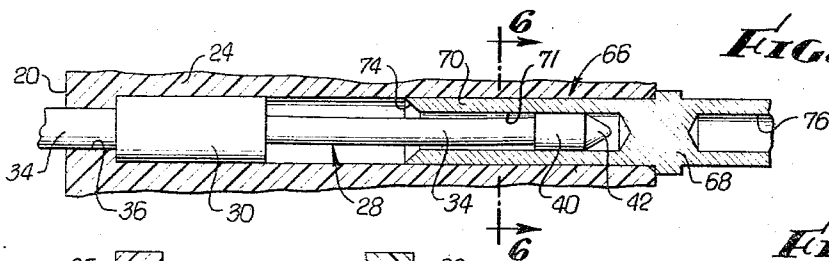


FIG. 5.

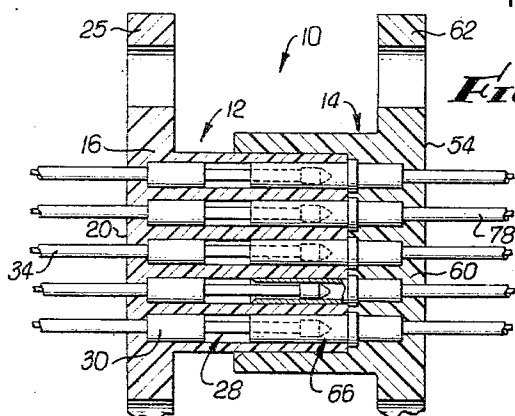
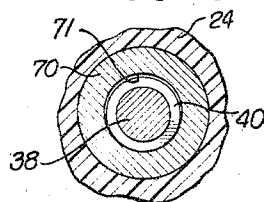


FIG. 6.



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3,242,456 ELECTRICAL CONNECTOR WITH SPRING PIN CONTACT

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16 Claims. (Cl. 339-64)

The present invention relates to electrical connectors of the type having one or more pin contact members in one connector member which are mateable with one or more socket contact members in another connector member when the connector members are interengaged, and the invention relates more particularly to a novel spring pin contact member and the mounting thereof in the respective electrical connector member which provides good spring contacting force between the pin and a mating socket contact member, provides unusually simple construction for both the pin and the mating socket, has good mechanical strength and electrical properties, and wherein the pin and mating socket contact members occupy a minimum amount of space. Although these desirable characteristics of the present invention make the invention particularly suitable for use in very small electrical connectors, as in subminiature and micro-miniature connectors, the invention is not necessarily limited to small electrical connectors.

In conventional electrical connector practice wherein mating pin and socket contact members are employed, the pin and socket contact members are supported in respective insulation bodies of the connector members, the pins normally extending forwardly out of the insulator and comprising generally rigid conductor rods of substantially uniform circular cross-section along their lengths with beveled or rounded forward ends. The socket contact members are usually fully recessed in bores extending through their respective insulation body, and the spring contacting force between the sockets and pins to provide the desired electrical continuity between pin and socket members is usually provided by some spring means on the socket contacts. Various spring means have been employed in the art, such as forming the socket contacts as resilient split sleeves or having separate wire or leaf spring members associated with the sockets for biasing the pins against the socket walls. There have been some prior art attempts to provide the spring means on the pins, as for example by constructing the pins of a plurality of spring wire strands.

While such prior art constructions are generally suitable for relatively large or standard size electrical connectors, they are to a large extent inadequate for very small electrical connectors because of certain problems which are peculiar to the small connectors, such as the subminiature and particularly the microminiature connectors. Thus, with pin and socket contact members of conventional types, in very small connectors it is difficult to provide adequate spring contacting force because of the necessarily small size of the contacts, and there is a strong likelihood of overstressing the contacts by going beyond the elastic limit in obtaining the required amount of spring movement. Generally, in such small electrical connectors the usual prior art pin and socket contacts and means thereon for providing the spring contacting force are too weak, complicated and space-consuming to be reliable and practical. As a rule size must be compromised in order to achieve adequate mechanical and electrical characteristics.

In view of these and other problems in the art, it is an object of the present invention to provide novel pin contact structure and mounting in an electrical connector

member, wherein the pin contact member is fully recessed within an insulation body bore, the pin contact member having a rearward mounting portion secured in the bore against lateral movement, an intermediate, elongated spring shank portion of reduced diameter adapted for lateral spring action, and an enlarged forward head portion which is engageable by a mating socket contact member, the spring shank portion of the pin being bent laterally so that the head portion is disposed, and preferably biased, against the wall of the bore. With this construction and mounting of pin contact member, a mating socket contact member will engage the enlarged forward contacting head of the pin and shift the contacting head laterally toward the axial center of the bore against the biasing force of the intermediate shank portion of the pin to provide biased contacting engagement between the pin and socket members. Thus, according to the present invention the pin contact member is deliberately misaligned and preferably laterally pre-stressed with the contacting head portion of the pin biased against the wall of the pin bore, which is directly opposite to the conventional approach of providing the best possible axial alignment of the pin contact with the bore in which the contact is mounted.

Another object of the present invention is to provide an electrical connector of the general character described wherein the novel construction and mounting of the pin contact or contacts provides the desired spring contacting force, yet wherein the pin contacts are simple in construction and can be made in one piece, without any separate spring members being required, and without the requirement of any spring means on or associated with the mating socket contact member.

Another object of the invention is to provide a novel spring pin contact for an electrical connector which combines the desirable qualities of good spring action with strong spring contacting force, low stress on the spring without any possibility of approaching the elastic limit thereof, high column strength so that the pin will not fail in longitudinal compression, relatively large contact surface area on the pin which, combined with the good spring contacting force, produces a low millivolt drop electrical connection with a mating socket contact member, and minimum space occupancy by the pin and its associated mounting structure. While all of these characteristics are highly desirable in electrical connector members of various sizes, they found particular utility in very small connectors.

Additional objects and advantages of the present invention will appear during the course of the following part of the specification, wherein the details of the construction and mode of operation of a preferred embodiment are described with reference to the accompanying drawing, in which:

FIGURE 1 is a longitudinal vertical section, partly in elevation, illustrating an electrical connector embodying the present invention, the portions of the connector being in their disengaged relationship.

FIGURE 2 is an enlarged, longitudinal vertical section, partly in elevation, illustrating the details of construction and mounting of one of the novel pin contact members of the present invention, with the pin separated from its mating socket contact member.

FIGURE 3 is a view similar to FIGURE 2, but illustrating the initial engagement between the pin contact member and its mating socket contact member.

FIGURE 4 is a view similar to FIGURE 3, but illustrating the pin and socket contact members in their fully engaged relationship.

FIGURE 5 is a view similar to FIGURE 1, but with the two portions of the electrical connector in their

fully engaged relationship, with the pin and socket contact members engaged in the manner shown in FIGURE 4.

FIGURE 6 is a further enlarged, transverse vertical section along the line 6—6 in FIGURE 4, further illustrating the relationship between the pin and socket contacts in their mated position.

Referring to the drawing, the electrical connector which is illustrated therein is of a type wherein the external and supporting structure of each of the two connector members comprises an integral part of the insulation body of the connector member. This type of construction is particularly useful in small connectors, such as subminiature and microminiature connectors.

The electrical connector 10 includes a plug connector member 12 and a receptacle connector member 14, the forward portion of plug member 12 being engageable within the forward portion of the receptacle member 14.

The plug member 12 comprises a unitary body 16 of insulation material having a front end 18 and a rear end 20, the body including a forward portion 22 which is engageable within the receptacle member 14, and a rearward portion 24 having an external mounting flange 25 thereon. The external cross-sectional shape of the forward body portion 22 of the plug member 12 may be any desired shape, as for example, rectangular, round, trapezoidal, or otherwise.

Extending axially through the forward and rearward body portions 22 and 24, respectively, of the plug insulation body 16 are a plurality of parallel bores 26 within which a plurality of pin contact members 28 are respectively supported.

Each of the pin contact members 28 includes a generally cylindrical rearward mounting portion 30 which is secured within the respective bore 26 so as to prevent lateral movement or wobble of the pin contact member, and also so as to prevent longitudinal shifting of the pin contact member within the insulation body 16. The rearward portion 30 of each contact member may be mounted in its respective bore 26 in any desired manner, as by being molded, adhesively bonded, or otherwise fastened therein. The rearward mounting portion 30 of each pin contact member is rearwardly cupped, having a rearwardly opening recess 32 within which an exposed end of an electrical conductor 34 may be crimped or soldered, the conductor 34 extending rearwardly out of the insulation body through a respective reduced bore portion 36.

The pin contact members 28 each include an intermediate, elongated spring shank portion 38 which is preferably round in cross-section to provide high column strength, but which has sufficient length and resiliency to permit lateral spring movement.

Each of the pin contact members 28 terminates at its forward end in an enlarged forward head portion 40 which is preferably generally cylindrical in shape, but which has a beveled or generally conical forward tip 42 to provide a lead-in surface for engagement of the pin contact member in a mating socket contact member in the manner hereinafter described in detail.

Each of the pin-receiving bores 26 includes a cylindrical forward portion 44 within which the intermediate spring shank portion 38 and the enlarged forward head portion 40 of the respective pin contact member are completely recessed. The cylindrical forward portion 44 of each bore is preferably provided with a lead-in flare 46 for guiding a respective mating socket contact member thereinto. A sufficient clearance 48 is provided within the cylindrical forward portion 44 of each bore about the enlarged head portion 40 of the respective pin contact member to permit entry of the mating socket contact member into this forward bore portion 44.

Due to the particularly simple construction of the pin contact members 28, these members may be provided in a one-piece construction, wherein the rearward mounting portion 30, the intermediate elongated spring shank por-

tion 38 and the enlarged forward head portion 40 of each pin contact member are integral. This one-piece construction is highly advantageous in very small electrical connectors, such as subminiature and microminiature connectors, as it reduces the millivolt drop through the pin contact member and precludes mechanical failure of the pin contact members by separation at joints.

An important departure of the present invention from prior art electrical connectors resides in the fact that each of the pin contact members has its reduced diameter, intermediate shank portion 38 deflected or bent, preferably proximate its root (i.e. proximate the juncture between the intermediate shank portion 38 and the rearward mounting portion 30) so that the enlarged forward head portion 40 is offset laterally a predetermined distance from the central axis of the rearward mounting portion 30. This bending or deflection is provided prior to insertion of the pin contact members into their respective bores 26, and upon insertion of the pin contact members in their respective bores 26, when the rearward mounting portions 30 are securely seated in the bores, the enlarged forward head portion 40 of the respective pin contact members are forced laterally against the walls of the respective bores by the spring action of the intermediate shank portions 38. Preferably, the amount of this deflection is sufficient so that the head portion 40 of each pin contact member is biased with a substantial force against the respective bore wall. The amount of this lateral biasing force will determine the amount of spring contact pressure between the pin and contact members when they are mated, and it can be controlled by properly relating the factors of the type of material in the pin contact members, the amount of deflection of the head portions 40 from the axes of the pins prior to insertion of the pin contact members in the bores, the length of the intermediate shank portion 38 and also the diameter of the intermediate shank portion 38. However, the length of the intermediate spring shank portion 38 of the pin will normally be so much greater than the diameter of this portion that despite the good spring biasing force which is available, this portion of the pin contact member will have a relatively low stress placed thereon, and the elastic limit of this portion of the pin contact member will never be closely approached.

FIGURE 2 shows in phantom lines how the reduced diameter spring shank portion 38 of the pin contact member is bent prior to insertion of the pin contact member into the respective bore of the plug insulation body 16. It will be seen that the amount of this bend is greater than that which can be accommodated by the diameter of the cylindrical forward bore portion 44, so that when the pin contact member is mounted in the bore the pin head 40 will be deflected back to the solid line position, thus placing the spring shank portion 38 of the pin in a pre-stressed condition which greatly improves the spring contacting force with the mating socket contact member.

The receptacle connector member 14 includes a unitary insulation body 50 having front and rear ends 52 and 54, respectively. Insulation body 50 includes a tubular forward skirt portion 56 having a cross-sectional shape corresponding to the shape of the forward body portion 22 of the plug insulation body 16, this skirt portion 56 of the receptacle insulation body being adapted to slidably receive the forward body portion 22 of the plug insulation body. The inside forward edge of skirt portion 56 is preferably chamfered or beveled at 58 as a lead-in for insertion of the plug member 12.

The receptacle insulation body 50 also includes a rearward portion 60 having an external mounting flange 62 thereon. A plurality of axially arranged, parallel bores 64 extend through the rearward portion 60 of the receptacle insulation body, and a plurality of socket contact members 66 are supported in the respective bores 64. Each of the socket contact members 66 includes a rear-

ward body portion 68 which may be molded or adhesively bonded or otherwise secured in the respective bore 64, and each socket contact member 66 also includes a forward socket contacting portion 70 which extends forwardly of the forward surface 72 of rearward insulation body portion 60 and is disposed generally within the tubular forward skirt portion 66 of the insulation body. The forward socket contacting portion 70 has a forwardly opening bore 71 therein and preferably is chamfered at its inside front end to provide a lead-in flare 74 which assists pin and socket mating as the connector members are interengaged. The body portion 68 of each socket contact member is rearwardly cupped to provide a rearwardly opening recess 76 within which the exposed end of a conductor 78 may be crimped or soldered, the conductor 78 extending rearwardly out of the insulation body 50.

FIGURE 1 illustrates the plug and receptacle connector members 12 and 14, respectively, in their disengaged relationship, while FIGURE 5 shows the connector members in their fully engaged relationship wherein the forward insulation body portion 22 of the plug is engaged within the tubular forward skirt portion 56 of the receptacle and wherein each of the pin contact members 28 has been slidably engaged into a respective socket contact member 66. The enlarged fragmentary views of FIGURES 2, 3, 4 and 6 illustrate the sequence of engagement between the pin and socket contact members. Thus, in the disengaged position shown in FIGURE 2 the pin contact member is deflected so that its enlarged forward head portion is biased against the wall of the bore; in FIGURE 3 the internally chamfered front end of the socket contact member 66 has just engaged the beveled tip 42 of the enlarged pin head portion 40 and has slightly deflected the head 40 away from the wall of the bore against the biasing force of the intermediate elongated spring shank portion 38 of the pin; and in FIGURES 4 and 6, the enlarged forward head portion 40 of the pin has become fully slidably engaged within the tubular forward socket contacting portion 70 of the socket contact member. There is a slight clearance between the cylindrical outer wall of the enlarged forward head portion 40 of the pin and the internal cylindrical wall of the forward contacting portion 70 of the socket contact member for ease of slidable engagement therebetween, as is best illustrated in FIGURE 6.

The combination of the enlarged head portion 40 of the pin and the reduced diameter spring shank portion 38 is important in the present invention for a number of reasons. For one thing, the enlarged head portion 40 causes the spring shank portion 38 to be spaced from the wall of the forward cylindrical bore portion 44 so as to increase the pre-stressing of the spring shank portion 38, thus providing greater spring contacting force between the pin and socket members. Also, the enlarged diameter of the head portion 40 permits the provision of a large lead-in bevel at the tip 42, which is an important factor in the present invention wherein the pin contact member is deliberately bent so as to have the head portion thereof disposed against the wall of the bore.

The combination of the enlarged head portion 40 and the reduced diameter shank portion 38 is also important to provide clearance between the spring shank portion 38 and the wall of the bore of the mating socket contact, so that despite the bending of the elongated spring shank portion 38 of the pin which is inherent in the operation of the present invention, the bent shank portion 38 cannot bind within the bore of the mating socket contact member.

Although the diameter of the shank portion 38 of each pin is substantially smaller than both the rearward mounting portion 30 and the head portion 40, it is nevertheless preferably larger than the diameter of the conductor wire 34. This results in reduced electrical resistance and corresponding low temperature rise in the contacts.

The enlarged head portion 40 of the pin contact member also provides a large surface area of engagement between the pin contact member and the socket contact member, resulting in a smooth, easy sliding action therebetween with low axial engaging and separating forces, which reduces wear of conductive plating on the contact members and improves the durability against environmental factors. Additionally, this large surface area of engagement results in a relatively low millivolt drop in the electrical connection between the pin and socket contact members.

Although the connector insulation bodies which have been shown and described are of unitary or monoblock form it is to be understood that the insulation body for either or both of the plug and socket connector members may be provided in a plurality of parts, if desired, within the scope of the invention. Additionally, although the illustrated connector members are of a type wherein the external and supporting structure of the connector members comprises an integral part of the insulation body, which is particularly useful in very small connector members, it is to be understood that this is merely for purposes of illustration, and that a wide variety of other connector forms may be employed, as for example connector members having external metal shells within which the insulation bodies are supported.

While the present invention has been shown and described herein in what is believed to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein but is to be accorded the full scope of the claims.

What is claimed is:

1. An electrical connector member which comprises an insulation body having front and rear surfaces and having at least one bore therein opening at said front surface, and a conductive pin contact member disposed in said bore, said pin contact member having a rearward mounting portion supported in said bore with its axis coincident with the central axis of the bore and so as to be restrained against both lateral and axial movement in the bore, an elongated, laterally resilient, intermediate spring shank portion extending forwardly from said mounting portion and deflected transversely of said coincident axes, and a contacting portion at the forward end of the shank portion, said shank and contacting portions being substantially completely recessed within the bore, said contacting portion being of smaller transverse dimension than the adjacent forward portion of the bore to provide clearance for receiving a mating socket contact member, the space between the shank and contacting portions and the wall of the bore being free of obstructions, and said contacting portion being laterally offset from the central axis of the bore by the deflection of the shank portion whereby when the mating socket contact member is axially inserted into the bore and engaged with said contacting portion the latter will be forced from said laterally offset position toward the central axis of the bore against the spring force of said shank portion to provide lateral spring biased engagement between the pin and socket contact members.

2. An electrical connector member as defined in claim 1, wherein said forward contacting portion of the spring contact member is laterally offset to a position against the wall of the bore.

3. An electrical connector member as defined in claim 2, wherein said forward contacting portion of the spring contact member is biased by said shank portion against the wall of the bore.

4. An electrical connector member as defined in claim 1, wherein said forward contacting portion of the pin contact member has a lead-in contour at its forward end for guiding said forward contacting portion into mating engagement with the socket contact member.

5. An electrical connector member as defined in claim 1, wherein said forward contacting portion of the pin contact member is of substantially larger cross-sectional area than said intermediate spring shank portion.

6. An electrical connector member as defined in claim 1, wherein said pin contact member is of one-piece construction, with said mounting, shank and contacting portions forming integral portions thereof.

7. An electrical connector member which comprises an insulation body having front and rear surfaces and having at least one bore therein opening at said front surface, and a conductive pin contact member disposed in said bore, said pin contact member having a rearward mounting portion supported in said bore so as to be restrained against both lateral and axial movement in the bore, an elongated, laterally resilient, intermediate spring shank portion extending forwardly from said rearward mounting portion and deflected laterally toward a wall of the bore, and a generally circularly cylindrical forward contacting portion at the forward end of the shank portion, said contacting portion having a larger cross-sectional area than said shank portion and having a lead-in contour at its forward end for guiding said forward contacting portion into mating engagement with a mating socket contact member, said shank and contacting portions being substantially completely recessed in the bore, said contacting portion being of smaller transverse dimension than the adjacent forward portion of the bore to provide clearance for the mating socket contact member, the space between the shank and contacting portions and the wall of the bore being free of obstructions, and said contacting portion being laterally offset from the central axis of the bore by the deflection of the shank portion to a position against the wall of the bore whereby when the mating socket contact member is axially inserted into the bore and engaged with said contacting portion the latter will be forced from said laterally offset position toward the central axis of the bore against the spring force of said shank portion to provide lateral spring biased engagement between the pin and socket contact members.

8. An electrical connector member as defined in claim 7, wherein said shank portion of the pin contact member is substantially round in cross-section and said shank and forward contacting portions of the pin contact member are generally coaxially arranged.

9. An electrical connector member as defined in claim 7, wherein said rearward mounting portion of the pin contact member is larger in cross-sectional area than said shank portion, and wherein said shank portion is bent proximate said mounting portion out of alignment with respect to said mounting portion so as to provide said laterally offset positioning of the forward contacting portion.

10. An electrical connector member as defined in claim 9, wherein said bore has a lead-in flare at its forward end for guiding the mating socket contact member into the bore.

11. An electrical connector member as defined in claim 7, wherein said forward contacting portion of the spring contact member is biased by said shank portion against the wall of the bore.

12. An electrical connector member as defined in claim 7, wherein said lead-in contour at the forward end of said contacting portion of the pin contact member is substantially conical.

13. An electrical connector which comprises a pair of interengageable connector members each including an insulation body having front and rear surfaces, each insulation body having a plurality of parallel bores therein opening at its front surface, the bores in each insulation body being generally axially aligned with the bores of the other insulation body when the connector members are interengaged, a plurality of conductive pin contact members mounted in the respective bores of one insulation body and a plurality of conductive socket contact members mounted in the respective bores of the other insulation body, said pin and socket contact members mating upon interengagement of the connector members, each pin contact member having a rearward mounting portion supported in the respective bore so as to be restrained against both lateral and axial movement in the bore, an elongated, laterally resilient, intermediate spring shank portion extending forwardly from said rearward mounting portion, and a forward contacting portion at the forward end of said shank portion, said contacting portion having a larger cross-sectional area than said shank portion and having a lead-in contour at its forward end for guiding said contacting portion into mating engagement with the mating socket contact member, said shank and contacting portions being substantially completely recessed in the bore, said contacting portion being of smaller transverse dimension than the adjacent forward portion of the bore to provide clearance for the mating socket contact member, and said contacting portion being laterally offset from the central axis of the bore to a position against the wall of the bore, each socket contact member having a tubular forward portion which projects forwardly out of the bore in which it is mounted, whereby upon interengagement of the connector members each socket contact member is axially inserted into a respective pin bore and engaged with said contacting portion of the respective pin contact member so as to deflect the latter from said laterally offset position toward the central axis of the pin bore against the spring force of said shank portion to provide lateral spring biased engagement between the pin and socket contact members.

14. An electrical connector as defined in claim 13, wherein said forward contacting portion of each pin contact member is generally cylindrical, with said lead-in contour thereof being generally conical.

15. An electrical connector as defined in claim 14, wherein said rearward mounting portion of each pin contact member is generally cylindrical and has a larger cross-sectional area than said intermediate shank portion.

16. An electrical connector as defined in claim 15, wherein said intermediate shank portion of each pin contact member has a generally circular cross-sectional shape.

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