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Griffin

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[54] **CONTACT ELEMENT FOR ELECTRICAL CONNECTOR**

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[51] **Int. Cl.**..... **H01r 25/02;** H01r 13/64

[58] **Field of Search**.... 339/47, 49, 176 M, 176 MP, 339/184 M, 186 M

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[57] **ABSTRACT**

An electrical connector of the type wherein each contact element of the plug engages a contact element of the receptacle at two locations, in which the contact region of each element has a straight rear portion extending at a constant height and a front end which is convexly curved at a small radius across the entire width of the element, the convex front end forming a projection lying only a small distance above the level of the straight rear portion. The contact element has a straight root portion with a rear end lying against a bottom wall of a groove and a front end normally above the top of the groove, the rear and front ends of the root portion forming sharp curves where they connect respectively to a shank of the blade and to the contact region.

3 Claims, 4 Drawing Figures

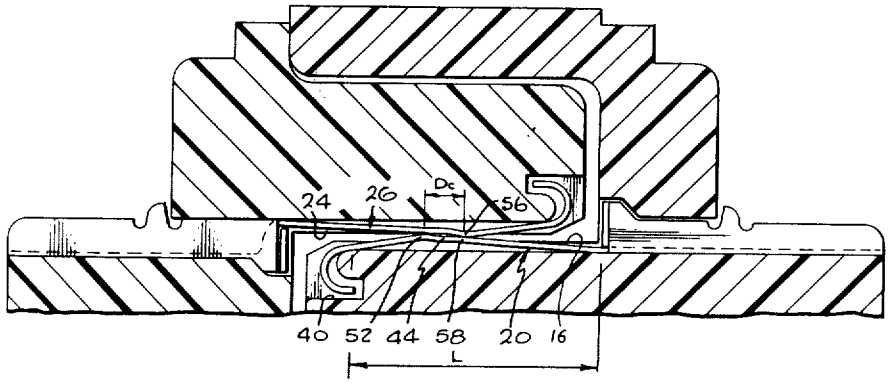


Fig. 1

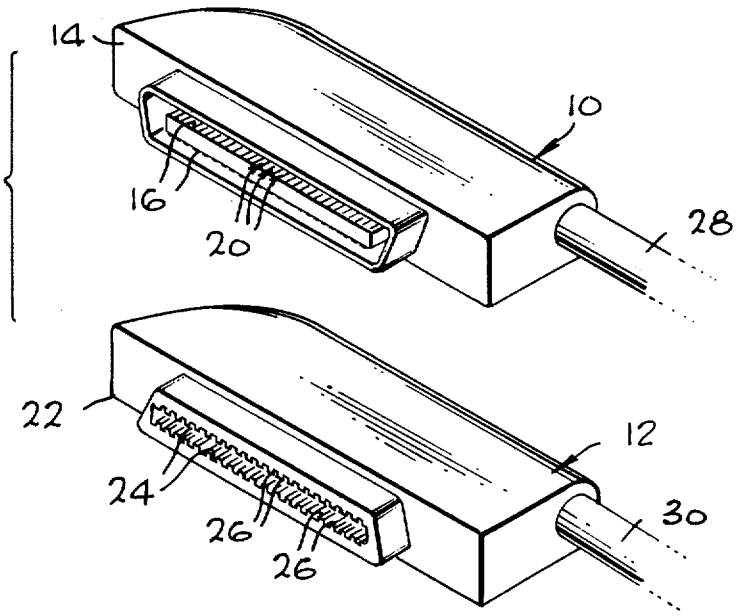
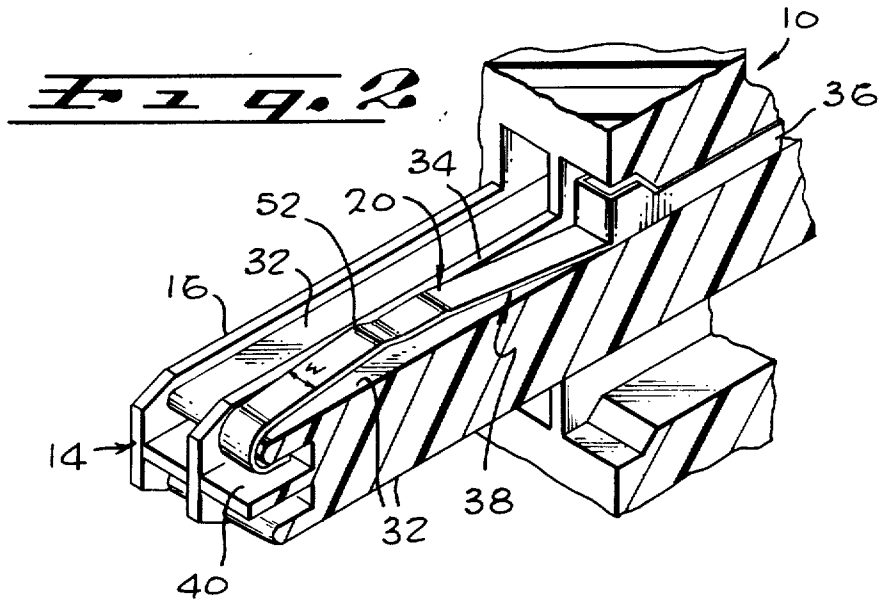


Fig. 2



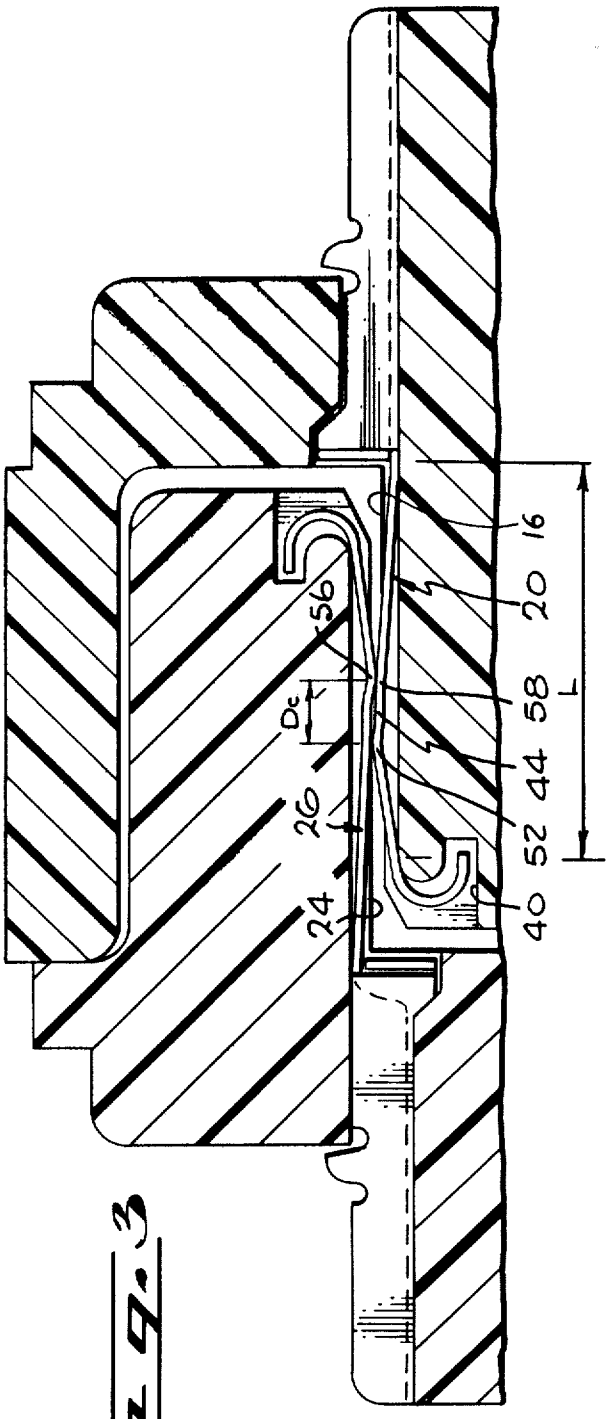

16
20
56
58
L
Dc
44
26
52
24
40

Fig. 3

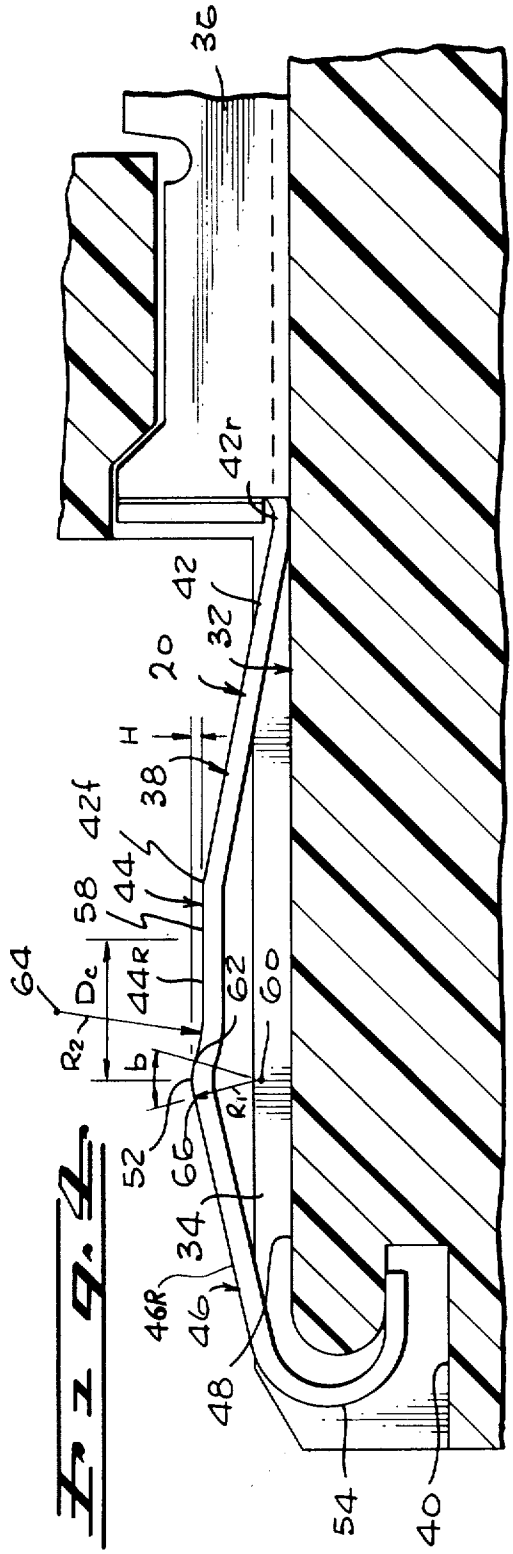

36
42r
42
32
20
H
38
42f
58
44
64
Dc
44R
62
60
R2
b
R1
52
66
34
46R
46
48
54
40

Fig. 4

CONTACT ELEMENT FOR ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

This invention relates to electrical connectors.

One type of electrical connector includes a plug and a receptacle with contact elements that make contact at two points. High contact pressure is achieved by embossing each contact to form a bump therein that will press against another contact. However, when the plug and receptacle are interfitted and the bumps on their respective contact elements slide across one another, each bump tends to push sidewardly against the other bump, which makes the action less smooth and which increases wear and the chance of damage. The bump generally occupies a considerable length of the contact element, and since the contact points must be spaced a moderate distance apart to assure high contact pressure, the length of the contact element is unduly extended. The contact elements are sometimes formed in a smoothly bowed configuration with the opposite ends supported against the frame and the center making contact with another contact element. However, considerable expense is involved in bending the contact element so that the entire bowed part follows a closely controlled curve so as to assure considerable pressure at each of the two contact points.

SUMMARY OF THE INVENTION

In accordance with the present invention, connectors are provided with contact elements that can be produced at relatively low cost and which reliably contact one another. Each contact element has an elongated blade supported only at its opposite ends and a contact region along the center of the blade. The front of the contact region is convexly curved at a small radius of curvature across the entire width of the blade, to form a protrusion thereat. The location immediately behind the convex protrusion is reversely bent and merges with a flat and straight contact region. Accordingly, the projection extends only a small distance above the level of the straight rearward contact region. The root and front portions of the unsupported blade part are straight and they meet the contact region at a sharp bend, which minimizes the cost of accurately bending the blade.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a plug and receptacle pair constructed in accordance with the invention;

FIG. 2 is a partial perspective view of the plug of FIG. 1;

FIG. 3 is a sectional view of a portion of the plug and receptacle of FIG. 1, showing the state of the contact elements when the plug and receptacle are interfitted; and

FIG. 4 is a greatly enlarged view of a contact element of the plug, showing its undeflected configuration in the plug frame.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a connector assembly which includes two connectors that may be referred to as the plug **10** and receptacle **12**. The plug **10** has a frame **14** with a pair of contactor surfaces **16** forming two rows of grooves which hold individual contact elements **20**. The receptacle **12** is similarly constructed, with a frame **22** having a pair of contactor surfaces **24** forming two rows of grooves that receive contact elements **26**. The plug and receptacle can be interfitted, or mated, so that the contact elements **20, 26** on the two frames are engaged, to connect wires **28** leading to the plug with wires **30** leading to the receptacle.

As illustrated in FIGS. **2–4**, each contactor surface **16** of the plug has grooves **32** that are separated by thin separating walls **34**. Each contact element **20** includes a shank **36** and a blade **38** extending forwardly from the shank along a groove **32**, and with the front end of the blade captured in a pocket **40** formed in the plug frame **14**. As best shown in FIG. **4**, the blade **38** includes a root portion **42** extending forwardly from the shank **36**, a contact portion or region **44** extending forwardly from the root **42**, and an outer or forward portion **46** extending forwardly from the contact region **44** and into the pocket **40**.

Most of the root portion **42**, contact region **44**, and forward portion **46** is straight. The root portion **42** has a rear end **42***r* which lies against the bottom wall **48** of the groove, and the root portion extends straight and at a gradual incline of less than 45° towards the top of the groove. The front end **42***f* of the root portion normally (when the plug and receptacle are not interfitted) lies above the top of the groove side walls **34**. The front end **42***f* of the root portion is sharply curved where it meets the rear end of the contact region **44**. The rear or secondary contact portion **44R** of contact region **44** extends straight and at a constant height above the top of the groove **32** along most of its length, but the contact region **44** rises and forms a sharply curved projection **52** at its front end. The forward portion **46** of the blade extends straight and at a downward incline from the projection **52** into the groove **32**, and the front end **54** of the forward portion has a horseshoe bend so that it extends into the pocket **40**.

When the plug and receptacle are mated, as illustrated in FIG. **3**, with their contactor surfaces **16, 24** facing one another, the contact elements **20, 26** are deflected towards the bottom of their grooves. The contact projection **52** on the plug contact element **20** presses against a location on the other contact element **26**, while a corresponding contact projection **56** on the receptacle contact element **26** presses against a point **58** near the rearward end of the contact region **44**. Accordingly, contact is established along two separated points of the contact elements. This helps to assure reliability of connection, because even if one of the contacts is not reliably established due to a local imperfection or the like, current can still flow through the other contact location. The two contact elements **20, 26** are of substantially the same shape, with only their shanks being somewhat different and with the blades being identical.

Referring again to FIG. **4**, the contact blade **38** is precisely formed with several bends and straight portions that are chosen to provide optimum performance with

a minimum cost of manufacture. The projection at **52** is formed by convexly bending the blade at a small radius of curvature R_1 about an imaginary point **60**, the bending being uniform across the entire width W of the blade. However, this bending occurs over a very small angle *b* of less than 60° and preferably about 30°. Beginning at a point **62**, the blade is concavely curved at a larger radius of curvature R_2 about a point **64**, and behind a location immediately below the center of concave curvature at **64** the blade extends flat and at a constant height above the top of the groove side wall **34**. As a result, the projection **52** lies at only a small height H above the flat portion of the contact region **44**. This height H is preferably less than the thickness of the blade. As a result of such bending, the projection **52** is sharp enough to minimize the contact area so there is a high contact pressure that establishes a low resistance connection. Furthermore, the distance D_c between the two contact points **52** and **58** is relatively short so that the blade does not have to be excessively long. The small height H results in only a small amount of bending being required, so that material stress and fatigue are reduced thus providing a more constant spring force. Accordingly, a more reliable electrical connection is maintained when the mated pair is connected and disconnected many times.

The projection region at **52** is convexly formed up to a point **66**. Thereafter, the blade extends straight along the rear half **46R** of the forward portion **46**. No concave or reverse curvature is required at **66**, but instead a smooth transition occurs between the sharply curved projection **52** and the straight forward portion **46R**. As a result, when the plug and the receptacle are mated, there is a smooth downward deflection of the contact elements unitl their projections **52** ride over one another. It also may be noted that the projections **52, 56** on two mating contact elements help to resist separation of the plug and the receptacle after they are connected. However, separation occurs smoothly because there are no extremely sharp bends or discontinuities, and even the radius of curvature R_1 is large compared to the height H of the projection **52** over the flat contact area behind it. Since the projection at **52** is convexly curved uniformly across the entire width W of the blade, the projections **52, 56** on the two contact elements do not tend to move around one another, as could occur where the projections are embossed in the middle of the blade rather than formed by curving the blade along its entire width.

The root portion **42** and the straight outer portion at **46R**, which are both formed straight, help to produce a uniform spring rate when the contact element is pressed downwardly during mating of the connectors. This is because each straight portion **42, 46** acts like a straight beam that is being bent. This may be compared with contact elements wherein the root portion **42** and forward portion **46** are curved, and wherein the spring rate and material stress increases as the contact element is depressed and the root and forward portions gradually lay down against the frame of the connector. In addition, the straight portions facilitate formation of the contact elements, because it is relatively economical to form and inspect a strip of material with a few sharp curves and with straight portions between the curves, as compared with a strip of material which is gradually curved in an accurate fashion along long lengths of the strip.

Contact elements have been formed as illustrated in the figures, using silvercopper strip stock of a thickness of 0.006 inch, with the blade having a length L (FIG. 3) along the unsupported or free-standing part which is supported only at its ends, of approximately 0.25 inch, a radius R_1 at the contact **52** of approximately 0.02 inch and a radius R_2 of approximately 0.1 inch. It may be noted that the contact points at **52** and **58** are each closer to the exact center of the freestanding part of Length L than to the opposite ends thereof which are supported on the frame. The height H of the contact point **52** above the other point at **58** was approximately 0.002 inch, or in other words about one-third the thickness of the blade. The distance D_c between the contact points was approximately 0.040 inch.

Thus, the invention provides an electrical connector with a contact element that can be produced relatively inexpensively, which assures high contact pressure at two locations in a relatively short blade, and which permits smooth engagement and disengagement of the connectors while tending to maintain the connectors in engagement. The contact element is produced relatively inexpensively by providing primarily straight regions joined at relatively sharp curves, but with the curves extending over small angles so that the blade is not unduly weakened. High contact pressure is maintained by sharply curving the blades to form sharply curved projections, but the projections lie only a small distance above a surrounding contact area so that two engagements of the elements can be made close to one another. The blade is uniformly curved along its entire width, particularly at the projection, so that smooth engagement and disengagement of the contact elements with one another is achieved.

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

What is claimed is:

1. An electrical connector comprising:

a pair of frames, each having at least one contactor surface with a plurality of uniformly spaced elongated grooves and a plurality of pockets formed at the front end of each groove below the level of the bottom wall of the groove, said frames being interfittable so that their grooves face one another; and

a plurality of contact elements, each having a shank fixed to a frame and a blade extending forwardly from the shank along one of the grooves;

each blade having a straight root portion with a rear end lying against the bottom wall of the groove, said root portion extending forwardly at an incline of less than 45° with the bottom wall of the groove and with its front end lying above the groove when the frames are disengaged from each other, said blade having a contact region with at least a rear half which extends substantially straight and at a constant height above the groove and with a front end that is convexly curved uniformly across the entire width of the blade and which forms a projection that projects above said substantially straight rear half of the contact region by less than the thickness of the blade, and said blade having a forward portion with a rear region which extends substantially straight from said projection at an incline

towards the bottom of the groove and with a front region that forms a horseshoe bend and projects in a pocket of the frame.

2. An electrical connector comprising:

a frame having a surface with a plurality of elongated parallel grooves therein, each groove having a bottom wall and a pair of side walls; and

a plurality of resilient and electrically conductive contact elements, each having a shank portion mounted in one of said grooves and a blade extending in a forward direction along the groove from said shank portion, said blade having a root portion with a rear end that is joined to the shank and that lies substantially against the bottom wall of the groove, said root portion normally extending in a straight line from the rear end thereof in a forward direction and at an upward incline towards the top of the groove and with the forward end of the root portion lying out of the groove, said blade having a contact region extending forwardly from the forward end of the root portion in a direction primarily parallel to the length of the groove, and said blade also having a forward portion extending in a straight line at a downward incline from said contact region into said groove, and with the forward end of said forward portion trapped in the frame, the blade forming a sharp bend at the intersection of the root and contact regions;

said blade having a contact protrusion formed across the entire width of the blade at the forward end of said contact region, said contact protrusion being sharply convexly curved at the top and concave at a larger radius of curvature than at the sharply convex top of the protrusion at a location a distance behind the convex top, and said contact region being substantially flat along a portion behind the concave portion, whereby to provide a double

contact with a similar contact element in another connector frame.

3. An electrical connector comprising:

a frame having a surface with a plurality of elongated parallel grooves therein, each groove having a bottom wall and a pair of side walls; and

a plurality of resilient and electrically conductive contact elements, each having a shank portion mounted in one of said grooves and a blade extending in a forward direction along the groove from said shank portion, said blade having a root portion with a rear end that is joined to the shank, said root portion normally extending from the rear end thereof in a forward direction and at an upward incline towards the top of the groove and with the forward end of the root portion lying out of the groove, said blade having a contact region extending forwardly from the forward end of the root portion in a direction primarily parallel to the length of the groove, and said blade also having a forward portion extending at a downward incline from said contact region into said groove, and with the forward end of said forward portion trapped in the frame;

said blade having a contact protrusion formed across the entire width of the blade at the forward end of said contact region, said contact protrusion being sharply convexly curved at the top and concave at a larger radius of curvature than at the sharply convex top of the protrusion at a location a distance behind the convex top, and said contact region being substantially flat along a portion behind the concave portion, whereby to provide a double contact with a similar contact element in another connector frame.

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