United States Patent [19]

Hoppe, Jr.

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[54] **INSULATION-PIERCING CONTACT MEMBER AND ELECTRICAL CONNECTOR**

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[73] Assignee: **Bunker Ramo Corporation,** Oak Brook, Ill.

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[21] Appl. No.: **395,746**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 288,998, Sept. 8, 1972.

[52] **U.S. Cl.** ..... **339/98,** 339/223 R

[51] **Int. Cl.** **H01r 9/06**

[58] **Field of Search** 339/95, 96, 97, 98, 99, 339/223

[56] **References Cited**

UNITED STATES PATENTS

2,873,434	2/1959	Drum et al.	339/97 C
3,162,501	12/1964	Wahl	339/98
3,480,723	11/1969	Golden	339/97 C

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[57] **ABSTRACT**

An electrical connector is provided with one or more contact members, each having an insulation-piercing terminal element of sheet metal construction to electrically receive an insulation-covered conductor. Each terminal element includes an elongated open channel of U-shaped cross-sectional configuration with side and bottom walls, the sidewalls including opposite portions dimpled in to provide inner folded flanges or detents forming and separated by a conductor-receiving notch for piercing the insulation of the conductor and electrically engaging the underlying exposed conductor, each detent including multiple wall sections integrally joined to and spaced apart at the portion of the adjacent sidewall and converging inwardly therefrom to a lower curved surface of thickened construction as a wiping and engaging surface for the conductor and an upper outwardly diverging tapered surface with an exposed thin cutting edge on at least one wall section to pierce the insulation of the conductor.

9 Claims, 10 Drawing Figures

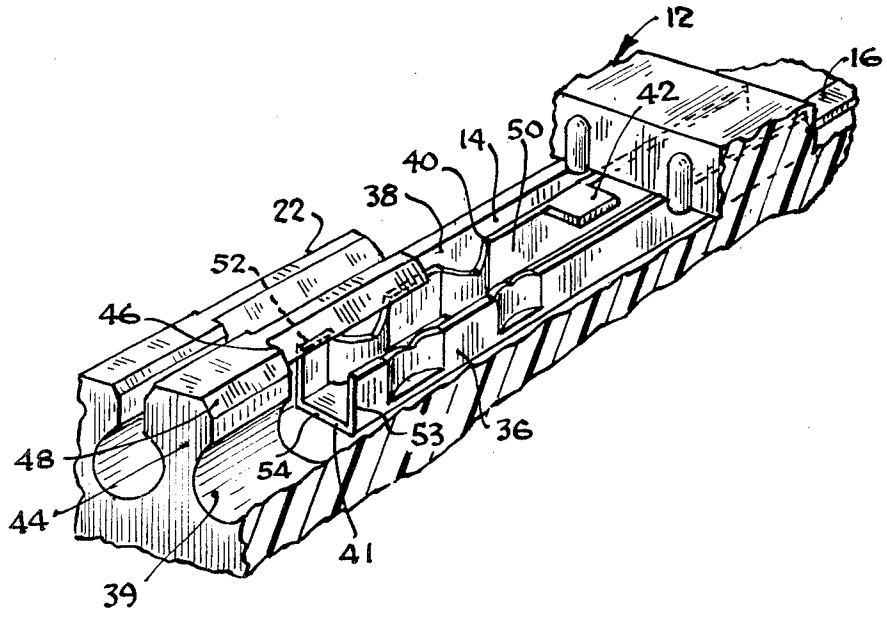


FIG.3

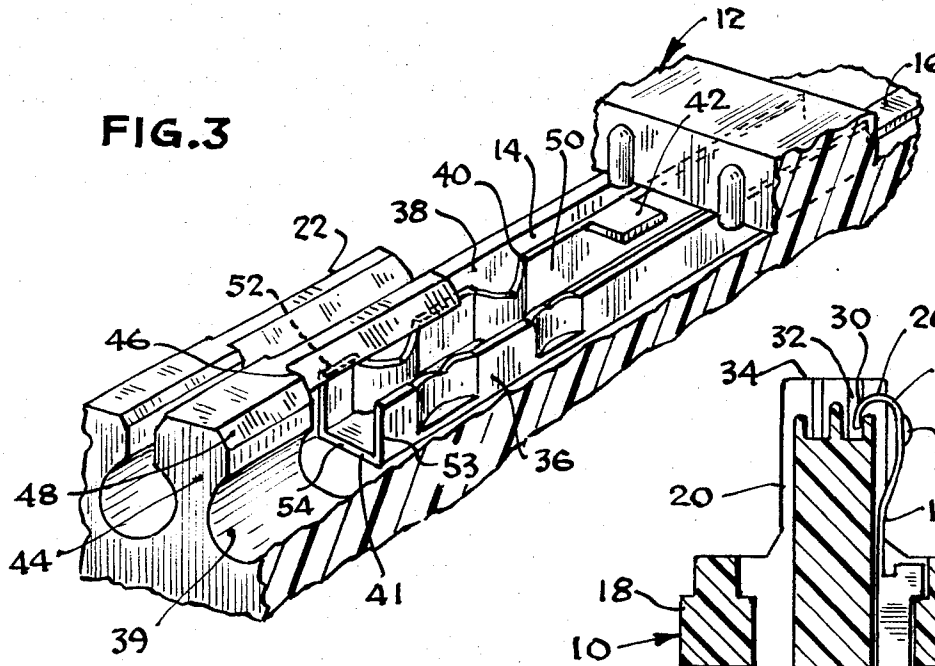


FIG.2

FIG.1

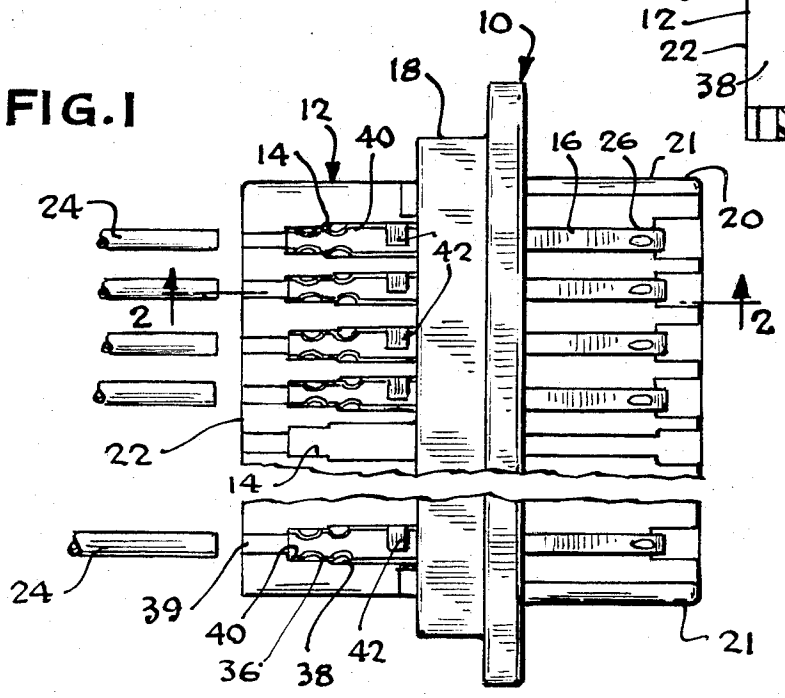


FIG.4

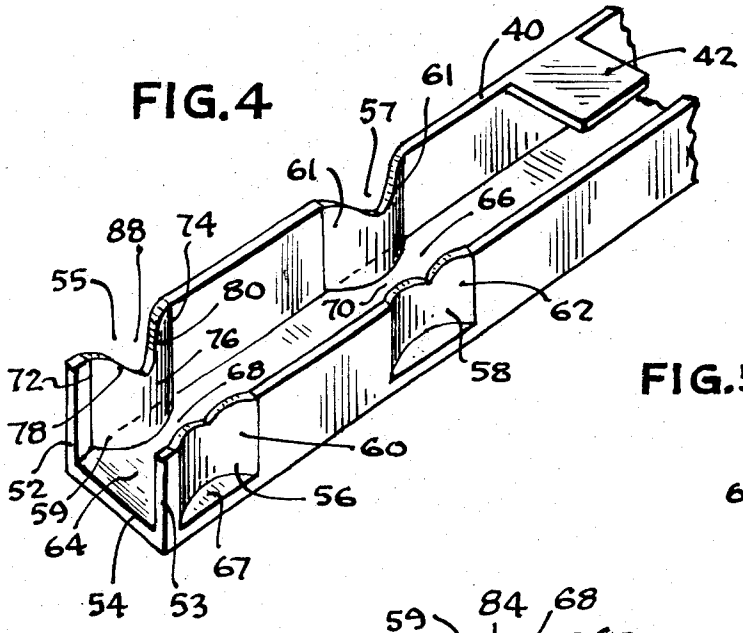


FIG.5

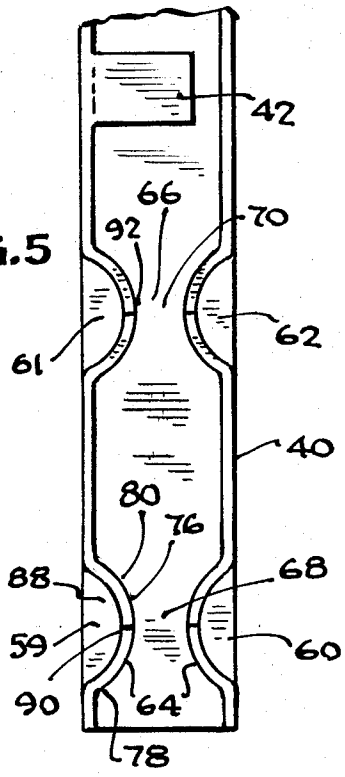


FIG.6

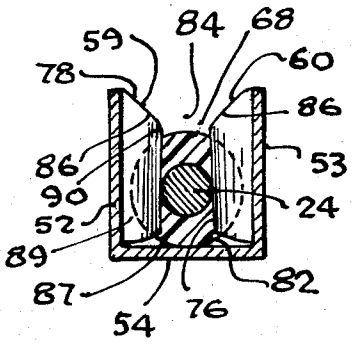
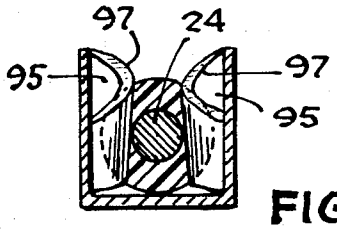


FIG.9



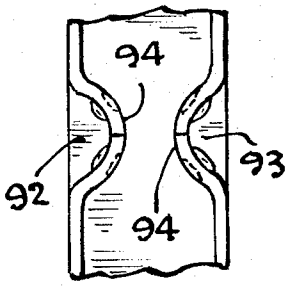


FIG.7

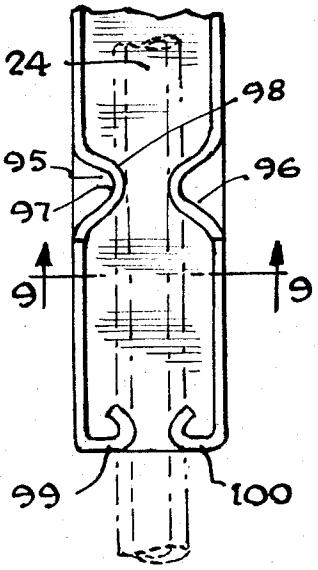


FIG.8

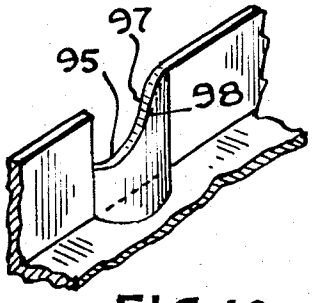


FIG.10

INSULATION-PIERCING CONTACT MEMBER AND ELECTRICAL CONNECTOR

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of my co-pending application Ser. No. 288,998 filed Sept. 14, 1972 and entitled "Electrical Connector and Insulation-Piercing Contact Member."

BACKGROUND OF THE INVENTION

In multi-circuit electrical connectors, used in great variety and numbers in communication systems and other data handling systems, the usual technique for connecting circuit elements such as individual solid or stranded wire conductors to the connector has been to strip the insulation from the end of the conductor and then solder the conductor to a connector contact. This procedure requires considerable skill on the part of the workman making the solder connection, particularly in miniaturized connectors. There is also a tendency to bridge the adjacent contacts within the connector, producing undesirable circuit connections.

An alternative technique gaining increasing acceptance uses insulation-piercing terminals for the contact members of the connector; these terminals cut through the insulation and establish an electrical connection to the conductor without preliminary stripping and without the conventional soldering step. These insulation-piercing terminals are usually of forked construction, with cutting edges that penetrate the wire insulation and that also serve as contact jaws that make the necessary electrical connection with the conductor. That is, a forked terminal element on the connector contact serves both as an insulation cutting device and as an electrical contact. A particularly advantageous and effective insulation-piercing contact construction which minimizes cutting into the conductor but provides a firm electrical and mechanical connection is set forth in my aforementioned application Ser. No. 288,998.

In one construction of particular advantage, the insulation-piercing contact construction described in my earlier application is formed as part of a contact terminal element which is rearwardly disposed in the connector for receiving an insulation-covered wire. The terminal element comprises a small elongated channel of U-shape cross-sectional configuration constructed of thin sheet metal in which a terminal flange or flanges are struck from one or both sidewalls of the channel and bent inwardly at essentially right angles to extend transversely of the channel with each flange being longitudinally separated from the other. Each flange is centrally slit to form an upwardly open notch for receiving an insulation-covered electrical conductor and for separating at least the upper portion of flange in the two sides. Each of the sides adjacent the notch forms a thin resilient supporting wall of sheet metal extending to the top portion of the notch and is tapered outwardly to form an entry portion with thin edges walls that afford a cutting section for cutting the insulation on the conductor without damaging the underlying conductor. The lower portion of the flange on both sides of the notch is shaped by folding the sheet metal back upon itself to form a multi-walled curved wiping surface extending over a width equal to at least two thicknesses of metal. The thickened curved surface is resiliently

supported by a wall section of a single thickness joined to the sidewall of the channel. A further feature of additional advantage in the construction of the flange is an integral side portion intermediate the cutting and wiping surfaces and shaped adjacent the notch to have a gradually increasing thickness as it extends from the thin cutting surface to the thickened wiping surface to spread the insulation and thereby expose the underlying metallic conductor for engagement with the wiping surface without interference by the insulation.

While a contact utilizing the insulation-piercing features described in my earlier application provides several advantages over the art, other embodiments of the invention in addition to the particular embodiment described above are desired, particularly when miniature sized contacts are utilized. Contacts of miniature size for use with the invention are frequently constructed of sheet metal having a thickness in the order of 0.006 inches which is shaped to form elongated channels of about 0.200 inches long with a U-shaped cross section of about 0.050 wide by 0.060 inches deep. The resultant channels can be fragile and easily bent during electroplating operations and after processing prior to the mounting of the contact members in the dielectric contact mount. Under these circumstances, adequate support of the channel by its side and bottom walls is important.

SUMMARY OF THE INVENTION

Accordingly, a further construction of my insulation-piercing contact is provided in which the sheet metal channel of the terminal element is shaped to form insulation-piercing and conductor-engaging flanges while maintaining the sidewalls substantially intact. In this invention, opposite portions of the sidewalls are dimpled in to form inner opposite detents or folded flanges of multi-walled thickness with two of the wall sections integrally joined to the adjacent sidewall. The wall sections of each detent are spaced apart as they join the adjacent sidewall of the channel and converge inwardly to a lower curved portion joining the wall sections and providing a wiping surface for the conductor. The upper portion adjacent the notch is cut to form an upper taper diverging outwardly to expose thin cutting edges for cutting the insulation of the conductor being inserted into the notch. The thin cutting edges of both wall sections are generally shaped to form a "V" shape with a longitudinal slope forming a medial portion at the junction with the wiping surface which acts to spread the insulation previously cut apart from the portion of the conductor.

The multi-walled construction of the detents provide enlarged wiping surfaces together with the desired degree of resiliency to yieldingly receive the metallic conductor. The contact also is of low cost and is easily manufactured.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of an electrical connector constructed in accordance with the present invention.

FIG. 2 is an enlarged sectional view of the connector along the line 2—2 of FIG. 1, without the contact normally in the left contact mounting passage.

FIG. 3 is an enlarged perspective view partially in cross section of the rear portion of the connector in

FIG. 1 illustrating the construction of the sheet metal channel and inner detents.

FIG. 4 is a similar view of the channel of FIG. 3 without the dielectric contact mount with the separation between the detents being enlarged to show further details of the construction.

FIG. 5 is a plan view of the channel of FIG. 4.

FIG. 6 is an end view of the channel and detents of FIG. 5 with a conductor positioned in a lower portion of the notch.

FIG. 7 is a partial plan view of a channel showing a second embodiment of the invention.

FIG. 8 is a plan view of a third embodiment of the invention with a conductor (shown dotted) inserted between each of the two pairs of oppositely disposed inner detents.

FIG. 9 is an end view taken approximately along line 9—9 of FIG. 8.

FIG. 10 is a perspective view of one of the detents in FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1–2 illustrate the basic structure of the connector unit constructed in accordance with one embodiment of the present invention. The electrical connector unit is illustrated in the form of a plug unit **10** adapted for conventional connection to a mating complimentary unit (not shown). Plug unit **10** comprises a contact mount **12** of molded dielectric material such as DAP, nylon, or polyester with a plurality of contact mounting passages **14** arranged in at least one row along the length of the unit to receive a plurality of contact members **16.** The passages extend through a central base **18** which serves as a frame for mounting the connector in a metallic shell (not shown) as an external support and are exposed on opposite sides of a front tongue-like portion **20** and a rear portion **22.** Tongue portion **20** is enlarged with guides **21** for guiding and orienting unit **10** into a mating connector. Rear portion **22** is shaped to receive a plurality of insulation-covered conductors **24.**

Each contact member **16** includes an active contact element **26** frontwardly positioned in mount **12,** which element is illustrated as a thin ribbon-like element **28** bent into a reentrant hook **30** captured in a small retaining slot **32** formed at the forward end **34** of the tongue portion **20.** The ribbon-like element **28** as illustrated also includes a smooth rounded convex bulge **31** to improve electrical engagement with mating circuit elements such as mating contact members. Contact member **16** further includes an integral terminal element **36** positioned in one of the multiple channels **38** in the rear portion **22** and adapted to interconnect the contact member with conductor **24.** The terminal element is shaped to include an open, elongated channel **40** of U-shaped cross-sectional configuration **41** (FIG. 3) which extends frontwardly into base **18** and includes one or more tabs **42** shaped for mounting the contact member in the base.

As thus far described, the construction of connector unit **10** is essentially similar to the multiple contact electrical connector described and illustrated in Yopp's U.S. Pat. No. 3,002,176. The individual contact member **16** can be readily and rapidly mounted into corresponding individual passage **14** adjacent tongue **20** and moved rearwardly to the desired mounting position. Tab **42** on each member may then be bent laterally to lock the member in the mount.

FIG. 3 represents an enlarged perspective view with metallic compound channel **40** mounted in channel **38** and channel **39,** the latter serving as a strain relief for the conductor. As illustrated, barrier walls **44** separate adjacent channels **38-39** and include tapered sidewalls **46** and **48** to guide the conductor (not shown) into the insulation-piercing portion **50** of metallic channel **40** and into the strain relief channel **39.**

In accordance with the present invention and as illustrated in FIG. 4, channel **40** is formed with sidewalls **52** and **53** and interconnecting bottom wall **54** serving to separate sidewalls **52** and **53** by a distance and to form an open threesided channel. Opposite facing portions **55, 56, 57** and **58** of sidewalls **52** and **53** are dimpled in to form inner detents **59, 60, 61** and **62** arranged in longitudinally displaced first and second detent pairs **64** and **66.** The detents in each pair are separated by a distance less than the distance between the sidewalls and are oppositely positioned and spaced apart to form a conductor-receiving notch **68** for detent pair **64** and notch **70** for detent pair **66.** As illustrated for detent **60,** sidewall portion **56** is slit at the bottom **67** to permit the entire portion to be forced inwardly and form the detent.

Representative detent **59** is integrally joined to sidewall **52** by one end of wall sections **72** and **74,** forming a fold of multiwalled construction. Through the dimpling technique, wall sections **72** and **74** are spaced apart at sidewall **52** and converge inwardly at the other ends to form an enlarged, smooth curved surface **76** joining the wall sections and forming one of the pressure jaws of the wiping section. The upper portion or free edge of the wall sections **72** and **74** at notch **68** is cut outwardly forming a slit to provide an entry for the conductor and expose the thin edges **78** and **80** of the separated wall sections to provide at least one insulation-cutting surface.

As illustrated in FIGS. **5–6,** each notch is shaped by the defining detent pair to include a lower opening **82** sized slightly smaller than the conductor so that the wiping sections resiliently engage the conductor and an upper portion **84** with outwardly diverging tapers **86** separated a maximum distance at least equal to the diameter **89** of the insulation **87** of the conductor. The smooth, curved surface **76** of the pressure jaws as illustrated extends over multiple thicknesses of the sheet metal and therefore resiliently yields when the conductor is inserted rather than cutting or significantly deforming the conductor. The upper outer taper on each detent exposes the cutting edges **78** and **80** of the wall sections to form a "V" shape which may be a symmetrical "V" **88** as in FIGS. **4–5** or a non-symmetrical "V" **97** as in FIGS. **8–10.** As the wall sections **72** and **74** converge inwardly towards the notch **68,** they also form a medial portion **90** as a transition zone for spreading the insulation **87** away from the conductor portion about to be inserted into the lower wiping section of the notch. In FIG. **6,** a conductor **24** is shown inserted into notch **68** and shows both detents **59–60** engaging the conductor.

In FIGS. **7–10,** other embodiments of the detents are illustrated. FIG. **7** illustrates the detents **92–93** swedged to further form a transition zone **94** where the insulation is spread apart from the conductor. In FIGS. **8–10,** the detents **95–96** are illustrated with a non-

symmetrical "V" shape **97** to form essentially one curved insulation cutting and spreading edge **98**. FIG. **8** also includes end detents **99–100** in form described above and in the afore mentioned earlier application Ser. No. 228,998.

The insertion of the conductor **24** into the terminal element **36** of the contact member **16** is as described in co-pending application Ser. No. 370,037 of Istvan Mathe filed June 14, 1973 descriptive of a tool and tool adapter designed to push the conductor **24** into the insulation cutting and spreading portions of the notch **68** and further into the pressure jaws, providing a wiping action on the underlying conductor. As described in that application, the tool is designed to avoid damage to the notch portion of the terminal elements while firmly and positively pushing the conductor at other points into the channel so that the conductor reaches the desired depth in the lower portion of the notch.

The resultant construction as described above provides a terminal element particularly advantageous for miniature contacts in which the channels are formed from sheet metal stock such as cadmium copper plated with gold or other corrosion-resistant metal. The flanges are formed with detents integrally joined to the sidewalls of the channels and thereby aid in strengthening the channels so important for elongated narrow channels constructed of thin sheet metal.

I claim:

1. In an electrical contact member for electrical connection to circuit element including an insulation-covered electrical conductor, a terminal element of thin sheet metal construction including at least one notch for cutting the insulation of said conductor and electrically engaging the underlying conductor, said terminal element comprising

an elongated channel of U-shaped, cross-sectional configuration with opposite sidewalls having opposite facing portions dimpled inwardly to provide at least one pair of inner detents, the space between said detents constituting said notch, said space between said detents being less than the distance between said sidewalls, each of said detents comprising

a pair of wall sections, each of said wall sections having one end integrally joined to the adjoining sidewall, the other ends of said sections joined together by a curved portion at said notch to provide an enlarged wiping surface for said conductor, said curved portion having a free edge and a slit along said free edge, said slit including at least one tapered cutting edge to form an insulation-cutting surface.

2. The electrical contact member of claim **1** wherein said wall sections at said curved portion of each of said detents are separated to form said slit in a "V" shape.

3. The electrical contact member of claim **2** wherein said "V" shape is symmetrical.

4. The electrical contact member of claim **2** wherein said "V" shape is non-symmetrical.

5. The electrical contact member of claim **1** wherein each of said detents include a medial portion shaped to spread said insulation away from the conductor prior to said conductor entering said wiping surface.

6. An electrical connector unit for use in interconnecting a plurality of electrical circuits including insulationcovered conductors and comprising a contact mount formed of molded dielectric material having a plurality of contact-mounting passages with outer ends each being of elongated U-shaped configuration

a plurality of contact members mounted in said contact passages of said contact mount, each contact member including an active contact element and a terminal element disposed within the outer end of the contact passage,

the terminal element of each contact member comprising an elongated channel of U-shaped cross-sectional configuration with opposite sidewalls having opposite facing portions dimpled inwardly to provide at least one pair of inner detents having a space therebetween constituting said notch, said space between said detents being less than the distance between said sidewalls, each of said detents comprising a pair of wall sections, each of said wall sections having one end integrally joined to the adjoining sidewall, the other ends of said sections joined together by a curved portion at said notch to provide an enlarged curved wiping surface for said conductor, said curved portion having a free edge and a slit along said free edge, said slit including at least one tapered cutting edge to form an insulation-cutting surface.

7. The electrical connector unit of claim **6** wherein said wall sections at said curved portion of said detents are separated to form said slit in a "V" shape.

8. The electrical connector unit of claim **6** wherein each of said detents include a medial portion shaped to spread said insulation away from said conductor prior to said conductor entering said wiping surface.

9. The electrical connector unit of claim **6** wherein said contact mount includes strain relief means for said conductors.

* * * * *