United States Patent [19]

Neale, Sr.

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[45] **June 4, 1974**

[54] **CONNECTOR FOR INSULATED CONDUCTORS**

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[73] Assignee: **National Telephone and Supply Co.**, Cleveland, Ohio

[22] Filed: **July 17, 1972**

[21] Appl. No.: **272,391**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 181,649, Sept. 20, 1971, abandoned.

[52] **U.S. Cl.** ..... **174/84 C**, 174/90, 339/97 C, 339/98, 339/276 R

[51] **Int. Cl.** **H02g 15/08**

[58] **Field of Search** ..... 174/84 C, 87, 90, 94 R; 339/276 T, 276 R; 287/75, 108, 109

[56] **References Cited**

UNITED STATES PATENTS

2,316,267	4/1943	McLarn	174/84 C
3,265,807	8/1966	Smith	174/84 C X
3,303,266	2/1967	Thompson	174/84 C
3,621,117	11/1971	Antas et al.	174/84 C

Primary Examiner—Darrell L. Clay

Attorney, Agent, or Firm—Fishburn, Gold & Litman

[57] **ABSTRACT**

A connector for electrically joining insulated conductors without removing the insulation therefrom. The connector is a generally channel shaped metal member with a plurality of protuberances struck from and extending inwardly from opposed walls thereof, said protuberances being inclined away from adjacent ends. The channel member has a covering layer or jacket of electrically non-conducting material which extends over certain edges for sealing engagement, said jacket preventing contact of the metal portions of the connector with other electrical conducting material. The connector receives conductors between the walls and in response to crushing force thereon the protuberances penetrate insulation of the conductors and curve away from adjacent ends of the connector to hold the conductors and make electrical contact with the wires therein. The crushing provides a crimp whereby the walls remain in the conductor engaging position. A flowable plastic or like material filling the interior of the connector forms a substantially solid encapsulation of the electrical connections of the conductors and connector member to provide an air and moisture tight structure for protection against atmospheric conditions.

16 Claims, 21 Drawing Figures

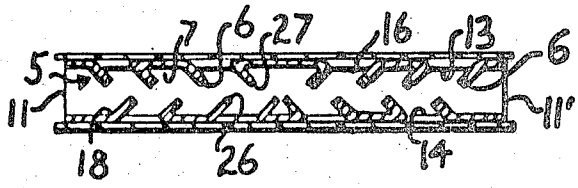
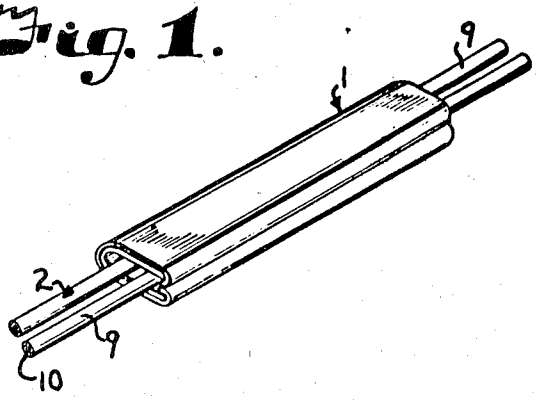


Fig. 1.



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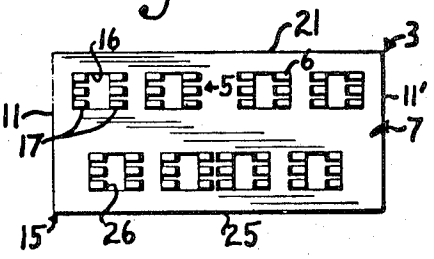
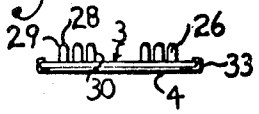


Fig. 3.



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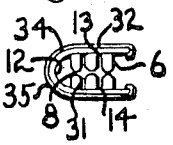

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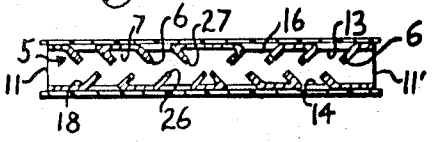

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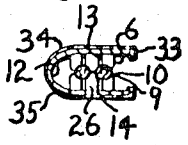

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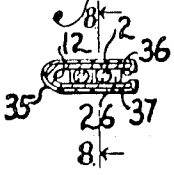

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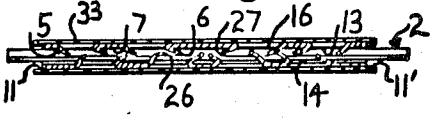


Fig. 9.

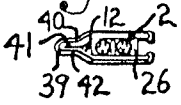


Fig. 10

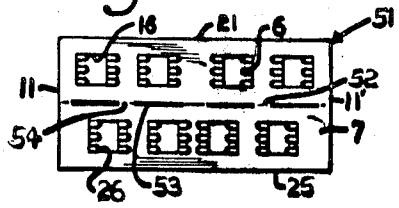


Fig. 11

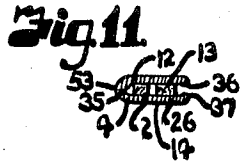


Fig. 12

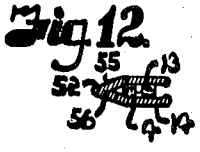
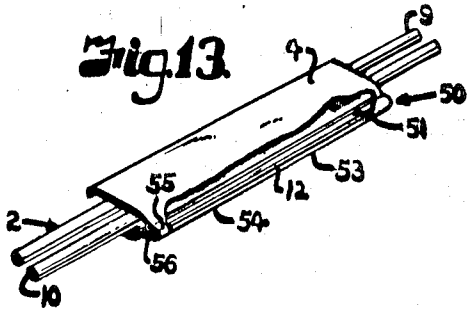


Fig. 13



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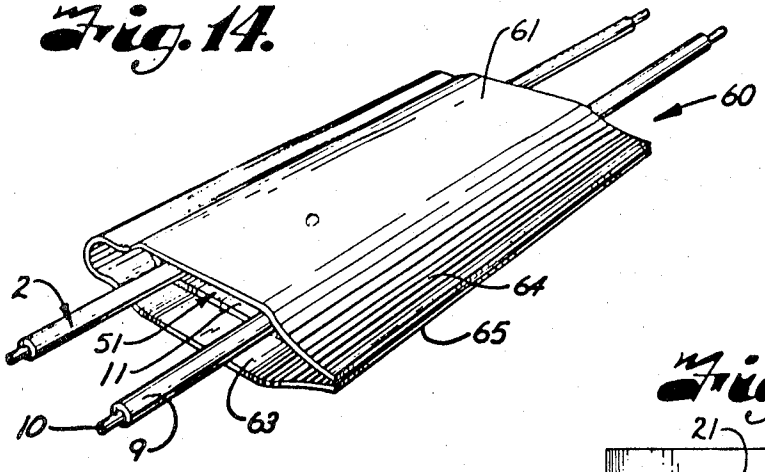


Fig. 15.

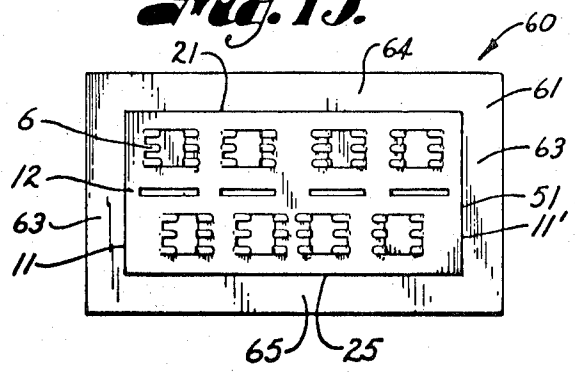
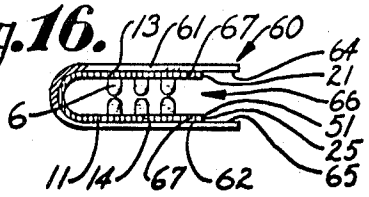


Fig. 16.



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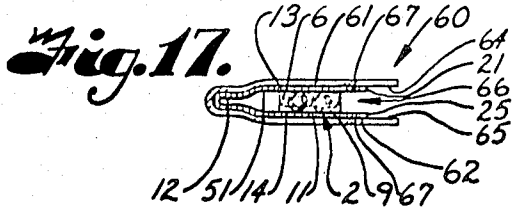

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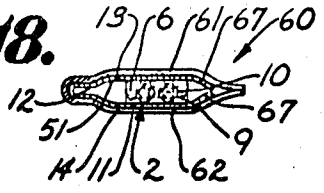
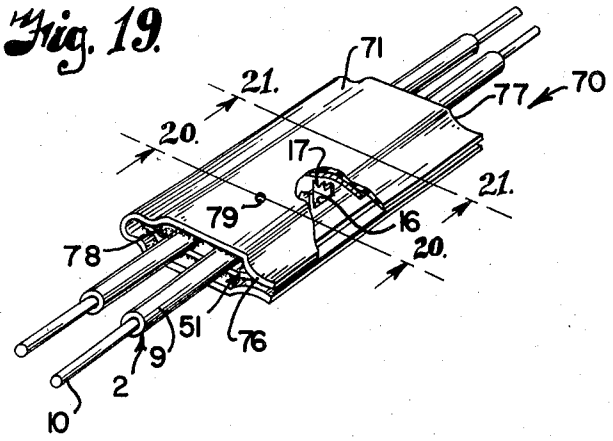


Fig. 19.



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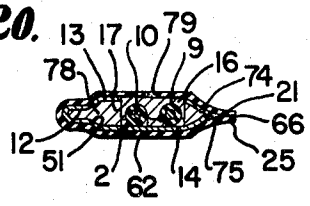
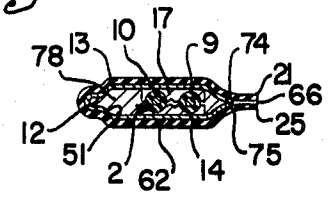


Fig. 21.



CONNECTOR FOR INSULATED CONDUCTORS

This invention relates to electrical connectors for insulated conductors and more particularly to a connector which is generally channel shape and crimped on to insulated wire, with members to penetrate the insulation and make electrical contact with the wire or core therein. This application is a continuation-in-part of my U.S. Pat. application Ser. No. 181,849, filed Sept. 20, 1971, now abandoned, which was a continuation-in-part of my U.S. Pat. application Ser. No. 101,904, filed Dec. 28, 1970, now abandoned, which was a continuation-in-part of my U.S. Pat. application Ser. No. 818,495, filed Apr. 23, 1969, now abandoned.

The principal objects of the present invention are to provide an improved connector adapted to be crimped on insulated electrical conductors to electrically join same; to provide such a connector that is a unitary structure having a metal member of low electrical resistance with a plurality of spaced insulation penetrating protuberances arranged to guide the wires and make electrical contact therewith; to provide such a connector with a covering forming an insulating sheath or jacket in surrounding relation to the connector to prevent circuit interfering contact with other structure when it is applied to conductors; to provide a splice type connector with protuberances inclined relative to ends of the connector with the protuberances adapted to be deformed and form a gripping engagement retaining the conductor in the connector when crimped thereon; to provide such a connector with laterally spaced protuberances or teeth that guide the wire during crimping and avoids cutting of the wires; to provide such a connector with a plurality of protuberances arranged to provide multiple contact with each electrical wire to assure electrical splice thereof; to provide such a connector that is easily crimped into position with ordinary tools such as pliers or the like; to provide such a connector wherein a flowable plastic or like material is injected into the interior to substantially fill all the voids and form a seal against air and moisture; to provide such a connector wherein the flowable material forms a solid encapsulating of the electrical connections of the conductors and connector to provide protection against moisture and deleterious actions and oxidation and corrosion resulting therefrom; and to provide an electrical connector for joining insulated conductors that is economical to manufacture, is in a unitary structure that is easily handled, and that is quickly and efficiently crimped on to insulate conductors for forming a positive, permanent, electrical connection therewith.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying drawings wherein are set forth by way of illustration and examples certain embodiments of this invention.

FIG. 1 is a perspective view of a connector of this invention crimped on insulated conductors.

FIG. 2 is an enlarged plan view of the metal member before it is finally formed and disclosing the arrangement of the protuberances thereon.

FIG. 3 is an end elevation of the metal member of FIG. 2 with the insulating cover applied thereto.

FIG. 4 is an end view of the connector shaped for application to insulated connectors.

FIG. 5 is a longitudinal sectional view through the connector taken on the line 5—5, FIG. 4.

FIG. 6 is a transverse sectional view through the connector with insulated conductors positioned therein prior to crimping.

FIG. 7 is a transverse sectional view similar to FIG. 6 with the connector crimped onto the insulated conductors.

FIG. 8 is a longitudinal sectional view through the crimped connector taken on the line 8—8, FIG. 7.

FIG. 9 is an end elevational view of a modified form of connector with an additional crimp to maintain engagement with the insulated conductors therein.

FIG. 10 is an enlarged plan view of a modified metal member before being finally formed and disclosing the arrangement of protuberances thereon and apertures therethrough to create a plane of weakness for crimping same to form a connector.

FIG. 11 is a transverse sectional view showing the modified metal member crimped onto insulated conductors.

FIG. 12 is a transverse sectional view showing an additional crimp to maintain engagement with the insulated conductors therein.

FIG. 13 is a perspective view of the modified metal member crimped to form the connector and having portions of an insulating jacket removed to show the apertures through the modified metal member.

FIG. 14 is a perspective view of a further modified form of connector crimped on insulating conductors with the open side closed by portions of an insulating jacket.

FIG. 15 is a plan view of the metal member and insulating jacket of said further modified form of connection.

FIG. 16 is an end elevation of the connection of FIG. 14 formed to receive conductors therein.

FIG. 17 is an end elevation of the connection of FIG. 14 crimped to maintain engagement with insulated conductors therein.

FIG. 18 is an end elevation of the connector and conductors shown in FIG. 14 and showing the insulating jacket closing the open side of the connector.

FIG. 19 is a perspective view of a form of connector on insulated conductors with portions broken away to show the protective material around the metal electrical connections.

FIG. 20 is a transverse sectional view through the connection taken on the line 20—20, FIG. 19.

FIG. 21 is a transverse sectional view through the connector on the line 21—21, FIG. 19.

Referring more in detail to the drawings:

The reference numeral 11 generally designates a connector electrically connecting two or more insulated conductors 2 and securing same relative thereto. The connector 1 comprises two components, namely, an inner member or liner 3 formed of brass or other conductive metal, and an insulating jacket 4 preferably of a film such as Mylar (polyethelene terephthalate) suitable bonded to certain surfaces of the liner to form an external covering thereof.

The liner 3 has a plurality of sets 5 of spaced protuberances or teeth 6 extending from the inner surface 7 and arranged with edges or portions 8 for penetrating the insulation 9 of the conductors 2 and engaging a wire core 10 thereof in connecting the conductors as later described. It is preferred that the protrusions or teeth extend inwardly from the inner surface 7 at an angle thereto with the teeth or protuberances for en-

gaging a conductor being inclined away from an end **11** of the liner or toward the free end of a conductor to be engaged by said protuberances. While the number of sets of protuberances may be one or more for each conductor, in the illustrated structure, the liner is formed in a generally channel shape as illustrated in FIG. **4** with a web **12** and opposed legs or walls **13** and **14** and extending inwardly from each of said walls are four sets of protuberances **6** for engaging and retaining conductors **2** extending inwardly between the walls from an adjacent end **11.** While the connector may be for connecting conductors extending only from one end, the structure illustrated shows sets of teeth arranged relative to both ends **11** and **11'** and is thereby adapted to receive conductors extending from both ends.

The liner is formed from a flat strip **15** of suitable metal such as phosphor-bronze or the like, and is then formed whereby the protuberances **6** are struck up therefrom providing a perforation **16** between a pair **17** of sets of protuberances, with all of the teeth of the pair of sets forming an obtuse angle **18** with the wall and extending therefrom. In the illustrated structure, there are a row of spaced perforations **16** adjacent the edge **21** of the strip. The protuberances at the perforations toward the end **11** are inclined away from said end or toward end **11'**; and the protuberances at the perforations toward the end **11'** are inclined in the opposite direction or toward the end **11,** but at the same angle relative to the wall. There is also a row of protuberances adjacent the edge **25** that correspond to the structure and formation of the protuberances of the pairs adjacent the edge **21,** however, the protuberances of each set adjacent the edge **25** are offset whereby the free edges or ends **26** are substantially equally spaced from the free edges **27** of the protuberances of the opposed wall when the strip is formed in a channel shape. Also, the sets of protuberances or teeth adjacent the edge **25** are inclined away from the adjacent end edges of the liner with the same angular relation to the wall as those adjacent the edge **21.**

Each set of protuberances consist of a plurality of transversely aligned teeth and it is preferred that the free edges have a straight end edge portion **28** with angled or beveled portions **29** at each end thereof terminating in side edges **30.** The side edges of adjacent teeth have a spacing slightly less than the diameter of the core of wire of a conductor to be connected and the beveled portions **29** cooperate to form recesses **31** to receive the insulated conductor therebetween. As for example, with an insulated conductor having core or wire of a diameter of approximately 0.019 of an inch, this spacing between side edges **30** of adjacent teeth preferably would be in the nature of 0.015 of an inch. The teeth **6** of one row are substantially aligned with the other teeth of the connector for engaging a conductor so the spaces between the teeth and the beveled portions forming the recessions make a path for receiving the conductor and positioning same before compression.

After the forming of the protuberances on the strip **15** as illustrated in FIG. **2,** a suitable insulating film of Mylar or the like is adhered to the surface **32** of said strip by suitable adhesive preferably a heat curing adhesive. The film **4** has a greater width than the strip whereby side margins **33** are turned up and inwardly to overlie the inner surface **7** of the wall portions **13** and **14** and are adhered thereto. The covered strip is then bent to provide longitudinal bends as at **34** and **35** whereby the walls **13** and **14** are substantially parallel and the structure of the liner and covering is substantially channel shape with the protuberances **6** from the opposed walls spaced sufficiently whereby conductors **2** can be inserted therebetween, as illustrated in FIG. **6.** With the conductors in place, the connector is positioned between jaws of a suitable tool and force is applied to the walls **13** and **14** to move same toward the conductor. The shape of the protuberances causes the conductor to be in the recesses between the teeth and as the walls **13** and **14** are moved toward each other the protuberances or teeth penetrate the insulation of the conductors so that the wire **10** moves between adjacent edges **30** with said edges penetrating the wire slightly to form a positive engagement therewith. The inclination of the protuberances as shown in FIG. **5** is such that as the walls **13** and **14** move toward each other the opposed teeth may engage each other or the opposed wall and then curve or bend in a manner tending to pull the conductor further into the liner, and also to form a bite on the insulation and wire therein so as to positively hold the conductor **2** and wire **10** to make the electrical connection. The position of the walls and protuberances when the compression is completed is shown in FIGS. **7** and **8.** This compression of the connector forms a clamping of the insulation and an engagement that tends to hold the structure in an intermeshed relation to prevent spring back. The space between the side edges of adjacent teeth in the sets having the greater distance from the ends of the connector may be less to provide more bite into the wire and thereby a firm anchorage thereof.

In using a connector constructed as shown and described to splice conductors, and with the connector in a channel shape as shown in FIG. **4,** two conductors may be inserted into the end **11** of the connector and moved longitudinally thereof. The conductors will move through the recesses formed by adjacent teeth ends and be positioned therebetween. Then force is applied to the opposed walls **13** and **14** to compress the structure forcing the conductors between the teeth which penetrate the insulation and bite into the metal core making an electrical contact therewith. Also the compression tends to flatten the structure so the teeth bend or curve back toward the wall from which they extend. This bending or curvature of the teeth forms an intermeshing that secures the conductors in place and prevents opening or spreading apart of the walls **13** and **14.** Also in the compression the margins of the jacket on the inside of the walls **13** and **14** are forced together forming a seal so the jacket acts as an insulating sleeve around the metal liner. This form of splicing is usable when the conductors extend into the connector from one end.

If it is desired to have conductors extend into the connector from both ends, as for example, in splicing four wires, the conductors are moved into the connector and supported by the teeth in the sets toward the ends from which the conductors enter. Then the connector is compressed and makes electrical contact and hold the wires in the same manner as when they extend in from only one end.

In the form of the invention illustrated in FIG. **9,** the structure of the liner and jacket **4** is the same as illustrated and described relative to FIGS. **1** to **8,** inclusive, however, the structure of FIG. **9** is particularly adapted

for use with hard spring like material such as spring tempered phosphor-bronze or the like, and after the clamping action to move the structure in position as illustrated in FIGS. 7 and 8, the fold or bend 39 in the web 12 is further crimped as at 40 to crush the portions 41 and 42 together making a relative sharp bend in the metal and this extra crimp aids in holding the walls and protrusions in the compressed position and electrical engagement with the wires 10 of the conductors 2 and prevent any spring back.

It is preferred that the connector have a metal liner that is relatively hard and such material has some spring back after bending, and also requires considerable force to form an effective crimp to hold the connector in conductor connecting position. In the form of the invention illustrated in FIGS. 10 to 13, inclusive, a modified connector 50 permits crimping with less force and substantially eliminates spring back. In this structure, an inner member or liner 51 is formed of hard brass or other conductive material. The liner 51 is substantially the same shape as the liner 3, shown in FIG. 2, and has the same sets of protuberances or teeth 6 formed and inclined the same as the structure illustrated in FIGS. 2 and 3.

In the structure shown in FIGS. 10 to 13, inclusive, the portions corresponding to the structure shown in FIGS. 1 to 9, inclusive, will be indicated by corresponding reference numerals. To facilitate crimping, the liner 51 has a line of weakness 52 extending longituidnally in the web portion 12 midway between the wall portions 13 and 14. This line of weakness may be of any suitable form, as for example, a portion of reduced thickness or a plurality of perforations longitudinally spaced along the line. In the illustrated structure, the line of weakness is the plurality of longitudinally spaced aligned elongate slots 53 extending through the mid portions of the web 12. The slots are of such length that the solid portions 54 between adjacent ends will have sufficient strength when the structure is crimped to hold the assembly in the formed position.

The connector 50 has a liner provided with an insulating jacket or cover 4 formed of a film bonded to the surfaces of the liner, and said film is continuous over any openings, including the slots 53, whereby it forms an external covering for the metal liner. The modified connector 50 with the covered metal liner is bent at the web portion to form a generally U-shaped structure, and when conductors 2 are placed between the protuberances or teeth 6, the walls 13 and 14 are moved toward each other whereby the protuberances penetrate the insulation 9 and engage the wire cores 10 to make the electrical connection, the structure being substantially in the form shown in FIG. 11. Then, to hold the connector with the protuberances engaging the wire, the web 12 is crimped by bending same at the line of weakness 52 whereby the adjacent wall portions 55 and 56 are moved substantially to face-to-face contact, as illustrated in FIG. 12. This bending is a positive crimp wherein the web portion is crushed and bent beyond the elastic limit of the material of the inner member 51 so there is no spring back, and the protuberances or teeth 6 anchor the conductors 2 and maintain a conductor connecting position.

The force for crimping the connector as described due to the line of weakness is such that it can be easily done with hand tools even though the liner metal is of a hard metal.

One of the uses of the connector illustrated and described herein is the splicing or connecting of telephone wires. It is common practice to have a large number of wires in a cable or conduit as for example 200 to 3,000 or more wires. In installation or in repair of breaks the wires have portions extending from open ends of a two cable portion and the wires from one are connected to respective wires of the other to complete individual circuits. After completion of the connections a larger enclosure or sleeve is placed over the connections and adjacent ends of the cables to provide weather protection for the connected wires. Some of the connectors are spaced longitudinally of the wires from other connectors, however, due to the large number there are many connectors that touch or may touch other connectors. If metal objects or metal portions of a connector contact metal portions of another connector or its respective conductors, circuit interference may result. This may cause interruption of service and cost in locating and repairing the difficulty.

In the form of the invention illustrated in FIGS. 14 to 18 inclusive, a modified form of connector 60 provides an insulating protection against foreign objects or members entering and contacting the metal member or conductors connected by the connector.

In the structure shown in FIGS. 14 to 18 inclusive, the portions corresponding to the structure shown in FIGS. 1 to 13 inclusive, will be indicated by corresponding reference numerals. The connector 60 has an insulating jacket or cover sheet 61 of an electrical nonconducting material preferably of a film such as Mylar (polyethelene terephthalate) suitably bonded to the outer surface 62 of the metal member or liner 51. The cover sheet 61 has a length and width greater than the liner 51 whereby margins 63 extend outwardly beyond edges at the ends 11 and 11′ of the liner and margins 64 and 65 extend outwardly beyond the side edges 21 and 25 of the liner 51. The cover sheet 61 is continuous over any openings in the liner and is impervious forming an external insulating covering for the metal liner.

The connector 60 with the covered liner 51 is bent to form a generally U-shaped structure FIG. 16, with protuberances or teeth 6 positioned to receive therebetween insulated conductors to be connected. In this shape of the connector the margins 64 and 65 of the cover extend out from the side edges 21 and 25 in spaced apart relation whereby conductors to be connected may be moved through the space and the side opening 66 and positioned between two teeth 6. After the conductors 2 are positioned in the connector the walls 13 and 14 are moved toward each other, the protuberances penetrate the insulation 9 and make electrical connection with the cores 10 of the conductors, the web 12 is crimped or crushed as shown in FIG. 17 to hold the connector with the protuberances engaging the wire cores 10. It is desirable to have the metal portions of the connector protected against contact with other connectors or other metal objects that might cause circuit interference. The overhanging margins 63 of the cover sheet 61 at ends of the connector provide a narrowed space that with the insulation 9 on the conductors 2 tend to prevent interfering contact. The side opening 66 presents more difficulty as it is more accessible. The margins 64 and 65 tend to prevent entry of other objects, but to insure closure and protection portions 67 of the walls 13 and 14 adjacent the edges 21

and 25 are bent one toward the other to narrow the space and effect positive engagement of the margins 64 and 65 and form an insulating closure preventing entry of foreign objects or portions of other connectors. This makes an effective closure protecting the metal portions of the connector to substantially eliminate possibility of circuit interference by electrical shorts with other connectors or objects.

In the form of the invention illustrated in FIGS. 19 to 21 inclusive, a further modified form of connector 70 a substantial encapsulation of the contacting portions of the wire 10 of the conductors and the edges 30 of the protuberances 6 to exclude moisture and air and thereby prevent corrosion.

In the structure shown in FIGS. 19 to 21 inclusive, the portions corresponding to the structure shown in FIGS. 1 to 18 inclusive, will be indicated by corresponding reference numerals. The connector 70 has an insulating jacket or cover sheet 71 preferably of film such as Mylar suitably bonded to the outer surface 62 of the metal member or liner 51. With the conductors 2 positioned in the connector and the walls 13 and 14 move toward each other and the protuberances penetrating the insulation 9 and making electrical connection with the cores 10 of the conductors and the connector crimped as shown in FIG. 17 on the edges 21 and 25 of the walls 13 and 14 substantially close the side opening 66. The margins 74 and 75 of the cover sheet 61 engage and form a side closure. However, the ends 76 and 77 of the structure are open. A filling 78 of a viscous or jelly-like material is applied to the interior of the connector to substantially fill the interior and particularly surround all metalic contacting points with the wires 10 of the conductors. The filling 78 may be of any suitable non-conductor material that is viscous or jelly-like, whereby it may be injected into the interior of the conductor and will remain in place during setting or curing to a pliable plastic or solid that will encapsulate electrical connections. Suitable materials for the filling are synthetic resins that will cure at room temperatures, such as epoxy resin and other thermo setting resins. Also, insulating putties and the like may be used.

In the structure illustrated the cover sheet 71 has an aperture 79 arranged to align with a perforation 16 between a pair 17 of sets of protuberances; this provides a communication with the interior of the connector whereby the filling may be applied through a suitable nozzle through the opening 79 and perforation 16 to the central portion of the interior of the connector. In this manner the filling may flow laterally to the side edges 21 and 25 and to the web 12 and also toward both open ends to substantially the ends of the walls 13 and 14. After completing the filling the nozzle is removed and upon setting of the filling there is a substantially permanent connection of the conductors that is protected against corrosion and circuit interference by electrical shorts.

While the disclosed embodiments of the invention are particularly adapted to make a splice for up to four wires it will be apparent that the principal of an arrangement of the portions is equally applicable to other connectors for different numbers of wires and variations in arrangement and still provide for penetrating the insulation and making electrical contact with the wire.

I claim:

1. An electrical connection of conductors having insulation thereon comprising:
   a. a generally channel-shaped metal member having a web and opposed spaced apart walls extending therefrom;
   b. rows of conductor engaging protuberances on said spaced walls with said rows arranged transversely thereof;
   c. conductors having insulation thereon with portions positioned between said walls;
   d. said rows of protuberances each having a plurality of said protuberances with a spacing between adjacent protuberances receiving said conductor therebetween with the adjacent edges of the protuberances being spaced less than the width of said conductor and engaging same;
   e. an imperforate cover sheet of electrical nonconductive material on outer surfaces of said web and walls in covering relation thereto; and
   f. said conductors being clamped between the walls of said channel-shaped member and said protuberance edge penetrating into the insulation of said conductors therebetween and said protuberances curving away from an adjacent end of the channel-shaped member to hold said conductor and make electrical contact therewith.

2. An electrical connection as set forth in claim 1 wherein the rows of protuberances in one wall are offset from the rows in the other wall with a row of protuberances in one wall being substantially between adjacent rows of protuberances in the other wall.

3. An electrical connection as set forth in claim 2 wherein:
   a. the rows of protuberances are in pairs struck inwardly from the spaced walls; and
   b. said protuberances of each pair of rows being inclined toward the opposed wall and away from the adjacent end of the channel-shaped member.

4. An electrical connection as set forth in claim 3 wherein:
   a. each opposed wall of the channel-shaped member has a plurality of rows of protuberances with protuberances of rows in one end portion inclined toward the protuberances of rows in the other end portion; and
   b. each row having a plurality of protuberances and a plurality of spaces therebetween receiving at least two of said conductors extending from an adjacent end of the connector with each of said conductors being engaged by edges of two adjacent protuberances in the respective rows.

5. An electrical connection as set forth in claim 4 wherein the channel-shaped member having the web connecting the walls at one side crushed to crimp the channel-shaped member to hold the protuberances in conductor engaging position.

6. An electrical connection as set forth in claim 1 and including:
   a. said rows of protuberances being formed in said metal member with openings between certain adjacent rows;
   b. said imperforate cover sheet having an entrance opening therethrough communicating with the area having the conductor therein through an opening between rows of protuberances in the metal member; and

c. a setable semi-solid filler inserted through said entrance opening and surrounding all electrical connections between said metal member and the electrical conductors to encapsulate same.

7. An electrical connection as set forth in claim **1** wherein said web has a line of weakness extending longitudinal thereof and crushing of the channel-shaped member along said line of weakness bends the web on said line and the wall portions adjacent said line are in substantially face-to-face contact.

8. An electrical connection as set forth in claim **7** wherein the line of weakness is a plurality of longitudinally aligned slots extending through the metal member.

9. An electrical connection as set forth in claim **7** wherein:

a. said channel-shaped metal member has side and end edges with said side edges defining a side opening at the other side of the web of said member; and

b. said imperforate cover sheet has marginal portions extending outwardly beyond the end and side edges of said metal member and forming an overhanging insulating protector from circuit interferring contact of said metal member and conductors with foreign objects.

10. An electrical connection as set forth in claim **9** wherein:

a. said spaced apart walls having portions adjacent said side edges being bent one toward the other whereby the marginal portions extending beyond said side edges are engaged and close and form an insulating closure for said side opening.

11. An electrical connector as set forth in claim **10** and including:

a. a filling of setable material in the metal member encapsulating the areas of electrical engagement and protecting same against moisture and air, said setable material being introduced after completion of the connection of the connector metal member with the conductors.

12. An electrical connection as set forth in claim **1** wherein:

a. said imperforate cover sheet has marginal portions extending outwardly beyond side and end edges of said channel-shaped metal member and form an insulating protector of said metal member from circuit interfacing contact with foreign objects.

13. An electrical connection as set forth in claim **1** wherein:

a. said channel-shaped metal member has side and end edges with said side edges defining a side opening;

b. said imperforate cover sheet has marginal portions extending outwardly beyond said side edges;

c. said spaced apart walls of said channel-shaped metal member having portions adjacent said side edges being bent one toward the other and the marginal portions of said cover sheet being engaged to close said side opening and form an insulating protector from circuit interferring contacts.

14. An electrical connection of insulated electrical conductors comprising, a generally channel-shaped metal member having a web and opposed spaced apart walls extending therefrom, rows of conductor engaging edges on said spaced walls with said rows arranged transversely thereof, said rows of edges on one wall being offset with respect to the rows of edges on the other wall with a row of said edges on one wall being substantially between adjacent rows of edges on the other wall, insulated conductors positioned between said walls and extending longitudinally of said channel-shaped member and from an end thereof, said conductors being engaged by certain of said rows of edges, each of said rows being inclined at an acute angel with respect to its respective wall and away from the end of the channel-shaped member from which the respective conductors engaged thereby extends, an imperforate cover sheet of electrical non-conductive material on outer surfaces of said web and walls in covering relationship thereto, said insulated conductors being clamped between said walls of the channel-shaped members with said edges penetrating into the insulation of the conductors and into engagement with the conductor and said edges curving away from an adjacent end of the said channel-shaped member from which the respective engaged conductor extends to hold said conductor and make electrical contact therewith.

15. An electrical connection of conductors having insulation thereon comprising:

a. a generally channel-shaped metal member having a web and opposed spaced apart walls extending therefrom;

b. rows of conductor engaging protuberances on said spaced walls with said rows arranged transversely thereof;

c. conductors having insulation thereon with portions positioned between said walls, said conductors extending longitudinally of said channel-shaped member and from an end thereof;

d. said rows of protuberances each having a plurality of said protuberances with a spacing between adjacent protuberances receiving said conductors therebetween with adjacent edges of the protuberances being spaced less than the width of the conductor and engaging same;

e. the rows of protuberances are in pairs struck inwardly from the spaced walls;

f. said protuberances of each pair of rows being inclined toward the opposed wall and away from the adjacent end of the channel-shaped member;

g. an imperforate cover sheet of electrical non-conductive material on outer surfaces of said web and walls in covering relation thereto;

h. the channel-shaped member has said web portion connecting the opposed walls at one side thereof;

i. said conductors being clamped between the walls of said channel-shaped member and adjacent protuberance edges penetrating into the insulation of said conductors therebetween and said protuberances curving away from an adjacent end of the channel-shaped member to hold the conductor and make electrical contact therewith; and

j. said web being further crushed and bent beyond the elastic limit of the material to hold the walls and the protuberances thereon in conductor connecting position.

16. An electrical connection as set forth in claim **15** wherein said web has a plurality of longitudinally aligned slots extending through the metal member and defining a line of weakness substantially midway between the spaced walls and the crushing and bend of the web is along said line with adjacent wall portions in substantially face-to-face contact.

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