Dec. 2, 1958 F. J. SOWA 2,863,132

ELECTRICAL CONNECTOR WITH INSULATED FERRULE

Original Filed Oct. 28, 1944 2 Sheets-Sheet 1

Fig. 1.

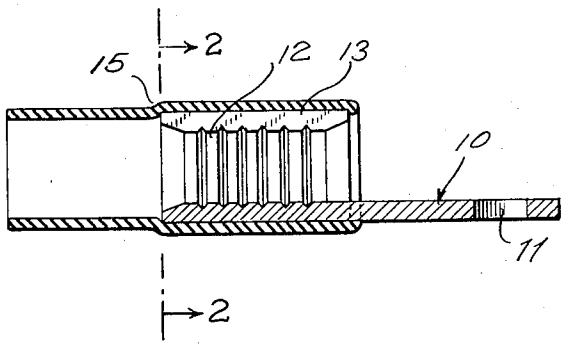


Fig. 2.

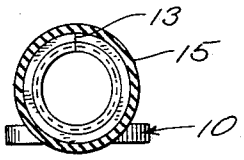


Fig. 3.

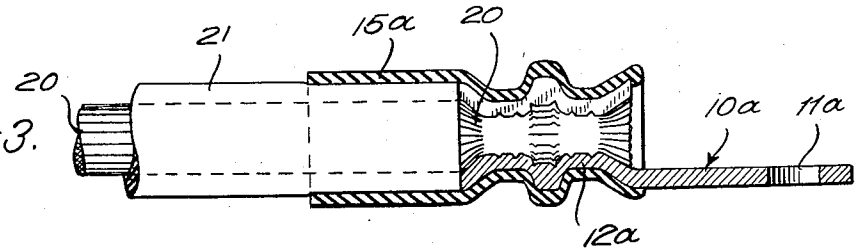
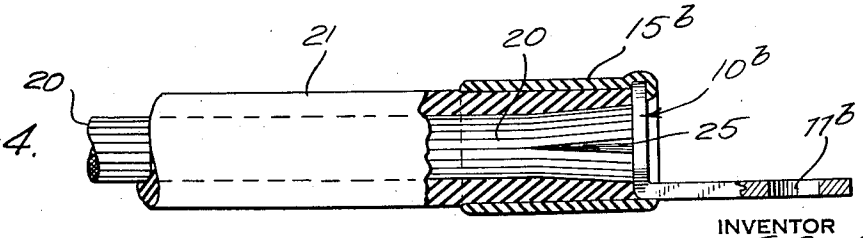


Fig. 4.



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Fig. 5.

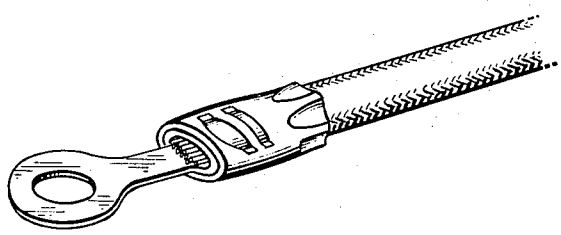
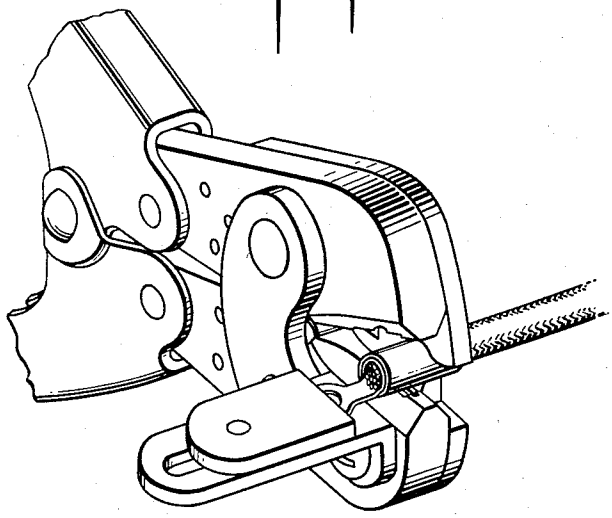


Fig. 6.



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ELECTRICAL CONNECTOR WITH INSULATED FERRULE

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Original application October 28, 1944, Serial No. 560,785. Divided and this application October 1, 1951, Serial No. 254,515

1 Claim. (Cl. 339—213)

This invention relates to electrical connectors and more particularly to electrical connectors having insulated ferrules.

It is an object of this invention to provide an inexpensive connector having the ferrule portion thereof for engaging a conductor and holding it in good conducting relation to a terminal portion, but fully insulated against peripheral contacts. Another object of the invention is to provide an electrical connector having a metallic ferrule and an insulated sleeve thereon capable of crimping by the usual methods to form a mechanically secure and electrically good connection with a wire or other conductor onto which the terminal is applied.

Although in this specification and the accompanying drawings I am showing and describing a particular example and various modifications thereof, it should be understood that these are not intended to be exhaustive or limiting of the invention, but on the contrary are chosen and presented for purposes of illustration and in order to explain the principles of the invention and the practical employment of those principles in applying the invention to practical use, and thus to so fully instruct others skilled in this art that they will be enabled readily to modify and to select and substitute alternatives, each as may be best suited to the particular conditions of any given application or use.

In the accompanying drawings,

Figure 1 is a view in axial section of a terminal connector embodying the invention;

Figure 2 is a cross-sectional view of the same terminal connector taken on line 2—2 of Figure 1;

Figure 3 is a view in axial section of a similar connector crimped onto an insulated wire;

Figure 4 is a view partly in axial section and partly in side elevation of another terminal connector embodying the invention;

Figure 5 is an isometric view of the connector of Figure 1 after its application to a wire and crimping in the same manner as the ferrule shown in Figure 3; and

Figure 6 is an isometric view showing the connector of Figure 1 in process of being crimped to the form shown in Figure 5.

Referring to these drawings the reference character 10 identifies an electrical terminal of conventional form. This may be made, for example, from flat strip of annealed high conductivity pure copper stamped out to form the tongue portion as shown with the hole 11 for reception of a binding post, and a substantially rectangular portion 12 which is rolled up as shown to cylindrical form bringing the ends together at 13 as shown in Figures 1 and 2.

A seamless sleeve 15 is formed, e. g. by extrusion, of plastic insulating material of the type which can be expanded under conditions such that it retains so-called "elastic memory," i. e. tends more or less slowly to return to a form and dimensions approaching that from which it has been expanded or deformed. Such return is generally delayed or inhibited by cold and hastened by heat. There are many such plastics known to the trade, mostly

compositions of organic polymers with plasticizers. I have found particularly suitable for such use an extruded tubing manufactured from a plasticized copolymer of vinyl chloride and vinyl acetate. This material, at ordinary atmospheric temperature and when dry and relaxed, should be tough and resistant to deformation, although it is capable of molding at higher temperatures; moreover it can be stretched mechanically or swollen in solvents or otherwise deformed without heat so as to retain a tendency to return to the form which it had before such expansion or deformation; and this property I take advantage of according to my present invention, first to facilitate the assembly of the parts, and secondly to permit crimping of the insulated ferrule by ordinary crimping tools without destruction of the insulating sleeve.

Referring once more to Figure 1, it will be noticed that the interior diameter of the free end of the sleeve 15 is smaller than the exterior diameter of the ferrule 12. This relationship is purposely chosen so that after the sleeve has been expanded and fitted over the ferrule the elastic recovery will grip the ferrule with a relatively high constrictive pressure with the consequences: first, that the seam 13, where the ends of the ferrule portion are abutted together, is sealed and closed against the entry of corrosive influences; secondly, that the ends of the sleeve are drawn in over the end of the ferrule giving more complete insulation and holding the sleeve securely in its desired longitudinal position; and thirdly, that the ferrule is held against springing open under the influence of the crimping tool.

Before this small sleeve can be fitted onto the ferrule it is, of course, necessary that it be in some way enlarged. According to my present invention this may be done either by swelling in solvents or by stretching mechanically.

If the sleeve is to be swollen by means of solvents, it is convenient to keep a supply of the sleeves immersed in the solvent until ready for use, then to remove them as needed and place each over a ferrule; whereupon evaporation of the solvent causes elastic recovery with the result that the sleeve securely grips the ferrule and is drawn over its edges as shown in Figure 1.

Unless special precautions are taken, however, this soaking in solvent will result in a leaching out of the plasticizer from the plastic material to such extent that after it is shrunk onto the ferrule it tends to become so brittle that a subsequent attempt to crimp the connector onto a wire, may destroy the sleeve. I have found that this difficulty can be avoided by using for this swelling operation either a liquid which swells the plastic but is a nonsolvent for the plasticizer, or it may be a solvent of the plasticizer but having already dissolved in it sufficient plasticizer to assure a desired concentration of plasticizer in the sleeve after soaking in the solution. This latter is of particular advantage because it gives a full control of plasticizer concentration independent of the composition of which the sleeves may have been originally formed. Thus it is ordinarily an advantage to have more plasticizer present during extrusion of the plastic tubing from which the sleeve is cut than during the crimping of the ferrule on which the sleeve is mounted. This is done by my invention by using a solution which allows a desired partial leaching out of the plasticizer. Or, if desired, an increase in the plasticizer can be brought about by soaking in more concentrated solution of the plasticizer.

To the same end I have found it advantageous, where the sleeves are applied by mechanical stretching to bake them, or subject to a vacuum or other controlled treatment for evaporating a part of the plasticizer after application to the ferrules. Using extruded tubing manufactured from a plasticized copolymer of vinyl chloride and vinyl acetate which is well known to the plastics industry, for example, satisfactory results are attained by baking for

one-half to one hour at temperatures of 375° F. to 390° F. in a closed oven. This treatment removes enough of the plasticizer to avoid excessive extrusion or shearing under the crimping dies, e. g., as shown in Figure 6, but not so much as to prevent cold molding during crimping. If the sleeve becomes brittle, too much of the plasticizer has been removed.

With extruded tubing as described above, I find most advantageous for this purpose a 5% to 10% solution of tricresyl phosphate in benzene. Depending upon the results desired, the concentration of this solution may be varied above 10% to about 30%, or below 5%.

The sleeve 15, when thus swollen with or without such reduction or increase of plasticizer, shrinks firmly and strongly onto the ferrule, but retains toughness and pliability so that subsequently when the terminal is crimped onto a conductor by an ordinary crimping tool, e. g., such a one as is shown in Figure 6 and more particularly described in the Carlson Patent No. 2,359,083, the pressure of the crimping die is transmitted evenly through the plastic to the metal.

The extent of plasticizing, degree of ploymerization and, in general, the nature of the plastic composition chosen for the insulating sleeve, should be such that its resistance to plastic flow is of the same order as, or even less than, that of the soft copper of which the ferrule is made, since it is essential to a good electrical connection that the metal of the ferrule should flow to some extent from under the crimping die. If the plastic did not yield at all it would cushion the die and so far distribute its pressure as to impair or prevent the action on the metal ferrule required for a good connection; and on the other hand if the plastic flows too readily it would so far squeeze out from under the die as to expose the metal and thus impair its insulating function. Even if the plastic is pressed excessively thin, however, advantage may be taken of the present invention if the plastic is one with sufficient elastic memory so that it creeps back into the crimped areas and restores a sufficient thickness of insulation.

Instead of the use of a swelling liquid, I have found it advantageous, under ordinary production conditions, to use a mechanical stretching of the sleeve. After this stretch, the lower the temperature at which the sleeve is maintained the slower will be its recovery, whereas if the temperature is increased the recovery is accelerated and, by even a moderate heating, the sleeve may be brought down into gripping relation within a very brief period. By this means again the sleeves which are normally smaller than the ferrule are nevertheless readily applied over the ferrule and then come down into strongly gripping relation thereon and with their ends drawn down tightly over the ends of the ferrule as shown in Figure 1.

The sleeves in this condition when delivered for use should be tough in their resistance to deformation and yet substantially plastic so that they lend themselves well to the crimping operation and advantageously have, as described above, some tendency to elastic recovery after deformation, which improves any condition of excessive extrusion or puncturing if such should occur during the crimping operation. Ordinarily these properties will be developed in the plastic by removal of some plasticizer, e. g. by baking as described above.

When the insulated connector of Figure 1 as described above is fitted onto a wire with a bared end of the conductor in ferrule 13 and the end of the insulated portion in the projecting end of sleeve 15, the sleeve and ferrule can be crimped into engagement with the wire and its insulation by ordinary commercial crimping tools, such, for example, as that described in the Carlson Patent No. 2,359,083, and shown in Figure 6.

Although in Figures 1 and 2 I have shown the insulating sleeve applied to the terminal before crimping onto the wire, it may in some cases be more convenient, and it is entirely feasible in accordance with my invention, to apply the insulating sleeve at the same time that the terminal is applied to the wire or after the terminal is applied. To this end a terminal such as shown, for example, in Figure 3, may be applied to the bared end 20 of an insulated electrical conductor 21 and the ferrule of the terminal crimped to produce a secure electrical connection. Thereafter a stretched and chilled sleeve 15*a* is slipped over the ferrule 12 overlapping slightly on the end toward the terminal portion 11 and overlapping substantially at the opposite end so as to engage and secure the insulated portion of the wire 21. With the sleeve thus in place it is warmed to a temperature at which it tends to recover its original diameter and thus is shrunk into secure gripping relation both to the ferrule 12 and the wire 21. Conveniently, the sleeve 15*a* is threaded cold onto the wire before the terminal is applied and is slid beyond the ferrule 12*a* on the insulated wire 21 until the ferrule has been crimped onto the bared end of the conductor 20. The sleeve 15*a* is then slid back along the wire to the position shown in Figure 3, where it is heated to shrink it onto the wire and terminal. If the terminal portion 11*a* is not excessively large, it is also feasible to stretch the sleeve so that it can be slipped over the terminal after application.

Because of the strength with which the shrunk tube of plastic insulation grips the metal parts which lie within it and the partial deformation which causes it to engage them with a mechanical interlock, my invention makes possible a number of simplifications in the design of terminals and like articles. One example of this is shown in Figure 4 wherein a terminal of utmost simplicity is made by merely bending a copper tongue 10*b* of suitable shape to a right angle and either forming thereon or applying thereto a spear 25. This spear may be of the same or a similar metal as the tongue 10*b*, advantageously integral therewith, or it may be of a brazing or soldering alloy as more fully described in the abandoned application of Robert C. Swengel, Serial No. 517,779, filed January 11, 1944.

An insulating sleeve 15*b* expanded and shrunk into place, in accordance with the present invention, grips and molds itself to this terminal so as to form a ferrule securely interlocked therewith for supporting the end of an insulated wire. As suggested above, the ferrule may be applied during the manufacture of the terminal and the wire subsequently inserted into the end of the shrunk ferrule and the latter then engaged with the wire, if desired, by a crimping or hot molding operation, or the terminal portion can be applied to the end of the insulated wire and the sleeve 15*b* then slipped over the end of the wire and the adjacent end of the terminal and allowed to shrink into place, engaging securely both the end of the terminal and the end of the wire and binding them securely together in conducting relation and sealing the connection against corrosive influences.

The expansion of the tubes used for insulating connectors according to the present invention can be done hydraulically by coupling one end to a fluid pressure source and closing the other, or advantageously coupling it to a pressure regulating valve or other means for permitting flow under pressure. The tube is first filled with cool or tepid water, which expands it to the required diameter, and then chilled, e. g. by a flow of cold water therethrough.

This application is a division of my prior copending application Serial No. 560,785, filed October 28, 1944, now abandoned.

I claim:

The combination, in an electrical connector, of: a metallic conducting member having a portion thereof adapted to be pressed into permanent contact and engagement with an electrical conductor, and an insulating sleeve surrounding and engaging said conducting member; said sleeve and conducting member providing an opening for reception of said conductor, said sleeve being of a tough

insulating plastic material of the type which is moldable under pressure at room temperature whereby it is molded by the crimping but with toughness whereby it transmits localized crimping pressure to produce said permanent contact and engagement without puncture or shearing through of the plastic material, said sleeve being characterized by an elastic memory of a previous condition in which its periphery was substantially less whereby it has a tendency to shrinkage exerting a constrictive force on the connector, said sleeve containing therein a substantial amount of vaporizable material of the class consisting of plasticizers and solvents and swelling agents, whereby said plastic is capable of slow shrinkage during slow evaporation of said vaporizable material therefrom.

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