ELECTRIC WIRE CONNECTOR ASSEMBLY

Raymond J. Burdick, Madison Township, Old Bridge, N.J., assignor to Buchanan Electrical Products Corporation, Union, N.J., a corporation of New Jersey

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The present invention relates generally to devices for connecting wires together in a bundle and pertains more specifically to those devices known as “wire connectors” which are employed in mechanically and electrically connecting electrical conductors in an effective insulated connection.

Wire connectors have proved to be highly effective in providing a simple means for securing electrical conductors together both mechanically and electrically in many different installations and have gained a high degree of commercial acceptance. As a result, a wide variety of such devices have been developed in an effort to simplify their design and construction while increasing their operating effectiveness. A desirable quality in such devices is the ability to be readily engaged with, as well as disengaged from, a bundle of conductors without causing serious damage to either the device or the conductors so that the device can be reused and need not be replaced after each use.

Because wire connectors are in such wide use, the range of sizes of the connections which the connectors are called upon to secure is relatively great. It would be advantageous then to be able to supply a single wire connector capable of accommodating a relatively wide range of sizes of bundled wires so as to add to the flexibility of use of each wire connector of a given size as well as reduce the total number of sizes which must be made available to cover the total range of commercial installations.

It is, therefore, an important object of the invention to provide a wire connector capable of accommodating a relatively wide range of sizes of bundled wires.

Another object of the invention is to provide a wire connector with the above capability, yet having minimum dimensions.

Still another object of the invention is to provide a wire connector capable of effective operation over a number of reuses including successive reuses with bundles either larger or smaller than the originally secured bundle.

A further object of the invention is to provide a wire connector of the type described capable of establishing an effective mechanical and electrical connection between a number of wires with a minimum of damage to the wires.

Still a further object of the invention is to provide a wire connector having a configuration capable of economical manufacture in large quantities of uniform quality.

Another important object of the invention is to provide a wire connector which can be applied to conductors by hand, without the use of tools.

Briefly, the invention provides, in a device for mechanically securing together a plurality of wires in a bundle, the device having a relatively limited axial length capable of accommodating bundles of diameters which vary over a relatively wide range, a resiliently expandable helically coiled member providing an opening extending axially from an entrance end to an opposite end, the member including helical groove-pressing means along the opening having a maximum internal radius at the entrance end and diminishing in radius at a first rate along a first portion of the axial length for accepting the largest of the bundled diameters and starting at least a portion of a helical groove in the wires of the bundle, thence diminishing in radius at a second rate along a second portion of the axial length to a minimum radius adjacent the opposite end, the second rate being less than the first rate, the resilient expansibility of the member allowing only limited expansion of each successive radius of the coiled member as the bundle advances axially through the opening and each rate being chosen great enough so that each successively smaller radius will tend to enlarge the groove pressed in the wires by a preceding larger radius until the helical member is sufficiently interlocked with the wires to preclude unwanted removal of the device from the bundle and the force required to pass the bundle beyond the next successive smaller radius becomes great enough to preclude further axial advancement of the bundle.

The housing is of relatively rigid insulating material having a cavity therein for receiving the spring member and generally complementary to the exterior of the spring member, the exterior portion of the housing at said opposite end being of smaller diameter than said entrance end, said housing having projections extending outwardly from said smaller diameter end portion for obtaining a greater leverage arm to achieve a greater torque value for applying the spring and housing onto a bundle of wires.

The invention will be more clearly understood and further objects and advantages thereof will become apparent in the following detailed description of an embodiment of the invention illustrated in the accompanying drawings wherein:

FIGURE 1 is a longitudinal cross-sectional view of a wire connector constructed in accordance with the invention; FIGURE 2 is an enlarged transverse cross-sectional view taken along line 2—2 of FIGURE 1; FIGURE 3 is an enlarged transverse cross-sectional view taken along line 3—3 of FIGURE 1; FIGURE 4 is an enlarged transverse cross-sectional view taken along line 4—4 of FIGURE 1; FIGURE 5 is an enlarged diagrammatic fragmentary longitudinal cross-sectional view illustrating the operation of the wire connector with bundled wires having a large bundle diameter; FIGURE 6 is an enlarged diagrammatic fragmentary longitudinal cross-sectional view illustrating the operation of the wire connector with bundled wires having an intermediate bundle diameter; FIGURE 7 is an enlarged diagrammatic fragmentary longitudinal cross-sectional view illustrating the operation of the wire connector with bundle wires having a small bundle diameter; FIGURE 8 is a view similar to FIGURE 2 but showing a modified helically coiled member; FIGURE 9 is an end view of a preferred embodiment of housing having external fins; FIGURE 10 is a side view of the housing shown in FIGURE 9; FIGURE 11 is another view of the housing of FIGURES 9 and 10; FIGURE 12 is an end view of a modified form of housing having retractable fins; and FIGURE 13 is a side view of FIGURE 12.

Referring now to the drawings and especially to FIGURE 1, a wire connector constructed in accordance with the invention is illustrated generally at 10 and has a housing 12 of relatively rigid dielectric material and a helically coiled member 14 fixed within the housing 12.

Housing 12 is of unitary construction and is preferably molded of a synthetic resin having desirable strength and toughness as well as the requisite electrical insulating properties. The housing is generally in the form of a
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shell providing an internal core or cavity 20 extending from an open end 22 of the housing 12 to a closed end 24, a first portion 26 of the cavity 20 having an internal diameter great enough to receive the ends of the insulated conductors to be placed within cavity 20 and a second portion 28 having an internal contour generally complementary to the external configuration of the helically coiled member 14 will be explained hereinafter.

As outlined above, it is the function of a wire connector to firmly secure together a plurality of wires to establish a fast mechanical joint as well as a good electrical connection between the wires. The wires are presented to the connector in the form of a plurality of bundled electrical conductors, usually twisted together in a bundle having a generally fixed overall diameter which will be referred to as the "bundle diameter." The bundle of wires is received within the wire connector 10 through the open end 22 and is engaged by the helically coiled member 14 by twisting the wire connector 10 to axially advance the bundle from open end 22 toward closed end 24, the engagement of member 14 with the bundle being likened to a screw-threaded engagement. By reversing the direction of twist, the wire connector 10 may be removed from the bundle to once again expose the bare wires.

It will be apparent that a wide range of bundled diameters will be encountered in the field since each bundle may be composed of any number of wires of a variety of sizes. In addition to the variety of bundled diameters initially encountered, very often a wire connector will be removed from a bundle so that further wires can be added to the bundle or, alternatively, so that some wires can be removed from the bundle, thus presenting a bundle having a different diameter than that originally engaged by the wire connector. Thus, it would clearly be of great practical value to have available a wire connector which could not only initially accommodate a wide range of bundled diameters, but one which can be reused with the same or with different bundled diameters and still attain an effective mechanical and electrical connection.

Through the employment of a unique configuration for helically coiled member 14, I have been able to construct a wire connector having the above advantages while still retaining the advantages of minimum overall dimensions, and especially without requiring an inordinately great axial length. Helically coiled member 14 is thus constructed in the form of a resiliently expansible spring having a plurality of resiliently dilatable convolutions 40, each convolution being designated individually as 40a, 40b, 40c, 40d, 40e, 40f, 40g, 40h, 40i, 40j, and 40k respectively, which define an opening 42 extending axially from an entrance end at convolution 40a to an opposite end at convolution 40n.

In order to firmly grip the incoming bundle of wires and engage each wire in a manner similar to a screw-threaded engagement, an edge 44 is provided in the member 14 on convolution 40 for permanently deforming the wires of the bundle by pressing a groove into the wires. As is apparent in FIGURE 1, the convolutions 40 diminish in radius from the largest convolution 40a toward the smallest convolution 40n; however, unlike commonly available wire connectors which generally make use of a spring member having convolutions of diminishing radii, the rate at which the convolutions 40 decrease in radius and the resilient expansibility of each convolution are so chosen as to enable member 14 to accommodate a relatively small bundle diameters as compared to such commonly available wire connectors. Thus, where ordinary wire connectors generally rely upon the engagement of the entire length of a spring member with any given bundle of wires to secure the wires together, the member 14 of wire connector 10 is so constructed as to attain an effective connection with a bundle of given diameter over a relatively few convolutions 40 and the provision of a number of convolutions in excess of these few allows
Turning now to FIGURES 5 through 7, the operation of wire connector 10 is diagrammatically illustrated in securing wires in a given bundle, FIGURE 5 showing a bundle of large diameter, FIGURE 6 illustrating an intermediate bundle diameter and FIGURE 7 depicting a small bundle diameter. In actuality, each bundle could be composed of more than two wires and the wires in a bundle would be twisted about one another; however, for purposes of diagrammatic simplicity and clarity in describing the operation of wire connector 10, the wires 60, 62, and 64 in FIGURES 5, 6, and 7, respectively, are shown parallel to one another in each respective bundle.

Looking first at FIGURE 5, wire connector 10 is seen twisted with convolutions 40b, 40c, and 40d dilated and edge 44 of each wire pressed into grooves 70, 72, and 74, respectively, such that the wire connector 10 is firmly engaged with the bundle of wires and the wires 60 are secured together in a good mechanical and electrical connection by virtue of the elastic reaction force of the convolution upon the wires. It is noted that the depth of groove 74 is greater than that of groove 72, which in turn is greater than the depth of groove 70. Initially as wire connector 10 was threaded on the wires 60, groove 74 was started as a more shallow groove by convolution 40b. Then groove 74 was enlarged to the illustrated extent by successive engagement with convolutions 40c and 40d, and each successive convolution was required to form only a part of the total extent of the groove 74, with no one convolution being required to deform the material of wires 60 to the full extent of groove 74. Likewise, groove 72 was formed through successive deformation by engaging convolutions 40b and 40c successively. Thus, grooves 70, 72, and 74 which are deep enough to firmly engage the wire connector with the bundle are established gradually in the bundles so as not to require excessive twisting forces such as would be required if grooves of similar depth were not formed gradually but were completely formed by only a single convolution. Such controlled deformation is established by the choice of the rate at which the radii of convolutions diminish and the amount of resiliency provided in the convolutions when these factors are properly balanced, as they are in FIGURE 5, only a few of the convolutions 40 are needed to engage and secure the wires 60 in the bundle.

Further advancement of the wires 60 in the axial direction toward closed end 24 is precluded by the positive stopping action of convolution 40e, which will not dilate and hence abut the ends of the wires at 76. Such positive stopping action is a result of limited resiliency in the convolutions as well as the proper decrease in convolution radius. The engagement of wire connector 10 with large bundled diameters can be further eased by the provision of a polygonal configuration in the initial convolutions commencing with convolution 40 as illustrated in FIGURE 2 as a pentagonal configuration as outlined above. The polygonal configuration has the effect of presenting only a portion of the edge 44 of each convolution to the bundled wires, thereby decreasing the contact area between the wires and the convolution and hence decreasing the frictional resistance to rotation of the wire connector onto the bundled wires.

An important feature of wire connector 10 is the ability of each convolution 40 to return to its original radius after engagement and disengagement of the wire connector and a bundle of wires so that the wire connector can be another bundle. Such a feature is attained by assuring that the elastic limit of the material of the member 14 is not exceeded by dilation of the convolutions. Dilation of the convolutions 40 is limited by providing the positive stop means as described above so that the wires cannot be axially advanced to stretch those convolutions which are not needed for securing purposes beyond their elastic limit. Those convolutions which are dilated beyond their elastic limit by virtue of the contour of second portion 28 of cavity 20 which limits such dilation by positive contact with the convolutions as seen at points 78. Thus, the contour of portion 28 generally follows the external contour of member 14 to enable the cavity 20 to act as a positive stop in the dilation of convolutions 40.

It will be apparent that since the requisite gripping action of wire connector 10 is obtained over a relatively few convolutions 40, a spring member having many more convolutions can be constructed within the limits of conventional dimensions, and the additional convolutions can be utilized to accommodate a wider variety of bundled diameters. However, in so extending the range of wire connector 10, it is still essential to maintain a balance between the resilient expansibility of the convolutions 40 and the rate at which the radi of successive convolutions diminish. I have found that the maintenance of such a balance for a wider range of bundled diameters requires a difference in the rate at which the radii diminish, the first portion of member 14 having an internal radius which diminishes at a first rate greater than the rate at which the internal radius of the second portion of member 14 diminishes as aforementioned. Thus, as seen in FIGURE 6, an intermediate bundled diameter is accommodated in the second portion of member 14, wires 62 being engaged by convolutions 40d, 40e, and 40f, in grooves 80, 82, and 84, respectively. Convolution 40g acts as a positive stop at 86 and the contour of second portion 28 of cavity 20 limits the dilation of convolution 40f by making contact at points 88. Thus, by employing different rates in the diminishing radii of edge 44, the range of bundled diameters which can be accommodated has been extended without unduly extending the axial length of member 14 and consequently the length of wire connector 10.

Referring now to FIGURE 7, the third portion of member 14 is shown engaging a bundle of the smallest diameter which is to be accommodated by wire connector 10. Since small bundles are usually composed of small diameter conductors which are often stranded so that the wires present in the bundle are generally delicate, precautions must be taken to see that such wires are not excessively damaged. Thus, convolutions 40h, 40i, 40j, and 40k are limited in radial dimension and grooves 90, 92, 94, and 95 established in wires 64 are all maintained relatively shallow. Adequate gripping action is attained by having a multiplicity of grooves. Thus, even though all of the grooves 90, 92, 94, and 95 are shallow, the sum of the gripping action provided by each groove is adequate for attaining a good mechanical and electrical connection in such small bundles of fins wire.

It will be apparent that through the principle of choosing the resilient expansibility of the convolutions 40 in member 14 and matching such resilience with the rate at which the radii of the convolutions diminish along the axial length of member 14, I have been able to construct a wire connector capable of accommodating a wide range of bundled diameters while still maintaining a minimum axial length. In addition, the wire connector is capable of continued reuse after disengagement from the original bundle, with bundles of either larger or smaller diameter as well as with the original bundle.

It should be noted that in lieu of the pentagonal spring configuration shown in FIGURE 3, the circular spiral form 41 of FIGURE 8 may be employed. A preferred form of insulation housing for the spring is shown in FIGURES 9, 10, and 11, and has an entrance end portion 30, a smaller diameter opposite end portion 32, and a conical portion 33. Therebetween, the closely-disposed projections 34 are molded integral with the smaller end portion 32 and the conical portion 33. Projections 34 are in the shape of fins, the outer surfaces of which are extensions of portion 30, forming a flat, key-like grip for the housing. These fins are preferably of substantially uniform thickness from end to end. The
said housing having a cavity containing said spring member, the cavity having a configuration generally complementary to the external configuration of said spring member with the relative dimensions of the cavity and the spring member allowing at least the largest convolution to be fixed within the housing and providing a clearance space between the housing and the successive smaller convolutions.

2. The invention of claim 1 wherein the convolutions along at least said first portion of the axial length are of polygonal configuration in planes transverse to said axial length for facilitating the starting of said helical groove in the bundles of greatest diameter.

3. The invention of claim 2 wherein said polygonal configuration is generally pentagonal.

4. The invention of claim 1 wherein said helically coiled spring member is of circular spiral form.

5. The invention of claim 1 wherein said spring member has a generally radial surface at the beginning of the largest convolution and said housing has a generally radial abutment confronting said radial surface for engaging said radial surface to preclude twisting of the spring member relative to the housing.

6. A device for mechanically securing together a plurality of wires in a bundle, comprising a helically coiled spring member providing a plurality of resiliently dilatable convolutions establishing an opening extending axially from an entrance end to an opposite end, the convolutions diminishing in radius from the entrance end to the opposite end, and a housing of insulating material, said housing having an open end and a closed end and an axial cavity therein receiving said spring member, with said entrance end of said spring member facing said open end of said housing, said cavity generally complementary to the exterior of said spring member, said housing having external projections extending a limited distance from said closed end toward said open end for obtaining a greater leverage arm to achieve a greater torque value for applying the device onto a bundle of wires, said projections being wings attached to said housing by thin webs about which said wings may swing outwardly for obtaining a greater leverage arm to achieve a greater torque value for applying the device to a bundle of wires.

7. A device as claimed in claim 6, in which said wings are retractable toward the axis of said housing.

8. A device as claimed in claim 7, in which said housing has sockets to receive and hold the outer ends of the wings when said wings are in their retracted position.

References Cited by the Examiner

UNITED STATES PATENTS

D. 186,599 11/1959 Schinske 174—87 X
1,678,752 7/1928 Van Gelderen 174—87
2,431,928 12/1947 Garreau.
2,656,204 10/1953 Blomstrand.
2,805,441 9/1957 Reder.
2,874,741 2/1959 Brancato 151—14
3,075,038 1/1963 Schinske 174—87

LEWIS H. MYERS, Primary Examiner.
D. L. CLAY, Assistant Examiner.