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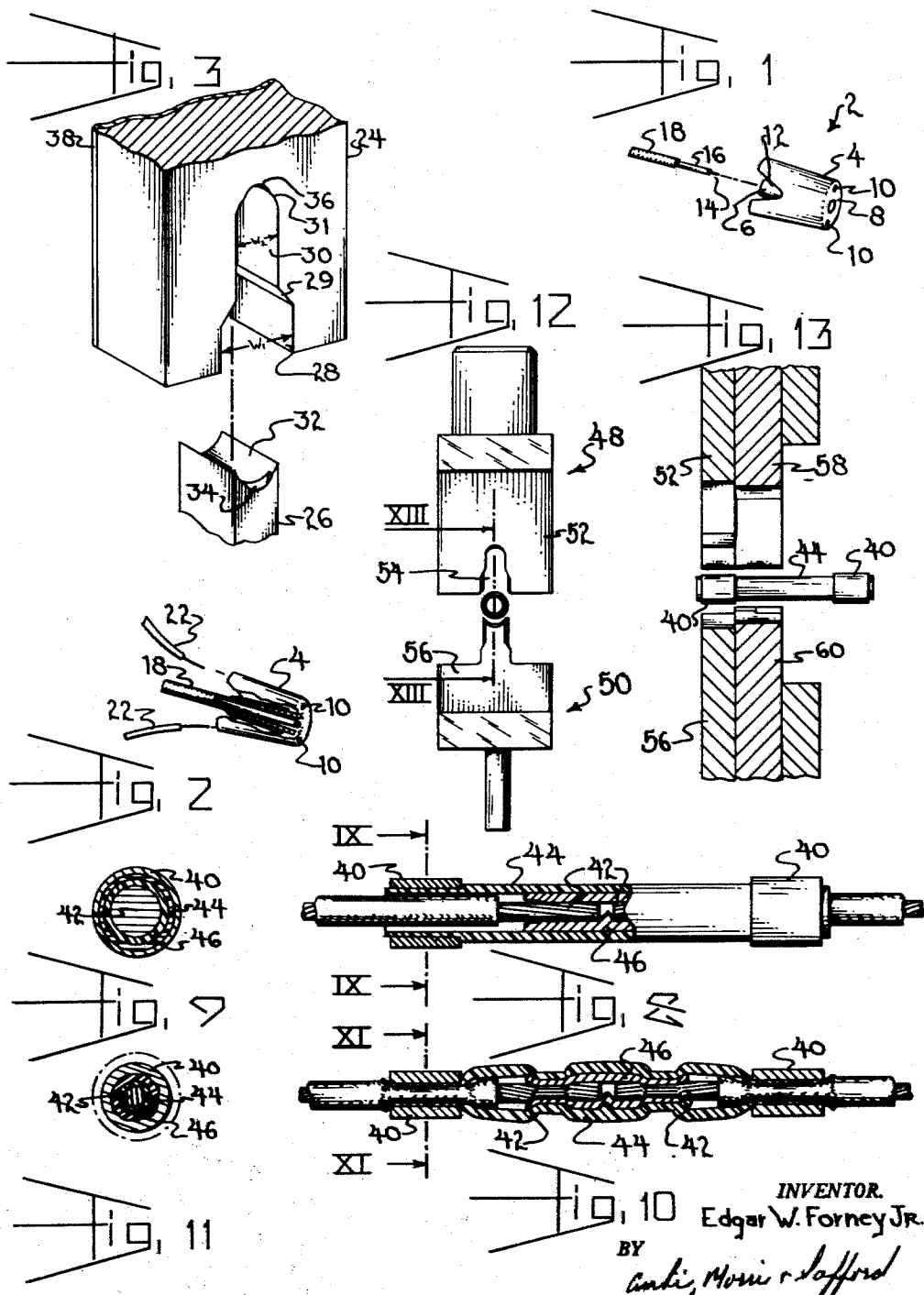
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METHOD AND APPARATUS FOR FORMING A CRIMPED CONNECTION

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METHOD AND APPARATUS FOR FORMING A CRIMPED CONNECTION

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This invention relates to the crimping of ferrules, particularly for the purpose of forming a crimped connection between a conductor and an electrical connector or terminal.

In the highly developed art of crimped electrical connections, it is generally speaking common to form a crimped connection by flattening or indenting a ferrule into engagement with the conductor. Prior art publications disclose a multitude of crimps of this type, some of which teach that a ferrule initially having a circular cross section should be flattened with concomitant lateral extrusion while others teach that the ferrule should be crimped and flattened in a confined manner and longitudinal extrusion induced. In still other prior art disclosures, the ferrule is intended upon itself to form the crimped connection. In any event, most of the prior art disclosures teach that the circular cross sectional configuration of the ferrule should be changed by the application of crimping forces in two diametrically opposed directions on the ferrule.

An alternative to flattening a ferrule, or otherwise changing the shape of its cross section, is to reduce the diameter of the ferrule without changing its cross sectional shape while longitudinally extruding it to some extent and/or increasing its wall thickness. Some prior patents take note of this alternative but it has not been developed to the extent that the flattened and indented types of crimps have been developed and exploited. This alternative crimping method offers some comparative advantages among which are neatness, a smaller maximum dimension as measured normally of the ferrule axis, and a tight, constrictive engagement extending completely around the circumference of the conductor which is impervious to corrosive liquids and gases. Furthermore, a confined crimp and crimping method of this type offers particular advantages for some specialized types of crimped connections such as a connection between a grounding wire and the metallic shielding of a shielded conductor as described below.

The attainment of a crimped connection by reducing the cross sectional area of a ferrule without change to its shape presents problems which are not encountered in making the more conventional types of crimped connections. For example, I have found that if it is attempted to crimp a cylindrical ferrule by means of a pair of reciprocable dies each providing a semi-cylindrical cavity having a diameter less than the initial diameter of the ferrule, the dies will bite into the ferrule before they meet each other and the ferrule will be laterally extruded thus changing the cross sectional shape of the ferrule. I am aware that some prior publications loosely discuss a crimping technique of this type and seem to indicate that a circular ferrule can be reduced in cross section by means of a pair of dies having undersized semi-cylindrical grooves, however I have not found this to be true. Thus, special crimping techniques are necessary to achieve a confined crimp in which the ferrule is reduced in cross section without material change to its shape.

An object of the present invention is to provide an improved crimping method in which a cylindrical ferrule is reduced in cross sectional area without material change to its shape.

A further object is to provide an improved crimped

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connection between a ferrule and a conductor which is neat and symmetrical in appearance and in which the ferrule is in circumferentially continuous constrictive engagement with the conductor.

A further object is to provide an improved crimped connection between the metallic shielding of a shielded conductor and an extraneous conductor.

These and other objects of the invention are achieved in a crimping method in which the ferrule is first partially flattened, advantageously by forcing it between the opposed sidewalls of a female die cavity so that these initial crimping forces are brought to bear along opposite sides of the ferrule and are directed normally of the ferrule axis. Thereafter, and while the partially flattened ferrule is retained within the die cavity, a second set of crimping forces, directed normally of the initial crimping forces and also towards the ferrule axis, are brought to bear on the partially flattened ferrule. This second set of crimping forces restores the ferrule substantially to its original cross sectional shape. A specific manner of practicing the invention is set forth in the detailed description which follows and shown in the drawing in which:

FIGURE 1 is a perspective view of a portion of a shielded conductor and a terminal of a type for use therewith;

FIGURE 2 shows the manner in which the shielded wire or conductor is threaded through the connector in the practice of one embodiment of the invention;

FIGURE 3 is a perspective view of a die set usable in the practice of the invention;

FIGURES 4, 5, 6, and 7 show the successive steps in the compression of a terminal of the type shown in FIGURE 1 in accordance with the invention;

FIGURE 8 is a plan view with parts broken away of a butt connector having a circular metallic ferrule on each end;

FIGURE 9 is a view taken along the line IX—IX of FIGURE 8;

FIGURE 10 is a sectional view of the connector shown in FIGURE 9 after crimping thereof;

FIGURE 11 is a view taken along the lines XI—XI of FIGURE 10.

FIGURE 12 is a frontal view of a die set adapted to crimp the connector shown in FIGURE 8; and

FIGURE 13 is a view on an enlarged scale taken along the line XIII—XIII of FIGURE 12.

The crimping method of the present invention will first be described with reference to the crimping of shielded braid terminators of the type generally shown in my copending application Serial No. 583,080 filed May 7, 1956, for Shielded Braid Terminators. A terminator or connector of this type is indicated generally by reference numeral 2, FIGURE 1, and comprises an outer ferrule 4 and an inner ferrule 6 concentric with the outer ferrule. The two ferrules are connected or joined at one end by means of a rim 8 providing openings 10, to permit inspection of the finished connection after crimping and also under some circumstances to receive the stripped end of a grounding wire or other extraneous wire indicated in the instant disclosure at 22. The inner ferrule 6 is advantageously circular in cross section to accommodate the circular cross section 16 of the braided conductor while the outer ferrule 8 may be somewhat oval shaped or elliptical in cross section although it will not usually be a true mathematical ellipse. It is to be understood that the actual cross section of the outer ferrule, and for that matter the inner ferrule 6, will vary to some extent depending on the precise size of the ferrule and the manner in which it is produced. The end of outer ferrule 4 opposite from rim 8 is advantageously cut away

as indicated at 12 to facilitate the crimping operation as will be apparent from the description which follows.

The shielded electrical conductor with which terminal 2 is usable is shown in FIGURE 1 to comprise an inner conducting core 14 which is surrounded by an insulating covering 16 over which is provided braided metallic shielding 18. It is frequently necessary to connect a grounding wire or other extraneous wire 22 to the metallic shielding 18 and because of the nature of the shielding 18 this is a relatively difficult operation. In the practice of the instant invention and as described in my aforesaid copending application, the metallic shield or braiding is cut back a short distance as indicated in the showing of FIGURE 1 and the exposed portions of the insulated conductor is then threaded through inner metallic ferrule 6 as shown in FIGURE 2. However, braiding 18 is not fed through ferrule 6 along with the insulated end of the wire but is expanded slightly and slipped over the external surface of inner ferrule 6 so that the end of this braiding lies between the external surface of ferrule 6 and the internal surface of ferrule 4 as clearly shown in FIGURE 2. To produce an optimum crimped connection the shielded conductor should be inserted through inner ferrule 6 to the extent that the braiding extends entirely up to the rim 8 which connects inner ferrule 4 and outer ferrule 6.

In crimping terminal 2 in accordance with the present invention a crimping die set of the type shown in FIGURE 3 is employed. This die set comprises a female die 24 and a male die 26 which dies are adapted to be moved toward and away from each other into engagement by any suitable means. For example, the dies might be mounted on a conventional bench press or on certain types of hand tools, particularly as disclosed in the copending application of Herbert C. Stoltz Serial No. 623,957 filed November 23, 1956, and now abandoned, for Hand Tool. Female die 24 provides a die opening which is enlarged at its lower end as indicated at 28 and which tapers at 29 to a narrow portion 30 rounded at its end as indicated at 31. The wider portion 28 of this die should have a width W_1 such that it can receive the terminal as disclosed in FIGURE 4 snugly and without permitting any rotation of the terminal after it is inserted. This portion of the female die should have a depth (the dimension measured at right angles to its width) which is also sufficient to receive the terminal without leaving any substantial portion thereof protruding, as also shown in FIGURE 4. The width W_2 of the narrower portion of the female die opening is less than the smaller of the diameters of the connector prior to crimping (assuming the connector is slightly oval shaped) and the rounded end 31 of the narrow portion has a radius of curvature substantially equal to the radius desired in the final crimped connection and less than the radius of the connector prior to crimping. Male die 26 provides a curved or dish shaped surface 32 of substantially the same radius of curvature as end portion 31 of the opening in the female die and this male die has a width such that it fits relatively snugly but smoothly within the narrow portion of the female die as shown best in FIGURES 6 and 7. Relieved lip portions 36, 34 are provided on both the male die and the female die for the purpose of relieving the stress on the extraneous wire 22 during final crimping. A plate 38 is provided on the back of female die 24 and this plate provides a slot wide enough to receive the end of the shielded conductor but not sufficiently wide to permit the connector to move through the die as shown best in FIGURE 4.

Turning now to FIGURES 4-7, in the method of the present invention the connector is positioned within the wider portion 28 of the female die opening as shown in FIGURE 4. It should be mentioned at this point that in FIGURES 4-7 the shielded conductor and the extraneous conductor that is being secured thereto are omitted in the interests of clarity and in order that the crimping

of the terminal itself might be more clearly illustrated. It will be apparent from FIGURE 4 that while the lower portion of the female die opening is of adequate width to receive the connector, the narrower portion having a width W_2 will not receive the connector without substantial flattening or pinching thereof. Flattening thus takes place as shown in FIGURES 5 and 6 as the two dies 24, 26 move relatively toward each other and the male die pushes the connector into the more narrow portion of the female die opening. In effect, during this portion of the crimping cycle the connector is pinched between the sides of the female die and elongated in the direction in which it is moved into the die. Inner ferrule 6 may be flattened slightly during this portion of the crimping cycle, as indicated in the drawing, but flattening of this inner ferrule is not essential. The connector and the dies are so proportioned that when the connector arrives at the position of FIGURE 6 the outer ferrule 4 is substantially against the inner ferrule 6 at opposite points of the diameter thereof. Since the metallic shielding or braiding 18 extends between the inner and outer ferrule at these points, at this stage of the operation the shielded conductor is secured within the terminal by virtue of this pinching effect. When the male die 26 arrives at the position of FIGURE 6 the stripped end 20 of the extraneous conductor is then inserted in the space separating the inner and outer ferrule which remains adjacent to openings 10, as shown in FIGURE 6. The extraneous conductor can be inserted from either side of rim 8 as desired. It will be understood that in many instances these dies will be mounted in a hand tool as disclosed in the aforesaid Stoltz application so that when the dies have been partially closed, the operator need no longer hold the shielded conductor and can at that point manually insert the extraneous conductor between the ferrules. It is also understood that two or possibly more extraneous conductors might be secured to the shielding by the practice of the instant invention.

After the extraneous conductor has been inserted as described above, the dies are further closed to the position shown in FIGURE 7, during which time the outer ferrule is reformed so that it has a substantially circular cross section and at the same time any flattening of the inner ferrule which might have taken place in the previous portion of the process is also nullified. During this final closing of the dies, there is some flow of metal in a longitudinal or axial direction of the terminal or connector but there is also substantial thickening in the wall of the connector. At this time the end of outer ferrule 4 which is cut away as at 12 is closed and the cut out V portions indicated at FIGURE 1 are urged each towards each other.

The crimping method of the present invention is particularly adapted to crimping shielded wire connectors as described above for the reasons that the numerous manual operations involved, such as first positioning the shielded conductor within the terminal and thereafter positioning the extraneous wire within the connector, render this operation extremely difficult since the operator requires one hand for the crimping tool and must then handle both the shielded conductor and the extraneous conductor with the other hand. In the practice of the invention, it is only necessary that the operator handle the tool with one hand leaving the other hand for one of the conductors, either the shielded conductor or the extraneous conductor. Furthermore, in the practice of the invention, continuous peripheral contact is obtained between the shielding 18 and the connector thereby insuring a mechanically sound and electrically conductive connection between the shielding and the extraneous wire.

It is not to be inferred, however, that the invention is applicable only to shielded wire connectors as described above. Decided advantages are obtained where simple tubular ferrules are crimped by first pinching and then confining the ferrule onto the conductor in accordance

with principles of the invention. An application of the latter type is shown in FIGURES 8-11 wherein reference 42 denotes the ends of a pair of conductors which are electrically and mechanically connected by means of a connector comprising a metal sleeve 46 which receives the stripped ends of the conductors. An insulating sleeve 44 is positioned over the metal sleeve 46, over the ends of the conductors and preferably, as shown in the drawing, over the insulation on these conductors. On each end of the insulating sleeve and in embracing relationship to the conductors 42 there is provided a metal sleeve 40. After the parts have been assembled in the relationship shown in FIGURE 8, the connector is crimped by means of a die set of the type shown in FIGURES 12 and 13 to comprise an upper die assembly 48 and a lower die assembly 50. The upper die assembly includes a ferrule crimping die 52 which provides a cavity 54, having relatively wide mouth which leads to a narrower portion and in general is similar to die 24 of FIGURE 3. An anvil 56 is provided as part of the lower die set, which anvil conforms to the cavity of the upper die so that upon movement of the two die assemblies towards each other, ferrule 40 is first partially flattened and is then reformed as a right circular cylinder of a diameter less than its initial diameter. An additional die set 58, 60 is provided as part of the upper and lower die assemblies for the purpose of crimping metal sleeve 46 during crimping of ferrule 40. The die set 58, 60 may be of any suitable type, for example, of the type adapted to crimp sleeve 46 by confining and ovaling it.

A salient advantage of the type of connection shown in FIGURES 8-10 is that a high degree of imperviousness to the admission of corrosive gases or liquids is obtained by virtue of the manner in which the ferrules 40 are crimped in accordance with the present invention. These crimped ferrules are circular in cross section, are in continuous circumferential engagement with the insulating sheaths of the conductors 42 and leave no discontinuities or corners which might admit corrosive fluids. Prior art crimps for the metal ferrules in connections of this type, by comparison, produce a non-circular crimp which is more susceptible to the passage of corrosive or other fluids in that such non-circular crimps result in corners or discontinuities in the cross section of the crimp.

Other uses for the invention will be apparent to those skilled in the art. The concept of crimping a cylindrical ferrule by first partially flattening it and then confining it as described above will find utility in many instances where neatness, a moistureproof crimp, and a crimped circular ferrule are desirable as well as in specialized cases such as the shielded wire connector described above.

I claim:

1. The method of securing an extraneous conductor to the metallic shielding sheath of a shielded conductor of the type comprising a conducting core, an insulating covering therearound, and metallic shielding over said insulating covering, said method comprising the steps of: first removing the metallic shielding sheath from the end portion of the shielded conductor to expose the insulating covering, threading the end portion of the conductor through the inner ferrule of a connector providing an outer ferrule in surrounding relationship to the inner ferrule, positioning the metallic shielding in surrounding relationship with the inner ferrule and between the inner ferrule and the outer ferrule, partially flattening the outer ferrule to pinch the metallic shielding between the outer ferrule and the inner ferrule thereby to secure the connector and the shielded conductor to each other, po-

sitioning the extraneous conductor between the outer ferrule and the inner ferrule, and compressively confining the outer ferrule around its entire periphery to constrict the outer ferrule about the metallic shielding and wedge the extraneous conductor between the outer ferrule and the inner ferrule while constricting the inner ferrule about the insulation covering.

2. A die set for crimping a cylindrical ferrule comprising a female die providing a cavity enlarged at its end to receive said ferrule, said cavity having a tapering width and an elongated narrow portion of a width less than the initial diameter of said ferrule, said elongated narrow portion terminating in a concave base having a radius of curvature equal to the radius desired in the crimped cylindrical ferrule, and a male die mounted for relative movement into said cavity, said male die having a width substantially equal but slightly less than the width of said elongated narrow portion and providing a concave die face having a radius of curvature substantially equal to the radius desired in the crimped connection, said female die providing flange means extending over said die cavity on one side thereof for retaining said connector within said cavity, whereby, upon relative movement of said dies towards each other, a ferrule positioned therebetween is first pushed from the enlarged end of said cavity into said elongated narrow portion thereby partially to flatten said ferrule, and upon further movement of said dies, said ferrule is restored substantially to its original cross sectional shape and its cross sectional area is reduced.

3. The method of securing an extraneous conductor to the metallic shielding sheath of a shielded conductor of the type comprising a conducting core, an insulating covering therearound, and metallic shielding over said insulating covering, said method comprising the steps of: removing the metallic shielding sheath from the end portion of the shielded conductor to expose the insulating covering, threading the end portion of the conductor through the inner ferrule of a connector having an outer ferrule in surrounding relationship to the inner ferrule, positioning the metallic shielding in surrounding relationship with the inner ferrule and between the inner ferrule and the outer ferrule, compressing the outer ferrule from a first pair of opposite sides to pinch the metallic shielding between the outer ferrule and the inner ferrule thereby to secure the connector and the shielded conductor to each other, positioning the extraneous conductor between the outer ferrule and the inner ferrule, and compressing the outer ferrule between a second pair of opposite sides substantially ninety degrees removed from the first pair of opposite sides thereby to constrict the outer ferrule onto the shielding and clamp the extraneous conductor against the shielding.

References Cited in the file of this patent

UNITED STATES PATENTS

1,727,895	Mraz	Sept. 10, 1929
1,793,293	Varney et al.	Feb. 17, 1931
2,137,712	Bratz	Nov. 22, 1938
2,476,731	Hobbs	July 19, 1949
2,526,740	Gilmore	Oct. 24, 1950
2,536,003	Dupre	Dec. 26, 1950
2,692,422	Pierce	Oct. 26, 1954
2,748,456	Berg	June 5, 1956
2,781,785	Davis	Feb. 19, 1957
2,789,277	Schumacher	Apr. 16, 1957
2,889,394	Aune	June 2, 1959
2,890,267	Forney	June 9, 1959