June 9, 1959 E. W. BOLLMEIER 2,890,266

WIRE-CONNECTOR

Filed March 1, 1955

FIG. 1

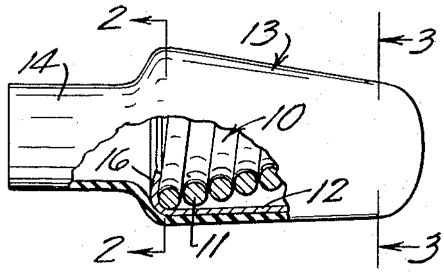


FIG. 2

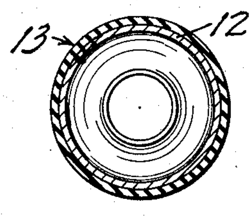


FIG. 3

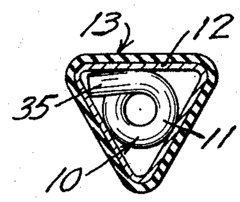


FIG. 4

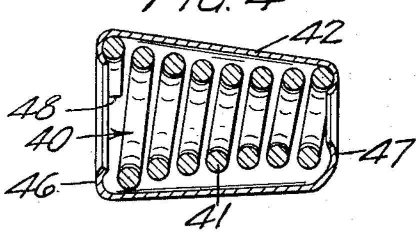


FIG. 5

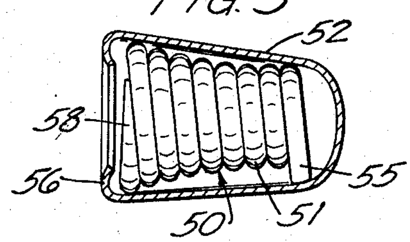


FIG. 6

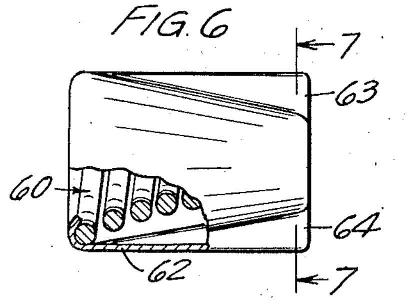


FIG. 7

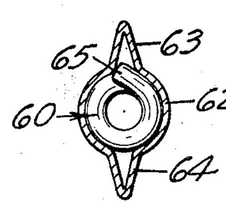


FIG. 8

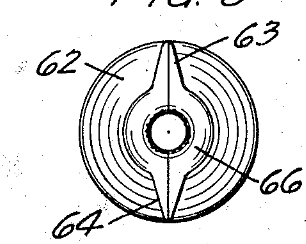


FIG. 9

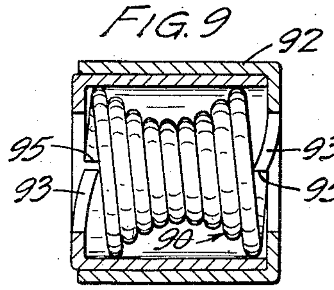


FIG. 10

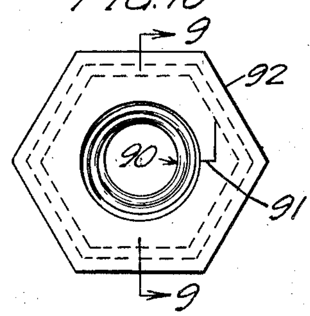


FIG. 11

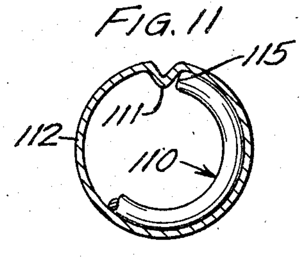
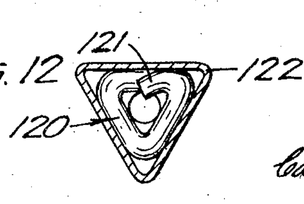


FIG. 12



INVENTOR
EMIL WAYNE BOLLMEIER

BY
Carpenter, Abbott, Coulter & Kinney
ATTORNEYS

United States Patent Office

2,890,266

Patented June 9, 1959

2,890,266

WIRE-CONNECTOR

Emil Wayne Bollmeier, St. Paul, Minn., assignor to Minnesota Mining & Manufacturing Company, St. Paul, Minn., a corporation of Delaware

Application March 1, 1955, Serial No. 491,342

13 Claims. (Cl. 174—87)

This invention relates to screw-on type connector devices such as wire-connectors having particular applicability to the fastening together of insulated copper wires in the making of wire-splices.

The connector provides a strong permanent connection or splice without soldering, and the splice remains effective under both constant and intermittent tension. The connector is resistant to crushing and shattering. It is small in size and provides for smoothly covering and insulating the splice, leaving no sharp or protruding corners or edges which might catch on other wires or adjacent mechanical parts. Such connectors are easily applied, either by hand or by mechanical means, to any of the usual wire sizes employed in electrical circuitry.

Connector devices illustrating the principles of this invention are further described in connection with the drawing, in which:

Figure 1 represents a side elevation, partly in section, of a preferred example of a wire-connector and including an insulating cover;

Figures 2 and 3 are cross-sections of the device of Figure 1, as indicated;

Figure 4 is a longitudinal cross-section of a modified connector without the insulating cover;

Figure 5 represents another modification, partly in section;

Figure 6 represents a further modification, partly in section, and Figures 7 and 8 represent sectional and rear end views of the article of Figure 6, as indicated;

Figures 9 and 10 represent a still further modification, in partial section and in end elevation respectively; and

Figures 11 and 12 represent details of structures, shown in partial cross-section, which may be employed in place of those of Figures 3 and 7.

The device of Figure 1 includes a tapered tubular helical coil **10** of spring wire **11** located within a metal shell **12** which is open at the forward end of the coil. The shell **12** is circular in cross-section at the open end, tapering to a triangular cross-section adjacent the opposite end. The circular cross-section at the forward end of the metal shell and insulating cover is illustrated at section **2—2** shown in Figure 2, the corresponding end turn of the coil **10** being omitted for clarity. The triangular section at the rearward end of the wire-connector is illustrated in section **3—3** shown in Figure 3 of the drawing. The shell **12** terminates at the open end in a crimped edge **16**, which is effective in permanently retaining the wire coil **10** within the confines of the shell.

The foremost end turn of the coil **10**, which is adjacent the opening in shell **12**, has an external diameter substantially equal to the internal diameter of the shell at the same area. Subsequent turns of the coil are reduced in diameter, to provide a coil tapered over about one-half its length and cylindrical over the remaining portion. The rearmost end turn of the coil **10** of Figure 1 has an external diameter equal to the diameter of the largest circle which may be inscribed within the triangular cross-

section of the shell **12** at that point, as illustrated in Figure 3; however the end turn may be of any desired smaller diameter in this modification. Intermediate turns are less in diameter than required to fit snugly within the shell and are therefore capable of expansion within the shell. The end of the rearmost turn is extended outwardly from the coil to form a pressure member **35**, fitting closely within one of the corners of the triangular end of the shell **12**.

An external insulating sleeve **13** fits over the entire coil and shell assembly. The sleeve **13** terminates in a tubular portion **14** providing access to the open end of the metal shell. The material of which the sleeve **13** is made is electrically insulating in character and is flexible and elastic so that the sleeve clings tightly to the shell and so that the terminal tubular portion **14** may conform closely to the surfaces of the insulated wires which are to be thrust therein.

As illustrated in Figure 4, the shell **42** of this modification of the connector is provided with a second axially centered opening at the triangular end, providing a free axial path through the entire structure. The device is illustrated without the insulating cover; and in this form it is suitable for making running splices as well as terminal or pigtail splices in electrical conductors and for attaching to wires or rods designed for non-electrical uses. However the insulating sleeve **13** of Figure 1 may equally well be applied to the modified device of Figure 4, the closed end of the sleeve being then removed or opened where it is desired to make a running splice. Alternatively, a tubular elastic insulating member open at both ends may be employed with the device of Figure 4, or the completed splice may be covered with a protective and insulative layer of adhesive tape or compound.

In the device of Figure 4 some or all of the turns of the coil **40** are separated, whereas the turns of coil **10** of Figure 1 are contiguous. Coil **40** is placed within the shell **42** under axial compression and expands to fit tightly against the subsequently crimped ends **46** and **47**. The end **48** of the wire **41** at the foremost or largest turn is sharp-edged and digs into the metal of the shell **42**, when the latter is turned in the removal direction, forming an angular recess against which the wire-end presses, thus permitting the removal of the connector from a splice. The coil terminates as in Figure 3.

Figure 5 represents a modification in which the coil **50** is not axially expanded and is shorter than the shell **52**, and the forward-most turn of the coil is tapered as at **58**. When the shell is turned in the removal direction, the tapered wire slides past the surface of the shell wall, thus preventing removal of the connector once it has been applied in connecting together a bundle of wires.

The coil **60** of the device of Figures 6–8 is substantially the same as coil **10** of Figure 1 except that the end portion **65** of the rearmost turn does not extend as far from the coil as does the pressure member **35** shown in Figure 3. The shell member **62** of Figure 6 likewise is similar at the foremost portion to the shell member **12** of Figure 1, but differs at the rearward portion in being in the form of a small circle having opposing fins **63** and **64** as indicated in Figure 7. The tip **65** of the rearmost turn of the coil **60** abuts against one of the corners formed by the fin **63** in transmitting torque for advancing the unit onto a wire splice. The fins **63** and **64** are closed at the rearmost ends, and the corresponding rearmost portion **66** of the shell **62** is crimped over the rearmost turn of the coil **60**, as indicated in Figure 8.

The two-part telescoped shell **92** of the device of Figures 9 and 10 is in hexagonal form, this modification being designed for application with a wrench. The device is useful as a wire-connector, and may also be used as a self-locking nut on threaded rods or the like. The coil spring compression member **90** is normally axially extended, and is inserted within the shell **92** under compression as the two halves of the shell are permanently forced together. The two end turns of the coil **90** will be seen to be of substantially identical diameter, the coil tapering to a smaller diameter at the central turns. Each of the ends of the shell is slotted as at **91** and the slotted portions upset as at **93** to produce internal angular recesses having sides against which the tips **95** of the helix **90** may press. Since the same construction exists at both ends of the connector, the latter may be applied and subsequently removed as desired. The radially contracting spring maintains the connector in firmly attached relationship to the wire-bundle or rod over which it is applied, until external torque is applied for removal.

Grooves or indentations **111** in the cylindrical shell **112** in Figure 11 provide an alternative type of angular recess for transmitting torque from the shell to the coil **110** through the wire-end **115**. In this structure, as in Figure 9, both end turns may be of the same diameter, and the wire-end is not extended. The structure is also applicable to coils having a smaller rearmost turn and contained in a tapered conical shell. A ribbed or fluted insulating cover may be placed over the metal shell if desired.

The rearmost turn of the coil **120** of Figure 12 is in the form of a triangle fitting snugly within the end portion of the shell **122**, which corresponds to the shell **12** of Figure 3. The tip of the wire **121** is here turned inward, rather than outward as in Figure 3, and bears against the ends of an inserted wire-bundle to indicate a completed installation. The triangular form of the terminal turn provides for effective torque transmission without distortion of the shell such as is sometimes caused by the protruding wire-end **35** of Figure 3 or the wire-end **65** of Figure 7 under excessive torque.

In operation in the splicing of insulated copper conductors, using the connector of Figure 1, the tips of the conductors are first freed of insulation and are bundled or lightly twisted together. The bundle of wires is then pushed into the open end of the wire-connector, through the tubular portion **14** of the sleeve **13** and through the open end of the shell **12**, while the entire connector is rotated. The uniformly angular shape of the rearward portion of the shell serves to provide an effective grip for manual or mechanical rotation of the connector and also serves to transmit the rotating movement to the coil **10** by way of the pressure member **35**. Pressure of the wire-ends against the interior of the spring wire coil **10**, combining with the rotating movement of the coil, causes the central turns of the coil to expand under tension and to grip the wire-ends, with the result that the coil is screwed onto the wire-ends to form a compact and permanent splice. Electrical contact between the wire-ends and mechanical stability of the entire splice is permanently maintained, even under extreme intermittent tension and vibration, due to the high compression provided by the expanded spring wire coil. The flexible coil is protected from deformation by the tough metal shell **12**, which also serves as a smooth uniform base for the flexible elastic insulating cover. The insulating cover provides effective electrical insulation for the entire assembly; but this component of the structure is not relied upon either for mechanical protection of the connection or for mechanical advantage in the application of the device to the wire-ends. The entire structure is neat in appearance, having smooth contours and fitting tightly to the insulated portion of the wires.

A given size connector permits the connecting of a wide range of sizes and numbers of wires. For any given splice, a connector should be selected in which the helical coil has an entrance opening capable of accepting the bundle of wire-ends and tapers to a diameter substantially less than that of a circle just capable of containing the bundle of wire-ends.

Application of the connector to wire splices may be accomplished either by hand or by mechanical operations. The shape of the wire-connector is such that the device may be easily applied and twisted with the fingers, or may readily be temporarily fitted into a suitably shaped socket in a speed wrench, thereby mechanically to provide the necessary twisting torque required for the application of the connector to the bundle of wire-ends.

The wire-connector of this invention is particularly adapted for forming end or pigtail splices between small copper wires. It may, however, be employed with much larger copper or other metallic conductors or with wires or rods employed for other than electrical purposes.

Particularly for high speed mechanical application the connectors illustrated in Figure 1 may be provided in the form of a continuous bar or coil, with the sleeve **14** of each following connector engaging the triangular tip of the preceding connector. The bar thus formed is fed into the applicator, each foremost member being removed and rotated onto successive wire-bundles.

The connectors of this invention may be pre-filled with insulating or protecting pastes or other flowable plastic material. Silicone greases, mineral oil greases, soft and plastic rubbery butadiene-styrene polymers, and other materials of analogous physical properties are useful. The inclusion of powdered zinc or aluminum in such compositions is of assistance in providing improved electrical contact, particularly in the case of oxide-coated aluminum wires. The adherent greasy plastic material fills all voids around the conductor terminals and affords improved mechanical, chemical and electrical protection to the wire-splice. Softer materials may be retained within the connector by lightly sealing over the open end or ends, e.g. with hardened wax or with a thin membrane of the same composition as the insulating sleeve.

The several structures described and illustrated, and other analogous modifications, may obviously be combined in other ways to provide additional specific but non-limiting structures and examples.

What is claimed is as follows:

1. A connector device capable of threadably advancing axially over an inserted wire-bundle to provide a firm compression grip thereon and comprising an outer metal shell member and an inner permanently retained helical spring-wire fastener member; said shell member progressing from circular cross-section at the forward end to uniformly angular lesser cross-section at the rearward end and having at least the forward end centrally open for insertion of said wire-bundle, each centrally open end being crimped to prevent withdrawal of said fastener member, said fastener member having a foremost turn contained within said crimped forward end of said shell, a rearmost turn contained within said rearward end portion of said shell, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn including a torque-transmitting portion fitting into and pressing against a torque-transmitting surface of said angularly cross-sectioned rearward portion.

2. A wire-connector comprising a tapered helical spring-wire fastening element permanently retained within a metal shell substantially coextensive in length therewith, said shell being centrally open at least at the forward end for insertion of wire-ends to be connected and progressing from maximum internal cross-section at said forward end to minimum internal cross-section at the rearward end, the rearward end portion being of uniformly angular cross-section; said tapered helical spring-wire fastening element having a foremost turn contained within the forward section of said shell, a rearmost turn contained within the angular rearward section of said shell, and a plurality of intermediate turns having a

diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn including a torque-transmitting portion fitting into and pressing against a torque-transmitting surface of said angularly cross-sectioned rearward section, each centrally open end of said metal shell being crimped to prevent withdrawal of said fastening element.

3. A wire-connector comprising a tapered helical spring-wire fastening element permanently retained within a longitudinally close-fitting metal shell centrally open at least at the forward end for insertion of wire-ends to be connected and progressing from circular cross-section at said forward end to uniformly angular lesser cross-section at the rearward end, said helical element having a foremost turn snugly contained within said forward circular section of said shell, a rearmost turn snugly fitting within said angular section of said shell, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn including a torque-transmitting portion fitting against a torque-transmitting surface of said angular cross-section, each centrally open end of said metal shell being crimped to prevent withdrawal of said fastening element.

4. A wire-connector comprising a tapered helical spring-wire fastening element permanently retained within a metal shell centrally open at least at the forward end for insertion of wire-ends to be connected, each centrally open end being crimped to prevent withdrawal of said fastening element, and progressing from circular cross-section at said forward end to triangular lesser cross-section at the rearward end, said helical element having a foremost turn snugly fitting within said forward crimped circular section of said shell, a rearmost turn snugly fitting within said triangular section of said shell, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn including a torque-transmitting portion fitting into and pressing against a torque-transmitting surface of said triangular cross-section.

5. A wire-connector comprising a tapered helical spring-wire fastening element permanently retained within a metal shell centrally open at least at the forward end for insertion of wire-ends to be connected, each centrally open end being crimped to prevent withdrawal of said fastening element, and progressing from circular cross-section at said forward end to triangular lesser cross-section at the rearward end, said helical element having a foremost turn snugly fitting within said forward crimped circular section of said shell, a rearmost turn snugly fitting within said triangular section of said shell, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn terminating in a short outwardly extending portion of spring-wire fitting into and pressing against a corner of said triangular cross-section.

6. A wire-connector comprising a tapered helical spring-wire fastening element permanently retained within a metal shell centrally open at least at the forward end for insertion of wire-ends to be connected, each centrally open end being crimped to prevent withdrawal of said fastening element, and progressing from circular cross-section at said forward end to triangular lesser cross-section at the rearward end, said helical element having a foremost turn snugly fitting within said forward crimped circular section of said shell, a rearmost turn snugly fitting within said triangular section of said shell, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said shell, the said rearmost turn being triangular and fitting snugly within the triangular cross-section at the rearward end of said shell.

7. A wire-connector in accordance with claim 1 in which the metal shell is open at both ends.

8. A wire-connector in accordance with claim 2 in which the metal shell is open at both ends.

9. A wire-connector in accordance with claim 1 in which the helical fastening element is under axial compression and presses firmly against both ends of the retaining shell.

10. A wire-connector in accordance with claim 1 in which the helical fastening element is shorter than the interior of the retaining shell.

11. A non-removable wire-connector in accordance with claim 2 in which the foremost end of the helically wound fastening element is tapered to provide a smooth annular face and to preclude frictional engagement with the interior of the crimped forward section of the retaining shell.

12. A connector device in accordance with claim 1 in combination with an external flexible and elastic insulating sleeve covering.

13. A wire-connector for torsional application to a bundle of wire-ends, comprising a tapered helical spring-wire fastening element permanently retained within an internally tapered rigid cover member centrally open at the forward end and progressing from circular internal cross-section at said forward end to uniformly angular lesser cross-section at the closed rearward end, said helical element having a foremost turn snugly fitting within the forward circular section of said cover member, a rearmost turn snugly fitting within the angular rearward section, and a plurality of intermediate turns having a diameter less than the diameter of said foremost turn and radially expandably fitting within the confines of said cover member, the said rearmost turn including a torque-transmitting portion fitting into and pressing against a torque-transmitting surface of said angular cross-section.

References Cited in the file of this patent

UNITED STATES PATENTS

1,458,247	Schleper	June 12, 1923
1,657,253	Fortin	Jan. 24, 1928
2,022,946	Staempfli	Dec. 3, 1935
2,308,286	Joyce	Jan. 12, 1943
2,387,257	Haas	Oct. 23, 1945
2,775,992	Smith	Jan. 1, 1957

FOREIGN PATENTS

657,405	Great Britain	Sept. 19, 1951