174-94

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Oct. 7, 1969 W. F. BROSKE Re. 26,685

EXPLOSIVELY-FORMED ELECTRICAL CONNECTION

Original Filed May 14, 1965 4 Sheets-Sheet 1

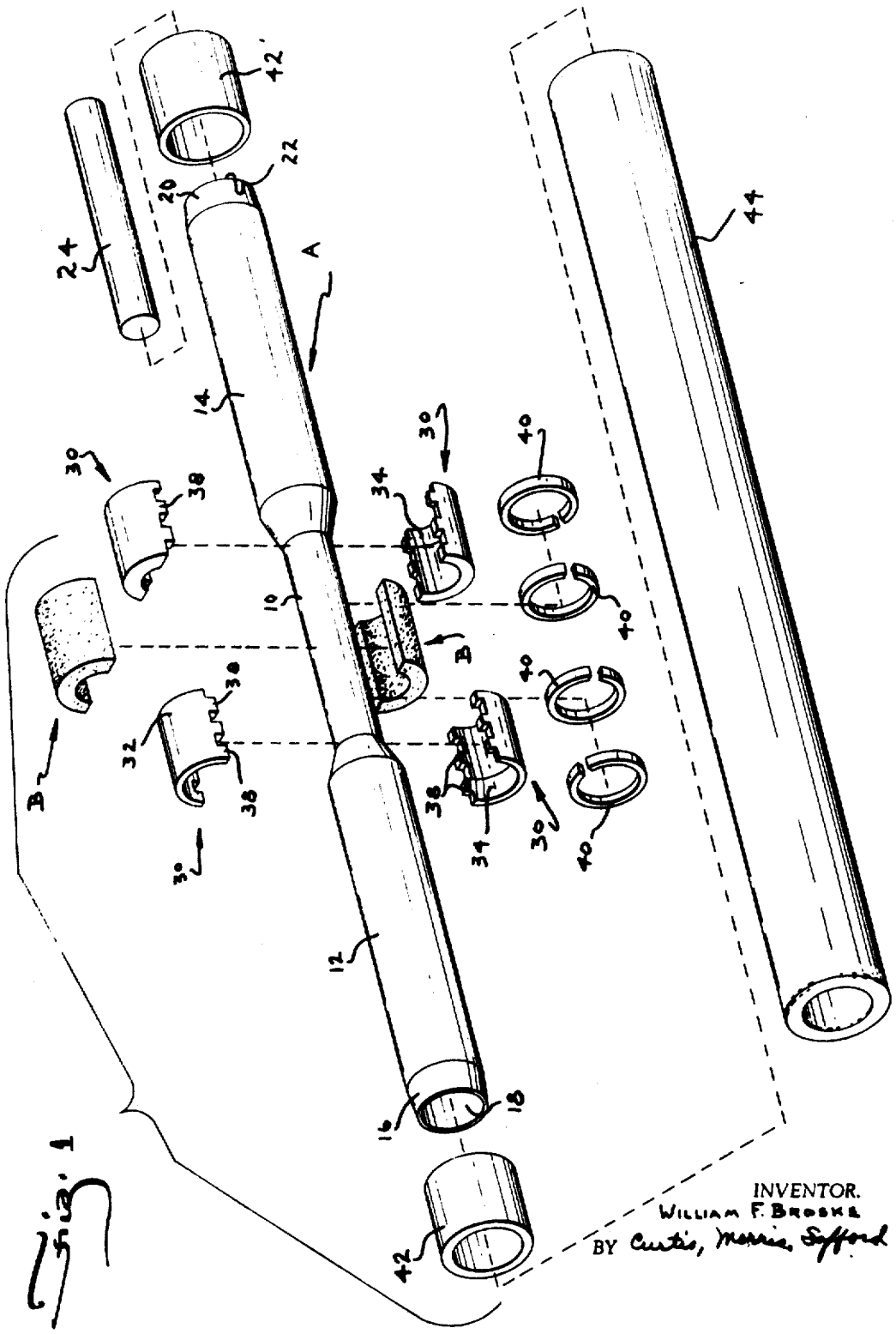


Fig. 1

EXPLOSIVELY-FORMED ELECTRICAL CONNECTION

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Fig. 3

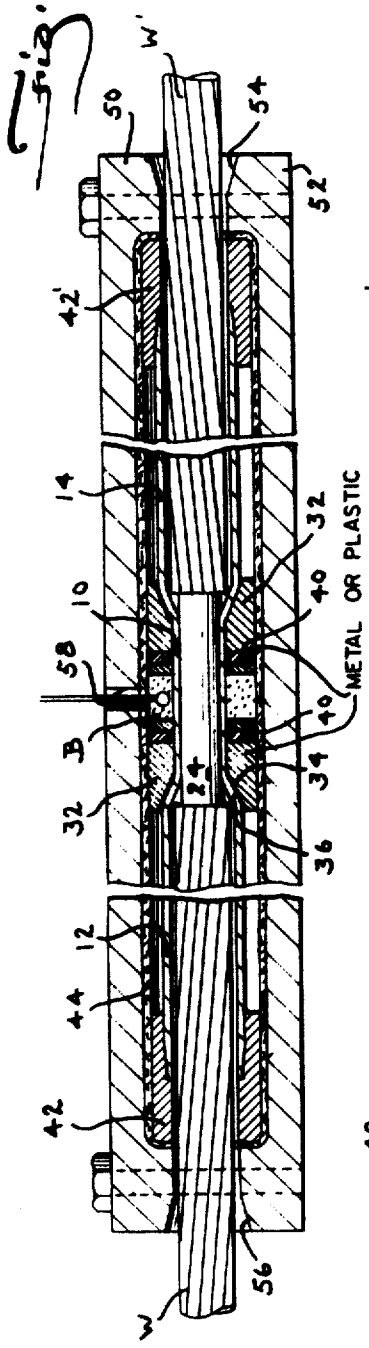


Fig. 4

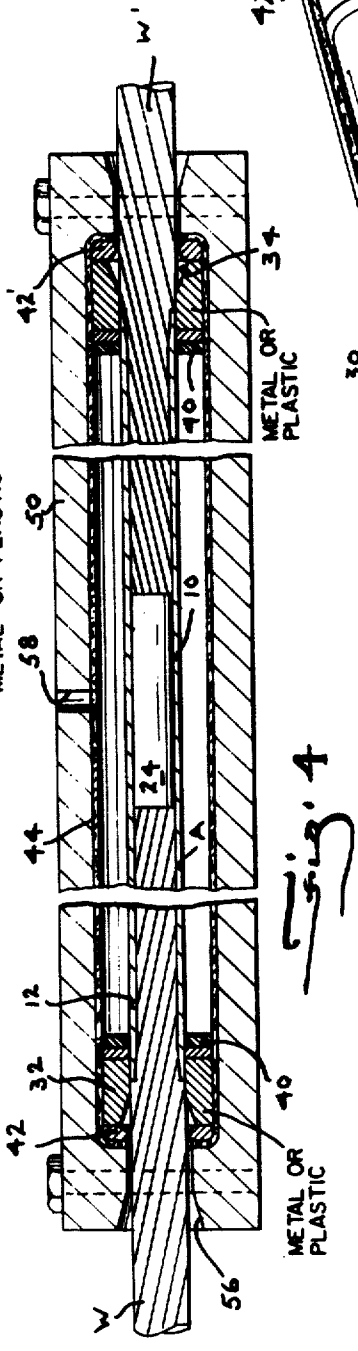
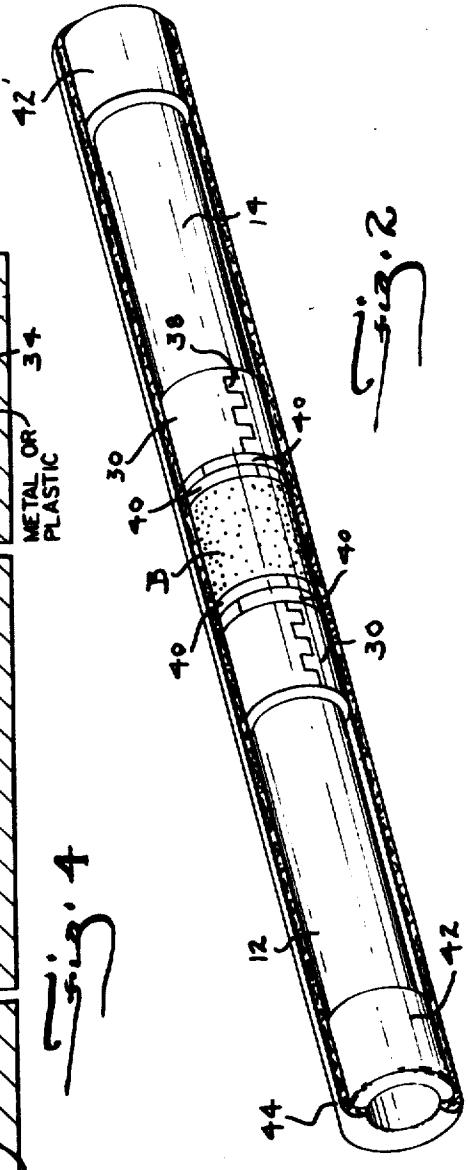


Fig. 2



INVENTOR.
WILLIAM F. BROSKE
BY Curtis, Morris & Safford

Oct. 7, 1969 W. F. BROSKE Re. 26,685

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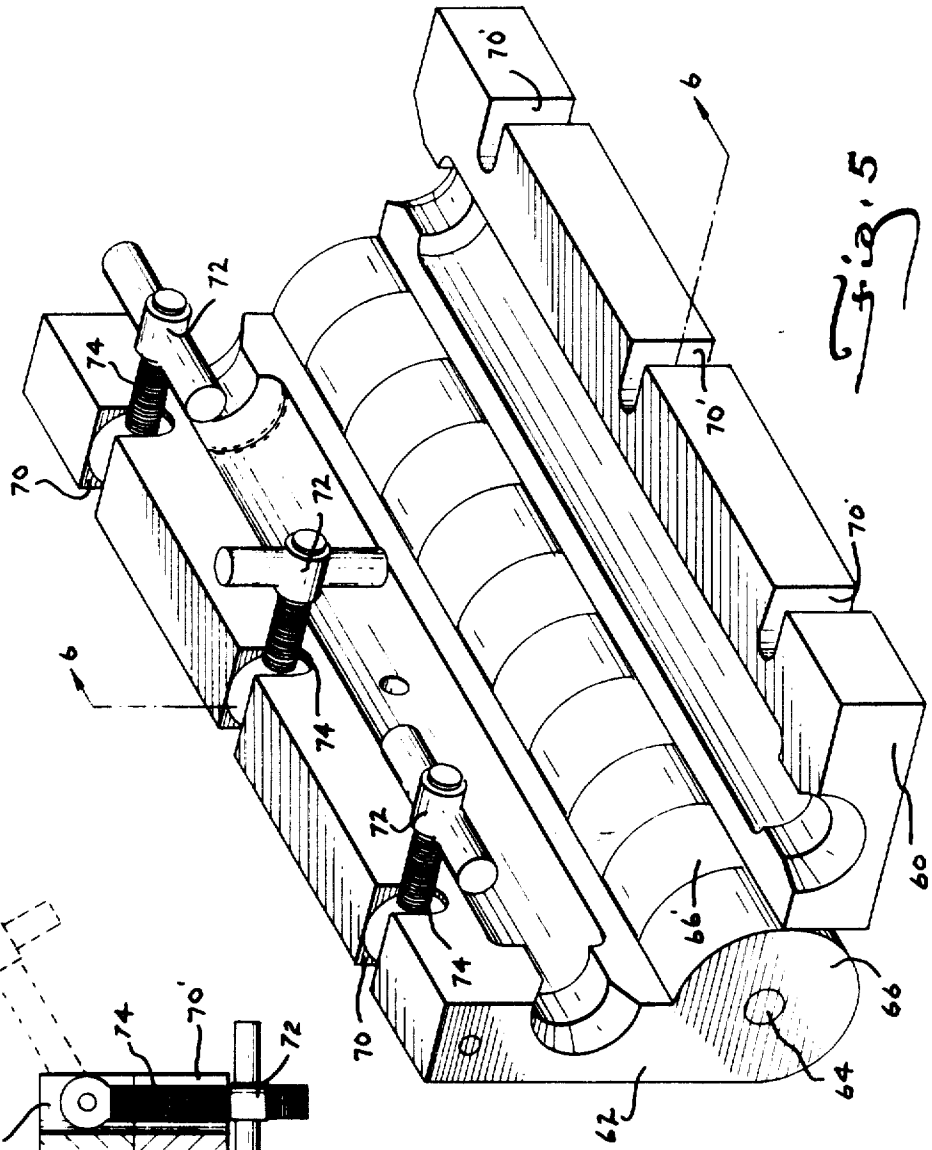


Fig. 5

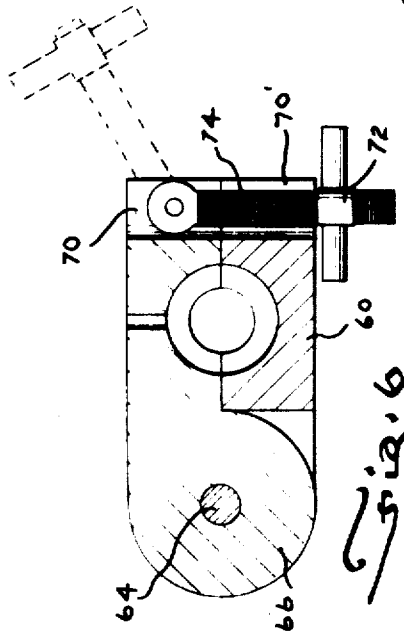


Fig. 6

INVENTOR.
WILLIAM F. BROSKE
BY Curtis, Morris & Safford

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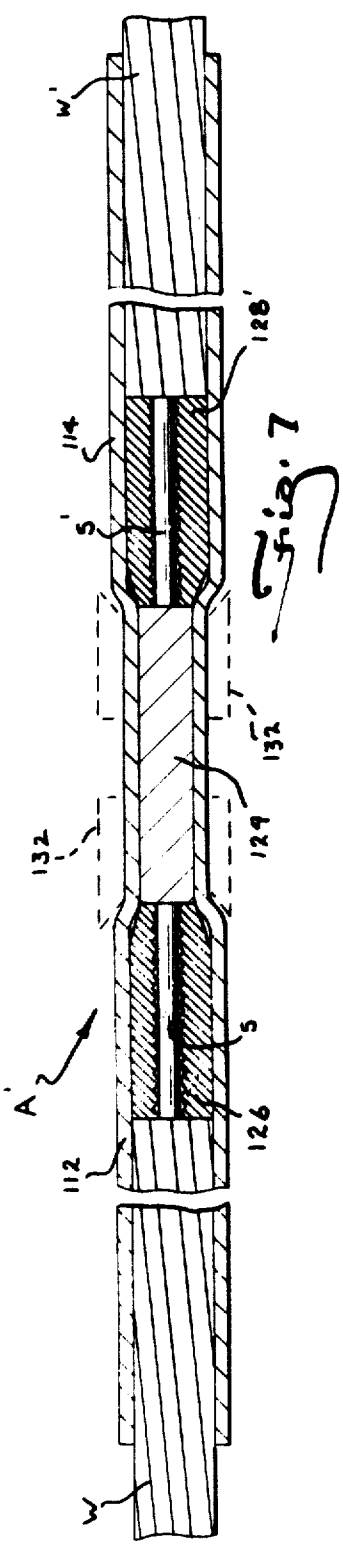


Fig. 7

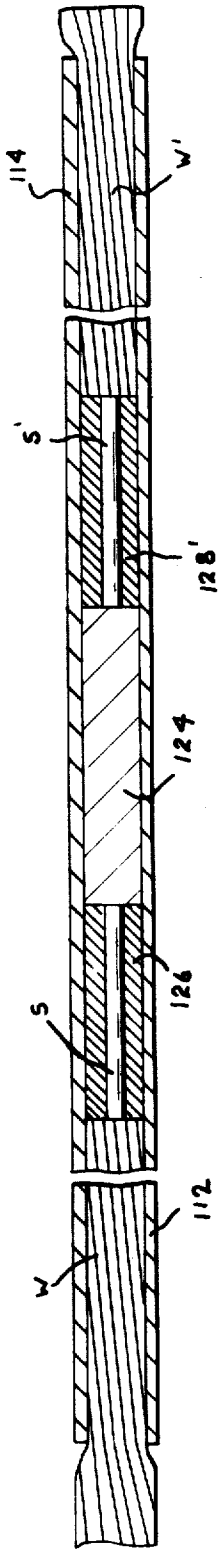


Fig. 8

INVENTOR.
WILLIAM F. BROSKE
BY Curtis, Morris & Safford

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EXPLOSIVELY-FORMED ELECTRICAL CONNECTION

William F. Broske, Camp Hill, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Original No. 3,341,650, dated Sept. 12, 1967, Ser. No. 455,818, May 14, 1965, which is a continuation-in-part of application Ser. No. 424,041, Jan. 7, 1965. Application for reissue Oct. 5, 1967, Ser. No. 676,662
Int. Cl. H02g *15/08*
U.S. Cl. 174—94 8 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

This invention relates to a connector for joining conductors whereby a die member is explosively-driven to cold-forge the connector onto the conductor.

This constitutes a continuation-in-part application of my prior application, Ser. No. 424,041, filed Jan. 7, 1965, now abandoned.

The art of joining electrical conductors requires a secure connection that will withstand vibration, corrosion, tensile failure, and concurrently provide a low millivolt drop through the connection. The art of joining electrical utility conductors is further complicated by the large sizes of the conductors (e.g., 4/0 and larger), as well as the fact that the connections are made at remote locations where auxiliary power is not available. Additionally, these connections must withstand the elements with a life expectancy of at least twenty years.

In view of these requirements, a suitable way of cold-forging a connection onto a pair of utility wires is accomplished by the application of energy generated by an explosive. It is an object of this invention to provide an explosively-powered means for splicing large-sized wires with ease of operation and concomitant excellence of the connection.

It is also an object of this invention to provide such a connection that is easily applied and available at a very reasonble cost.

It is also an object of this invention to cold-forge a connection onto aluminum-stranded wire having a steel reinforcing means, whereby the connector is deformed onto the steel strand as well as onto the aluminum strands.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described illustrative embodiments of the invention[; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention but are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use].

In the drawings:

FIGURE 1 is an exploded view illustrating the various components of a connector embodying the principles of this invention;

FIGURE 2 is a perspective view, partially broken away, showing the device of FIGURE 1 in assembled condition;

FIGURE 3 is a sectional view showing the device of FIGURES 1 and 2 prior to application;

FIGURE 4 is a view similar to FIGURE 3 showing the device after application;

FIGURE 5 is a perspective view of another embodiment of a tool for containing a connector during the assembly cycle;

FIGURE 6 is a sectional view taken through plane 6—6 of FIGURE 5;

FIGURE 7 is a sectional view of another embodiment of a connector employing the principles of the invention in assembled condition prior to being secured to the wire; and

FIGURE 8 is a view similar to FIGURE 7 illustrating the device after application.

As shown in FIGURE 1, the central connecting member, generally indicated A, includes a ferrule-shaped member having a central section **10** of reduced diameter which flares into a pair of conductor-receiving sections **12** and **14** of a greater diameter. The conductor-receiving member **12** has a tapered outer surface **16** at its mouth **18**. The conductor-receiving member **14** has a similar tapered outer surface **20** at its mouth **22**. The inner diameters of members **12** and **14** are adapted to receive (FIGURE 3) a pair of wires W, W', respectively.

A solid rod **24** (FIGURE 1) is inserted into the central portion **10** of the connecting member A. This rod is approximately the same length as the central section **10**.

A die member **30** (FIGURE 1) is formed in two parts, **32** and **34**, which, when joined together, complement each other to form a right-circular cylinder. These die members have tapered outer surfaces **36** (FIGURE 3). As shown in FIGURE 1, the outer edges of the die half **32** include a series of projections **38** with corresponding indentations therebetween. The projections and indentations are designed so that the projections on one half are offset with the indentations on the other half. A friction-fit between the projection and the indentation permits the dies to be assembled, forming the cylindrical member **30**; the other die being identical except that it tapers in the opposite direction. These dies may be made out of a suitable metal, or even a sufficiently stiff plastic such as Lexan or Synthane.

A series of seals **40** are also constructed as split rings for ease of assembly. A pair of these seals is fitted around the central section **10** of the connecting member A on each side of an explosive charge B adjacent the untapered portion of each of the dies **30**. These seals are for the purpose of confining the gas generated during the explosive cycle and may be made out of linear polyethylene. The split sections of the seals are misaligned to lessen the possibility of gas blowout.

A cylindrically-shaped, cushioning device **42**, **42'** is inserted around each open end of the conductor-receiving members **12** and **14**. As shown in FIGURE 3, these cushioning devices are tapered on their inside surfaces to

match the corresponding surfaces **16** and **18** on the outer surfaces of the conductor-receiving members.

The powder charge B is contained between the gas seals **40** and may be either a molded charge or a quantity of granulated explosive powders properly held in position. One means of retaining the entire assembly in operating condition includes a tubular, stiff, paper cylinder **44** of sufficient length to encompass all the components. The outer ends of the cylinder are turned over (FIGURE 2) to retain the parts in assembled condition.

The device may be inserted into any suitable chamber capable of permitting detonation. The chamber, shown in FIGURES 3 and 4, includes a pair of identical connector-receiving portions **50** and **52**. These sections may be made of cold-rolled steel and bolted together to retain the connector therein. A pair of tapered apertures **54, 56** permits insertion of the wires W, W' during the connecting cycle. A minor aperture **58** in one of the sections permits insertion of a detonator (e.g., electrical match) for access to powder charge B.

Another embodiment of the invention is shown in FIGURES 7 and 8. In this embodiment, means is provided for gripping the steel strands S, S'. The device illustrated in FIGURES 7 and 8 is similar in most respects to the device shown in FIGURES 1–4. It includes a connector A' comprised of a central section **110**, and conductor-receiving sections **112** and **114** having tapered surfaces **116** and **120** at the respective mouths **118** and **122**. A solid rod **124** is disposed within the central section **110**.

A pair of collars **126** and **128** are also disposed within the connector A'. As shown in FIGURE 7, the collars are concentric with the connector A', with one of the collars disposed on each side of the central rod **124**. The collars **126** and **128** have an outside diameter slightly smaller than the inside diameter of the conductor-receiving sections **112** and **114** to provide an interference fit. Alternatively, the collars **126, 128** and the central rod **124** could be made integral. In the event that they are made integral, the outer tube of the connector A' may be made of constant diameters and the central section reduced in diameter after the integral member is inserted. It is noted that the central aperture of the collars **126** are of sufficient diameter to accommodate the steel strands S, S'.

Another embodiment of a device for containing the wires, connector and powder charge is shown in FIGURES 5 and 6. A chamber having complementary connector-receiving portions **60** and **62** is secured along one edge of these portions by pivot pin **64** which passes through piano-hinge portions **66, 66'**. The opposite edge of each portion has U-shaped recesses **70, 70'**. A series of handles are threadedly connected to pivoted rods **74** in the U-shaped recesses of connector-receiving portion **62**.

The connector-receiving portions **60** and **62** may be closed (FIGURE 6) to encompass the connector and wires in the same manner as the device shown in FIGURES 3 and 4. The rods **74** are pivoted into the recesses **70'**, and the handles **72** are tightened to firmly secure the portions **60** and **62** together.

Operation.—When it is desired to splice a pair of wires W, W', the connector is assembled in the manner illustrated in FIGURE 3. The connector is retained in the tool sections **50, 52**, with the wires extending through the apertures **54, 56**. The tool is bolted together and an electric match inserted into the aperture **58**. Excitation of the electric match by standard voltage causes it to ignite, thereby detonating the powder charge B.

Detonation of the powder drives the dies **30** outwardly and causes cold-forging of the ferrule portions **12** and **14** onto the wires W, W'. The resistance of the metal to cold-forging reduces the speed of the dies as they travel outwardly. At their outer limits, the dies meet with further resistance when they contact cushioning members **42, 42'**. Longitudinal deformation of these cushioning members prevents further travel of the dies **30**. The tool may then be unbolted and a secure electrical connection is formed.

It is noted that between forty and fifty grains of "Bull's Eye" or "Unique" powder may be used in connecting 4/0 ACSR wires to each other. The connecting member A may be made of aluminum.

The embodiment shown in FIGURES 7 and 8 is, in most respects, identical with the embodiment of FIGURES 1–4. However, in preparing the wires W, W', the outer strands are stripped back to expose the central steel strands S, S'. When positioning the wires W, W' in the connector A', the central steel strand S is positioned within the collar **126**, with the end of the other strands of the wire W abutting the collar S. The wire W' is inserted in the opposite end of the connector in the same manner.

In operation, the actuation of dies **132** (in the same manner as the previous embodiment) compresses the collars **126, 128** onto the steel strands S, S', respectively, and concurrently the outer sections **112, 114** of the metallic tube onto the collars **126, 128**. Since the strongest strand of the wires is directly secured to the connector, the tensile strength of the connection is increased.

[Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.]

I claim:

1. A connector for splicing conductors comprising: a ferrule adapted to receive [an electrical] *a* conductor, an explosive charge surrounding the outer surface of the central portion of the ferrule, means disposed on said ferrule actuated by the explosive charge for cold-forging the ferrule to the conductor.

2. An electrical connector for splicing an electrical conductor comprising: a ferrule adapted to receive a conductor therein, an explosive charge located on and surrounding the outside surface of the central portion of the ferrule, a first cylindrically-shaped die surrounding said ferrule adjacent one side of the explosive charge and a second cylindrically-shaped die surrounding said ferrule adjacent the other side of the explosive charge.

3. A connector adapted to receive a pair of conductors, said connector having a minor diameter in the central section and a major diameter in the outside sections, a cylindrically-shaped explosive charge on the mid-portion of the central section surrounding the outer surface thereof, and a pair of cylindrical dies disposed about the minor diameter, one on each side of the explosive charge.

4. The device of claim **3** wherein the dies are made of plastic material.

5. The device of claim **3** wherein the dies taper outwardly from a thicker section at the inside edge to a thinner section at the outside edge.

6. The device of claim **3** wherein the central section is solid.

7. A device for connecting stranded cable comprising a tubular metallic member adapted to receive a length of stranded cable in each end thereof, explosive means surrounding the exterior central section of said tubular member, a pair of die means, each of said die means located adjacent said explosive means and adapted to be driven outwardly to cold-forge the tubular member onto the cable, a metal sleeve located within the tubular member adapted to encompass a strand of said cable, and means for retaining said dies and explosive means on the outer surface of said tubular member.

8. A connector for joining cable comprising: a tubular metal member, a die means surrounding the exterior of

the tubular metal member, said die means comprising a pair of dies having an inner surface conforming to the outer surface of the tubular member, an explosive member located between said dies, and a pair of circular metal collars located within the tubular member with one of said collars positioned outwardly of one of said dies and the other collar positioned outwardly of the other of said dies.

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The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

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DARRELL L. CLAY, Primary Examiner

U.S. Cl. X.R.

29—254, 421, 628; 174—90; 287—101; 339—276