July 21, 1970 D. E. KRUP 3,520,986

NO-STRIP EXPLOSION CONNECTOR

Filed Dec. 24, 1968

Fig. 1.

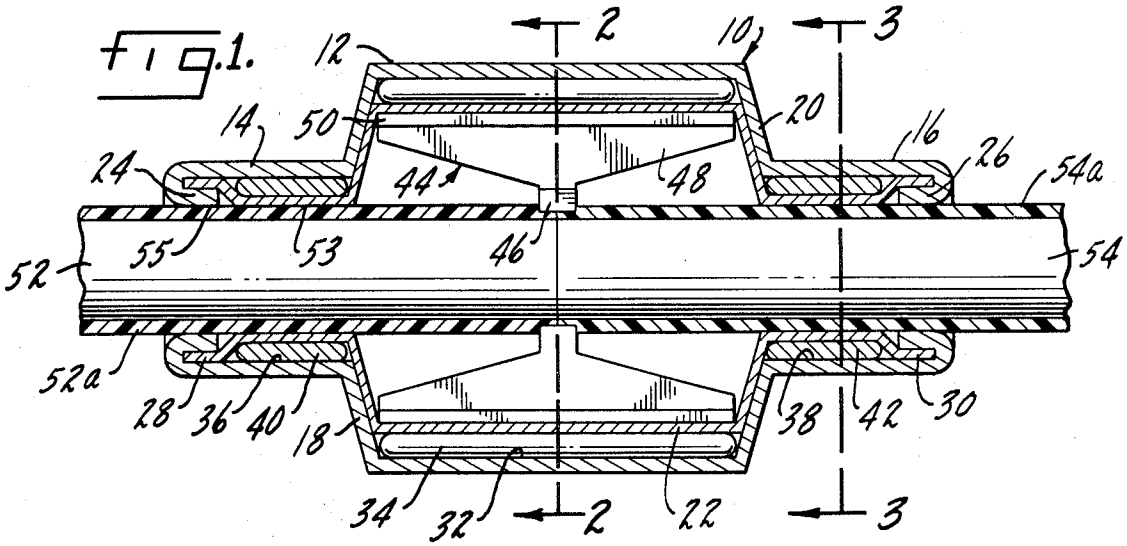


Fig. 2.

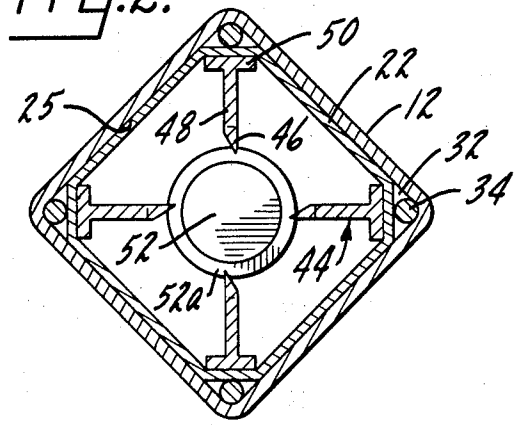
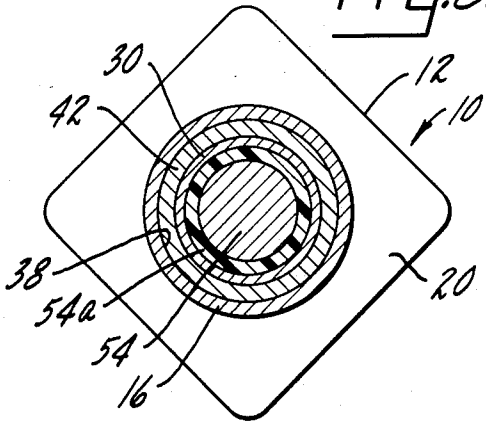


Fig. 3.



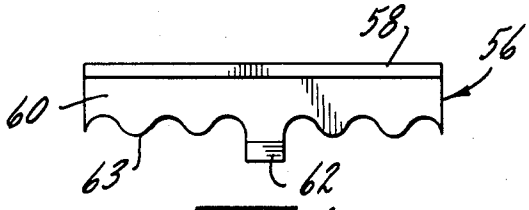


Fig. 4.

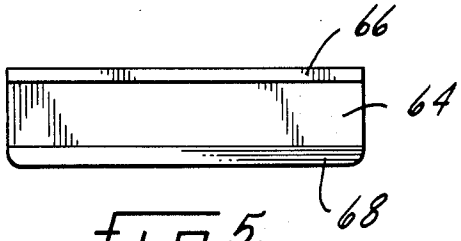


Fig. 5.

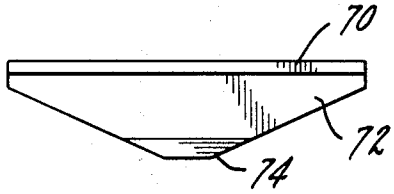


Fig. 6.

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3,520,986

NO-STRIP EXPLOSION CONNECTOR

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U.S. Cl. 174—84 15 Claims

ABSTRACT OF THE DISCLOSURE

A no-strip explosive connector having spaced inner and outer shells and an explosive charge or charges between the shells. Detonation of the explosive is effective to drive electrical conductors, positioned within the inner shell, through the insulation of the wires positioned within the connector and into intimate electrical contact with the wires in the connector to thus form an elecrical bridge between the wires. In addition, there is at least one clamping electrical charge so positioned as to be simultaneously detonated to effect a clamp between the connector and the wires positioned within it.

SUMMARY OF THE INVENTION

This invention relates to a method of electrically connecting insulated wires by the use of an explosive charge and has particular relation to a connector for use on insulated wires in which electrical conductors are driven by one or more explosive charges into electrical contact with the wires.

A primary purpose of the invention is a method of the type described utilizing one or more charges to effect an electrical connection between the wires within the connector and to provide a clamping action between the connector and the wires within it.

Another purpose is an electrical connector in which explosive charges are detonated to drive a plurality of electrical conductor members into electrical contact with the wires positioned within the connector to thus form a no-strip electrical connection.

Another purpose is a connector of the type described utilizing a plurality of conductors, each having an insulation piercing or insulation cutting area which can be driven into the electrical wires within the connector by means of an explosive charge.

Another purpose is an improved method of the type described utilizing a simply and reliably constructed electrical explosive connector to provide both physical and electrical connection between the insulated wires within the connector.

Other purposes will appear in the ensuing specification, drawings and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is illustrated diagrammatically in the following drawings wherein:

FIG. 1 is an axial section through a connector of the type described,

FIG. 2 is a section along plane 2—2 of FIG. 1,

FIG. 3 is a section along plane 3—3 of FIG. 1,

FIG. 4 is a plan view of a modified form of connector member,

FIG. 5 is a plan view, similar to FIG. 4, illustrating a further form of connector member, and

FIG. 6 is a plan view, similar to FIGS. 4 and 5, illustrating still a further form of electrical connector member.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 an outer shell **10**, preferably formed of a rigid material such as metal, forms the outer surface of

the connector. As shown, there is a section **12**, having an enlarged cross section, and end sections **14** and **16** each of which have a cross section less than the section **12**. There may be somewhat slanted areas **18** and **20** which join the sections **14** and **16** with the area **12**. Positioned within the outer shell **10** is an inner shell **22** which has a cross sectional shape similar to that of the outer shell **10**. As shown, the cross section of the inner and outer shells is somewhat square. Obviously the invention should not be limited to such a construction. The opposite ends of the outer shell **10** may have in-turned flanges **24** and **26** which are clamped over outwardly extending flanges **28** and **30** of the inner shell **22**, to form a rigid connection between the two shells.

As shown in FIG. 2, there are a plurality of spaced confined chambers **32** between the section **12** of the outer shell and a like portion of the inner shell **22**. Positioned within the chambers **32** are explosive charges indicated at **34**. (Note that the outer walls of the inner shell **22** is in contact with the inner wall **25** of the outer shell except for the confined chamber **32**.) As will appear hereinafter, the explosive charges, as well as the means or method for detonating them, may take a number of different forms.

There are peripheral chambers **36** and **38** formed by the portions **14** and **16** of the outer shell and like portions of the inner shell. Within the peripheral chambers **36** and **38** may be additional or secondary explosive charges indicated at **40** and **42**, which are preferably continuous. Again, the explosive charges **40** and **42**, as well as the means or method for detonating them, may vary widely.

Positioned within the inner shell **22** are a plurality of wedge-shaped members or electrical conductors, indicated at **44**. Note particularly FIG. 2. Each of the wedge-shaped conductors, and the number four is merely illustrative, may have an inner knife-like edge **46**, a body section **48**, and an outer head **50**. Note that the cross section of the conductors **44**, as illustrated in FIG. 2, takes a shape like that of a nail. The explosive charges **34**, when detonated, are effective against the heads to drive the conductors **44** inward thus forming an electrical connection between the wires positioned within the connector.

As indicated in FIG. 1, there are a pair of insulated wires **52** and **54**, positioned within the conductor. The wires may have an outer layer of insulation, for example polyvinyl, indicated at **52***a* and **54***a*. Each of the wires pass through aligned openings **53** and **55** in the inner and outer shells respectively, with the aligned openings being effective to form wire receiving passages.

In a conductor of the type illustrated herein, in which the insulated wires come from opposed openings or wire receiving passages, the wires are positioned end to end within the connector. Detonation of the explosive charges **34** is effective to drive the knife-like edges **46** of the conductors into and through the insulation covering the wires **52** and **54** so as to form an electrical bridge between the two wires. Simultaneously with the detonation of the charges **34**, the secondary or clamping charges **40** and **42** will be detonated to clamp the inner shell, at spaced points, to the wires **52** and **54**. In this way, there will not only be an electrical connection between the two wires, but they will also be physically connected. The invention should not be limited to a method in which the charges are all detonated simultaneously, although such a method has been found to be advantageous. In some application the clamping charges may be detonated either before or after the charges which are effective to provide the electrical connection between the wires.

When the wires **52** and **54** are intially inserted within the wire receiving passages, they will be held in their posi-

tion, in end to end contact, by the knife-like edges **46**. Note in the position of FIG. 1, which is prior to detonation of the charges, that the knife-like edges **46** extend through a portion of the insulation on the wires, but not completely through the insulation or into electrical contact with the wires themselves.

The explosive charge is preferably of the deflagrating type and may be gunpowder of the "double-base" type which contains nitro-cellulose and nitro-glycerin, or it may be straight nitro-cellulose. This type of explosive is readily ignited by a spark or a flame or other source of heat, but not by an ordinary shock as would be produced by dropping a connector on a hard surface such as a floor. A detonating type of explosive may also be used, but would require a thicker external shell for the same amount of deformation of the inner shell. The explosive may be selected to be detonated by shock, spark, flame, heat, friction or electricity, to suit a specific design purpose. Explosive combinations which include detonating, deflagrating, and priming mixtures in various proportions, or any two of the foregoing, may be used as the end use, commercial considerations and manufacturing needs may dictate. The amount of the explosive charge may be varied, depending upon the cross section of the wires to be connected, but it should be sufficient, upon explosion, to deform the inner shell **22** in such a manner as to drive the conductors **44** into intimate electrical and physical contact with the wires **52** and **54**.

The explosive charges may be detonated in a number of ways. In some applications, a source of electrical energy may be used to ignite a priming charge. In other applications, a match-type of arrangement may be provided whereby the rapid pulling of a member is effective to cause a spark adjacent or within the explosive charge. Heat may be used in some applications, such as high frequency heating of magnetic shells. A percussion primer of the type used in a rifle cartridge has been found to be satisfactory in some connectors.

FIGS. 4, 5 and 6 illustrate modified forms of the conductor. In FIG. 4 a conductor **56** may have a head **58**, a body section **60** and a knife-like inner edge **62**. Note that the edge **62** has a relatively limited length, somewhat similar to the knife edge **46** in FIGS. 1, 2 and 3. The areas **63** adjacent the knife-edge **62** are somewhat sinuous or serrated and of less depth than the knife-edge **62** for gripping adjacent portions of the wires **52** and **54**.

In FIG. 5 a similar conductor **64** has a head **66** and a knife-like edge **68**. Note that the knife-like edge **68** extends generally the length of the conductor.

FIG. 6 shows yet a further form in which there is a head **70** attached to a body portion **72** with a knife-like edge **74**. The body portion **72** is generally triangular or wedge-shaped with the knife-like edge **74** being formed at the small end of the triangle.

The conductors shown herein may take several different forms. In all cases the body portion, for example as shown at **48** in FIG. 2, should be formed of an electrically conductive material. In some applications the conductor may be a single piece in which case the head **50** would also be formed of an electrically conductive material. However, it is desirable in some applications to form the head **50** of insulated material, for example a fiberglass reinforced plastic.

The use, operation and function of the invention are as follows:

In operation, the explosive charges **34** may be detonated simultaneously with the explosive charges **40** and **42** so as to drive the conductors into the previously positioned wires to form both a physical and electrical connection between the wires **52** and **54**. Normally the electrical connection or contact will be formed by the knife-like edges on the conductors and the clamping charges **40** and **42** will be effective to physicially clamp the connector to the wires. There will also be some clamping action by the electrical conductors.

Although the invention has been described in connection with a connector in which the wires are positioned within the connector from wire receiving passages at opposite ends of the connector, obviously the invention should not be so limited. There may be a single wire receiving passage and both wires or more than two wires may be positioned within the cavity formed by the inner and outer shells. In some applications the wires may be positioned between the inner and outer shells with the explosive charges within the inner shell.

It is preferred that the outer shell **10** be formed of a rigid material such as metal. There may be an outer cover or the like, not shown, of insulating material. The relative strength and the particular materials of the inner and outer shells will depend on the size of the connector and the size of the explosive charges. The inner shell particularly must be subject to deformation so that the explosive charges which are used to drive the conductors into the wires may have their force transmitted from their confined explosive chambers, through the inner shell and to the head of the conductors. The particular size and shape of the conductors is not important providing that they have a knife-like or insulation piercing portion or area and that they are so constructed so as to receive the maximum benefit of force from the detonated charge.

Whereas the preferred form of the invention has been shown and described herein, it should be realized that there are many modifications, substitutions and alterations thereto which may be made without departing from the fundamental theme of the invention.

What is claimed is:

1. A method of electrically connecting and physically joining at least two insulated wires or the like including the steps of:

placing insulated wires adjacent one another in a cavity of a collapsible shell having at least one insulation piercing member of electrically conductive material positioned therein,

positioning said insulated wires end to end in said cavity and holding said wires in position prior to detonation by means of said insulation piercing member, and

detonating an explosive charge positioned outside of the collapsible shell, and directing the force of the explosive charge to cause the insulation piercing member to penetrate the insulation and contact the wires and thereby form an electrical connection between the wires.

2. The method of claim **1** further characterized by and including the steps of detonating at least one additional explosive charge positioned adjacent a portion of the collapsible shell and directing the force of said last named explosion to move a portion of the collapsible shell into clamping relationship with the wires.

3. The method of claim **2** further characterized in that said first-named confined explosive charge and said additional explosive charges are all detonated simultaneously.

4. The method of claim **2** further characterized in that there are two additional explosive charges, simultaneously detonated for moving spaced portions of the collapsible shell into clamping relationships with the wires.

5. A connector for joining the ends of at least two insulated wires or the like, including:

an outer shell having at least one opening therein formed of a generally nondeformable material,

an inner shell positioned within and spaced from said outer shell, said inner shell having at least one opening therein in alignment with the opening of the outer shell and being formed of a generally deformable material,

an explosive charge positioned between the inner and outer shells, and

a plurality of separate electrically conductive members positioned within the inner shell, said electrically

conductive members being generally circumferentially spaced around the inner shell with each having an insulation piercing area directed generally towards the center of the inner shell.

6. The structure of claim **5** further characterized in that both the inner and outer shells have a pair of spaced openings, with each of said openings being arranged to receive at least one insulated wire for positioning within the inner shell.

7. The structure of claim **5** further characterized in that each of said electrical conductive members has a generally centrally located insulation piercing area terminating in a cutting edge.

8. The structure of claim **5** further characterized in that each of said electrically conductive members have wire gripping areas adjacent the insulation piercing area.

9. The structure of claim **5** further characterized in that each of said electrically conductive members is generally wedge-shaped with an insulation piercing area being formed along the small edge.

10. The structure of claim **5** further characterized by and including at least one additional explosive charge positioned between portions of the inner and outer shell, detonation of said additional explosive charge being effective to clamp the inner shell onto the exterior of at least one insulated wire.

11. The structure of claim **10** further characterized by and including a pair of spaced additional explosive charges positioned on opposite sides of the first-named explosive charge, detonation of said last-named explosive charges being effective to clamp the inner shell to spaced portions of the insulated wires positioned within the inner shell.

12. The structure of claim **5** further characterized in that said inner and outer shells each have a pair of openings, said openings being aligned to form spaced wire receiving passages into the inner shell, a pair of additional explosive charges positioned between portions of the inner and outer shells adjacent said wire receiving passages, detonation of said additional charges being effective to clamp the inner shell about an insulated wire positioned within a wire receiving passage.

13. The structure of claim **5** further characterized in that each of said electrically conductive member has a single knife-like edge extending generally along the length of the member.

14. The structure of claim **5** further characterized by a plurality of explosive charges positioned in defined spaces between the inner and outer shell, a plurality of electrically conductive members, there being an explosive charge positioned near each electrically conductive member.

15. The structure of claim **5** further characterized in that each of said electrically conductive members is generally T-shaped in cross-section with the cross arm of the T located adjacent the collapsible shell and the insulation piercing area being located at the foot of the T.

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DARRELL L. CLAY, Primary Examiner

U.S. Cl. X.R.

29— 421, 628; 174—84; 339—97