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M. D. BERGAN

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CASE HARDENED CABLE CONNECTOR AND METHOD

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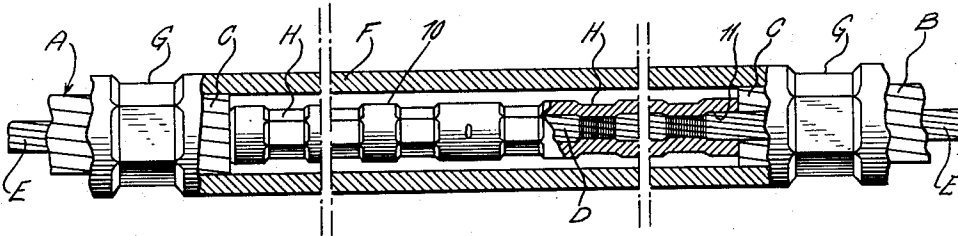


Fig. 1.

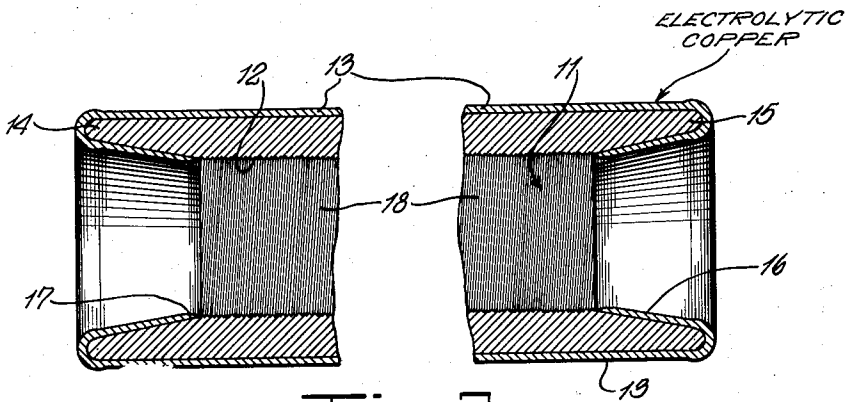


Fig. 2.

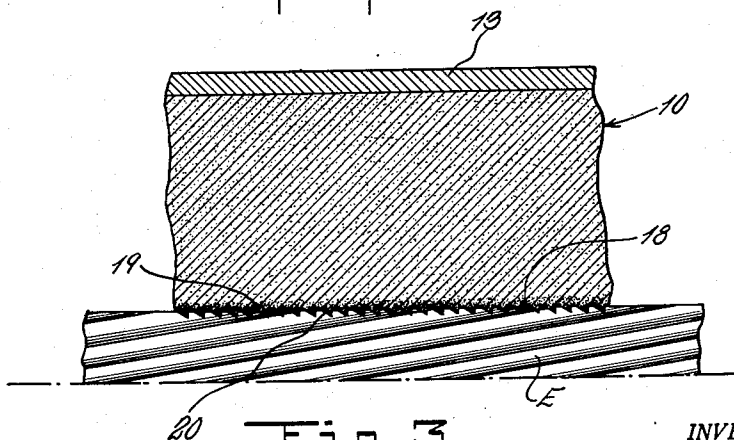


Fig. 3.

INVENTOR.
MARTIN D. BERGAN
BY

Warren S. Ostou
ATTORNEY

UNITED STATES PATENT OFFICE

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CASE HARDENED CABLE CONNECTOR AND METHOD

Martin D. Bergan, Westfield, N. J., assignor to
The Thomas & Betts Co., Elizabeth, N. J., a corporation of New Jersey

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The invention relates in general to an improvement in the art of anchoring connectors of the tension splicer type in place and specifically relates to the art of preparing and securing a metallic connector to a steel core. More specifically defined, the invention relates to a method of forming an improved type of connection between a clamping connector and a core intruded therein; to the resulting joint forming product, and to the basic pre-prepared, case-hardened connector as an article of manufacture for use in the method herein featured.

The invention is particularly applicable to the art of splicing or otherwise joining high strength cables, wherever it is required that the splicing connection have a folding strength at least equal to that of the rated strength of the cable. In the form of the invention selected for illustration the invention relates to an improvement in the electric art where a connection is to be made to an electric cable.

More specifically identified, the invention relates to an improvement in the art of joining, splicing and otherwise holding hard drawn steel wires or cables when in single solid or multiple strand form such as are used in electric distribution systems as guy wires, messenger wires and core reinforcements of copper and copper clad steel conductors and of (A. C. S. R.) aluminum cable steel reinforced. Such steel wire cores are normally zinc coated for corrosion protection. The zinc coating acts as a lubricant and must be penetrated to obtain a bite therethrough onto the steel in order to obtain the desired engagement with the steel core at the center of the cable.

It is a usual practice in this art to secure such a stranded steel core of a cable, a guy wire, ground wire, a messenger wire or the like, hereinafter referred to generically as a core, to another cable or wire or to a fixed support, by intruding an end of the steel core into a malleable connector of tubular form, usually of soft low carbon steel, and then roll, die-compress, crimp or otherwise squeeze the connector onto the portion of the core intruded therein.

These steel cores are usually formed of wire strands twisted together into a rope and formed of steel of a degree of hardness considerably harder than the softer steel tubes herein used as connectors. The cores are usually covered with zinc or with a similar rust preventive coating.

Despite the use in this art of powerful rollers, dies, crimping tools and other connector distorting mechanism, the cores eventually pull out of the connectors, especially where the resulting

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joint between connector and core is subjected to vibration, abnormal loads like ice accumulation thereon or after they have been in use for a long time. In the case of these crimped connectors the effectiveness of any resistance to slippage between the connector and the core is dependent upon the degree of friction which can be produced in the joint therebetween.

Numerous suggestions have been made to increase the friction in the joint as by means of a keying material inserted in the joint with the hope that this would more firmly and positively anchor the core in the connector and thus resist any pull-out or separating action between the connector and core.

It has been suggested for instance to spray fine particles of hard metal while in a molten form into the bore; to coat the inner surface of the connector with an adhesive containing an abrasive such as emery dust; to line the bore with a separate frangible tube or to line the tube with a brittle metal and thus form a bi-metal connector whose bore wall would shatter into keying particles when the tube was squeezed in the act of securing it to its core.

These practices have not proved satisfactory in actual practice for many reasons; for instance when the bores or the entrance thereto are of small diameter, it is simply impossible to obtain access to the bore wall surface in order to coat or otherwise treat the same as previously suggested. Of even more serious import is that these known practices are so complicated and involved in their steps as to render them difficult to apply and to control their dimension limitations, as well as too expensive to be of any commercial importance.

The primary objects of the invention insofar as its method aspects are concerned are to suggest an improved and easily practiced technique for securing the core in its tubular connector, even in those cases where the tube bore and its intruded core are of very small diameter, and in this way to avoid the difficulties and objections inherent in presently known practices, and to affect a positive and permanent connection between the core and its connector with the least number of operative steps, incidentally for the most part following conventional practices in the crimping or clamping step, and in this way feature economy in the fabrication of the resulting product.

The primary objects of the invention insofar as its apparatus or article aspects are concerned is to provide a positive, secure and permanent coupling or bonding effect between the core and

its connector, without the addition of any separate keying materials as heretofore practiced, and thus to form a keyed joint which will be of the least possible number of parts and which will be permanent and safe.

Broadly, these objectives are attained by case-hardening the gripping surface defining the bore of the connector to an extent to cause it to become frangible while being installed on its core, and at the same time to protect all other surfaces from any hardening reactions. In this way, the connector considered as a whole is maintained in its initial malleable condition so that it may be distorted by the usual crimping, rolling or other squeeze operation into engagement with its core following conventional practices in this respect and to do this without injury to the forming tools.

Various other objects and advantages of the invention will be in part obvious from a consideration of the method features of the disclosures and from an inspection of the accompanying drawings, and in part will be more fully set forth in the following particular description of one method of practicing the invention, and the invention also consists in certain new and novel modifications of the preferred method and other features of construction and combination of parts hereinafter set forth and claimed.

In the accompanying drawings:

Fig. 1 is an explanatory view partly in elevation and partly in axial cross section with parts broken out of a tension splicer including a preferred embodiment of the invention shown partly in elevation and partly in axial section;

Fig. 2 is an enlarged view in axial section of the connection of Fig. 1, with its mid-portion broken out, as the stock tube exists at the termination of the masking step of the process herein featured, and

Fig. 3 is a sectional view grossly enlarged showing a portion of the connector illustrated in the preceding figures as it exists after the clamping surface has been case-hardened as herein featured and showing the joint formed thereby with the adjacent surface of the enclosed core.

In the drawings and referring first to Fig. 1 for an illustration of one situation in which the invention herein disclosed may be utilized, there is disclosed two electric cables A and B in axial alignment and in end-to-end relation and in each of which their wire strand conductors C have been stripped back to expose the ends D of their central zinc coated steel cores E. These cables may be of either the insulated or non-insulated type as this detail is not involved as a factor in the present disclosure. The conductor ends are connected electrically and mechanically by an outside connector F. In the instant case it is assumed that the conductors C are of aluminum; in which case the connector F is likewise of aluminum and is crimped onto the ends by crimps G or otherwise secured to the two conductors C following conventional practices in this art and not involved in the method herein featured.

The ends D of the steel core are connected by a tubular member 10 which may be a sleeve, jumper, dead-end connector or similar strain transmitting device, hereinafter referred to generically as a connector. The connector is secured to the core end D by crimps H.

The stock material from which the connector is formed is of conventional design and in the case where it is utilized to connect a steel core

as in the illustration it is preferably formed of a low carbon grade of soft steel. The connector is provided with a bore 11 which extends axially therethrough from end to end and the bore outlining surface of which may be either smooth or roughened as by means of the threads 12 in the illustrated form of the disclosure. Of course, in the case of dead-end connectors, the bores do not extend entirely through the connectors.

The stock tube is cleaned and otherwise prepared to receive a masking layer on those surfaces which are designed to receive the tools used later in securing the connector in place. For instance, a deposit of an electrolytically deposited layer of some malleable metal is used in the illustrated case to form a protective coating on the exposed surfaces of the connector. In one successful operation the tube is deposited in an electrolytic bath containing copper and its exposed surface electro-plated by any of the known cyanide copper or acid copper solution methods, until a thin layer of dense copper of the thickness of about 0.0002-0.001 of an inch is deposited thereon after which the connector so treated is removed from the bath, washed and otherwise finished following conventional practices in copper coating steel objects.

Copper is suggested because it is not hardened by heat or chemical treatment; it has a high melting point (1900 degrees F.) compared to the cyanide hardening treatment hereinafter described where the temperature is not so high, that is, in the range of 1500-1700° F.

While copper electrolytically deposited has been suggested as the preferred protective coating, any soft malleable metal may be used which will not be dissolved or otherwise lose its protective characteristics in the subsequent hardening process; nor is it necessary that the masking metal be electrolytically deposited or even that it be a metal. While copper is preferable and may be applied otherwise as by chemical deposition, aluminum, cadmium and silver are suggested as other electrolytically deposited metals which may be used and certain thermo-plastics capable of withstanding the subsequent hardening processes, such as those of the phenol-formaldehyde group, may be used as secondary substitutes. Clay may be used as a mask.

As the result of this electrolytic deposition treatment, a thin copper layer 13 is formed on all fully exposed surfaces of the connector 10. It has been found that the copper layer laps both of the tapered ends 14-15 of the connector and extends slightly into the opposite ends of the bore 11 as indicated at 16 and fades more or less into a feather edge 17. This leaves the major portion of the surface 18 of the bore wall uncoated, in its initial soft condition, and either smooth or threaded as may be the case with the original stock tube.

The tube so partially electroplated is subjected to a carburizing process which has the effect of case hardening the surface 18 and the operation is continued until the original soft surface 18 becomes brittle and frangible to form a hard surface 19. The case hardening may be obtained at the normal carburizing temperature of about 1700 degrees F. by any of the usual methods for case hardening soft steel, and may be done either by pack carburizing, by gas carburizing and by liquid carburizing. The device illustrated was case hardened in an activated bath of potassium cyanide with the usual controlling chemicals for decomposing the cyanides such as are conven-

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tionally employed in the well known cyanide process for case hardening soft steel.

It has been found that the carburizing by the cyanide process has only a slight, if any, dissolving effect upon the copper layer 13 and any such lessening of the thickness of the copper layer as did accrue in no way diminished its function of avoiding case hardening of any portion of the surface of the connector except the surface 18 which is herein intended to be case hardened. The connectors as thus prepared are cleaned and marketed as is, but preferably are electroplated with cadmium or zinc or are otherwise finished on their outside to better their appearance and to avoid rust in accordance with approved practices in finishing such connectors for the market.

In use the connectors so prepared may be slipped on to one or both of the steel cores E as suggested to the left of Fig. 1, and the connector subjected to the squeezing effect of rollers, dies, crimping tools and like tube distorting tools to shrink the connector onto the core as is usual in such operations. It has been found that the case hardened surface 19 bites into the strands of the steel core as is evidenced by the appearance of thread impressions on the steel core strands when the connector is sawed to expose the gripped surfaces of the joint. Insofar as can be ascertained by a microscopic examination of the joint 20 formed between the case hardened surface 19 and the outer strands of the core, the case hardened surface has become broken and disintegrated to form extremely small particles of an extremely hard keying material formed incidental to the squeezing of the connector onto the core. As the threaded brittle surface of the bore wall disintegrates incidental to forming the crimps H, the small steel particles broken off from the main body of the sleeve, and particularly from the threads or similar projections, present irregular, minute, glass-like slivers or chips, often with ragged edges which penetrate deeply into both the soft metal of the sleeve and the metal of the steel core E. The particles so broken off from the threads or other projections each present a greater exposed area of keying or bonding contact with both the sleeve and core than when forming an integral part of the sleeve. It is thus seen that the connector itself automatically provides its own keying material, and nothing additional need be provided to insure a positive bonding between the connector and the steel core. As the forming tools engage the relatively soft copper surface formed by the layer 13, the tool surfaces are not injured as would be the case if the surfaces engaged thereby were likewise case hardened. Except for the extremely thin case hardened surface located well within the bore 11, the balance of the steel connector retains its initially soft and relatively easily distortable characteristics such as are inherent in the original soft steel stock material.

It is a particular feature of this disclosure that extremely small size connectors may be used, in fact, any size whose bore will permit the passage therethrough of the molten cyanide compound. While in the illustrated disclosure the bore has a diameter of about 0.080 inch, tubes with bores as small as one-thirty seconds of an inch can equally be used. Where gas carburizing is used connectors with even smaller bore diameters may be used and still sufficient depth of skin penetration can be had to give the desired hardness and resulting keying effect.

It is, of course, within the scope of the dis-

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closure to plug the open ends of the bore of the stock tube to avoid the formation within the bore of the copper layers at 16 and thus utilize the entire length of the bore as a hard faced clamping surface. However, so shielding the ends of the bore is of advantage in that it keeps the ends 14-15 of the coupling sleeve in their initial soft condition. This means that the copper faced ends will not bite into the intruded steel cores as the connectors are shrunk thereon. This is a highly desirable form of connection in that it avoids the formation of sharp, stiff edges at the ends of the connectors, which might cause the connector to chafe or even wear through and break the core at the places where the cores leave the connector.

It is noted that the copper plate gradually becomes thinner the further it intrudes into the end of the tube until it gradually disappears at the feather edge 17. This means that the hardened surface does not start abruptly at the edge 17 but starts somewhat outwardly of the edge 17 and increases in hardness as the copper becomes thinner. This has an advantage in that blending effect is obtained where the crimping or squeezing effect is applied with the degree of bite tapering off from a hard bite to a soft cushioning bite nearer the ends of the tube.

The two step method herein featured of first masking tool engaging parts and case hardening gripping surfaces is preferred largely because it is economical. It is also suggested that the entire surface of the stock connector be case-hardened and then those parts which are to be engaged subsequently by the deforming tools be ground off to expose the initial soft metal surfaces for tool contact leaving those surfaces which are to form gripping surfaces in their hard frangible condition. Of course, in such cases the stock tube will be of such oversize dimension as will result in the desired size when so surfaced ground or otherwise machined to remove the hardened skin from those surfaces where it is not desired.

I claim:

1. An article of manufacture forming a hollow connector fashioned to be distorted into a crimping engagement with an insert therein, said connector formed primarily of soft steel and including a recess opening through one side of the connector, the inner portion of the recess being of cylindrical form and gradually increasing in diameter from the inner portion towards its open end to form a frusto-conical tapered wall, the wall defining the cylindrical portion being case-hardened and rough to the extent of being brittle and frangible and the frusto-conical tapered wall being lined with a layer of copper extending from the open end to the case-hardened portion and forming a smooth funnel-like entrance for inserts passed therethrough into the case-hardened inner portion.

2. An all-steel joint including solely two parts, one of the parts being a one-piece steel sleeve and the other part being a stranded steel core in the bore of the sleeve, at least a portion of the surface of the wall forming the bore of the sleeve being threaded and case-hardened to the extent of being brittle and the balance of the sleeve being of a soft malleable steel, softer than the strands of the steel core, said sleeve being in crimped engagement with the core and said case-hardened surface provided with a thread-like line of separate keying particles biting into the strands of the core.

3. A tubular article of manufacture for use as

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a connector fashioned to be deformed by squeeze pressure of a crimping tool into a crimping engagement with a cable in its bore, comprising a one-piece steel sleeve, with a portion of its bore being case-hardened, brittle to the extent of being frangible and capable of breaking up into steel keying particles when subjected to the squeeze action of a crimping tool, the balance of the sleeve bore exteriorly of its case-hardened portion and including the outer surface of the sleeve being of soft malleable steel, and a lining of copper on its outside forming a malleable surface fashioned to be engaged directly by the crimping tool, and said copper lining lapping at least one end of the sleeve and extending about said end and along the bore wall to its case-hardened portion.

4. An electric connector including a sleeve formed of a soft steel and having a bore with an open end, and a layer of soft copper lining the bore at its open end, said lining gradually decreasing in thickness of material from the open end towards a feathered edge spaced inwardly from said open end, the wall of the bore inwardly of the feathered edge being case-hardened to the extent of being brittle and frangible and adapted to be disintegrated into steel keying particles, and said case-hardening extending beyond the feathered edge towards said open end in a gradually less hardened condition.

5. In the art of connecting a stock sleeve of malleable low-carbon grade soft steel to a steel wire core considerably harder than the sleeve and wherein the bore of the sleeve is too small to permit the insertion therein of carburizing apparatus, the method which consists in providing a thin layer of electrolytic copper on the stock sleeve to cover its exterior surface, to lap its ends and to extend into opposite ends of the bore, leaving the mid-portion of the bore exposed and free of the copper layer, subjecting the exposed portion of the bore between the copper layer at its ends to a carburizing treatment of the fluid type, continuing the carburizing treatment until the exposed mid-portion of the bore becomes brittle and frangible, inserting the bared wire core into the bore, and subjecting the sleeve in the portion so carburized to the squeeze pressure of a crimping device directly engaging the copper-covered exterior surface and acting through the sleeve to

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deform the bore of the sleeve into a binding engagement with the core and incidentally in deforming the sleeve to cause the hard core to react on the brittle frangible surface of the bore to disintegrate at least part of its bore surface into hard, small steel particles penetrating both the soft metal of the sleeve and the hard metal of the core and thus operate automatically to cause the sleeve to provide its own hardened keying material to key the sleeve to the core.

6. A tubular article for use as an electric connector in those situations where the article is to be deformed by squeeze pressure applied externally thereof and acting transversely therethrough to crimp the article to a core inserted in its bore, comprising primarily a one-piece sleeve whose major portion is of soft malleable metal and whose bore is fashioned to receive the core therein, at least a portion of the length of the bore wall provided with inwardly extending projections and said length with its projections being case-hardened and which case-hardened bore wall is integrally surrounded by the soft metal of the sleeve, said case-hardened bore surface being frangible and capable of disintegrating to form separate hard keying particles of the same material as the sleeve and capable of penetrating into the soft metal of the sleeve and into the core for automatically securing the sleeve to the core when the sleeve is subjected to the squeeze pressure operative to crimp the sleeve onto the core.

MARTIN D. BERGAN.

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