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Gillemot et al.

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[54] **BONDING DEVICE AND ANCHORAGE FOR SHIELDED CABLES**

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[52] **U.S. Cl.** ..... **174/78,** 174/79.88 R, 29/628, 339/14 R, 339/95 A, 339/97 R, 24/153 UC

[51] **Int. Cl.** **H02g 15/08**

[58] **Field of Search** ..... 174/78, 88 S, 88 R, 174/75 C, 51, 87, 84 C, 79; 24/153 UC, 67.9, DIG. 9, 87 R; 29/628

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[57] **ABSTRACT**

A bonding device and method for attachment to shielded electrical cables and effective in bonding the shields to a grounding conductor or to another cable shield and utilizing the strength of the cable sheath as an anchorage for the bonding device and for dead-ending the cable or cables themselves. The device comprises a one-piece, U-shaped conductive clip assembled astride the edge of the shield and sheath and having burrs which penetrate into at least the shield as an assembly bolt or stud for the clip is tightened after being inserted through aligned holes of all components. This bolt may also pass through a terminal strip or anchorage for the cable as well as through a pair of cable sheaths superimposed in back-to-back relationship.

20 Claims, 7 Drawing Figures

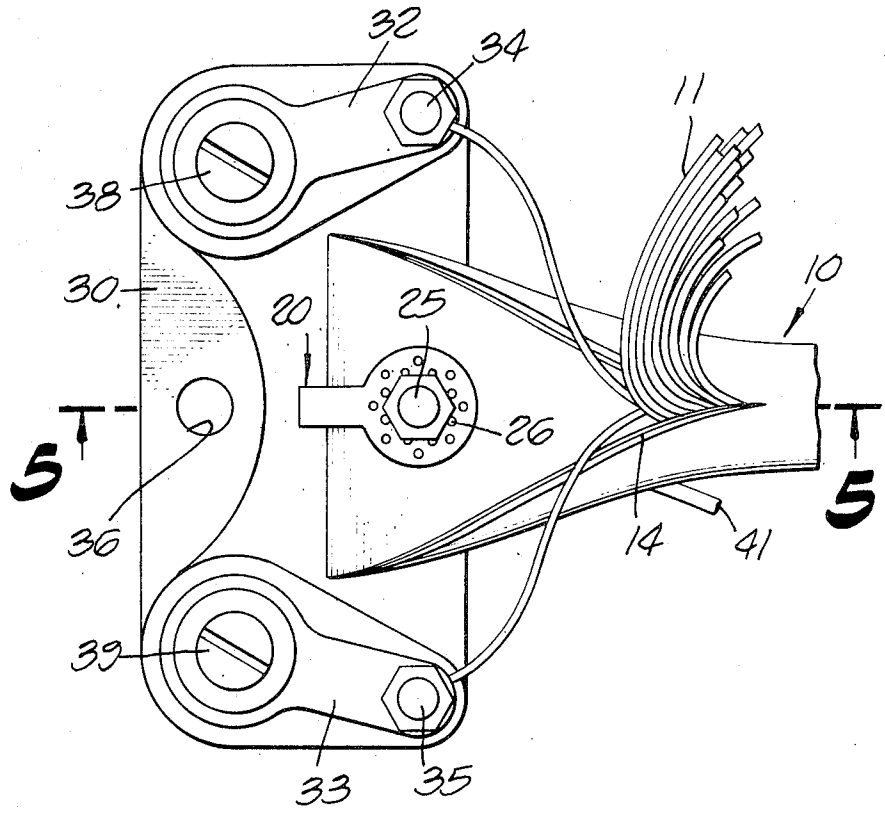

FIG. 1.

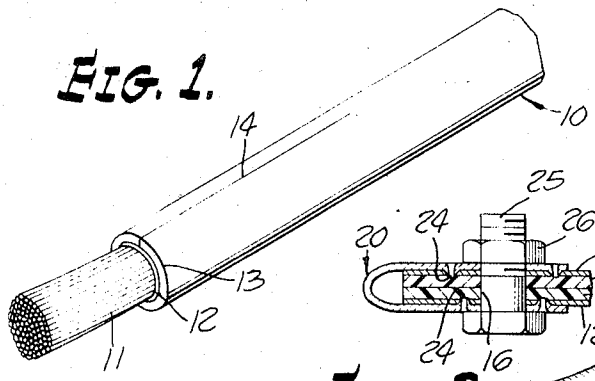

FIG. 3.

FIG. 2.

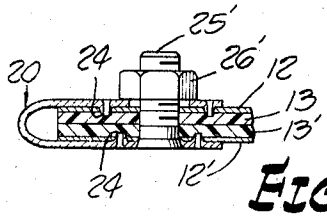

FIG. 7.

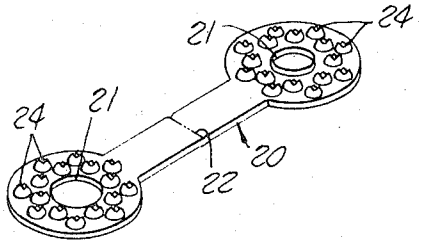

FIG. 6.

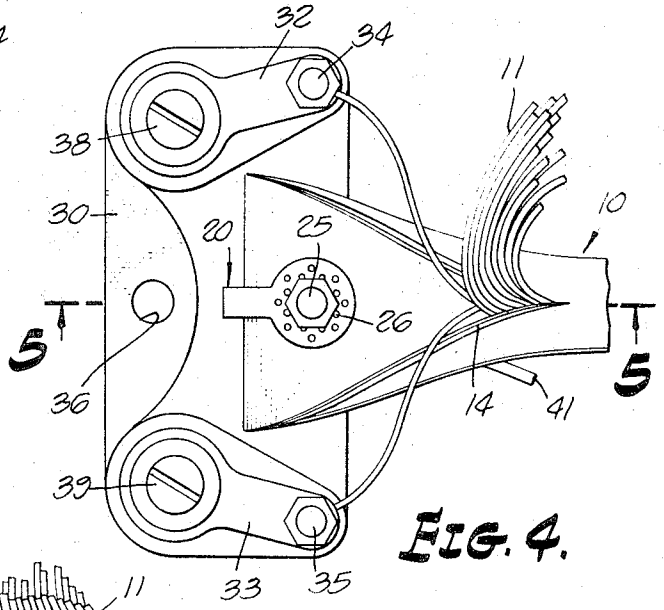

FIG. 4.

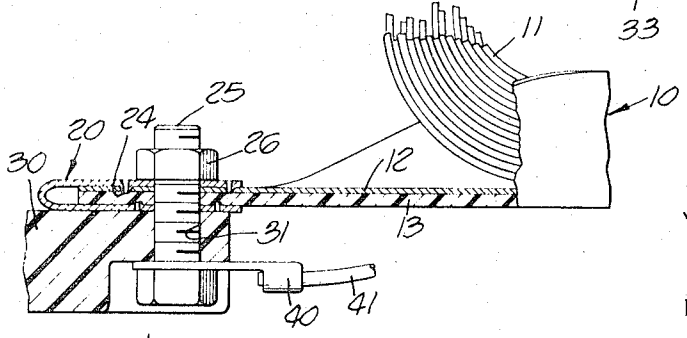

FIG. 5.

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BONDING DEVICE AND ANCHORAGE FOR SHIELDED CABLES

This invention relates to cable terminal fittings and grounding devices, and more particularly to a simple, highly effective bonding device and method for making a strong, highly reliable, electrical connection to a shielded cable and usable additionally as an anchorage for the cable itself.

Many proposals have been made heretofore for connecting a heavy duty grounding wire or other conductor to the thin foil-like shielding jacket commonly employed between a cable sheath and its conductors. Oftentimes the interior surface of the shield is coated with a non-conductive insulative film difficult to remove without risk of damage to the shield itself. The bonding problem is particularly pronounced as respects cables of smaller size having only a limited number of conductors and customarily enclosed by a heavy tough sheath of thermoplastic material.

By the present invention there is provided a simple, rugged, bonding coin or device comprising a U-shape clip of conductive material having a multiplicity of sharp burrs protruding from the inner surfaces of its legs in the area surrounding holes for a clamping stud or bolt. Preparatory to its installation, a short length of the cable sheath and shield is slit lengthwise from one end and perforated for assembly therethrough of a clamping stud or bolt. The clip is assembled astride the edge of the cable sheath and shield and then firmly tightened causing the burrs to penetrate into both the shield and the sheath. The wide area pressure contact between the shield, sheath and clip provides an excellent electrical connection with the shield and utilizing the strength of the tough, strong cable sheath to sustain and transmit heavy tensile stresses without risk of damaging the shield or interfering with the integrity of its connection to the bonding clip. If desired, a pair of cable sheaths can be clamped back-to-back between the clip legs with the burrs on each leg penetrating into a respective one of the cable shields thereby bonding the shields to one another and, if desired, to a heavy duty grounding conductor as well. The tightening of the clip bolt may also be utilized to hold the cable ends anchored to a terminal strip or to any other suitable anchorage for the cables. The clamping bolt or stud may have one end suitably bonded or swaged to a leg of the clip thereby providing a one-piece bonding assembly.

Accordingly, it is a primary object of the present invention to provide an improved bonding device and method of unusual versatility for use in making a strong electrical and mechanical connection to the shield and sheath of a shielded electrical cable.

Another object of the invention is the provision of a one-piece, bonding clip adapted to be assembled astride the edge of a shielded cable sheath and clamped rigidly thereto.

Another object of the invention is the provision of a bonding clip for shielded electrical cables comprising a U-shaped conductive member provided with a multiplicity of sharp edged burrs protruding from the inner surface of one or both legs and adapted to penetrate into a cable shield jacket as the legs are compressed thereagainst.

Another object of the invention is the provision of an improved method of providing a combined electrical connection and dead end anchorage for the end of a shielded cable and adapted to be clamped astride the terminal end of one or more slit and flattened cable sheath and shield jackets.

These and other more specific objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawing to which they relate.

Referring now to the drawing in which a preferred embodiment of the invention is illustrated:

FIG. 1 is a perspective view of a shielded cable under preparation for assembly of the invention bonding device thereto;

FIG. 2 is an exploded perspective view showing a pair of cable ends having their sheaths opened and arranged back-to-back with the invention bonding clip in readiness for assembly thereastride;

FIG. 3 is an enlarged cross sectional view through the bonding clip shown in FIG. 2 after being tightened by a clamping bolt;

FIG. 4 is a plan view of the invention bonding clip assembled to a cable end and anchored to one illustrative type of terminal strip or protective device;

FIG. 5 is a fragmentary cross sectional view on an enlarged scale taken along line 5—5 on FIG. 4;

FIG. 6 is a perspective view of the bonding clip before being folded into U-configuration; and

FIG. 7 is a cross sectional view similar to FIG. 3 but showing a modified embodiment of the bonding clip with the clamping bolt permanently assembled to one leg.

Referring initially to FIG. 1, there is shown a typical electrical cable 10 having a plurality of conductors 11 enshrouded by a metal shielding jacket 12 and a tough high strength sheath 13 of non-conductive thermoplastic or the like material. In preparing this cable end for attachment of the invention bonding device thereto, the cable sheath and shield is slit several inches lengthwise of the cable, as is indicated at 14.

The bonding device may be assembled to either a single cable or employed to bond together the shields of two cables at the user's election. For example, FIG. 2 shows a pair of similar cables 10,10' having their jackets similarly slit, flattened out and super-imposed against one another. It will be noted that the two shield jackets 12,12' face outwardly away from one another to either side of the two sheath jackets 13,13' which lie back-to-back. The ends of the flattened jacket are formed with a hole 16 spaced inwardly from one edge to accommodate a clamping bolt for the bonding device.

A typical embodiment of the bonding device comprises a U-shape clip 20 stamped from sheet metal in a suitable configuration, such as that best shown in FIG. 6. The outer ends of each leg are there shown as enlarged and formed with an opening 21 spaced equidistantly from a score line 22 extending across the mid length of the clip. This score line facilitates folding of the clip legs so that the two openings 21, 21 will be accurately aligned with one another. Surrounding openings 21 along the same surface of the clip are a multiplicity of sharp edged burrs 24 formed in any suitable manner as by perforating the clip from its opposite face to provide low height but sharp burrs on the inner face thereof. These burrs are so distributed about the opposite ends of the clip as to be misaligned with one another in the assembled position of the clip as is made clear by FIGS. 3 and 7.

The described bonding clip is assembled either astride the edge of a single cable sheath or a pair of sheaths arranged back-to-back, as indicated in FIG. 2, simply by placing the legs over the edge of the flattened sheaths until the holes 21 are in alignment with hole 16. The clamping bolt or stud 25 is then assembled through the hole and nut 26 is tightened causing burrs 24 to penetrate into the underlying surface. If the bonding device is being applied only to a single cable end then one set of burrs will penetrate and form a firm anchorage with the cable sheath as the other set of burrs penetrates into the thin metal shielding jacket 12. If a pair of cable sheaths are being anchored together, then the burrs on each leg of the clip will penetrate into the juxtaposed one of the cable shield jackets. In either case it will be appreciated and recognized that the large area legs of the bonding clip will forcibly compress the cable shield and sheath jackets together over a wide area to provide a high strength mechanical anchorage to the strong cable sheath while forcing the burrs into firm electrical contact with the shield.

Referring to FIGS. 4 and 5, it will be observed that the cable 10 is mechanically anchored to a fixed anchorage as, for example, a terminal strip 30 by means of the invention bonding device 20 and its clamping bolt 25. For this purpose a longer bolt 25 is employed which passes through an opening 31 in the insulative terminal strip. The latter is provided at spaced intervals with conductive terminal lugs 32,33 having clamping screws 34,35 for connecting individual conductors 11 thereto. A mounting opening 36 can be utilized to anchor the strip to a suitable support, not shown. Terminal strip 32,33 includes clamping screws 38,39 for clamping other conductors to the terminal strips in accordance with customary practice.

Attention is also called to FIG. 5 showing clamping bolt 25 for the bonding device utilized to secure a terminal lug 40 for a heavy gauge grounding conductor 41 to bonding device 20. If desired, lug 40 may be assembled between bonding clip 20 and its clamping nut 26.

FIG. 7 shows a bonding clip 20 having the clamping bolt 25' permanently assembled to one leg of the clip. This may be done by providing a high strength swaged, welded or brazed connection between one end of the bolt 25' and one leg of the clip. A swaged connection made in a manner well known to persons skilled in the fastener art has been found highly reliable and satisfactory. Although the holes through which the threaded stud or bolt pass have been shown as having a close fit with the shank it will be understood that sufficient clearance is provided to facilitate the assembly of the parts with ease. It will also be understood that a suitable washer is preferably assembled between the clip leg and the clamping nut.

In view of the foregoing it will be appreciated that a highly versatile bonding device and technique has been disclosed which is readily assembled astride the edge of a shielded cable jacket in such manner as to compress the cable shield and sheath tightly together over a wide area thereby developing the full strength of the cable sheath while providing a strong wide-area electrical connection between the bonding clip and the cable shield without risk of damage or rupture of the fragile shield. If an insulative coating is present on the shield this is penetrated in a multiplicity of places by the sharp burrs 24. It will also be recognized that the invention bonding clip also provides a highly effective terminal anchorage for the end of the cable.

While the particular bonding device and anchorage for shielded cables herein shown and disclosed in detail is fully capable of attaining the objects and providing the advantages hereinbefore stated, it is to be understood that it is merely illustrative of the presently preferred embodiment of the invention and that no limitations are intended to the detail of construction or design herein shown other than as defined in the appended claims.

We claim:

1. In combination with a cable having a tough plastic sheath enclosing a thin metal shield jacket, a mechanically strong high electrical capacity bonding device designed to utilize the strength of a wide area portion of the cable sheath as a backup support for the cable shield in the area thereof embraced by the bonding device and held forcibly compressed together between portions of said bonding device, said device comprising a wide U-shaped sheet metal clip having an aligned pair of openings through the legs thereof, a multiplicity of sharp burrs projecting toward one another from the inner faces of each of said legs about said aligned openings, said cable sheath and shield having aligned openings therethrough near an edge thereof, said clip embracing the edge of said cable sheath and shield with the openings thereof aligned with the intervening openings in said sheath and shield, and clamping stud means assembled through all of said aligned openings holding wide areas of said sheath and shield forcibly compressed together between the legs of said clip with the sharp burrs on one leg penetrating into said sheath and the sharp burrs on the other leg penetrating into said shield to make multiple electrical contacts therewith, and a conductive grounding member securely connected to said clip.

2. The combination defined in claim 1 characterized in that said stud means is permanently secured within the opening in one of said clip legs with its other end extending through the aligned openings in said sheath, shield and the other leg of said clip.

3. The combination defined in claim 1 characterized in that said stud means is threaded and provided with a clamping nut for holding said grounding conductor and said clip detachably assembled to said cable sheath and shield.

4. That method of electrically and mechanically terminating the end of a shielded electrical cable to an anchorage therefor which comprises: slitting the end of the cable sheath and shield lengthwise from the end of the cable, perforating the flattened sheath and shield inwardly from the edge thereof to receive fastener stud means, placing a U-shaped conductive clip astride said sheath edge which clip is provided with sharp burrs projecting from the inner surface thereof, and clamping said legs against said sheath and shield and a conductive grounded anchorage for the cable by said fastener stud means passing through said legs and said perforation through the shield and sheath to force said burrs to penetrate into said cable shield.

5. That method defined in claim 4 characterized in the step of anchoring said cable sheath to terminal strip means having a plurality of conductive terminals for individual ones of the cable conductors.

6. That method defined in claim 4 characterized in the step of utilizing a U-shaped clip having sharp burrs

along the inner side of each leg thereof, and compressing the burrs in one leg thereof into the cable shield and the burrs in the other leg thereof into the cable sheath as said fastener stud means is forcibly tightened.

7. That method defined in claim 4 characterized in the step of slitting the shields and sheaths of a pair of electrical cables to facilitate expansion of a length of the sheath and shield of each away from the cable conductors, forming aligned holes through the shield and sheath of each of said cables spaced inwardly of an edge of each, superimposing the expanded sheaths of said cables against one another with their shilds facing outwardly and with said holes in registry, placing a stud-equipped U-shaped conductive clip astride said shields and sheaths and inserting said stud through said holes and the legs of said clip, providing the inner surfaces of said clip legs with sharp burrs, and clamping said legs together by tightening nut means assembles to said stud threby to force said burrs to penetrate into the juxtaposed one of said cable shields.

8. That method defined in claim 7 characterized in the step of utilizing said stud to clamp said clip and said cable ends to a fixed anchorage for said cables.

9. That method defined in claim 7 characterized in the step of connecting a conductive grounding member to said clip thereby to ground each of said cable shields.

10. That method of mechanically connecting two cable ends together and simultaneously electrically bonding the cable electrical shields to one another which comprises: slitting the cable shields and sheaths and flattening the same with their sheaths against one another and their shields facing outwardly, forming a hole inwardly of the edge of each of said shields and sheaths, placing a conductive clip astride said edges which clip has burrs facing toward one another along the inner surfaces of each leg, clamping said legs forcibly against said sheaths and shields by tightening fastener means assembled through said legs and said holes as said burrs penetrate said shields.

11. That method of providing a high-capacity high-strength bonding connection to the normally concealed shield jackets of a shielded cable which comprises: opening the cable sheath and shield from one end thereof to expose the conductors and permit flattening a short length of the sheath and shield; perforating said sheath and shield inwardly from the edge thereof to provide a pair of aligned openings; sandwiching the perforated portions of said sheath and shield between the legs of wide area U-shaped conductive strap means provided with a plurality of perforations having sharp burrs along the rims thereof and distributed about openings through said legs aligned with said pair of openings through said shield jacket and sheath; and utilizing high strength conductive fastener means extending through said aligned openings and the terminal end of a grounding conductors to clamp said conductor, said shield, said conductive means and said sheath immovably together with said sharp burrs penetrating the adjacent surface of said shield.

12. That method defined in claim 11 characterized in the step of providing said conductive strap means with a set of sharp burrs on each leg thereof so disposed that one set penetrates the juxtaposed surface of said shield and the other set of which penetrates the juxtaposed surface of said sheath as said fastener means is tightened to compress said conductive means against the intervening portions of said sheath and shield.

13. That method defined in claim 11 characterized in the step of utilizing said fastener means to anchor said sheath and shield to an anchorage for said cable.

14. That method defined in claim 11 characterized in the step of utilizing fastener means of the type having a threaded shank and a threaded nut mateable therewith.

15. That method defined in claim 11 characterized in the steps of forming aligned openings in the free ends of the legs of said U-shaped strap means and providing the adjacent inner faces of said strap means in the area surrounding said aligned openings with a multiplicity of sharp burrs effective to penetrate into said sheath and shield as said U-shaped strap means is compressed by said fastener means.

16. That method of providing a high strength electrical and mechanical connection with the shielding jacket of a sheath-enclosed shielded cable which comprises: opening the non-conductive cable sheath and the underlying conductive shield to expose the cable conductors and to provide access to the shield, forming aligned openings through said sheath and shield inwardly from the edge thereof to accommodate fastener means, straddling the expanded end portions of said sheath and shield with a wide U-shaped clip having a multiplicity of sharp burrs protruding from the surface of the clip leg closest to the shield, clamping the legs of said clip tightly over the opposite ends of said aligned openings by conductive fastener means inserted through said aligned openings and the legs of said clip, thereby forcing said multiplicity of sharp burrs to penetrate the surface of said shield as said clip legs are clamped compressively against said shield and cable sheath by said fastener means.

17. That method defined in claim 16 characterized in the step of utilizing said fastener means additionally to anchor a heavy gauge grounding conductor to said fastener and to said U-shaped clip.

18. That method defined in claim 17 characterized in the step of utilizing said fastener means additionally to clamp said cable sheath and shield firmly to support means.

19. That method of anchoring a shielded cable to a fixed ground support which comprises: opening a length of the cable sheath and shield from one end to form a flattened anchor tab for the cable lying along one side thereof, forming aligned openings through the portion of said cable sheath and shield forming said anchor tab inwardly from the edge thereof, assembling the openings in said flattened anchor tab over conductive grounded fastener stud means passing through said fixed support with a portion of said shield closely adjacent said stud means in contact with a plurality of sharp conductive burrs, tightening said fastener means to compress said sheath and to force said burrs to penetrate into said shield and provide a high strength large-area anchorage of said flattened anchor tab to said fixed support and a multi-contact pressurized electrical connection between said shield and said grounded support.

20. That method defined in claim 19 characterized in the step of assembling large area conductive plate means over said fastener means and formed with a multiplicity of sharp burrs on one face thereof facing toward the surface of said shield in the area surrounding the opening for said fastener means, and tightening said fastener means to clamp said plate means between said shield and a portion of said fastener means which is grounded.

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