

Dec. 13, 1960

A. I. APPLETON ET AL

2,964,437

MINERAL INSULATED CABLE FITTING

Filed April 19, 1957

2 Sheets-Sheet 1

Fig. 1

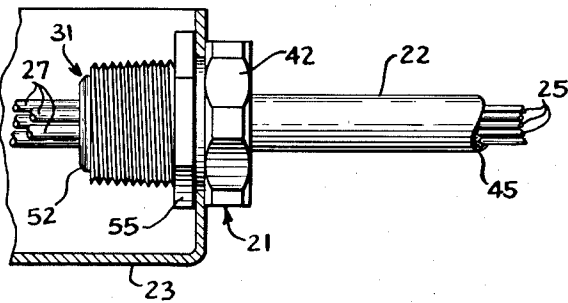


Fig. 2

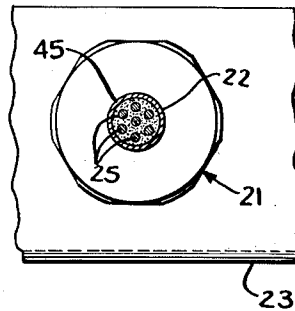


Fig. 3

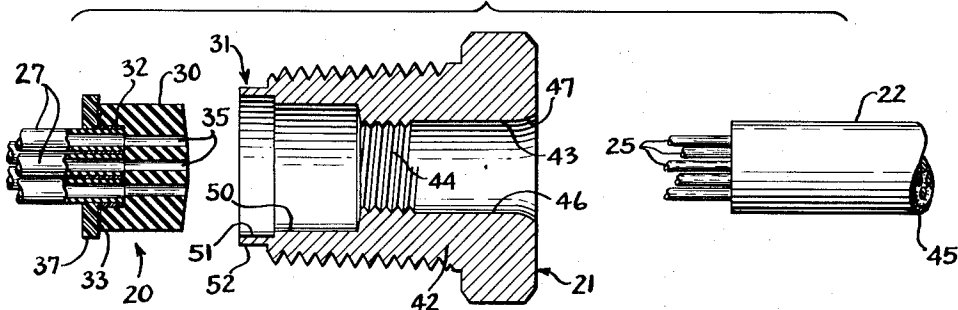
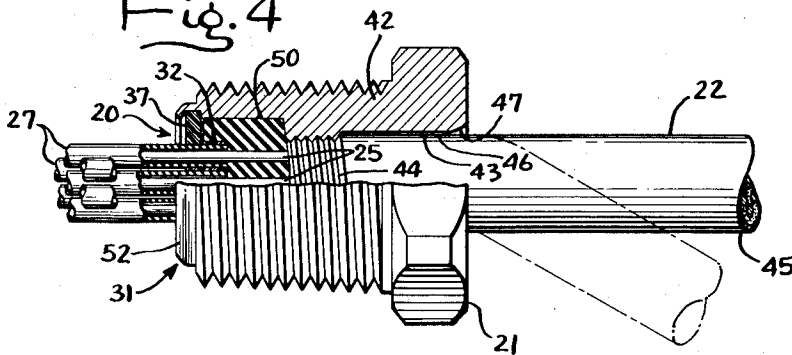


Fig. 4



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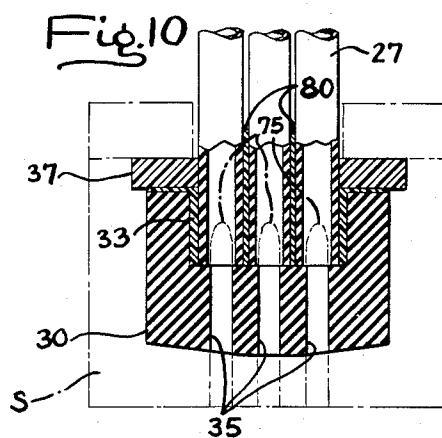
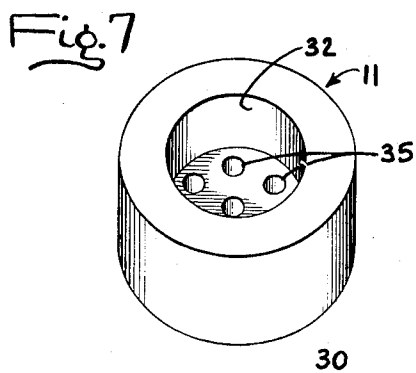
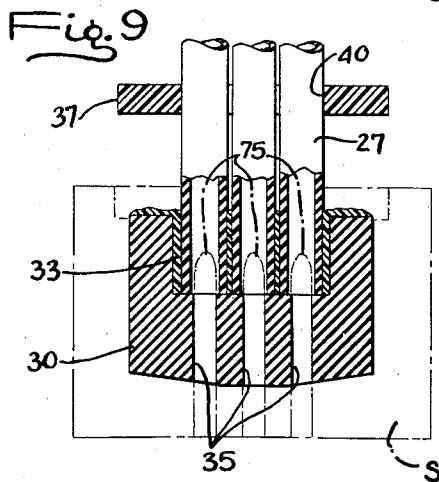
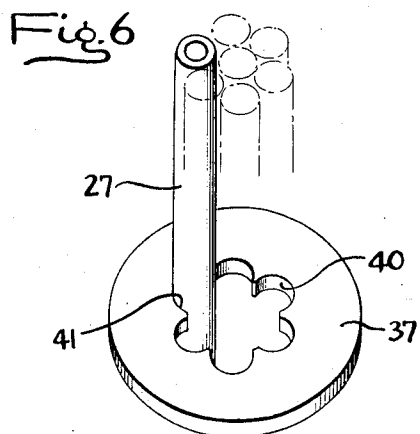
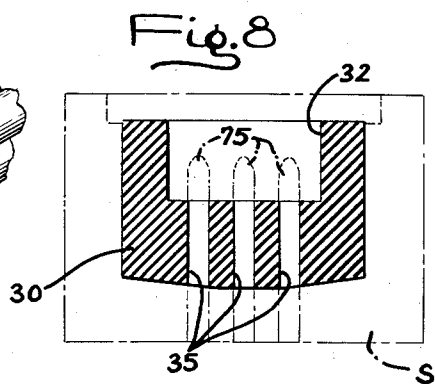
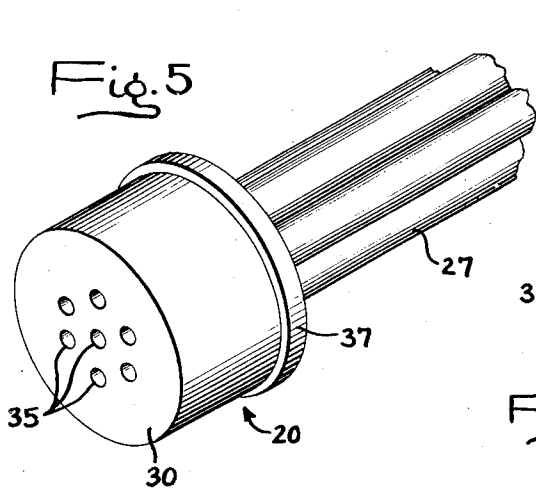
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2,964,437

MINERAL INSULATED CABLE FITTING

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2 Claims. (Cl. 154—2.23)

This invention relates in general to a method of preparing a sealing element for mineral insulated cable fittings. The product of this invention is particularly suited for use in a fitting of the type described in application Serial No. 495,244, filed March 18, 1955, now Patent No. 2,856,452, entitled Sealing Means for Mineral Insulated Cable Fittings, of which this disclosure is a continuation-in-part.

The expression "mineral insulated sheathed cable" as used herein, connotes a type of electrical cable or conduit comprising a seamless, tubular metallic sheath which houses one or more conductors, the latter being maintained in installation relation to each other and to the sheath by an inert mineral substance such as powdered magnesium oxide. This type of cable possesses many highly advantageous qualities, such as resistance to moisture and various fluids, high resistance to heat and to extremes of temperature, compactness with extremely high current carrying capacity, and mechanical flexibility. Largely because of these qualities, mineral insulated cable is often used in installations where it is subject to moisture, fluids or vapors. To adapt it for such installations, it is necessary that terminal fittings be applied to the ends of the cable and so constructed as to be fluid-tight. To accommodate the cable for application of the fitting, the last few inches of the tubular sheath and the mineral insulation associated therewith are first removed, exposing the bare end portions of the conductors.

For effecting a fluid-tight connection between the fitting body and the exterior of the cable sheath, in general two methods have been followed. According to the first method, free material which can be powdered mineral insulation, or an insulating putty, is packed in the fitting around the bared conductors. The other method has been to use a resilient, insulating sealing plug held in place in the fitting by some mechanical device. With either method, insulating sleeves may be used to protect and further insulate the bared conductors. Heretofore, difficulty has been experienced with the first method in retaining the insulating material properly packed in place; in shifting of the bared conductors so that short circuits occur; in that the fitting is complicated and time-consuming to assemble; and in that the material is messy and difficult to work with. With the latter method, the major problems lie with obtaining a satisfactory seal to prevent the entrance of fluid, moisture and vapors; and finding a resilient material which is not subject to excessive shrinkage, swelling, moisture absorption, or change in physical as well as electrical properties as a result of use under adverse conditions over a long period. Where insulating sleeves have been employed, heretofore, considerable difficulty has been experienced both in obtaining an adequate bond or lock to anchor the sleeve in place within the fitting at the time of assembly, and in obtaining a permanent bond which will not be weakened as a result of bending or twisting the insulating sleeves during installation of the terminal fitting on a fixture or in a subsequent period of use of the fixture.

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It is a general object of the invention to provide an improved sealing means for a mineral insulated cable terminal fitting, in the form of a sealing element which avoids these difficulties, is inexpensive to manufacture, has long life at specified temperatures, and is easily installed in a fitting.

More specifically, it is an object of this invention to provide a sealing element for a fitting of the type described, embodying a plug of resilient insulating material which functions to seal the fitting against the entrance of fluids and vapors and provides adequate electrical insulation, insulating sleeves which are adapted to receive the bared conductors for protecting and further electrically insulating them, and a bonding material by means of which the sleeves are bonded to the plug so as to anchor the sleeves in place when the sealing element is assembled within the fitting.

Another object of the invention is to provide a method of manufacture of the sealing element wherein the product may be expeditiously made.

Other objects and advantages will become apparent as the following description proceeds, taken in connection with the accompanying drawings, wherein:

Figure 1 is a side elevation of an exemplary assembled fitting having a sealing element embodying the invention and shown as terminating a mineral insulated cable in a junction box or the like;

Fig. 2 is a vertical section taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged exploded longitudinal sectional view illustrating details of the fitting of Fig. 1 and the sealing element used therein;

Fig. 4 is a sectional view similar to Fig. 3 and showing the parts in assembled relation;

Fig. 5 is a view in perspective of the sealing element used in the fitting of Figs. 1—4;

Figs. 6 and 7 are views in perspective illustrating the separate parts of the sealing element in unassembled form and together comprise an exploded view of the parts of the elements; and

Figs. 8, 9 and 10 are diagrammatic views illustrating the successive manufacturing steps involved in making the completed product illustrated in Figure 5.

While the invention is susceptible of various modifications and alternative constructions, illustrative forms have been shown in the drawings and will be described below in detail. It is to be understood, however, that there is no intention to limit the invention to the specific forms disclosed but, on the contrary, the invention covers all modifications, alternative constructions and equivalents falling within the spirit and scope thereof as expressed in the appended claims.

Referring to Figures 1—4, a sealing element 20 is illustrated, constructed in accordance with the present invention and adapted to be used, for example, in a terminal fitting 21 for mineral insulated cable. This fitting 21 applied to a mineral insulated sheathed cable 22, is mounted in one knock-out of a junction, switch, or outlet box 23 and serves as a connector bringing the end of the cable 22 into the box. The bared end portions of the conductors 25, in extending for electrical connection to switch contacts, tie points, or other electrical apparatus in the box, are protected by means of insulator sleeves 27 which are part of the sealing element 20. These insulating sleeves are bonded to a plug 30 which is secured within the fitting 21 by means of crimping the wall material of the fitting at one end 31, in the present instance. Thus, the sealing element 20 is effective to seal the fitting against the entrance of moisture and various fluids and at the same time electrically insulates the conductors.

In accordance with the invention, the plug 30 (Figs.

5-7) of the sealing element 20 is formed at one end with a large diameter cavity or hole 32 within which the ends of a cluster of insulating sleeves 27 are received to be locked in place by means of a bonding material 33. This plug 30 is preferably molded from a relatively soft plastic material such as neoprene, having a durometer reading of about 50. The insulating sleeves are preferably made from vinyl. "Flexite 105-C," available from L. Frank Markel and Co., has been used. The bonding material 33, when set, bonds the sleeves 27 and the plug 30 into a unitary resinous mass as shown in Figs. 5-7. For a low temperature rating (105° C.), a temperature range for which the neoprene plug and vinyl sleeves are satisfactory, the bonding material is preferably catalyzed activated epoxy resin, which is available in liquid form, plus a suitable activator such as Armstrong's "Activator E." To lead conductors 25, from a cable 22 into the sleeves 27, the solid end of the plug 30 receives a plurality of conductor-size holes 35 extending axially thereof, all of which open into the large hole 32 in the plug. In the present instance, the large hole is of such a size as to receive the cluster of sleeves 27, and the individual insulating sleeves are aligned in register with the smaller holes 35 formed in the solid end of the plug. The number of insulating sleeves, and likewise the number of conductor holes in the solid end of the plug vary with the particular fitting and depend upon the number of conductors in the mineral insulated cable for which the fitting is intended.

Over the cavity end of the plug 30, and surrounding the cluster of insulating sleeves, the present invention provides an annular insulating washer 37 preferably made of relatively non-compressible, non-absorbent material so as to transmit forces from the crimped edge of the fitting to deform the plug. A low temperature rated material which has been used for the washer is fiber, for example, phenolic laminate of glass, wood or corn fibers. As shown in Fig. 6, the inner edge of the washer 37 is scalloped, the individual curved indentations 40 being generally circular and conforming to the diameter of the insulating sleeves, a typical one 41 of which is shown in place within a particular indentation 40. The washer 37 thus aids in locating the outermost sleeves of the cluster, those which contact the washer, in register with particular conductor-size holes extending through the solid part of the plug, and the non-compressibility or rigidity of the washer aids in reaching this result. In forming the bond between the plug 30, the insulating sleeves 27, and the washer 37, the liquid adhesive 33 which is used as the bonding material completely fills the crevices and interstices between the insulating sleeves and the bottom and side walls of the cavity in the plug.

Referring again to Figs. 1-4, the assembled fitting 21 with the sealing element 20 in place is shown to comprise a fitting body 42 with a longitudinal cable-receiving passage 43. Adjacent the innermost end of the latter, there are a plurality of self-cutting threads 44 which adapt the fitting to screw onto the cable sheath 45 upon rotation of the fitting body in the proper direction. The unthreaded portion 46 of the passage 43 is of only slightly larger diameter than the cable sheath 45 and telescopically receives the sheath without excessive clearance. When engaged with the cable sheath, the threads 44 afford not only a good mechanical anchorage for the same, but also create a fluid-tight connection between the sheath and the body. In addition, the threads 44 provide a highly satisfactory electrical connection which amply assures the ground continuity of the wiring system.

That part of the fitting from which the cable extends after all the elements are assembled, is formed in a manner to permit the cable to be curved or bent at the region of its emergence from the fitting without any attendant tearing or cutting of the cable sheath. In accomplishing this, the mouth from the cable sheath extends is smoothly chamfered or flared to form in effect

a "bell mouth." As shown in these figures, the right-hand end of the passage 43 through the body 42 is smoothly flared outwardly as at 47 to form the bell mouth.

With the end of the cable sheath 45 gripped in the threads 44, the exposed cable conductors 25, extend through the opposite end of the passage 43. It becomes desirable to seal off the end of the sheath 45 so that moisture cannot enter the dry mineral powder therein, yet at the same time to seal around and insulate the conductors. For this purpose, the passage 43, which is of relatively small diameter at its right end portion and which contains the self-cutting threads 44 on its medial portion, is made of larger cross-section or diameter at its left end portion, thereby defining a sealing well 50. This well, as shown, has an axial length and a diameter indicated respectively by the dimensions *a* and *b*. At the outer end or mouth of the sealing well 50, its inner wall is radially stepped to create a recess 51, the inner surface of which is continued as a part of an axially extending, deformable retainer skirt 52 which forms a wall and surrounds the sealing well mouth. The sealing element 20 of this invention is sized to fit within the sealing well 50 of the fitting, and thus its outer diameter is just slightly less than the diameter of the sealing well. The length of the sealing element 20 is such that in unassembled form, the outer face of the washer 37 lies slightly inside the very end of the skirt 52 which defines the wall of the sealing well. Thus this skirt may be turned transversely or crimped radially inward to engage the washer 37 and hold the sealing element in place within the cavity or sealing well 50. Deformation of the skirt inwardly over the washer 37 results in compression of the sealing element 20 in all directions so that it then has snug, fluid-tight engagement with the walls of the sealing well or cavity and with the conductors themselves.

In order to make certain that the inner end of the resilient plug of the sealing element 20 makes firm sealing contact with the end of the sheath 45 (even though the latter is spaced slightly inwardly of the bottom of the cavity or well 50), the inner end of the plug is given a curved or rounded shape as shown in Figs. 8-10. Thus when the sealing element is axially compressed, its inner end will project into the passage 42 to abut the end of the cable sheath 45.

To install the fitting 21 on the cable, as mentioned hereinbefore, the first step is to remove the last several inches of the sheath, the fitting body is then slipped over the exposed conductors and the remaining end portion of the sheath. The latter enters the body passage 43 and ultimately encounters the threads 44. The unthreaded portion 46 of this passage 43 guides the cable sheath and the fitting body so as to insure proper starting of the threads for coaxial threaded engagement of the end of the sheath.

The stripped conductors 25, which extend completely through the fitting body, are then inserted into the respective holes in the solid end of the plug of the sealing element. In this manner the sealing element is slid over the exposed conductors so that the latter enter the insulating sleeves 27, the plug ultimately being inserted axially into the sealing well 50 in the fitting. The sealing element slips freely into the well inasmuch as it is just slightly smaller in diameter. Next, the skirt 52 is subjected to radial deformation so as to move axially against the outer face of the washer 37. For this purpose, a crimping tool of the type disclosed and claimed in co-pending application of Arthur I. Appleton, Serial No. 435,331, filed September 10, 1954, may be employed. This deformation of the skirt 52 shifts the sealing element axially inward until it seats firmly in the sealing well and as an incident thereto compresses the resilient plug. The plug is therefore snugly engaged at its inner end against the end of the sheath

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45. But such axial compression of the resilient plug also tends to make it expand radially so that, in effect, the plug "flows" into every available space within the cavity in the fitting, the compressive stress placed upon it resulting in snug, fluid-tight engagement with the walls thereof. With that, the assembly of the fluid-tight fitting is complete. It will be apparent, of course, that disassembly may be accomplished in the reverse sequence after spreading the skirt 52 back in its axial position or cutting it from the body. The resilient sealing element may be used over and over with different fittings.

After the fitting 21 has been attached to the cable in the manner just set forth, the installation may be completed by thrusting the inner end of the fitting through one knock-out aperture of the box and applying a lock nut 55. The latter simply draws the two engaging portions of the fitting snugly against the outer face of the box wall.

Further in accordance with the invention, the sealing element 20 may be formed in the following manner. The individual parts of the element shown unassembled in Figs. 6 and 7, include the plug 30, the insulating sleeves 27 and the washer 37.

As shown in Fig. 8, the plug 30 is preferably placed upright on a support indicated diagrammatically at S over a plurality of pins 75 which penetrate through the axial holes 35 in the plug, to extend into the large hole 32 which in that position of the plug appears exposed. These pins 75, which may be made of Teflon, are somewhat oversize with relation to the conductor-size holes 35 in order to seal the entrance to these holes against the entry of liquid adhesive which is used to bond the insulating sleeves to the plug.

Lengths of insulating material 27 in the form of sleeves are then slipped over the upper ends of the pins 75 and slid down to a position a short distance away from the bottom of the large hole 32 in the end of the plug. By so locating the insulating sleeves with a short distance between the ends thereof and the bottom of the hole in the plug, there is sufficient space left to provide a temporary reservoir for liquid adhesive. The number of pins 75 which are mounted on the support or fixture correspond with the number of axial openings 35 in the plug. As illustrated in Figure 1, the plug 30 may have seven openings, or the number may be larger or smaller depending upon the requirements of the particular terminal fitting involved.

Following the step of forcing the insulating sleeves 27 on the pins, liquid adhesive 33 is then applied under the ends of the insulating sleeves 27 in the lower region of the hole 32 in the plug 30 where the reservoir is then extant. A certain amount of adhesive is also spread on the upper flat annular surface of the end of the plug 30 which at this stage of the process lies exposed as illustrated in Figs. 8 and 9 of the drawings.

The liquid adhesive which is used must have the property of remaining free flowing for only a short period so as to enable its placement as described hereinbefore. Moreover, the adhesive when dried and cured must bond to the sleeves 27 and the plug 30. Depending on the material used for these parts, different adhesives may be employed, however, as specified hereinbefore, an epoxy resin in liquid form has been used.

While the adhesive 33 remains in liquid form, to insure that the circumference of each of the insulating sleeves 27 is completely coated, the sleeves are turned as they then are forced down on the pins 75 and brought into abutment with the bottom of the plug cavity 32. Each of the sleeves is so moved until the entire cluster is seated against the bottom of the plug cavity so as to form the continuous, uninterrupted axial passages extending through the solid end of the plug and through the respective insulating sleeve interiors. In the course of so moving the insulating sleeves 27, the liquid adhesive is displaced thereby and forced to rise in the spaces be-

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tween the outer surfaces of the sleeves and to spread somewhat laterally on the annular top edge of the edge or end of the plug body. The product in this stage of manufacture is illustrated in Fig. 9, and it will be noted that the liquid adhesive has substantially filled the interstices and crevices between the insulating sleeves and between the same and the walls of the cavity and the plug.

As shown in Fig. 9, the washer 37 is then placed around the sleeves and moved down and forced against the end of the plug. Due to this action, the liquid adhesive spread on the annular end of the plug body, and between the sleeves in the region under the washer, is forced by the plug between the wall of the cavity and the plug and the outer surfaces of the insulating sleeves in such a manner as to further assist in filling the interstices between the sleeves. By reference to Fig. 10, it will also be observed that after all voids have been completely filled, the excess liquid adhesive is forced upwardly between the insulating sleeves 27. By placing sufficient liquid adhesive so that the columns 80 of the bonding material are caused to rise between the insulating sleeves, it may be insured that all voids are eliminated and the sleeves are anchored in place.

With the sealing element 20 in its completely assembled form, the insulating sleeves, washer, and plug are bonded into a unitary, resinous mass by the liquid adhesive which is dried and at least partially cured in high temperature ovens in a final processing step. After this baking step, the sealing element 20 may be removed from the support S, and in the process of doing this pulled off the pins 75. It is then ready for use in a terminal fitting 21 of the type shown in Figs. 1-4 or in an equivalent fitting designed to employ this sealing element.

We claim as our invention:

1. The method of making a sealing element for a mineral insulated cable terminal fitting, which comprises bonding a cluster of insulating sleeves to a plug of resilient, insulating material having a relatively large opening at one end of a size for receiving the cluster of sleeves and a conductor size hole for each sleeve in the cluster extending from the large opening by first inserting pins in the conductor size holes so that they form a cluster extending into the large opening, secondly aligning the sleeves adjacent one another by sliding them over the exposed ends of the pins until the sleeve ends are closely spaced from the bottom of the opening in the plug, thirdly applying liquid adhesive in the space between the sleeves and the bottom of the opening, next turning the sleeves in place in the opening to coat the ends circumferentially thereof and retaining the same alinement, at the same time forcing the sleeves to the bottom of the opening in the plug to force liquid adhesive between the sleeves and towards the said one end of the plug, and thereafter sliding a washer encircling the plurality of sleeves against the end of the plug to force the liquid adhesive in the opening into the crevices and interstices between the sleeves to provide a voidless bond between the plug, the cluster of insulating sleeves, and the washer.

2. The method of making a sealing element for a mineral insulated cable terminal fitting, which comprises bonding an insulating sleeve to a plug of resilient, insulating material having a relatively large diameter hole at one end of a size substantially larger than the sleeve and a conductor size hole extending from the large diameter hole by first inserting a pin in the conductor size hole so that it extends into the large diameter hole, secondly aligning the sleeve with the conductor size hole by sliding it over the exposed end of the pin until the sleeve is closely spaced from the bottom of the hole in the plug, thirdly applying liquid adhesive in the space at the bottom of said large diameter hole, next turning the sleeve in place to coat the end circumferentially thereof and at the same time forcing the sleeve to the bottom of said large diameter hole to force liquid adhesive from

the space around the sleeve and toward the end surface of the plug, and thereafter sliding a washer which encircles the sleeve against the end of the plug to force the liquid adhesive around the sleeve into the crevices between the sleeve and the walls of the opening in the plug, so that said adhesive when set provides a voidless bond between the plug, the insulating sleeve, and the washer.

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References Cited in the file of this patent

UNITED STATES PATENTS

2,856,452 Appleton et al. Oct. 14, 1958

FOREIGN PATENTS

481,856 Canada Mar. 18, 1952

701,562 Great Britain Dec. 30, 1953