Oct. 14, 1958 A. I. APPLETON ET AL 2,856,452

SEALING MEANS FOR MINERAL INSULATED CABLE FITTINGS

Filed March 18, 1955 2 Sheets-Sheet 1

Fig 1

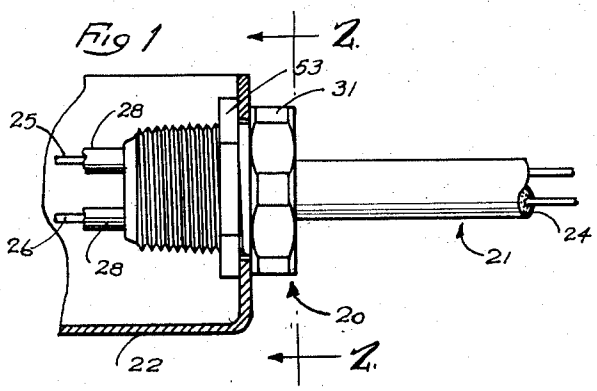


Fig 2

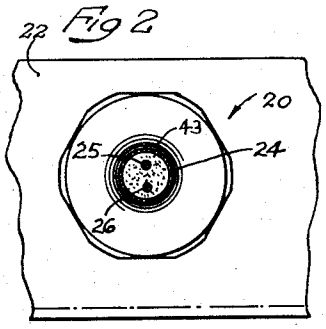
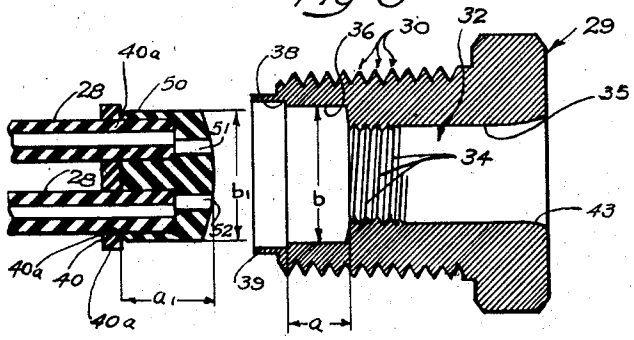


Fig 3



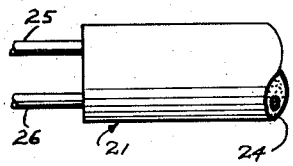
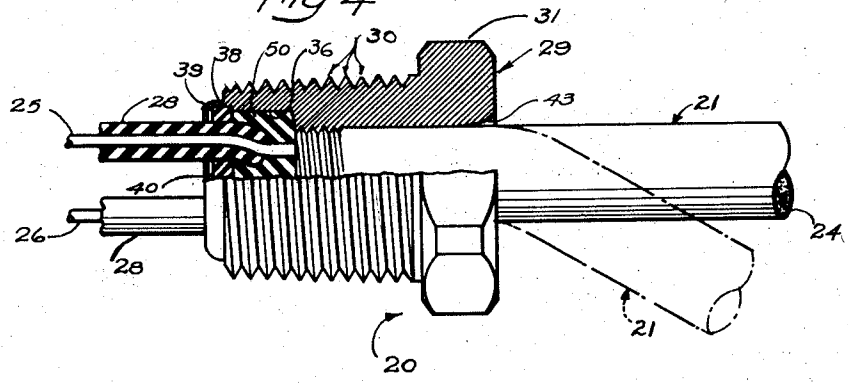


Fig 4



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SEALING MEANS FOR MINERAL INSULATED CABLE FITTINGS

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Fig 5

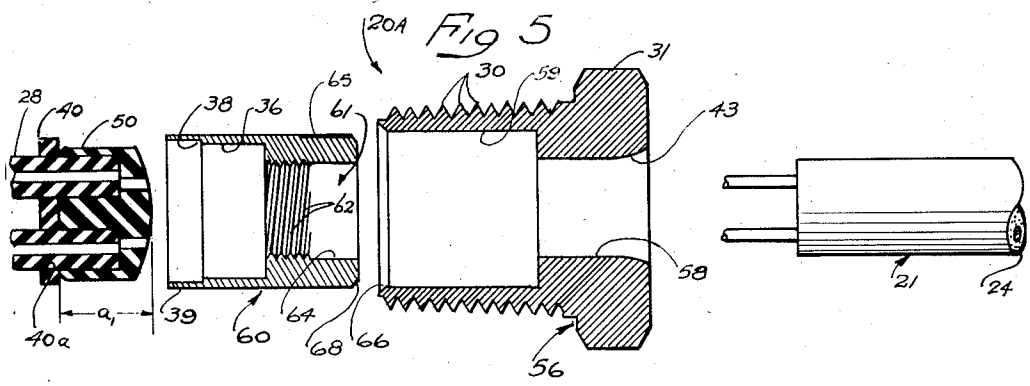


Fig 6

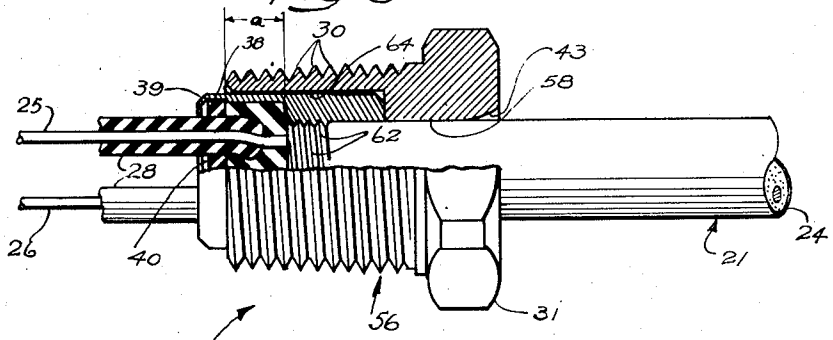


Fig 7

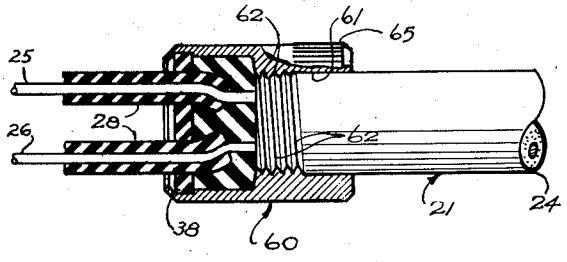


Fig 8

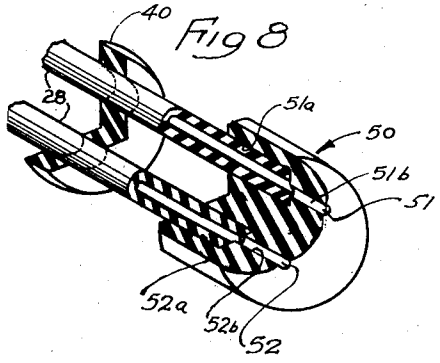


Fig 9

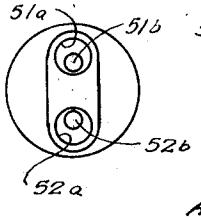
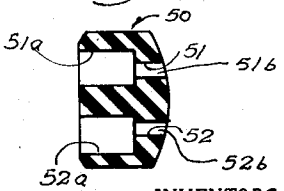


Fig 10



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2,856,452

SEALING MEANS FOR MINERAL INSULATED CABLE FITTINGS

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Application March 18, 1955, Serial No. 495,244

1 Claim. (Cl. 174—77)

The present invention relates in general to fluid-tight fittings for terminating metal-sheathed mineral insulated cables, and in particular to improvements in means for sealing the interior of the cable sheath against the ingress of fluids and vapors.

The instant invention may be viewed as an improvement in terminal fittings for mineral insulated cable of the type disclosed and claimed in the copending application of Arthur I. Appleton, Serial No. 446,475, filed July 29, 1954. The expression "mineral insulated cable," as used herein, connotes a type of electric cable or conduit comprising a seamless tubular metallic sheath which houses one or more conductors, the latter being maintained in insulated 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 subjected to moisture, fluids or the weather. 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.

It is the general aim of the invention to provide sealing means for fittings of the genus disclosed in the above-identified copending application which totally eliminate the necessity of a paste-like sealing compound (which is often awkward to handle in close quarters), yet which more reliably seals the cable sheath against entry of moisture and vapor.

An ancillary object is the provision of sealing means for fluid-tight fittings of the type described which permit such fittings to be readily disassembled after once installed. This was impossible previously with fittings which employed a gummy, hardened insulating paste.

Another object of the invention is to greatly simplify the handling and assembly of the fitting components.

Still another object of the invention is to provide means for effecting a highly reliable seal in a conveniently assembled terminal fitting for mineral insulated cables, but which also affords excellent insulation, immune to deterioration with age, between conductors extending from the terminated cable sheath.

A related object is to provide such a fitting in which the conductors are spaced farther apart when they emerge from the fitting than they are in the cable, and wherein they are anchored against internal movement so as not to disturb the spacing thus established, and promoting the general usability of the fitting.

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

Figure 1 is a side elevation of an exemplary assembled fitting having sealing means 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 in Fig. 1;

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

Fig. 4 is a sectional view similar to Fig. 3 but showing the several components in assembled relation;

Figs. 5 and 6 are similar to Figs. 3 and 4 although showing a second form of terminal fitting utilizing sealing means embodying the invention;

Fig. 7 is a longitudinal section of a fluid-tight head as shown in Figs. 4 and 5, illustrated as assembled on a mineral insulated cable with sealing means of the present invention;

Fig. 8 is a perspective view, partially cut away for clarity, of the sealing member employed in the fittings shown by the previous figures; and

Figs. 9 and 10 are end elevational and longitudinal sectional views of the plug-shaped resilient body employed for sealing purposes.

Although the invention has been shown and is described in some detail with reference to a single embodiment as applied in different kinds of fluid-tight fittings, it is to be understood that there is no intention to thus limit it to such detail. On the contrary, it is intended here to cover all modifications, alterations, and equivalents falling within the spirit and scope of the invention as defined by the appended claim.

Referring more particularly to Figs. 1 through 4, the present invention is embodied in an illustrative fluid-tight fitting 20 applied to a mineral insulated sheathed cable 21. The fitting 20 is mounted in the knock-out aperture of a housing such as a junction, switch, or outlet box 22 and serves as a connector bringing the end of the cable 21 into the box 22. To accommodate the cable 21 for application of the fitting 20, the last few inches of the tubular sheath 24 and the mineral insulation associated therewith are first removed, exposing the bare end portions of the conductors 25, 26. The latter in extending for electrical connection to switch contacts, tie points, or other electrical apparatus in the box are protected by means of insulator sleeves 28.

The improved fitting 20 comprises, in general, a hollow body 29 having external mounting threads 30 and a tool engaging portion 31 which in this case happens to be of hexagonal form. For effecting a fluid-tight seal between the fitting body and the exterior of the cable sheath, sealing means are provided within the body 29; and for effecting a fluid-tight seal between the body and the mineral filled interior of the sheath, while at the same time insulating exposed cable conductors, the sealing means of the present invention are disposed at the left end of the body 29.

For the purpose of receiving the end of the cable sheath 24 remaining after stripping away of the last few inches, the fitting body 29 is formed with a longitudinal cable-receiving passage 32. Adjacent the innermost end of the latter, there are a plurality of self-cutting threads 34 which are adapted to screw onto the cable sheath 24 upon rotation of the fitting body in the proper direction. The unthreaded portion 35 of the passage 32 is of only slightly larger diameter than the cable sheath 24 and telescopically receives the sheath 24 without excessive clearance. When engaged with the cable sheath, the threads 34 afford not only a good mechanical anchorage for the same, but also create a fluid-tight connection between the sheath and fitting body. In addition, the threads 34 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 which the cable sheath extends is smoothly chamered or flared to form in effect a "bell mouth." As shown in the embodiment of Figs. 1–4, the right end of the passage **32** through the body **29** is smoothly flared outwardly as at **43** to form the bell mouth. It has been found, for example, that where the inside diameter of the passage **32** is about .344 inch, a flaring radius of .75 inch for the bell mouth **43** provides the advantages contemplated. If the cable sheath **24** were bent at its end prior to its connection to the fitting the assembly would be more difficult. With the present construction, however, after the fitting is assembled, as in Fig. 4, the cable **21** may be bent or angled to connect with other electrical components located laterally of the fitting axis, the bell mouth **43** creating a smooth curvature of the sheath **24** and preventing either cutting of the sheath on a sharp edge of the body or tearing of the sheath as a result of its being angled too sharply.

With the end of the cable sheath **24** gripped in the threads **34**, the exposed cable conductors **25**, **26** extend through the opposite end of the passageway **32**. It becomes desirable to seal off the end of the sheath **24** 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 passageway **32**, which is of relatively small diameter at its right end portion and which contains the self-cutting threads **34** in its medial portion, is made of larger cross section or diameter at its left end portion, thereby defining a sealing well **36**. 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 **36**, its inner wall is radially stepped to create a recess **38**, the inner surface of which is continued as a part of an axially extending, deformable retainer skirt **39** which surrounds the sealing well mouth. This skirt may be turned transversely or radially inward to engage and hold a retaining disk **40** which is sized to slip into the recess **38**.

Heretofore, it has been the practice to fill the sealing well **36** with an insulating paste or compound which while semi-fluid or after drying excludes moisture or vapor from the end of the cable sheath at the rear of the well. The insulating sleeves **28** were retained in place over the conductors **25**, **26** by virtue of enlarged or bulbous inner ends which could not pass through the openings **40***a* in the cap **40**. This had several disadvantages including the fact that the bulbous ends were difficult and expensive to mold on the sleeves **28**. Secondly, the assembly procedure was time-consuming and messy with the requirement that the well **36** be filled with a paste before the cap **40** was inserted into place, especially where working room was limited. Often, too, excess sealing compound or paste would be squeezed from within the well **36** as the skirt **39** was turned inwardly against the cap **40**. Once the fitting was assembled, it could not be readily disassembled since the removal of the hardened compound was, indeed, a laborious task.

In accordance with the invention, these drawbacks are all overcome by the provision of a resilient, insulating sealing member adapted to be inserted into the sealing well **36** ahead of the cap **40** and in surrounding relation to the spaced conductors **25**, **26**. Deformation of the skirt **39** inwardly over the cap **40** results in compression of the sealing member in all directions so that it then has snug, fluid-tight, engagement with the walls of the sealing well and with the conductors themselves. Moreover, the insulating sleeves **28** are fixed directly to and become a part of the sealing member so that they need not be handled as separate components nor independently retained in place by means such as bulbous formations on their ends.

As here illustrated in Figs. 3, 4, 8, 9 and 10, the sealing member is made as a plug-shaped body **50** of a resilient, deformable material such, for example, as rubber, synthetic rubber, or a plastic such as neoprene which has rubber-like qualities and which does not deteriorate with age. As illustrated in Fig. 3, the plug-shaped body is preferably made axially longer than the length of the sealing well **36**, having when undeformed an axial length indicated by the dimension a_1 which is greater than the dimension *a*. Also, the body **50** when undeformed is preferably very slightly smaller in cross section or diameter than the sealing well **36** so that it will be readily insertable into the latter. The diameter of the body **50**, as shown by the dimension b_1 is slightly less, therefore, than the diameter *b* of the sealing well **36**.

Depending upon the number of conductors extending from the particular mineral insulated cable employed in any given case, the plug-shaped body is formed to have at least one axial hole therethrough, and in the present case, is illustrated with two axial holes **51**, **52** extending from end to end to receive the conductors **25**, **26** therein. For receiving the ends of the respective insulating sleeves **28**, these two holes have enlarged or counterbored portions **51***a*, **52***a* at their left ends. With the ends of these sleeves **28** inserted as shown, they may be made fast in the enlarged portions **51***a*, **52***a* by any means, e. g., thermal fusion or a separate gluing agent. It will also be apparent that the sleeves **28** and the resilient body **50** may be molded as one integral subassembly if it is so desired. In any case, with the body **50** and the sleeves fixed together as a unit, assembly is greatly simplified, since the retaining cap **40** may be slipped over the sleeves **28** (with the latter entering the two spaced openings **40***a* in the cap) so that the cap **40**, sleeves **28**, and body **50** become a sub-assembly (see Fig. 3) conveniently handled as one piece when the fitting is being installed.

In many instances the conductors **25**, **26** are so closely spaced from one another within the cable sheath **24** (because the mineral powder is such an excellent insulator), that it is desirable to give them a greater separation at the point where they depart from the sheath. It is for this reason that the sealing well **36** is made of larger diameter than the remaining portions of the passageway **32**. Moreover, this gives a larger size to the resilient body **50** and permits greater compression forces for sealing purposes to be created therein. In order to leave a separating wall in the body **50** between the larger hole portions **51***a*, **52***a*, and to effect this wider separation of the conductors **25**, **26**, the smaller portions **51***b* and **52***b* of the two holes **51**, **52** are eccentrically located relative to the larger portions. Fig. 10 illustrates that the larger and smaller portions of the two holes are not exactly coaxial, but are eccentrically disposed so that the smaller portions are spaced apart a distance agreeing with the spacing of the conductors within the cable sheath **24**. As the conductors are slipped through the smaller hole portions **51***b*, **52***b*, they simply compress slightly one side of the insulating sleeves **28** and then bend to be spread apart to project through the sealing well with slightly greater spacing.

In order to make certain that the inner end of the resilient body **50** makes firm sealing contact with the end of the sheath **24** (even though the latter is spaced slightly inwardly of the bottom of the well **36**), the inner end of the body is given a curved or rounded shape as shown in Fig. 10. Thus, when the body **50** is axially compressed, its inner end will project into the passage **32** to abut the end of the cable sheath **24**.

To install the fitting **20** on the cable **21**, the first step is to remove the last few inches of the sheath **24** as mentioned earlier herein, taking care to avoid raggedness or burrs on the end of the sheath **24** which remains. The

fitting body 29 is slipped over the exposed conductors 25, 26 and the remaining end portion of the cable sheath 24. The latter enters the body passage 32 and ultimately encounters the threads 34. The unthreaded portion 35 of the passage 32 guides the cable sheath and the fitting body so as to insure proper starting of the threads 34 for coaxial threaded engagement with the end of the sheath 24. Such threaded engagement is brought about by holding the cable sheath 24 and turning or screwing the fitting body 29 in the proper direction until the end of the sheath 24 is approximately flush with the bottom of the sealing well 36, as shown in Fig. 4.

The stripped conductors 25, 26 which extend completely through the body 29 are then inserted into the respective holes 51, 52 in the plug-shaped body 50. The latter at this time carries the insulating sleeves 28 fixed integrally thereto as by bonding within the larger hole portions 51*a*, 52*a*. The retaining cap 40, also, has been previously slipped over the sleeves 28 to complete the sub-assembly which is manipulated as a unit. Thus, the body 50 is slid over the exposed conductors so that the latter enter the sleeves 28, the body ultimately being inserted axially into the sealing well 36. The plug-shaped body slips freely into the well inasmuch as it is just slightly smaller in diameter. As an incident to this, the retaining cap 40 is also disposed in the recess 38, although not at this time firmly seated therein. Next, the retainer skirt 39 is subjected to radial deformation so as to bear axially against the outer edge of the cap 40. For this purpose, a crimping tool of the type disclosed and claimed in copending application of Arthur I. Appleton, Serial No. 435,331, filed September 10, 1954, is preferably employed. This deformation of the skirt 39 shifts the cap 40 axially inward until it seats firmly in the recess 38 and as an incident thereto axially compresses the plug-shaped body 50. The resilient body is therefore snugly engaged at its inner end against the end of the sheath 24 and at its outer end against the inner surface of the cap 40. But such axial compression of the resilient body also tends to make it expand radially so that, in effect, the body "flows" into every available space within the sealing well 36, the compressive stress placed upon it resulting in snug, fluid-tight engagement with the walls of the sealing well and, likewise, with the bent conductors extending through the fitting. This snug fit with the bent conductors frictionally anchors them in place within the plug-shaped body and thus within the fitting. 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 39 back to its axial position or cutting it from the body. The resilient sealing plug 50, and the attached insulating sleeves, may be used over and over with different fittings.

After the fitting 20 has been attached to the cable 21 in the manner just set forth, the installation may be completed by thrusting the inner end of the fitting through the knock-out aperture of the box 22 and applying a lock nut 53. The latter simply draws the tool engaging portion 31 of the fitting snugly against the outer face of the box wall.

Turning now to Figs. 5 and 6, there is shown another form of fitting 20A which also utilizes effectively the sealing means of the present invention. The fitting 20A finds particular utility in installations where the fitting is mounted by threading the body 29 into the tapped hole of a box or fixture hub. Such an installation makes it highly desirable to avoid direct threaded engagement between the fitting body and the cable sheath. The fitting 20A is designed to fulfill that objective but in other respects it is similar to the fitting 20. In the following description, like reference characters will be applied to parts common to both fittings.

The fitting 20A has a body 56 generally similar to the body 29 of the fitting 20 in that it is provided with mounting threads 30 and a tool engaging portion 31. However, the body 56 has no threaded connection with the cable sheath 24, being provided with a smooth cable receiving passageway 58 terminated at one end in a bell mouth 43 and freely slidable along the cable 21.

Housed within a relatively large, counterbored recess or enlarged portion 59 of the passage 58 is a sealing head 60 (Figs. 5, 6 and 7). The latter is proportioned to slide easily into or out of the recess 59 and is formed with a sealing well 36, cap recess 38, and retainer skirt 39 similar to those associated with the sealing well 36 of the fitting 20. Communicating with the sealing well 36 and situated in the sealing head 60 is a cable-receiving passage 61. Adjacent the well 36, the passage 61 has a plurality of self-cutting threads 62 for entering into threaded engagement with the cable sheath after the manner of the threads 34 of the fitting 20. The passage 61 has an unthreaded portion 64 situated between the self-cutting threads 62 and the bottom or inner end of the sealing head 60. The unthreaded portion 64 is proportioned to make a telescopic fit with the end of the cable sheath 24 and thereby to guide the threads 62 into coaxial threaded engagement with the cable sheath. To facilitate turning of the sealing head 60 during this threading operation, the head 60 may be formed with knurling 65 on its outer peripheral surface. Also, to facilitate entry of the head 60 into the recess 59, the mouth of the recess 59 and the inner edge portion of the sealing head 60 may have chamfers 66, 68.

Starting with the parts in the condition illustrated in Fig. 8, fitting 20A may readily be installed by slipping the fitting body 56 over the end of the cable 21. The exposed conductors 25, 26 and the end of the cable sheath 24 are then introduced into the cable-receiving passage 61 of the sealing head 60 until the cable sheath 24 engages the threads 62. Upon turning of the head 60 in the proper direction, the threads 62, under the guidance of the unthreaded portion 64 of the passage 61, enter into coaxial threaded engagement with the cable sheath, such engagement being completed when the end of the sheath becomes about flush with the bottom of the sealing well 36.

At this point, the sub-assembly comprising the resilient, plug-shaped body 50, the insulating sleeves 28 fixed therein, and the retaining cap 40 slipped over the sleeves, is telescoped over the exposed conductors 25, 26 with the body freely entering the sealing well 36. Then, the retaining cap 40 loosely enters the recess 38 and the skirt 39 is rolled inwardly (Fig. 7), by any suitable means, so as to bear against the cap 40 and shift the latter inwardly to compress the resilient body 50 into sealing engagement with the bounding walls of the sealing well as explained above.

The insulated conductors and sealing head 60 may then be inserted into the tapped hole of a cast junction box (not shown) and the fitting body 56 (turning relative to the head 60) is then screwed into such hole. As such action progresses, the body 56 and the sealing head 60 tend to telescope together, the latter entering into the recess 59. When the body 56 has been fully threaded into the tapped hole the sealing head 60 should be approximately seated in the recess 59, any slight clearance being easily eliminated by a moderate outward pull on the cable 21.

We claim:

A sealed fitting for connecting a multi conductor mineral insulated cable to a housing having an aperture for receipt of the cable, said fitting comprising in combination, a generally cylindrical body having external mounting threads thereon and means defining a cylindrical cable-receiving passage therethrough, said passage being of smaller diameter and having self-cutting threads therein at one end portion to snugly receive and sealingly lock the end of the cable sheath, said passage being of larger diameter at the other end portion to define a sealing well, a generally cylindrical plug of resilient insulating ma-

terial disposed in said sealing well and sized such that when undeformed it is slightly longer but radially smaller than the sealing well, said plug having a plurality of axial holes therein and a plurality of sleeves of insulating material bonded in and extending from said holes, said sleeves being disposed eccentrically with relation to said axial holes so that the sleeves are arranged with greater spacing than the conductors of the cable, the cable conductors extending through said holes and being bent to pass through the eccentrically disposed sleeves, a cap inserted into the mouth of said sealing well, a retainer skirt on said body bordering the mouth of said sealing well and crimped radially inward to hold said cap shifted into the well so that said plug is axially compressed to sealingly engage the walls of the well and into snug engagement with the bent conductors extending through the fitting and frictionally anchoring the same therein, and threaded means cooperating with said mounting threads for locking said body in the housing aperture.

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