Oct. 23, 1962 J. E. BUDOVEC ET AL 3,059,283

METHOD OF MAKING A WATERPROOF TRANSFORMER SEAL

Filed March 31, 1958 2 Sheets-Sheet 1

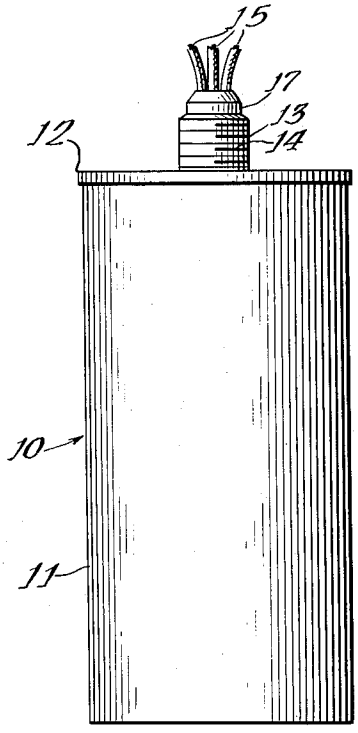



FIG. 1

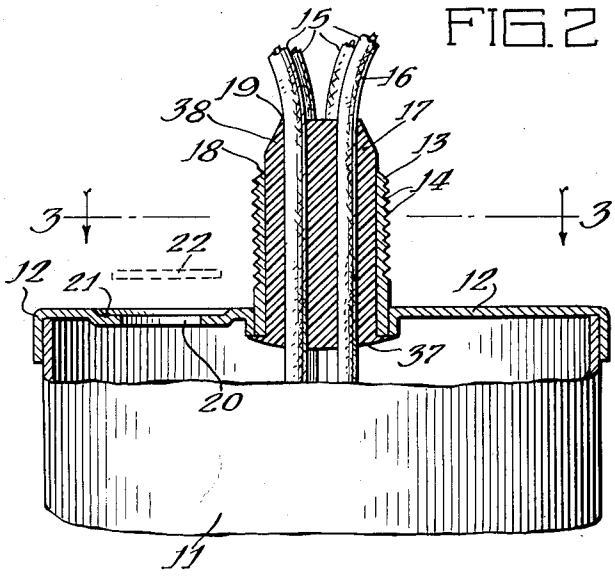



FIG. 2

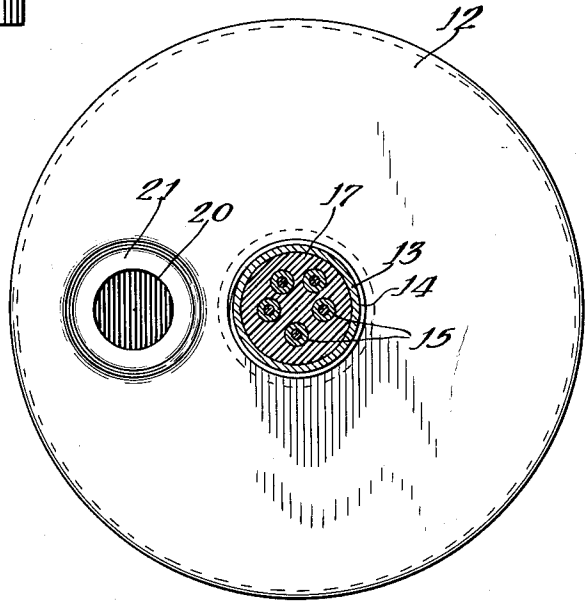



FIG. 3

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FIG. 4

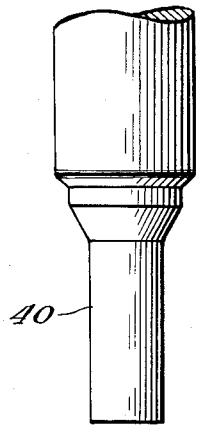



FIG. 5

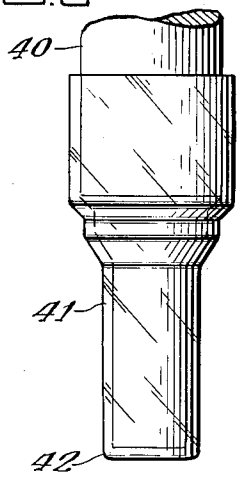



FIG. 6

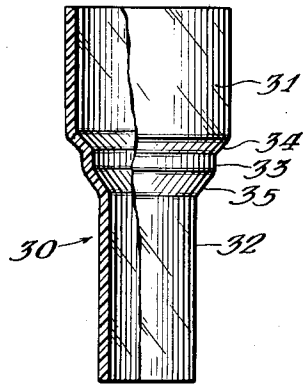



FIG. 8

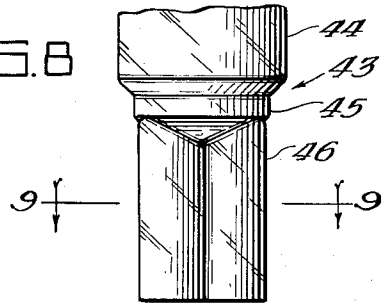



FIG. 9

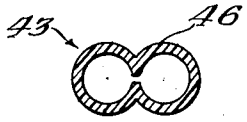
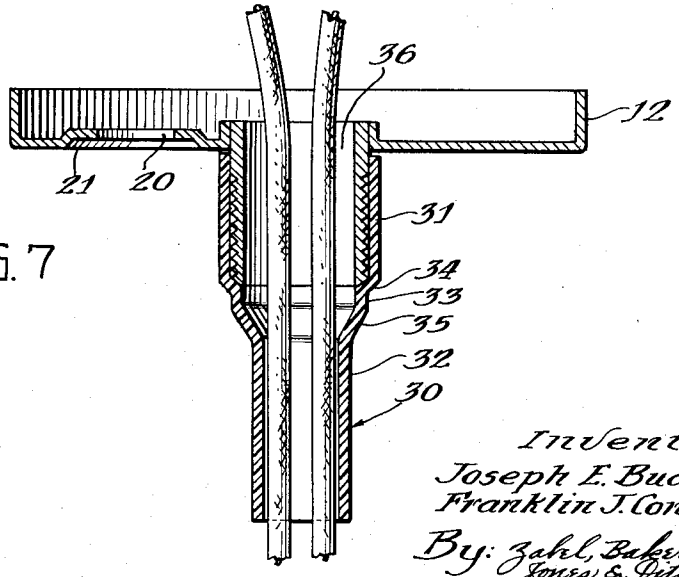



FIG. 7




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# METHOD OF MAKING A WATERPROOF TRANSFORMER SEAL

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3 Claims. (Cl. 18—59)

This invention relates to a method of making a waterproof transformer seal.

In out door installations, it is customary to mount a transformer in a container which may be in the form of either a box-like structure or a cylindrical tank, plus a cover. The cover is provided with a pipe or a nipple, and the transformer leads are brought out through this pipe or nipple. The transformer proper is embedded within the tank or other casing by means of a suitable potting compound. Although the potting compound is water resistant to a certain extent, its physical characteristics are such that it does not form a bond with the sheathing of the transformer leads. Thus, small crevices may open up which permit the introduction of water down into the windings. Therefore, means are customarily provided to seal the leads to the nipple.

Such sealing means as heretofore utilized may comprise a packing gland which is threaded onto the nipple, or it may comprise a boot which fits over the nipple and has a portion which may embrace the leads either separately or collectively, but in either event it is customary to tape the leads to the boot in order to prevent the entry of moisture into the interior of the casing. According to such prior art methods, it is sometimes customary to fill the nipple also with the potting compound. However, the potting compound merely serves to fill up the space and does not act as a seal to any greater extent than if the nipple were not filled. Still another expedient has been to place within the nipple a rubber washer having a separate hole for each lead, then to draw the leads through the holes, and then to pour asphalt in the nipple above the washer.

It is an object of the present invention to seal a transformer cover without the use of auxiliary mechanical means, such as a packing gland, a boot, or a perforated washer.

It is another object to seal a transformer cover with an improved seal which has improved mechanical properties to the end that the transformer as a whole may be lifted or pulled around by the leads without incurring the danger of opening up any cracks or crevices which would destroy the waterproof characteristics of the transformer.

According to the present invention, the foregoing objects are achieved, in part, by providing a transformer cover in which the nipple is filled wtih a reaction setting epoxy resin, the leads being embedded in the resin. The mechanical properties of epoxy resin are such that it forms a bond with the neoprene wire jacketing and also with the metal surfaces which not only prevents the seepage of water along the interfaces, but which is so tenacious that it permits a 50 to 100 pound transformer to be lifted by the leads without opening up any cracks or crevices. Furthermore, the epoxy resin material in itself is a good insulator with the result that there will be no electrical strain between any high voltage leads and the transformer casing or nipple.

Still another object is to provide an improved method of making a seal of the type described which improved method greatly reduces the labor required. According



to this aspect of my invention, the leads and the cover are first assembled separately, and the seal effected by filling the nipple with the epoxy resin. Then the leads are connected to the transformer proper, and the transformer put in the casing at the same time that the cover is placed on the same. Then the casing may be filled with the potting compound through a suitable opening in the cover, which opening is later sealed by a metal disc soldered in place.

Still another object is to provide an improved method of filling the nipple to effect the desired seal in such a manner that the epoxy resin is prevented from running out of the nipple as it is being filled.

One of the problems encountered in effecting a preassembled seal of the precast type is that of plugging up the nipple during the casting or filling operation.

A still further object of my invention is to provide an improved method and means for partially obstructing or plugging the nipple during this filling or casting step, which means can be readily removed after the epoxy resin has set, either before or after heat curing thereof.

Other objects, features and advantages of this invention will become apparent as the description proceeds.

Referring now to the drawings in which like reference numerals designate like parts:

FIG. 1 is an elevation of a transformer manufactured in accordance with this invention;

FIG. 2 is a section of the cover showing the preassembled seal;

FIG. 3 is a plan section taken along line 3—3 of FIG. 2;

FIG. 4 is an elevation of the pattern used in fabricating the strippable mold;

FIG. 5 is a view similar to FIG. 4 but showing the formation of the mold;

FIG. 6 is a view showing the completed mold and after it has been stripped from the pattern and cut;

FIG. 7 is a sectional view of the inverted cover with the strippable mold applied, and showing the relationship of these parts to the leads, as well as the manner in which the strippable mold serves to position the leads and to maintain them out of contact with the metal of the cover;

FIG. 8 is a view similar to FIG. 6, but showing a modified type of mold; and

FIG. 9 is a plan section taken along line 9—9 of FIG. 8.

With reference now to FIGS. 1 to 3, the reference numeral **10** designates a transformer such as a street lighting transformer or ballast of a type which is now in common use for mercury vapor street lights. The transformer comprises the core and windings, not shown, which are disposed within a casing or tank **11** which is provided with a cover **12**. The cover may be suitably sealed to the tank to provide a weatherproof structure, as by brazing, welding or rolling.

The cover is provided with a nipple **13** which may be threaded as indicated at **14**, if desired. The leads **15** for the windings extend through the nipple **13**. The leads are provided with the customary sheathing **16** which may be of neoprene for example.

The casing **11** and its associated parts are of any suitable material, such as galvanized sheet steel for the casing **11** and cover **12**, and a short length of galvanized steel pipe for the nipple **13**, the latter being welded to the cover.

Disposed within the nipple is a cast plug **17** which provides the seal, the leads **15** being imbedded within the plug **17**. The plug is of a material that forms a good mechanical bond at the interface **18** between the plug and the metal of the nipple, and at the interface **19** of the plug with the sheathing **16**.

The cover is also provided with an opening **20** through

which potting compound, not shown, may be introduced into the container as previously indicated. The rim **21** of the opening **20** may be depressed as shown to receive a suitable disk **22**, shown in broken lines. After the container has been filled, the disk is soldered to the depressed rim **21**, and this forms the final step in the closing and sealing of the transformer.

According to the present invention, the plug **17** is of epoxy resin which is cast in situ, thus forming an exceedingly strong bond at the interfaces **18** and **19**, so strong, in fact, that a 50 lb. transformer may be lifted by the leads without incurring any danger of either opening up the bond or cracking the plug itself. As will be pointed out hereinafter, the material of the plug is actually a two component thixotropic epoxy base resin.

The method of making the seal, which is to say, the method of casting the plug in situ, will now be described with reference to FIG. 7.

FIG. 7 shows the cover **12** in an inverted position and placed over the nipple **13** is a strippable mold **30**. The leads **15** extend through the strippable mold **30** and the nipple **13**. The elements here shown represent the relationship of the parts during an intermediate stage of manufacture, which stage, is to be followed by pouring of the epoxy resin into the interior of the nipple **13**.

The strippable mold **30** comprises a large diameter base **31** which tightly surrounds the nipple **13**, a narrow neck portion **32**, and an intermediate cylindrical portion **33**. A connecting portion **34** accommodates the offset between portions **31** and **33**. A diagonally disposed connecting portion **35** connects portions **32** and **33**.

The interior of the nipple **13** cooperates with the strippable mold **30** to provide a chamber **36**, of which the narrow neck portion **32** constitutes a restricted outlet. The outlet is sufficiently large as to permit the leads **15** to be easily drawn through narrow neck portions but it is sufficiently small as to constitute an obstruction to the free flow of a relatively viscous fluid therethrough. The presence of the leads **15** in the neck also constitute an obstruction which further restricts this type of fluid flow. Thus it is possible to plug the nipple during the filling operation without resorting to the use of mechanical sealing devices.

Although the filling operation outlined below in its broader aspects is applicable to various types of viscous quick setting resins, we prefer to utilize a thixotropic resin to effect plugging. The properties of the thixotropic epoxy base resin are such that the material, prior to setting, is a free flowing fluid when the various elements thereof are subject to pouring or flowing stress; however, if the motion of the particles of the fluid is substantially arrested, the substance immediately jells, with the result that the substance loses its fluid characteristics.

The above mentioned restriction serves to arrest the flowing motion of the substance to an extent sufficient to cause it to jell at a point within or just below the connecting portion **35**. Thus the continuous passageway through the nipple **13** and the mold **30** is obstructed sufficiently so that the material above this point will jell as soon as it comes to rest within the interior of the nipple.

Thus, it is possible to cast the plug **17** in situ without the use of auxiliary mechanical plugging means. The resin material is poured or suitably injected into the chamber **36** until the entire space is filled, even providing a meniscus **37**, as shown in FIG. 2.

After the filling operation, as above described, the cover assembly is permitted to set for the required period, which, in the present example, is about six hours. At the end of the curing time the resin has been set up in its final form, after which the mold **30** may be stripped from the nipple and the leads **15**. Any excess resin which extends below the connecting portion **35** may be trimmed off for the purpose of appearance to provide a finished appearing bushing as shown in FIG. 2.



The offset between the portions **31** and **33** is provided to improve the appearance as indicated in FIG. 2.

An important feature of the foregoing process is that the neck portion **32** serves to center the leads **15** within the chamber **36**, and consequently within the plug **17**, so that the possibility of having the leads contact the metal of the nipple can be eliminated, particularly if the upper ends of the leads are held in a centered position during the filling step.

The fabrication of the strippable mold **30** is shown in FIGS. 4, 5 and 6 in which the reference numeral **40** designates a pattern which may be formed of aluminum. The pattern is dipped into a suitable thermoplastic resin to provide a coating **41** as shown in FIG. 5, which coating, upon cooling, constitutes the strippable mold **30**, except for the bottom portion **42**. The coating **41** is removed from the pattern **40**, the pattern surfaces being suitably tapered to facilitate easy removal, and the bottom portion **42** is cut off to provide the finished mold **30**, shown in FIG. 6.

The resin into which the pattern **40** is dipped is preferably a molten cellulose acetate butyrate resin having a melting point of **350°** F. The advantage of this type of resin is that no mold release compound is required in order to render the same strippable either from the pattern or from the nipple; furthermore, the resin sets at room temperature and can be hastened by cooling in water.

The nipple stripping operation can be speeded up by slitting the mold **30** with a sharp knife and then the rejected mold can be thrown back into the pot in which the pattern **40** is dipped.

In actual practice, the dipping operation is mechanically effected, and a plurality of patterns **40** are mounted in a single holder so that the supply of strippable molds is sufficient to permit continuity of successive filling operations.

Thixotropic properties are imparted to the resin by incorporating into one of the components of the epoxy resin, a colloidal silica in the amount of $\frac{1}{10}$ of 1% by weight (referred to the weight of both components), although up to 2% by weight can be used if desired. A suitable type of amorphous type silica is sold under the trademark Cab-O-Sil, by John L. Cabot Company, Boston, Mass.

The epoxy resins that may be used in our process include the various fluid polyaryl ethylene oxide resins obtained by reacting a polyhydric phenol such as a bisphenol with epichlorhydrin or alphadichlorhydrin as described in Castan U.S. Patents 2,324,483 and 2,444,333. Particularly satisfactory results have been obtained with the epoxy resin sold by Rubber and Asbestos Corporation of Bloomfield, New Jersey, under the trademark "Bondmaster" formulation No. M638. The components are mixed just prior to the filling operation.

A modified strippable mold **43** is shown in FIGS. 8 and 9 in which the mold **43** is provided with a base portion **44** and an intermediate portion **45** corresponding to portions **31** and **33** of the mold **30**. However instead of a single neck portion **32**, a double neck portion **46** is provided so as to further restrict the cross section of the outlet.

To summarize the operation which has been described above in detail, the cover assembly is first fabricated by casting the plug **17** in situ about the leads **15**. Then the inner ends of the leads are connected to the transformer, not shown, the latter placed in the casing **11**, and the cover **12** fitted to the casing, and sealed thereto. Then the casing is filled with potting compound through the opening **20** and the disk **22** is soldered in place. Thus an entirely waterproof structure is provided without the use of mechanical seals and without incurring the substantial labor cost incident to taping the leads to the nipple or to the boot or other sealing device.

Furthermore, the cast plug **17** provides a mechanical bond with the neoprene lead sheathing **16** and with the metallic surface of the nipple which will withstand a pull

of up to 500 pounds, a force sufficient to permit the handling of a 50 to 100 pound transformer by its leads.

The present method of casting the plug **17** in situ permits the provision of a plug which has a portion **38** which projects beyond the nipple **17**, thus eliminating any concavity which would collect water. Thus splitting of the nipple due to freezing of the water cannot occur. Furthermore, the present method permits any desired shape to be imparted to the projecting portion, so that a finished appearance can be obtained.

Although only a preferred embodiment of our invention has been shown and described herein, it will be understood that various modifications and changes may be made in the construction shown without departing from the spirit of our invention as pointed out in the appended claims.

We claim:

1. The method of sealing leads to the nipple of a transformer cover without the use of auxiliary mechanical nipple plugging means comprising the steps of placing over the nipple a mold having a narrow neck portion located beyond the outer end of the nipple to provide a chamber having a restricted outlet, drawing the leads through said narrow neck portion and said nipple, maintaining said cover in an inverted position with the nipple extending downwardly, and with said restricted outlet at the bottom of said chamber, filling said chamber with a thixotropic reaction setting resin, curing said thixotropic resin, and



stripping said mold from said nipple, the difference between the cross-sectional area of said restricted outlet and the cross-sectional area of said leads being sufficiently small with respect to the viscosity of said resin as to cause said resin to gel substantially immediately, the reaction setting of said resin occurring while said resin is in a gelled condition.

2. The method as claimed in claim 1 in which said thixotropic resin is an epoxy base resin.

3. The method as claimed in claim 1 in which said mold is of a cellulose acetate butyrate resin.

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