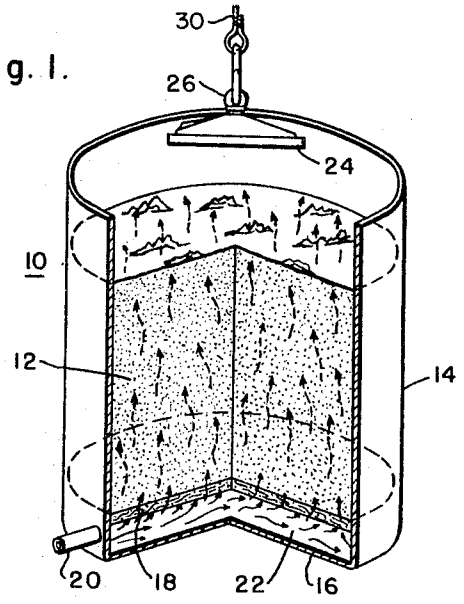
Feb. 21, 1967 T. L. MACCHIA ET AL 3,305,812

RESIN COATED HARDWARE AND TANK COVERS FOR DISTRIBUTION TRANSFORMERS

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Fig. 1.



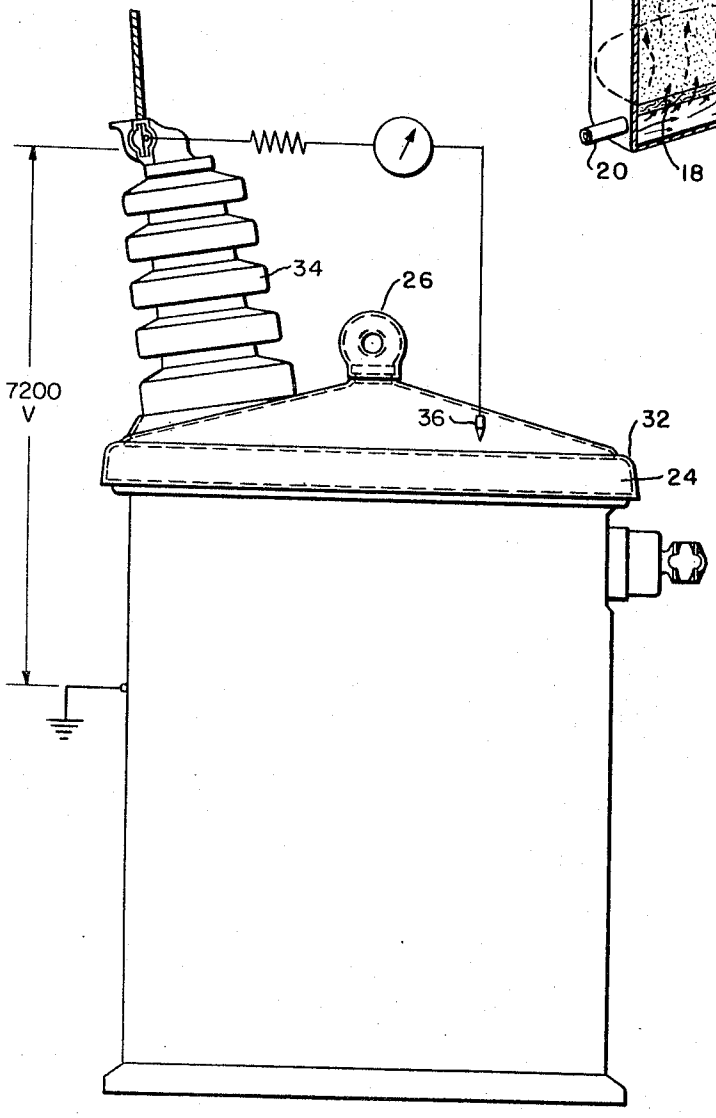


Fig. 2

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RESIN COATED HARDWARE AND TANK COVERS FOR DISTRIBUTION TRANSFORMERS

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This application is a continuation-in-part of application Serial No. 731,919, filed April 30, 1958, now abandoned and assigned to the same assignee as the instant invention.

The present invention relates to the insulation of electrical transformers and has particular reference to resin coated hardware and tank covers for electrical distribution transformers.

Electric power companies sometimes suffer service discontinuities created by line "lock-outs." In the past, a number of these lock-outs have been the result of bird and animal electrocutions occurring on the tank covers of pole-mounted high voltage distribution transformers. In an attempt to prevent such lock-outs, the high voltage terminals and line leads located on the top of such transformers sometimes have been wrapped with many layers of heavy insulating tape. In other cases, screens and guards of various types and designs have been placed over the terminals and leads to prevent animals and birds from coming in contact therewith. These prior preventative measures, although effective to some degree, materially increase the cost of manufacturing the transformers, and present other shortcomings.

The object of the present invention is to provide for the insulation of hardware and tank covers of distribution transformers by coating the same with a relatively thick coating of a resin applied by a melt-coating process such as application of the resin by dry spraying or a fluidized bed technique.

Another object of this invention is to provide hardware and tank covers for electrical distribution transformers coated with a relatively thick coating of a resin applied by a melt-coating process.

Other and further objects of the invention will, in part, be obvious and will, in part, appear hereinafter.

For a more complete understanding of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying drawing, wherein:

FIGURE 1 is a front view, with parts broken away and partly in cross section, illustrating one form of apparatus suitable for use in coating articles in accordance with this invention; and

FIG. 2 is a front view in cross section illustrating a distribution transformer tank cover and associated hardware provided with a relatively thick coating of an insulating resin.

In accordance with this invention and in the attainment of the foregoing objects, hardware and tank covers for electrical distribution transformers are provided with a 10 to 30 mil thick, and preferably 15–25 mil thick insulating coating of a resin applied by a melt-coating process. The insulating coating is applied uniformly over the entire transformer cover and its associated hardware. Birds and animals which come in contact with any of these parts are not harmed and cannot cause

failure of the transformers. The resin coating in addition to providing electrical insulation for the transformer, also affords excellent corrosion and weather protection for the metal parts which it covers. The resinous coating is also characterized by excellent heat stability and flexibility.

In one method of application, the process employed in coating tank covers in accordance with this invention includes preheating the metal parts to be coated to a temperature above the melting point of the resin to be applied. The resin, in finely divided form is fluidized in a container by passing a stream of gas, usually air, upwardly therethrough. When the preheated parts are immersed in the fluidized particles, the particles coming in contact with the heated metal parts are melted and adhere to the parts. Upon withdrawal of the parts from the fluidized resin particles, the resin particles adhering to the parts flow out over the heated metal and harden to provide a uniform thick coating thereon.

FIGURE 1 of the drawing illustrates one form of apparatus which has been found to be particularly satisfactory for use in coating hardware and tank covers for electrical distribution transformers in accordance with this invention. Reference numeral **10** refers to a tank adapted to contain a mass of resin particles **12**. Tank **10** has a side wall **14** and a bottom wall **16**. A porous porcelain plate **18** is mounted in tank **10** near bottom wall **16**. A gas inlet **20** is mounted in the tank wall to allow gas to enter the tank into a gas chamber **22** defined by poreclain plate **18** and bottom wall **16**.

Parts to be coated, such as a tank cover **24** and associated hardware including a ring **26** and a nut (not illustrated) are attached to a cable **30** by means of which they may be lowered into and withdrawn from tank **10**.

Parts which are to be coated in accordance with this invention preferably are cleaned prior to immersion into the mass of fluidized resin particles. Such cleaning may be effected, for example, by dipping the parts into either a dilute alkaline or acid washing bath. For only slightly soiled parts, dipping in a detergent and rinsing in water generally is all that is necessary.

Tank **10** is partially filled with the dry powdered resin particles. It has been determined that the resin particles should be of a 50 to 350 mesh size, i.e., will pass through a sieve having from 50 to 350 meshes per lineal inch. A gas, usually air, is injected upwardly through porcelain plate **18** into the bed of powdered resin. The porous plate **18** may be of metal or of sintered ceramic material. The injection of gas into the powdered resin causes the dry powder to be suspended therein so as to appear to increase in volume within the tank **10** and assume the characteristics of a fluid.

Parts to be coated are first heated to a temperature above the melting point of the particular resin being applied. Generally, this will be a temperature within the range of about 250° F. to 900° F. The exact temperature to which the parts are heated is dependent not only upon the melting point of the resin to be applied but also upon the desired coating thickness and the thermal content of the parts being coated.

The heated parts are immersed into the fluidized powdered resin mass for a period of about 2 to 15 seconds. Resin particles contacting the heated parts will melt and adhere thereto. During immersion and immediately upon withdrawal of the parts, the melted resin

will flow out over the parts and will solidify into a smooth uniform coating as the parts cool. If complete melt-flow does not occur, the parts may be post-heated in an oven or the like for a period of time sufficient to permit the development of a smooth coating. The parts may be reheated and redipped several times to build up a coating of the desired thickness. A melt-flowed coating **32** (FIG. 2) of a thickness on the order of 10 to 30 mils has been found to be suitable for transformer tank covers and associated hardware.

The following is a specific example illustrating the coating of a transformer tank cover with its associated hardware. The metal parts were heated at a temperature of about 350° F. for a period of from 10 to 20 minutes. The heated parts then were dipped for about 10 seconds into a fluidized powder mass comprising 80 parts of finely divided epoxy resin having a 325 mesh size, 16 parts of titanium dioxide, and 4 parts of dicyandiamide. The coated parts then were baked at 350° to 500° F. for from 15 to 60 minutes. The resulting uniform coating had a thickness of about 16 mils. The coating will withstand a voltage of 600 volts per mil without damage.

To determine effectiveness of the coating, leakage current measurements were made between the bushing **34** in FIG. 2, energized at 7200 volts and a probe **36** making contact through the coating with the tank cover maintained at ground potential. A 1000 ohm resistor was placed in series with a microammeter to represent the resistance of a small animal. Measurements were made in the original condition and after a "weathering" cycle consisting of the following:

(1) 24 hrs. exposure to salt water and industrial dust

(2) 24 hrs. exposure to salt water, ultra violet and heat rays

(3) 24 hrs. exposure to tap water followed by air drying and electrical test.

The grounded probe was located at 3 different positions on the tank cover to simulate conditions under which an animal, such as a squirrel, could "bridge" between the bushing **34** and the cover **24**. The following table shows leakage current as a function of sixteen weathering cycles:

No. of Weathering Cycles	Leakage Current, Microamperes		
	Pos. 1	Pos. 2	Pos. 3
0	84	93	97
1	86	97	96
2	60	60	60
3	55	60	60
4	60	55	60
5	60	60	60
6	60	60	60
7	60	60	70
8	60	60	60
9	60	60	60
10	40	38	39
11	40	40	40
12	46	46	48
13	46	46	53
14	46	44	48
15	42	48	53
16	34	40	41

The test results given in the table show that a squirrel, under these conditions, would draw a current of only about 34–97 microamperes. A current of 5000 microamperes would be required to electrocute the squirrel. The small current drawn by the squirrel is only enough to drive him from the transformer. The results demonstrate the effectiveness of this invention in preventing service lock-outs resulting from animal electrocutions occurring on the tank covers of pole-mounted high voltage distribution transformers.

In another exemplification of the invention, a dry, powdered cellulose acetate butyrate resin was employed. The resin contained, as a filler and track resistant agent, about 30% by weight of titanium dioxide together with a small amount of carbon black. The transformer tank cover was first heated to about 520° F. Thereafter the cover and associated parts were sprayed with the dry resinous particles until a coating about 16 mils thick had melted and flowed over the tank cover surface. The metallic cover was then cooled somewhat until the melted resin particles had completely coalesced into a substantially uniform coating thereover. The resin coated cover was then baked in an oven until the resin was converted to infusible state. The so-treated transformer tank cover was highly heat resistant and exhibited excellent weathering and flexibility properties. The electrical properties of the cellulose acetate butyrate coating was comparable to the properties given in the above table.

As generally stated hereinbefore, resins which may be applied to hardware and tank covers of distribution transformers in accordance with this invention include polyethylenes, polyamides (nylon), cellulose such as ethyl cellulose, cellulose acetate-butyrate and cellulose acetate, polyvinyls, acrylates, polyesters, epoxies, alkyds, ureas, melamines, phenolics, silicones, polytetrafluoroethylene and polytrifluorochloroethylene, and the like, either singly or in combinations of two or more. The resins are preferably applied together with from about 10% to about 40% by weight of finely divided non-conductive inorganic filler materials which enhance the electrical resistance properties of the resins themselves. Due to the finely divided nature of the resins, the fillers are carried along during the melt-coating procedure and are substantially uniformly distributed throughout the so-applied resin coating. The filler materials may be titanium dioxide, silicon dioxide, or the like as well as any of the conventional coloring pigments having satisfactory electrical properties.

While the present invention has been described with reference to what at present is considered to be the preferred embodiments thereof, it will be understood, of course, that certain changes, substitutions, modifications and the like may be made therein without departing from its true scope.

We claim as our invention:

1. In a distribution transformer having a tank cover at ground potential and means proximate to the cover at a high potential, the cover and proximate means so disposed that small animals can form a bridge between the cover and the proximate means and be electrocuted by a current surge, the improvement comprising a melt-flowed resinous coating of a thickness of from 10 to 30 mils deposited on the cover so that the current through an animal bridging the coated cover and the proximate means is only enough to drive the animal from the transformer but not enough to electrocute the animal.

2. The transformer of claim **1** in which the resinous coating contains, in substantially uniform distribution, about 10 to 40% by weight of a finely divided non-conductive inorganic filler.

3. The transformer of claim **2** in which the filler is titanium dioxide.

4. The transformer of claim **2** in which the resinous coating is a coating of a resin selected from the group consisting of epoxy and cellulose acetate butyrate resins.

5. The transformer of claim **4** in which the resinous coating is a coating of epoxy resin.

6. The transformer of claim **4** in which the resinous coating is a coating of cellulose acetate butyrate resin.

7. In a distribution transformer having a metal tank cover and associated hardware at ground potential and lead means at a high voltage potential, the cover, hardware and lead means being arranged so that small animals can form a bridge between the ground potential and the high voltage potential and be electrocuted by a current surge, the improvement comprising a smooth, melt-flowed epoxy resin coating of a thickness of from 10 to 30 mils on the cover and associated hardware, the resin coating containing from about 10 to 40% by weight of a finely divided non-conductive inorganic filler, said coating limiting the current through bridging animals to a level that is only enough to drive the animal from the transformer.

8. The transformer of claim 7 in which the coating limits the current flow through a 1000 ohms resistance to a level of only about 34 to 97 microamperes at an applied potential of about 7200 volts.

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