May 25, 1943. J. A. SZILARD 2,320,201

ELECTRICAL CONDUCTOR

Filed Aug. 3, 1940

Fig. 1.

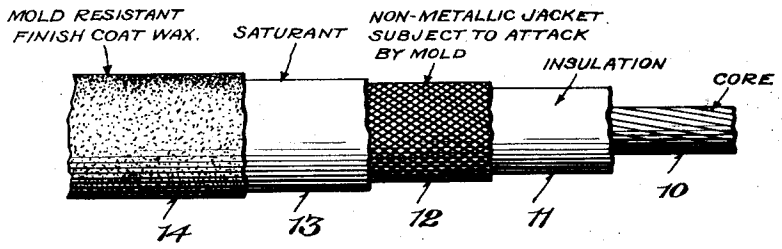



Fig. 2.

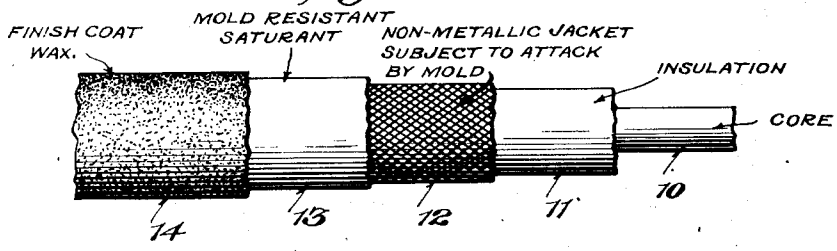



Fig. 3.

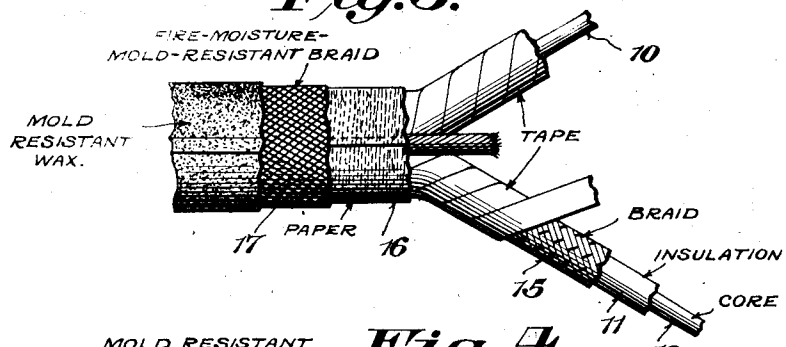
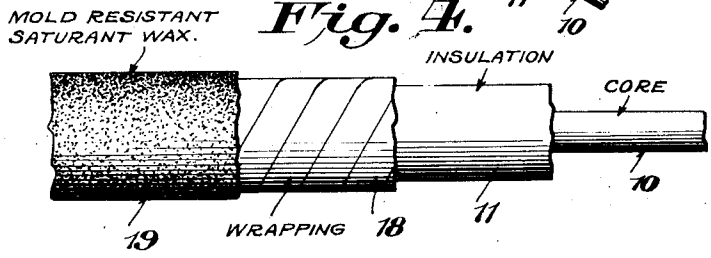



Fig. 4.

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# UNITED STATES PATENT OFFICE

2,320,201

## ELECTRICAL CONDUCTOR

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Application August 3, 1940, Serial No. 350,459

19 Claims. (Cl. 174—121)

This invention relates to mold-proof and rot-proof non-metallic coverings, particularly those adapted for use as insulating and protecting jackets for electrical conductors, and the invention has for its principal object the improvement of such conductors as well as the insulating and protective jackets therefor.

For a long time there has been a great need for a low cost substance suitable for use in saturants and finishers for non-metallic conductor jackets or sheaths which will be highly resistant to mold (fungus growth) as well as to rotting (decomposition in presence of bacteria) and which will blend readily with the saturants and finishers without affecting their properties in general and their resistance to weathering and aging in particular.

From a practical angle rotting is, as a rule, more dangerous because it may completely destroy the outer coverings of a cable. Cases are known where in barns, stables and other similar places the entire outer coverings of non-metallic sheathed cables rotted away in a relatively short time. These outer coverings frequently consists of cotton braid, saturated and finished with asphalt and stearin pitch compounds, overlying folded kraft paper armor treated with paraffin. At times only the cotton braid rotted away, but in more severe cases even the paper armor and the paper or cotton braid, which is below it, became rotten. In some cases there was a very definite mold growth on the surface of the rotten outer coverings.

Mold growth without rotting occurs frequently in warm damp places like the conduits in power houses and substations, where no decaying organic matter is present. This may be observed on either the dry or the saturated braids of station wires and cables. The mold may be only on the surface, in which case it is comparatively harmless, or it may penetrate below the finishing coat and slowly destroy the cotton braid. It is this latter type of mold growth which may cause serious damage to cables. If permitted to go unchecked, it may destroy the entire outer coverings.

Furthermore, many non-metallic sheathed electrical conductors are required to be made flame- and fire-resistant, which is customarily accomplished by saturating or coating one or more of the fibrous jackets or coverings with a stearin pitch compound.

One of the principal aims and objects of the present invention is the provision of an inexpensive compound which may be used alone, or combined with customarily used moisture-proofing saturants or flame-resistant finishing compounds, and which will be highly effective as a mold and rot inhibitor for use in non-metallic sheathed electrical cables.

According to the present invention, this need is satisfied by the use of the still residue of diphenyl-oxide distillation containing phenolic compounds, including alkali metal phenolates. This tarry residue may be used alone, or combined with customary asphaltic saturants, as a saturant for insulating bodies, or it may be compounded with customary stearin pitch finishing compounds. This still residue is inexpensive of use and highly effective as a mold and rot inhibitor in electrical cables.

A specific embodiment of the invention comprehends the use of the tarry residue obtained during the distillation of diphenyl-oxide as a mold and rot inhibitor on the fibrous jackets or coverings of electrical cables which may be subject to mold or rot. This tarry residue has been known for some time, but has been considered a waste material. So far as I know, it has never been used or suggested for use heretofore as a mold and rot inhibiting material.

The exact composition of this diphenyl oxide still residue, referred to hereinafter for short as "still residue," is not definitely known. Tarry phenolic bodies make up the bulk of it. It contains high boiling ethers like diorthophenyl-phenol-ether, $C_6H_5.C_6H_4.O.C_6H_4.C_6H_5$, phenyl-ortho-phenyl-phenol-ether, $C_6H_5.O.C_6H_4.C_6H_5$; also some diphenyl oxide $C_6H_5.O.C_6H_5$ ortho-phenyl phenol, $C_6H_5.C_6H_4.OH$, triphenyl $C_6H_5.C_6H_4.C_6H_5$.

In addition it contains water soluble alkali metal salts of phenolic materials, mostly sodium salts like sodium phenolate, $C_6H_5ONa$, sodium ortho-phenyl phenolate $C_6H_5.C_6H_4.Na$ and others. These alkali metal salts amount to about 20% of the total. These are water soluble and since a certain water solubility is required for effective fungicidal and germicidal action against fungi and bacteria occurring on wet or damp places, these sodium salts and notably sodium phenolate represent the most active ingredient of this still residue.

This still residue is a dark colored tarry compound with properties similar to a bituminous compound. It is tacky at room temperature, but is quite brittle at low temperature. It melts at 60° C. and is quite fluid at 80–100° C.

At 100–120° C. it impregnates cotton and other fibrous materials readily. Its flash point is at

145° C. and its fire point at 165° C. Like a great number of bituminous compounds, this still residue has a certain amount of cold flow. It also has a certain oil resistance. When ignited it burns readily, but has some tendency to coke. This permits its use in stearine pitch base bituminous compounds which have flame resistance due to their choking properties. This still residue may vary somewhat in physical properties depending on the distillation process, but the above characteristics are typical.

As a compound for use in the manufacture of electrical cables the principal virtues of this still residue are its excellent mold and rot resisting properties; its impregnating qualities for cotton, its compatibility with moistureproof asphalt saturants, its compatibility with flame and moisture resistant stearine pitch compounds and finally its low cost.

The invention may be embodied in the manufacture of electrical cable in a variety of ways, depending upon the use to which the cable is to be put. For example, it may be used alone as a saturant for cotton, jute or other fibrous layers in the interior of the cable structure where adhesion between layers is desired. It can not be used alone on the outside of the cable unless a sticky surface is desired. It may be compounded with moisture-proofing asphaltic saturants used in the cable industry. These are usually petroleum asphalts with melting points of 130–190° F. (ball and ring) and penetration values at 77° F. of between 20–30. These petroleum asphalts used as saturants usually contain modifying agents like montan wax, rosin, paraffin wax, etc., to get the desired properties both in the solid state after it has been applied to the cable, and in the molten state as it is applied to the cable. I have found that this still residue may be combined with any of the saturating compounds in amounts of 15–50%. The addition of this still residue will make these saturants rot and mold resistant.

Due to its oil resistance this still residue does not readily blend with some of the more viscous petroleum asphalts. I found that in such cases the addition of 5–10% of montan wax or rosin helps to form a homogeneous blend of asphalt and still residue.

A second group of saturants used in the cable industry are known as flame retardant compounds; these are based on stearine pitch because of the good coking properties of this material. Stearine pitch too, is blended with montan wax, petroleum waxes or other modifying agents and is used in this modified form. I found that this still residue can be combined with any of these stearine pitch compounds in amounts of 15–30% without destroying their flame retardant properties, and imparting mold and rot resistance to these finishers. As in case of asphalts, the addition of rosin or montan wax helps the blending of some of the more viscous stearine pitch compounds with the still residue.

In addition to the saturating compounds the cable industry uses hard finishing compounds over the saturants to improve appearance and the handling properties of the cable. These finishers usually have a melting point range of 180–220° F. and a penetration at 77° F. of 4-10. These are either mixtures of petroleum asphalts or native asphalts like gilsonite with waxes like montan, paraffin, etc., or they are based on stearine pitch modified with native asphalt and waxes. I have found that this still residue may be combined with either type up to 10–25% and that the addition of this still residue will make either type of finisher rot and mold resistant.

The following is an example of a rot and mold resistant—also flame and moisture resistant finisher:

| | Pounds |
|---|---|
| Hard stearine pitch (190° F. M. P.) | 45 |
| Gilsonite | 25 |
| Montan wax | 10 |
| Still residue | 10 |
| Paraffin | 10 |

For all types of fibrous coverings, jackets, wrappings, felts or braids which are used on cables and may be subject to attack by mold, rot, termites and the like, the use of saturants and finishers containing this still residue will give protection against rot, mold, termites and the like.

Illustrative of the wide range of uses of the invention, reference is made to the accompanying drawing showing several forms of conductors embodying the invention, in which:

Fig. 1 is a side view of one form of non-metallic covered conductor embodying the invention;

Fig. 2 is a similar view of a modified form thereof;

Fig. 3 is a side view of a non-metallic sheathed cable construction embodying the invention; and

Fig. 4 is a side view of one form of underground cable embodying my invention.

In the various figures the outer coverings are cut away successively to show the structure underneath, and the numeral 10 represents the core, which may be solid or stranded, and 11 the insulation thereover, which may be a rubber compound, synthetic resin or saturated fibrous insulating material.

In the construction shown in Fig. 1, the insulation 11 may be provided with an overlying non-metallic jacket 12, subject to attack by mold, rot, termites and the like, such as a cotton braid, cotton tape wrap, jute cord wrap or felted fibrous covering. This jacket 12 is conveniently saturated with a moisture-proof saturant, such as an asphaltic saturant, or a flame-resistant and moisture-resistant bituminous saturant, for example, stearine pitch, as desired. An overlying finishing coat 14 of an asphalt wax type or a stearine pitch type finisher containing from 10% to 25% of the still residue provides a smooth, non-sticky, mold- and rot-resistant finish for the cable.

Instead of incorporating the fungicide with the finish coating, as in Fig. 1, it may be mixed with the saturant, either an asphaltic moisture-proof saturant or a flame-resistant stearin pitch, as illustrated in Fig. 2. In such cases up to 15% to 30% of the still residue may be mixed with the saturant 13 to render the jacket 12 mold- and rot-resistant.

In the form of invention shown in Fig. 3, a plurality of insulated conductors 10 may be individually covered with a paper-cotton braid as at 15 and enclosed in a protective tape wrapping, for example paper. The assembled conductors are enclosed by a paper dam 16 and an overlying nonmetallic fibrous jacket 17 which is subject to attack by rot and mold. The braid 17 may be provided with a conventional saturant, such as a fire- and moisture-resistant stearin pitch and with a coat of finisher containing from 10% to 25% of the still residue. Alternatively, the

saturant for the jacket 17 may be compounded with 15% to 50% still residue as in the case of the cable shown in Fig. 2, in which case the finish coat may be of any convenient type.

In the case of underground cables, illustrated in Fig. 4, the insulated conductor 10 may be wrapped or braided with cotton, jute, sisal or other fibres 18, which may be saturated as at 19 with the still residue when tackiness is not objectionable, or with a mixture of bituminous compounds containing from 15% to 50% of the still residue. Also it is feasible to presaturate the cotton, jute, sisal or other fibres and apply the presaturated fibres to the cable.

I have found that the inclusion of still residue in the finisher of from 10% to 25%, or in the saturating compound of from 15% to 50%, produces a conductor which not only withstands mold growth and is perfectly preserved after four weeks of incubation at 25° C. seeded with chaetomium globosum, but in which the cost of saturating and finishing the braid is substantially reduced due to the cheapness of the still residue as compared with the cost of the usual saturating and finishing materials.

I am aware that heretofore many mold and rot inhibitors have been known and used, or suggested for use, for proofing textile and fibrous bodies, such as sulphur and copper salts and aldehydes. The cost of using these materials, however, was prohibitive except where it was possible to use inexpensive residual coal tar compounds which have good mold- and rot-resistance and which may be used in certain underground cable construction. However, for non-metallic sheathed electrical conductors, coal tar compounds cannot be used because these compounds are not flame-resistant, do not age well above ground and cannot be mixed well with customary stearin pitch finishing compounds.

The insulated conductor constructions shown in the drawings are merely illustrative of the various applications of the invention, and it will be understood that the phenolic compound containing an active sodium salt of phenol, for example the still residue hereinabove described, may be used alone, or combined with the saturant and waxes in desired proportions, depending upon the particular use for which the cable is intended.

As sodium phenolate is one of the active ingredients of the still residue similar results can be obtained by mixing sodium phenolate with the various saturants and finishers. However, since it is easier and cheaper to blend the still residue which is a bituminous material with similar bituminous compounds than it is to mix pure sodium phenolate with the bituminous compounds I prefer to use the still residue which in addition is much lower in cost than equivalent amounts of sodium phenolate would be.

It is customary when saturating fibrous materials with bituminous compounds to keep the temperature below 350–400° F. because above that temperature the strength of the fibrous material is adversely affected by the high temperature. This holds true for the saturating compounds containing the still residue; these should therefore not be used as saturants over 400° F.

It should be also noted that both the saturant and finisher may contain the still residue.

It will be undestood that the invention may be variously embodied within the limits of the prior art and the scope of the subjoined claims.

I claim:

1. An electrical conductor comprising an insulated conducting core and a mold and rot resistant fibrous jacket therefor saturated with the phenolic tarry residue of diphenyl oxide distillation.

2. An electrical conductor comprising an insulated conducting core and a mold and rot resistant fibrous jacket therefor saturated with a moisture-resistant saturant containing 15% to 50% of the phenolic residue of diphenyl oxide distillation.

3. An electrical conductor comprising an insulated conducting core and a fibrous jacket therefor saturated with a moisture-resistant saturant containing bituminous materials and 3% to 10% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed in this form with the bituminous materials of the saturant to render the fibrous jacket mold and rot resistant.

4. An electrical conductor comprising an insulated conducting core and a mold and rot resistant fibrous jacket therefor saturated with a moisture-resistant and flame-resistant stearine pitch base saturant containing 15% to 30% of the phenolic residue of diphenyl oxide distillation.

5. An electrical conductor comprising an insulated conducting core and a fibrous jacket therefor saturated with a moisture-resistant and flame-resistant stearine pitch base saturant containing 3% to 6% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed in this form with the stearinic pitch of the saturant to render the fibrous jacket mold and rot resistant.

6. An electrical conductor comprising an insulated conducting core, a mold and rot resistant fibrous jacket and a finish coating therefor of an asphalt-wax base finisher containing 10% to 25% of the phenolic tarry residue of diphenyl oxide distillation.

7. An electrical conductor comprising an insulated conducting core, a fibrous jacket and a finish coating therefor of an asphalt-wax base finisher containing 2% to 5% of sodium phenolate contained in the residue of diphenyl oxide distillation and combined in this form with the asphalt wax used in the finisher to render the finisher mold and rot resistant.

8. A mold-resistant and rot-resistant electrical conductor comprising a conducting core and a fibrous jacket therefor treated with the phenolic tarry residue of diphenyl oxide distillation.

9. A mold-resistant and rot-resistant electrical conductor comprising a conducting core and a fibrous jacket therefor treated with a still residue of diphenyl oxide distillation containing sodium phenolate.

10. A saturant or finisher for rendering mold-resistant and rot-resistant the fibrous protective jacket of an electrical conductor comprising the phenolic tarry residue of diphenyl oxide distillation.

11. A saturant for rendering moisture-resistant, mold-resistant and rot-resistant the fibrous protective jacket of an electrical conductor comprising an asphalt base and 15–50% of the phenolic tarry residue of diphenyl oxide distillation blended with the asphaltic material by 5–10% of rosin or montan wax.

12. A saturant for rendering moisture-resistant, mold-resistant and rot-resistant the fibrous protective jacket of an electrical conductor comprising an asphalt base combined with 3–10% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed

in this form with the asphaltic materials of said base.

13. A saturant for rendering flame- and moisture-resistant and also mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising a stearine pitch base containing 15–30% of the phenolic tarry residue of diphenyl oxide distillation blended with the stearine pitch base by 5–10% of rosin or montan wax.

14. A saturant for rendering flame- and moisture-resistant and also mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising a stearine pitch base combined with 3–6% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed in this form with the stearinic pitch materials of said base.

15. A finisher for rendering mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising an asphalt-wax base containing 10–25% of the phenolic tarry residue of diphenyl oxide distillation blended with the asphalt-wax base by 5–10% of montan wax.

16. A finisher for rendering mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising an asphalt-wax base combined with 2–5% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed in this form with the asphalt-wax materials of said base.

17. A finisher for rendering flame- and moisture-resistant and also mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising a stearine pitch base containing 10–25% of the phenolic tarry residue of diphenyl oxide distillation blended with the stearine pitch base by 5–10% of montan wax.

18. A finisher for rendering flame- and moisture-resistant and also mold- and rot-resistant the fibrous protective jacket of an electrical conductor comprising a stearine pitch base combined with 2–5% of sodium phenolate contained in the residue of diphenyl oxide distillation and mixed in this form with the stearinic pitch materials of said base.

19. A treating material for rendering fibrous materials mold-resistant and rot-resistant comprising the phenolic tarry residue of diphenyl oxide distillation.

JULIUS A. SZILARD.

CERTIFICATE OF CORRECTION.

Patent No. 2,320,201. May 25, 1943.

JULIUS A. SZILARD.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 8, for "choking" read --coking--; line 33, for "20-30." read --20-40.--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of June, A. D. 1943.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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