

Jan. 31, 1933.

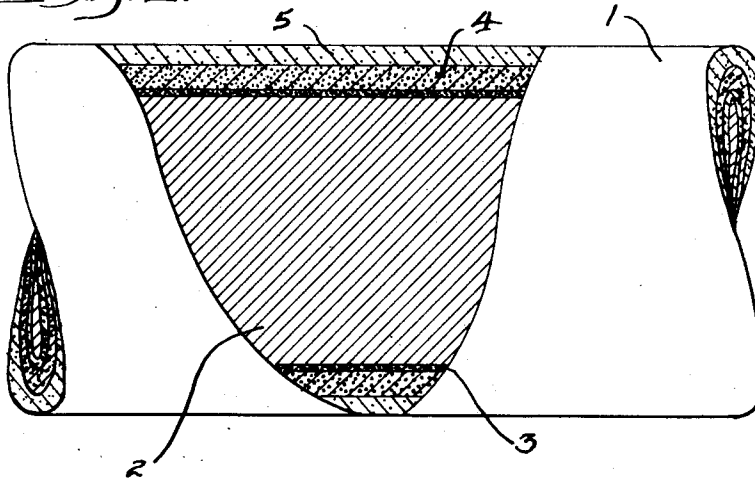
S. RUBEN

1,896,040

INSULATED WIRE AND PROCESS THEREFOR

Filed Sept. 17, 1932

Fig. 1.



Samuel Ruben
INVENTOR.

BY *Ken R. R. R.*
ATTORNEYS.

UNITED STATES PATENT OFFICE

SAMUEL RUBEN, OF NEW ROCHELLE, NEW YORK, ASSIGNOR TO VEGA MANUFACTURING CORPORATION, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE

INSULATED WIRE AND PROCESS THEREFOR

Application filed September 17, 1932. Serial No. 633,608.

This invention relates to an improved type of insulated wire and to a method of making the same.

This application is a continuation in part of my copending applications Serial No. 499,845, filed December 3, 1930, and Serial No. 557,383, filed August 15th 1931.

An object of the invention is to produce a wire having a flexible refractory insulation.

A further object of the invention is to produce a wire having a flexible water-proof insulation capable of withstanding high temperature and abrasion without injury.

Another object is to produce a refractory insulation which is relatively thin and smooth.

A further object is the provision of a wire having a closely applied flexible insulating coating containing refractory inorganic material unaffected by high temperatures.

Another object is to provide a refractory wire coating containing finely divided chromium oxide held upon the wire in flexible form.

Further objects will be apparent from the disclosure, and drawing in which is shown an insulated wire made in accordance with this invention.

I have found that it is desirable, in coating a wire with an insulating material having the desired characteristics, to have (1) a flexible binder of the resinous type to give a satisfactory bond at ordinary temperatures and (2) a further binder, which material is to be effective at high temperatures. The choice of a material of this type is governed by the temperature which the insulation will be called upon to withstand, the object in using a higher temperature binder of this nature being to provide a binding action after the organic materials have lost their ability to hold the refractory material in place. The most satisfactory materials of this type are the borates such as boric acid, sodium borate, lead borate, etc., the boric acid being preferred. The so called "solvent oxides", such as antimony oxide, zinc oxide, etc., come next in degree of satisfaction. After these, the phosphates, sulfates and

other "reducing" compounds. The borates or other inorganic binders may be added separately or in the form of a compound with any of the other mixture components, organic or inorganic.

This inorganic binding material may serve two purposes; one, to bind the refractory and insulating material at high temperatures, and may itself become a part of such insulation; two, in the case of boron compounds, it prevents scaling and surface oxidation and it may dispense with the necessity of a flux in soldering the wire, particularly when copper wire is coated. It may also react with other materials of the mixture to raise their melting point. Preferably, this secondary inorganic material should have a melting or fluxing point below the carbonization temperature of the organic materials used in the coating.

The coating may consist of a finely divided inorganic material, such as an oxide, a water-insoluble resinous binding material which may itself be insulating and an inorganic binding or fluxing agent, such as a borate.

The refractory material used in the coating may consist of one or more of the insulating metal or metalloid compounds, which include the oxides, borates, silicates and in some cases hydrates and hydroxides of the metals and/or metalloids. Among those materials usable singly or in combinations, may be mentioned finely divided aluminum, the oxides of such elements as iron, chromium, titanium, beryllium, magnesium, aluminum, silicon, tantalum, vanadium, manganese, cobalt, nickel, copper, zinc, molybdenum, tungsten, lead, thorium, zirconium. Where the borates, silicates, hydroxides or hydrates of these elements form insulating compounds, these may be used. Mixtures containing more than one compound, for example, beryl, rutile, or mica, may also be used in combination or otherwise. It is desirable that the inorganic materials should be of such size, shape and weight, as not to deposit too rapidly in the resinous carrier and to afford a good adherence to the wire. The materials used should be ground to as fine a state as possible and should pass through a 200 mesh

screen, the small particle size of these inorganic materials greatly contributing to the flexibility of the coating.

While aluminum in a more solid state is highly conductive, deflocculated, powdered or otherwise finely divided aluminum is not. This is attributed to the thin film of oxide which seems to naturally form upon the surface. If desirable, the thickness of this film can be materially increased by chemical treatment, as for instance, by immersion in nitric acid.

As a flexible binding insulation of the resinous type, I prefer to use shellac or shellac and Venice turpentine in a volatile solvent such as alcohol or an acetate. For the inorganic binder, I prefer to use boric acid.

In the coating of some wires, for instance copper, in order to have the insulating coating adhere to the copper and prevent surface oxidation effects, I have found that it is desirable to preliminarily coat the wire with a coating that is integral with the base and preferably fused thereon, such as a solvent oxide coating. For this purpose I have found that a fused on layer of antimony oxide is especially suited; or the wire may also be treated by passing it through a borate solution and heating it, whereupon (if copper) it acquires a hard red fused surface.

In a typical coating mixture I use 200 grams of chromium oxide, 100 grams of boric acid, 100 grams flake shellac, 100 grams of Venice turpentine and 450 cc. alcohol, chromium oxide being preferred over the other oxides because of its high melting point and dielectric properties; also because under abnormal heat conditions it will not be broken down or detrimentally react with the organic binding materials used in the coating. This mixture is milled until the various materials are thoroughly ground and have been reduced to a very fine dimension.

The figures given and the composition of the coating may be varied within wide limits, according to the nature of the coating desired, it being recognized that in some cases less flexibility and greater refractory insulation or vice versa may be desired. That is to say, in the formula given above, twice the amount of oxide might be used or only one tenth as much; or the boric acid might be increased 100% or reduced as much as 95%. The resinous binder or carrier should be of proper consistency in relation to the specific gravity of the solid materials used.

The process used is that of a continuous coating whereby the wire is passed through a mixture of antimony oxide in alcohol, then into a furnace which dries the mixture and melts it. The fused antimony oxide flows over the surface of the wire and when cool presents a tough integral layer of minute thickness. The wire then passes through

cups containing the insulating compound, being heated and baked, in furnaces located between the cups, a thin, smooth, non-porous, flexible coating being obtained.

It is desirable that the temperature of the coating during heating be raised to the melting or flowing point of the inorganic binder, for instance 186° C. where boric acid is used, so that it may bind together the refractory crystals.

The baking of the insulation upon the wire has the effect of evaporating the solvent and any water vapor, driving out part of the organic materials and increasing the proportion of heat resistant materials in the coating.

The thickness of the coating is regulated by the consistency of the solution, the speed with which the wire passes through the coating cups, the number of cups used, the temperature of the furnace and the size of the wire.

This thickness may be the standard thickness set by the American Engineering Standards Committee for enamel insulated wire or may be less or greater, depending upon the flexibility, dielectric strength, abrasion resistance, etc., required. Likewise, the amount of refractory material, such as the oxide, may be determined by the degree of heat resistance necessary. Generally, it may be stated that the amount of refractory material should be such that after the wire has been wound into coils, it will afford a non-conductive spacer between turns even though the dielectric organic carrier or binder, such as varnish, should become carbonized or burn out.

The thicknesses prescribed by the American Institute of Electrical Engineers Standards Committee for enameled magnet wire are as follows:

Bare wire diameter	A.W.G.	Minimum addition	Maximum addition
<i>Inches</i>		<i>Inches</i>	<i>Inches</i>
.1285 to .0571 inclusive	(8 to 15)	.0015	.0025
.0508 to .0358 inclusive	(16 to 19)	.0012	.0020
.0320 to .0253 inclusive	(20 to 22)	.0010	.0018
.0226 to .0179 inclusive	(23 to 25)	.0009	.0015
.0159 to .0100 inclusive	(26 to 30)	.0007	.0012
.0089 to .0080 inclusive	(31 to 32)	.0006	.0010
.0071 to .0063 inclusive	(33 to 34)	.0005	.0008
.0056 to .0050 inclusive	(35 to 36)	.0004	.0007
.0045 to .0040 inclusive	(37 to 38)	.0003	.0006
.0035 to .0031 inclusive	(39 to 40)	.0002	.0005

The very high space factor obtainable through the use of this wire, made possible by the thin refractory insulation which is in great measure due to the minute particle sizes of the inorganic materials, is of primary importance in the manufacture and design of electrical equipment, it being well known that the activity of a coil winding varies directly as the ratio between the cross-sectional area of the conductor and that of the conductor plus insulation. In refractory insulated wires of the prior art the space factor ob-

tainable was very poor due to the fact that these insulations usually consisted of asbestos windings with or without added cohesive materials. The thin refractory insulation of this invention allows more turns in a given space and a greater efficiency in coil windings.

The initial process of fusing on a layer of antimony oxide or borate is not, of course, necessary to the production of satisfactory insulated wire, but is desirable in some instances as an added safety factor.

After the wire has been coated with the insulating compound or mixture, it may be desirable for purposes of abrasion resistance, further moisture-proofing or greater flexibility, to provide an additional top coat. For this purpose I may use an oleoresinous or synthetic resinous varnish, a cellulose lacquer, a rubber varnish or rubber coating, etc.

In the drawing, the insulated wire (1), is composed of copper base (2) having formed therein an integral oxide coating (3) upon which the insulation (4) has been coated. Covering this insulation is cellulose lacquer coating (5).

I claim:

1. A wire having on its surface a closely adherent layer of flexible refractory insulation in which the refractory material consists substantially of finely divided chromium oxide held upon the wire by a baked water-insoluble resinous binder.

2. A wire having on its surface a closely adherent layer of a flexible refractory insulation consisting substantially of finely divided titanium oxide held upon the wire by a baked water-insoluble resinous binder.

3. A wire having on its surface a closely adherent layer of a flexible refractory insulation consisting substantially of finely divided iron oxide held upon the wire by a baked water-insoluble resinous binder.

4. A wire having on its surface a closely adherent layer of flexible insulation having a thickness not greater than .00125 inches and containing refractory inorganic material consisting substantially of chromium oxide particles capable of passing through a 200 mesh screen, said chromium oxide particles being held upon the wire by an organic binder.

5. A wire having on its surface, a closely adherent flexible insulating layer consisting of a mixture of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating binding material and an inorganic binder compound effective at elevated temperatures.

6. A wire having on its surface, a closely adherent flexible insulating layer consisting of a mixture of finely divided insulating oxide, a water-insoluble resinous insulating binding material and an inorganic binder compound effective at elevated temperatures.

7. A wire having a flexible insulating coat-

ing consisting of finely divided non-fibrous inorganic insulating material, a boron compound and a water-insoluble resinous insulating binding material.

8. A wire having a flexible insulating coating consisting of finely divided insulating oxide, a boron compound and a water-insoluble resinous insulating binding material.

9. A copper wire having directly on its surface a flexible insulating coating consisting of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating binding material and a boron compound.

10. A wire having a flexible insulating coating consisting substantially of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating binding material and an inorganic binder compound having a melting or flowing point lower than the carbonization temperature of said resinous binding material.

11. A wire having a flexible insulating coating consisting substantially of finely divided oxide, a water-insoluble resinous insulating binding material and an inorganic binder compound having a melting or flowing point lower than the carbonization temperature of said resinous binding material.

12. A wire having a flexible insulating coating consisting of a plurality of baked on layers of a mixture of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating material and an inorganic binder compound effective at elevated temperatures.

13. A wire having a flexible insulating coating consisting of a baked mixture of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating material and boric acid.

14. A wire having a flexible insulating coating consisting substantially of finely divided chromium oxide, a water-insoluble resinous insulating binding material and an inorganic binder compound effective at elevated temperatures.

15. A wire having a flexible insulating coating consisting substantially of finely divided chromium oxide, a water-insoluble resinous insulating binding material and a boron compound.

16. A wire having a flexible insulating coating consisting substantially of finely divided chromium oxide, a water-insoluble resinous insulating binding material and boric acid.

17. A wire having a flexible insulating coating consisting substantially of finely divided titanium oxide, a water insoluble resinous insulating binding material and a boron compound.

18. A wire having a flexible insulating coating consisting substantially of finely divided iron oxide, a water-insoluble resinous

insulating binding material and a boron compound.

19. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of the combination of finely divided insulating oxide and an inorganic binding material, held upon the wire by a water-insoluble resinous binder.

20. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of the combination of non-fibrous inorganic insulating matter and a boron compound, held upon the wire by a water-insoluble resinous binder.

21. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of the combination of finely divided insulating oxide and boric acid, held upon the wire by a water-insoluble resinous binder.

22. A wire having a coating of finely divided chromium sesquioxide, held together with an organic binder and a second binder capable of withstanding temperature at red heat.

23. A wire having a coating of a finely divided chromium oxide, held together and upon the wire by a binder composed of a compound of shellac and Venice turpentine, and a second binder of inorganic material capable of standing a temperature of red heat.

24. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of finely divided non-fibrous inorganic insulating material, held upon the wire by an organic binder, said insulation being of a thickness no greater than .00125 inches.

25. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of finely divided insulating oxide held upon the wire by an organic binder, said insulation being of a thickness no greater than .00125 inches.

26. A wire having on its surface a closely adherent layer of flexible refractory insulation in which the refractory material consists substantially of finely divided chromium oxide held upon the wire by an organic binder, said insulation being of a thickness no greater than .00125 inches.

27. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of finely divided titanium oxide held upon the wire by an organic binder, said insulation being of a thickness no greater than .00125 inches.

28. A wire having on its surface a closely adherent layer of a flexible refractory insulation consisting substantially of finely divided iron oxide held upon the wire by an organic binder, said insulation being of a thickness no greater than .00125 inches.

29. A wire having on its surface a closely adherent layer of flexible refractory insula-

tion consisting substantially of finely divided non-fibrous inorganic insulating material held upon the wire by a baked resinous binder, said insulation being of a thickness no greater than .00125 inches.

30. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of finely divided insulating oxide held upon the wire by a baked resinous binder, said insulation being of a thickness no greater than .00125 inches.

31. A wire having on its surface a closely adherent layer of flexible refractory insulation consisting substantially of finely divided insulating oxide particles capable of passing through a 200 mesh screen, said oxide particles being held upon the wire by a baked resinous binder.

32. A wire having on its surface a closely adherent flexible insulating layer consisting of a mixture of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating binder material and an inorganic binder compound effective at elevated temperatures, said insulation being of a thickness not greater than .00125 inches.

33. A wire having on its surface a closely adherent flexible insulating layer consisting of a mixture of finely divided non-fibrous inorganic insulating material, a water-insoluble resinous insulating binder material and an inorganic binder effective at elevated temperatures, the inorganic materials of said insulation consisting of particles capable of passing through a 200 mesh screen.

34. A wire having on its surface a closely adherent flexible insulating layer consisting of a mixture of finely divided insulating oxide, a water-insoluble resinous insulating binding material and an inorganic binder compound effective at elevated temperatures, the inorganic materials of said insulation consisting of particles capable of passing through a 200 mesh screen, and the thickness of said insulation being not greater than .00125 inches.

35. A wire having a flexible insulating coating consisting substantially of finely divided chromium oxide, boric acid, and a water-insoluble resinous insulating binding material, said insulating coating being of a thickness not greater than .00125 inches.

36. A wire having a flexible insulating coating consisting substantially of finely divided chromium oxide, boric acid, and a water-insoluble resinous insulating binding material, said chromium oxide and boric acid consisting of particles capable of passing through a 200 mesh screen.

37. The process of forming a closely adherent flexible insulating coating upon a wire which comprises applying to the wire a refractory inorganic material, a boron compound, a water-insoluble resinous insulating binding material and a volatile sol-

70

75

80

85

90

95

100

105

110

115

120

125

130

vent therefor, and heating said insulating layer upon the wire to a temperature greater than 185° C.

38. The process of forming a closely adherent flexible insulating coating upon a wire which comprises applying to the wire a layer of a mixture consisting substantially of finely divided non-fibrous refractory inorganic material, a water-insoluble resinous insulating binding material, and a volatile solvent therefor, an inorganic binder compound, and heating said insulating layer upon the wire.

39. The process of forming a closely adherent flexible insulating coating upon a wire which comprises applying to the wire a layer of a mixture consisting substantially of finely divided non-fibrous refractory inorganic material, a water-insoluble resinous insulating binding material and a volatile solvent therefor, an inorganic binder compound, and heating said insulating layer upon the wire to a temperature greater than 185° C.

40. The process of forming a closely adherent flexible insulating coating upon a wire which comprises applying to the wire a layer of a mixture consisting substantially of finely divided insulating oxide, a water-insoluble resinous insulating binding material and a solvent therefor, an inorganic binder, and heating said insulating layer upon the wire to a temperature greater than 185° C.

In testimony whereof, I affix my signature.
SAMUEL RUBEN.