

May 19, 1942.

G. L. McCREERY ET AL

2,283,685

HIGH RESISTANCE CONDUCTING COATING FOR ELECTRIC INSULATORS

Filed Aug. 20, 1940

Fig. 1.

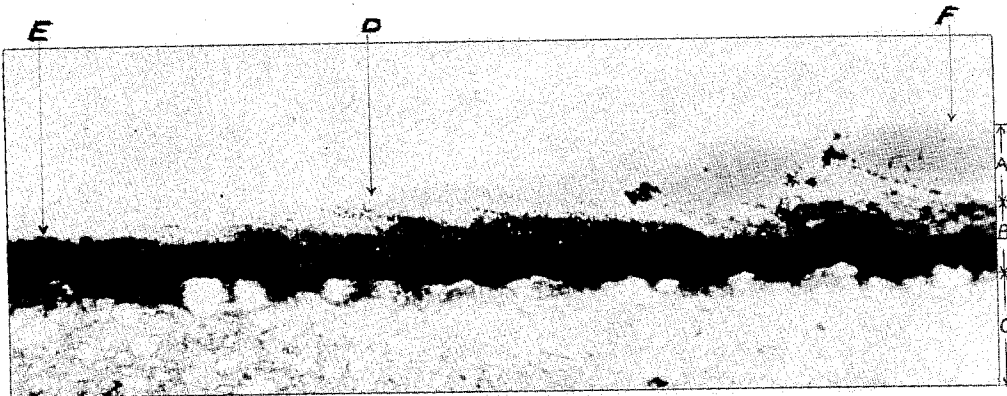
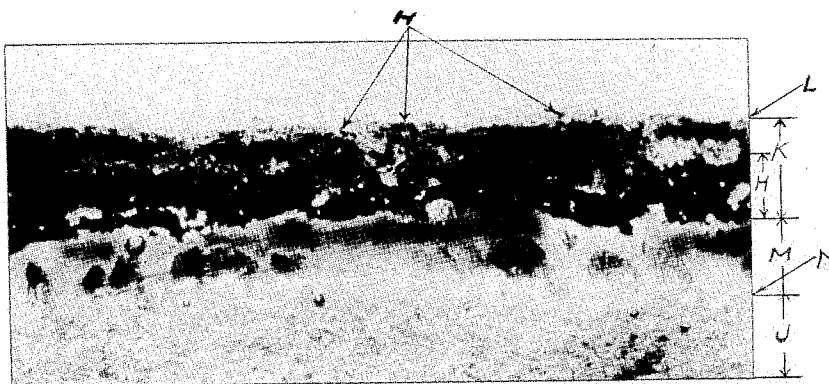


Fig. 2.



INVENTORS
George L. McCreery
Van E. Campbell
BY *Alpheus J. Crane*
ATTORNEY

UNITED STATES PATENT OFFICE

2,283,685

HIGH RESISTANCE CONDUCTING COATING
FOR ELECTRIC INSULATORS

George L. McCreery and Van E. Campbell, Wadsworth, Ohio, assignors to The Ohio Brass Company, Mansfield, Ohio, a corporation of New Jersey

Application August 20, 1940, Serial No. 353,368

9 Claims. (Cl. 174-140)

This invention relates to high resistance conducting coatings for electric insulators and has for one of its objects the provision of such a coating that will provide the desired resistance and conductivity, that will produce a durable and attractive finish, that will afford good electrical connection between the coating and conductors secured to the insulator and that can be economically and easily applied and that will not involve serious losses in insulator manufacture.

Other objects and advantages will appear from the following description.

The invention is exemplified by the combination and arrangement of parts and by the steps of the process shown in the accompanying drawing and described in the following specification, and it is more particularly pointed out in the appended claims.

This application is a continuation in part of our prior application, Serial No. 255,284, filed February 8, 1939.

In the drawing:

Fig. 1 is a photomicrograph of a section through a portion of a porcelain body having a high resistance conducting coating applied thereto, the portion of the coating at the right hand side of the figure being covered by a layer of silicate glaze which layer tapers in thickness leaving the conducting coating at the left of the figure uncovered. The magnification is approximately one hundred and fifty diameters.

Fig. 2 is a view similar to Fig. 1, except that the silicate glaze extends across the entire figure and an activating agent has been added to the conducting coating which has carried portions of the conducting material to the surface of the silicate glaze.

In the operation of electric insulators it has, in many cases, been found desirable to have portions of the insulator surface coated with a high resistance conducting coating to control the voltage distribution over the surface and regulate the electrostatic stress in the dielectric field. This regulation is especially useful in reducing or preventing radio disturbances that would otherwise be produced by the electrostatic stress at the terminal edges of the insulator fittings and at other points of high electrostatic stress. Many forms of conducting coatings for insulator surfaces have been proposed, one being a coating of various metallic oxides covered by a coating of silicate glaze. In the practical application of this form of conducting coating, however, serious difficulties have been encountered in securing uniformity of conductivity and particularly

in securing good electrical connection between the terminal conductors and the conducting coating. It has heretofore been possible to secure desirable results where this form of coating has been used only by employing special glazing operations to insure an abnormally thin coat of the plain silicate glaze over the treated areas when good electrical contact must be obtained. Fig. 1 of the drawing of the present application is a photomicrograph of a thin cross section of such an insulator through plain glaze A, conducting glaze B and porcelain C. The plain glaze A shows a gradually increasing thickness from left to right. The conducting glaze B is of practically the same thickness throughout and shows only scattered diffusion into the plain glaze A beyond the point D where the thickness of the covering layer of plain glaze A is about .001". At point E the conducting layer is practically without any plain glaze cover in which condition the electrical resistance of this type of conducting material approaches infinity because exposure to kiln atmosphere in the firing process destroys the conducting property. At point F the plain glaze reached a thickness of .004" to .005" which is in the order of thickness usually obtained by the practices employed in the glazing of a plain insulator. Between points D and F it is very difficult to make electrical contact with the conducting layer because of the thick insulation of the plain glaze. The best electrical contact with this type of glazing we have found to be secured when the covering coat is within the range of .0005" to not over .0015". This unusually thin covering of plain glaze has been found very difficult to maintain in quantity production.

Insulators manufactured with the type of conducting glaze illustrated in Fig. 1, under carefully watched conditions seldom showed less than a 5% rejection for radio interference mainly due to poor electrical contact and frequently this rejection reached 50%. With our improved conducting glaze repeated testing using several hundred insulators at a time from routine production batches has demonstrated that the rejections for radio interference can be readily held to less than 0.5%.

This improvement has been accomplished by our discovery of a conducting glaze composition, which automatically relocates the conducting layer at the proper position with reference to the surface of the covering coat of plain glaze when the latter is applied in the usual manner and with the usual range of thickness variations encountered in ordinary glazing, thus insuring

both good conductivity and good contact resistance in the treated areas. The ingredients and their individual functions in accomplishing this result are as follows:

Our improved conducting glaze consists of magnetic iron oxide (Fe_3O_4) blended with a relatively fusible composition and an activating agent.

This glaze is prepared as a water suspension to which may be added, if desired, a small amount of a suspending agent such as an organic compound like glue or the mineral bentonite as is well known in the ceramic art.

This conducting glaze is applied directly on the unfired insulator and then the entire insulator is covered with the usual thickness of plain silicate glaze after which the subsequent operations including firing are the same as for plain insulators. The silicate cover glaze is the same as is usually used for plain insulators, one suitable composition being known as brown glaze and comprising approximately 96% Albany slip, 1.5% MnO_2 and 2½% whiting.

We have found that magnetic iron oxide has many advantages as the conducting element of the combination over conducting materials heretofore suggested. It possesses natural conducting properties and does not combine readily with the other ingredients in addition to its peculiar action due to its magnetic properties, as will be explained.

The fusible composition becomes fluid at the firing temperatures for electrical porcelain and allows some movement of the magnetic iron oxide, which because of its self magnetic properties shows a tendency for the particles to migrate toward each other in the fluid and form a continuous conducting layer in the molten composition. The fusible composition must not combine with and decompose the magnetic iron oxide, but because the latter is quite resistant to chemical recombinations with fused silicate compositions, a wide choice of ingredients and proportions is available and well known in the ceramic art. However, one suitable composition which has given good results in firing the ware at cone 10 to cone 12 is as follows:

Molecular formula for fusible composition

.1322 K_2O	} 421 Al_2O_3 (3.67 SiO_2)
.0498 Na_2O	
.5680 CaO	
.1190 BaO	
.1310 ZnO	

1.0000

The incorporation of a suitable quantity of an activating agent in our glaze combination makes a unique change in the reactions during firing and produces a valuable improvement in conductivity at the surface of the glazed area. Without the activating agent the layer of magnetic iron oxide remains close to the porcelain and shows little tendency to diffuse or migrate into the covering coating of plain glaze during the firing operation.

Fig. 2 is a photomicrograph of a thin cross section through the porcelain, conducting glaze and plain glaze of an insulator treated with our improved conducting glaze, showing the appearance after the firing operation is completed. The dense black layer of conducting material H, due to the effect of the activating agent, has moved away from the surface N of the porcelain J and into the stratum K which was originally

occupied only by plain glaze. Many minute chains of the conducting material H¹ have diffused through to the surface of the plain glaze and form a good electrical connection between the surface of the plain glaze L and the main conducting layer H. The clear glassy stratum M is a result of the chemical reaction between the activator in our conducting glaze formula and the porcelain and is not evident except when an activator is used.

A suitable example of an activating agent is, manganese dioxide. This is an active flux in a silicate mixture and it reacts vigorously with the porcelain and the fusible composition to dissolve and completely vitrify the adjacent porcelain to a depth of about .0005". The vigorous nature of this reaction, which is possibly accompanied by the release of some gases, lifts the layer of magnetic iron oxide and causes an outward migration of the conducting material through the covering of plain glaze, which is sufficient to penetrate readily a covering layer of .004" to .006" of plain glaze and produce the desired low contact resistance well distributed over the surface area. This reaction makes a simple operation of the final glazing procedure since the entire insulator may be uniformly coated with the same density of plain glaze without interfering with the conducting properties of the treated area.

Other activating agents have been found in the group comprising nickel oxide, cobalt oxide and copper oxide. For example, a combination of approximately equal parts of black nickel oxide and black copper oxide may be substituted for the manganese dioxide although neither nickel oxide nor copper oxide performs the activating result alone. The combination of nickel oxide and copper oxide does not produce a conducting coating without the presence of the magnetic iron oxide. We have found that chromium oxide, uranium oxide and red iron oxide (Fe_2O_3) do not exhibit desirable properties as activators in our glaze combination. It should be understood that the term "oxide" is also intended to include the related compounds which revert to the oxide form during the firing operation as is well known in ceramic practice. Manganese dioxide exhibits the property of activation to an unusual degree and at the same time has excellent stability in the prepared mixture and a uniform reaction under considerable variations in the routine of insulator manufacture.

The proportion of the activator, such as manganese dioxide, to be incorporated in the conducting glaze depends upon the characteristics of the plain glaze with which it is to be used. Too small a quantity fails to move the conducting layer to the surface of the covering layer of plain glaze; too much manganese dioxide frequently causes exposure of the conducting layer to kiln gases during the firing operation and results in a matte finish with excessive electrical resistance. However, the suitable limits for the amount of manganese dioxide were found to be quite broad. For example, when tested in combination with the particular plain glaze referred to above, the manganese dioxide content of the conducting composition could be varied from 7.5% to 22% before the suitable limits were exceeded. With other plain glazes these limits may be broader or narrower ranging from 5% to 25%, but a content of 17% has been found to work successfully with a variety of plain glazes,

by merely adjusting the procedure for applying the plain glaze to provide a coating of proper thickness to balance the activity of the conducting glaze.

The proportions of magnetic iron oxide are also capable of considerable variation. Insufficient magnetic iron oxide is evidenced by a lack of continuous conductivity in the treated area; an excess is shown by blistering of the finished coat. The properties of the plain glaze employed as the covering coat limit the extremes which may be used with that particular combination. A range of 35% to 65% was found to be the suitable limit of magnetic iron oxide in the conducting composition when used with the particular plain glaze recited above, but a magnetic iron oxide content of approximately 50% was found to be suitable for a variety of plain glazes. Proportions of fusible glassy composition may vary from 25% to 50% of the conduction glaze mixture.

A suitable formula of ingredients for use with a variety of plain glazes, including the brown glaze referred to above, is as follows:

	Per cent (dry weight)
Fusible composition-----	33
Magnetic iron oxide-----	50
Manganese dioxide-----	17

The dry ingredients are prepared for use by grinding in a glaze mill with water and a suspending agent according to well known ceramic practices. The ingredients discussed and the proportions noted are all based on commercial grades of average quality.

We claim:

1. An insulator body and a conducting glaze composition thereon comprising a conducting layer of magnetic iron oxide, a substantially thicker covering coating of plain glaze, and means in said conducting layer for automatically conveying portions of said magnetic iron oxide to the surface of said plain glaze by reactions incident to the firing operation.

2. An electric insulator and a coating therefor comprising a conduction layer and a cover layer, said conduction layer including an activating agent that causes distribution of the material of said conduction layer through said cover layer during firing.

3. An electric insulator and a high resistance conducting glaze thereon comprising magnetic iron oxide, a glassy composition that fuses during firing of the insulator and an activating agent for redistributing said magnetic iron oxide while said glassy composition is in a fused state.

4. An electric insulator and a coating thereon comprising a conduction layer and a cover layer of silicate glaze, said conduction layer including magnetic iron oxide, a glassy composition that fuses at the firing temperature of the insulator,

and an activating agent that causes portions of said iron oxide to penetrate through to the surface of said cover layer during firing to provide electrical connection between the surface of said coating and said conduction layer.

5. An electric insulator and a coating thereon comprising a conduction layer and a layer of silicate glaze disposed over said conduction layer, said conduction layer including magnetic iron oxide, a fusible glassy composition and an activating agent selected from the group composed of manganese dioxide, cobalt oxide and a mixture of nickel oxide and copper oxide.

6. The combination with an electric insulator of a high resistance conduction coating thereon, said coating comprising a conduction layer and a cover layer of silicate glaze, said conduction layer including magnetic iron oxide, the main body of which is covered by said silicate glaze but electrically continuous portions of which penetrate through to the outer surface of said silicate glaze to provide electrical connection between said surface and said conduction layer.

7. The combination with a porcelain insulator of a conduction coating therefor comprising a conduction layer contacting the surface of said porcelain layer and having a fused connection thereto and a silicate glaze covering said conduction layer and fused to said conduction layer, said conduction layer comprising magnetic iron oxide, a glassy composition that fuses during firing of said insulator and an activating agent that reacts with said porcelain during firing and produces relocation of said magnetic iron oxide causing portions thereof to penetrate through to the surface of said silicate glaze and provide electrical connection between said surface and said conduction layer.

8. An insulator having a high resistance conduction coating thereon, said coating comprising particles of magnetic iron oxide mixed with a fusible glassy material and having electrical contact with one another to provide electrical continuity while being protected from mechanical and electrical impairment by said fusible glassy material.

9. An insulator having a high resistance conduction coating thereon, said coating comprising a thin layer of magnetic iron oxide particles in the presence of a fusible glassy material and covered by a protection coating of silicate glaze, the particles of said magnetic iron oxide being in electrical contact with one another to provide electrical continuity of said coating and some of said particles forming minute chains of conducting material extending from said layer of magnetic iron oxide particles to the surface of said silicate glaze and providing electrical connection between said layer and surface.

GEORGE L. McCREERY.
VAN E. CAMPBELL.