United States Patent [19]

Tsuzuki et al.

[11] **3,798,351**

[45] **Mar. 19, 1974**

[54] **ELECTRIC INSULATORS HAVING NON-CORONA AND ANTI-POLLUTION PROPERTIES**

[75] Inventors: **Kaoru Tsuzuki**, Nagoya; **Setsuo Kozaka**, Kasugai, both of Japan

[73] Assignee: **NGK Insulators, Ltd.**, Nagoya, Japan

[22] Filed: **Oct. 25, 1972**

[21] Appl. No.: **300,574**

[30] **Foreign Application Priority Data**

Nov. 1, 1971 Japan 46-86280

[52] **U.S. Cl.** .... **174/140 C**, 174/182, 174/211

[51] **Int. Cl.** **H01b 17/42**, H01b 17/50

[58] **Field of Search** .... 174/140 R, 140 C, 141 R, 174/141 C, 182, 209, 210, 211

[56] **References Cited**

UNITED STATES PATENTS

3,658,583 4/1972 Ogawa .... 174/140 C UX

FOREIGN PATENTS OR APPLICATIONS

647,313 7/1937 Germany .... 174/140 C

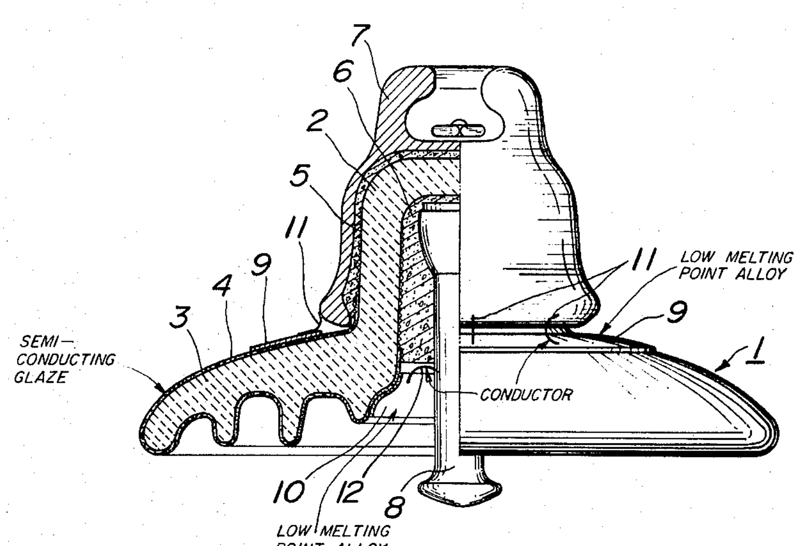
586,065 3/1947 Great Britain .... 174/140 C

Primary Examiner—Laramie E. Askin

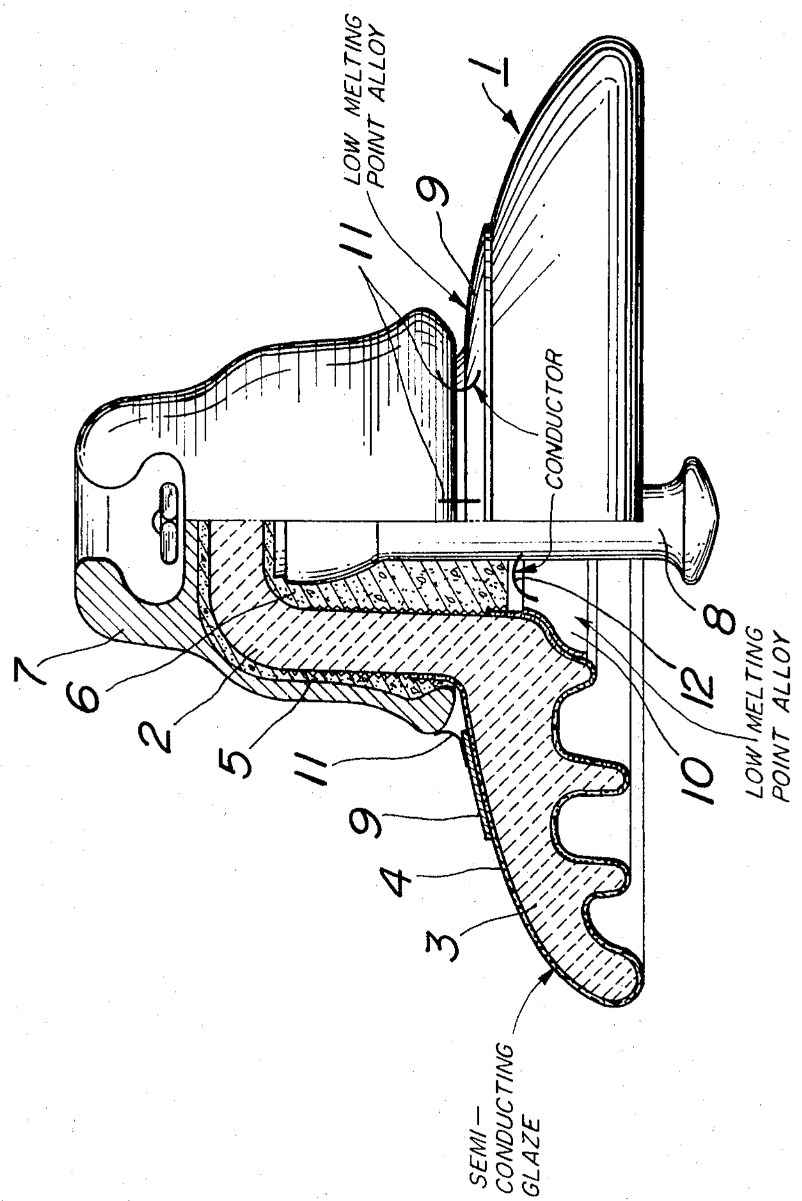
[57] **ABSTRACT**

An electric insulator for maintaining excellent non-corona property and pollution resistant property for a long period of time, comprises a porcelain body provided at its both poles with metal fittings fixed thereto by means of cement, a semi-conducting glaze applied to the porcelain body and projected slightly into the cement and connecting said both poles, low melting point alloy portions applied directly on said semi-conducting glaze and kept in a substantial insulation from said metal fittings, and conductors connecting electrically said metal fittings to said low melting point alloy portions, respectively.

4 Claims, 1 Drawing Figure



PATENTED MAR 19 1974 3,798,351



ELECTRIC INSULATORS HAVING NON-CORONA AND ANTI-POLLUTION PROPERTIES

The present invention relates to electric insulators, and more particularly, to an improvement in an electric insulator which comprises porcelain coated at its exposed surface with a semi-conducting glaze and by which excellent non-corona discharge property and pollution resistant property can be maintained for a long period of time. In general, electric insulators of this kind comprise porcelain coated wholly or partly at its exposed surface with a semi-conducting glaze. In the present invention, the term "electric insulator" means any types of these insulators wherein the coated semi-conducting glaze is connected to both poles of the exposed surface of the porcelain.

In the electric insulators of this kind, in addition to the presence of surface leakage current, an electric current, which is considerably larger than the surface leakage current and flows through the semi-conducting glaze, flows through Portland cement (hereinafter referred to as cement) which adheres the metal fitting and the porcelain. As the result, the cement is dried due to Joule's heat and formed into an insulating material and corona discharge is liable to occur in this portion. That is, the non-corona property of the electric insulator is considerably deteriorated in spite of the presence of semi-conducting glaze coating. Therefore, it is a very important problem how to make the passage between the metal fitting and the semi-conducting glaze conductive.

In order to overcome these drawbacks, it has hitherto been proposed a method wherein the exposed surface of the cement, the metal fitting and the semi-conducting glaze near the exposed surface of the cement are simultaneously covered with a metallic film of zinc or lead to effect a direct electrical connection between the metal fitting and the semi-conducting glaze. However, since the electrode potential of the surface material of the metal fitting and that of the semi-conducting glaze are different, a local battery action is caused in the wet state regardless of the kind of the metallic film, and the metal fitting, the semi-conducting glaze or the metallic film is corroded electrically to make the passage between the metal fitting and the semi-conducting glaze non-conductive. In order to prevent this local battery action, insulating paint has hitherto been applied to the surface of the metallic film and its peripheral portion. However, since any kind of insulating paint is insufficient in weather resistance, water is easily penetrated into the paint, and a local battery action occurs to make the passage between the metal fitting and the semi-conducting glaze less conductive in a very short period of time.

Particularly, in a prior art for preventing electric corrosion of metal fitting of electric insulators used for direct current, for example, in British Pat. No. 505,981, an electrode (hereinafter referred to as guard electrode) is adhered to that portion of a porcelain body which is located near the metal fitting by means of cement, and the metal fitting and the guard electrode are connected by means of a conductor. However, since the guard electrode is used essentially for the purpose of preventing electric corrosion of the metal fitting, the guard electrode and the porcelain body are electrically connected only when the surface of the porcelain body and the exposed surface of the cement are made conductive due to wetting and pollution. Therefore, even when a semi-conducting glaze were applied to such kind of electric insulator, the above described corona discharge could not be prevented.

Further, an electric insulator having a semi-conducting glaze coating shown in FIG. 3 of British Pat. No. 586,065 has been known, wherein a conductive metal layer is arranged between a cement and the outer surface of a porcelain body on one hand and another conductive metal layer is arranged between a cement and the inner wall of the porcelain body on the other hand in such a manner that the upper end of the former metal layer reaches near the top of the porcelain body, while the upper end of the latter metal layer reaches near the top of the recess of the porcelain body. The lower ends of both the metal layers are projected slightly from the cements and contacted closely with a semi-conducting glaze. If necessary, each of the conductive metal layers may be connected to the metal fitting by means of wires. However, in the electric insulator shown in FIG. 3 of British Pat. No. 586,065, when wire is absent, the passage between the metal fitting and the semi-conducting glaze is made conductive through the cement, and it is impossible to prevent corona discharge at the inner and outer surfaces of the cement similarly to the above described conventional electric insulators. While, when wire is present, if the cement is wet, a local battery is formed by a circuit constituted with the metal fitting, wire, conductive metal layer and cement due to the reason that the conductive metal layer is faced to the metal fitting through the cement over the whole circumference of the metal layer, and a relatively large circulating electric current flows to corrode electrically the metal fitting and the conductive metal layer, whereby the adhesive strength of the cement is deteriorated and the mechanical strength of the electric insulator is decreased in a short period of time.

The object of the present invention is to provide an electric insulator which comprises porcelain coated at its exposed surface with a semi-conducting glaze and by which excellent non-corona discharge property and pollution resistant property can be maintained for a long period of time.

The present invention will be more fully understood by reference to the following detailed specification and claims taken in connection with the appended drawing, in which:

The single FIGURE shows a front view of one embodiment of electric insulators of the present invention, the left half of which being shown in cross-section.

Referring to the FIGURE, the cap and pin type electric insulator of the present invention, which may be of any other type, comprises a porcelain body **1**, which is composed of a head **2** and a skirt **3** and coated at its exposed surface with a semi-conducting glaze **4** described, for example, in the specification of U.S. Pat. No. 3,658,583, an upper metal fitting **7** fixed to the outer periphery of the head **2** by means of cement **5**, a lower metal fitting **8** fixed to the recess of the head **2** by means of cement **6**, low melting point alloy portions **9** and **10** directly applied to the semi-conducting glaze **4** without using insulating adhesives, such as cement, and isolated from the metal fittings **7** and **8** by a proper surface leakage distance so as to effect a substantial insulation therebetween, and conductors **11** and **12** connecting electrically the metal fittings **7** and **8** to the low melting point alloy portions **9** and **10,** respectively. In this insulator, neither the conductive current nor the circulating current due to local battery action substantially flows through the cement. The semi-conducting glaze is slightly projected into the cement beyond its exposed end surface. In the adhering portion of the porcelain to the cement, sanding has previously been effected by a conventional glaze. In the FIGURE, the thicknesses of the semi-conducting glaze **4** and low melting point alloy portions **9** and **10** are shown on an enlarged scale.

The low melting point alloy portions **9** and **10** may be formed in the following manner. A certain metal is previously melt-sprayed or metallized on the semi-conducting glaze **4** on the surface of the skirt **3,** and then a conventional soft solder is fused and coated on the metal. Alternatively, an indium soft solder or a soft solder for ceramic use, which is composed of 40 to 90% ("%" means percentages by weight) of Pb, 0.05 to 10% of Sn, 1.8 to 50% of Sb, 0.05 to 10% of Zn, up to 0.1% of Al and up to 0.5% of Si+Be+Ti, is melted and directly applied on the semi-conducting glaze **4.** In the electric insulator shown in the FIGURE, low melting point alloy portions **9** and **10** are applied on the skirt **3** in an annular shape. However, the shape, position and number of the low melting point alloy portions **9** and **10** are not limited to those shown in the FIGURE, when these alloy portions are arranged on the semi-conducting glaze **4** and substantially insulated from the metal fittings **7** and **8.** As the conductors **11** and **12,** single wires are preferably used, but twisted wires or strips may be also used. The shape of the conductors is optional.

The conductor **11** or **12** is connected to the metal fitting **7** or **8** and to the low melting point alloy portion **9** or **10** respectively by conventional means used for ordinary electrical connection, such as soldering, welding, embedding and terminal connection. Further, the conductors **11** and **12** can be connected to the metal fittings **7** and **8** at any position, respectively. For example, the conductors **11** and **12** may be connected to the metal fittings **7** and **8** through the cements **5** and **6,** respectively.

In the electric insulator shown in the FIGURE, the metal fittings **7** and **8** are insulated from the low melting point alloy portions **9** and **10** respectively by merely isolating the metal fittings from the alloy portions at a prolonged surface leakage distance. However, the insulating method is not limited to the above method. For example, the metal fittings **7** and **8** or the low melting point alloy portions **9** and **10,** or both of them may be applied with an insulating paint or subjected to a surface insulating treatment, or insulating mediums may be interposed between the metal fittings **7, 8** and the alloy portions **9, 10** respectively, in order that the metal fitting and the alloy portion are contacted through these insulating materials. As the result of this insulation treatment, local battery actions between the low melting point alloy portions **9, 10** and the metal fittings **7, 8** respectively can be substantially prevented.

Moreover, in order to prevent the local battery actions between the conductors **11, 12** and the low melting point alloy portions **9, 10** on one hand and between the conductors **11, 12** and the metal fittings **7, 8** on the other hand, or to suppress the local battery actions to such an extent that causes substantially no practical obstacles, the surfaces of the both ends of the conductors **11** and **12** at the connecting portions are insulated, or the surface material metals of the conductors **11, 12** and the metal fittings **7, 8** connected thereto and those of the conductors **11, 12** and the low melting point alloy portions **9, 10** connected thereto are selected such that the surface material metal having a smaller area at the connected position is nobler. That is, in the preferred embodiment of the electric insulators of the present invention, wherein wires are used as the conductors **11** and **12** and zinc is used as the surface material metal of the metal fittings **7** and **8,** since the area of the metal fitting is considerably larger than that of wires, copper wires are preferred to be used as the conductors **11** and **12.**

Further, the embodiment shown in the FIGURE is a cap and pin type electric insulator. However, any types of electric insulators included in the above described definition may be used in the present invention regardless of the type. According to the electric insulator of the present invention, both of the conductive current and circulating current due to local battery action do not flow through cement regardless of its type, and a non-corona property considerably superior to that of the above described conventional electric insulators can be maintained for a long period of time.

In order to prove excellent properties of the electric insulator of the present invention, the following tests were effected by using the cap and pin type electric insulator shown in the FIGURE.

The electric insulator of the present invention and a conventional electric insulator having a zinc film obtained by spraying melted zinc were compared with respect to the liability of the electrical connection faculty and to the life maintained against electric corrosion of the electrical connection. The obtained results are shown in the following Tables 1 and 2.

TABLE 1.—LIABILITY OF ELECTRICAL CONNECTION FACULTY

Test	Repeated tensile load test				Repeated cooling and heating test*			
Condition	Maximum tensile load: 6.8 ton Minimum tensile load: 2.27 ton				Highest temperature: 96°C Lowest temperature: 4°C			
Integrated repeated number of tests	1	10	6×10^4	9×10^4	10	10^2	3×10^2	10^3
Insulator of the present invention	○	○	○	○	○	○	○	○
	Number of samples: 20				Number of samples: 20			
Conventional insulator	6: good 4: bad	×	–	–	×	–	–	–
	Number of samples: 10				Number of samples: 10			

*According to Para. 9.3.6 of American National Standard, C29.2–1971.

TABLE 2.—LIFE MAINTAINED AGAINST ELECTRIC CORROSION OF THE ELECTRICAL CONNECTION

Test	Accelerating electric corrosion test[1]					
Condition	AC (60 Hz)			DC[2]		
Integrated amount of leakage current	Unit: amp/sec			Unit: coulomb		
	3×10^4	5×10^4	10×10^4	3×10^3	5×10^3	10×10^3
Insulator of the present invention	O	O	O	O	O	O
	Number of samples: 5			Number of samples: 5		
Conventional insulator	3: good 2: bad	×	–	×	–	–
	Number of samples: 5			Number of samples: 5		

NOTE:
[1] All the accelerating electric corrosion tests are carried out in a 3 percent aqueous solution of table salt.
[2] In the direct current accelerating electric corrosion test, the lower metal fitting is used as an anode.

In the above described Tables 1 and 2, the term "good" means a state that the electrical connection faculty was maintained, and the term "bad" means a state that the electrical connection faculty was not maintained. The mark "O" shows that all the samples are good, and the mark "×" means that all the samples are bad. The integrated repeated number of tests of 9×10^4 in the repeated tensile load test, the integrated repeated number of tests of 10^3 in the repeated cooling and heating test, the integrated amount of leakage current of 10×10^4 amp×sec in the alternate current accelerating electric corrosion test and the integrated amount of leakage current of 10×10^3 coulombs in the direct current accelerating electric corrosion test correspond to the practical use periods of an electric insulator for about 50 years, 50 years, 25 years and 15 years, respectively.

Further, the electric insulator of the present invention and that shown in FIG. 3 of British Pat. No. 586,065 were compared with respect to the following properties.

The radio noise test, which is an indication of corona discharge, was effected according to Para. 9.3.4 of American National Standard, C29.2–1971. In the electric insulator shown in FIG. 3 of British Pat. No. 586,065 and having no wires, a radio noise more than the back noise level, which is about 15 dB in the case when 1 microvolt is expressed by 0 dB, was generated 60 minutes after applying a voltage of 30 KV, 120 minutes after applying a voltage of 20 KV and 210 minutes after applying a voltage of 10 KV. While, in the electric insulator of the present invention, a radio noise more than the back noise level was not substantially generated even when a voltage of 30 KV was applied for 1 year.

Further, the electric insulator of the present invention was compared with the conventional electric insulator shown in FIG. 3 of British Pat. No. 586,065 and having wires with respect to the repeated cooling and heating test and the mechanical tensile breaking test by using each 20 test samples to obtain a result as shown in the following Table 3.

TABLE 3

Insulator		Result: Repeated cooling[1] and heating test	Result: Mechanical tensile breaking test[2]: Tensile load	
Insulator of the present invention.	Sound insulator	All good	Minimum: 15.8 tons; Maximum: 17.0 tons; Average: 16.3 tons	In all samples, metal fitting was broken.
	After outdoor suspension for three years.	All good	Minimum: 15.7 tons; Maximum: 17.2 tons; Average: 16.4 tons	In all samples, metal fitting was broken.
Conventional insulator	Sound insulator	All good	Minimum: 16.0 tons; Maximum: 17.1 tons; Average: 16.6 tons	In all samples, metal fitting was broken.
	After outdoor suspension for three years.	12 samples: good; 8 samples: bad	Minimum: 7.0 tons; Maximum: 14.3 tons; Average: 11.1 tons (12 samples)	In all samples, cement was broken.

NOTE:
[1] According to Para. 9.3.6 of American National Standard, C29.2–1971.
[2] According to Para. 9.4.4 of American National Standard, C29.2–1971.

As seen from the above described tests, according to the present invention, various drawbacks in the conventional electric insulators of this kind can be completely removed, and even when the electric insulator of the present invention is subjected to the repeated loads and repeated temperature changes, or is used in a salt-injurious district where a large amount of surface leakage electric current flows, or as an electric insulator for direct current, a non-corona property is maintained for a long period of time without losing the electrical connection faculty. Therefore the electric insulator of the present invention contributes greatly to the industry.

I claim:

1. An electric insulator comprising

a porcelain body,

said porcelain body provided at its both poles with metal fittings fixed thereto by means of cement,

a semi-conducting glaze applied to the porcelain body and projected slightly into the cement and connecting said both poles,

a pair of low melting point alloy portions which encircle the body, respective portions of which being in the neighborhood of said respective poles but isolated from the respective cements,

said semi-conducting glaze being between said alloy portions and said body,

and conductors connecting electrically said metal fittings to said low melting point alloy portions, respectively.

2. The insulator as claimed in claim 1, wherein each conductor is a copper wire.

3. The insulator as claimed in claim 1, wherein said insulator is a cap and pin type insulator.

4. The insulator as claimed in claim 1, wherein said insulator is of an insulator whose porcelain body is provided at its total exposed surface with said semi-conducting glaze.

* * * * *