Sept. 19, 1950 W. R. WILSON 2,523,082

SURFACE COATED ELECTRICAL BUSHING

Filed Nov. 30, 1946

Fig. 1.

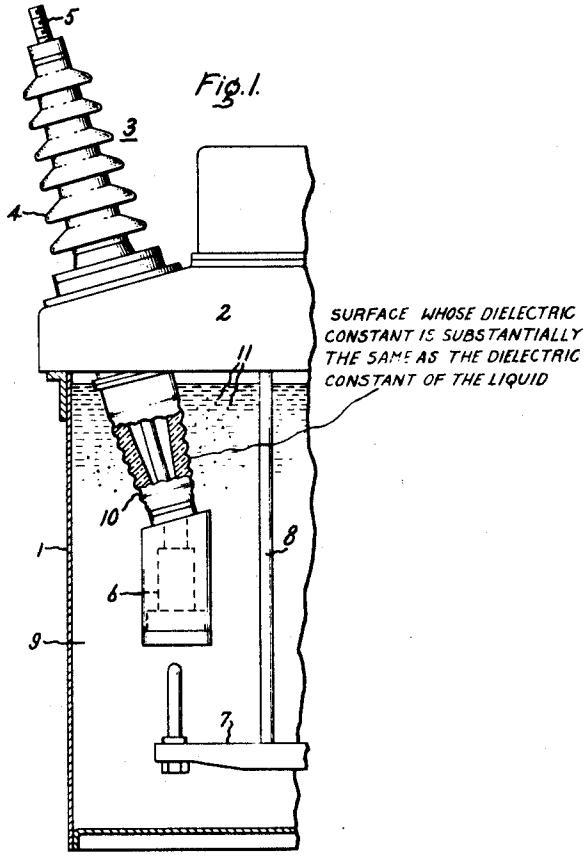


Fig. 2.

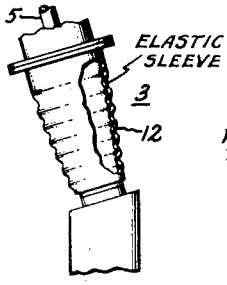


Fig. 3.

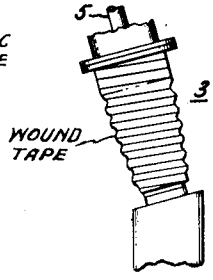
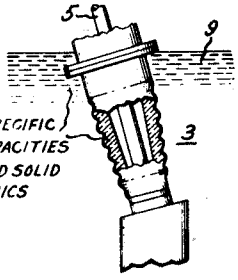


Fig. 4.



Inventor:
Walter R. Wilson,
by Ernest A. Britton
His Attorney.

Patented Sept. 19, 1950 2,523,082

UNITED STATES PATENT OFFICE

2,523,082

SURFACE COATED ELECTRICAL BUSHING

Walter R. Wilson, Pittsfield, Mass., assignor to General Electric Company, a corporation of New York

Application November 30, 1946, Serial No. 713,249

2 Claims. (Cl. 174—18)

1

This invention relates specifically to electrical bushings and more generally to phenomena occurring at the boundary of solid and fluid dielectrics in an alternating electric field.

High voltage oil circuit breakers usually include glazed porcelain clad bushings. A part of the porcelain shell of the bushing extends down into the oil which fills the tank and which, of course, surrounds the circuit interrupting contacts. It is a well known fact that the porcelain which is in the oil in time becomes coated with carbon. This deposited carbon layer being an electrical conductor or at least a semi-conductor reduces materially the dielectric strength of the bushing and, in fact, actual arcovers and failures of the apparatus from this cause have occurred during normal operation.

The carbon which is deposited on the bushing porcelain comes from carbonized and other cracked oil products which are created by the electric arc when the circuit breaker interrupts current. These particles migrate throughout the tank and are drawn to the porcelain of the insulating bushing by reason of non-uniformities or distortions in the electric field in which they are located. These distortions in the electric field may be produced in a number of different ways. One is a result of the physical design and shape of the bushing and its various parts. Another cause is the non-homogeneity of the bushing porcelain or glaze such as is produced by gas or air pockets in the porcelain or other foreign particles therein which have different dielectric properties than the porcelain itself. Still another cause is the carbon particles themselves for they have different electrical properties than the oil and porcelain and consequently distort the field.

It is true that a conducting particle in a uniform alternating electric field will not be acted upon by any electrically produced force. However, I have discovered that when a solid dielectric of a given specific inductive capacity (dielectric constant) is in a fluid insulating medium of substantially lower dielectric constant, the surface of the solid insulator acts like an electrical mirror with respect to conducting particles which are in the fluid. In other words, a carbon particle in conventional insulating oil (dielectric constant about 2.2) when it approaches the surface of the glazed porcelain (dielectric constant about 7) is imaged at the back of the porcelain surface and this image in effect distorts the electric field so that the particle is attracted to its image. Once the carbon particle is deposited on

2

the surface of the porcelain it, of course, changes the dielectric properties of the surface of the porcelain at the point and thus directly causes field distortion so that it attracts additional carbon particles to it.

I have found from theoretical considerations, which have been confirmed by actual tests, that if the surface of the solid insulator has a dielectric constant which is the same as the dielectric constant of the fluid, the electrical mirror action is completely eliminated and if the electric field is otherwise relatively uniform, conducting particles (or particles of any dielectric constant) in the fluid will not be attracted to this dielectric surface. If the dielectric constant of the surface is less than the dielectric constant of the fluid, then the force is actually reversed and conducting particles in the fluid will be repelled from the surface. I have also found that a very substantial reduction in the amount of attractive force and deposit of conducting particles on the surface is obtained even though the dielectric constant of the surface is higher than the dielectric constant of the fluid providing it is lower than the dielectric constant of the main body of the solid insulator.

In order to give the surface of the solid insulator the proper dielectric constant, the entire solid insulator may be made of material having the desired dielectric constant in which case the dielectric properties of the surface will be the same as the interior of the insulator. Another way of obtaining the proper surface dielectric constant is to coat the surface of the solid insulator with material having the proper dielectric constant. This coating may be either organic or inorganic and it may be applied as a varnish, a condensed film, a tape which is wrapped or wound around the solid insulator, a sheath or stocking like member which is fitted over the solid dielectric or it may be applied in any other way.

While controlling the dielectric constant of the surface of the solid insulator controls the attractive force for conducting particles due to the above described mirror action, it does not necessarily control the attractive force due to non-homogeneity of the solid dielectric. If the solid dielectric is practically perfectly homogeneous, or if the usual glaze on the porcelain is perfectly homogeneous, then the coating of lower dielectric constant need be no more than about 1 to 2 mils thick for a 115 kv. bushing. For other voltages the minimum thickness will vary accordingly. On the other hand, a homogeneous coat-

ing of the proper dielectric constant which is as much as 12 mils thick will practically eliminate attractive forces due to the non-homogeneity of the underlying dielectric material. In other words, a 12 mil thick homogeneous coating can be used over poor quality glazed porcelain which has a substantial amount of flaws or bubble inclusions in it and its glaze. The 12 mil figure is based on the fact that the diameter of the inclusion bubbles in cast porcelain is of the order of 6 mils and on electrical field strengths which are normally found in bushings. In actual practice, it is doubtful that a coating as thick as 12 mils is necessary because of the fact that the oil has some movement and causes a washing action along the surface of the solid insulator. The reason that the outer homogeneous surface of the solid insulator should be of the thickness stated above is to insure that the electrical force on the particles is less than their weight, so that they sink to the bottom of the tank rather than being attracted to the surface of the solid insulator. The thicknesses given are only suitable examples. The actual thicknesses needed vary depending upon the electric field of the particular bushing to which the film is applied.

While the invention was conceived as the solution of a problem encountered with glazed porcelain bushings in oil circuit breakers, it will of course be apparent to those skilled in the art from the foregoing that the principles involved are in no wise limited to such application or to such materials and that in its broader aspects the invention relates to controlling the force near the boundary of solid and fluid dielectrics in an alternating field on conducting particles in the fluid, whether the fluid is liquid or gaseous.

An object of the invention is to provide a new and improved electrical insulating bushing.

Another object of the invention is to provide a new and improved high voltage electrical apparatus.

A more specific object of the invention is to prevent the deposition of carbon particles on glazed porcelain bushings for oil circuit breakers.

A general object of the invention is to control the attractive force near the boundary of solid and fluid dielectrics in an alternating field on conducting particles in the fluid.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a broken away part sectional view of an oil circuit breaker embodying the invention while Figs. 2, 3 and 4 illustrate modifications.

Referring now to the drawing and more particularly to Fig. 1, there is shown therein a broken away view of part of an oil circuit breaker. This comprises a tank 1 having a cover 2 into which is fitted an insulating bushing 3. The bushing 3 may comprise a main body 4 of glazed porcelain having a line terminal 5 mounted on the outer end and a stationary contact 6 mounted on the inner end. Cooperating with the stationary contact 6 is a movable contact 7 which is operated by a suitable actuating mechanism of any well known type, which is indicated by the rod 8. The tank 1 is substantially filled with dielectric liquid 9, such as conventional mineral oil.

For controlling the attraction of carbon and other conducting particles in the oil 9 to the surface of the bushing which is submerged in the oil, a coating 10 is applied to that part of the

bushing and this coating or outer surface has a dielectric constant which is preferably substantially the same as the dielectric constant of the liquid 9. Its thickness should be at least of the order 1½ mils for average voltages and there appears to be no advantage in having it thicker than about 12 mils. The nearer the dielectric constant of the surface is to the dielectric constant of the oil 9, the less the force on carbon or other conducting particles which are in the oil. Such particles are indicated greatly magnified in the drawing at 11.

The dielectric constant of a typical oil used in oil circuit breakers is 2.2. I have found theoretically that a range of dielectric constants for the outer surface or coating 10 which gives good results varies between 1 and 3.5. One suitable material for coating 10 is silicone varnish which has a dielectric constant of about 3.2. Other suitable materials are ethyl-cellulose (2.7) or barium fluoride (2.3) The latter is similar to magnesium fluoride, a material which has been used in coating optical lenses. Other low dielectric constant materials which have been tested and found suitable are polyethylene (2.3), polytetrafluorethylene (Du Pont "Teflon") (2.0), phenolic resins (2.8) and synthetic rubber (2.6).

There are many other low dielectric constant materials which would be suitable provided they can be put on the porcelain in a homogeneous and smooth film and provided they would not be damaged by the oil or water in the oil.

Another type of coating which may be used is an elastic stocking like member which can be drawn over the lower end of the bushing. This is indicated by the member 12 in Fig. 2. It may be made of oil resistant synthetic rubber, for example, which has been treated in such a way as to have the desired dielectric constant.

Another way of coating the surface of the lower end of the bushing is to wrap it with a tape of suitable material as is shown in Fig. 3. One such material is polyethylene which has a dielectric constant of about 2.2. In a modification shown in Fig. 4, the solid dielectric has no outer coating and is itself made of homogeneous material whose dielectric constant is sufficiently close to that of the liquid 9.

While there have been shown particular embodiments of the invention, it will be obvious to those skilled in the art that changes and modifications can be made without departing from the invention and therefore it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination with a casing containing liquid dielectric and adapted to house alternating current electrical apparatus, an insulating electrical bushing extending through a wall of said casing and having a shell of insulating material surrounding an elongated electrical conductor whose ends extend beyond said shell, a portion of said shell extending into said liquid with one of the ends of said conductor submerged in said liquid, the dielectric constant of said insulating material being substantially different from the dielectric constant of said liquid, and means for inhibiting electrical conducting particles in said liquid from being attracted to and deposited on said portion of said shell comprising a homogeneous coating completely covering all the outside surface of said portion of said shell, said coating having a di-

electric constant which is so much closer to the dielectric constant of said liquid than it is to the dielectric constant of the insulating material of said shell that it is substantially the same as the dielectric constant of said liquid.

2. A glazed porcelain high voltage bushing having a portion for extending into mineral oil, the dielectric constant of said oil being about 2.2 and the dielectric constant of said bushing being about 7, and means for preventing carbonized oil particles in said oil from being attracted to and deposited on said porcelain comprising a thin homogeneous coating over all the outer surface of said portion of the porcelain which is for extension into said mineral oil, said coating having a dielectric constant which is substantially the same as that of said mineral oil and whose optimum value is exactly the same as that of said mineral oil, the effectiveness of said coating varying inversely with the difference between its dielectric

constant and the dielectric constant of mineral oil, the permissible range of said difference being plus or minus a few per cent of the dielectric constant of said mineral oil, the thickness of said coating being typically 1.5 mils but having a range of 0.1 mil to 12 mils.

WALTER R. WILSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,537,352	Hilliard	May 12, 1925
1,811,887	Jansson	June 30, 1931
1,871,356	Bakken	Aug. 9, 1932
1,908,779	Morrison	May 16, 1933
2,408,990	Mitchell	Oct. 8, 1946