United States Patent

Graybill

[15] **3,688,015**

[45] **Aug. 29, 1972**

[54] **CONDUCTIVE ALUMINUM TUBES FOR METAL-ENCLOSED, COMPRESSED GAS-INSULATED CONDUCTORS AND THE LIKE**

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Related U.S. Application Data

[62] Division of Ser. No. 138,094, April 28, 1971.

[52] **U.S. Cl.**.....**174/16 B,** 174/28, 174/99 B

[51] **Int. Cl.**.....**H01b 9/04**

[58] **Field of Search** ...174/28, 29, 16 B, 99 B, 133 B, 174/129 B, 15 C; 134/2

[56] **References Cited**

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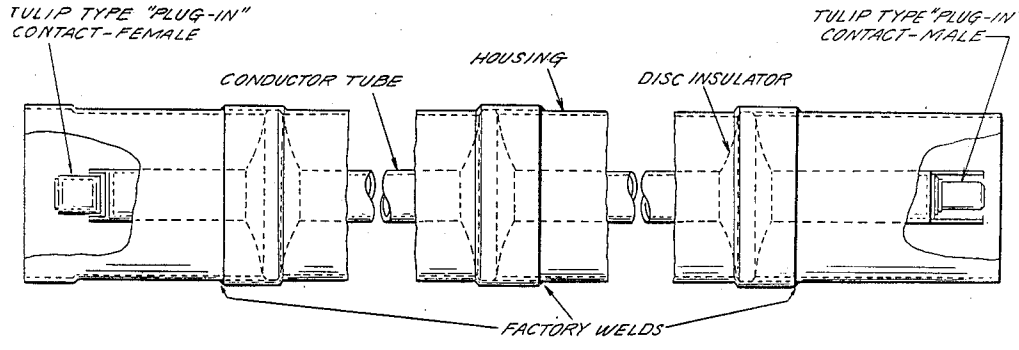
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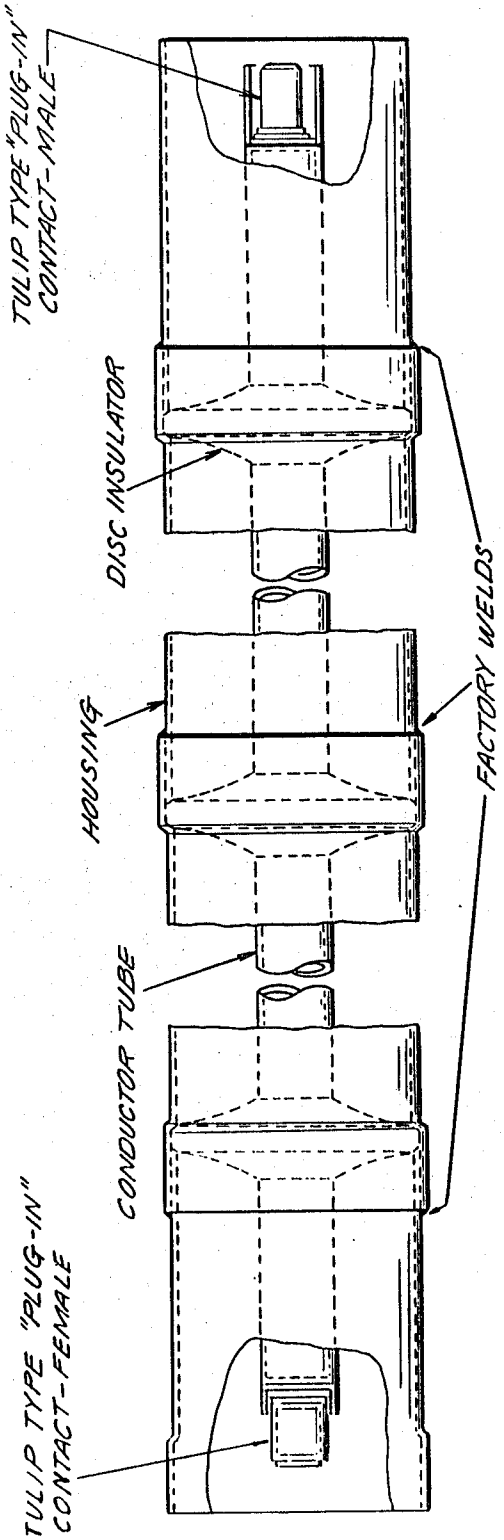
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[57] **ABSTRACT**

The confronting interior surfaces of the metallic central conductor and housing of an isolated phase bus system are treated by degreasing the surfaces of the central conductor and housing, etching the degreased surfaces, washing the etched surfaces, contacting the washed surfaces with an oxidizing agent, washing the resulting surfaces and drying the resulting treated surfaces under dust-free conditions. The process provides surfaces which are devoid of all particles which can deteriorate or otherwise destroy the dielectric integrity of the isolated phase bus while at the same time having surfaces of higher coefficients of emissivity as compared with conventional untreated surfaces thereby reducing the operating temperatures of the bus run.

2 Claims, 1 Drawing Figure




TULIP TYPE "PLUG-IN" CONTACT-MALE
DISC INSULATOR
HOUSING
CONDUCTOR TUBE
TULIP TYPE "PLUG-IN" CONTACT-FEMALE
FACTORY WELDS

CONDUCTIVE ALUMINUM TUBES FOR METAL-ENCLOSED, COMPRESSED GAS-INSULATED CONDUCTORS AND THE LIKE

This is a division of application Ser. No. 138,094, filed Apr. 28, 1971.

BACKGROUND OF THE INVENTION

Bus systems as described in U.S. Pat. Nos. 3,546,356 and 3,573,341, assigned to the assignee of the present invention, are employed in high voltage power transmission systems in compact sub-stations. Such bus systems typically are comprised of an inner or central conductor concentrically arranged within a tubular conductive housing in which the spacing is maintained between the conductor and housing by means of suitable insulating spacers arranged at spaced intervals along the bus run. Since the isolated phase bus is designed to operate at extremely high power and voltage ratings, the bus is preferably filled with a gas such as sulfurhexaflouride (SF_6) which has the characteristics of providing extremely high dielectric strength within the bus.

In spite of the arrangement of the gas filled bus, a very high voltage gradient exists in the compressed gas filled space between the central high voltage conductor tube and the concentrically arranged grounded tubular conductive housing. The voltage gradient may be of the order of 85 volts per mil or higher for normal operating voltages and as high as 350 volts per mil or more during voltage surges which the system must withstand without flashing over internally. Electronegative gases such as SF_6 have the ability of absorbing free electrons in the gas filled space, thereby tending to prevent the electron avalanche type of flashover from occurring at these voltages due to ionization by electron collision. As with other gases, the flashover voltage increases with the gas density, i.e., with the number of molecules per unit volume. However, it is well known that the presence of conducting particles within the medium of the SF_6 can drastically lower the flashover voltage. Such particles can pick up a charge and are thereby accelerated by the electron field, being drawn toward the conductor of opposite polarity from that of the charge so as to be accelerated by the electron field. A number of changes in the charge picked up by the particles can occur causing the particles to travel back and forth between the electrodes which can result in generation of small sparks and, in quantity, can lead to a flashover condition. Additionally, the high voltage gradient existing within the bus run, i.e., between the central conductor and grounded housing, can cause such rapid acceleration of the charged particles as to cause a significant collision to occur whereby the particles, upon colliding with either of the two internal surfaces, are caused to free other particles which may create an "avalanching"effect.

It is therefore necessary to take every possible precaution in the fabrication, assembly, shipment and installation of such bus system in order to eliminate any metallic or carbon particles in the size range of about 1 micron to about 3 millimeters in diameter.

Various techniques have been developed to collect and confine such particles, however, all such techniques require the addition of components within the bus to achieve these results thereby increasing the fabrication operation and costs of such bus sections.

See, for example, U.S. Pat. Nos. 3,515,909 and 3,515,939.

It has now been discovered that extruded aluminum tubes used for both the conductor and housing have aluminum and graphite particles imbedded in their surfaces, particularly in their inner surfaces. The graphite is used as a lubricant in the extrusion process. These particles cannot be removed by wiping, washing with conventional solvents, and the like. Some of these particles are released into the gas during the evacuation process necessary for filling the bus with SF_6, by vibration, by the high voltage electric field, or by various combinations of these factors.

Accordingly, it is the object of this invention to provide a method for treating the confronting surfaces of the central conductor and conductive housing of an isolated phase bus system so as to provide particle-free surfaces and thereby maintain the integrity of the dielectric pattern within the bus run.

This and other objects will become apparent to those skilled in the art from the following detailed description and drawing in which:

The sole FIGURE shows one typical isolated phase bus run which may be chemically treated by the method of the invention.

SUMMARY OF THE INVENTION

The present invention relates to isolated phase bus systems and the like and more particularly to a method of treating the confronting interior surfaces of isolated phase bus systems to free such surfaces of any impurities and thereby eliminate or significantly reduce deterioration of the dielectric stress within the isolated phase bus system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sole FIGURE shows one typical isolated phase bus run. The conductive housing is normally at ground potential while the central conductor can be at 500-1,500 kilovolts. Particles which may be present on the confronting interior surfaces of the bus sections can acquire a charge (either positive or negative) causing the charged particles to be attracted to the oppositely polarized surface. The acceleration of such particles can cause a collision with the surface resulting in the release of additional particles and thereby causing a "-pyramiding" effect. The presence of a quantity of such particles can cause sparking and/or a flashover condition.

In order to remove the aluminum and graphite particles which have now been found imbedded in the surfaces of the extruded aluminum tubes used for both the central conductor and housing, the tubes are treated by the process of this invention.

The surfaces treated by the process of this invention must be cleaned of all oil and grease because any oil or grease left on the surfaces inhibit the subsequent cleaning operations. Advantageously, the degreasing can be accomplished by employing a high pressure pump connected to spray heads mounted at the ends of the aluminum tubes in such a way that every square inch of both interior and exterior surfaces are subjected to high velocity jet spray approximately perpendicular to the surface. A suitable spray is mildly alkaline hot water

containing synthetic bio-degradable detergents which serve as surface active or wetting agents. Degreasing can also be accomplished with familiar vapor degreasing agents such as liquid hydrocarbon or chlorinated hydrocarbon solvents, e.g., trichloroethylene.

The degreased aluminum surfaces are etched at a temperature of about 100°–180° F. and preferably about 130°–160° F. The etching serves a three-fold purpose. It dissolves fine aluminum particles attached to the surface of the aluminum, some of which cannot be removed by wiping or brushing; it dissolves a portion of the surface thereby freeing the graphite particles imbedded therein, particularly in the inner surface; and by roughening the mirror-like smooth surface finish normally present on extruded aluminum tubing, the surface emissivity factor increases from about 0.1–0.3 to about 0.5–0.6, thereby at least doubling the heat loss by radiation from the conductor and decreasing the temperature rise when carrying a given current.

An aqueous solution of a strong alkali such as sodium hydroxide, potassium hydroxide and the like, can be employed as the etchant. Caustic is preferred on the basis of availability and economics. The caustic employed generally has a pH of at least about 13 and contains surface active agents and chelating agents. The surface active agents and chelating agents are employed in order to maintain better control over the rate of etching and to lower the surface tension of the solution so as to obtain more intimate contact with the surfaces being treated. Without such agents, the etched surface would become pitted and uneven instead of being evenly etched. The agents also serve to give a uniform rate of etch over an extended period of time and additionally keep the aluminum metal from precipitating out of the solution. Without such chelating agents, gelatinous aluminum hydroxide would precipitate and could dry as an inert white scale of aluminum oxide on the side of the etching tank.

Among the surfactants which can be employed are alcohols such as ethanol, butanol, hexanol, decanol, and the like; polyhydric alcohols such as ethylene glycol, diethylene glycol, propylene glycol, dipropylene glycol, glycerol, and the like; alkyl amides such as formamide, ethylformamide, propylformamide, dimethylformamide, diethylformamide, acetamide, ethylacetamide, and the like; alkylphenoxypoly(ethyleneoxy) ethanols such as octylphenoxypoly(ethyleneoxy) ethanol and the like; alkali metal alkylbenzene sulfonates such as sodium dodecylbenzene sulfonate; alkali metal alkyl sulfates of which sodium lauryl sulfate is a typical member; and the like.

Among the chelating agents which can be employed are ammonia; amines such as ethylenediamine, propanediamine, and the like; quinoline; pyridine; and the like.

The surfaces are maintained in contact with the etchant for a time sufficient to remove the desired amount of surface. The amount of surface necessary to be etched away will vary depending upon what, if any, preconditioning has been performed. For example, less surface need be etched if the aluminum pieces have been machined prior to being treated by the process of this invention. In general, etching is continued until about 0.001–0.01 inch of the surface has been etched and preferably about 0.005 inch.

The resulting etched surfaces are thereafter washed with water in order to remove any clinging droplets of the etching solution and fine aluminum or other particles clinging to the surfaces. The washing is preferably performed in two stages. In the first stage, the surfaces are sprayed with water as they are removed from the etching tank and the excess water is allowed to enter the etching tank to make up water lost by evaporation. In the second stage, the treated aluminum pieces are immersed in an agitated cold water rinse tank.

In the next step of the preferred process of the preferred embodiment of the invention, the washed, etched aluminum pieces are treated with an oxidizing agent in order to remove the black residual film thereon which includes compounds of aluminum and the alloying metals such as silicon, magnesium and copper, which is left on the surface by the etching operation. Suitable oxidizing media include the hypophosphates, ceric perchlorate, ceric nitrate, ceric sulfate, potassium permanganate, potassium dichromate, potassium bromate, potassium iodate, iodine-potassium iodide, potassium ferricyanide, ferric chloride, cupric chloride, ammonium persulfate, and the like; oxidizing mineral acids such as nitric, hydrochloric, hypochloric, phosphoric, periodic, sulfuric, chromic, and the like; peracids; peroxides; organic and inorganic ozonites such as KO_3, and the like. The preferred oxidizing agent is nitric acid in the form of in about 5–20 volume percent water solution. Any temperature in the range of about 50°–100° F. is satisfactory and it is preferred to perform this treatment step at ambient temperatures. Treatment time is advantageously measured by observing the color of the treated surfaces since the surfaces are black before subjected to the oxidizing medium and are almost white at the end of the treatment. In general, a treating time of about 10–20 minutes is sufficient.

The resulting treated surfaces are then washed with water preferably by immersion in an agitated water rinse tank to remove any oxidizing media remaining on the treated surfaces. In a preferred embodiment, the treated surfaces are subjected to a high velocity jet spray of cold water after removal from the agitated rinse bath.

In the final step of the preferred process of this invention, the resulting washed, treated surfaces are dried under dust-free conditions. This can be accomplished by flushing the bus with very dry, filtered air and then sealing, i.e., caping, the bus to exclude atmospheric dust.

The following example illustrates the preferred process of the invention. An isolated phase bus system having a central conductor surrounded by a concentrically aligned conductive housing, both of extruded aluminum, was degreased with a mildly alkaline water spray containing a synthetic biodegradable detergent. The degreased bus was transferred to a tank containing an aqueous solution of sodium hydroxide containing a surfactant and a chelating agent, maintained at about 140° F., for about 20 minutes. About 0.005 inch was removed from the exposed surfaces.

The etched bus was lifted out of the etching solution and immediately rinsed with a cold water spray and then immersed in an agitated cold water rinse tank.

The rinsed bus was then immersed in a tank containing a 20 volume percent solution of nitric acid maintained at room temperature until the surfaces were almost white in color. This took about 10–15 minutes. The bus was then removed from the oxidizing tank and immersed in an agitated water rinse tank and then sprayed with cold water from a high velocity jet. Thereafter, the inside surfaces of the bus were flushed with very dry, filtered air until the surfaces were dry whereupon the open ends of the bus were sealed. The resulting treated surfaces, especially the inner facing surfaces, were devoid of all particles which could deteriorate or otherwise destroy the dielectric integrity of the bus and had a surface emissivity factor of 0.5–0.6.

Various changes and modifications can be made in the process and products of this invention without departing from the spirit and the scope thereof. The various embodiments of the invention disclosed herein serve to further illustrate the invention but are not intended to limit it.

I CLAIM:

1. An isolated phase bus system comprising a tubular conductive housing and a central conductor concentrically arranged within said housing wherein the housing and conductor are aluminum and wherein the inner confronting surfaces of the housing and conductor are uniformly etched and particle-free.

2. The isolated phase bus system of claim 1 wherein the space between the housing and the conductor is filled with SF_6.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,688,015 Dated 29 August 1972

Inventor(s) Howard W. Graybill

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the Front Sheet add:

"[73] Assignee: I-T-E Imperial Corporation, Philadelphia, Pennsylvania"

Signed and sealed this 14th day of January 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

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