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BRUSH SEATING TECHNIQUE

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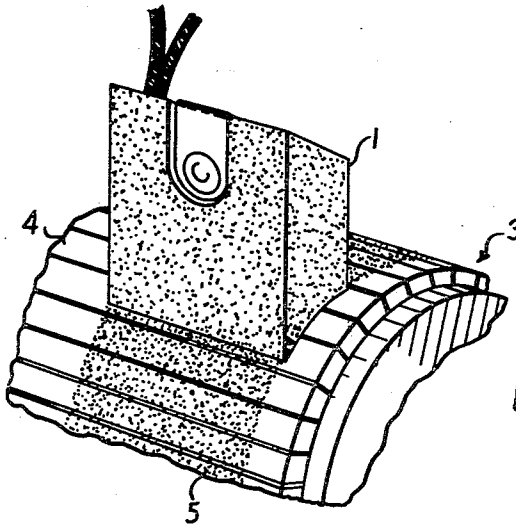


FIG. 2

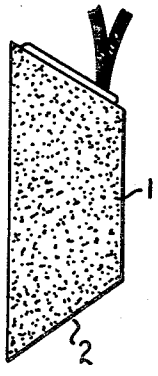


FIG. 1

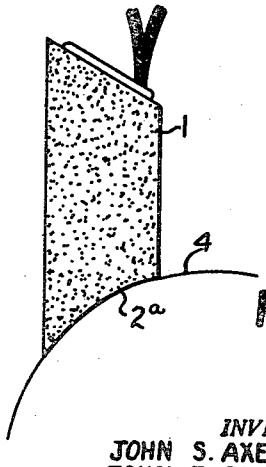


FIG. 3

INVENTORS
JOHN S. AXELSON
JOHN J. REARDON

BY Robert N Montgomery
ATTORNEY

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BRUSH SEATING TECHNIQUE

John J. Reardon and John S. Axelson, Erie, Pa., assignors to General Electric Company, a corporation of New York

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This invention relates to a new and improved process for seating brushes on a current collector and an agent for accomplishing such seating.

By the term "seating" we mean providing a concave arc in the contact surface of the brush complementary to the convex portion of the periphery of the current collector engaged by the brush. Previously, carbon or carbon composition brushes have been seated on rotating current collectors such as commutators and slip rings by practice of a multiple step process. In this process the collector-engaging surface of the brushes are first pre-sanded using a piece of sandpaper on the current collector as the collector is rotated to develop an approximate seat. The brushes after the pre-sanding operation have an approximate arc, but due to the thickness of the sandpaper, this arc does not match the curvature of the current collector exactly. It is then necessary to perform a "stoning" operation in which a stick of abrasive material, usually aluminum oxide, is placed against the periphery of the current collector adjacent a brush, and particles of the stone are abraded from the stone. The particles pass under the collector-engaging surface of the brush and abrade a seat on the brush conforming to the surface of the current collector. This stoning operation must be performed one or more times per machine depending on the number of brushes per machine, usually once for every two brushes per track. Additionally, where brushes are to be seated on commutators and an edge of the brush is beveled by removal of sandpaper after the pre-sanding operation, the seating time with the stone is prolonged and brush wear is increased in bringing in the seat.

In view of the inefficiency of this prior art method of seating brushes on a current collector, we have developed a new and improved process for effecting such seating by which a multiplicity of brushes may be rapidly seated simultaneously, and it is therefore a primary object of this invention to provide an improved process for seating brushes on a current collector.

It is a further object of this invention to provide a process for seating brushes by which brushes may be seated with minimum waste and hence increases brush life.

It is another object of this invention to provide a liquid seating agent for use in such process.

Briefly stated, these and other objects of our invention are accomplished in one form thereof by applying a thin coating of a liquid, having suspended abrasive particles therein, to the surface of a rotating current collector with a surface of the unseated brush engaging the current collector. The liquid brush seating agent is preferably water having colloidal silica and suspended particles of aluminum oxide therein.

The novel features of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization, method of operation, and composition, together with further objects and advantages thereof, may best be understood by reference to the following description appropriately illustrated by the following drawings wherein:

FIGURE 1 illustrates a new brush;

FIGURE 2 illustrates a brush contacting the surface of a current collector, in this illustration a commutator; and

FIGURE 3 illustrates a brush seated on the surface of a current collector.

We have found that electrically non-conductive abrasive particles may be dispersed in a thin liquid film and caused to adhere to the surface of a current collector as the collector is rotated, and abrade a highly polished seat in the collector-engaging surface of carbon brushes conforming to the engaged surface of the collector. By "carbon brushes" we mean electrically conductive brushes of carbon or graphite which are termed carbon-graphite, electrographitic, metal-graphite, and carbon compositions impregnated with binders such as resin.

In the preferred form of our invention, particles of a non-conductive mineral oxide, aluminum oxide (Al_2O_3) are mixed with colloidal silica in proportions hereinafter disclosed to provide a liquid brush seating agent.

In practicing our invention where new dynamoelectric machines are involved, brushes are positioned in brush holders of a dynamoelectric machine as the brushes are received from stock. Such brushes have the appearance of the brush of FIG. 1, having a flat collector-contacting surface **2**.

The surface **2** of the brush **1** is placed in biased tangential contact with the surface of the collector by means of the contact biasing springs of the brush holder, not shown. Provision of brush holder contact biasing springs are commonplace and reference is made to Patent 2,602,-100, assigned to the same assignee as this invention for purpose of illustration.

It will be understood that the current collector upon which the brushes are to be seated is mounted on a shaft of a dynamoelectric machine adapted to be rotated either mechanically or electrically.

A thin coating of the liquid brush seating agent is then applied to the surface of the current collector which may be the commutator **3** of FIG. 2 having surface **4**. The liquid agent is applied to the surface **4** in a thin film, preferably as by holding a bristle brush that has been dipped in the liquid seating agent on the surface of the collector as it rotates. The particles in the liquid seating agent applied to the collector surface cut or abrade an arc **2***a*, FIG. 3, in the engaging surface of the brush conforming to the surface portion of the collector. When seating brushes using the brush seating agent, we prefer to have the collector rotated at a peripheral speed of approximately 1500–2200 feet per minute. We have noted that above 2200 feet per minute spotting is observed on the brush holders, indicating that some of the liquid seating agent is thrown off the surface of the collector. Moreover, the water tends to dry out too rapidly. Below 1500 feet per minute the cutting time is slightly lengthened, as hereinafter explained.

The liquid seating agent causes an arc to be cut or abraded in the brushes of a track or a plurality of tracks simultaneously and a black film **5** will be observed to form in each track. This film **5** is caused by carbon particles cut or abraded from the engaging surface of the brushes by the brush seating agent. This film will disappear as the liquid dries out, usually in less than a minute, and carbon particles will be thrown from the surface, leaving a slightly dull mat-appearing finish on the collector. Plain water is then applied across the brush tracks to disperse the particles of Al_2O_3 and silica and remaining carbon particles. The water application will again cause a black film to form in the brush tracks, which as before will dry up and disperse very quickly, leaving a fully polished arc on the brush face and a slightly dull but very smooth finish on the collector surface. An air jet may then be directed on the surface of the collector to blow off any carbon and abrasive particles not thrown off the surface of the collector due to centrifugal force. We have found that when the peripheral speed of the current collector is

decreased below 1500 feet per minute, the liquid films take longer to dry out and hence increase the brush seating time. However, at the lower speeds a good, highly polished brush seat is still obtained.

The foregoing disclosure of a process embodying our invention contemplates initial seating of brushes on a current collector. In such cases where direct current machines are involved, the brushes may have to be reset if not initially located on the no-load neutral position. When such shifting of brushes is necessary, the film of plain water applied to the surface of the collector has been found to be sufficient to bring in the new arc.

The liquid seating agent has the following composition in the tabulated preferred proportions:

H_2O (distilled)	cc	100
Colloidal silica containing 30% by weight silica as SiO_2	cc	10
−200 mesh Al_2O_3	gm	35
−325 mesh Al_2O_3	gm	5

In preparing the liquid seating agent having the above-tabulated composition, the Al_2O_3 is preferably first added to the H_2O which is well shaken. To this is added the colloidal silica and the mixture is again well shaken. However, the steps of mixing may be interchanged. At intervals during use, it may be necessary to shake the mixture to keep the particles of Al_2O_3 in suspension.

The larger particles of Al_2O_3 cut or abrade the arc in the engaging surface of the brush. The smaller particles of Al_2O_3 are included to help to polish the engaging surface of the brush, and while we have found the presence of the smaller Al_2O_3 particles desirable, their presence is not essential. The water is a vehicle for the Al_2O_3 and silica.

The colloidal silica serves a two-fold purpose. We have found that it acts as a binder to cause the particles of Al_2O_3 to adhere to the collector surface while the collector is rotating, and the particles of silica serve to polish the engaging surface of the brush.

Inasmuch as the pH factor of the water from a given water supply may fluctuate in the acid direction which might precipitate the silica, we prefer to use distilled water. However, where water having a constant pH factor close to neutral is available, the use of distilled water is not necessary.

The tabulated proportions of the composition of a liquid brush seating agent which we have found preferable for a brush of a particular grade, hereinafter described, is not considered critical in proportion. We have found that if the quantity of Al_2O_3 is increased, the total quantity of Al_2O_3 becomes too heavy to be easily mixed and suspended in the liquid; and if the quantity of Al_2O_3 is decreased, the time required to seat brushes is increased due to the smaller quantity of the cutting or abrading particles. If a liquid seating agent should be used without the colloidal silica, we have found that only a short brush cutting action is achieved, inasmuch as the Al_2O_3 particles are not retained on the surface of the current collector. This has led us to the conclusion that the colloidal silica acts as a binder to cause the Al_2O_3 particles to adhere to the surface of the current collector. If particles of Al_2O_3 are not used in the liquid seating agent, the colloidal silica will still provide a very good highly polished brush seat conforming to the collector surface. However, the time required to achieve a highly polished brush seat is lengthened inasmuch as the more abrasive Al_2O_3 particles are not present.

We prefer to use colloidal silica identifiable as a product of E. I. du Pont de Nemours Company by the trade name HS "Ludox," which is described as an aqueous dispersion of amorphous silica particles containing 30.0% by weight colloidal silica as SiO_2, 0.04% chloride as NaCl, 0.005% sulfate as Na_2SO_4, has a SiO_2/Na_2O weight ratio of 95, a pH factor of 9.8 at 25° C., viscosity of 3.6 at 25° C., and the approximate particle size of the silica is 15 millimicrons.

Ludox is also available in other grades designated as LS and SM, which may also be utilized in preparing a liquid brush seating agent, but which for purposes of this invention have been found to be less preferable than the HS grade. The LS grade differs from the HS grade principally in having a low percentage of chloride and sulfate and higher viscosity (13 at 25° C.), and also a slightly lower pH factor (8.4). The SM grade has a lower silica content (15%) and still lower chloride and sulfate content and smaller approximate particle diameter (7 millimicrons).

For any particular grade or composition of the carbon brushes to be seated, the proportions of the ingredients of the brush seating agent may be varied to accomplish brush seating. For example, on some resin-impregnated brushes we have found that the resin becomes gummy during the brush seating process, and it may be necessary to twice apply the liquid seater of the composition disclosed to make a desired seat, or, in the alternative, the size of the aluminum oxide particles could be increased. We have found by comparative tests that the brush seating method disclosed herein greatly reduces carbon waste in comparison to the conventional pre-sanding method. Following are measurements denoting the amount of waste occurring when seating a ¾" x ⅜" electrographitic brush having the following properties, on a commutator:

Apparent density	gm./cc	1.58
Scleroscope hardness		65
Transverse strength	lbs./sq. in	3600
Abrasiveness		Low

Coefficient of friction, less than 0.22.

The transverse strength is determined by supporting a specimen near the ends of two knife edges. A third knife edge is pressed on the top of the specimen midway between the two supporting edges, and the force on the third knife edge is increased until the specimen breaks. The transverse strength is then computed by using the beam formula

$$S_t = \frac{3PL}{2WT^2}$$

where P is the total force in pounds applied at the upper knife edge, L is the distance between supports in inches which should be at least four times the thickness dimension, W is the width of the specimen in inches, and T is the thickness of the specimen in inches. The coefficient of friction is determined from tests made on a 10-inch diameter copper commutator at a peripheral speed of 3,000 feet per minute having a brush pressure of 4 lbs. per square inch on brushes having a cross-section of 1 square inch.

Abrasiveness refers to the ability of the brush to prevent excessive build-up of film usually caused by corrosive or oily atmospheres and is also referred to as "polishing action." The abrasiveness of a brush is influenced by its hardness, grain structure and ash content. The particular brush tested would be termed "nonabrasive" by the trade.

Brush wear in comparative seating of brushes having the above characteristics were as follows:

	Mils wear
Conventional seating using sandpaper and stoning operation (average of 4 brushes)	45.3
Liquid seat (average of 4 brushes)	17.8

The measurements taken when the brushes were seated by the conventional seating method denotes the absolute minimum wear involved since the brushes were checked for full seat on each revolution, and sanding was stopped as the pre-seat was accomplished. The liquid seating technique and liquid seating agent disclosed herein has

been used in seating brushes on current collectors varying in size from 5/8" to 15" in diameter, and on commutators utilizing from 2 to 72 brushes per machine. In every case effective seating has been accomplished, and high potential testing of commutators after seating has indicated no deterioration in dielectric strength.

A comparative test was made of the time required to seat 3/8" x 3/4" brushes of the above-tabulated grade using our liquid seating technique, and the previously described conventional method using medium grade sandpaper on a 4-pole, 4-brush, 6½ kw., 250 volt, 26 ampere direct current generator having all four brushes in one track on a five-inch diameter commutator. Using the liquid seater in the procedure previously disclosed, the time required to achieve a full, highly polished brush seat was 52 seconds. The conventional method to seat the same type brush took 3 minutes, not including the time for applying and removing the sandpaper from the commutator for and after the pre-sanding operation. Using the conventional method, the stone was applied at two locations on the commutator, each stoning operation being sufficient to seat two brushes. The generator was not loaded and was run at a peripheral speed of approximately 1500 feet per minute.

It will be apparent that the time differential between the liquid seating technique and the conventional brush seating method will be increased on machines having a greater number of brush tracks, inasmuch as the liquid seating agent may be used on a plurality of brush tracks simultaneously, while in the conventional method each brush track must be stoned individually a number of times depending on the number of brushes per track. Usually each stoning operation will seat two brushes per track.

A collateral benefit from using the liquid seating technique is that it produces less carbon dust in the surrounding atmosphere than is produced during the conventional stoning operation. This decreases the chance of carbon dust settling on the dynamoelectric machine end turns and providing electrical creepage paths, and is also less noxious to the workmen than seating brushes in the conventional manner.

We have observed that the brush tracking surface of a commutator upon which brushes have been seated using the liquid seating technique has a smoother finish than the brush tracking surface of commutators upon which brushes have been seated by the conventional stone. The smoother commutator surface will cause less abrasion of the brushes thereon, thereby giving increased brush life.

Our brush setting technique is applicable either to seating replacement brushes as well as in initially seating brushes on a new collector. In existing installation where it is necessary to change brushes on multiple-track machines, a brush may be lifted while the machine is in operation and removed, and a new brush having a flat surface 2, as shown in FIG. 1, placed in the brush holder and again placed in contact with the commutator. A thin application of the brush seating agent is then made

only to the track of the replaced brush and a full seat will be developed thereon very quickly. Brushes making other tracks on the current collector are unaffected by the localized application of the liquid seating agent. This is in contrast to the stoning step of the conventional brush seating process wherein particles from the stone were apt to spread on the surface of the collector and cause wear on brushes other than those in the track of the brush being seated.

If desired, our invention may also be used to provide a highly polished brush seat after the conventional pre-sanding operation. In such circumstances, it would be sufficient to use only colloidal silica or colloidal silica plus the smaller particles of Al_2O_3 in the liquid brush seating agent.

While we have specifically described the use of aluminum oxide in the practice of our invention, and we prefer to compound the liquid seating agent using aluminum oxide, it is contemplated that other abrasive particles may be suitable, and while we have described the preferred composition of a liquid brush seating agent, it will be apparent that changes in proportions of the ingredients thereof may be made and used in our invention.

Other changes and modifications of our invention may occur to those skilled in the art which do not depart from the spirit and scope of the invention. Accordingly, it is our intention to cover all changes and modifications of example of the invention herein chosen for purpose of disclosure which do not constitute departure from the spirit and scope of the invention.

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

1. The method of seating a carbon brush on the surface of a commutator which comprises applying a thin coating of an aqueous vehicle containing electrically non-conductive abrasive particles to the surface of the commutator while the commutator is rotating, continuing to rotate the commutator with a surface of the brush in contact with the commutator and the coating while the coating is in liquid form, and applying a cleaning medium to the surface of the commutator after the coating has dried.

2. The method of seating a carbon brush on the surface of a commutator which comprises applying a thin coating of an aqueous vehicle containing electrically non-conductive particles to the surface of the commutator while the commutator is rotating, continuing to rotate the commutator with a surface of the brush in contact with the commutator and the coating while the coating is in liquid form, and applying a film of water to clean the surface of the commutator after the coating has dried.

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