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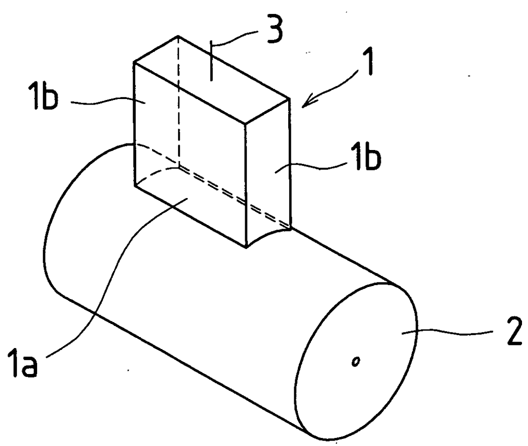
(54) CARBON BRUSH FOR ELECTRICAL MACHINE

(57) An electromechanical carbon brush 1 applied against a conductive rotating body 2 has a brush base material which is a material made of an aggregate including carbon as at least one (1) ingredient and of a binder, the electromechanical carbon brush 1 containing 0.2 to 10 % by weight of a water-soluble lubricant, 0.2 to 3 % by weight of fluorine denatured silicone oil or 0.2 to 10 % by weight of the water-soluble lubricant and a metallic compound, relative to the brush base material.

FIG.1



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Description

TECHNICAL FIELD

[0001] The present invention relates generally to an electromechanical carbon brush and, more particularly, to an electromechanical carbon brush for use with small-sized motors.

BACKGROUND ART

[0002] Electrically-powered motors have evolved into having smaller size, larger capacity and higher output. For example, motors used for electric vacuum cleaners are required to be of smaller size and higher sucking force. Therefore, the external diameters of motor's fans are reduced, the motors are rotated at ultra-high speed (30,000 rpm or more) . In these motors rotated at ultra-high speed, it has been considered that an important challenge is to maintain a better electrical contact by keeping a good sliding condition between an electromechanical carbon brush (hereinafter referred to as a brush) and a commutator which is a conductive rotating body.

[0003] Conventionally, in view of such a challenge, so-called resin bonded brushes has been frequently used, which are graphite powder bonded by synthetic resins. In these resin bonded brushes, better electrical contact is ensured by the graphite powder providing better sliding performances and by the resins providing better riding conditions.

[0004] In an electric vacuum cleaner and the like, in order to enhance the sucking force (suction power), a current density of a brush can be made higher by increasing input power to the motor. However, in the case of using this method, more particularly, in these resin bonded brushes, bad rectification can be generated by being increased temperature of the brush or by being increased wear of the brush due to prolonged usage.

[0005] Further, input regulations must be considered as a background, and a motor has been required to provide higher output for constant input.

[0006] In these situations, the strongly desired brush has been a brush which can ensure stable rectification and which can provide higher efficiency (output relative to input) to a motor.

[0007] In order to deal with these problems, Japanese Patent Application Laid-Open Publication No. 2002-56944 (hereinafter referred to as Patent Document 1) discloses a method for partially reducing specific resistance of a brush by plating a brush surface with metal, such as copper. In this method, since apparent specific resistance is reduced, the temperature of the brush is prevented from rising; stable rectification is achieved; the wear of the brush is reduced; and higher motor efficiency can be obtained.

[0008] Also, US Patent Publication No. 6068926 (hereinafter referred to as Patent Document 2) discloses a method for improving wear characteristics of a brush by impregnating pores of the brush with silicone oil. In this method, by improving sliding performance between the brush and the commutator, the temperature of the brush is prevented from rising and the wear of the brush is reduced.

[0009] In techniques in accordance with these publications, the wear of the brush is restrained and a longer life of the brush is expected to be achieved. However, in the method shown in Patent Document 1, although stable rectification is achieved and the rise in temperature and the wear of the brush can be reduced, since specific resistance is partially reduced by applying metal plating to the brush surface, improvement of efficiency of the motor has been limited. In other words, the improvement is limited to that of efficiency of the motor and a life of the brush generated by achieving stable rectification due to the action of the metal plating applied to the circumference of the brush.

[0010] Also, the method shown in Patent Document 2, although the rise in temperature and the wear of the brush are reduced, since the silicone oil is emulsified and is impregnated in the pores of the brush, it is difficult to uniformly impregnate the pores of the brush with the silicone oil, and uneven impregnation is generated. As a result, good sliding performance can not be ensured between the brush and the commutator, and stable rectification may not be ensured.

[0011] The present invention was conceived in view of these situations and an object thereof is to provide an electromechanical carbon brush which ensures more stable rectification and which can achieve higher efficiency for the motor, a longer life, a reduced temperature, suppressed sliding noises and reduced wear of the commutator.

DISCLOSURE OF THE INVENTION

[0012] In order to solve above problems, an electromechanical carbon brush of the present invention is an electromechanical carbon brush applied against a conductive rotating body; and comprises a brush base material that is a material made of an aggregate including carbon as at least one (1) ingredient and a binder, wherein the electromechanical carbon brush contains a water-soluble lubricant, and wherein the content of the water-soluble lubricant is 0.2 to 10 % by weight relative to the brush base material.

[0013] In accordance with this composition, the above purpose is achieved by providing an electromechanical carbon brush to which higher efficiency relative to a motor, a longer life, a reduced temperature, suppression of sliding noises and reduced wear of the commutator can be applied.

[0014] Although, in the brush base material consisting of the aggregate and the binder, void parts called "pores" exist, as used herein, impregnation means to make the water-soluble lubricant exist in the pores in the material.

[0015] Sizes and capacities of the existing pores are different depending on differences between types, production methods and production conditions of the brush. The pores exist all over the brush and include open pores continued from the surface of the brush to the inside thereof and closed pores isolated within the brush. Hereinafter, when "pores" are simply used, the term means the open pores.

[0016] Since the water-soluble lubricant is aqueous solution, the pores of the brush can be impregnated with the water-soluble lubricant remaining a size of a molecular level. Also, the water-soluble lubricant has surface active effects, reduces surface tension and facilitates the impregnation through the inside of microscopic pores by the capillary phenomenon. Therefore, the water-soluble lubricant can be impregnated in the microscopic pores of the brush and is impregnated not only in a surface portion of the brush, but also toward the inner part. In this way, by impregnating the brush pores with the water-soluble lubricant uniformly, it is believed that the water-soluble lubricant uniformly acts upon an entire sliding surface of the rotating body for a long time period, reduces mechanical resistance on the sliding surface and achieves a better sliding performance for attempting to achieve improvement of the motor efficiency, a longer life, a reduced temperature, suppression of sliding noises and reduced wear of the commutator. If the content of the water-soluble lubricant relative to the brush is less than 0.2 % by weight, advantages of the water-soluble lubricant is not generated, and if the content is 10 % by weight or more, the motor efficiency is decreased. In the case that the content of the water-soluble lubricant relative to the brush is 0.2 to 3 % by weight, since equivalent advantages can be obtained when the content is reduced, this case is economical and more preferred.

[0017] The water-soluble lubricant is a material soluble in water with the lubricating ability, and the water-soluble lubricants preferred for applying to the electromechanical carbon brush of the present invention are polyethylene glycol and derivatives thereof, polyvinyl alcohol, polyvinyl pyrrolidone, water-soluble silicone oil or mixtures thereof. The derivatives of polyethylene glycol include polyethylene glycol ester, polyethylene glycol ether and the like.

[0018] Among these water-soluble lubricants, the water-soluble silicone oil has better stability at high temperature and is more preferred.

[0019] Also, in the electromechanical carbon brush of the present invention, the material impregnated in the electromechanical carbon brush may be fluorine denatured silicone oil, instead of the water-soluble lubricant. In this case, the content of fluorine denatured silicone oil is preferred to be 0.2 to 3 % by weight relative to the brush base material.

[0020] In accordance with this composition, the above purpose is achieved by providing an electromechanical carbon brush to which higher efficiency relative to a motor, a longer life, a reduced temperature, suppression of sliding noises and reduced wear of the commutator can be applied.

[0021] Since the fluorine denatured silicone oil has small surface tension to the brush surface and easily permeates through the inside of microscopic pores by the capillary phenomenon, the fluorine denatured silicone oil can be contained in the brush by impregnation. Therefore, the fluorine denatured silicone oil can be impregnated in microscopic pores of the brush and is impregnated not only in surface pores of the brush, but also through the inner pores uniformly. In this way, by impregnating the brush pores with the fluorine denatured silicone oil uniformly, it is believed that the fluorine denatured silicone oil uniformly acts upon an entire sliding surface of the rotating body for a long time period, reduces mechanical resistance on the sliding surface and achieves a better sliding performance for attempting to achieve improvement of the efficiency relative to the motor. If the content of the fluorine denatured silicone oil relative to the brush is less than 0.2 % by weight, advantages of the fluorine denatured silicone oil is not generated, and if the content is more than 3 % by weight, the motor efficiency is decreased.

[0022] Further, in the electromechanical carbon brush of the present invention, the material impregnated in the electromechanical carbon brush may have composition containing water-soluble lubricant and a metallic compound, instead of the above material. In this case, the content of the water-soluble lubricant is 0.2 to 10 % by weight relative to the brush base material and the content of the metallic compound is preferred to be 0.05 to 10 % by weight relative to the brush base material, and since equivalent advantages can be obtained when the content is reduced in the case of 0.1 to 4 % by weight, this case is economical and more preferred.

[0023] In this composition, it is believed that the water-soluble lubricant and the metallic compound are uniformly impregnated on the surface of the brush and within the microscopic pores to further reduce the wear of the brush and the commutator, to reduce the temperature and the sliding noises and to further improve the efficiency of the motor.

[0024] If the impregnated amount of the water-soluble lubricant and the metallic compound is departed from the above ranges relative to the brush, the advantages of the improvement due to these materials are not generated for the efficiency of the motor.

[0025] In the electromechanical carbon brush of the present invention, the binder is preferred to consist of a synthetic resin.

[0026] Although, in the resin bonded brush with the binder consisting of the synthetic resins, the pores tends to be finer, the above purpose is achieved by uniformly impregnating such a brush with the water-soluble lubricant, the fluorine denatured silicone oil, and the water-soluble lubricant and the metallic compound.

[0027] In the electromechanical carbon brush of the present invention, the binder may be carbonization product of the synthetic resin or carbonization product of a pitch. As specific examples in this case, the synthetic resins include epoxy resins, phenol resins, polyester resins, vinylester resins, furan resins, polyamide resins, polyimide resins and mixtures thereof. The pitches include coal pitches, petroleum pitches and mixtures thereof.

[0028] Further, the electromechanical carbon brush of the present invention can utilize a brush with good-conductive metal coating formed on at least one portion of the surface of the carbon brush except the surface contacting with the conductive rotating body of the electromechanical carbon brush.

[0029] By using such a brush with the metal coating formed, the efficiency relative to the motor can be further improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

Fig. 1 is a perspective view showing a schematic configuration of a motor using a brush according to an embodiment of the present invention;

Fig. 2 is a diagram showing a chemical structure of water-soluble silicone oil according to an embodiment of the present invention; and

Fig. 3 is a diagram showing a chemical structure of fluorine denatured silicone oil according to an embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0031] Embodiments of the present invention will now be described with reference to the drawings.

[0032] Fig. 1 shows a schematic configuration of a motor using a brush according to an embodiment of the present invention.

[0033] The brush 1 slides on a portion where a rotating body 2, i.e. a commutator, of the motor contacts with a under surface 1a of the brush 1.

[0034] A base material of the brush 1 is a material made of an aggregate including carbon as at least one (1) ingredient and a binder. The base material has pores as stated above and, in this embodiment, is impregnated with water-soluble lubricant, fluorine denatured silicone oil or both of the water-soluble lubricant and a metallic compound in the pores of the brush base material.

[0035] For the pores of the brush 1, for example, the brush base material may have pores with a small pore radius which has less than 1 μm of an average pore radius obtained by the mercury porosimetry.

[0036] For the base material of the brush 1, the brush can be a carbon graphite brush called CG (Carbon Graphite) type, an electric graphite brush called EG (Electric Graphite) type, a resin bonded brush which is a synthetic resin with a non-carbonized binder, a metal type brush using metal powder such as copper powder, iron powder, silver powder or the like as a portion of the aggregate, and the like, and especially, the resin bonded brush is preferred.

[0037] A production method of the resin bonded brush base material is described as follows.

[0038] First, the aggregate and the binder are mixed and kneaded in approximate compounding ratio of a 10 to 40 binder weight portion to a 100 aggregate weight portion.

[0039] As the aggregate, artificial graphite, natural graphite, exfoliated graphite and the like can be used. Among these materials, especially preferred composition is the artificial graphite with less development of crystallization of the graphite or a composition with the natural graphite and the artificial graphite compounded.

[0040] On the other hand, a synthetic resin is used as the binder, and either or mixture of thermosetting synthetic resins or thermoplastic synthetic resins may be used. Especially preferred synthetic resins include epoxy resins, phenol resins, polyester resins, vinylester resins, furan resins, polyamide resins, polyimide resins.

[0041] When mixed and kneaded, organic solvents such as alcohols, acetone or the like may be added in an appropriate amount if necessary. Also, a portion of the aggregate may be added with addition agents such as solid lubricants or coating regulators, for example, if necessary. For example, solid lubricants such as molybdenum disulfide and tungsten disulfide or coating regulators such as alumina, silica or silicon carbide may be added.

[0042] Then, the mixed and kneaded block is broken up and adjusted to powder for forming. Subsequently, the powder is formed into the shape of the brush base material. Then, the formed material is heat-treated under the curing temperature of resins (generally, 100 to 300 °C) to cure the resins.

[0043] On the brush 1, in the stage of the brush base material, good-conductive metal coating may be formed on whole are or one portion of the side surface 1b and the upper surface 1a of the brush 1, except the under surface 1a. Materials of this coating can include nickel, copper and silver.

Thickness of this coating is about 3 to 10 μm, however, the present invention is not limited to this.

[0044] The formation of this metal coating can be performed by known methods such as electrolytic plating or electroless plating.

[0045] As a method for making the brush contain the water-soluble lubricant, the fluorine denatured silicone oil or both of the water-soluble lubricant and the metallic compound, employable methods include a method for mixing the brush with the aggregate and the binder in the middle of manufacturing or a method for impregnating the brash base material manufactured in advance with the water-soluble lubricant, the fluorine denatured silicone oil or both of the water-soluble lubricant and the metallic compound.

[0046] Description will then be made of a configuration impregnating the brush base material with the water-soluble silicone oil which is more preferred among the water-soluble lubricants.

[0047] Fig. 2 shows a constitutional formula of the water-soluble silicone oil.

[0048] In this water-soluble silicone oil, one of methyl groups coupled to a principal chain consisting of SiO is replaced by a functional group which is an alkyl group and polyalkylene oxide coupled to each other. The average molecular weight of the silicone oil is varied by values of x and y (natural numbers) of Fig. 2 and the kinetic viscosity is also varied correspondingly. In this embodiment, the silicone oil is preferred to have 10 to 20000 mm^2/s of the kinetic viscosity (20 °C). It is more preferred to use the water-soluble silicone oil having 10 to 1000 mm^2/s of the kinetic viscosity.

[0049] In order to impregnate the brush base material with the water-soluble silicone oil, first, an aqueous solution of the water-soluble silicone oil shown in Fig. 2 (silicone oil aqueous solution) is prepared. Since the water-soluble silicone oil and water is easily mixed, the silicone oil aqueous solution can be prepared by simple operation such as stirring with a stirrer by hand. An amount of the water-soluble silicone oil in the silicone oil aqueous solution is determined accordingly to an intended impregnation rate, an impregnating condition, a type of the selected base material and the like.

[0050] The prepared silicone oil aqueous solution permeates through the inside of the microscopic pores by the capillary phenomenon and impregnates the pores of the brush base material uniformly. Therefore, the impregnation can be performed by simply dipping the brush base material into the silicone oil aqueous solution. However, vacuum degassing or pressurize operation known as common impregnation methods may be used at the same time.

[0051] The temperature of the silicone oil aqueous solution can be room temperature on the order of 20 to 30 °C. If necessary, the impregnation may be performed at higher temperature such as 60 to 80 °C. The impregnation time is determined accordingly to conditions such as a viscosity of the silicone oil aqueous solution, temperature and the brush base material and, for example, is on the order of 10 to 60 minutes.

[0052] After impregnating the brush for a given length of time, the brush is taken out and dried under temperature of 100 °C or more to remove water from the silicone oil aqueous solution impregnated in the brush. When the weight of the brush becomes a constant weight due to drying, it is considered that the removal of water reaches an end point, and drying is terminated. The weight of the water-soluble silicone oil remaining in the brush base material is the impregnated weight. In this embodiment, the weight of the impregnated water-soluble silicone oil will be 0.2 to 10 % by weight relative to the brush base material.

[0053] A lead wire 3 or the like is accordingly attached to the brush impregnated with the water-soluble silicone oil in this way.

[0054] Then, descriptions are made for a configuration impregnating the brush base material with the fluorine denatured silicone oil.

[0055] Fig. 3 shows a constitutional formula of the fluorine denatured silicone oil.

[0056] In this fluorine denatured silicone oil, one of methyl groups coupled to a principal chain consisting of SiO is replaced by a functional group which is $(CH_2)_2$ and CF_3 coupled to each other. The average molecular weight of the silicone oil is varied by a value of x (natural numbers) of Fig. 3 and the kinetic viscosity is also varied correspondingly. In this embodiment, the silicone oil is preferred to have 10 to 20000 mm^2/s of the kinetic viscosity (20 °C). It is more preferred to use the fluorine denatured silicone oil having 10 to 1000 mm^2/s of the kinetic viscosity.

[0057] The fluorine denatured silicone oil has small surface tension to the brush surface, permeates through the inside of microscopic pores by the capillary phenomenon and impregnates the pores of the brush base material uniformly. Therefore, the impregnation can be performed by simply dipping the brush base material into the fluorine denatured silicone oil. However, vacuum degassing or pressurize operation known as common impregnation methods may be used at the same time.

[0058] The temperature of the fluorine denatured silicone oil can be room temperature on the order of 20 to 30 °C. If necessary, the impregnation may be performed at higher temperature such as 60 to 80 °C. The impregnation time is determined accordingly to conditions such as a viscosity of the fluorine denatured silicone oil, temperature and the brush base material and, for example, is on the order of 10 to 60 minutes.

[0059] After impregnating the brush for a given length of time, the brush is taken out to remove the fluorine denatured silicone oil adhering to the brush surface by wiping away with a soft cloth, for example. The weight of the fluorine denatured silicone oil remaining in the brush base material is the impregnated weight.

[0060] In this embodiment, the weight of the fluorine denatured silicone oil will be 0.2 to 3 % by weight relative to the brush base material.

[0061] A lead wire 3 or the like is accordingly attached to the brush impregnated with the fluorine denatured silicone oil in this way.

[0062] Further, descriptions are made for the case of impregnating the brush base material with the water-soluble lubricant and a metallic compound.

[0063] The metallic compound is a metallic compound soluble to water or organic solvents and preferably is a chelate compound. Metal species of the metallic compound is groups 3 to 14 and period 3 to 5 on the periodic table of the elements and preferably are Al, Ti, Fe, Ni, Cu, Zn, Ag and Sn, and more preferably are Fe, Cu, Zn and Ag.

[0064] The metallic compound used in this embodiment may be electrovalent or covalent bonded compounds and includes inorganic salts such as sulfates, nitrates and hydrochlorides of the metallic species, organic salts such as acetates, oxalates, benzoates and benzenesulfonates of the metallic species, and metallic complex compounds and chelate compounds whose central atoms are the metallic species, however, the present invention is not specifically limited to these and can utilize commercially available metallic compounds. Preferably, ligands of complex compounds or chelate compounds are amine compounds such as ethylene diamine (en), diethylene triamine (dien), triethylene tetramine (trien), ethylene diamine tetra-acetic acid (edta), bipyridine (bpy) and terpyridine (terpy), ketonic compounds such as acetylacetone (acac), oxime compounds such as dimethylglyoxime, and the like.

[0065] In this embodiment, the silicone oil is preferred to have 10 to 20000 mm^2/s of the kinetic viscosity (20 °C). It is more preferred to use the mixture of the water-soluble silicone oil and the metallic compound having 10 to 1000 mm^2/s of the kinetic viscosity.

[0066] The mixture of the water-soluble lubricant and the metallic compound also has small surface tension, permeates through the inside of microscopic pores by the capillary phenomenon and impregnates the pores of the brush base material uniformly. Therefore, the impregnation can be performed by simply dipping the brush base material into the mixture of the water-soluble silicone oil and the metallic compound. However, vacuum degassing or pressurize operation known as common impregnation methods may be used at the same time.

[0067] Although the temperature of the mixture of the water-soluble lubricant and the metallic compound can be room temperature on the order of 20 to 30 °C, the impregnation is preferred to be performed at higher temperature such as 40 to 60 °C. The impregnation time is determined accordingly to conditions such as a viscosity of the mixture of the water-soluble lubricant and the metallic compound, temperature and the brush base material and, for example, is on the order of 10 to 60 minutes.

[0068] After impregnating the brush for a given length of time, the brush is dried at 100 °C. The weight of the mixture of the water-soluble lubricant and the metallic compound remaining in the brush base material is the impregnated weight.

[0069] In this case, the content of the water-soluble lubricant will be 0.2 to 10 % by weight relative to the brush base material, and the content of the metallic compound will be 0.05 to 10 % by weight relative to the brush base material.

[0070] In this composition, a synergic effect is generated due to using two (2) materials which are the water-soluble lubricant oil and the metallic compound as the impregnated materials, and it is believed that this composition remarkably achieves improvement of the efficiency relative to the motor, a longer life, a reduced temperature, suppression of sliding noises and reduced wear of the commutator.

[0071] Hereinafter, the present invention is described more specifically with reference to examples.

[0072] First, a resin bonded brush base material used in the examples was produced as follows.

[0073] A 30 weight portion of an epoxy resin was combined with a 100 weight portion of artificial graphite powder (100 μm average grain diameter, 5 % or less by weight of ash content) and was mixed and kneaded at normal temperature for a certain length of time (30 to 120 minutes) such that the resin and the artificial graphite powder is mixed uniformly.

[0074] This mixed and kneaded material was broken up into 40 Mesh or less to produce forming powder for forming the brush. The forming powder was formed into the shape of the brush (dimensions: 5.5 x 6 x 25 mm) using a metal mold and then heat-treated at 150 °C using a commercially available drier to cure the resin.

[0075] For the brush base material, a powder density was 1.45 g/cm^3 and a resistivity was 700 μΩ·m. For the brush base material, an accumulative pore capacity is 212 mm^3/g and an average pore radius was 0.76 μm. The porosity was obtained by the mercury porosimetry (using the mercury porosimetry Model MAPO 120 and PO 2000, FISONS Instrument co.).

[Example 1]

[0076] In the embodiment, water-soluble silicone oil having the chemical structure shown in Fig. 2 was impregnated in pores of a resin bonded brush base material produced as above. For the water-soluble silicone oil used, a kinetic viscosity was 100 mm^2/s (20°C) .

[0077] In the impregnating operation, the water-soluble silicone oil was dissolved in a predetermined amount of water to form silicone oil aqueous solution, and the brush base material was dipped into the aqueous solution for a predetermined length of time.

[0078] In order to produce a several types of brushes with different rates of impregnation of the silicone oil in the brush base material, by producing silicone oil aqueous solutions with silicone oil concentrations adjusted from 1 to 80 % by weight, the rates of impregnation was adjusted by differences in the silicone oil concentrations. Lengths of time for dipping the brush base material into the silicone oil aqueous solutions were set to points of time when the increases of weight were approximately saturated. Although varied by the concentrations of the silicone oil, the lengths of time for dipping were 15 to 30 minutes. Temperatures of the silicone oil aqueous solutions were set to 60 °C in each case.

[0079] After the impregnating operation was completed, the brush base material was taken out of the silicone oil aqueous solution, and the brush impregnated with the silicone oil aqueous solution was put into a drier kept at 120 °C to remove only water impregnated along with the silicone oil by drying.

[0080] In this way, (four (4) types of) brushes impregnated with the water-soluble silicone oil were obtained and respective rates of impregnation were 0.2, 1.2, 2.7 and 4.0 % by weights. The rate of impregnation (% by weight) is indicated by a percent determined when an increased weight due to the impregnation is divided by the weight of the brush before the impregnation to obtain a value which is then multiplied by 100.

[0081] For the cases of using these four (4) types of brushes impregnated with the water-soluble silicone oil, motor efficiencies were obtained.

[0082] In order to measure the motor efficiencies, after attaching lead wires to the brushes first, these brushes were set to a test motor with a spring pressure of 35 kPa. Under constant conditions, suction power P (W) was measured for each brush. About 1000 W electric power was input to the motor under a voltage of 100V at 60Hz. In this case, the number of rotation of the motor was about 32000 rpm.

[0083] The motor efficiency is calculated by equation (1).

$$\eta = (P/I) \times 100 \qquad (1)$$

wherein η is the motor efficiency (%) ; P is suction power (W); and I is input power (W).

[0084] The motor efficiency (η) is shown in table 1 as the efficiency of the motor for the case of using a brush which is not impregnated with the water-soluble silicone oil and the case of using the four (4) types of brushes impregnated with the water-soluble silicone oil.

<Table 1>

Impregnation Rate of Water-Soluble Silicone Oil (% by weight)	Motor Efficiency η (%)
0	40.2
0.2	40.3
1.2	40.4
2.7	40.3
4.0	39.8

[0085] As shown in table 1, when the rate of impregnation is 1.2 % by weight, the motor efficiency is 40. 4%, which is 0.2 % higher than the motor efficiency of the brush without impregnation of the water-soluble silicone oil (non-impregnation brush) which is 40.2 %. When the rate of impregnation is 0.2 and 2.7 % by weight, the motor efficiency is 40.3 %, which is 0.1 % higher than the motor efficiency of the non-impregnation brush. As shown in table 1, when the rate of impregnation is 4.0 % by weight, the motor efficiency is decreased as a result.

[0086] 0.1 to 0.2 % improvements of the motor efficiency is determined as a remarkable advantage in the field of small motors used with electric vacuum cleaners and the like. Therefore, these improvements are of great significance and are evaluated as improvements with a high utility value. Especially, in the situation that the input power is regulated by specifications and the like of motors, considering that the output power can not be increased by increasing the input power, it is inevitable that such a brush with higher motor efficiency is required.

[0087] Further, copper coating with 10 μm of thickness was formed on the entire circumferential surface of the brush base material produced in this example, except a portion contacting with the rotating portion of the brush, by electroless copper plating.

[0088] The brush base material with the copper coating was impregnated with the same water-soluble silicone oil using the same method as above (of this example) . As a result, in the brush base material with the copper coating, the rate of impregnation of the water-soluble silicone oil was lowered by on the order of 20 percent in comparison to the brush without the copper coating. However, in the case of brush base material with the copper coating, the rate of impregnation equivalent to the case of the brush without the copper coating could be obtained by methods such as elongating the time period of the impregnation or changing the temperature of the impregnation.

[0089] These brushes contribute to the above advantages in that, due to the effects of the good-conductive metal coating on the brush surface, a rise in temperature of the brush can be suppressed and that stable rectification can be maintained for a long period of time.

[Example 2]

[0090] In the example 2, the brush base material produced in example 1 was impregnated with the fluorine denatured silicone oil having the chemical structure shown in Fig. 3. For the fluorine denatured silicone oil, a kinetic viscosity was 100 mm^2/s.

[0091] The impregnation of the fluorine denatured silicone oil was performed by dipping the brush base material into the fluorine denatured silicone oil for a predetermined length of time at room temperature of 25 °C. Then, the brush was taken out to remove the fluorine denatured silicone oil adhering to the brush surface by wiping away with a soft cloth.

[0092] By changing the length of time for dipping the brush base material into the fluorine denatured silicone oil, the brushes with the same rates of impregnation as example 1 was obtained and, in other words, (four (4) types of) brushes impregnated with the fluorine denatured silicone oil were obtained and respective rates of impregnation were 0.2, 1.2, 2.7 and 4.0 % by weights. The rates of impregnation were obtained by the method same as the case of example 1.

[0093] For the cases of using these four (4) types of brushes and brush base materials impregnated with the fluorine denatured silicone oil, motor efficiencies were calculated by equation 1 as is the case with example 1.

[0094] The motor efficiency (η) is shown in table 2 for the case of using a brush which is not impregnated with the fluorine denatured silicone oil and the case of using the four (4) types of brushes impregnated with the fluorine denatured silicone oil.

<Table 2>

Impregnation Rate of fluorine denatured Silicone Oil (% by weight)	Motor Efficiency η (%)
0	40.2
0.2	40.4
1.2	40.7
2.7	40.5
4.0	39.7

[0095] As shown in table 2, when the rate of impregnation was 0.2 % by weight, the motor efficiency was 40.4 %; when the rate of impregnation was 1.2 % by weight, the motor efficiency was 40.7 %; and when the rate of impregnation was 2.7 % by weight, the motor efficiency was 40.5 %. In other words, these rates of impregnation showed motor efficiencies higher than the 40.2 % of the motor efficiency of the non-impregnation brush by 0.2 to 0.5 %. When the rate of impregnation was 1.2% by weight, the motor efficiency was significantly increased as shown. As shown in table 2, when the rate of impregnation is 4.0 % by weight, the motor efficiency is decreased as a result.

[Example 3]

[0096] The brush base material produced in example 1 was impregnated with a mixture of the water-soluble silicone oil having the chemical structure shown in Fig. 2 and a metal complex compound Cu(edta). For the water-soluble silicone oil and the metal complex compound, a kinetic viscosity was 100 mm^2/s.

[0097] The impregnation of the water-soluble silicone oil and the metallic compound was performed by dipping the brush base material into the mixture for 15minutes at liquid temperature of 50 °C. Then, the brush base material was taken out of the mixture, and the brush was put into a drier kept at 100 °C to remove water impregnated along with the water-soluble silicone oil and the metallic compound.

[0098] The respective obtained brushes had the rates of impregnation of the water-soluble silicone oil and the metallic compound shown in table 3. The rates of impregnation were obtained by the methods same as the case of example 1.

[0099] For the cases of using these brushes and brush base materials impregnated with the water-soluble silicone oil and the metallic compound, motor efficiencies (η) were calculated by equation 1 as is the case with example 1. Also, table 3 shows each measured result of wear amounts of brushes per 100 hours (mm/100h), temperatures of circumferential end portions of brush holders (°C), sliding noises of the brushes (dB) (measured with a sound level meter manufactured by ONO SOKKI) and wear amounts of commutators per 100 hours.

[0100] In order to measure the motor efficiencies, after attaching lead wires to the brushes first, these brushes were set to a test motor with a spring pressure of 41 KPa. Under constant conditions, suction power P (W) was measured for each brush. About 1550 W electric power was input to the motor under a voltage of 230V at 60Hz. In this case, the number of rotation of the motor was about 34000 rpm.

[0101] As shown in table 3, in sample numbers (2) to (4) and (6) to (17), the motor efficiencies are 41. 4 to 41. 9 %, which is 0.4 to 0.9 % higher than the motor efficiency of the brush without impregnation of the water-soluble silicone oil and the metallic compound (non-impregnation brush) which is 41.0 %, and the motor efficiencies show significant advantages. Also, for the wear amounts of brushes per 100 hours, the sample numbers (2) to (4) and (6) to (17) have values ranged from 3.8 to 7 (mm/100h), which are significantly reduced in comparison to that of the non-impregnation brush which is 10 (mm/100h). Further, the temperatures are suppressed at 100 °C or less. Further, in the sample numbers (2) to (4) and (6) to (17), the sliding noises are lowered in comparison to that of the non-impregnation brush which is 110 dB.

[0102] For the wear amounts of commutators per 100 hours, the sample numbers (2) to (4) and (6) to (17) have values ranged from 0.04 to 0.08 (mm/100h), which are significantly reduced in comparison to that of the non-impregnation brush which is 0.12 (mm/100h).

<Table 3>

Sample Number	Impregnation Rate of Water-Soluble Silicone Oil (% by weight)	Impregnation Rate of Metallic Compound (% by weight)	Motor Efficiency η (%)	Wear Amount of Brush per 100h (mm/100h)	Temperature (°C)	Sliding Noise (dB)	Wear Amount of Commutator per 100h (mm/100h)
(1)	0	0	41.0	10	95	110	0.12
(2)	3	0	41.7	5	100	107	0.06
(3)	5	0	41.6	6	100	106	0.06
(4)	10	0	41.4	7	100	107	0.07
(5)	12	0	41.0	10	100	110	0.11
(6)	2.95	0.05	41.7	4.8	99	106	0.05
(7)	2.9	0.1	41.8	4.8	98	106	0.05
(8)	2.84	0.16	41.9	4.3	96	106	0.05
(9)	2.68	0.32	41.8	3.8	94	105	0.04
(10)	2.52	0.48	41.8	3.8	96	106	0.05
(11)	2.04	0.96	41.7	4	98	107	0.05
(12)	1.0	2.0	41.7	5	99	107	0.06
(13)	1.0	4.0	41.7	6	100	109	0.06
(14)	0.8	5.0	41.7	6	100	109	0.07
(15)	0.8	8.0	41.7	7	100	109	0.08
(16)	0.5	10.0	41.7	7	100	109	0.08
(17)	10	10.0	41.5	7	100	108	0.08
(18)	0.5	12.0	41.5	10	100	110	0.12

INDUSTRIAL APPLICABILITY

[0103] For electric machines equipped with motors, such as electric vacuum cleaners, if the input power is regulated by specifications and the like of the motors, higher motor efficiencies are required. The present invention can be utilized in these motors. Moreover, the present invention achieves a longer brush life, can reduce sliding noises, is beneficial from an economical standpoint, can make the brush short and can contribute to miniaturization of the motor.

Claims

1. An electromechanical carbon brush applied against a conductive rotating body, comprising:

   a brush base material that is a material made of an aggregate including carbon as at least one (1) ingredient and of a binder, wherein
   the electromechanical carbon brush contains a water-soluble lubricant, and wherein
   a content of the water-soluble lubricant is 0.2 to 10 % by weight relative to the brush base material.

2. The electromechanical carbon brush of claim 1, wherein
   the water-soluble lubricant is any one or a mixture of polyethylene glycol or derivatives thereof, polyvinyl alcohol, polyvinyl pyrrolidone and water-soluble silicone oil.

3. An electromechanical carbon brush applied against a conductive rotating body, comprising:

   a brush base material that is a material made of an aggregate including carbon as at least one (1) ingredient and of a binder, wherein
   the electromechanical carbon brush contains fluorine denatured silicone oil, and wherein
   a content of the fluorine denatured silicone oil is 0.2 to 3 % by weight relative to the brush base material.

4. The electromechanical carbon brush of any one of claims 1 to 3, wherein
   the electromechanical carbon brush contains a metallic compound.

5. The electromechanical carbon brush of claim 4, wherein
   a content of the metallic compound is 0.05 to 10 % by weight relative to the brush base material.

6. The electromechanical carbon brush of any one of claims 1 to 5, wherein
   the binder is comprised of a synthetic resin.

7. The electromechanical carbon brush of any one of claims 1 to 5, wherein
   the binder is comprised of carbonization product of a synthetic resin or carbonization product of a pitch.

8. The electromechanical carbon brush of any one of claims 1 to 7, wherein
   good-conductive metal coating is formed on at least one portion of a surface of the carbon brush except a surface in contact with the conductive rotating body of the electromechanical carbon brush.

FIG.1

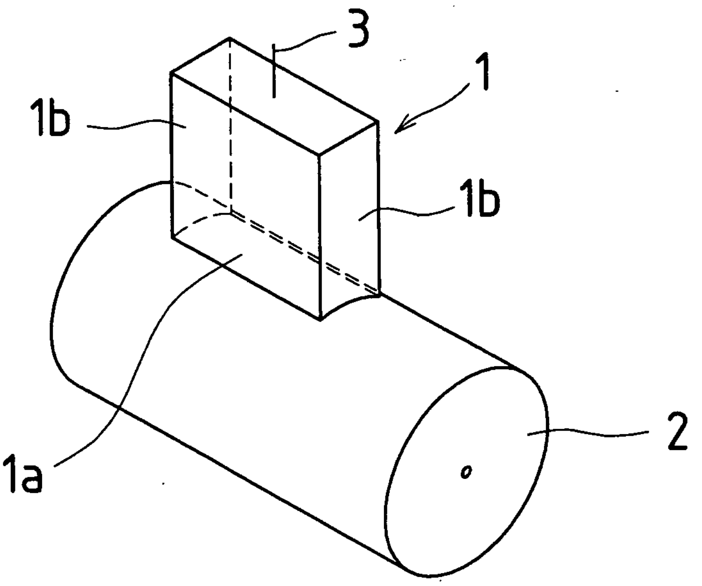


FIG.2

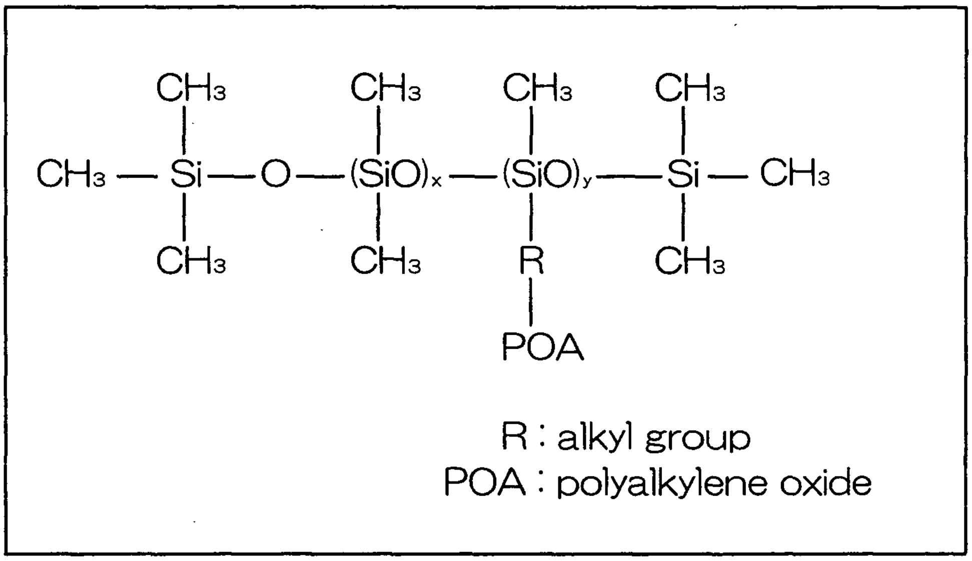
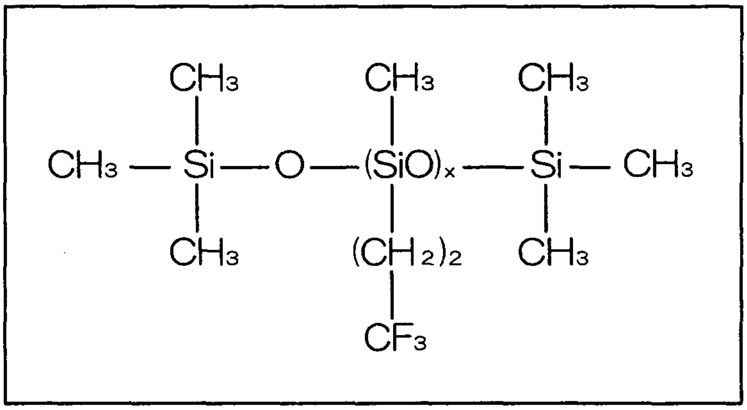

CH3
CH3 — Si — O — (SiO)x — (SiO)y — Si — CH3
R
POA
R : alkyl group
POA : polyalkylene oxide

FIG.3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2004/013272

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^7 H02K13/00, H01R39/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl^7 H02K13/00-13/14, H01R39/00-39/64, 43/027-43/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Jitsuyo Shinan Toroku Koho	1996-2004

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6068926 A (SPRRLING et al.), 30 May, 2000 (30.05.00), Column 1, line 63 to column 3, line 35 & EP 647993 A2 & DE 4330547 A1 & AT 190760 T & ES 2144021 T	1-8
A	US 2859139 A (D. RAMADANOFF), 04 November, 1958 (04.11.58), Column 2, lines 13 to 24 (Family: none)	1-8
A	JP 5-182733 A (Totan Kako Kabushiki Kaisha), 23 July, 1993 (23.07.93), Par. Nos. [0011] to [0030]; Figs. 1, 2 (Family: none)	6-8

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November, 2004 (26.11.04)	14 December, 2004 (14.12.04)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	JP 2004-173486 A (Aisin Seiki Co., Ltd.), 17 June, 2004 (17.06.04), Par. Nos. [0008] to [0085]; Figs. 1 to 20 (Family: none)	1,2,4-6

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