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Leaf brushes for electric motor brush gear

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FIG. 1

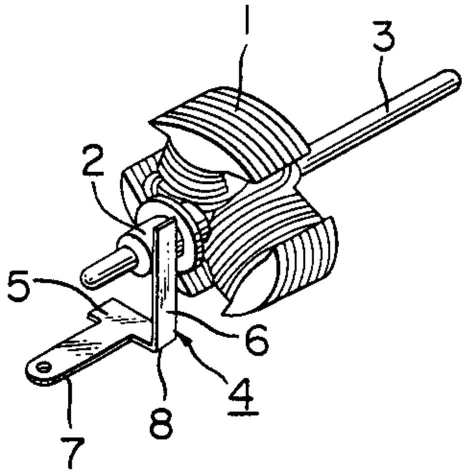

FIG. 2

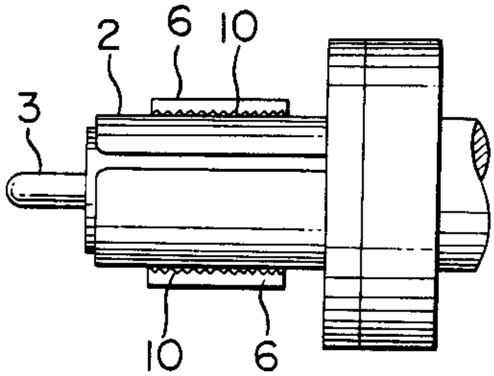

FIG. 3A

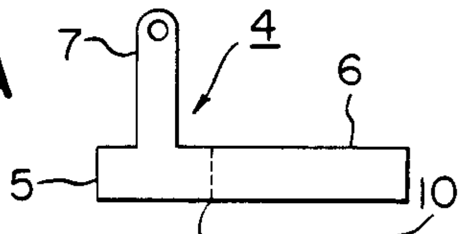

FIG. 3B

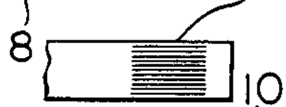

FIG. 3C

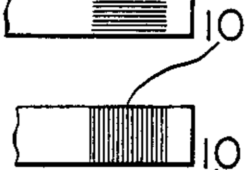

FIG. 3D

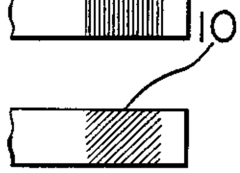

FIG. 3F

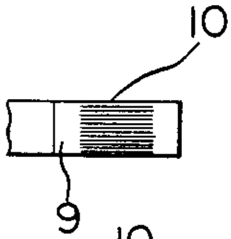

FIG. 4

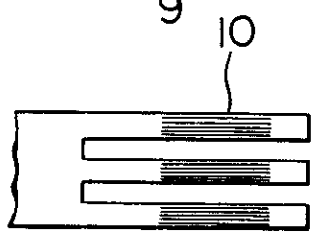

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FIG. 3E

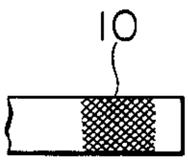

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FIG. 5

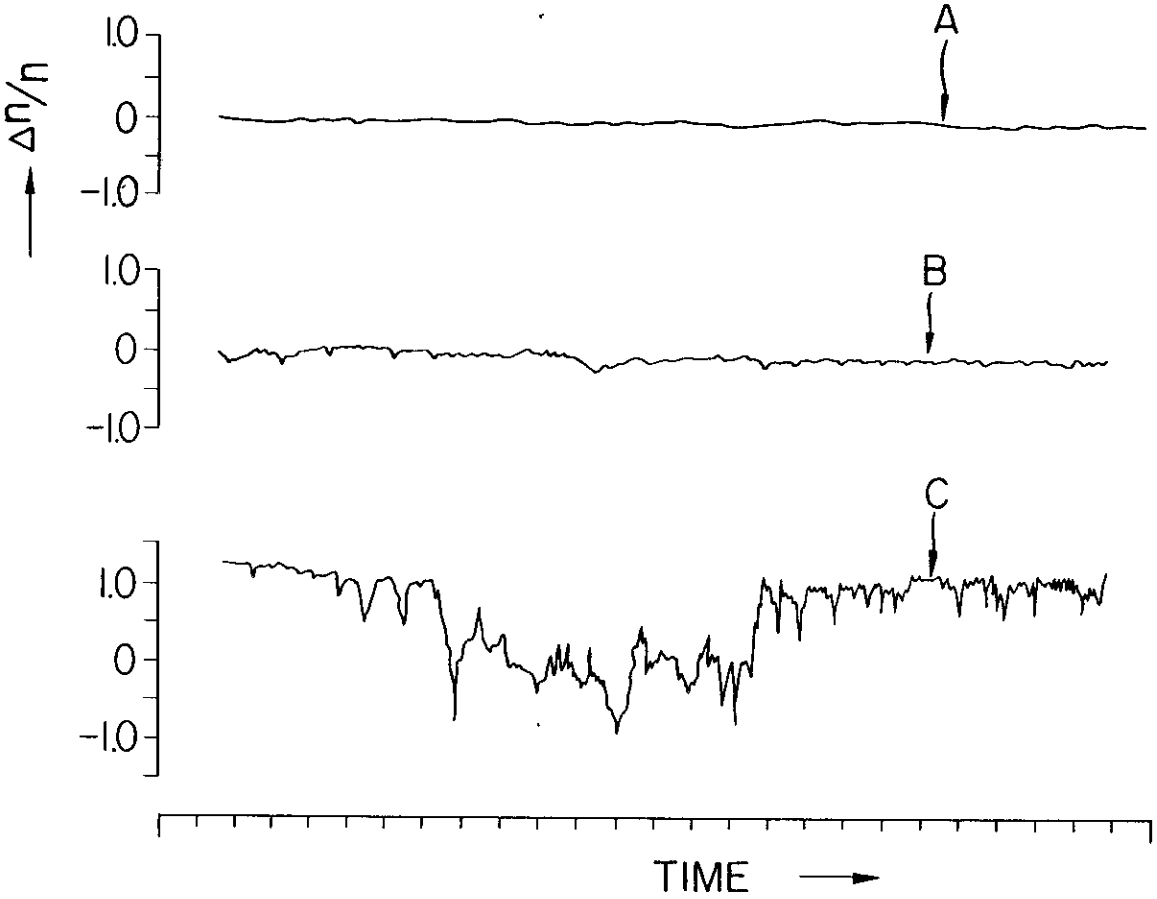

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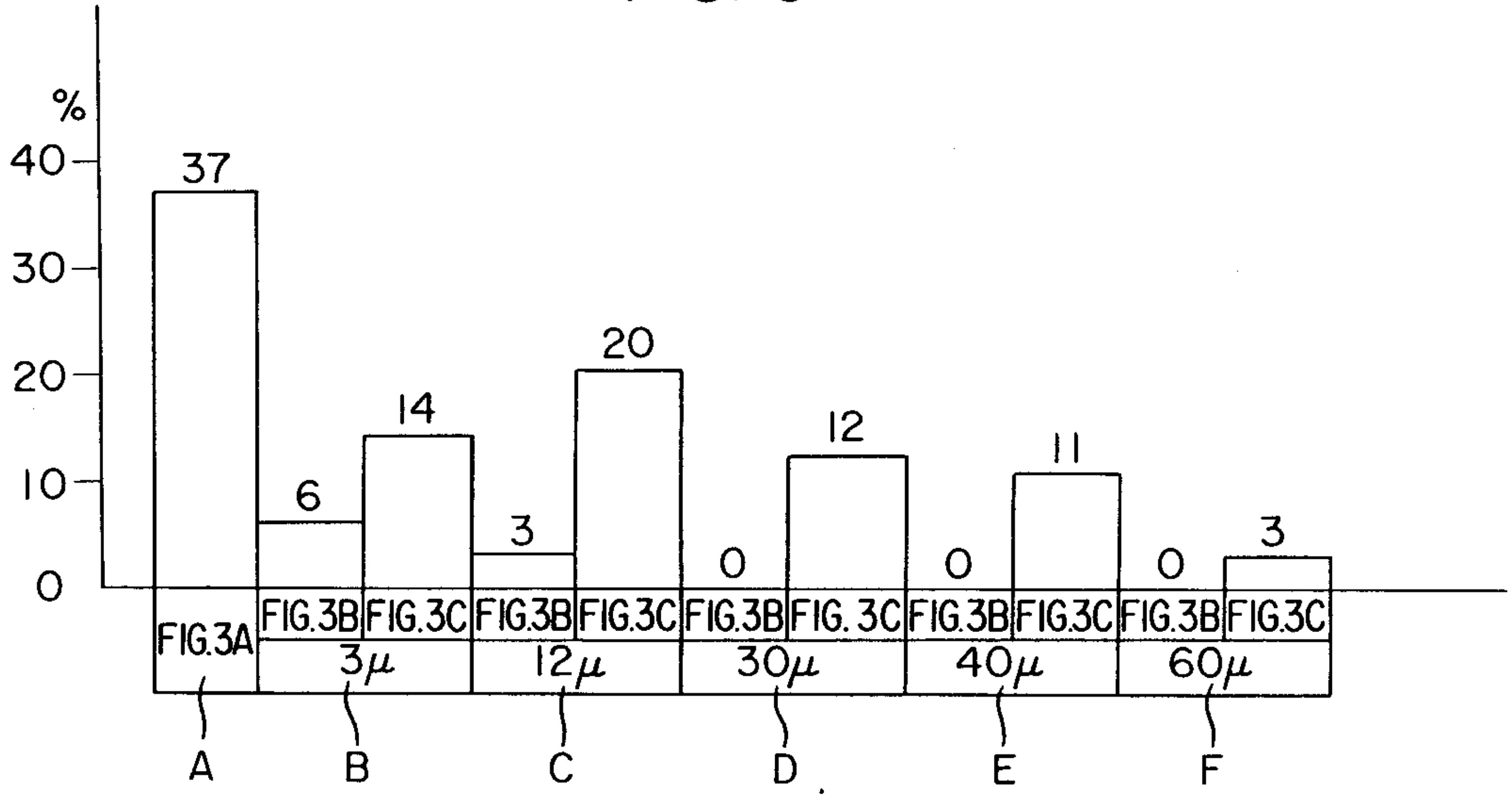
FIG. 6



LEAF BRUSHES FOR ELECTRIC MOTOR BRUSH GEAR

This invention relates to leaf brushes for electric motor brush gear.

In recent years so-called "small" electric motors have been used on an increasing scale, for example in audio equipment and in precision instruments. There is a need in such equipment for the small electric motor to have a stable operating performance. In order to reduce variations in the rate of revolution which tend otherwise to occur, a variety of speed governing means, for example employing electronic circuitry have been proposed in this art. It is desirable, in addition that the motor itself should have as stable a rotating speed as possible, even without the use of such speed governing means.

The performance of the commutator and the brush gear is known greatly to affect variation in the rate of rotation of the motor. Various means have been proposed for improving the performance of the commutator and brush gear, and notably the following:

(i) the brush slide surface of the commutator has been polished into a mirror-smooth surface, for example by machining with a diamond cutter, with a view to improving contact between the commutator and the brushes and to reduce abrasion and contact resistance;

(ii) a material having excellent conductivity and abrasion resistance has been used for the commutator;

(iii) the surface of the commutator has been plated;

(iv) the commutator slide surface of the brushes has been coated with a film of tin or of platinum; or

(v) the commutator slide surface of the brushes has been clad with a precious metal.

However, we have found that none of these prior proposals has proved sufficiently satisfactory; none is able to prevent variations in motor rotation to the extent we would wish. All involve high manufacturing costs.

In the past, efforts have been principally directed towards improving the smoothness of the contact surfaces as it was the general belief in this art that the contact surfaces between the commutator and the brushes should be finished as smoothly as possible and that a positive contact between the smoothly finished surfaces should be ensured so as to minimise contact friction between them. Our research has however shown that this long held belief is incorrect and that the practice of highly polishing the contact surfaces to a mirror-smooth surface results only in heavy deposition of abrasion products and contaminants on the contact surfaces which causes unwanted spark generation and poor conductivity leading to significant variations in the rate of motor revolution.

We have found that, contrary to the established practice of this art, if the contact surfaces are made rough rather than mirror-smooth, a material reduction in the variations in the rate of revolution of the motor may be achieved. This is a very surprising discovery in view of the established practice in this art.

In accordance with a first aspect of the present invention, there is provided for electric motor brush gear, a leaf brush provided with a commutator slide surface arranged for operative contact with an electric motor commutator and which has a dense multiplicity of fine ridges formed thereon.

In accordance with a second and alternative aspect of this invention, there is provided for an electric motor, brush gear comprising a pair of leaf brushes supported on a brush support means in opposed fashion such that commutator slide surfaces of the brushes make operative contact with the commutator of an electric motor in use, each said commutator slide surface having a dense multiplicity of fine ridges formed thereon.

There is provided, in accordance with a third alternative aspect of the present invention, an electric motor provided with brush gear comprising a pair of leaf brushes supported on a brush support means in opposed fashion such that commutator slide surfaces of the brushes make operative contact with the commutator of the motor, each said commutator slide surface having a dense multiplicity of fine ridges formed thereon.

The invention is hereinafter more particularly described by way of example only with reference to the accompanying drawings, in which:-

Fig. 1 is a perspective view of the rotary parts of a motor and one brush constructed in accordance with the present invention, other parts of the motor being omitted for clarity;

Fig. 2 is a somewhat schematic side elevational view illustrating a pair of brushes in accordance with this invention in contact with the surfaces of a commutator;

Fig. 3A shows a blank for forming a brush with a conventional commutator slide portion;

Fig. 3B to Fig. 3F show the commutator slide portions of embodiments of leaf brush in accordance with the present invention;

Fig. 4 shows the commutator slide portion of an alternative embodiment of leaf brush in accordance with the present invention; and

Figs. 5 and 6 are graphs of diagrammatic assistance in comparing embodiments of leaf brush in accordance with the present invention with corresponding embodiments constructed according to the previously conventional practice and illustrating the advantages obtained by the present invention.

A typical small electric motor such as that shown in Fig. 1 has a rotor 1 which is provided with windings around an iron core and a commutator 2, both fixedly mounted on a rotatable shaft 3. This rotary assembly is mounted in a motor casing (not shown) which houses a stator magnet. The shaft 3 which protrudes from one end of the motor case is supported in bearings in the motor case and in a motor case cover (also not shown) therefor. A leaf brush 4 is formed by cutting a blank from a resilient and electrically conductive material. A base portion 5, a brush portion 6 and a terminal portion 7 are defined by the configuration of the blank and by bending the blank along a line 8. The base portion 5 is fixed to the motor case cover, which serves as a brush support means such that the terminal portion protrudes from a hole provided on the motor case and such that the brush portion 6 is biased into contact with the commutator 2. Though not shown in the Figure, it will be understood that a second and similar brush is provided on the opposite side of the commutator.

The blank for a conventional leaf brush is shown in Fig. 3A prior to bending along the line 8 to provide the configuration shown in Fig. 1. Its commutator slide portion 6 is polished to a mirror-like finish.

In contrast, as is shown in Fig. 3B and in Fig. 2, the commutator slide portion of an embodiment of leaf brush in accordance with the present invention has a dense multiplicity of fine ridges 10 on the surface of the leaf brush where it makes sliding contact with the commutator 2 (see Fig. 2).

We have found that the arrangement of Figs. 2 and 3B has substantially reduced variations in the rate of revolution of the motor as compared with the conventional arrangement of Fig. 3A. We are not entirely certain as yet why this should be so, but we believe it possible that the large number of fine ridges densely formed on the commutator slide surface of the brushes where they make contact with the surface of the commutator have the effect of separating abrasion products dirt and contaminants which tend to be produced between the commutator and the brush and accumulate these in the large number of recesses formed between the ridges on the commutator slide surface of the brushes. In this way, we believe that a self cleaning effect may be produced resulting in the surfaces of the ridges where they make contact with the commutator surface and the commutator surface itself being kept clean. We also believe it possible that contact of a large number of sharp ridges on the brush surfaces with the commutator surface has the effect of cutting through any thin oil or oxide film which may be present on the commutator surface, thereby leading to good electrical contact between the brushes and the commutator.

The ridges 10 are formed in the longitudinal direction of the metal strip in the arrangement of Fig. 3B, in the transverse direction in the arrangement of Fig. 3C, in a direction oblique to the longitudinal direction of the metal strip in Fig. 3D, and in an oblique criss-cross fashion in the arrangement of Fig. 3E. In the embodiment of Fig. 3F the fine ridges 10 are provided on a surface 9 formed on the commutator slide portion of the leaf brush by plating, cladding or other appropriate surface treatment. The ridges 10 provided on the surface 9 need not be restricted to the longitudinal direction as in Fig. 3F, but may take any of the configurations of Figs. 3B to 3E.

In the embodiment of leaf spring shown in Fig. 4, the commutator slide portion is formed in a fork-shape having a plurality of prongs. Fine ridges 10 are densely provided on the commutator slide surface as shown. Though the ridges 10 are shown extending parallel to the longitudinal direction of the metal strip, this is not essential and the ridges 10 could be formed as shown in any of Figs. 3B to 3E.

The multiplicity of fine ridges 10 in the various embodiments described above with reference to Figs. 3B to 4 can be formed in a number of suitable ways, including the use of an abrasive-coated paper or of a lapping tape, or by means of a press or a roll. The selection of the appropriate means for forming the ridges 10 between the above suggestions or by some other appropriate means will depend upon the economy of the manufacturing process and other factors. We prefer to form the fine ridges on a metal sheet prior to the cutting out of blanks to the shape shown in Fig. 3A, the blanks subsequently being bent along a line 8 thereby to define the commutator slide portion 6.

Referring now to Fig. 5, this Figure diagrammatically represents test results for three small electric motors which have different configurations for the commutator slide surfaces of their leaf brushes, but are otherwise essentially the same in other respects. The three motors identified A, B and C were respectively operated under zero load at a designed rate of revolution of 2,400 rpm by applying a voltage of 6 Volts D.C. The rate of variability $\Delta n/n$ expressed in percentage terms of their rate of revolution was plotted against time. The abscissa represents time and is graduated in minutes, while the ordinate represents $\Delta n/n$. Motor A had leaf springs, the commutator slide surfaces of which were provided with a multiplicity of fine ridges of 12μ average height densely spaced and extending in the longitudinal direction of the metal strip, as shown in Fig. 3B. As is clear from Fig. 5, this motor exhibited a rate of variability in rotation of less than 0.1%, and thus exhibited an essentially stable rotation. Motor B has leaf springs, the commutator slide surfaces of which had fine ridges of 12μ average height densely spaced and extending in the transverse direction of the strip, as shown in Fig. 3C. As the graph shows, this motor had a rate of variability in rotation of less than 0.3%, and thus a rotation which was stable to a considerable degree. Motor C had conventional leaf brushes of the kind shown in Fig. 3A with smooth commutator slide surfaces. As Fig. 5 shows, motor C had a rate of variability in rotation of as much as 2.2% and so was subject to significant variations in the rate of rotation.

It will be seen that there is a clear distinction between the leaf brushes constructed in accordance with the present invention (namely those of motors A and B) as compared with the conventional leaf brushes of motor C. The leaf brushes in accordance with the present invention showed substantially better test results than those of the prior art.

It is additionally shown by Fig. 5 that, of the leaf brushes constructed in accordance with the present invention, brushes having their fine ridges extending generally in the longitudinal direction of the brush show better results than those having fine ridges extending in the transverse direction.

Referring now to Fig. 6 which expresses, as a histogram, the percentage of motors with various kinds of leaf brush commutator slide surfaces which, when operated under the same operating conditions, showed a rate of variability in rotation of more than 0.5%. The different configurations of commutator slide surface are identified on the abscissa. The letter A designates a motor having conventional leaf brushes with smooth commutator slide surfaces. The letters B, C, D, E and F designate motors having fine ridges respectively of 3μ, 12μ, 30μ, 40μ, and 60μ average heights formed on their leaf brush commutator slide surfaces. In each of the cases B, C, D, E and F a comparison is shown between a motor in which the leaf springs were as shown in Fig. 3B (i.e. ridges extending in the longitudinal direction of the brush) and as in Fig. 3C (ridges extending transversely).

As is clear from Fig. 6, the use of leaf springs in accordance with the present invention substantially reduce the frequency of variability in rate of rotation in excess of 0.5% as compared with the conventional smooth leaf brushes identified A in Fig. 6. Fig. 6 further shows that brushes which have fine ridges extending in the longitudinal direction show a greater effect in reducing variability in the rate of revolution of the motor than brushes in which the fine ridges extend in the transverse direction. In general there is less variability in the rate of revolution of the motor as the height of the ridges increases.

CLAIMS

1. For electric motor brush gear, a leaf brush provided with a commutator slide surface arranged for operative contact with an electric motor commutator and which has a dense multiplicity of fine ridges formed thereon.

2. A leaf brush according to Claim 1, wherein the commutator slide surface comprises one surface of a metal strip.

3. A leaf brush according to Claim 2, wherein the said metal strip surface is plated.

4. A leaf brush according to Claim 1, wherein the commutator slide surface comprises the surface of a metal strip to whcih a cladding material has been bonded.

5. A leaf brush according to any preceding claim, wherein said commutator slide surface is formed by dividing a brush portion of the leaf brush into a fork shape with a plurality of prongs.

6. A leaf brush according to any preceding claim, wherein said fine ridges are formed on said commutator slide surface in a direction generally parallel to the longitudinal direction of said leaf brush.

7. A leaf brush according to any of Claims 1 to 5, wherein said fine ridges are formed on said commutator slide portion in a direction generally oblique to the longitudinal direction of said leaf brush.

8. A leaf brush according to any of Claims 1 to 5, wherein said fine ridges intersect in a criss-cross pattern.

9. A leaf brush according to any of Claims 1 to 5, wherein said fine ridges are formed on said commutator slide portion in a direction generally transverse to the longitudinal direction of said leaf brush.

10. For electric motor brush gear, a leaf brush substantially as hereinbefore described with reference to and as shown in Figs. 1, 2 and 3B to 4 of the accompanying drawings.

11. For an electric motor, brush gear comprising a pair of leaf brushes supported on a brush support means in opposed fashion such that commutator slide surfaces of the brushes make operative contact with the commutator of an electric motor in use, each said commutator slide surface having a dense multiplicity of fine ridges formed thereon.

12. An electric motor provided with brush gear comprising a pair of leaf brushes supported on a brush support means in opposed fashion such that commutator slide surfaces of the brushes make operative contact with the commutator of the motor, each said commutator slide surface having a dense multiplicity of fine ridges formed thereon.

13. An electric motor according to Claim 12, wherein said fine ridges are formed in a direction generally parallel to the direction of relative sliding movement between the commutator surface and the commutator slide surface.

14. An electric motor according to Claim 12, wherein said fine ridges are formed in a direction generally oblique to the direction of relative sliding movement between the commutator surface and the commutator slide surface.

15. An electric motor according to Claim 12, wherein said fine ridges are formed in a direction generally transverse to the direction of relative sliding movement between the commutator surface and the commutator slide surface.

16. An electric motor substantially as hereinbefore described with reference to and as shown in Figs. 1, 2 and 3B to 4 of the accompanying drawings.

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