

PATENT SPECIFICATION (11)

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(21) Application No. 41509/77 (22) Filed 5 Oct. 1977 (19)

(44) Complete Specification published 23 April 1981

(51) INT. CL.³ H01R 39/18

(52) Index at acceptance
H2A AA

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(54) BRUSH DEVICE

(71) We, MABUCHI MOTOR COMPANY LIMITED, a company organised under the laws of Japan, of 14-11, Tateishi 3-chome, Katsushiki-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to commutator brushes.

Hitherto, some commutator brushes for small electric motors have included a brush portion and a terminal portion and have been fixed to the motor casing by appropriate fastening means. Such fastening means, however, have given rise to problems such as unwanted movement or loosening of the brush in the motor casing. Various fixing means have been proposed to overcome these problems. One proposed structure has a raised portion provided on the terminal portion of the brush, the tip of the raised portion engaging with a shouldered portion provided on the inside wall of a terminal insert hole in the motor casing end cap to prevent the brush from coming out of the terminal insert hole. This fixing means, however, requires a certain degree of dimensional tolerance to allow the raised portion to engage with the shouldered portion. Unwanted movement of the brush cannot therefore be entirely eliminated. Furthermore, a complicated process is required to form such a shouldered portion in the terminal insert hole.

According to a first aspect of the invention we provide a commutator brush, for insertion into a support, with a base having at least one raised portion which has at least one sharp burr thereon for biting engagement with the support.

According to a second aspect of the invention we provide brush gear comprising at least one commutator brush according to the first aspect of the invention; and a brush support comprising a terminal insert hole into which said base is inserted having a surface with which said burr or burrs is or are

adapted to engage and having means for supporting the base so that the burr or burrs engage said surface.

Various embodiments of the invention will be described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a perspective view illustrating the relation between two brushes and a motor casing end cap.

Fig. 2 is an elevation of a first embodiment illustrating a brush fixed in a terminal insert hole provided on the motor end cap, as viewed from the direction shown by an arrow α in Fig. 1.

Fig. 3 is a cross section taken on line X—X¹ in Fig. 2.

Fig. 4 is a cross section taken on line Y—Y¹ in Fig. 2.

Fig. 5 is a plan view taken on line Z—Z¹ in Figs. 3 and 4.

Figs. 6 and 7 illustrate a second embodiment in which a raised portion is provided on a side opposite to a terminal portion on the periphery of the brush base; Fig. 6 is a cross section corresponding to Fig. 3, and Fig. 7 is a plan view corresponding to Fig. 5 and taken on line Z—Z¹ in Fig. 6.

Figs. 8 to 11 illustrate an embodiment in which one or more projections are provided at the tip of a raised portion; Fig. 8 is a cross section corresponding to Fig. 3; Fig. 9 is a plan view taken on line Z—Z¹ in Fig. 8, corresponding to Fig. 5, illustrating an embodiment in which the projection at the tip of the raised portion is of a pointed shape; Fig. 10 is a plan view corresponding to a portion A in Fig. 9 illustrating a particular modification of the third embodiment in which the projection at the tip of the raised portion is of an arc shape; and Fig. 11 is a plan view corresponding to the portion A in Fig. 9 illustrating a further modification of the third embodiment in which the projections at the tip of the raised portion are of a plateau shape.

Figs. 12 and 13 illustrate a fourth embodiment in which a small laterally extending ridge is provided on an inside wall of

the terminal insert hole; Fig. 12 is a cross section corresponding to Fig. 3; and Fig. 13 is a plan view taken on line Z—Z' in Fig. 12.

5 Figs. 14 to 17 illustrate a fifth embodiment in which the tip of two raised portions of a brush bitingly engage with seats additionally provided, instead of engaging with the inside wall surface of the terminal insert hole; Fig. 14 is a perspective view showing the relation between two brushes and a motor casing end cap; Fig. 15 is an elevation as viewed from the direction shown by an arrow *a* in Fig. 14, illustrating a brush fixedly inserted in the terminal insert hole; Fig. 16 is a cross section taken on line X—X' in Fig. 15; and Fig. 17 is a plan view taken on line Z—Z' in Fig. 16.

10 Figs. 18 to 20 show a sixth embodiment in which one or more retaining pieces are provided around the base of the brush; Fig. 18 is a plan view of the brush base; Fig. 19 is an elevation showing a brush of the embodiment shown in Fig. 18 fixed in the terminal insert hole provided on a motor casing end cap; and Fig. 20 is a plan view showing an embodiment in which retaining pieces are provided on a brush base having the terminal portion on a side opposite to the commutator slide.

15 In Fig. 1, brushes 1 and 1' comprise commutator slides 2 and 2', brush bases 3 and 3', terminal portions 4 and 4', and raised portions 5 and 5' respectively, the raised portions being made of a resilient electrically conductive material, for example beryllium-copper alloy, and being provided on the brushes bases 3 and 3'. In mounting brushes 1 and 1' on a motor casing end cap 6, the brushes 1 and 1' are inserted in a direction shown by arrows *a* and *a'* in the figure. That is, the terminal portions 4 and 4' and the brush bases 3 and 3' of the brushes 1 and 1' are inserted into terminal insert holes 7 and 7' on the end cap 6. In this case, the central parts of the brush bases 3 and 3' of the brushes 1 and 1' are supported by first supporting means 8 and 8', and both sides of an outer face of each of the brush bases 3 and 3' are supported by end faces K and K' of second supporting means 9 and 9', thus the brush bases 3 and 3' are subject to a flexing force and supported by a so-called three-point support. (In the figure, numeral 10 refers to a hole through which a motor shaft (not shown) is inserted.)

20 Fig. 2 is an elevation of the first embodiment, as viewed from the direction shown by the arrow *a* in Fig. 1, of the brush 1 fixed in the terminal insert hole 7 provided on the end cap 6. When inserting the brush 1 into the end cap 6, as described above, the terminal portion 4 is passed through a hole 11 provided in the end cap 6, and the raised

portion 5 is slid along the inside wall surface 12 of the second supporting means 9. Once inserted, the brush 1 is prevented from falling out of the hole 9 rearwardly, that is, in the reverse of the direction of insertion, by means of sharp burrs 13 provided on the upper edge of the raised portion 5: when the brush is pulled rearwardly the burrs, which are on the side of the raised piece contacting the inside wall surface 12, tend to cut into the wall to prevent further rearward movement. This can be seen from Figs. 3 and 4.

The brush 1 is prevented from falling out forwardly by abutment of shoulders 14 against the vertical wall 15 of the terminal hole 7, as is shown in Fig. 4 and Fig. 5.

In order for the tip of the raised portion 5 to cut into the inside wall surface 12, as described above, the burrs 13 must be provided on the edge of the tip of the raised portion 5 on the side contacting the inside wall surface 12. If a raised portion 5 of a brush similar to that of the invention is punched out of a metal sheet in a single operation, the burrs at its tip are formed facing the metal sheet, so that when the brush is inserted into the terminal insert hole 7 there are no burrs situated suitably for biting engagement with the inside wall surface 12. Thus the raised portion 5 cannot be formed by such a single step operation.

For this reason, in forming the raised portion 5 of this invention, a hole 16 having a width *d*₂ equal to or larger than the width *d*₁ of the raised portion 5 is punched in the brush base 3 from the bottom surface (from below the plane of the page of Fig. 5) upwards, as shown in Fig. 5, while concomitantly, both sides of the raised portion 5 are lanced so that it can be subsequently raised. In the subsequent operation, the raised portion 5 is raised along a dotted line in the Figure from the bottom surface upwards. By forming the raised portion 5 in this way, the burrs 13 at the tip of the raised portion 5 are produced on a side situated suitably to contact the inside wall surface 12.

Figs. 2 to 5 show a groove 19 having a width almost equal to that of the raised portion 5 provided on the inside wall surface 12 of the terminal insert hole 7, with which groove the raised portion engages, so tending to prevent lateral movement thereof. In Fig. 5 the groove 19 is shown to have a width *d*₃ (see also Fig. 2) almost equal to width *d*₁ of the raised portion 5.

The second embodiment is shown in Figs. 6 and 7. The raised portion of this embodiment is provided on an edge of the brush base 3 opposite to the terminal portion 4.

The brush of this embodiment is manufactured by first so punching it out from the top surface (from above the plane of the page of Fig. 7) downwards of a blank

plate that the piece 5 is in the plane of the brush base 3, and then raising piece 5 above the top surface of the brush base 3 along a dotted line in Fig. 7.

5 By this method burrs 13 are formed on the upper surface of the tip of piece 5, as shown in Fig. 6.

10 The brush is prevented from falling rearwardly out of the terminal insert hole 7 in the manner previously described, that is the brush is pulled backwards after insertion into the terminal insert hole 7, so that the burrs 13 tend to cut into the inside wall surface 12 of the hole 7 to prevent further rearward movement.

15 The third embodiment is shown in Figs. 8 to 11, and in this one or more projections 17 are provided at the tip of the raised portion 5 to increase the pressure exerted by sharp burrs 13 onto the inside wall surface 12.

20 A modification of the embodiment shown in Fig. 9, in which sharp projections 17 are provided at the tip of the raised portion 5, is manufactured similarly to the first embodiment. The hole 16 is punched in the brush base 3 from the bottom surface (from beneath the plane of the page of Fig. 9) upwards and concomitantly both sides of the raised portion 5 are lanced. The piece 5 is then bent above the brush base 3 along a dotted line in Fig. 9. In this way the burrs 13 are formed on the upper surface of the tip of the raised portion 5.

35 Two modifications of this embodiment shown in Figs. 10 and 11 have raised portions 5 whose tips have projections 17 of an arc or plateau shape respectively with sharply pointed burrs 13 on a side situated suitably to contact the inside wall surface 12; these modifications are manufactured similarly to that of Fig. 9.

40 The increased pressure exerted by burrs 13 on projections 17 on a raised portion 5 according to the embodiment of Figs. 8 to 11 improves the cutting action of the burrs, so that a brush may be more firmly held in place.

45 Brushes as thin as 0.1 mm or less are often used in a small motor, provided that the commutator rotates at a sufficiently low speed, to prevent unwanted resonance resulting from rotation of the motor and to minimize friction between the brush and commutator. In such a case, an effective cutting action by the burrs may not be obtained because of lack of resiliency of the raised portion. When thin brushes are used, therefore, a fourth embodiment shown in Figs. 12 and 13 may be used. As shown in Fig. 12, a small ridge 18 is provided, at a position corresponding to that of the tip of the raised portion 5 of a brush inserted in the end caps, on the inside wall surface 12 of the terminal insert hole 7 provided in the end

cap 6. Since the height (Δh in Fig. 12) of the small ridge 18 may be as small as 0.03 mm, for example, the small ridge can be formed merely by providing a small groove on the metal mold used for molding the terminal insert hole 7. This causes no problem in extracting the mold after the molding operation. The burrs 13 provided at the tip of the raised portion 5, which is formed similarly to that of the first embodiment, tend to cut into the small ridge 18 to secure the brush 1 in the terminal insert hole 7.

70 The fifth embodiment is shown in Figs. 14 to 17. The brush base 3 of the brush 1 has raised portions 5 provided on each side of the brush base 3. Seats 20 for receiving the tips of the raised portions 5, together with supporting means 8, are provided on the end cap 6. Sharp burrs 13 are formed on the edges of each raised portion 5 on a side situated suitably to contact the respective seat 20. The raised portions 5 are made similarly to the raised portion 5 of the first embodiment, and likewise may be made to cut into the seats 20 to prevent the brush from falling out by pulling the brush 1 rearwardly after insertion. As shown in Figs. 15 and 17, shoulders 21 for guiding the outer sides of the raised portions 5 are provided on the seats 20 to at least reduce lateral movement of the brush 1. Distance d_4 between the shoulders is almost equal to distance d_5 between the outer sides of the raised portions 5. The shoulders 21 may alternatively be positioned to guide the inner edges of the raised portions 5.

80 The sixth embodiment is shown in Figs. 18 to 20. Two retaining pieces 22 which are bent down along dotted lines seen in Figs. 18 and 20 are provided on an edge opposite the terminal portion 4 of the brush base 3. The retaining pieces 22 are formed so that internal distance, d_7 in Fig. 18, is almost equal to a width d_8 of the first supporting means 8 which supports the central part of the brush base 3. When the brush 1 having the retaining pieces 22 is inserted into the terminal insert hole 7, the tip of the raised portion 5 provided on the brush base 3 when the brush is pulled rearwardly tends to cut into the inside wall 12 of the terminal insert hole 7 to prevent the brush 1 from falling out. The two retaining pieces 22 engage with the first supporting means 8 to at least reduce lateral movement of the brush 1 in the terminal insert hole 7.

85 If the terminal portion 4 cannot be provided at the position shown in Fig. 18 because of the shape of the end cap or for some other reason, the terminal portion 4 may be formed by extending the brush base 3 towards a direction opposite to the commutator slide 2, as shown in Fig. 20. Particularly, when the terminal portion 4 is formed as shown in Fig. 20, lateral move-

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ment of the brush 1 in the terminal insert hole 7 may be prevented by providing the retaining pieces 22 as shown in Fig. 20.

5 WHAT WE CLAIM IS:—

1. A commutator brush provided, for insertion into a support, with a base having at least one raised portion which has at least one sharp burr thereon for biting engagement with the support.

10 2. A commutator brush according to Claim 1 having a raised portion consisting of a tongue formed from a central portion of said base.

15 3. A commutator brush according to Claim 1 or 2 having a raised portion consisting of a tongue formed on an edge portion of said base.

20 4. A commutator brush according to any preceding claim having at least one sharp burr formed on one or more projections on a raised portion, whereby to increase the pressure exerted on the support by the burr or burrs.

25 5. A commutator brush according to any preceding claim having a pair of projecting retaining pieces forming therebetween a slot.

30 6. A commutator brush according to any preceding claim having a terminal portion extending from a central portion of an edge of said base, the end portions of the edge constituting shoulders.

35 7. A commutator brush substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

40 8. Brush gear comprising at least one commutator brush according to any preceding claim; and a brush support comprising a terminal insert hole into which said base is inserted having a surface or surfaces with which said burr or burrs is or are adapted to engage and having means for supporting the base so that the burr or burrs engage said surface or surfaces.

45 9. Brush gear according to Claim 8;

wherein said surface is a wall of said hole and said supporting means comprises a longitudinal rib adapted to abut a surface of said base opposite that from which the raised portion or portions project.

50 10. Brush gear according to Claim 9 wherein said brush comprises a brush according to Claim 5 and said rib engages the slot defined by the projecting retaining pieces.

55 11. Brush gear according to any of Claims 8 to 10 wherein said surface has a groove adapted for engagement with at least one of said raised portions, whereby said base is located laterally.

60 12. Brush gear according to Claim 8 wherein said supporting means comprises a longitudinal rib adapted to abut a face of said base and wherein two raised portions project from said face, one on either side of said rib, and wherein the burrs engage respective ones of said surfaces on either side of said rib.

65 13. Brush gear according to Claim 12 wherein each said respective surface has a longitudinal shoulder whereby said base is located laterally.

70 14. Brush gear according to any of Claims 8 to 13 wherein the or each surface has a laterally extending ridge for engagement with one or more of said burr or burrs.

75 15. Brush gear according to any of Claims 8 to 14 wherein said brush comprises a brush according to Claim 6, and wherein an aperture is provided in an end wall of the support for said terminal portion, the end wall being adapted for abutment with the shoulders of said brush.

80 16. Brush gear substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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ment of the brush 1 in the terminal insert hole 7 may be prevented by providing the retaining pieces 22 as shown in Fig. 20.

5 WHAT WE CLAIM IS:—

1. A commutator brush provided, for insertion into a support, with a base having at least one raised portion which has at least one sharp burr thereon for biting engagement with the support.

2. A commutator brush according to Claim 1 having a raised portion consisting of a tongue formed from a central portion of said base.

3. A commutator brush according to Claim 1 or 2 having a raised portion consisting of a tongue formed on an edge portion of said base.

4. A commutator brush according to any preceding claim having at least one sharp burr formed on one or more projections on a raised portion, whereby to increase the pressure exerted on the support by the burr or burrs.

5. A commutator brush according to any preceding claim having a pair of projecting retaining pieces forming therebetween a slot.

6. A commutator brush according to any preceding claim having a terminal portion extending from a central portion of an edge of said base, the end portions of the edge constituting shoulders.

7. A commutator brush substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

8. Brush gear comprising at least one commutator brush according to any preceding claim; and a brush support comprising a terminal insert hole into which said base is inserted having a surface or surfaces with which said burr or burrs is or are adapted to engage and having means for supporting the base so that the burr or burrs engage said surface or surfaces.

9. Brush gear according to Claim 8,

wherein said surface is a wall of said hole and said supporting means comprises a longitudinal rib adapted to abut a surface of said base opposite that from which the raised portion or portions project.

10. Brush gear according to Claim 9 wherein said brush comprises a brush according to Claim 5 and said rib engages the slot defined by the projecting retaining pieces.

11. Brush gear according to any of Claims 8 to 10 wherein said surface has a groove adapted for engagement with at least one of said raised portions, whereby said base is located laterally.

12. Brush gear according to Claim 8 wherein said supporting means comprises a longitudinal rib adapted to abut a face of said base and wherein two raised portions project from said face, one on either side of said rib, and wherein the burrs engage respective ones of said surfaces on either side of said rib.

13. Brush gear according to Claim 12 wherein each said respective surface has a longitudinal shoulder whereby said base is located laterally.

14. Brush gear according to any of Claims 8 to 13 wherein the or each surface has a laterally extending ridge for engagement with one or more of said burr or burrs.

15. Brush gear according to any of Claims 8 to 14 wherein said brush comprises a brush according to Claim 6, and wherein an aperture is provided in an end wall of the support for said terminal portion, the end wall being adapted for abutment with the shoulders of said brush.

16. Brush gear substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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