

COMMUTATOR

This invention is concerned with commutators and more particularly with commutators adapted to facilitate the construction of rotors for electric motors.

As we shall explain below with particular reference to Fig. 3, difficulties arise in providing the windings in so-called "miniature electric motors" particularly in view of the tendency to thinner motors (i.e. motors of lesser axial extent).

In accordance with a first aspect of the present invention, we provide a commutator adapted for axial mounting on a rotor shaft together with a rotor core and rotor windings; the commutator having a plurality of angularly separated commutator segments and respective commutator tongues associated therewith and adapted to extend generally outwardly from the rotor axis in the assembled rotor, and being provided with locating means adapted for locating the commutator in position on the rotor shaft in a selected angular orientation relative to the rotor core, which locating means comprise projections the distal ends of which are adapted for locating the projections within corresponding locating key holes of the rotor core of cross-section greater than the cross-section of said distal end portions, and the proximal end portions of which are adapted for generally fixedly mounting the commutator to the rotor core, thereby firstly enabling winding of the rotor windings with the said commutator in a temporary position with the said distal end portions serving simply to locate the projections within the key holes and secondly enabling the commutator to be driven axially home with said proximal portions engaging with said key holes when the winding operation is essentially complete.

The invention also extends to rotors for electric motors, wherein the rotor comprises a rotor shaft, a

laminated rotor core generally fixedly mounted in position on said shaft, and having a plurality of locating key holes formed in the rotor core, and also having a commutator as defined above mounted on said rotor shaft in selected
5 angular orientation about the axis thereof relative to the angular orientation of the rotor core, the locating projections of the said commutator being engaged with said key holes so as to hold said commutator in a generally fixed position, and a plurality of windings on said core
10 electrically coupled to the said commutator tongues.

In an alternative aspect of the invention, we provide a method of constructing a rotor for an electric motor, comprising: mounting a laminated rotor core in a generally fixed position on a rotor shaft; locating a
15 commutator having a plurality of angularly separated commutator segments and respective commutator tongues associated therewith on the rotor shaft in a temporary position selected both axially and rotationally in which distal ends of locating projections provided on the
20 commutator are located within corresponding key holes of the rotor core of cross-section greater than the cross-section of said distal end portions; performing a winding operation to provide the rotor windings with the commutator in the said temporary position; and subsequently driving
25 the commutator axially home until proximal portions of said projections engage with the said key holes to generally fixedly mount the commutator to the rotor core.

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

Fig. 1 shows an embodiment of commutator constructed in accordance with the present invention in side elevation at (A) and in underneath plan view at (B);

Fig. 2 schematically illustrates successive stages (A), (B) and (C) in the construction of a rotor in accordance with the present invention; and

Fig. 3 shows a previously proposed commutator in side elevation at (A) and in underneath plan view at (B), a rotor core and shaft in an axial end view at (C) and in side elevation at (D), and stages in two different methods of construction of a rotor utilizing the commutator of Fig. 3 (A) and (B) at (E) and (F).

In the conventional construction of a so-called "miniature" electric motor with a commutator and associated brush gear in which power is fed to the rotor windings via brushes and the commutator, the relative angular position of the rotor core and the segments of the commutator should be suitably selected.

In one previously proposed arrangement illustrated in Fig. 3 at (A) and (B), the commutator 1 has a plurality of commutator segments 5, here three in number and disposed at 120° angular intervals about the axis of a column 13 formed of insulating material on which the segments are mounted. Coupled to the column 13, and suitably integral therewith is a portion 14 of enlarged radial extent. The commutator segments have associated therewith respective commutator tongues 6, suitably integral with the respective segments, the tongues 6 extending generally radially outwardly and being held in place between the enlarged portion 14 and a co-operating washer 15 fitted over the commutator segments. On the opposite axial side of the enlarged portion 14 are provided a plurality of projections 2 between which are respective reference surfaces 11.

To mount the commutator of Fig. 3 (A) and (B) in selected angular orientation relative to a rotor core 3 generally fixedly mounted on a rotor shaft 7, the rotor core has a plurality of locating key holes 4 equal in

number to the number of projections 2 located in its axial end surface. The commutator may be mounted in generally fixed position by driving home the projections 2 into firm engagement with the corresponding key holes 4.

5 We have found that the most desirable production procedure is for the commutator to be placed on the rotor shaft in advance of the windings 9 being provided so that the winding end 10 can be temporarily attached to the commutator tongue 6 during the winding operation. For this
10 to be possible, the commutator tongue 6 must be located at a position at a greater axial separation from the rotor core than the height H by which the windings extend axially beyond the rotor core. To ensure this, it has been proposed to select the axial length L_2 shown in Fig. 3 (A) suffi-
15 ciently large so that winding can be performed with the projections 2 already driven home into the key holes 4.

In recent years there has been an increased desire for thinner constructions of miniature motors (i.e. for motors with a reduced axial extent). We have considered
20 various ways in which the axial extent of the motor may be reduced. Specifically, axial length L_1 of the commutator segments may be reduced to the minimum consistent with satisfactory commutation. We have also considered reducing the length L_2 . However this has the effect of the com-
25 mutator tongue 6, when the commutator is mounted in position, being below the axial height H of the windings posing considerable difficulties in performing a winding operation. We have proposed three different ways in which this problem could be overcome utilizing a commutator of the kind shown
30 at (A) and (B) in Fig. 3, namely as follows:-

- (i) as indicated schematically at (E) in Fig. 3, the commutator may be axially located on the rotor shaft 7 at a position where the commutator tongues 6 are sufficiently separated

from the rotor core to lie above the axial height H of the intended windings. It should be understood that in this state the projections 2 will not yet be engaged with the key holes 4. Winding is conducted with the commutator in this state including attachment of the winding end 10 to the commutator tongue 6. After winding is complete, the commutator is forced home with the projections 2 being received in the key holes 4 until the commutator reference surfaces 11 make contact with the face of the rotor core 3.

(ii) Alternatively, the windings may be provided before the commutator 1 is located on the rotor shaft 7, the winding ends 10 then being connected to the commutator tongues 6.

(iii) In place of projections 2 and key holes 4, a knurled or roughened portion may be provided on the rotor shaft, the winding and fitting operation otherwise being as in (i) above with the commutator being pushed home onto the knurled portion to fix the commutator in position subsequent to winding being complete.

We have found as a practical matter that none of these methods is sufficiently satisfactory for us.

Specifically, in operating method (i), since the engagement of the projections 2 with the key holes 4 has to take place subsequent to the rotor winding operation, there is a considerable risk of a mismatch between the projections and the key holes. Great care must therefore be taken as the commutator 1 is driven home if damage is to be avoided or if the commutator is to be adequately fixed in position.

In attempting to follow method (ii), again since the commutator is fitted after the windings are provided, there is difficulty in accurately locating the projections 2 with the key holes 4 and precisely similar problems to those which arise following method (i) will occur.

Finally, method (iii) involves an additional operation, namely the provision of knurled or roughened portions, thereby increasing manufacturing time and cost.

As will become clear from the description of a preferred embodiment of the present invention with reference to Figs. 1 and 2, we have solved the problems which we found and which the various methods (i), (ii) and (iii) all failed adequately to overcome, in a simple and efficient manner which enables the provision of embodiments of electric motor with relatively reduced axial extent without adding to manufacturing cost or reducing productivity significantly.

In Figs. 1 and 2 we use the same reference numerals for corresponding parts to the parts illustrated in Fig. 3.

The projections 2 of the commutator of Fig. 1 are substantially greater in overall axial extent than the projections 2 illustrated in Fig. 3 (A). In the Fig. 1 arrangement distal end portions 2-1 of the projections have a relatively reduced cross-sectional area as compared with proximal end portions 2-2 of the projections 2. These distal end portions serve simply to locate the projections in the locating key holes of the rotor core which are of greater cross-section than the distal end portions. In order to construct the rotor, the commutator is located both axially and rotationally on the rotor shaft by locating the distal end portions 2-1 of the projections 2 in the key holes 4. In this condition, as illustrated in Fig. 2 at (A), the commutator tongues 6 will lie at an axial

separation L_3 from the rotor core, this axial separation being greater than the intended axial height H of the windings.

With the commutator in this temporary position,
 5 the winding operation can then be performed, as indicated at (B) in Fig. 2 with the winding ends 10 of the windings attached to the commutator tongues 6. This operation is susceptible to automation because the commutator tongues 6 are positioned beyond the winding height H . After completion of the winding operation, the winding end is
 10 connected to the commutator tongue 6 by soldering, for example, this operation also being susceptible to automation.

Thereafter, the commutator 1 is pushed home axially towards the rotor core 3 using a commutator pushing
 15 jig 12 as indicated at (C) in Fig. 2 through a distance L_4 (see Fig. 1 at (A)) to engage the proximal end portions 2-2 of the projections 2 firmly in the key holes 4.

Because the projections 2 have already been accurately located in the key holes by virtue of the
 20 distal end portions 2-1 being located in the key holes in the temporary position during the winding operation, no additional step of locating the commutator relative to the rotor core is necessary before operation of the commutator pushing jig 12. This clearly facilitates operation
 25 allowing for increased efficiency and a fully automated construction procedure.

Thus, the change in the configuration of the projections 2 as between the arrangement of Fig. 3 and the arrangement of Fig. 1 and which might at first sight
 30 appear to be a relatively minor change, in reality both solves problems which previously were unsolved and enables the ready construction of relatively thin rotors with a significant labour saving with a construction operation which is susceptible to virtually fully automated construction methods.
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CLAIMS

1. A commutator adapted for axial mounting on a rotor shaft together with a rotor core and rotor windings; the commutator having a plurality of angularly separated commutator segments and respective commutator tongues
 5 associated therewith and adapted to extend generally outwardly from the rotor axis in the assembled rotor, and being provided with locating means adapted for locating the commutator in position on the rotor shaft in a selected angular orientation relative to the rotor core, which
 10 locating means comprise projections the distal ends of which are adapted for locating the projections within corresponding locating key holes of the rotor core of cross-section greater than the cross-section of said distal end portions, and the proximal end portions of
 15 which are adapted for generally fixedly mounting the commutator to the rotor core, thereby firstly enabling winding of the rotor windings with the said commutator in a temporary position with the said distal end portions serving simply to locate the projections within the key
 20 holes and secondly enabling the commutator to be driven axially home with said proximal portions engaging with said key holes when the winding operation is essentially complete.

2. A commutator according to Claim 1, wherein said
 25 commutator segments are disposed at 120° angular intervals about the axis of a column formed of insulating material on which said segments are mounted; wherein said commutator includes a portion of enlarged radial extent coupled to said column, the commutator tongues being held between
 30 said enlarged portion and a co-operating washer fitted over said commutator segments; and wherein said locating projections extend axially of said commutator on the side of said enlarged portion opposite to the said commutator segments.

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3. A commutator substantially as hereinbefore described with reference to and as shown in Figs. 1 and 2 of the accompanying drawings.

4. A rotor for an electric motor, the rotor comprising: a rotor shaft; a laminated rotor core generally fixedly mounted in position on said shaft, and having a plurality of locating key holes formed in said rotor core; a commutator according to Claims 1 or 2 mounted on said rotor shaft in selected angular orientation about the axis thereof relative to the angular orientation of the rotor core, the locating projections of the said commutator being engaged with said key holes so as to hold said commutator in a generally fixed position; and a plurality of windings on said core electrically coupled to the said commutator tongues.

5. A rotor according to Claim 4, wherein said locating key holes are three in number, being provided on the axial end face of the rotor core at angular intervals of 120° , said projections being three in number and disposed at 120° angular intervals.

6. A rotor substantially as hereinbefore described with reference to and as shown in Figs. 1 and 2 of the accompanying drawings.

7. An electric motor comprising a stator and a rotor according to any of Claims 4 to 6.

8. A method of constructing a rotor for an electric motor, comprising: mounting a laminated rotor core in a generally fixed position on a rotor shaft; locating a commutator having a plurality of angularly separated commutator segments and respective commutator tongues associated therewith on the rotor shaft in a temporary position selected both axially and rotationally in which distal ends of locating projections provided on the commutator are located within corresponding key holes



of the rotor core of cross-section greater than the cross-section of said distal end portions; performing a winding operation to provide the rotor windings with the commutator in the said temporary position; and subsequently driving
5 the commutator axially home until proximal portions of said projections engage with the said key holes to generally fixedly mount the commutator to the rotor core.

9. A method substantially as hereinbefore described with reference to Figs. 1 and 2 of the accompanying
10 drawings, for constructing a rotor for an electric motor.

