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PATENT SPECIFICATION

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(54) MOTOR

(71) We, MABUCHI MOTOR KABUSHIKI KAISHA (also known as Mabuchi Motor Co. Ltd) of 14-11 Tateishi 3-chome, Katsushika-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 electric motors.

Electric motors of generally rectangular parallelepiped shape and of generally small dimensions (such as for example of approximately 20×20×10 mm in external dimension) have been proposed for use in electric model toys such as model racing cars to improve the space factor. Small dimension is achievable by minimising the magnetic gap between the permanent magnet or magnets and the core of the motor rotor. The previously proposed arrangements employed an adhesive to secure the permanent magnet in close contact with the inner wall of the casing.

We have found that with this previously proposed arrangement close attention was required if unwanted contacts between the permanent magnet and the motor rotor was to be avoided and to ensure that the magnetic gap was reasonably uniform. We further discovered that the strength of the adhesive may decrease due to time generated changes in the adhesive itself or due to vibrations caused by the revolution of the motor or by external impact, and that in any such case the permanent magnets may become separated from the inner surfaces of the casing, unwanted contact with the motor rotor resulting. Needless to say, this results in a total failure of the motor. In one effort to overcome this drawback, there was proposed the use of lanced and formed pieces on the side face of the magnet casing to support the permanent magnet. We found that such pieces tended to create unwanted magnetic short-circuits, lowering the efficiency. The use of a material with good permeability for the magnetic casing

so that it may then serve as a yoke must generally be avoided in an arrangement with lanced and formed side pieces because of the increased reactive magnetic flux due to the magnetic short circuit which tends to be created.

We have sought to avoid the various problems outlined above in a simple and efficient manner and the present invention has arisen out of this work.

In accordance with the present invention, there is provided an electric motor of generally rectangular parallelepiped shape, having a magnet casing of rectangular cross section; a plurality of permanent magnets mounted with a close fit to the inner wall of the casing, the magnets extending inwardly of the casing from said inner wall by a distance greater than adjacent portions of the side walls of the casing, and a plurality of lugs being provided on the casing to hold the permanent magnets in position.

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

Fig. 1 shows an embodiment of electric motor which is constructed in accordance with the present invention in a side elevational view;

Fig. 2 shows the embodiment of Fig. 1 in a plan view; and

Fig. 3 shows a cross-sectional view of the motor of Figures 1 and 2 taken along the line X—X as shown in Fig. 2 with the motor rotor removed.

The drawings show a magnetic casing, generally indicated 1, which has a rectangular cross section, as is evident from Fig. 3, and which is formed by bending a channel-shaped iron sheet into a generally U-shape. As is clear from Figures 2 and 3, one side face 1-4 of the casing includes side face portions 1-4A and 1-4B of the channel in two arms of the U. Similarly the opposite side face 1-5 of the casing includes opposite side face portions 1-5A and 1-5B of the channel. Permanent magnets 2 and 2' are mounted as shown in

the channels and have respective curved surfaces 2—1 and 2'—1 directed inwardly of the casing. A cover 3 made of synthetic resin is removably fitted to the magnet casing 1 at the one end. The motor has a shaft 4, 4' mounted in motor bearings 5, 5'. Fastening means 6, 6' and 6'' fasten the cover 3 to the magnet casing 1. Brush insert holes 7, 7' with brush retaining cylinders are provided on side faces 3—1 and 3—2 of the cover 3. A mark 8 is provided on the boundary between face 1—1 formed by the channel bottom on one arm of the U and the end face 1—3 of the magnet casing 1 away from cover 3, a like mark being provided on the boundary between the opposite face 1—2 and end face 1—3 (not shown). The motor has rotor cores 9 and 9' respectively wound with windings 10, 10'. A commutator segment is shown at 11, and supported at 12. Terminals 13 and 13' of the windings are electrically connected to the supporting means 12. A plurality of lugs 14—1, 14—2, 14—3, 14—4, and 15—1, 15—2, 15—3, 15—4 are respectively and symmetrically formed on the side faces 1—4 and 1—5 of the magnet casing and have their respective distal end portions bent inwardly of the casing at 14—1A, 14—2A, 14—3A, 14—4A and 15—1A, 15—2A, 15—3A, 15—4A to support and retain the magnets 2, 2' as shown. Neither of lugs 15—3 or 15—4 nor their distal ends are actually depicted in the drawing, but it will be appreciated that they occupy positions which correspond to those of lugs 14—3, 14—4. A metal bearing 16 provided on the inner surface of the magnet casing 1 can be seen in Fig. 3 and has a hole 17 through which the motor shaft 4 passes.

The width or lateral extent T1 of the side faces 1—4 and 1—5 of the magnet casing 1 is smaller than the corresponding width or lateral extent T0 of the magnets 2 and 2', as shown in Fig. 2.

The lugs 14 and 15 must extend beyond the width T0 to be inwardly bent. Thus, to firmly support and secure the permanent magnets 2 and 2' in the magnet casing 1 in this construction, the distal end portions 14—1A, 14—3A and 14—2A, 14—4A of the lugs 14—1, 14—3 and 14—2, 14—4 are fixedly staked to edge portions 2—1A and 2'—1A of the curved inner surfaces 2—1 and 2'—1 of the permanent magnets 2 and 2'. Similarly, the distal end portions 15—1A, 15—2A, 15—3A and 15—4A of lugs 15—1, 15—2, 15—3 and 15—4 are fixedly staked to edge portions 2—2A and 2'—2A of the curved inner surfaces 2—1 and 2'—1 of the permanent magnets 2 and 2' on the side face 1—5.

As a result, the permanent magnets 2 and 2' may be tightly fixed to the magnet casing 1 without the need for adhesive by positioning the magnets 2 and 2' along the length of the respective channels (i.e. in a direction into the paper in Fig. 3) and then bringing the lugs into engagement with the edge portions of the magnets, and staking the lug ends thereto. In this way the appropriate magnetic gap between the permanent magnets and the rotor windings is achieved. Since the arrangement described ensures that T0 is always larger than T1, the possibility of an unwanted magnetic short-circuit being formed by the side faces 1—4 or 1—5 is practically eliminated. The protruding lugs 14 and 15 are disposed at positions where they do not interfere with the rotor cores 9 and 9'.

Thus, the specifically described arrangement makes it possible to securely hold the permanent magnets in a magnet casing by simple means; and to construct an efficient small electric motor of rectangular parallelepiped shape using a casing material with good permeability in which unwanted reactive magnetic fluxes which flow between the permanent magnets and the magnet casing bypassing the motor rotor are reduced.

WHAT WE CLAIM IS:

1. An electric motor of generally rectangular parallelepiped shape, having a magnet casing of rectangular cross section; a plurality of permanent magnets mounted with a close fit to the inner wall of the casing, the magnets extending inwardly of the casing from said inner wall by a distance greater than adjacent portions of the side walls of the casing, and a plurality of lugs being provided on the casing to hold the permanent magnets in position.

2. An electric motor according to Claim 1, wherein the lugs are formed as continuations of the side walls and have their distal ends bent through a right angle to engage the inner end faces of the permanent magnets.

3. An electric motor substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

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