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[54] Title: MICROMOTOR

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[56] Reference (s) Cited and/or Considered:

U. S. Pat. No. 4,500,804 2/1985 Jones

[57]

A B S T R A C T

A micromotor having a cylindrical motor case, a cylindrical rubber or plastic magnet comprising a field, fixedly fitted to the inside surface of the motor case, a shaft rotatably supported by a bearing provided on the motor case, and a rotor provided inside the cylindrical magnet, in which the motor outside diameter is made less than 15 mm and the thickness - outside diameter ratio of the magnet is set to a range of 0.085 - 0.125.

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SPECIFICATION

TITLE OF THE INVENTION: MICROMOTOR

ABSTRACT OF THE DISCLOSURE

A micromotor having a cylindrical motor case, a cylindrical rubber or plastic magnet comprising a field, fixedly fitted to the inside surface of the motor case, a shaft rotatably supported by a bearing provided on the motor case, and a rotor provided inside the cylindrical magnet, in which the motor outside diameter is made less than 15 mm and the thickness-outside diameter ratio of the magnet is set to a range of 0.085 - 0.125.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates generally to a micromotor using a rubber or plastic magnet, and more particularly to a micromotor using a rubber or plastic magnet in which the thickness-outside diameter ratio of the magnet is set within a predetermined range so that changes in revolution per torque can be minimized.

DESCRIPTION OF THE PRIOR ART

Attempts have heretofore been made to use anisotropic sintered strontium ferrite magnet in a micromotor less than 1.5 mm in outside diameter. The anisotropic sintered strontium ferrite magnet, however, is usually expensive and difficult to machine into a shape fit for a field magnet in a micromotor. This leads to the substitution of the rubber magnet for the anisotropic sintered strontium ferrite magnet. The rubber magnet used for such a purpose is manufactured by mixing strontium ferrite powder with about 10% of rubber, and magnetizing the mixture. The magnet thus formed is hard to crack, and can be easily machined into any desired shape. In practice, however, no motors fitted with the rubber magnet as described above have been manufactured as yet, and therefore no data are available on the optimum design of such a motor.

SUMMARY OF THE INVENTION

This invention is intended to overcome the above-mentioned problems.

It is an object of this invention to provide a slender and cylindrical micromotor using a low-cost rubber or plastic magnet, and having such a thickness-outside diameter ratio as to minimize changes in revolution per torque. To this end, the micromotor of this invention has a cylindrical motor case, a cylindrical rubber of plastic magnet serving as a field and fixedly fitted to the inside surface of the motor case, a shaft rotatably supported by a bearing provided on the motor case, and a rotor provided within the cylindrical magnet, and is characterized in that the outside diameter of the motor is made less than 15 mm and the ratio of thickness to outside diameter is set to a range of 0.085 - 0.125.

These and other objects and advantages of this invention will become apparent through a perusal of the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram illustrating the revolution-torque ratio with respect to the thickness-outside diameter ratio of a rubber magnet used in the micromotor of this invention.

Fig. 2 is a diagram illustrating changes in magnetic flux with respect to the thickness-outside diameter ratio of the rubber magnet.

Fig. 3 is a diagram illustrating changes in winding resistance with respect core diameter.

Fig. 4 shows changes in revolution per torque (N/T) as seen from a motor characteristic table.

Fig. 5 (A) is a diagram illustrating a cylindrical rubber magnet.

Fig. 5 (B) is a schematic diagram showing a micromotor using a cylindrical rubber magnet.

DETAILED DESCRIPTION OF THE EMBODIMENT

In Fig. 5, reference numeral 1 refers to a rubber magnet; 2 to a motor case; 3 to a rotor; and 4 to a shaft, respectively.

Shown in Fig. 5 (A) is a cylindrical magnet having an outside diameter of D and a thickness of T by winding a rectangular rubber magnet sheet into a cylindrical shape. The cylindrical magnet thus manufactured is disposed in close contact with the inside surface of the motor case 2, as shown in Fig. 5 (B), to form a field. The micromotor is formed by disposing the rotor 3 inside the field.

In the meantime, one of the most commonly used methods of expressing the performance of a motor is motor revolution per torque (rmp/gcm). The smaller this value, the less motor revolution is subjected to change in accordance with changes in torque. It is therefore desirable, in designing a motor, to set this value at as small a value as possible for the same motor volume.

Fig. 1 is a diagram illustrating the revolution-torque ration (N/T) for the thickness-outside diameter ratio (t/D) of a low-cost rubber magnet used in a micromotor of this invention, Fig. 2 is a diagram illustrating changes in magnetic flux for the t/D of the rubber magnet shown in Fig. 1. The data shown in both figures are based on a motor having a magnet outside diameter of 11.25 mm, and magnet overall length of 25 mm.

As is evident from Fig. 1, the revolution-torque ratio becomes minimum at about 0.10 of t/D, and is kept under approx. 420 when t/D is kept within the range of 0.085 - 0.125, as shown by dotted lines in the figure.

Meanwhile, the increase rate of magnetic flux drops slightly due to magnetic saturation at over 0.9 of t/D, as is evident from Fig. 2. A t/D range up to about 0.125, however, is not a complete magnetic saturation region, posing no problems.

Fig. 3 is a diagram illustrating changes in winding resistance with respect to core diameter, with the outside diameter of the magnet held constant.

Since the magnet outside diameter is kept constant, the thinner the magnet thickness, the larger can be made the core diameter. With the same turns of winding (kept at 52 turns in this instance), the larger the core diameter, the larger can be made the wire diameter. Thus, winding resistance can be reduced, as shown in the figure. Within the t/D range of 0.085 - 0.125, as described above, the magnet thickness can be made relatively thinner, and accordingly the winding resistance can also be reduced.

Fig. 4 shows change in revolution per torque

(N/T) as seen from the motor characteristic table.

The foregoing description is concerned with an embodiment where a low-cost rubber magnet is used as a field, but the same description can be applied to a low-cost plastic magnet as well.

As is apparent from the foregoing description, this invention makes it possible to minimize changes in revolution per torque in a cylindrical motor having a limited volume and a motor outside diameter of less than 15 mm by using a low-cost rubber or plastic magnet, and setting the magnet thickness-outside diameter ratio to a range of 0.085 - 0.125.

WHAT IS CLAIMED IS:

(1) A micromotor having a cylindrical motor case, a cylindrical rubber or plastic magnet comprising a field and fixedly fitted to the inside of said motor case, a shaft rotatably supported by a bearing provided on said motor case, and a rotor provided within said cylindrical magnet, and characterized in that the outside diameter of said micromotor is made less than 15 mm, and the thickness-outside diameter ratio of said magnet is set to 0.085 - 0.125.

(2) A micromotor as claimed in Claim (1) wherein said cylindrical rubber of plastic magnet is provided in such a manner that the outer circumferential surface of said rubber or plastic magnet comes in close contact with the inner circumferential surface of said motor case.

(3) A micromotor as claimed in Claim (1) wherein said rubber magnet is manufactured by magnetizing a mixture of the powder of anisotropic sintered strontium ferrite and rubber in an amount

substantially equal to 10% of said powder.

(4) A micromotor as claimed in Claim (1) wherein said plastic magnet is manufactured by magnetizing a mixture of the powder of anisotropic sintered strontium ferrite and a plastic material in an amount substantially equal to 10% of said powder.

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FIG. 1

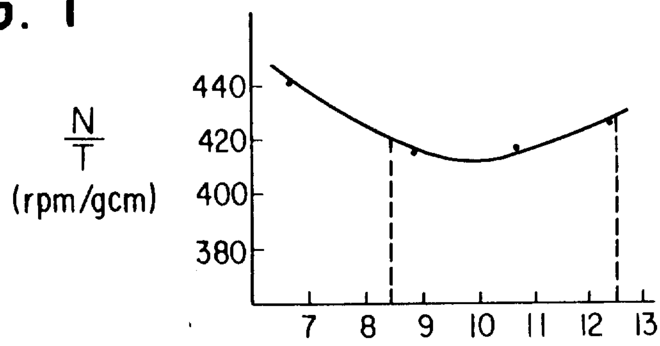

FIG. 2

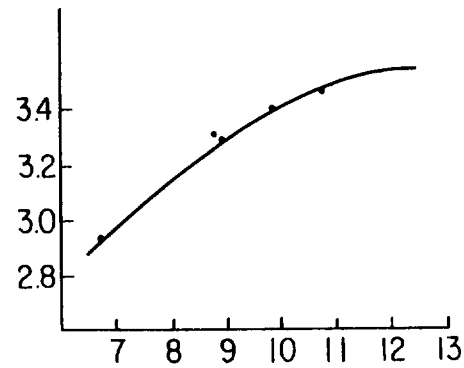

FIG. 3

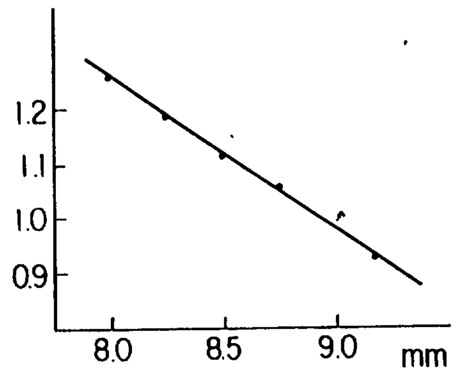

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FIG. 4

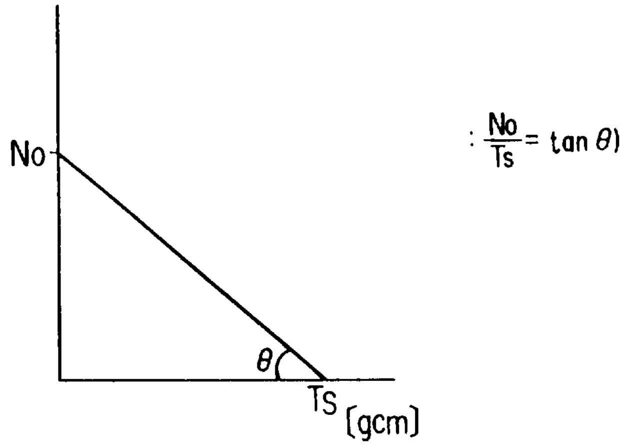


FIG. 5A

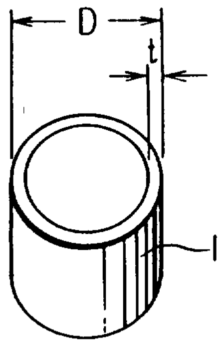
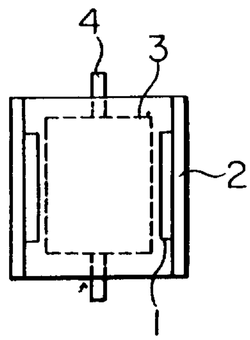


FIG. 5B



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