Introduction of New Brushless Blower Motor for Car Air Conditioner

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Abstract

In recent years, the automobile market has increased demand for lightweight parts that lower fuel consumption of vehicles as well as small-sized parts that are easily installed on vehicles. There is also demand for low-noise parts that improve cabin comfort. Meanwhile, air conditioning systems in Europe have a high air pressure drop and require high-output motors. To meet these demands, we have developed a new brushless blower motor that achieves "a small-sized, lightweight body with high output using the increased number of poles of the magnet circuit," "lower noise with the control of a pseudo sine wave," and "a longer service life through the adoption of a low-noise ball bearing and a bearing housing with high-accuracy coaxiality."

1. Features of New Brushless Motor

1.1. Introduction

Blower motors used in automotive air conditioning units include brush types and brushless types. In particular, brushless types have been widely used in recent years because of their advantages in power consumption, noise reduction, and durability. To respond to this trend, we have developed a new high-output brushless motor that can meet each of these requirements from automobile manufacturers: excellent air blow performance, ease of vehicle installation, and low noise level (Fig. 1).

Table 1 shows a comparison of the conventional and new blushless motors.

Fig. 1 New Brushless Motor Made by CK

Table 1 Comparison of Motor Spec

		Current Product	New Product
Motor Performance (@13V)	Output Power	175W	200W(14%UP)
Weight		1280g	1150g(10%DOWN)
Height		93.5mm	83.5mm(11%DOWN)
Noise(@1500min-1)		37dB-A	34dB-A(-3dB-A)
Motor Control		Square Wave	Sine Wave

1.2. Technologies adopted in the new brushless motor

The following summarizes new technologies adopted in the brushless motor.

Table 2 Technology with Incorporation of New Brushless Motor

Purpose	Means
High Output	Incorporation of Multipole Structure of Magnetic Circuit
Lightweight	
Long Life	Incorporation of the Low Noise Ball Bearing
	Incorporation of High Accuracy Alignment (Bearing Housing)
Improvement of Vibration Durability	Weight Reduction of Magnetic Circuit
Suppression of Air Flow Variation by ASIC	Incorporation of Constant Speed Control (For Torque Fluctuation)
Protection Control	Incorporation of Over Current Protection
	Incorporation of Over Temperature Protection

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1.3. Increase of poles of the magnetic circuit

The new brushless motor has a six-pole magnet and a nine-slot core while the conventional motor has a four-pole magnet and a six-slot core (Fig. 2). Increasing the number of poles from four to six extends the effective angle of the magnetic flux. By this method, the motor ensures the target amount of magnetic flux while minimizing the height of the magnet, which results in a smaller overall length of the motor.

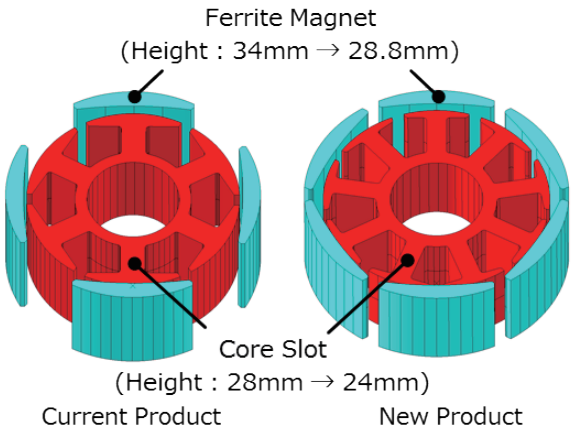


Fig. 2 Comparison of Motor Structure

1.4. Extension of the service life of the bearing with high reliability

The new brushless motor adopts a ball bearing, which replaces a conventional sintered metal bearing, in order to further extend the service life while ensuring the reliability. The sintered metal bearing had a difficulty that it took more time to be installed in the motor because of many auxiliary components. In addition, the sintered metal bearing had another disadvantage in service life depending on the amount of impregnating oil.

The new ball bearing uses a plastic ball retainer as one of low-noise specifications (Fig. 3). Further, the housings for retaining a ball bearing have been integrated into a single part in order to improve accuracy of the coaxiality (Fig. 3). In the conventional brushless motor, two housings were used since the motor did not require high accuracy of the coaxiality due to the characteristics of the sintered metal bearing. Thus, the new brushless motor has achieved a long service life of more than 20 thousand hours while maintaining low noise performance.

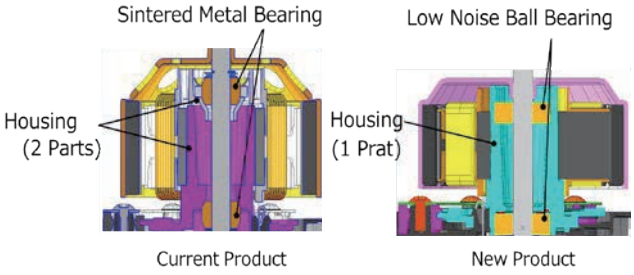


Fig. 3 Comparison of Motor Structure

1.5. Improvement of vibration durability

There has been the increasing demand for improving the vibration durability of the motor in recent years to respond to road conditions in emerging countries. To meet this demand, the new brushless motor has achieved 1.7 times higher vibration durability than the conventional brushless motor by lowering the center of gravity, in addition to lightening the body with the increased poles of the magnetic circuit (Fig. 4).

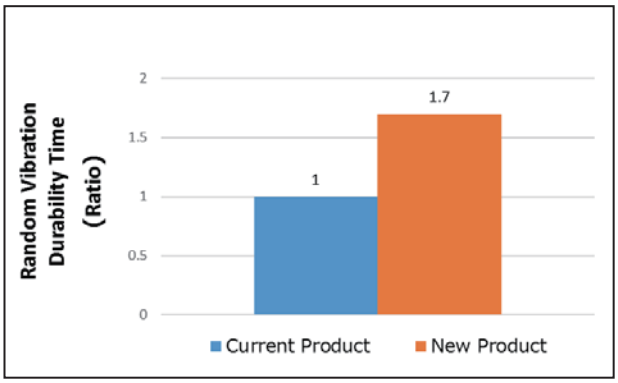


Fig. 4 Vibration Durability

1.6. New control specifications

A) Constant rotational speed control (using signal feedback from hall sensors)

The newly adopted ASIC regulates the new brushless motor at a constant rotational speed and thus prevents fluctuation of the air flow rate and noise.

In typical motors, the rotational speed varies due to changes in loads (torque). In the new brushless motor, however, the control system has the ability to maintain a constant rotation speed even when load changes occur due to ram pressure during vehicle driving and battery voltage drop (Fig. 5). Thus, the new motor can prevent rotation speed fluctuation even when the surrounding conditions change, and thereby achieve stable air blow to occupants.

In addition, the control system can eliminate rotation

deviation caused by motor's properties such as body dimension and assembly accuracy.

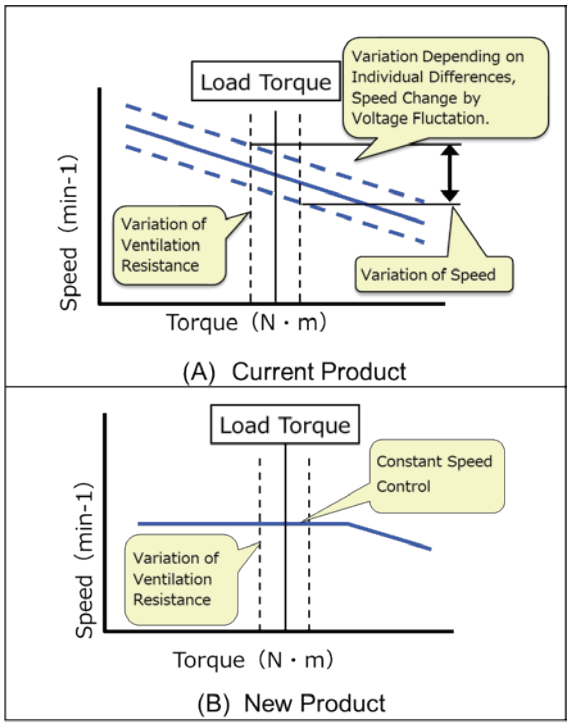


Fig. 5 Comparison of N-T Characteristics
(A) Without Constant Rotational Speed Control
(B) With Constant Rotational Speed Control

B) Overcurrent protection

In the conventional brushless motor, a fuse (a spring and solder) was used for overcurrent protection because the ASIC had no such functions. The new brushless motor, on the other hand, employs the new ASIC that incorporates an overcurrent protection function, along with a low-resistance shunt resistor (1 mΩ, high-accuracy type) (Fig. 6). This function works when the shunt resistor detects an excessive current value and then the new ASIC drops the output duty to slow down or stop the motor rotation.

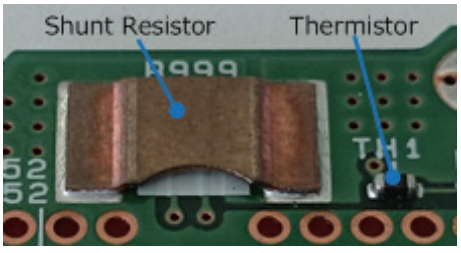


Fig. 6 Circuit Assy

C) Overheat protection

For having redundancy in the overcurrent protection function, the thermistor is installed in the proximity of the shunt resistor where the temperature becomes the highest to prevent overheat (Fig. 6). When an abnormal temperature is detected, the new ASIC drops the output duty to slow down or stop the motor rotation (Fig. 7).

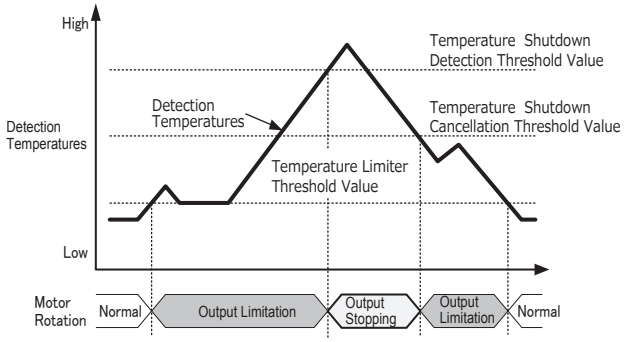
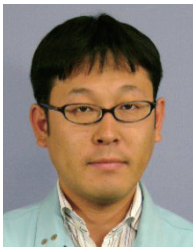


Fig. 7 Timing Chart of Over Temperature Protection

2. Conclusion

We have developed a new brushless motor that excels the conventional motor in terms of output, noise weight, size, and life, through the adoption of new motor technologies such as "the increased number of poles of the magnetic circuit for a small-sized and lightweight body with higher output," "the control of a pseudo sine wave for lower noise," and "a low-noise ball bearing and a bearing housing with high-accuracy coaxiality for a longer service life."

We will further enhance the technologies obtained through this development, for contributing to the realization of more power-saving climate systems.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