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RESEARCH ON ELECTROMAGNETIC NOISE OF ROTARY COMPRESSOR FOR HOUSEHOLD REFRIGERATOR

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ABSTRACT

Among many kinds of noise of a small rolling piston type rotary compressor (horizontally installed) for household refrigerator and other application, the electromagnetic noise may be most uncomfortable because of its beat noise. The electromagnetic noise is generated by the stator-rotor holding structure vibration caused by the electromagnetic force, which accelerated by many kinds of electromagnetic unbalances in fundamentalmagnetic field of stator and harmonic magnetic field of stator and rotor. The main factors of electromagnetic unbalance for electromagnetic noise in each frequency become clear by the detailed exper-imental research. The reduction of electromagnetic noise in below 500Hz and 1~1·2KHz frequency range wil be achieved by uniforming these electromagnetic unbalances.

INTRODUCTION

Recently the type of compressor for household refrigerator is getting rotary type main instead of reciprocating type. Concerning the vibration and noise generation, rotary type has some structural disadvantages in comparison with recipro type, though it has been reaching as the level of recipro type through continual improvement. Therefore the noise reduction of rotary compressor for household refrigerator has been shifting to improvement of noise quality from simple reduction of noise level.

For the point of view of uncomfortable compressor noise when household refrigerator driving, the most uncomfortable noise is low frequency range noise because it has beat noise. Though it is known that the electromagnetic noise of motor is the principal element of low frequency range noise. And the reduction of these noise is not easy. The electromagnetic noise is generated by the stator-rotor holding structure vibration caused by the electromagnetic force, which accelerated by unbalances of air-gap, rotor-bridge, stator-winding, secondary-resistance, power-voltage, and many other electromagnetic unbalances in magnetic field.

This paper shows the result, as a fundamental research for electromagnetic noise reduction of small rolling piston type rotary compressor, that the main factors of electromagnetic unbalance in each frequency range become clear by the detailed experimental research about the electromagnetic noise in each frequency range, and magnetic noise in below 500Hz frequency range by means of uniforming the unbalance of air-gap and for the electromagnetic noise in 1~1·2 KHz frequency range by means of correction of rotor dimension.

THE ELECTROMAGNETIC NOISE IN BELOW 500HZ FREQUENCY RANGE

The electromagnetic noise in below 500Hz frequency range of the rotary compressor exist in two frequency components, one is the running-frequency-component which is just integer number of running frequency and the other is the power-frequency-component which is integer multiple of power frequency ± slip frequency when in odd-number times and just integer multiple of power frequency when in even-number times (Fig.1), and the noise level of both components can be reduced by uniforming the unbalance of air-gap between stator and rotor (Fig.2).

The air-gap is composed by the amount of eccentricity and the amount of inclination of crank-shaft to motor-stator (Fig.3) and the interrelation betwee the electromagnetic noise and the amount of eccentricity is stronger than the interrelation between the elctomagnetic noise and the amount of inclination (Fig.4·Fig.5).

The electromagnetic noise in blow 500Hz frequency range can be reduced by controling the amount of eccentricity and the amount of inclination with the way of making the shape of parts better and improving the assembly and manufacturing accuracy of parts (Fig.6).

THE ELECTROMAGNETIC NOISE IN 1~1·2KHZ FREQUENCY RANGE

The electromagnetic noise in 1~1·2KHz frequency range which has some peaks in each (stator slot number ± 1) times frequencies (Fig.7). These peak frequencies are varied by changing of stator slot number (Fig.8) and amplified by the slit grinded rotor (Fig.9·Fig.10). So this noise will be reduced by means of correction of rotor dimension.

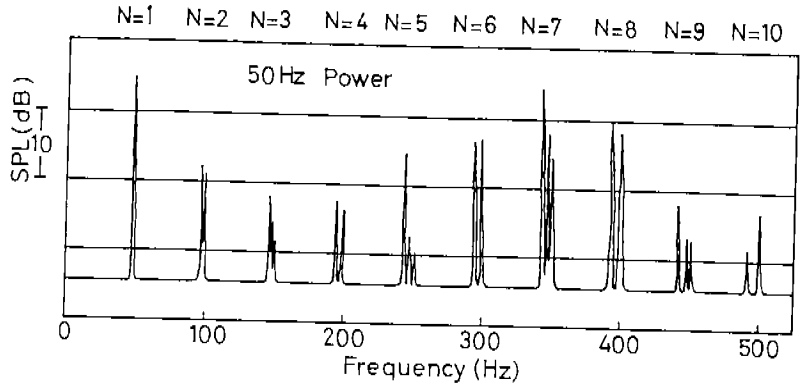

Fig.1 Narrow band sound spectra in below 500Hz frequency range

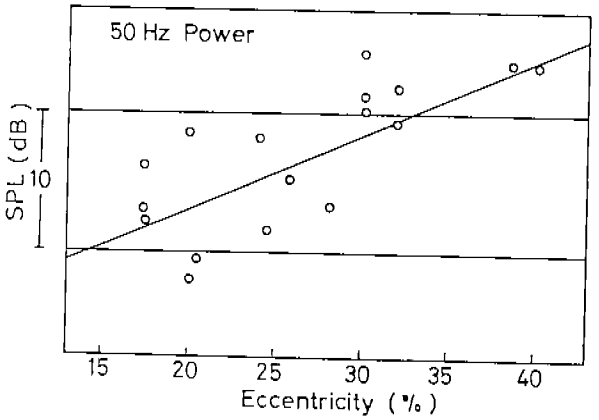

Fig.2 Relation between rotor-stator eccentricity and sound pressure level in below 500Hz electromagnetic noise

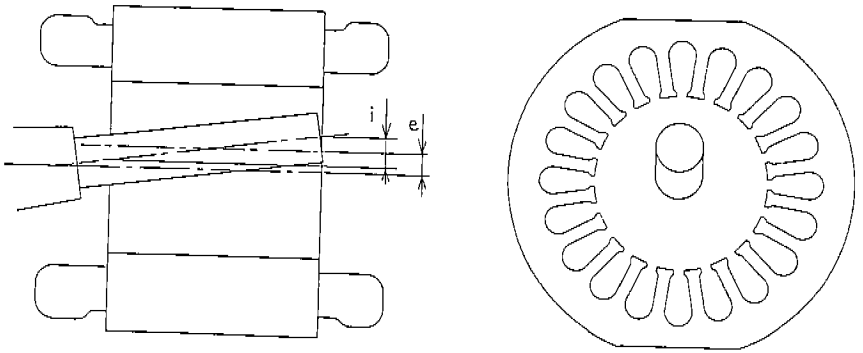

Fig.3 The amount of eccentricity e and the amount of inclination i

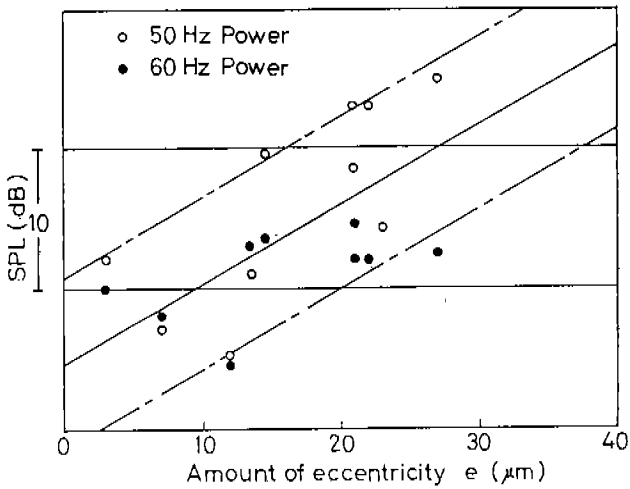

Fig.4 Reration between the amount of eccentricity e and Max. sound pressure level of spectra in below 500Hz electromagnetic noise

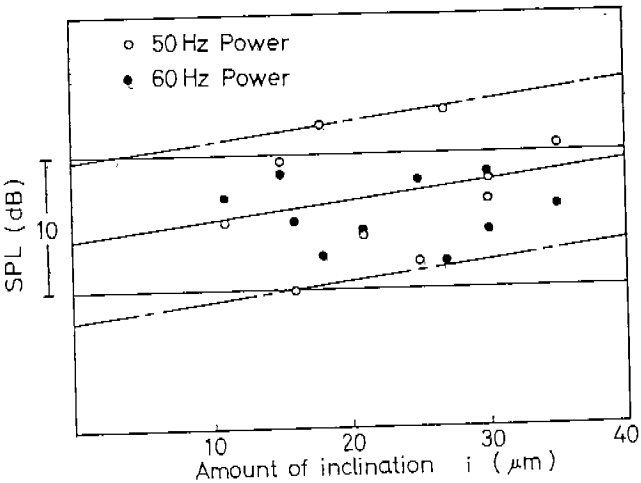

Fig.5 Reration between the amount of inclination i and Max. sound pressure level of spectra in below 500Hz electromagnetic noise

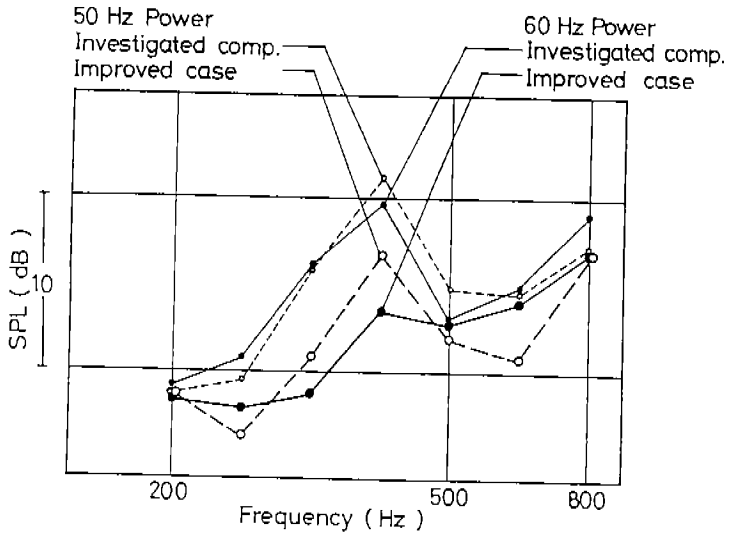

Fig.6 Reduction of electromagnetic noise in belw 500Hz frequency range in one-third octave band analysis

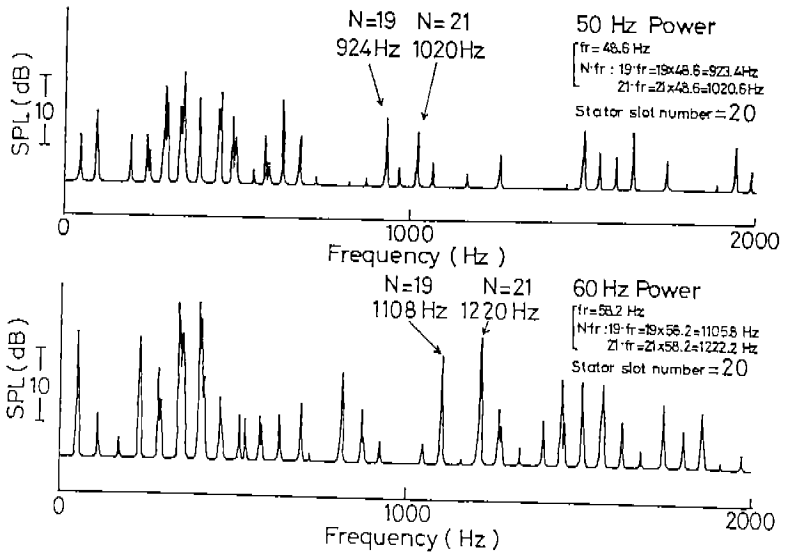

Fig.7 Electromagnetic noise in 1~1·2KHz frequency range

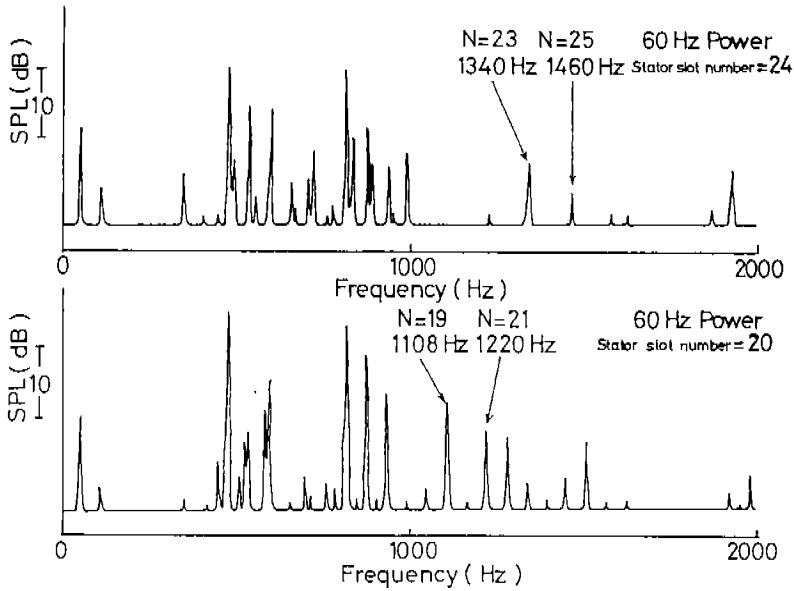

Fig.8 Change of 1~1·2KHz electromagnetic noise frequency by stator slot number change

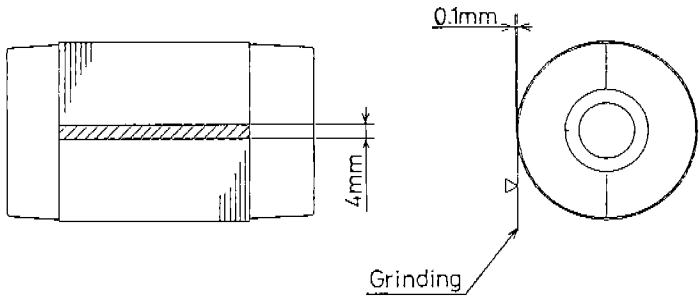

Fig.9 Slit grinded rotor

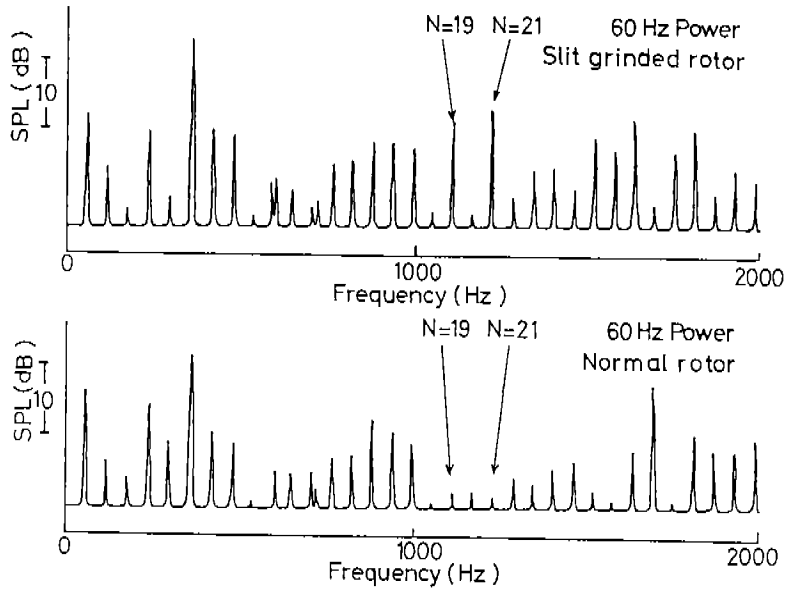

Fig.10 Change of 1~1·2KHz electromagnetic noise frequency by slit grinded rotor