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Improved loudspeaker by linear motion type ultrasonic motor
直動型超音波モータを用いたスピーカの改良

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1. Introduction

The loudspeaker driven by piezoelectric ultrasonic motors is characterized by a precise very-low frequency reproduction due to its high driving mechanical impedance. It has a lot of merits comparing to the conventional electrodynamic loudspeakers. One of the reason will be that this loudspeaker is a power flow modulator, not a transducer.

In this presentation, two sorts of ultrasonic motors are compared as driver elements of the loudspeakers.

The loudspeaker driven by ultrasonic motors is characterized by a precise low frequency reproduction due to its high mechanical impedance.

The conventional electrodynamic loudspeaker suffers disturbance due to a mechanical resonance. It is because radiator of the conventional loudspeaker is driven indirectly.

2. A loudspeaker by linear motion type ultrasonic motor

The solution for reduction of distortion was use of motors designed for linear motion only. The authors examined a prototype linear motion model by composite vibration type linear ultrasonic motors.

A loudspeaker by using the linear motion type ultrasonic motors is expected to be suitable for low frequency sound signal reproduction. Its driving mechanism can be simpler than that the driving mechanism by rotational type motors, because no parts for the mechanism of rotation to linear motion are necessary. Moving part of the motor is connected directly to the cone radiator.

An ordinaly equipment including the linear ultrasonic motors is a driver for linear slider for a conveyer in, for example, IC manufacturing plants. The authors examined loudspeakers with a cone radiator connected a linear slider which is driven by two ultrasonic motor blocks at opposite sides.

3. The 2009 model

Figura 1 and Figure 2 show the first experimental models by using linear ultrasonic motors. The slider and its rail for the models were ready-made components for a conveyer system. Weight of the solid steel slider was 430 gram. A model shown in Figure 7 is called as 2009 Model 1. The cone radiator and the slider were connected by a brass rod and a star-shaped spider. Silicon rubber dampers were insertedat the connedting point.The other model shown in Figure 8 is called as 2009 Model 2.

The cone and the slider were connected by tight metal components.

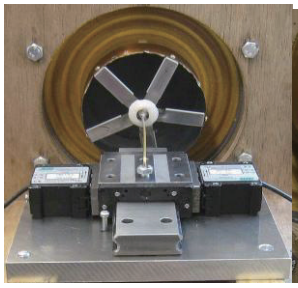

Fig.1 The 2009 Model-1

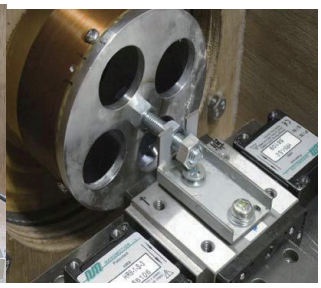

Fig.2 The 2009 Model-2

Figure 3 compares frequency responses of two models. The response of the Model 1 includes a peak at 56 Hz. Thispeak seems to be a resonance by silicon rubber damper. The frequency response of the Model 2 does not include this remarkable peak.and performance t higher frequency is better.

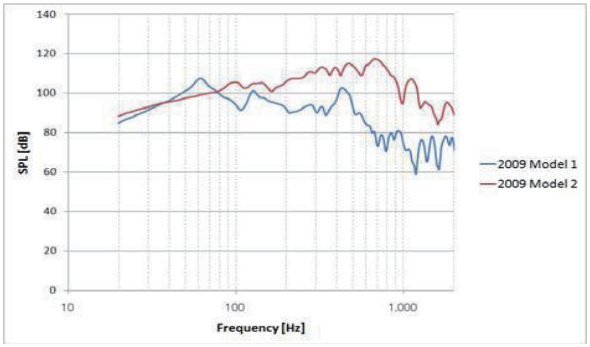

Fig.3 Frequency response of the 2009 models

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4. The 2010 model

Figure 4 shows a viw of improved model called as 2010 Model. Figure 11 describes its configuration:
The 2009 model included a steel slider, connected directly to a cone radiator and set on a sliding rail. It radiated a satisfactorily large sound. However, its efficiency and distortion characteristics were unsatisfactory.
The 2010 model has an improved simple construction. Size and weight of the movement was reduced and the slide rail was removed.

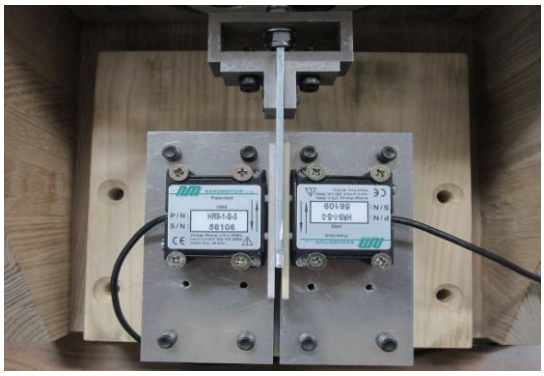

Fig.4 The 2010 Model

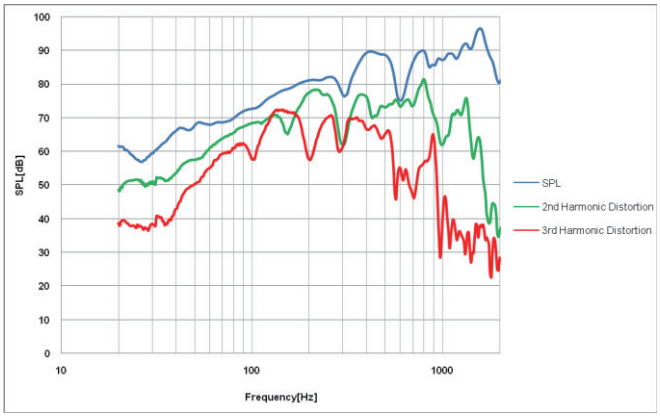

Fig.5 Frequency response of the 2010model

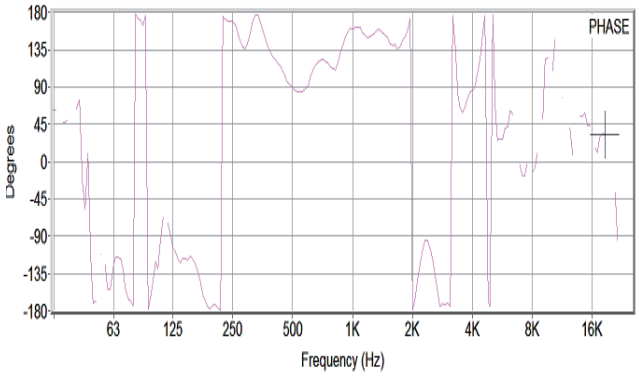

Fig.6 Phase response of the 2010 model

5. CONCLUSION

New loudspeaker models suitable for a low frequency reproduction were proposed. They utilize linear motion of composite vibration type ultrasonic motors. Their performance was improved by a simpler driving mechanism.

ACKNOULEDGEMENT

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