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Examination for a High Power of Aerial Ultrasonic Sound Source Using Cross Type Direction Changer of Longitudinal Vibration

縦振動の十字型方向変換を利用した空中超音波音源の高出力化

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1. Introduction

We have studied a practical ultrasonic sound source adopts a longitudinal vibrating system which comprise of ultrasonic transducer equipped with horn to magnify vibration amplitude, a multiple stripe-mode flexural vibration plate connected to the cross type vibration transmission rod to radiate a great-capacity aerial ultrasonic wave.[1 - 2)]

In previous study, we realized the higher capacity output 300 W to drive vibration plates of eight using four stages cross type vibration transmission rod in this sound source system.[3)] On the other hand, it is essential to realize the efficient vibration transmission because this sound source is orchestrated the improvement of higher output. Therefore, we consider to need the longitudinal vibration system is structure has multiple cross type transmission rod connected in vertical direction without screw coupling. We think that it is expected producing the vibration loss at the connecting part with screw coupling of cross type transmission rods in a conventional sound source.

In this report, we examined the ultrasonic source (about 20 kHz) using the longitudinal vibration system which integrate four stages cross type transmission rods without screw coupling.

2. Structure of sound source using cross type transmission rod

Figure 1 shows a schematic view of sound source using four cross type transmission rod. This sound source consists of Bolt-Clamped Langevin Transducer, amplitude expansion horn, and cross type transmission rods of four sets make up by connecting transmission rods (C2, C4, C6) and vertical transmission rods (C1, C3, C5, C7). Fig.1(a) shows a conventional system with screw coupling, and Fig. 1(b) shows a new system without screw coupling.

First of all, it examined the length of transmission rod C to adjust the desired resonance frequency of the longitudinal vibration system. In

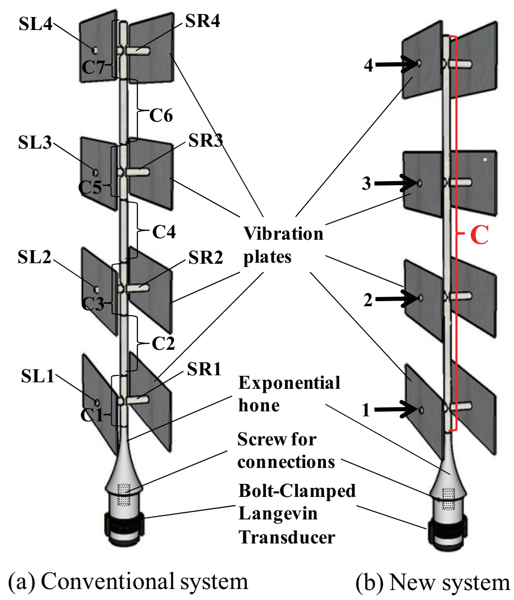

Fig. 1 Aerial ultrasonic sound source using cross type direction changer.

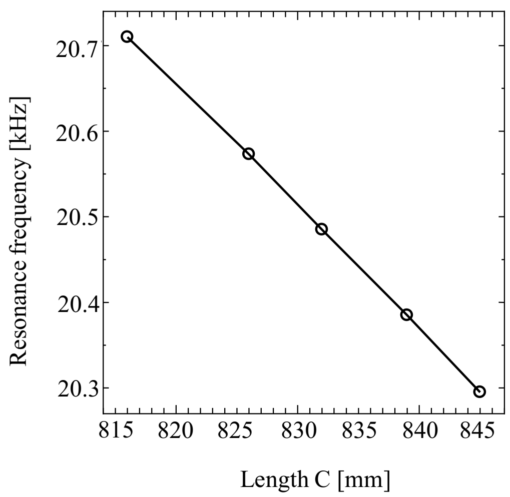

Fig. 2 Relationship between resonance frequency and lengths of C.

previous study, it is found that the vibration displacement of transmission rods SL and SR did not change when the resonance frequency of longitudinal vibration changed by variation of the

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length of transmission rod C.[3] Therefore, in this study, it was decided that the lengths of transmission rods SR and SL were 43mm. In addition, these transmission rods were connected with screw coupling at four positions being a node of longitudinal vibration, because these position has the maximum stress in the radial direction.

In this study, we prepared eight vibration plates with stripe-mode (resonance frequency: 20.38 kHz, width: 138.87mm, length: 360.21 mm, thickness: 2 mm, material: aluminum alloy). We determined to 839 mm the length of transmission rod C so that we decided resonance frequency of longitudinal vibration was 20.38 kHz to match the resonance frequency of the stripe-mode vibration plate in **Figure 2.** As mentioned above, we examined the characteristics of the ultrasonic source with new system. **Figure 3** shows the result of the motional admittance characteristics of this ultrasonic source. In the figure, parameters are the number of driving vibration plate with stripe-mode at the same time. As a result, although the number of vibration plate with stripe-mode increased and the acoustic impedance became higher, the sound source was possible to drive at almost the same frequency.

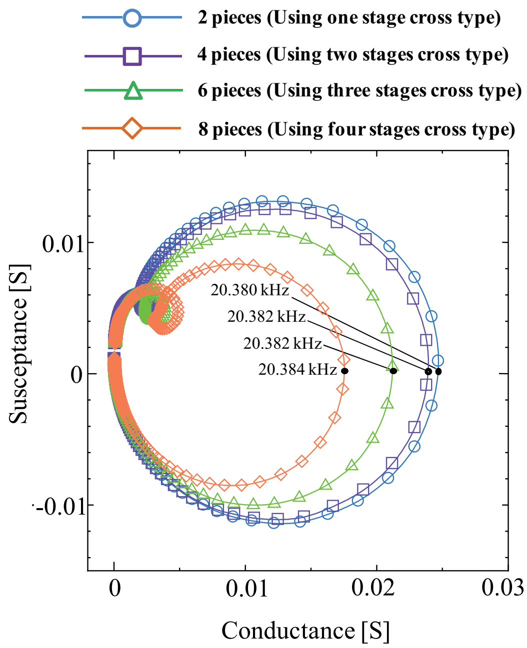

Fig. 3 Motional admittance characteristics when the number of stripe-mode vibration plates is changed.

3. Characteristics of fabricated sound souce

Figure 4 shows relationship between the electric input power to the sound source and vibration displacement. The measurement of the vibration displacement was performed at 1-4 points in Fig. 1. In addition, characteristics of the sound source using the conventional system for comparison are also shown in Fig. 4. The vibration displacement increased in the ratio of the 0.5th power of the electric input power. When comparing the two systems in the same power supply, the vibration displacement of the integrated longitudinal vibration transmission rod is larger than the conventional system. Furthermore, it was confirmed that the electric input power to the sound source is possible to input up to 350W.

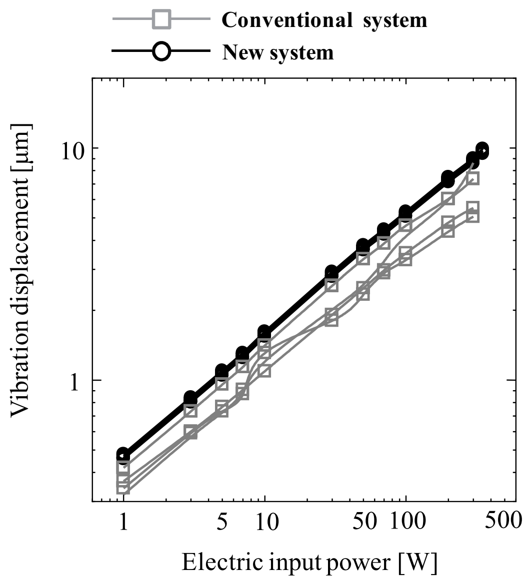

Fig. 4 Relationship between vibration displacement and electric input power.

4. Conclusions

In this report, we examined the sound source has the longitudinal vibration system which integrate four stages cross type transmission rod without screw coupling , and compared with the conventional sound source. As a result, it was found to be possible improving the transmission efficiency of vibration and increasing the input power by the proposed system.

References

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