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Flexible-Type Coiled Stator Ultrasonic Motor for Thrombus Removal System

コイル状ステータを用いた血栓除去システム用フレキシブル型超音波モータ

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1. Introduction

In order to apply medical use such as the thrombus removal system (TRS), a traveling-wave-type miniature ultrasonic motor using a helical coiled waveguide as a stator, called CS-USM (Coiled Stator Ultrasonic Motor), has been developed.[1-5] Owing to its simple structure, CS-USM can be made smaller than the conventional ultrasonic motors. However, the torque of the CS-USM was not sufficient for practical applications. We have been developing the ultrasonic power circulation-type quadratic excitation method (UPC-QEM) for improving of the torque of the CS-USM[4-5]. In addition, one method to improve the torque of the CS-USM is to increase the length of the coiled stator. However, the length will be a problem for actual use such as the TRS. In addition, for the use of the CS-USM in TRS, the rotor with a hollow tube may be convenient for sucking and removing thrombus.

We propose a flexible-type CS-USM (FT-CS-USM) which has a hollow spring rotor. To confirm the performance of the FT-CS-USM, we constructed FT-CS-USMs with straight and curved shapes, and measured the rotation speeds of the FT-CS-USMs.

2. Principle

The basic structure of the FT-CS-USM is shown in Fig. 1. The hollow spring rotor is placed in the coiled stator. The constructed CS-USMs have flexibility.

3. Experiment

Figure 2 shows the fabricated FT-CS-USMs. The spring rotor was made by a copper wire with a diameter of 0.4 mm and coiled stator was made by a stainless steel sheet with a thickness of 0.5 mm and a width of 2.3 mm. The outer diameter of the coiled stator was 2.1 mm, and the outer diameter of the spring rotor was 1.8 mm. In this measurement, ultrasonic cleaner (50 kHz, 11 W, UW-800 Kumazaki-aim Corp.) was used for ultrasound generator.

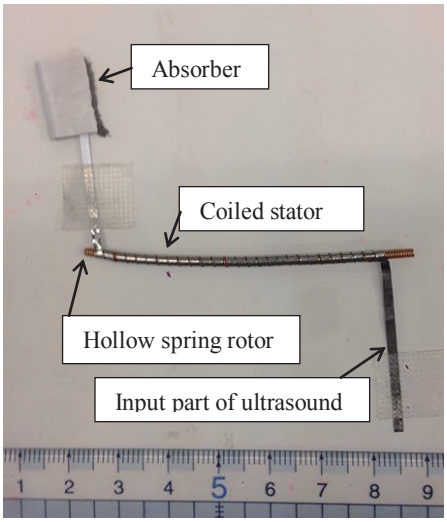

Fig. 1. Basic form of FT-CS-USM.

4. Results and discussion

Figure 3 shows the images of the rotor rotation of the prototype FT-CS-USM with straight and curved shapes. Table 1 shows the rotational speed of the prototype FT-CS-USM with straight and curved shapes.

The FT-CS-USM with Curved 2 shape was rotated faster than with Curved 1 shape. The reason for this is that the gap distance between the coiled stator and the hollow spring rotor became suitable for ultrasound transmission. In the future, it will be necessary to examine the most suitable gap distance and shape between the coiled stator

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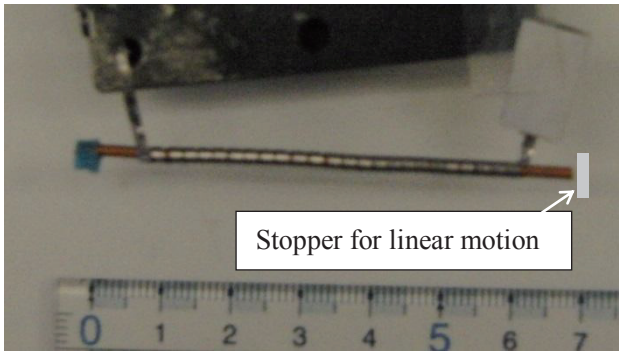
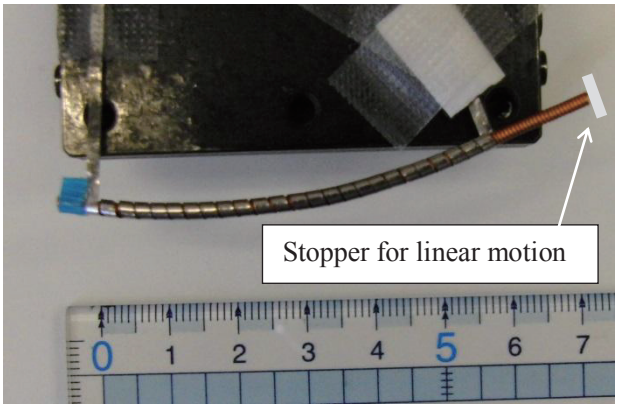
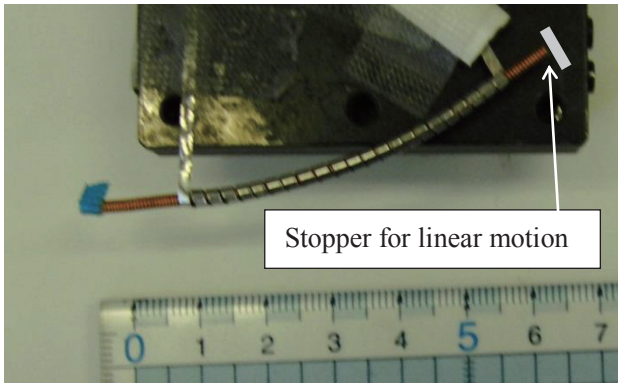
and the hollow spring rotor. There are various structures about the hollow spring rotor and the coiled stator. Figure 1 shows one example.



(a) Straight

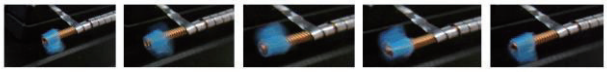


(b) Curved 1

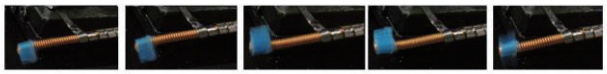


(c) Curved 2

Fig. 2. Constructed FT-CS-USMs



(a) Straight



(b) Curved 1

(c) Curved 2

Fig. 3. Images of rotation of rotor (30fps)

Table 1. Rotational speed

Style	Rotational speed [rps]
Straight	7
Curved 1	5+1/4
Curved 2	19

5. Conclusion

For confirmation of the operation of the FT-CS-USM, we demonstrated the FT-CS-USM with straight and curved shapes. As the result, we confirmed that the FT-CS-USM worked even if FT-CS-USM with curved shape.

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