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Anonymous

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Manufacture of Acoustic Transducer With Improved Radiation Efficiency

ABSTRACT

This disclosure describes the design and manufacture of an acoustic transducer with superior radiation efficiency. In contrast to traditional acoustic transducers, the diaphragm and the speaker frame are bonded along a vertical surface, and the flange of the diaphragm is removed using laser cutting. The manufacturing procedure includes applying ultraviolet adhesive to the vertical side of frame; assembling the diaphragm into the fixture; combining the frame and the diaphragm together with fixture; curing the adhesive with ultraviolet light; removing the fixture; and laser-cutting the flange shape of diaphragm.

KEYWORDS

- Acoustic transducer
- Transducer diaphragm
- Speaker
- Effective radiation area
- Radiation efficiency
- Laser cutting
- Ultraviolet adhesive

BACKGROUND

An acoustic transducer is a device that converts sound energy to electrical energy, as does a microphone, or vice-versa, as does a speaker. An acoustic transducer includes a diaphragm, a speaker driver frame, and other components. The diaphragm is similar to a thin, flexible disk or cone that vibrates in response to sound waves to produce electrical signals, as in a microphone, or that vibrates in response to electrical signals to produce sound waves, as in

a speaker. It is commonly constructed of a thin membrane or sheet of various materials, suspended at its edges. The frame is typically made of polycarbonates (PC), e.g., a material from a group of thermoplastic polymers that include carbonate groups in their chemical structures. Polycarbonates used in engineering are considered as tough materials; some grades are optically transparent. These are easily worked, molded, and thermoformed.

The components of an acoustic transducer can be made of thermoplastic polyurethane (TPU), which is a material that is in-between the rigidity, texture, and feel of plastics and rubber. TPUs can be engineered to be rubber-like, e.g., flexible, durable, and smooth to the touch.

The effective radiation area of a speaker is denoted as *Sd*, typically measured in square centimeters. *Sd* is a measure of the acoustic efficiency of a speaker, and can be different from the geometric cross-sectional area of the speaker.

DESCRIPTION

Fig. 1 illustrates sectional and exploded views of an acoustic transducer, per the techniques of this disclosure. The diaphragm can be made of TPU of thickness, e.g., 0.175 mm, and black paper of thickness, e.g., 0.1 mm. The voice coil can be constructed out of tinsel wire of appropriate gauge, e.g., corresponding to a diameter of 0.14 mm. The frame can be made of polycarbonate. The top plate can be made of steel plate of appropriate thickness, e.g., 1.2 mm. The magnet can be, e.g., an N45 magnet of type Nd-Fe-B. The yoke can be made of steel plate of appropriate thickness, e.g., 1.1 mm.

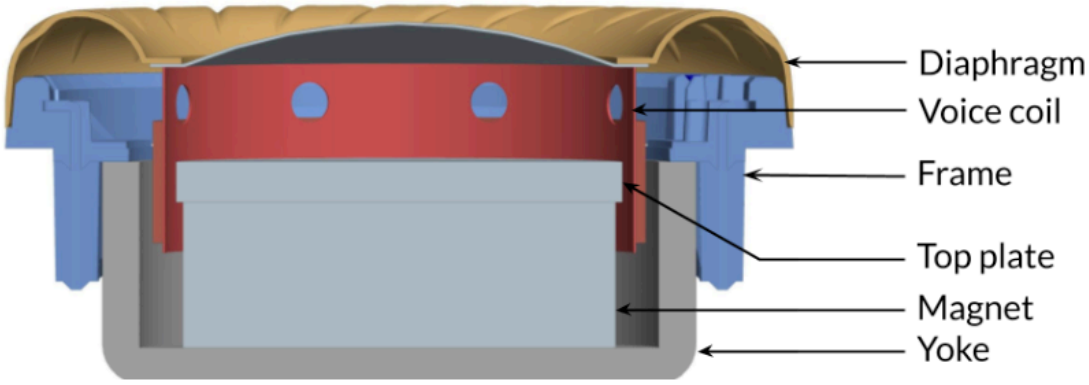

Fig. 1(a): Acoustic transducer - sectional view

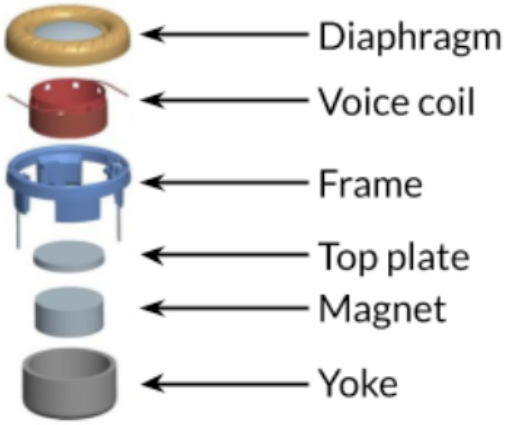

Fig. 1(b): Acoustic transducer - Exploded view

Fig. 2 illustrates the manufacture of an acoustic transducer with improved radiation efficiency, per the techniques of this disclosure.

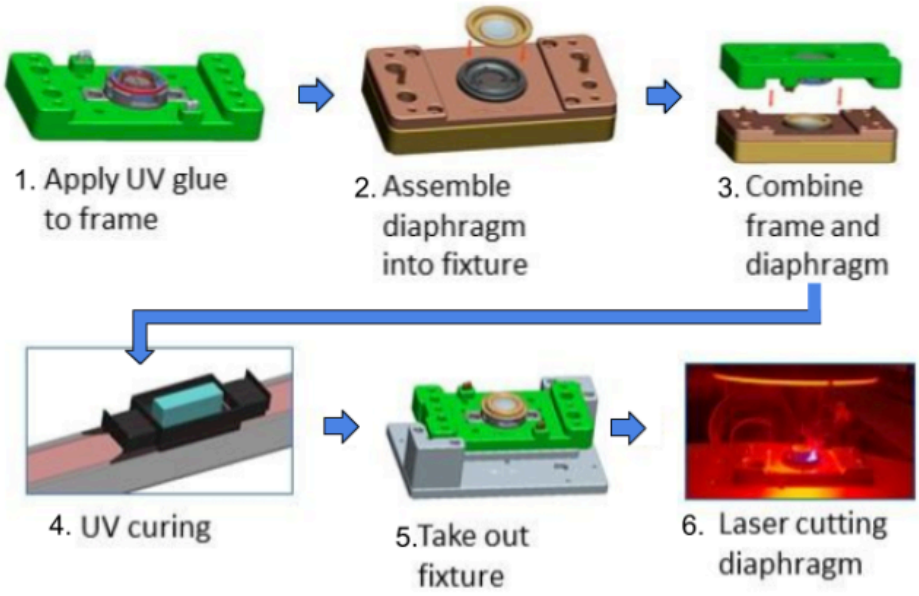

Fig. 2: Example process for manufacture of an acoustic transducer with improved radiation efficiency

The manufacturing procedure includes the following steps:

1. applying ultraviolet adhesive to the vertical side of the frame;
2. assembling the diaphragm into the fixture;
3. combining the frame and the diaphragm together with the fixture;
4. curing the adhesive with ultraviolet light;
5. removing the fixture; and
6. laser-cutting the flange shape of diaphragm.

The ultraviolet light used to cure the adhesive can be of wavelength between, e.g., 320 and 450 nm. The laser used to cut the flange shape of the diaphragm can be of wavelength, e.g., 355 nm.

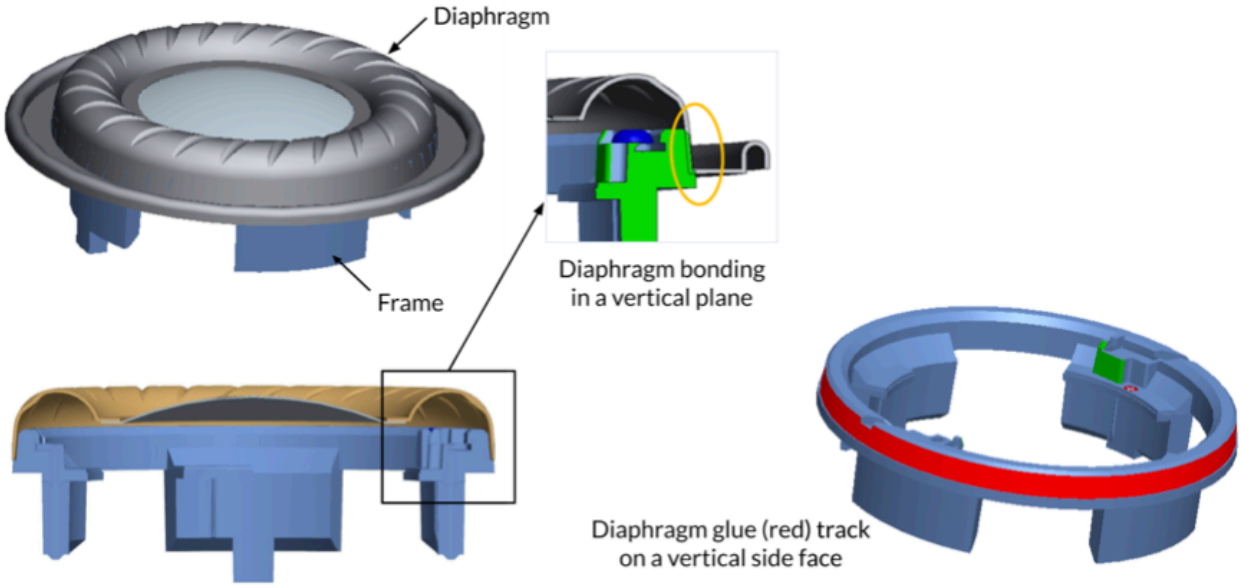

Fig. 3: Bonding the diaphragm with the frame

Fig. 3 illustrates the bonding, e.g., assembly, of the diaphragm with the frame. In contrast to traditional acoustic transducers, the diaphragm is bonded with the frame along a vertical plane. The diaphragm-frame glue is correspondingly on a vertical side face of the frame.

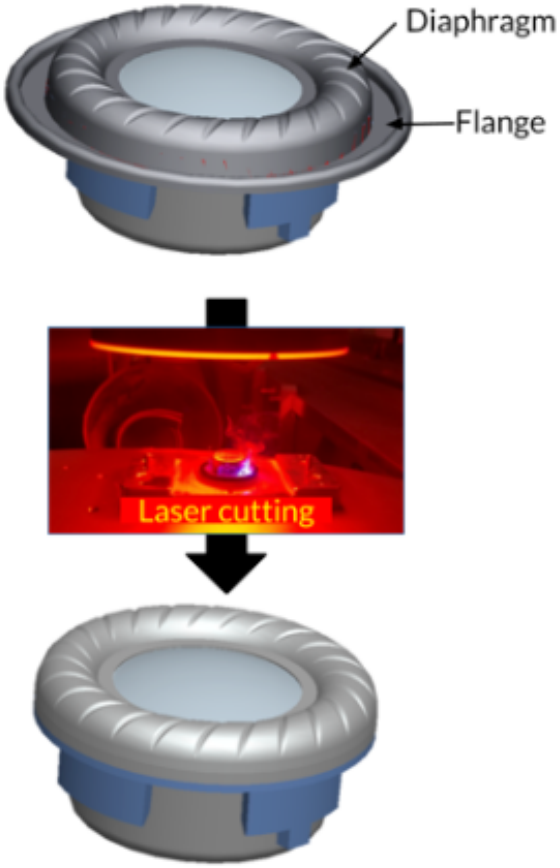

Fig. 4: Laser-cutting to remove the flange of the diaphragm

In contrast to traditional acoustic transducers, the flange of the diaphragm is removed using laser cutting, as illustrated in Fig. 4.

The techniques described herein result in an acoustic transducer with an effective radiation area *Sd* larger by, e.g., 10%, than a traditional transducer, which in turn results in an increased sound level, e.g., one decibel more across the operating frequency range, for the same physical speaker dimensions.

CONCLUSION

This disclosure describes the design and manufacture of an acoustic transducer with a radiation efficiency superior to traditional acoustic transducers. In contrast to traditional acoustic

transducers, the diaphragm and the speaker frame are bonded along a vertical surface, and the flange of the diaphragm is removed using laser cutting. The manufacturing procedure includes applying ultraviolet adhesive to the vertical side of frame; assembling the diaphragm into the fixture; combining the frame and the diaphragm together with fixture; curing the adhesive with ultraviolet light; removing the fixture; and laser-cutting the flange shape of diaphragm.