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Electrostatic excursion sensing in a moving coil transducer

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ABSTRACT

This disclosure describes an active, direct, and real-time method for the measurement of moving coil transducer, e.g., as utilized in a speaker, parameters. Two charged electrodes made of graphite are attached to the moving coil transducer. A positive electrode is attached as small ring at the base of a cone of the speaker or as a small ring around a spider of the cone. A negative electrode is disposed on a magnet of the moving coil transducer. The positive electrode moves with vibration of the coil while the negative electrode remains stationary. A supply voltage is applied to the electrodes. The circuit also includes an analog to digital converter (ADC) and a resistor in series with the ADC. Current measured across the series resistor is calibrated against moving coil excursion and is used subsequently to determine the excursion of the moving coil transducer.

KEYWORDS

- Voice coil
- Moving coil
- Graphite electrode
- Speaker
- Transducer
- Excursion sensing

BACKGROUND

Loudspeakers include a moving coil (voice coil) system designed to excite a cone that in turn produces sound waves. The output displacement (excursion), velocity, and acceleration of the moving coil system is a nonlinear function of the input signal. Accurate real-time identification of the vibration characteristics of a large moving coil transducer enables accurate linearization of the output of the transducer at low frequencies. The excursion of the moving coil transducer is usually determined from the back electromagnetic force (EMF) component generated in the transducer using a current sensing circuit, typically in the form of a sense resistor. A mathematical model for the speaker is determined from associated Thiele/Small parameters.

DESCRIPTION

This disclosure describes an active, direct, and real-time method for the measurement of moving coil transducer parameters. Parameters such as acceleration, velocity, excursion, sensor feedback, etc. are captured and correlated as the moving parts vibrate.

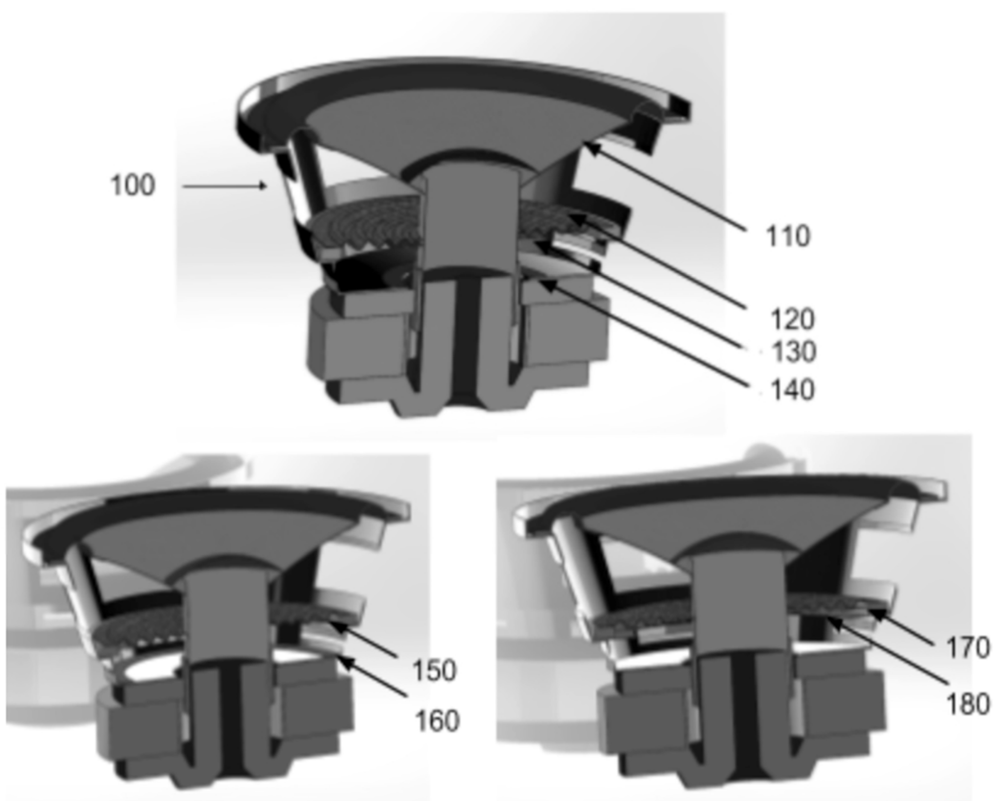

Fig. 1: Charged electrodes attached to a moving coil transducer

Fig. 1 illustrates an example moving coil transducer (100). As illustrated in the top portion of the figure, two charged electrodes (plates) made of graphite or another conducting material are attached to the moving coil transducer. A first (positive) electrode (130) is attached as small ring at the base of a cone (110) of the speaker or as a small ring around a spider (120) of the cone. A second (negative) electrode (140) is disposed on a magnet of the moving coil transducer. The positive electrode moves with the vibration of the coil while the negative electrode remains stationary.

A supply voltage (V_{dd}) (e.g.,100V DC) is applied to the electrodes. The circuit also includes an analog to digital converter (ADC) and a resistor in series with the ADC.

The capacitance of the electrode is governed by the equation:

$$C = \varepsilon_r \varepsilon_0 \frac{A}{d}$$

where:

C represents the capacitance;

A represents an area of overlap of the two electrodes;

ε_r is the relative static permittivity (sometimes called the dielectric constant) of the material between the electrodes;

ε_0 is the electric constant; and

d is the separation between the electrodes.

The vibrations of the moving coil transducer leads to a change in the distance between the electrodes, and consequently, a change in the capacitance and the current measured across the series resistor. The measured current is calibrated against the moving coil excursion and the linear relationship between the measured current and excursion is used subsequently to determine the excursion of the moving coil transducer. Additional parameters such as acceleration, velocity, sensor feedback, etc. are derived from the excursion of the moving coil transducer thus determined.

CONCLUSION

This disclosure describes an active, direct, and real-time method for the measurement of moving coil transducer, e.g., as utilized in a speaker, parameters. Two charged electrodes made of graphite are attached to the moving coil transducer. A positive electrode is attached as small ring at the base of a cone of the speaker or as a small ring around a spider of the cone. A negative electrode is disposed on a magnet of the moving coil transducer. The positive electrode moves with vibration of the coil while the negative electrode remains stationary. A supply voltage is applied to the electrodes. The circuit also includes an analog to digital converter (ADC) and a resistor in series with the ADC. Current measured across the series resistor is calibrated against moving coil excursion and is used subsequently to determine the excursion of the moving coil transducer.