Radiation From a Tuning Fork

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Aim:

Through this experiment we aim to study the radiation of sound field from a tuning fork.

Theory:

When a sounding tuning fork is rotated about its long axis, one can observe that it has 4 positions of maximum loudness. These are marked by A and B in Fig.1 below. It is also observed that the maximas are noticeably louder in the plane of the fork (A) than in the plane perpendicular to the fork (B). In this experiment, we use a microphone and preamp connected to an oscilloscope and make the tuning fork rotate through a stepper motor controlled via Arduino.

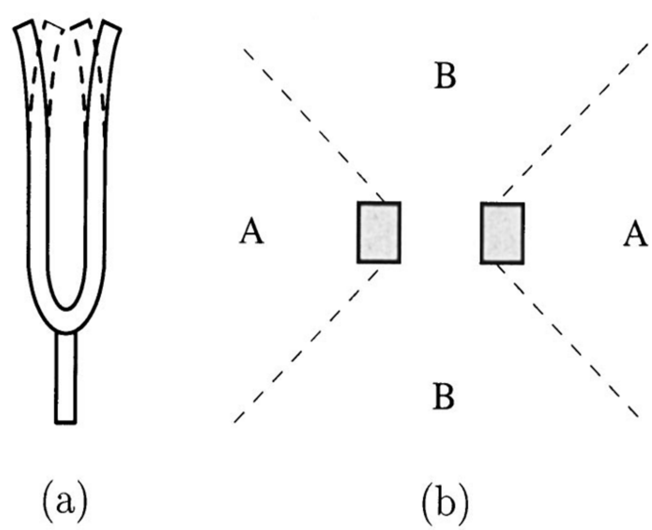

Figure 1: (a) Principal mode of a tuning fork. (b) End view of a tuning fork showing regions of loud and quiet.

Observations:

Polar plot:

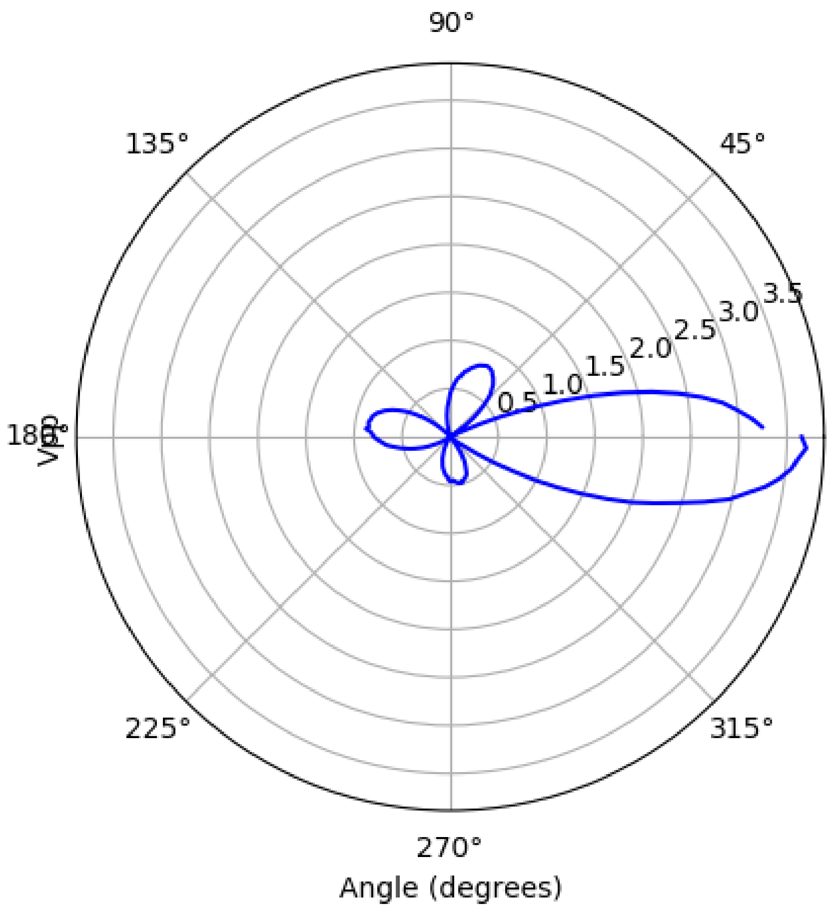

Figure 2: A polar plot showing the variation of measured voltage (and therefore, loudness) with angle.

- We can see four lobes of intensity at integral multiples of 90°.
- The lobes are bigger at even multiples: 0° and 180°.
- Ideally, both the even multiple lobes should be equally big, but as the tuning fork rotates in a way that the 0° orientation is closer than the 180° orientation to the microphone.

Fourier Transform of Input and Output on Oscilloscope:

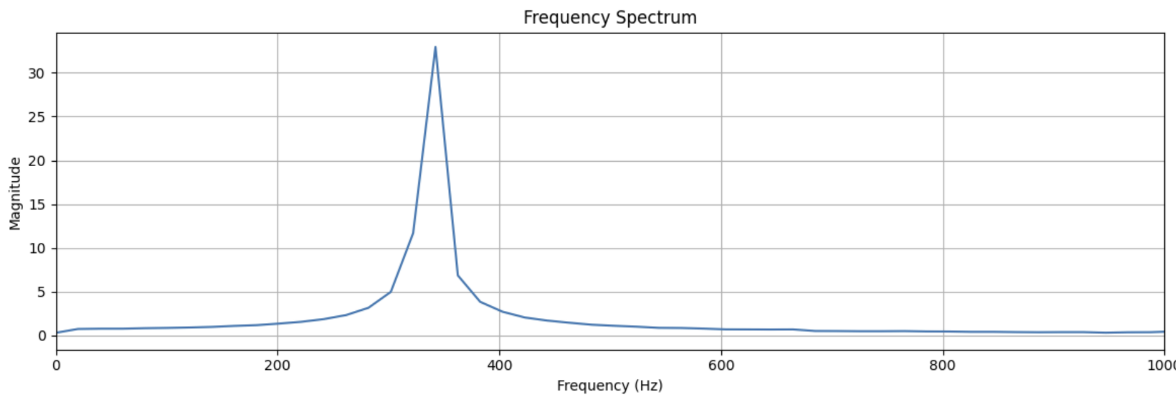

Figure 3: Fourier Transform of Input Sine Wave

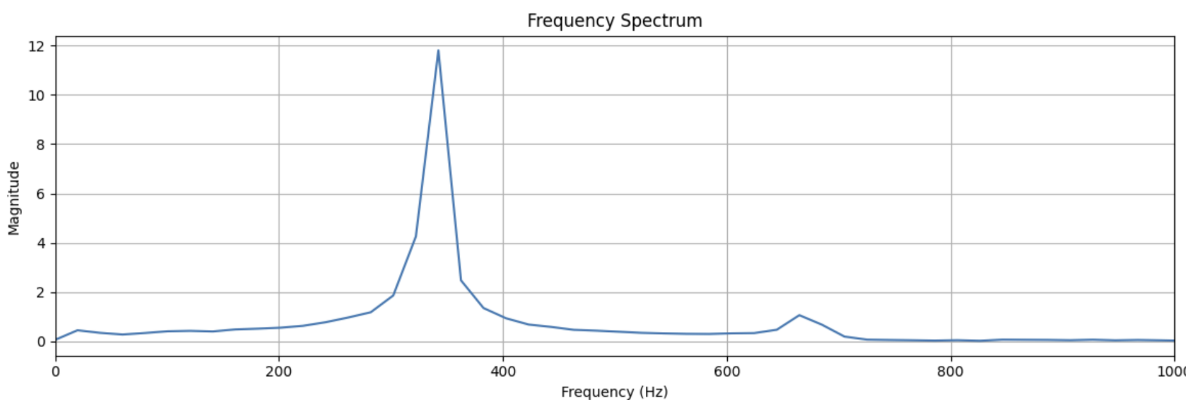

Figure 4: Fourier Transform of Output Sine Wave

- Both the Fourier transforms have maximum magnitude at the frequency 342.47 Hz.
- The magnitude is, as expected, greatly reduced in the output.
- We can thus conclude that the resonant frequency here, which he had calibrated in the beginning of the experiment is 342.47 Hz.

Discussion and Errors:

- The attached magnets and setup cause the resonant frequency of the tuning fork to be changed from what is initially marked so that has to be calibrated on your own.

- The rotations of the stepper motor and tuning fork are inexact.
- The vibration of the tuning fork seem to increase quite a bit as the V_{pp} doesn't exactly overlap at $0°$.