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RESONANCE TUBE

LA50-350

NOTE: EXERCISE CAUTION WITH HIGH INTENSITY SOUNDS. USE EAR DEFENDERS WHEN REQUIRED

INSTRUCTIONS FOR USE

RESONANCE TUBE
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INTRODUCTION

This apparatus provides a modern approach for the experimental study of resonating air columns. When used with a laboratory signal generator the resonance modes of open or closed pipes can be investigated. With the introduction of a fine powder, a "Kundt's tube" approach can be adopted to visually depict the nodes and anti-nodes in the stationary wave.

SYSTEM DESCRIPTION

The main tube is 1m long and is supported on a pair of stands as shown. A 5W loudspeaker unit can be attached to one end and a moveable plunger inserted into the other. A laboratory signal generator covering the range 100 to 1000Hz is used to drive the speaker unit. This signal generator should have low-impedance output connections (4 - 8 ohms) and preferably be able to provide square and sine waveforms.

The assembly arrangement is shown in the photograph.

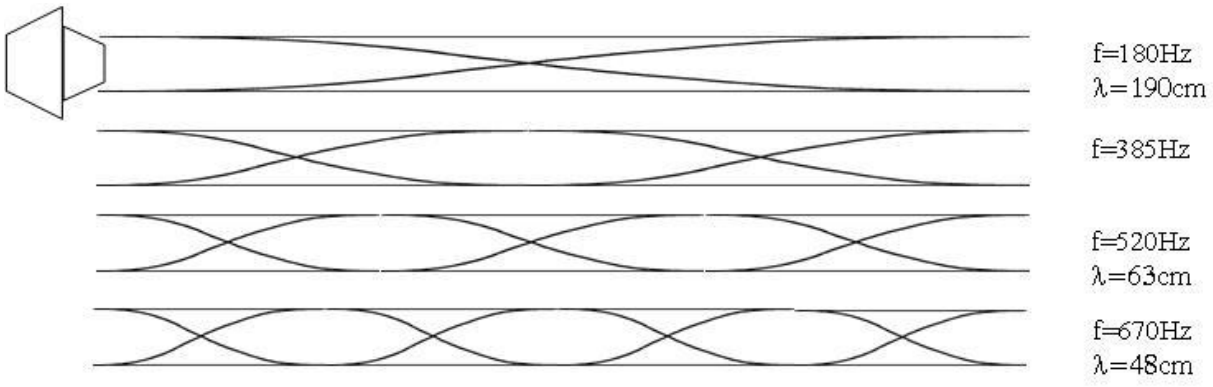
EXPERIMENTS

OPEN PIPE RESONANCE

Insert the loudspeaker unit leaving the other end of the tube open.

Starting at about 100Hz sine wave at moderate amplitude increase the frequency slowly. At certain frequencies the note will be louder indicating a resonance mode.

The loudspeaker unit produces an antinode (maximum displacement) and the open end of the pipe is also at an antinode. Resonance modes are therefore integral multiples of l/2. Typical results are shown below:



The fundamental mode (top diagram) is difficult to detect well. The higher harmonics give more distinct amplitude changes at resonance. The theoretical wavelength for each frequency can be calculated from v=fl using a value of 330 ms^{-1} for the velocity of sound in air, v.

Visual demonstration of nodes and anti-nodes

If a fine powder is introduced into the tube and gently shaken down its length, the powder will be seen to move most violently at the antinodes. This gives a clear depiction of the diagrams above. Traditionally, dry lycopodium powder is used but others to try include cork dust and polystyrene dust. Both the latter can be produced by rubbing cork or polystyrene packing material against coarse glass paper.

This approach is known as Kundt's tube experiments and a full treatment is given in many text books. The main factor to note is that the loudspeaker diaphragm is not at a node or antinode since it has to both move the air and reflect the wave. A value for l is best obtained from the separation of areas of greatest displacement.

NOTES

When using a powder in the tube remove the speaker unit while it is being introduced.

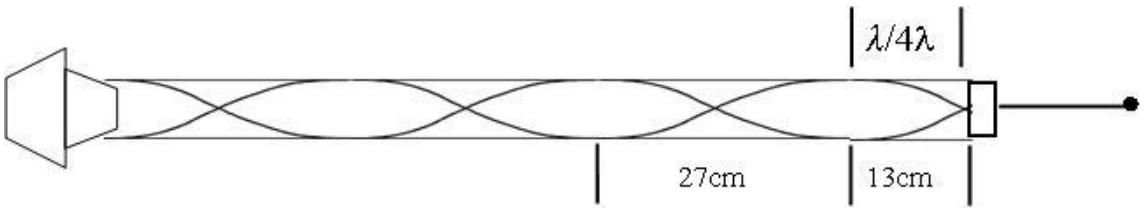
Resonance is best heard using sine waves but dust agitation is most obvious using square waves at high amplitude. **When using open tubes at high sound levels ear defenders should be worn.**

CLOSED PIPE RESONANCE

The above experiments can be repeated using a closed pipe by inserting the plunger assembly. Closed pipe resonance can still be detected by ear and the dust patterns work equally well but the sound levels in the laboratory are more tolerable. Slight rotation of the plunger facilitates its movement along the tube.

With a closed tube, a constant length can be used and the frequency varied as before or, alternatively, the frequency can be kept constant and the length varied.

Typical results are shown for resonance at 635Hz with a theoretical wavelength of 51cm.



For a pipe closed at one end there is a node at the plunger surface and the tube length is a multiple of an odd number of quarter wavelengths. The diagram shows seven quarter wavelengths.

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