

THE DEMONSTRATION CORNER

MAKING SOUND WAVES VISIBLE

by
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The demonstration described below was demonstrated at the OAPT conference in London in June 1989. Since there was a fair bit of interest in the details of construction of the apparatus, I thought this column would provide a convenient opportunity to give the specifications. Essentially, a speaker at one end of the closed air column is used to set up a standing wave of sound inside the column. Natural gas enters the device through two copper tubes. The gas is lit and burns at numerous holes drilled across the top of the duct. Due to differences in pressure at the nodes and loops of the standing wave inside the air column, the flames that are generated vary in height giving a visual outline of the wave inside.

The device can be constructed using round heating ducts which can be purchased from a heating contractor, a hardware store, or from Canadian Tire Ltd. If the ducts are flat sheets of metal when purchased, they must be assembled. It is also a good idea to solder all seams so that they become air tight. A metal plate, also made of sheet metal, is soldered at one end. A wooden frame is constructed for the other end. Simply cut two pieces of plywood that are the same size as the metal plate that is soldered to the one end. Cut a circular hole equal in diameter to the heating duct in the middle of each of these two wooden pieces. Mount the speaker (5") to one of these pieces. Insert a piece of flexible rubber (available as rubber dam from Boreal Scientific Ltd.) between the two pieces of wood. Bolt the two pieces of wood together using a carriage bolt in each of the four corners. Now slide this assembly over the remaining open end of the duct. Use caulking to

seal the space between the wooden frame and the duct and to attach the duct to the wood.

Drill holes in the top of the duct so that they are spaced about $1/2''$ or 1 cm apart. In the model I constructed, these holes are quite small ($3/32''$). A piece of copper tubing must be inserted and soldered in place at each of two locations on the duct so that natural gas can be forced into the device.

To operate this demonstration, simply turn on the gas and then light the gas escaping from the numerous holes across the top. Once all the air has been expelled from the duct, the flames will be yellow in colour. Now switch on the signal generator and amplifier that power the speaker. At low frequencies (below 100 Hz), the flames can be seen to vibrate at the audio rate. If the volume is turned up, the flames begin vibrating so vigorously that they are easily blown out. For the model I constructed, resonance could readily be demonstrated between 200 and 300 Hz. Carefully adjust the frequency until the numerous flames of various heights trace out a sine wave. Measurements of wavelength can then be made directly from the flames. (Remember that this is the wavelength of sound in natural gas.) As the frequency is changed, the wavelength of the sound can be seen to change as well.

Some students have told me that this is their favourite demonstration in physics. When performed in a darkened room, it is impressive!

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Submissions describing demonstrations will be gladly received by the column editor.

