

How to Build a Ruben's Tube




A Ruben's Tube is an apparatus that is used to demonstrate acoustic standing waves in a closed tube filled with gas. One end is sealed with a cap and the other with a flexible diaphragm. Holes are drilled in the top where gas can escape and the flames can be lit. A speaker is placed close to the diaphragm and a standing wave can be formed in the tube when specific frequencies are played. The Ruben's Tube is very easy to build, relatively inexpensive, and is a wonderful and engaging classroom demonstration.

Materials

The following are materials that you will need to build the Ruben's Tube. Most of these items can be found at Home Depot or your local hardware store (links are included for many of the specific items).

- One round metal duct pipe – 3 in. x 5 ft. (<http://is.gd/2drBIM>)
- One plastic or metal end cap – 3 inches inner diameter (<http://is.gd/xkxPLd> or <http://is.gd/QGkO3a>)
- Two brass barb MIP adapters – 3/8 in. x 1/4 in. (<http://is.gd/nYoWlQ>)
- One plastic barb tee – 3/8 in. x 3/8 in. x 3/8 in. (<http://is.gd/X8vNlK>)
- Two rubber o-rings – #10, 1/2 inch inner diameter (<http://is.gd/B0Yedt>)
- Two washers – 1/2 in. inner diameter (<http://is.gd/4rvLMN>)
- One latex hose – 10 ft. x 3/8 in. outer diameter x 1/4 in. inner diameter (<http://is.gd/UHJ2kE>)
- One 1/2 in. drill bit, capable of drilling metal
- One 1/8 in. drill bit, capable of drilling metal
- One latex balloon – 12 in. diameter
- Computer speakers – Logitech LS11 speakers work very well & can be found at Target (<http://is.gd/wNXPGW>)
- Electric drill
- One roll of duct tape
- One roll of masking tape
- Scissors
- Pliers
- Permanent marker
- Metal file

Build Instructions

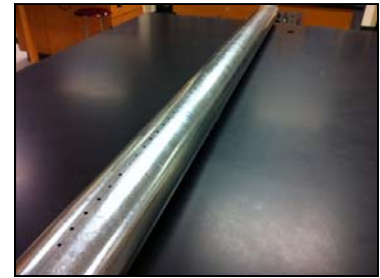
1. Assemble the metal duct pipe and place a piece of duct tape down the seam of the pipe. Cut the duct tape so that it reaches right up to the edge of the pipe but does not wrap around it. Be sure that the duct tape is smooth and that there are no wrinkles. The side of the tube with the duct tape will be referred to as the “bottom” of the tube, while the side of the tube opposite the duct tape will be the “top” of the tube.
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2. A line of 1/8 inch diameter holes will be drilled along the top of the tube and will be 3/4 inches apart. To make sure that the holes are drilled in a straight line, place a piece of masking tape down the length of the pipe with one edge of the tape along the center of the top of the pipe.

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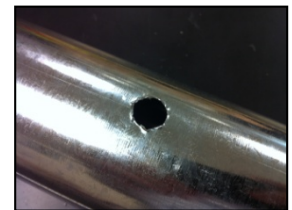
- Starting about 8 inches from one end of the tube, make marks every $\frac{3}{4}$ of an inch until you get to about 8 inches from the other side of the tube. Use the edge of the masking tape so that all of the marks are in a straight line. There will be a total of about 59-60 marks. Remove the masking tape when all of the marks have been placed.



- Use a $\frac{1}{8}$ inch drill bit to drill a hole where each mark was made. Be sure that the drill bit is precisely lined up on the mark before the hole is drilled. Since the metal is very thin, some of the holes might have jagged edges. A metal file or pliers may be used to clear up the holes. It is important that all of the holes are clear and round so that the flame heights will be uniform.



- Two $\frac{1}{2}$ inch holes will be drilled in the side of the tube for gas hoses to be connected. Place two marks on one side of the tube, each about 18 inches from the end of the tube. Use a $\frac{1}{2}$ in. drill bit to drill a hole where each mark is located. The two holes might have jagged edges. It is very important that the edges of these holes are as smooth and round as possible in order to ensure that there will not be a leak.



- Locate the two brass barb adapters, two washers, and two o-rings. Place a washer over the threaded end of each adapter, and then place an o-ring over the threaded end of each adapter. This will be connected to the side of the pipe and is where the gas hoses will attach.



- Screw the threaded end of each barb adapter into the $\frac{1}{2}$ inch holes. Pliers might need to be used to tighten the barb and o-ring down to the pipe. It is very important that there be a tight seal between the o-ring and metal pipe to ensure that there are no leaks. If the adapter will not thread properly, it might be that the hole needs to be rounded out with a file or pliers.



- At this point all of the holes are drilled and the hose adapters have been installed in the side of the tube. Now one end of the tube will be sealed with a cap while the other will be sealed with a flexible diaphragm.



- Place the cap over the crimped end of the tube. Be sure that it is pushed down as far as possible on the end of the tube. Seal the end by wrapping a piece of duct tape around the cap and pipe. Be sure that the tape is smooth and has no wrinkles.



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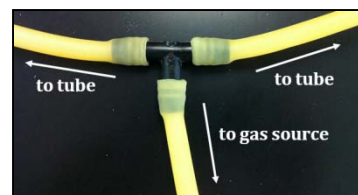
10. Locate a latex rubber balloon and use scissors to cut off the end of the balloon. Stretch the balloon over the open end of the tube to form the diaphragm. Be careful to stretch the balloon tightly but not so tight that it will tear against the edge of the tube. Use a piece of duct tape to secure the balloon to the tube.



11. Locate the latex hose and use scissors to cut two 14 inch hose pieces. Connect each of the 14 inch hose pieces to the barb adapters that have been installed into the side of the tube. Ensure that the hose is connected as far up on the adapter as possible so that it has a good seal. Be sure that there are no kinks in the hose.



12. Locate the plastic barb tee. The two hoses that lead to the tube should be connected to the top of the tee, while one end of the remainder of the hose is connected to the bottom of the tee. This long length of hose will be connected to the gas source.



13. Construction of the Ruben's Tube is completed. If necessary a wooden or metal stand may be built to hold the tube. Otherwise, books can be used just as easily. The hose can be connected to a gas source such as a propane tank or a natural gas outlet in a science classroom lab table. The computer speaker can be placed in front of the diaphragm and connected to a computer. Turn on the gas and use a lighter to light flames coming out of the holes at the top. Play single tones of different frequencies through the speakers to produce standing waves or play music to make the flames dance with the beat. Refer to the "Ruben's Tube Operating Instructions" for more information.

