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Improved Vacuum Bazooka

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This apparatus is a modification to the well-known "vacuum bazooka" (PIRA 2B30.70).[1] My vacuum bazooka is easy to construct and demonstrate, requires no precise fittings, foil, or vacuum grease, and propels ping-pong balls at a tremendous velocity!

The bazooka consists of a length of pipe that has been loaded with one or more ping-pong balls. It is sealed at both ends and then evacuated. When one end is punctured, the inrush of air pushes the balls out the other end. A longstanding problem with this demonstration has been that the end seal must be strong enough to withstand atmospheric pressure and yet easy enough to penetrate so as not to significantly impede the motion of the fired ping-pong balls. A common sealing material has been aluminum foil held in place with machined fittings and sealed with vacuum grease. I have found these seals to be highly prone to failure, making the demonstration unreliable. After trying many different materials, I discovered that ordinary 3-in cellophane boxing tape is perfect for this application.

To construct the vacuum bazooka, start with a length of 1½-in PVC pipe from your local hardware or building supply store. This diameter is perfect for ping-pong balls. My pipe is 5 ft long, but you may choose a much different length. Now take a quick-disconnect fitting or shut-off valve and attach it to a short length (about 3 in) of smaller diameter PVC (I use ½ in) pipe. At about 5 cm from the "puncture end" of the bazooka (see Fig. 1), drill a hole and insert the short length of pipe. The air inside the bazooka will be evacuated via this pipe and so a tight seal is required. Application of hot glue inside and out creates a good bond and prevents air leakage. The short pipe should penetrate to the center of the bazooka. This maintains a separation between the ping-pong balls (which are loaded into the "muzzle end") and the tape at the puncture end. It also

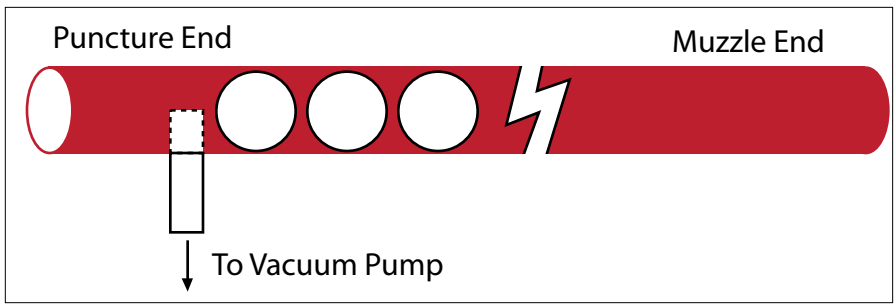

Fig. 1. Schematic of improved vacuum bazooka.

Fig. 2. The author holds the vacuum bazooka.

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catches any pieces of punctured boxing tape that may be pulled into the bazooka when the device is fired.

To prepare the bazooka for firing, first center one 3-in square piece of boxing tape flat against the puncture end and run your finger several times around the rim to create a good seal with no creases or bubbles. Then fold the excess tape around the sides of the pipe, so that the tape will not be pulled into the bazooka when the air is evacuated. No end fittings or vacuum grease is necessary! Load one to three ping-pong balls into the open (muzzle) end of the bazooka. They should roll easily down to the puncture end and come to rest against the evacuation pipe. It is a good idea to always use new ping-pong balls, as recycled balls may be deformed and become lodged inside the bazooka. Now use a second piece of tape to seal the muzzle end of the pipe.

While there are other ways[2] to evacuate the bazooka, it's best to use a good vacuum pump. Use thick-walled vacuum hose to connect the pump to the fitting on the evacuation tube. As you evacuate the pipe, you can tell that you have a good seal if the pump quiets down and you can see the sealing tape being pulled inward. After the pipe is evacuated, close the shut-off valve (if a quick-disconnect fitting has been used, the bazooka may be completely disconnected from the vacuum hose and operated remotely). Be sure to keep the muzzle end of the pipe elevated so that the ping-pong balls remain near the puncture end. Use a knife or a pair of scissors to puncture the pipe.

Be very careful about where the bazooka is aimed — the ping-pong balls will "explode" loudly from the end of the pipe at a very high speed. I've measured ball speeds as high as 150 mph. A colleague of mine has constructed a larger bazooka having more than twice this muzzle velocity! We have found this improved vacuum bazooka demonstration to be highly reliable. Our students find it to be both instructional and exciting.

References

1. Physics Instructional Resource Association. Homepage at Wake Forest University, http://www.wfu.edu/physics/pira/PIRAHome3.html. Select DCS (Demonstration Classification Scheme) to access a downloadable version of the classification scheme.
2. Neil A. Downie, *Vacuum Bazookas, Electric Rainbow Jelly, and 27 Other Saturday Science Projects* (Princeton University Press, New Jersey, 2001), p. 70.

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