Sound of a pop-pop engine

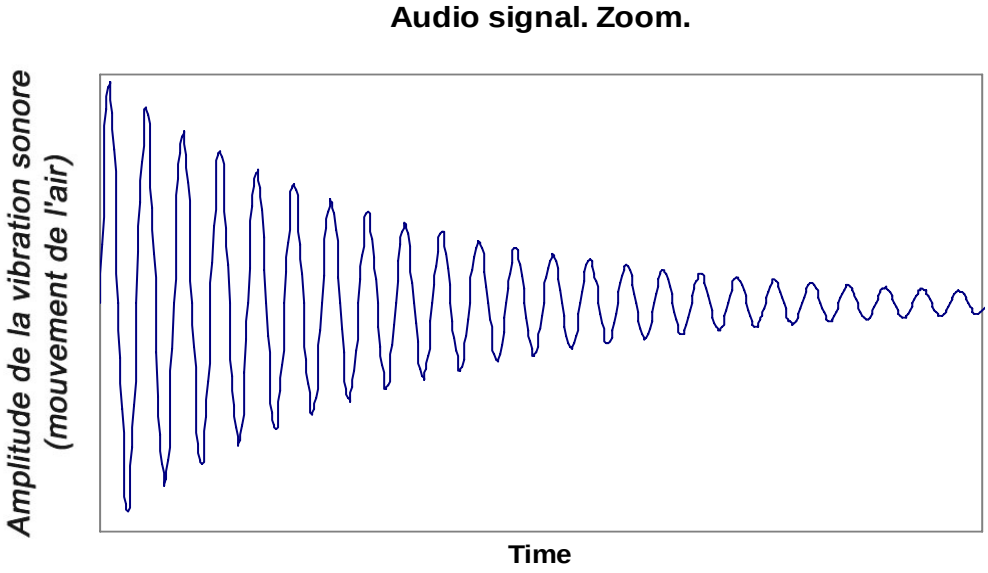
By Jean-Yves

A comparison can be done with a fire truck or ambulance siren. We hear the successive blasts which occur at a very low frequency (for instance 0.5Hz) because the natural (or basic, or main) frequency of the siren is an audio one (for instance 3000Hz).

For a pop-pop engine it is the same. Due to its size and stiffness the diaphragm vibrates at an audible frequency. When the diaphragm is made of brass, is taught and is small the frequency is rather high (for instance 1000Hz). When the diaphragm is made of mylar, as on Jeff's engines, the frequency is low (300Hz? I'm not an expert in music).

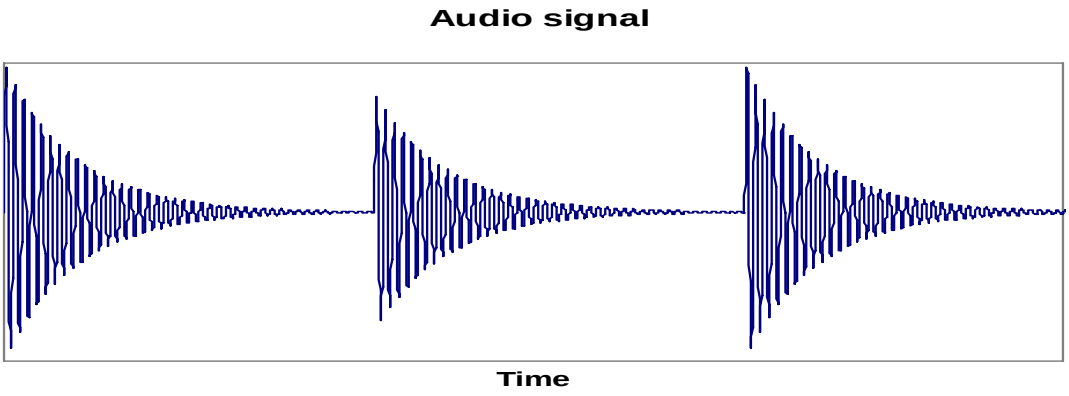
Now, let's examine a gong or a bell. If you ring it only once, you hear clearly and loudly its sound, but the sound level vanishes slowly. It is because it is damped, mainly by the air surrounding the gong or the bell.

For a pop-pop engine it is similar. There is a natural frequency as explained above, and a damping effect due to air, steam, water, and diaphragm material. The result for each shot looks like what is displayed on the following graph.



If we look at several consecutive shots, the result (audio signal versus time) is a little bit more complicated because the time between membrane bulging in and bulging out is not the same as in the opposite way.

Nevertheless, roughly it works as described here above and can be for instance displayed as follows.



On this diagram we can see that the amplitude of the signal when bulging in (second shot) is not the same as when bulging out (first and third shots).

We can add that depending on the engine :

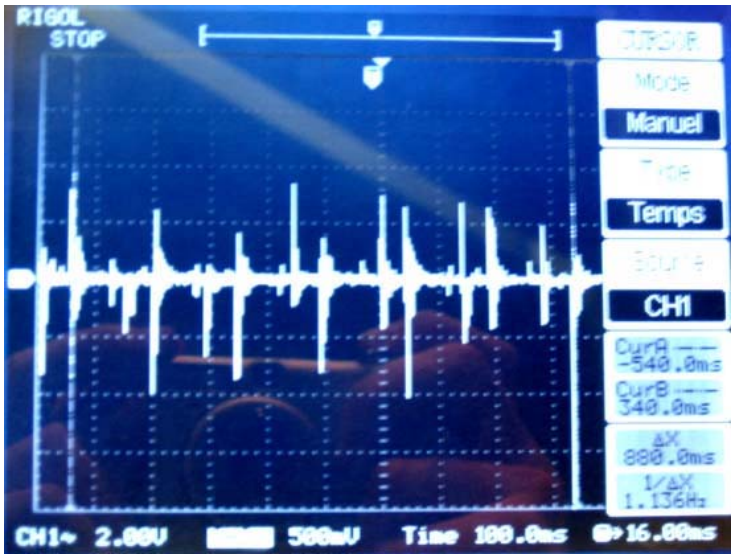
The low frequency of the cycle is more or less stable.

The amplitude varies from one shot to the next one (in the same direction)

There is not only the basic frequency. There are harmonics.

However, roughly it works as explained here above.

Several people recorded the sound of pop-pop engines. Hereafter is a recording done by Christophe.



Every time the diaphragm is suddenly bulging in or out it vibrates. On this recording we can see 14 movements of the diaphragm, 7 in and 7 out. Each one corresponds to a sort of vertical dash followed by a vanishing signal. In that particular case, the damping is important.

Not displayed here, on another engine a smaller damping was recorded. The next shot arrived before the effect of the previous one was finished.

Both recordings are in accordance the above explanation.