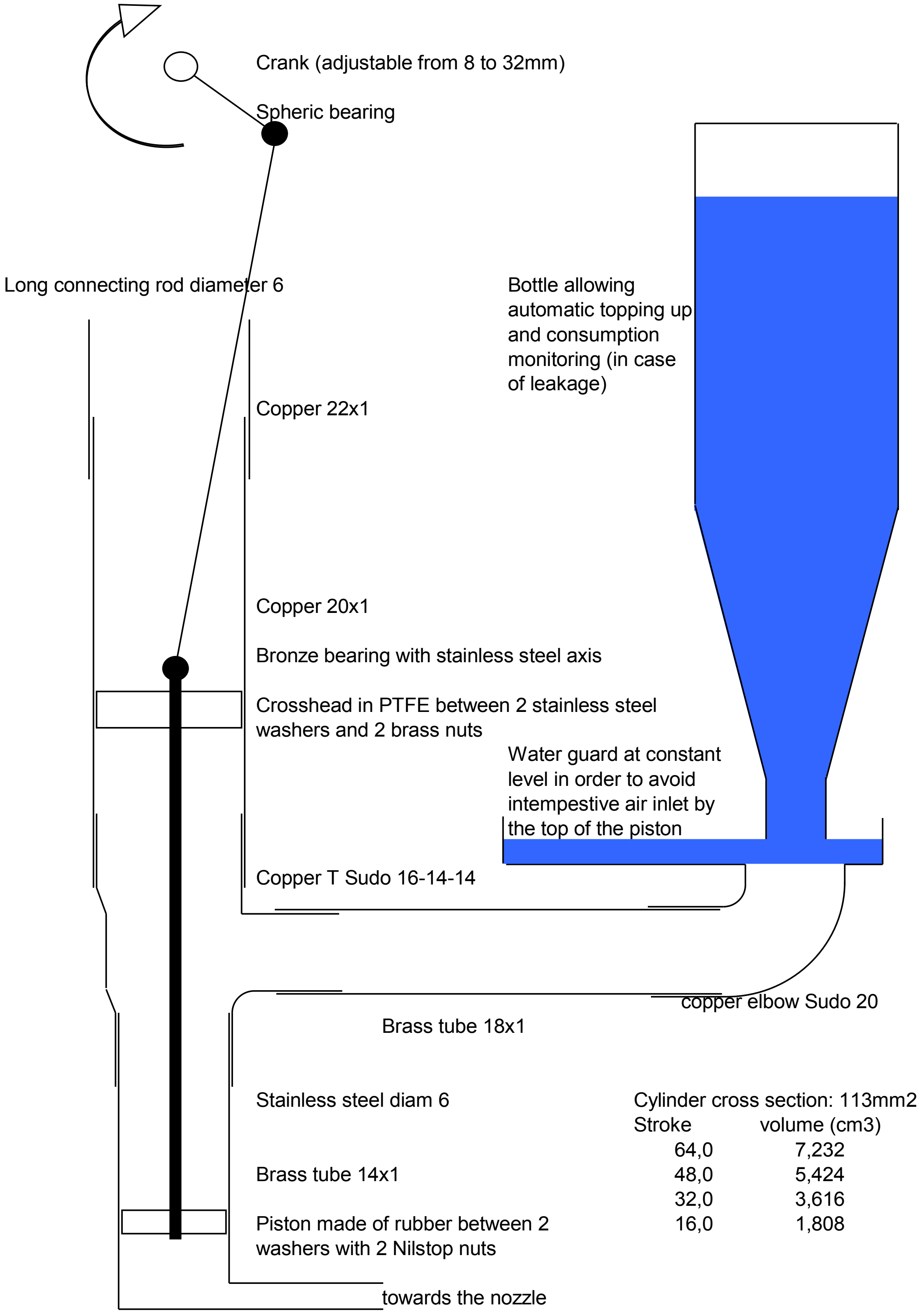
Why do we use “*Frequency* x *Stroke Volume*”?

To know the relationship between a permanent flow Qc and an alternative one Qa we built the reciprocating pump described hereafter.



Cylinder cross section: 113mm2

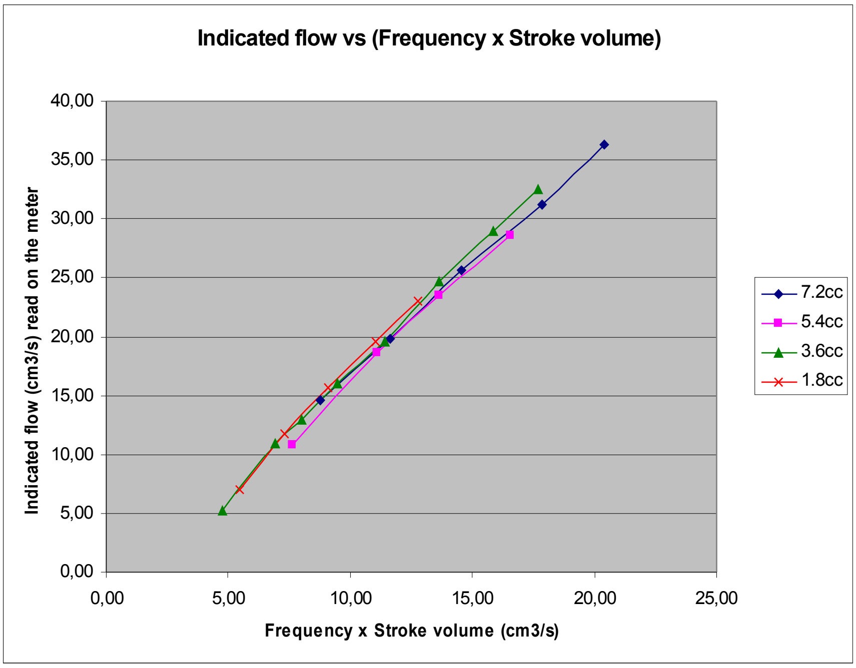
Stroke	volume (cm3)
64,0	7,232
48,0	5,424
32,0	3,616
16,0	1,808

This pump is still in working condition. It is perfectly watertight. We have never seen one bubble climbing up in the topping up bottle. (We must confess that to get that there is a big friction between piston and cylinder which requires a big torque only to move the piston. Nevertheless, energy saving was not a concern for a pump which worked totally may be only 20 hours).

Here is a picture of the pump.
Three little holes can be seen on the crank. The fourth one is actually used to connect the rod.
The length of the crank defines the stroke volume.
Except the piston and the upper pieces, the only "mechanical part" is the cylinder indicated by the yellow arrow. All the rest is recovery plumbing.

On this picture a flow meter is visible at the bottom. That was for the first series of tests. Then, we used the same pump with thrust meters.

We used this pump to simulate a pop-pop engine. 11 nozzles were tested, each one with four different stroke volumes, and each time with about 8 different frequencies. Here is an example taken by chance among all of the results.



This graph was got with one nozzle (ID 5.15mm) and 4 different stroke volumes.
It can be seen that the dots are aligned (taking into account the inaccuracy of the measurements).
The other graphs (for the 10 other nozzles) are very similar. Only the "y" scale differs.
On any of these graphs, no dot has been recorded far from the mean straight line.

Conclusion:
What is to be considered is the product *Frequency x Stroke Volume*. The permanent flow through the nozzle which gives the same effective flow (see *Hydraulic test bench for pop-pop engine*) or the same mean thrust (see *Thrust measuring test bench*) is proportional to it.