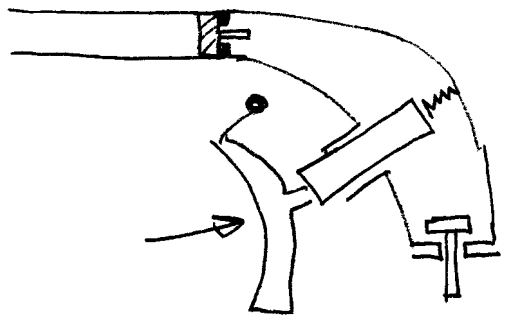
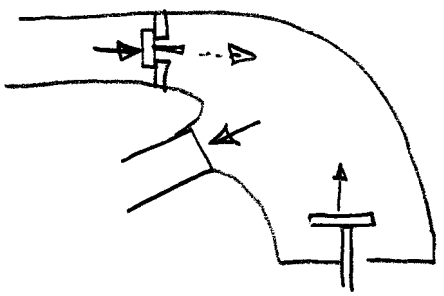
Positive Displacement Pumps 10.2

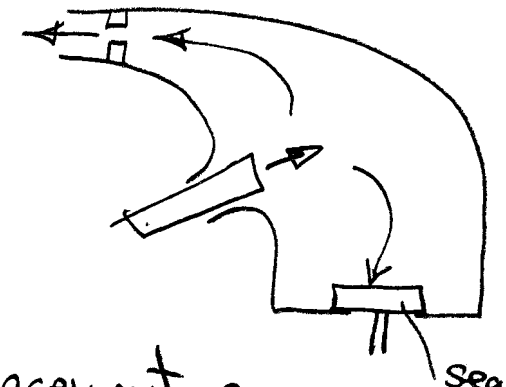
Examples oil & fuel injector pumps in cars
hydraulic systems Backhoes
Cosmetic, Catsup, Soap dispensers etc.
& hearts of most animals

I Simple Positive Displacement pump: Syringe – only one shot

II Squirt GUN







This is a positive displacement pump

more PD pumps in world than any other pump

homework { 10.17, 10.24 } (CS 8.11, 5.11)

Classic Water Gun

http://entertainment.howstuffworks.com/water-blaster.htm/printable

Before the 1980s, water guns had fairly limited capabilities. Handheld pistols could only shoot water a short distance. They shot a weak, narrow stream and you had to run to a spigot to refill them after every shoot-out. These guns are still terrific toys, of course, and they're a wonderful demonstration of basic plumbing principles.

In a classic squirt gun, there are just a few basic parts:

- There is a **trigger lever**, which activates a small **pump**.
- This pump is attached to a plastic **tube** that draws water from the bottom of the **reservoir** (in most cases, the reservoir is the entire inside of the gun).
- The pump forces this water down a **narrow barrel** and out a small hole at the gun's muzzle.
- The hole, or **nozzle**, focuses the flowing water into a concentrated stream.

The only complex element in this design is the water pump, and it's about as simple as they come. The main moving element is a **piston**, housed inside a **cylinder**. Inside the cylinder is a small **spring**. To operate the pump:

- You pull the trigger back, pushing the piston into the cylinder.
- This compresses the spring, causing it to push the piston back out of the cylinder when you release the trigger.

These two strokes of the piston, into the cylinder and out again, constitute the entire pump cycle.

The **downstroke**, the piston pushing in, shrinks the volume of the cylinder, forcing water or air out of the pump. The **upstroke**, the spring pushing the piston back out, expands the cylinder volume, sucking water or air into the pump. In a water gun, you need to suck water in from the reservoir below and force it out through the barrel above. In order to get all the water moving through the barrel, the pump must only force water up -- it cannot force water back into the reservoir. In other words, the water must move through the pump in only one direction.

The device that makes this possible is called a **one-way valve**. The one-way valve in a basic squirt pistol consists of a tiny rubber ball

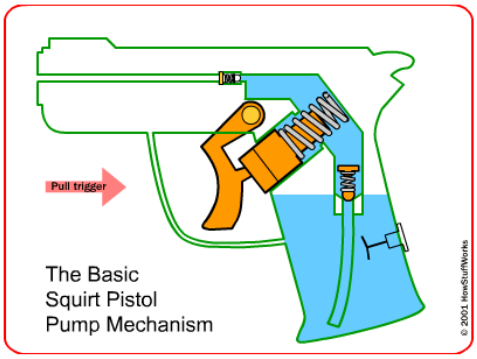


Figure 1: Start, both valves closed

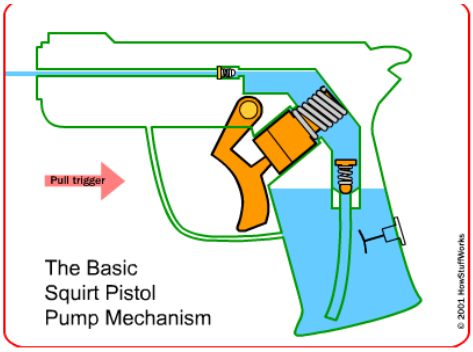


Figure 2: Discharge valve open; suction valve closed

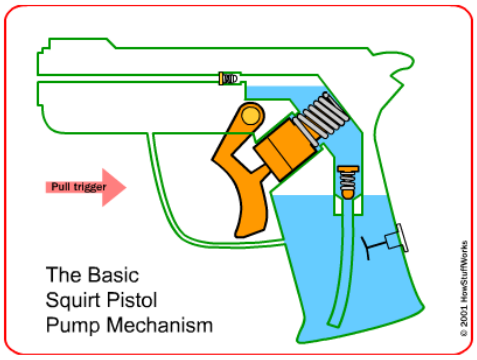


Figure 3: Fully discharged

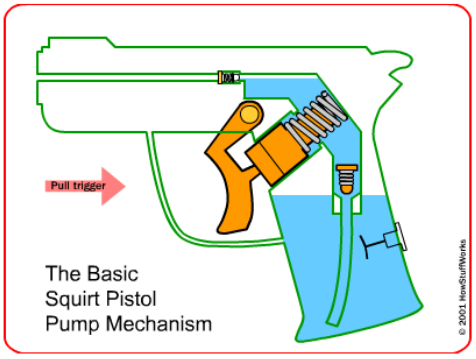


Figure 4: Discharge valve closed, suction valve open

that rests neatly inside a small **seal**. There are two one-way valves: one between the reservoir and the pump, and another between the pump and the nozzle.

This pump 00design is beautiful in its simplicity, but it has a two big limitations:

- The **amount of water** in each blast is limited by the size of the pump cylinder. The size of the pump cylinder, in turn, is determined by the range of the trigger mechanism. To compress and expand more water, you have to push and pull the piston a greater distance, which means pulling the trigger farther back.
- The **duration of the blast** is also limited. Each pull on the trigger creates only a small burst. To squirt water continually, you have to keep squeezing and releasing the trigger.

Throughout the history of water guns, designers have been wrestling with these problems to create a better pumping system. In the next section, we'll look at two simple water-gun designs that increase the stream's range, pressure and duration. Then we'll check out the gun design that blew all other water weapons away.