Pressure Regulator for a High-Altitude Balloon

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Introduction

What is a high-altitude balloon?

- High altitude balloons are large latex balloons filled with gas that carry a payload to near space.

Why are they useful?

- Because they can travel to around 100,000 feet, they provide a convenient way to study the Earth's atmosphere.

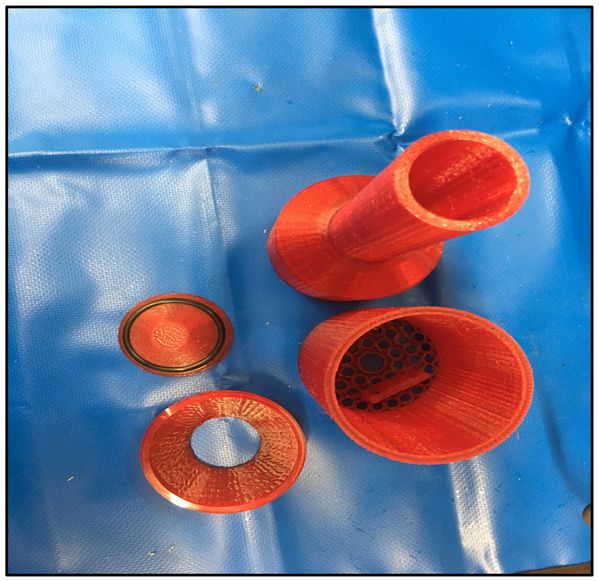
How do they work?

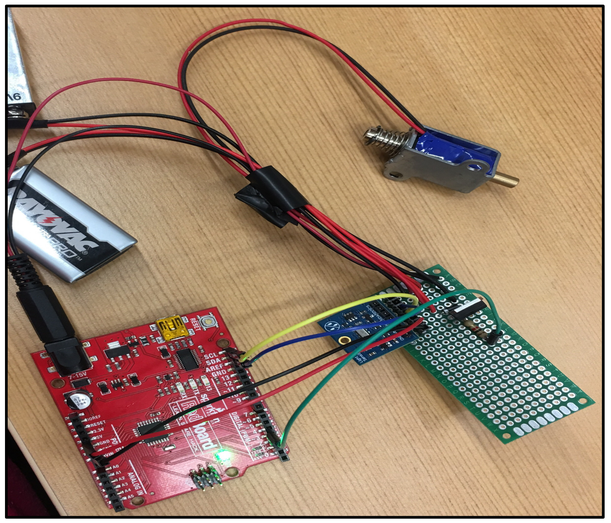
- Per Boyle's Law, the pressure and volume of a confined gas are inversely proportional. Thus, as the balloon ascends and the atmospheric pressure decreases, the gas inside the balloon expands. This pressure difference allows the balloon to ascend, but it also causes it to expand until it bursts.

Materials and methods

For some observations, one might want their balloon to maintain a desired altitude over a period of time. Since the volume inside the balloon increases as the balloon ascends, one way to maintain altitude is to periodically release some of the gas from the balloon. The objective of this experiment was to insert a valve with a sensor to regulate the pressure inside the balloon and in turn, prolong its flight. To do this, we designed an automated pressure valve.

The design of the valve consisted of a 3D printed cylindrical tube with a plug. The diameter of the valve was smaller at the top, where it was inserted into the neck of the balloon. Below that, the diameter of the tube increased to fit the components of the valve. At the bottom of the valve, the diameter gradually decreased again to fit a 3D printed plug with an O-ring around it. The mechanism consisted of the plug attached to a push-pull solenoid, which was controlled by a Redbord micro-processor, wired to an altimeter. The altimeter collected the pressure data and relayed the information to the Arduino board. The Redboard then sent different voltages to the motor causing it to move the plug up and down based on the given pressure.





Arduino Code

This program takes input from the altimeter and outputs voltages to the motor. By changing the desired atmospheric pressure in the code, the operator can dictate the altitude of the balloon. As the balloon ascends and the atmospheric pressure decreases, this code sends voltage to the motor which opens the valve. As gas is released and the balloon descends, the pressure increases. When the altimeter reads above the desired atmospheric pressure and the valve is open, this code stops sending voltage to the motor and the valve closes.

```
if(sensor.GetPres() < 94969)
{
      digitalWrite(4, HIGH); //set pin 4 to high to open
valve            delay (2000);            //delay 2000 ms
}
if(sensor.GetPres() > 94969 && digitalRead(4) ==
HIGH)        {
      digitalWrite(4, LOW); //set pin 4 to low to close
valve  delay(2000);            //delay 2000 ms
}
```

Test Plan

The mechanism will be tested in 3 steps:

- To begin with, we will test the valve in a pressure chamber to simulate the pressure at around 80,000 feet.
- Next, we will test the valve inside a balloon tethered to the roof of the Science II building at CWU.
- Finally, we will launch a balloon attached to the valve.

Summary

- High-Altitude balloons provide a convenient way to study the Earth's atmosphere.
- In order to maintain a balloon's altitude for a period of time, we designed a pressure regulator.
- The pressure regulator consisted of 3D printed parts and a plug attached to a push-pull solenoid, which was controlled by a Redboard micro-processor, wired to an altimeter.
- Future work includes testing the mechanism and making any necessary improvements.

Acknowledgments

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