Air-Breathing Gridded Ion Engine

Novel Design Combining Ionic Wind and Grids for Atmosphere and Vacuum Propulsion

Design Iterations

- Our first prototype focused on validating our design could potentially work. We came up with the idea for on board battery. We used an arc lighter and a voltage multiplier that we created to power this design and bring the voltage to ~67kV in order to ionize the air. Fortunately, the rough prototype worked (for the most part).

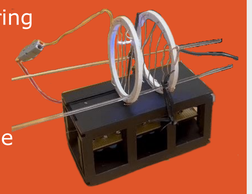

Figure 1: First Prototype

- The second prototype focused on discovering if two or more stages could be run simultaneously. Experiments were done to determine the optimal emission and reception materials such as copper, brass, or steel. Additionally, we wanted to know which shape produced better results. This means we tested whether wires, nails, and tubes on each stage. Finally, we wanted to find the optimal distance between each stage which is why we opted for a modular spacer design.

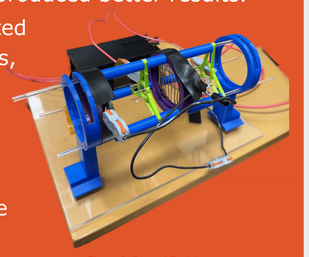

Figure 2: Second Prototype

- The third prototype focused on fixing issues. One important aspect is ensuring everything is well insulated to prevent arcing. Attention was given to making the prototype sturdier and able to operate in the vacuum chamber.

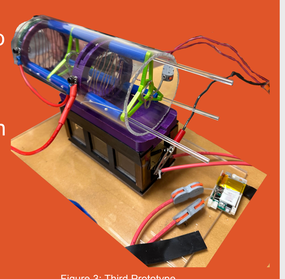

Figure 3: Third Prototype

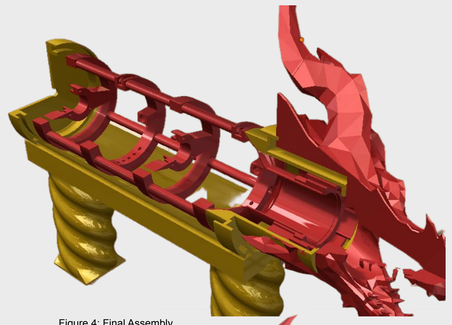

Figure 4: Final Assembly Render

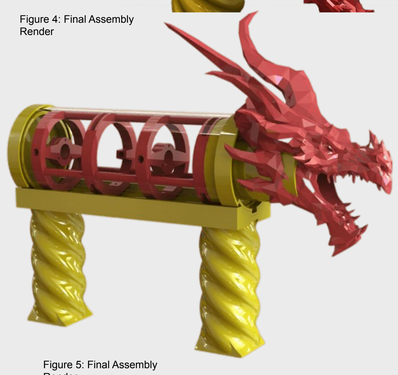

Figure 5: Final Assembly Render

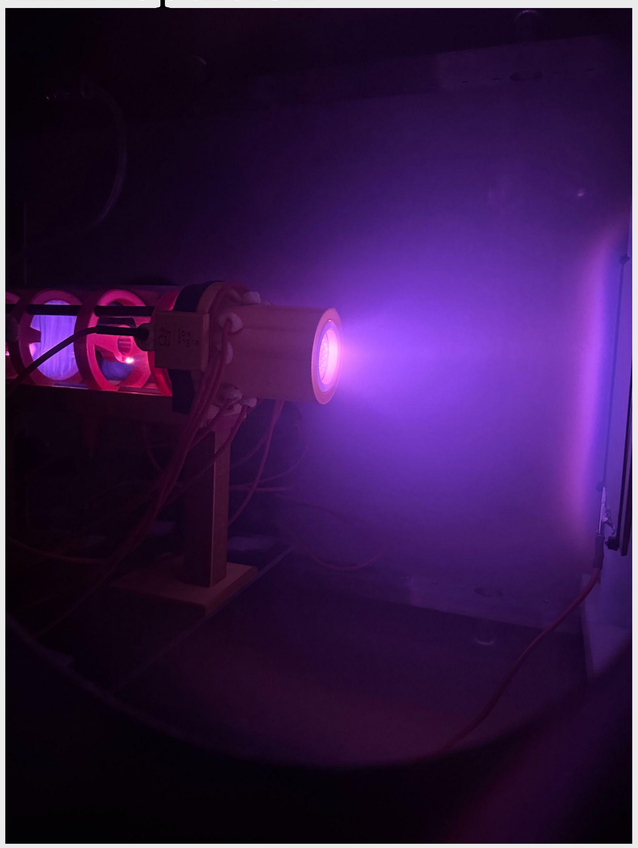

Figure 6: Final Assembly In Vacuum Chamber

Introduction

Ion engines have been used for decades in space exploration and satellite propulsion due to their high efficiency and low fuel consumption. However, previous versions of ion engines were limited by their use of uncommon gasses such as xenon and argon and could only be operated in the vacuum of space. In this project, we aimed to develop a new prototype of an ion engine that uses air-breathing ionic wind as its fuel source and is made of lightweight plastic components. Our ultimate goal was to create an engine that could operate independently on a small power source and produce thrust in both an open room and a vacuum. In this poster, we present the design, experiments, and results of our air-breathing ionic wind ion engine prototype and discuss its potential applications in space exploration and beyond.

Data collection

We measured the thrust of the ion engine in the vacuum chamber by placing the prototype in front of a metal sheet and measuring the voltage sent to it. The voltage was used as an approximation for thrust. The prototype was powered by 4 neon sign transformers (NSTs) with variable voltage outputs up to 10kV. We first determined the optimal voltage supply for the two stages using NST 1 and 2, and then varied the voltage supplied to the grids using NST 3 and 4 to collect data. We changed the voltage in increments and recorded the corresponding thrust. The gathered data was compared to previous prototypes and presented in a graph on the right side of the poster. Our prototype performs much better than the last and continues to trend upwards as higher voltage is applied.

How Air breathing Gridded Ion Engine works

- This prototype uses the theory of ionic wind in combination with a four-grid system to produce propulsion. To ionize the gas, a constant mass flow rate is required, along with high voltage and low current electricity. This ionizes the gas and produces a plasma state.
- To generate thrust, a high potential difference is applied, which causes the gas molecules to become positively ionized, pulling electrons from the atoms and turning them into plasma. The ions then flow towards the negative poles, generating thrust through the laws of conservation of momentum.
- Overall, this prototype uses ionic wind and plasma acceleration through the use of grids to generate propulsion.

Figure 7: Visible plume in vacuum chamber

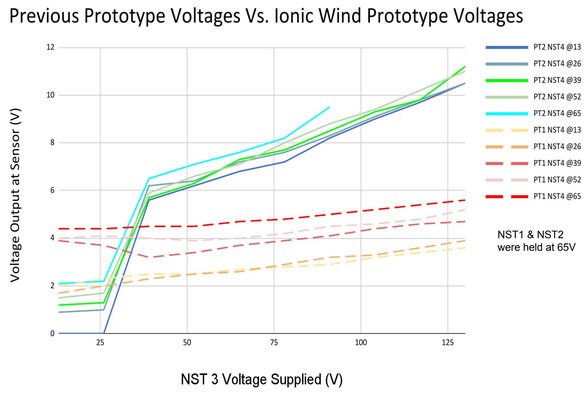

Figure 8: Data of Final Prototype compared to previous teams prototype

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