Fastener-less Flange

Team Members: Joseph Trafecanty - Noah Sampiere Prochnow - Ryan Lim - Richard Rosas - Xiangyu Luan
Liaisons: A.J. Fillo - Josh Kaye - Sarah Pollock
Faculty Advisors: Farzad Ahmadkhanlou - Mark Walter
Additional Support: Ben Dolan - Relativity Space Team

Background

The Fastener-less Flange project is set to redesign the flange. Bolted Flanges are the current go-to method for temporary pipe connections. These flanges rely on bulky, threaded bolts to secure the two pipe ends together. Additionally, the mated ends must be of a certain machined finish and have a gasket inserted between them to achieve a reliable seal. This leads to a large increase in weight and assembly time for any piping systems.

Goals

- Create a fastener-less flange

But what is a fastener-less flange?

- The intent is to create a fully integrated connection system with respect to the pipe network of a rocket
- No separate pieces required for connection
- It would be simpler than a bolted flange in terms of manufacturing and installation
- Contributes to the greater goal of a fully 3D-printed rocket

Objectives

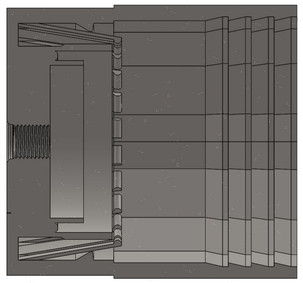
Main Objectives

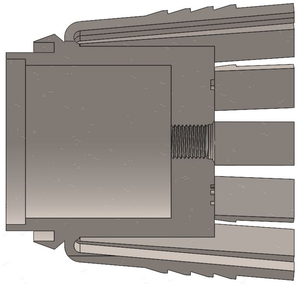
- Design needs to be fully 3D printable
- Reduce weight compared to a traditional flange
- Able to withstand pressures and leak rates according to ASME B16.5 Class 150 standards

Secondary Objectives

- Have an equally distributed load
- Reduce required machining
- Minimize part count
- Allow for easy installation and disassembly

CAD Models

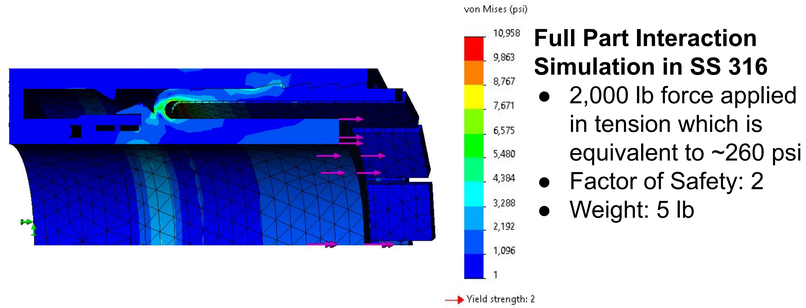




Design Highlights

- External zip-lock lockarm
- Variable number of locking arms
- Face and Labyrinth Seal
- Internal lock arm to prevent dislodgement from vibration

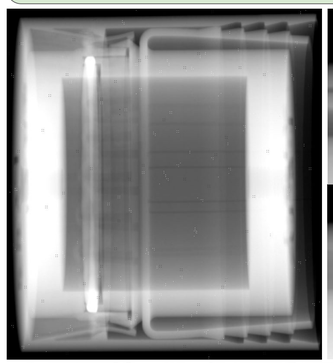
Analysis

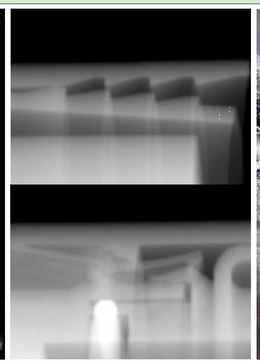


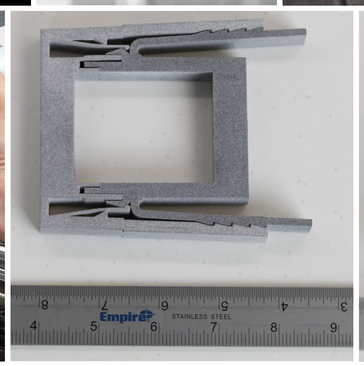
Full Part Interaction Simulation in SS 316

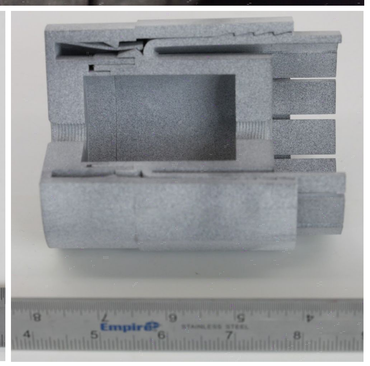
- 2,000 lb force applied in tension which is equivalent to ~260 psi
- Factor of Safety: 2
- Weight: 5 lb

Testing

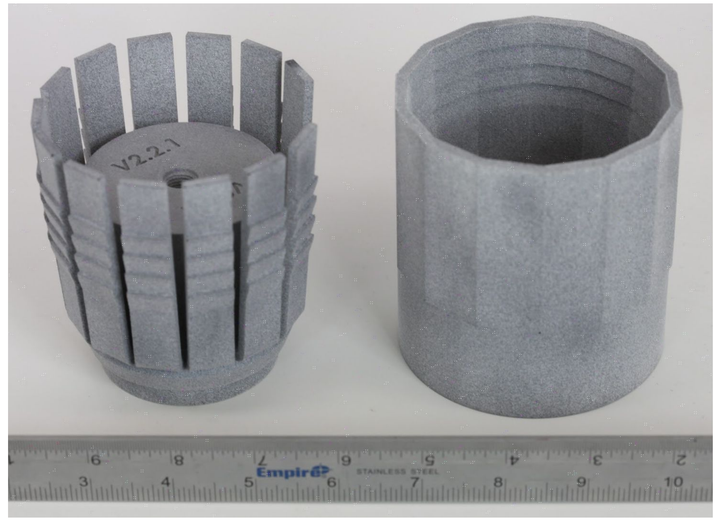








Current Prototype



Results Highlights

	Printing Defects	Assembling	Water Tight	Disassembly	Failure Location
Rev 1.7 to 1.9	Minor,bubbles	Arm Misalignment	Fail	Damaged	lock arm: arm length and # of teeth was off;
Rev 2.1 and 2.2	Minor,bubbles	Hand assembled	Pass	Difficult to Disassembly	End of lock arm scrap asgainst outer wall
Rev 3 Series	Current Prototype: Awating Testing				

Future Plans

After a successful design using Nylon 12, the next steps for the project is to print in SS316 which requires a redesign of the arms specifically due to metal being less flexible than plastic. This would also increase the maximum operating pressure limit and allow the fastener-less flange to be used with cryogenic fluids. If successful in the metal design the fitting will be used on rockets to reduce weight and increase the payload size.

We would like to give a special thanks to Relativity Space and their extended support from their X-ray and Quality control teams, along with Ben Dolan from our UCI IDMI labs.