

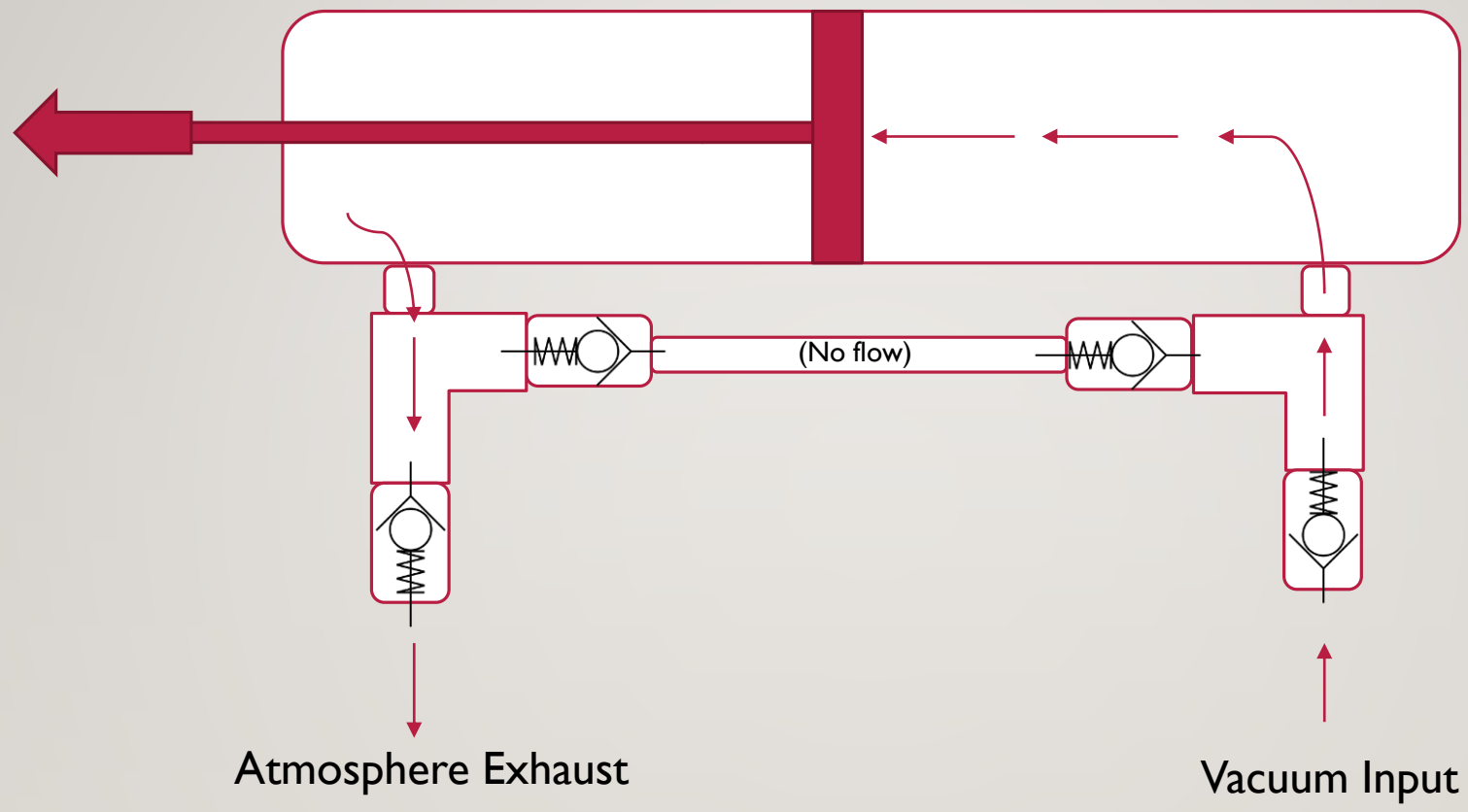
# DEEP SPACE ON EARTH

---

TEAM 3826's VACUUM GENERATOR

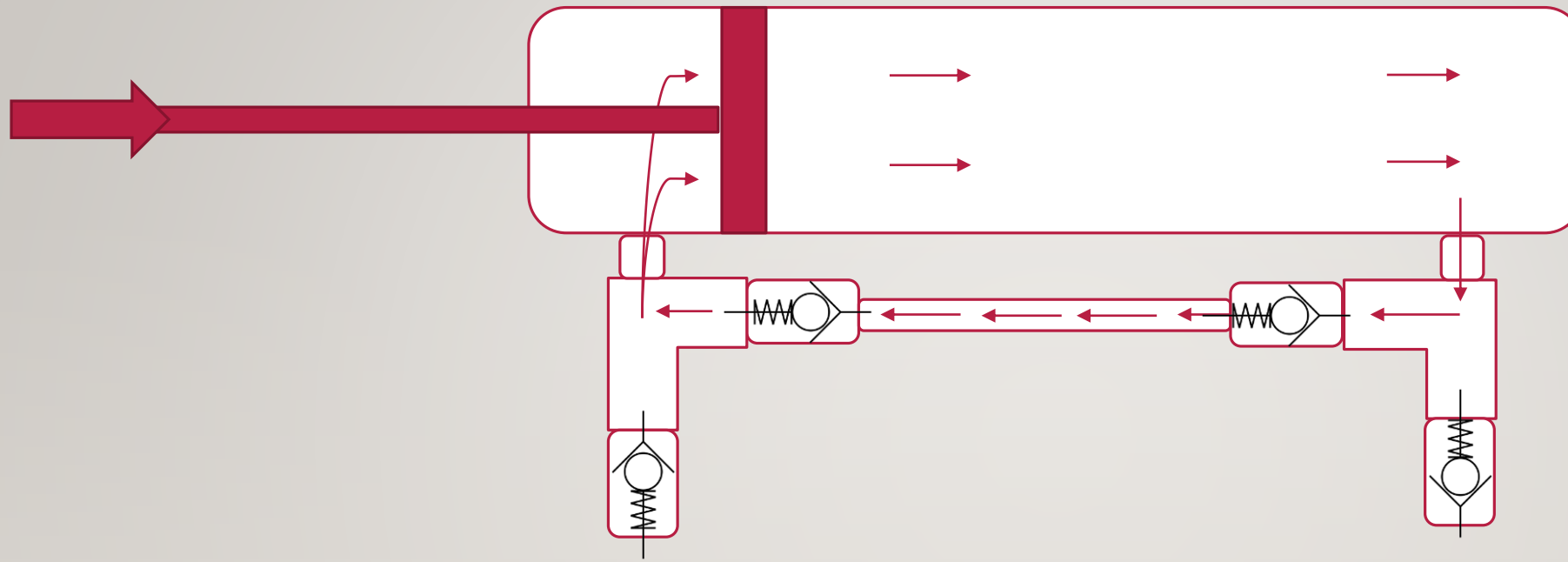
# INSPIRATION

- 3826 needed a fast, powerful vacuum for holding hatches and perhaps climbing
- Many commercial vacuum pumps avail, but often \$\$\$ and motors not FRC legal
- **INSIGHT:**
  - Piston vacuum pumps use one way valves, aka “check valves”
  - Valves are often internal but no reason they have to be
  - Can operate a pneumatic cylinder as a piston via FRC legal drive and shop built crank.
  - Then, just add external check valves to make it a pump!
- Prototype results of 25 inHg exceeded expectations!
- **Any team needing high vacuum with low air volume can build this!**



Key:  
→ = Air  
⊘ = Check Valve

# 1<sup>st</sup> Stroke



Key:

→ = Air

⊗ = Check Valve

(No flow)  
Atmosphere Exhaust

(No flow)  
Vacuum Input

# 2<sup>nd</sup> Stroke

# PERFORMANCE & RELIABILITY

- 2.75” stroke length (out of potential 3”), driven at ~ 4 strokes / second
- Vacuum > 20 inHg after just 2 to 3 revolutions of the pump shaft
- Max vacuum achieved with two stage pump is 27 inHg
- At 27 inHg, two suction cups of 2-3/8” dia theoretically hold 90 pounds combined; in practice they grip hatch reliably and enable floor pickup too.
- Pump, valves, and fittings held vacuum for days
- No discernable breakdown of air cylinder seals during competition season

# VACUUM PUMP BILL OF MATERIALS

- **COTS components likely needed:**

- Two check valves (e.g. Clippard MJCV-IAB and MJCV-IBA) \$27.00
- Brass 1/8" NPT Street Tee 5.50

- **Components likely already on hand for most teams:**

- Miscellaneous hardware, 1/8" NPT fittings \$20.00
- Bag motor 30.00
- VersaPlanetary gearbox (with 10X and 5X stages) 75.00
- Aluminum plate & angle for shop built crank & mount 25.00
- Air cylinder, 3" stroke, 1-1/16" ID (e.g. Bimba 93), with pivot hardware 27.00

- **Total cost:**

- Maybe \$32.50 out of pocket; or up to \$210.00 if starting from scratch



# PROTOTYPE CONSTRUCTION

Crank (bottom & center) with piston that pivots with each rotation / stroke (side).  
Stroke here is only 2" of possible 3"



Check valves (for one stage pump):  
Vacuum inlet (top)  
Exhaust to atmosphere (side)  
Attached via 1/8" NPT brass Street Tee

# TIPS FOR OPTIMIZATION

- Connect a simple crank to trial air cylinder with open shaft end
- Drive the crank's shaft manually, and/or with variable speed drill (or similar)
- Include an analog vacuum gauge for visual feedback of vacuum achieved
- Observe forces encountered and decide on sustainable rotation speed:
  - Too fast can wear out seals unnecessarily
  - Too slow is inefficient
- For highest vacuum:
  - Select a longer stroke air cylinder
  - Select a larger cylinder bore
  - Add a second stage in series with the first (easy with double acting cylinder - see animations)
- Pick drive motor and gearbox to suit power and speed needed