Pneumatics

2008

FRC Kick-off Workshops

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What's Wrong with Pneumatics?

- Too Heavy!
- Too Springy!
- Too much demand on Battery!
- Too Fast
- Too Slow
- Too much Footprint/Space Req'd
- Others?

Weight

- "Tare" weight: 7.5 lbs
  - Compressor
  - Accumulators (2)
  - Regulator/fittings
  - Spike relay
- Individual Systems: .5-2.0 lbs
  - Cylinder
  - Connections
  - Solenoid

Battery Problem

- Motor current is a function of its speed and load
- Rapid starting and stopping at high set pressure uses max current (easily over 10 A for start)
- Existing pressure switch has very low latency

Battery Help

- Pre-2006 FRC kit pressure switches turned off at about 115 psi—turned back on at about 105 psi
- 2006-7 switches better: 115 to 95 psi
- Still an unpredictable significant current
  - Use logic s/w to prevent turn on during critical non-pneumatic operations
  - Use delay logic to delay turn-on

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What's Right with Pneumatics

- No "magic smoke"
  - Do not overheat, even with overloads
- Provide controlled force
- High speed combined with high force
- Accurate end position control
- Holds energy without additional power consumption
  - An adjustable Spring
  - No backdrive at End-of-Match!

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Where to use

- Two-position linear applications
  - A “lifter” or “gate”
- Two-position with stored energy
  - Transmission Shifter
- Limited-arc rotary applications
  - Gripper
  - Arm Elbow or Shoulder

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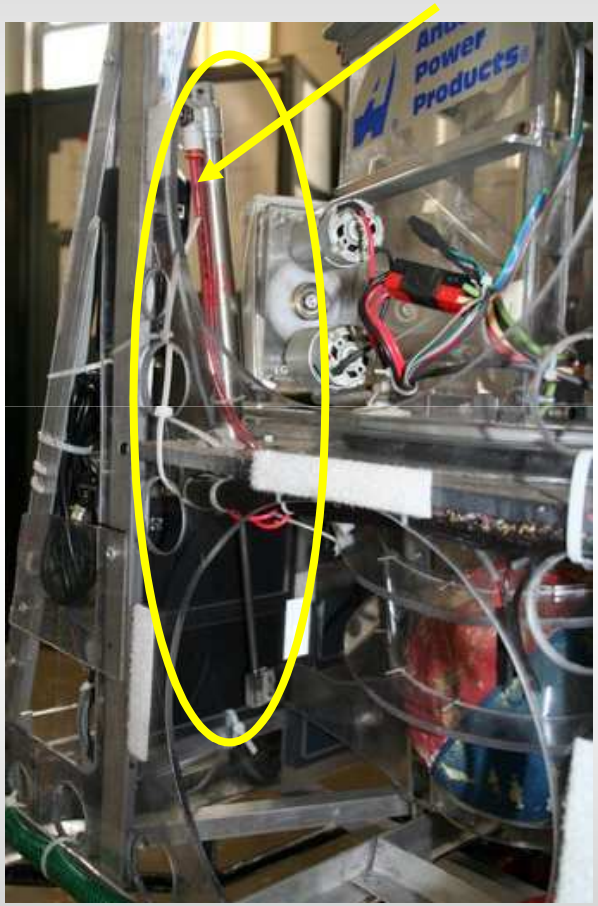
Example “Lifter”

- 2K6 FRC Robot: lifts balls to spinning shooter wheels
  - ¾ x 6 cylinder
  - Magnetic switch-activated return stroke
  - Capable of feeding shooter at 3 balls per 2 secs



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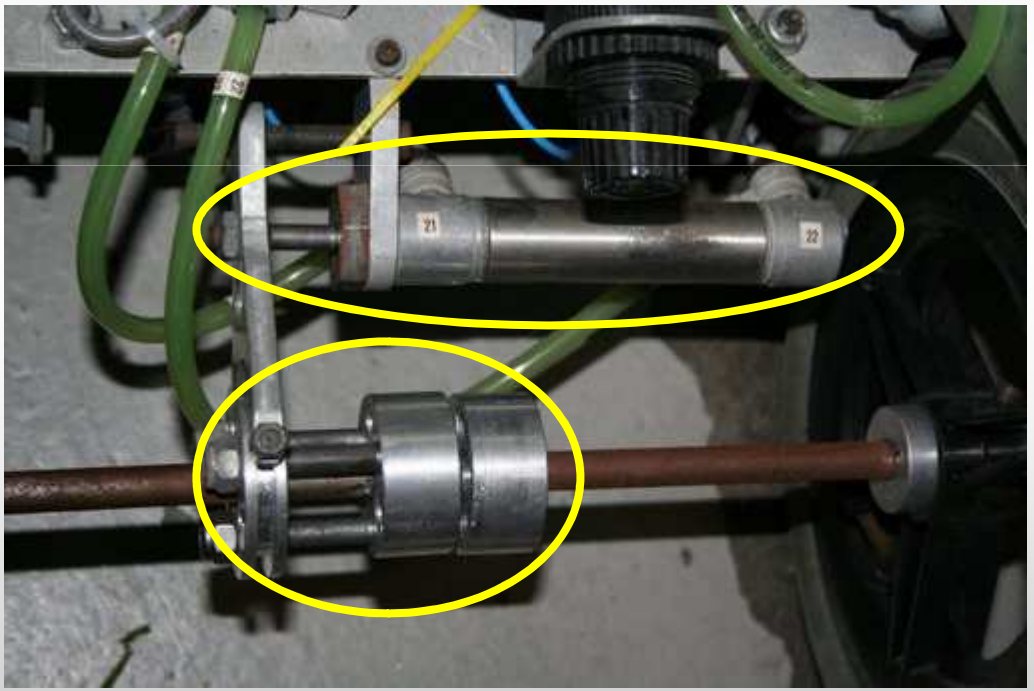
Lifter Design Considerations

- **Force of pulling vs pushing (piston rod effect)**
  - **$F=P \times A$, $F = 60psi * \pi ((3/8)^2 - (1/8)^2) = 24$ lbs**

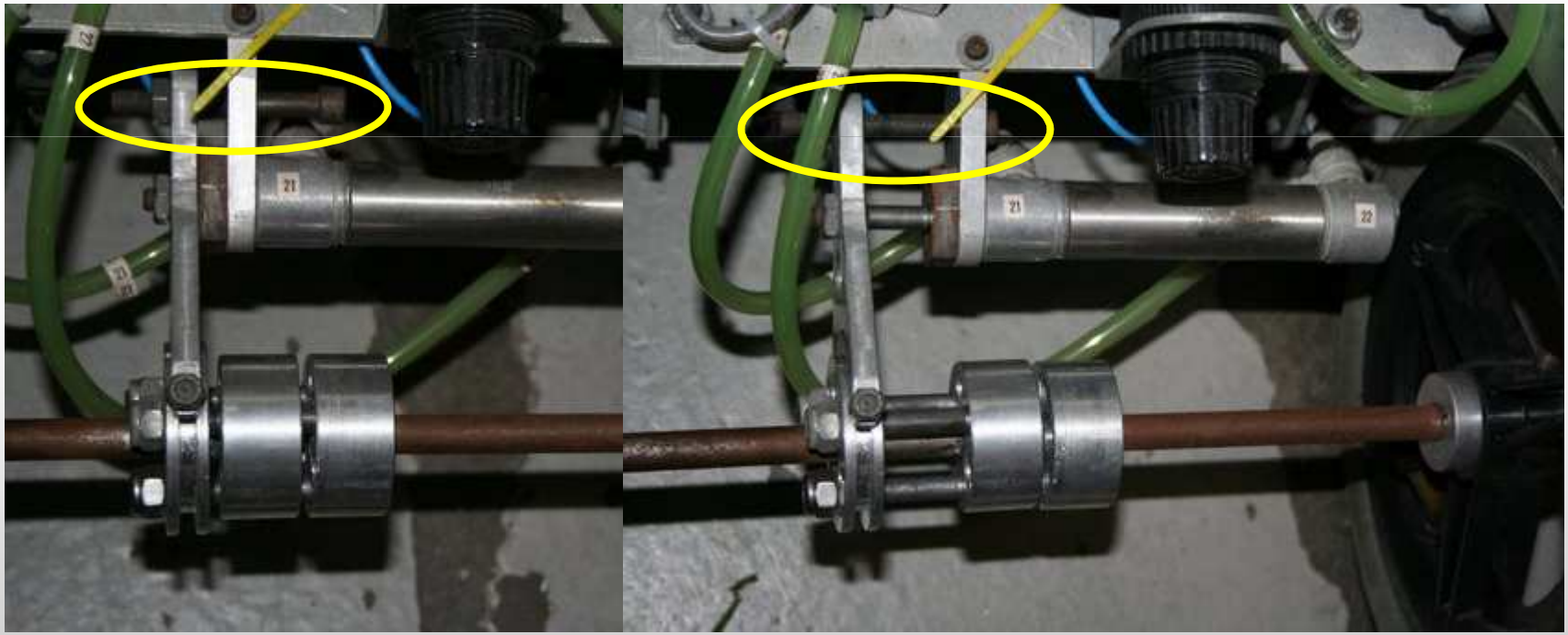
Example “Shifter”

- 2K4 FRC Robot: slides pins to lock/unlock “differential”
  - ¾ x 2 cylinder
  - 3 pins to be locked into 3 of 6 holes



Shifter Design Considerations

- Only wanted ¾ in of motion
  - Used adjustable fixed stop



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Example “Gripper”

- 2K1 FRC Robot: grab 30” ball from floor and place on high goal tower
  - Needed secure 10 pound grip
  - Had to balance on tower
  - Nice to be able to grab 10” balls also

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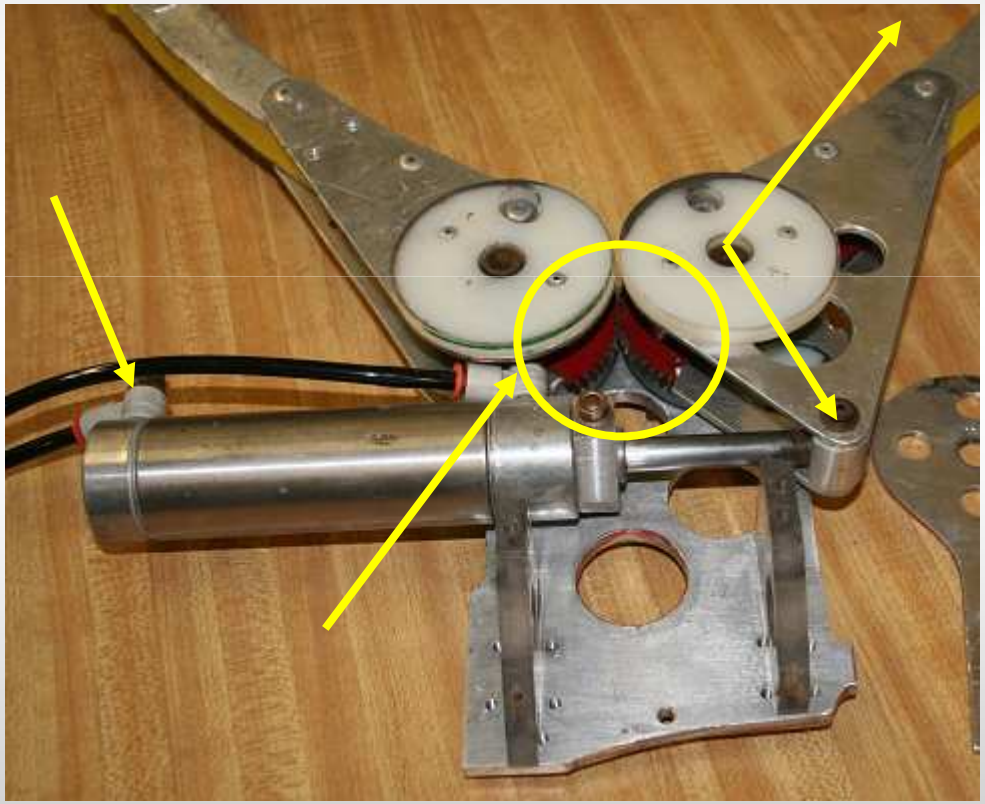
Gripper Design Considerations

- Geared joint insured symmetry, doubled rotation angle
- Effective radii
  - 3” for cylinder
  - 15” for gripper
- Used 1½ x 3 cylinder
  - $F = 60psi * \pi (3/4”)^2$
    $= 106$ lbs
  - At 3:15 ratio & 2 arms
  - Closing force = 10.6 lbs
- Used flow-controls
  - Quick grip
  - Slow release



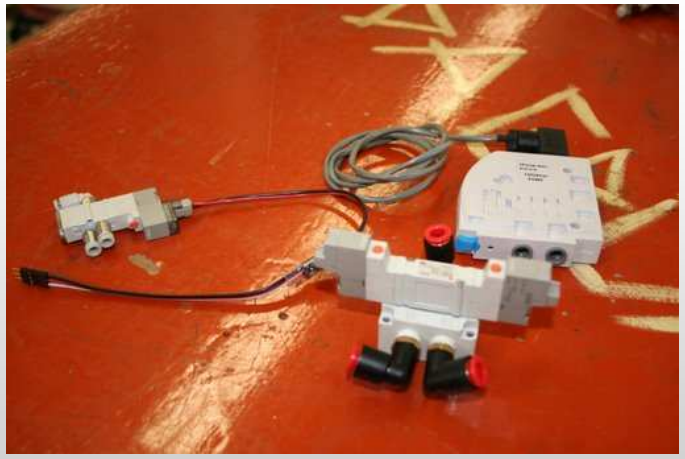
Bits and Pieces

- **Adjustable Regulator**
  - **Use minimum psi req'd**
  - **Saves air**
  - **Maintains force**

- **Magnetic Switch**
  - **Digital position**

More Bits

- **Flow Controls**
  - **Needle valve controls outflow only**
  - **DOES NOT control force, just speed**
- **Solenoid Valves**
  - **Very low current**
  - **Require 6-10 psi**



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General Suggestions

- Do not use unless you have 2 or more systems that really benefit from pneumatics
- Unless…you can use accumulators only—no compressor
  - EG: you could shift a transmission (3/4 x 1 cylinder) ~70 times on two 2 X 6 tanks
- Do not tolerate leaks!

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Summary

- In 16 years of FIRST (only 14 with pneumatics?), Team 190 has used pneumatics in 10 robots—6 of the last 7
- The weight is manageable when multiple systems are used
- When used appropriately they are great
  - SHIFTERS!
  - GRABBERS!
  - LIFTERS!

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Questions?

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