The Crush Project Outline

Background

Pascal's Law is the most fundamental principle in fluid power. It is the principle of transmission of fluid-pressure. It states that pressure exerted anywhere in a confined incompressible fluid is transmitted equally in all directions throughout the fluid such that the pressure is the same throughout. For hydraulics, this means $P_{IN} = P_{OUT}$.

Objective

Design and test a can crusher that will crush a can using only an index finger and only one input syringe. Line pressure should not exceed 50 psi.

Materials

- Multiple size syringes
- 1/8 in. diameter plastic tubing
- Luer lock adaptors
- Tubing Tees
- 4 Check Valves (max pressure = 150 psi)
- 2 Directional control valves
- Medium density fiberboard to use with the laser cutter
- Birch wood to use with the laser cutter
- ABS plastic to 3D print
- Treaded 7 in metal rods
- Any other materials approved by the instructor
- VEX equpiment

Procedure

1. Test aluminum drink cans on the tensile tester to determine the amount of force required to crush the can. Record this in Table 1.Using a force sensor, measure how much force a person can apply using only the index finger. Record this in Table 1.
2. Calculate the Ideal Mechanical Advantage (IMA) required to crush a can using only the index finger. Record this in Table 1.
3. Using a caliper, measure various size syringes and calculate their cross sectional area. Record this in Table 2. Using a force sensor, test each syringe for the force required to push water through the syringe. Record this in Table 2.
4. Calculate 3-4 combinations of syringes to find a theoretical solution of the size and number of syringes required. Only 1 input syringe may be used. Multiple numbers of output syringes may be used. Determine with the team how to calculate these solutions. Record calculations in Table 3.
5. Calculate the system pressure to assure it is below the 50 psi constraint of the check valves and tube fittings. If it is not, more syringes may be required.
6. With the team, choose one solution to be used in the final can crusher design. Design should be chosen based on friction force efficiency of syringes.
7. With the team, design a tubing system so the input syringe acts like a pump to move water from a reservoir to the output syringes with the use of 4 check valves. Then by changing 2

directional control valves, the input syringe will act like a pump to return the water from the output syringes to the reservoir.

8. With the team, brainstorm an apparatus design to hold the output syringes and can, and the ability to crush the can. Record this information in Table 4.
9. Fabricate the design. Record problems and solutions encountered in Table 5
10. Using a force sensor, test the actual input force required to crush a can. Record this in Table 6.
11. Calculate the Final Actual Mechanical Advantage (AMA) and the efficiency.
12. Automate the final can crusher using VEX equipment and RobotC software to program it.
13. Include a picture of the final design in the report.

Table 1: Ideal Mechanical Advantage

Force Required to Crush a can - F_{can} (lbs)	
Force Applied by One Index Finger - F_{finger} (lbs)	
TMA_{can}	

Table 2: Syringe Measurements

Syringe type	Syringe size	Diameter (in)	Cross Sectional Area (in^2)	Force Required to Push Water through (lb)

Table 3: Syringe Combinations (May need more than 4)

		Type	Cross Sectional	$IMA_{syringe}$	INS	Measured $F_{syringe}$	$F_{out\ total}$	$F_{in\ total}$	AMA	ANS	Line Press.

			Area (in^2)			(lb)					(psi)
1	Input Syringe			XXXX	XXX		XXX		XXX	XXX	XXX
	Output Syringes							XXX			
2	Input Syringe			XXXX	XXX		XXX		XXX	XXX	XX
	Output Syringes							XXX			
3	Input Syringe			XXXX	XXX		XXX		XXX	XXX	XXX
	Output Syringes							XXX			
4	Input Syringe			XXXX	XXX		XXX		XXX	XXX	XXX
	Output Syringes							XXX			

Table 4: Structure Design

		Why?
Material Chosen		
Base Dimensions		
Syringe Hole Dimension		
Rod Hole Dimension		

Table 5: Problems and Solutions

Problems Encountered	Solutions

Table 6: Final Actual Mechanical Advantage

Output Force Required to Crush a can + Force required to push each output syringe (lbs)	
Input Force Required (final apparatus) (lbs)	
Final AMA	
%Efficiency	