Honeywell Reference Pressure Regulator

Team C2:

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Honeywell Pressure Regulator Team

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  - YiTong Zhang – Budget Liaison
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  - Amy Swartz
- Honeywell Contacts
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  - Kayla Goodrich – Project Engineer
  - Dave Tournquist – Chief Engineer

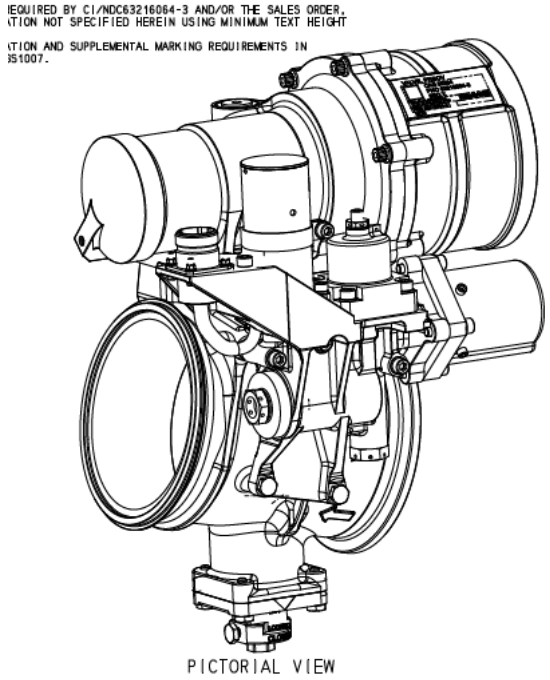


Figure 1: Honeywell Reference Regulator [1]

Project Description

- Become familiar with Honeywell regulator design
- Compare & contrast current Honeywell design with other designs on the market
- Redesign a reference regulator
  - Improve closure element – decrease friction
- Provide prototype for proof of concept
  - Prototype should be able to withstand at least 25psi

Honeywell Reference Pressure Regulator

- Average B737 contains ≈ 15 reference pressure regulators (according to client)
- Serve to limit pressure for valve structural integrity
- Maintain pressure used for pneumatic controls

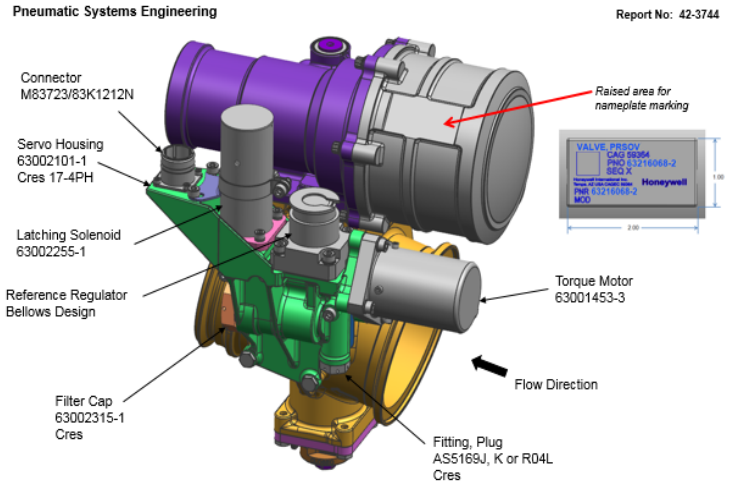


Figure 2: Honeywell Reference Regulator [1]

Identified Problems

- Hysteresis (friction)
  - System instability
- Accuracy
- Leakage
- Uneven wear on the poppet and spring system

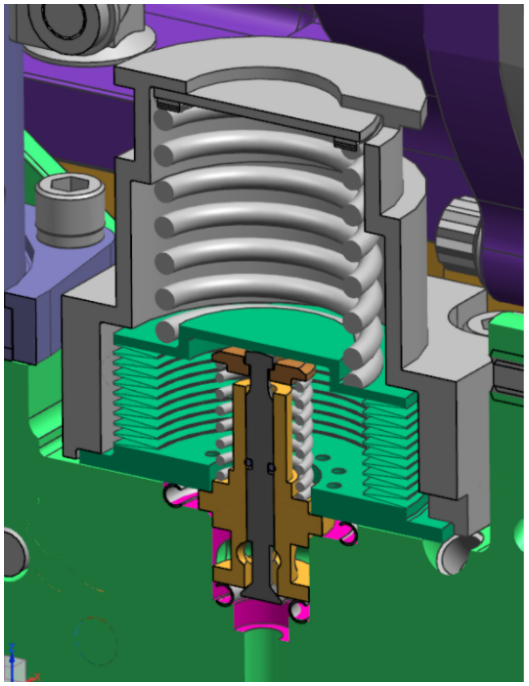


Figure 3: Honeywell Reference Regulator Section Cut [1]

Pressure Regulator - Current Design

- Standard pressure regulator includes
  - Closure element
  - Calibration spring
  - Sensing area
  - Guide
  - Return spring

- Allows for adaptable mechanical system to account for varying inlet and outlet pressures

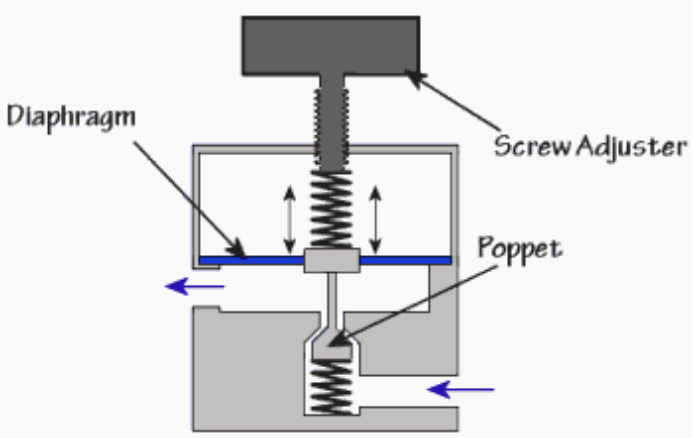


Figure 4: Reference Regulator Schematic [2]

Honeywell Current Design

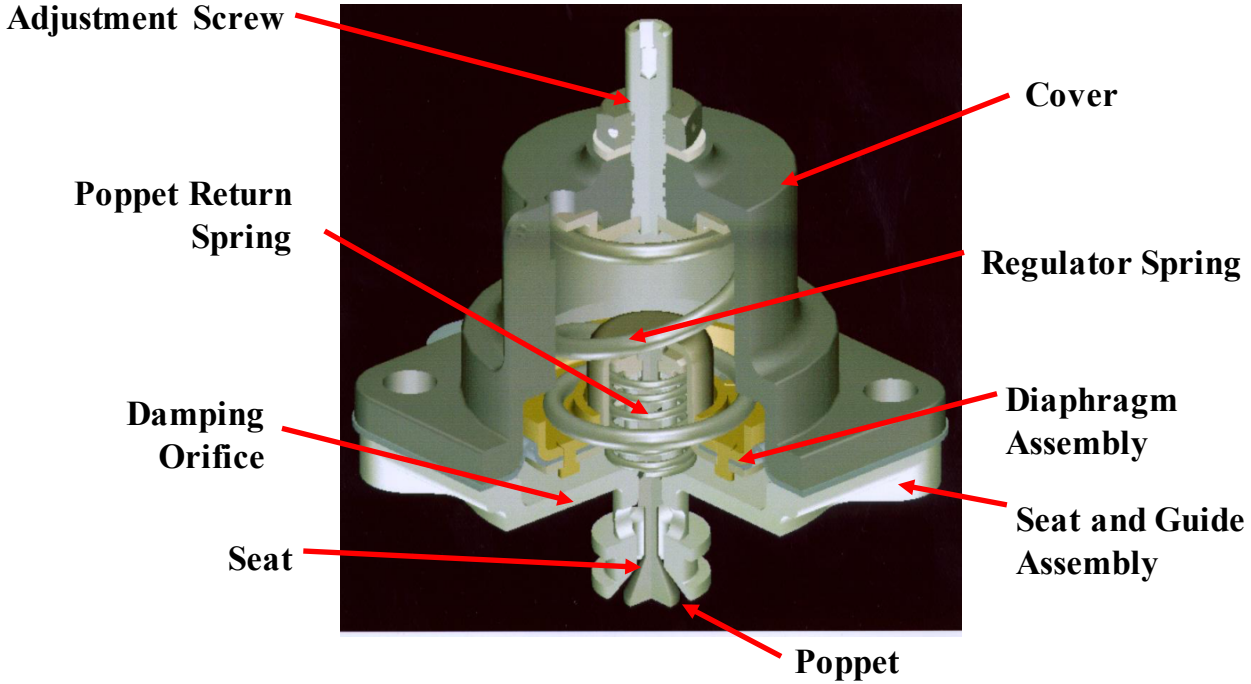


Figure 4: Honeywell Reference Regulator [3]

Existing Design –Scuba Gear

- Actuated by inhaling (breathing in)
- Spring pushes on soft diaphragm
- Ambient pressure of water pushes on soft diaphragm

Existing Design – Scuba Gear

- Lever translates motion direction
- Ambient pressure of water pushes on soft diaphragm
- **Soft diaphragm cannot be used in reference pressure regulator design**

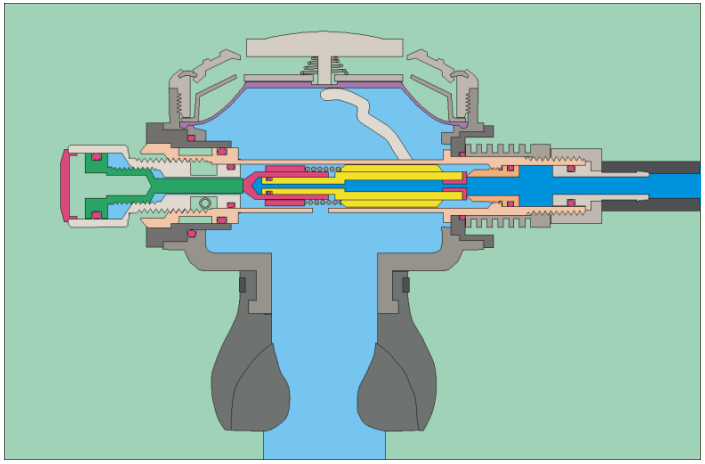


Figure 5: Scuba Gear pressure regulator [5]

Closure Elements – Butterfly Valve

- Non-sealing
- A disk mounted on a shaft
  - When shaft turns, disk moves from perpendicular to the flow to parallel to the flow
- Shaft is perpendicular to the direction of flow
- Circular or elliptical plate is mounted on the shaft
- No piston ring
- Relatively high leakage

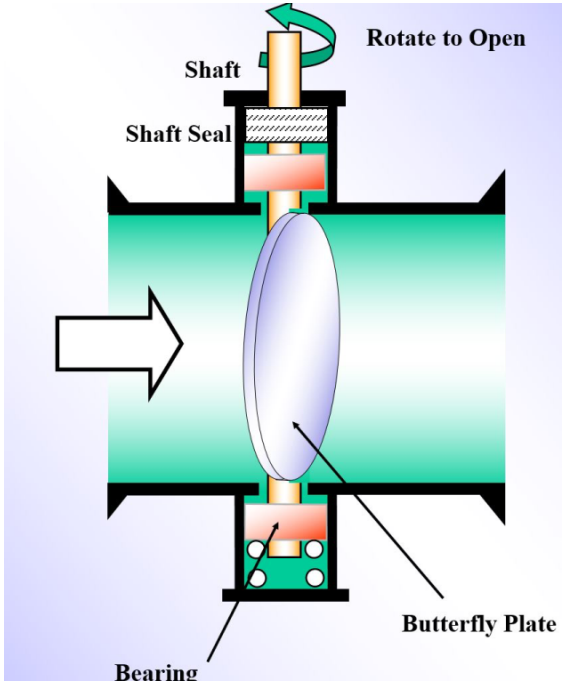


Figure 6: Butterfly Valve Closure Element [6]

Closure Elements –Ball Valve

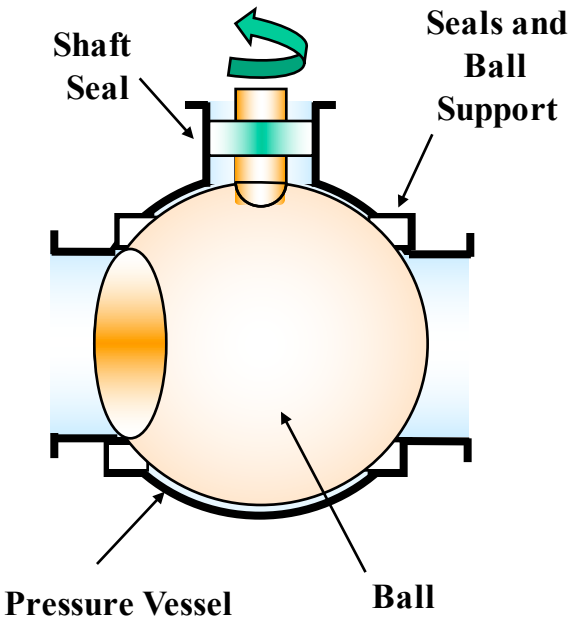


Figure 7: Ball Valve Closure Element [6]

- Spherical ball with a cylindrical hole drilled through
  - Open when the hole is aligned with the flow duct
  - Closed when it is at a right angle to the flow
- Unrestricted flow when open
- Minimal pressure drop
- Seals act support and seal the ball
- Material is typically teflon
- Limited to low pressure
  - Most aircraft valves run too hot for ball valve use

Closure Element – Poppet

- Disk shaped plug inserted into a hole to shut off the flow of air
- Actuator mounted in line with poppet
- When open, air flows in through the side and out of the bottom of the valve
- Pressure is "sensed" on the bottom
- Seal failure = increase friction and flow

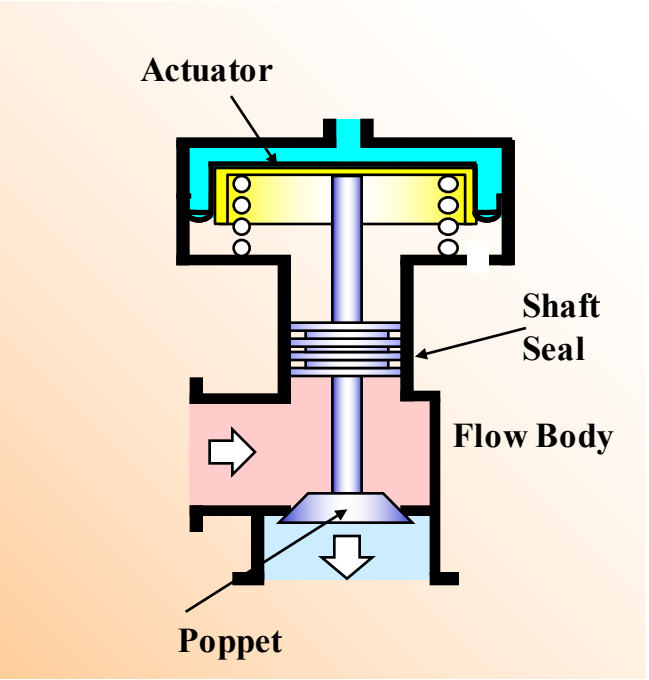


Figure 8: Right Angle Poppet Closure Element [6]

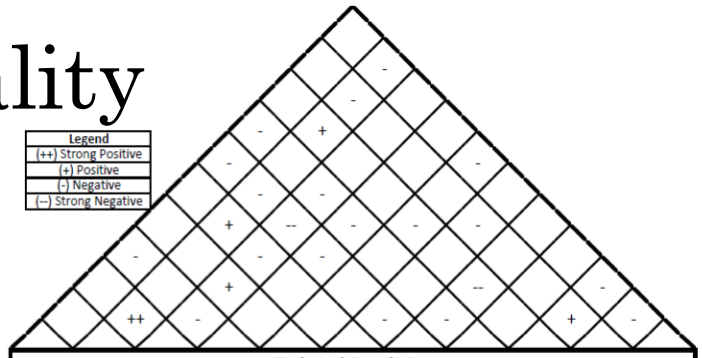
Design Requirements – Client Specified

- Reduce friction within the regulator
- Maximize pressure range
- Maximize temperature range
- Maximize regulation accuracy
- Minimize leakage

Customer Requirements

- Reliability
- Durability
- Effectiveness
- Maintenance
- Production Time
- Affordability
- Safety
- Accuracy

House of Quality



Improvement Direction		↓	↑	↑	↓	↓	↑	↓	↓	↑	↓	↓
		Engineering Characteristics										
Customer Requirements	Importance Weight Factor	Surface Area	Pressure Range	Strength of Material	Weight	Friction	Temperature Range	Cost	Part Count	Accuracy	System Instability	Leakage
		in^2	psi	psi	lbs	N	F	$	#	psi	%	cfm
Reliability	5.0		9	9		9	9			9	9	3
Durability	4.7			9		9	3			3	3	9
Effectiveness	4.5		9							9	9	9
Maintenance	3.0	3		9	3			3	3			3
Production Time	2.5	3		3	1			3	9			3
Affordability	3.5	3	9	9			3	9	3	9	9	
Safety	5.0	3	3	3	3		9					3
Accuracy	4.5		9			9	1	9		9	9	3
Raw Score	1242.1	42.00	172.50	168.30	26.50	127.80	88.50	88.50	42.00	171.60	171.60	142.80
Relative Weight %		3.4%	13.9%	13.5%	2.1%	10.3%	7.1%	7.1%	3.4%	13.8%	13.8%	11.5%
Absolute Technical Important (ATI)		42.00	172.50	168.30	26.50	127.80	88.50	88.50	42.00	171.60	171.60	142.80
Relative Technical Importance (RTI)		9	1	4	11	6	7	8	10	2	3	5

Figure 9: Honeywell Reference Regulator

House of Quality

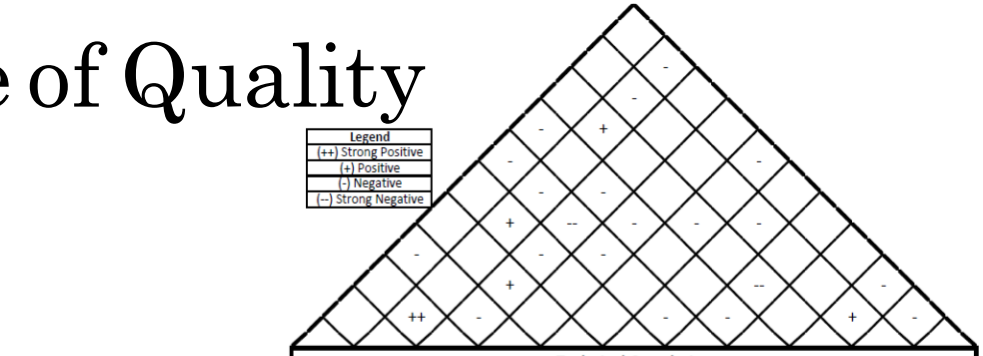


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Figure 9: Honeywell Reference Regulator

References

[1] Honeywell International Inc., "Reference Regulator Pressure - Technical Exchange," Tempe.

[2] UK Essays, "Applications of Pneumatic Systems in Aircraft," All Answers Ltd., 2013.

[3] Honeywell International Inc., "Standard Reference Regulators - Technical Exchange," Tempe, 2008.

[4] "How its work - Scuba Dive Regulators Balanced Diaphragm - www.ScubaTraveller.com," YouTube, 2010.

[5] "Schematic section animation of Scuba regulator 2nd stage," 2007. [Online]. Available: https://upload.wikimedia.org/wikipedia/commons/6/66/Scuba_regulator_2nd_stage_animation.gif. [Accessed 3 October 2017].

[6] Honeywell International Inc., "Closure Elements - Technical Exchange," Tempe, 2010.

Questions?