

Electromechanical Valvetrain Conversion (EMV)

Donald P. Shiley School of Engineering Senior Capstone Project

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Problem

Modern internal combustion (IC) engines produce harmful emissions and waste enormous amounts of precious fossil fuel. While the automobile world is slowly converting to electric drive systems, this option is too costly for many companies and their customers. The camshaft has been identified as an inefficient engine component. If this system, which was originally designed over a century ago, was reimagined with a modern twist, current IC engines could still remain relevant, efficient, and cost-effective in today's world.

Background

In a modern engine, as the camshaft rotates, cam shaped lobes come in contact with rockers to open the cylinder inlet and exhaust valves. The valves are subsequently closed using integrated springs. The result is that the valves open and close on a sinusoidal cycle. The peak of the wave is the point when the valve is fully open, only occurring at a single point. The engine assembly is shown in Figure 1 and sinusoidal cam cycle is shown in Figure 2.

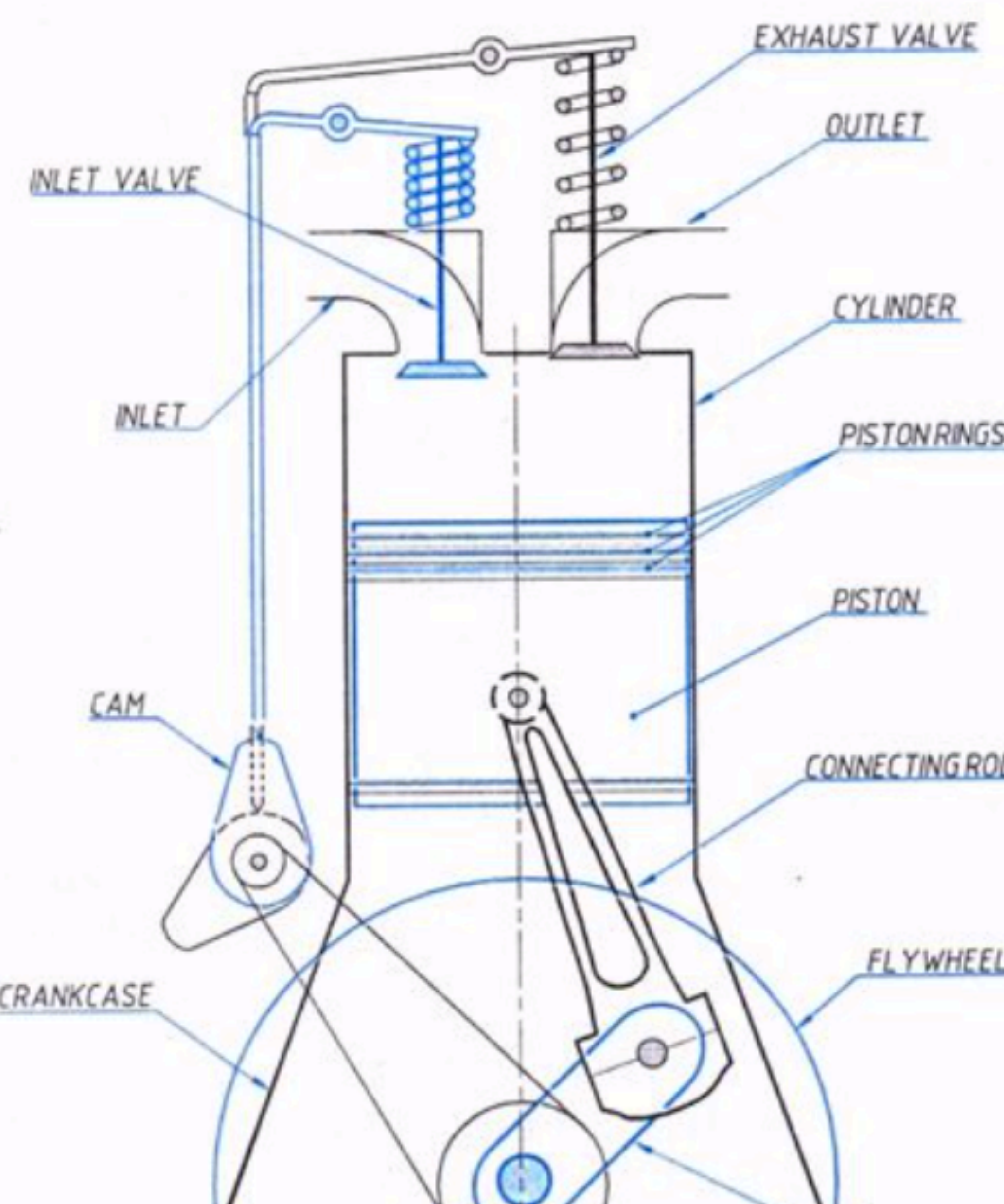


Figure 1: Parts of an Internal Combustion Engine Cutaway⁴

Valve Timing Curves

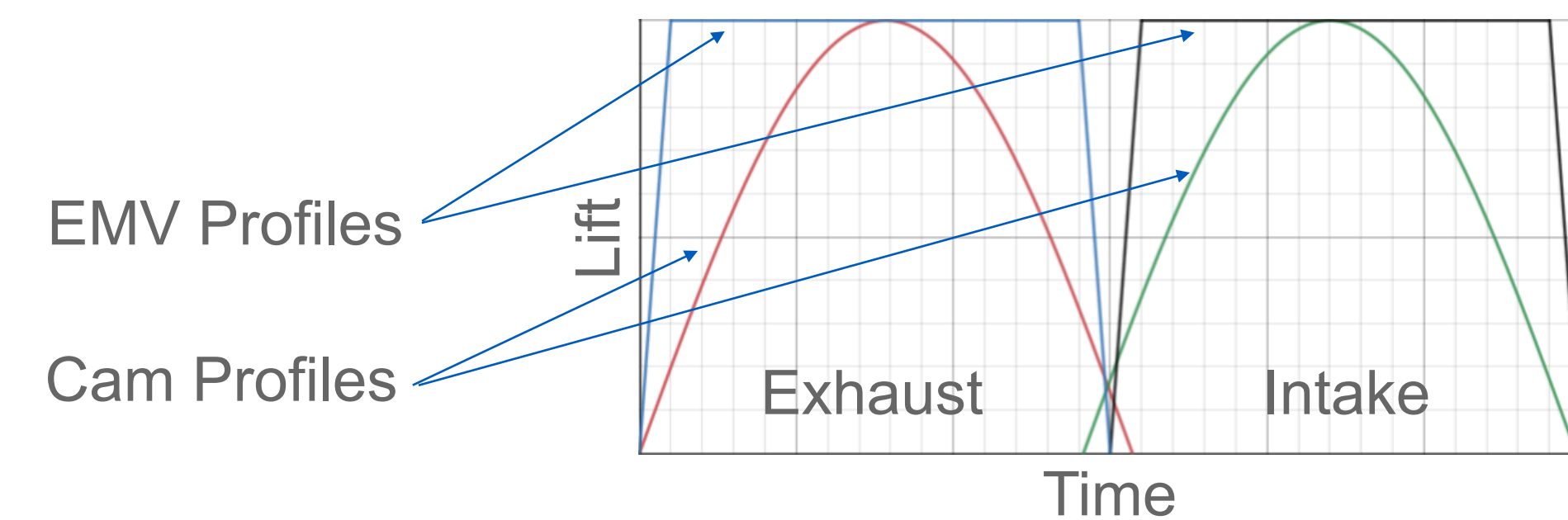


Figure 2: Comparison of valve timing profiles

Solution

Design a system which replaces the mechanically controlled valves with quick electronically controlled valves. This system would lengthen the delay before the exhaust valve is opened, improving both engine power and engine efficiency. Allowing the engine the time to fully consume the fuel would also decrease emissions by reducing the amount of unburnt fuel leaving the engine. Further, electronic control allows for the timing of valves to change based on engine speed, allowing for the ideal combination of efficiency and power.

Design Criteria

- A. Cost less than \$2000
- B. Operate safely and reliably
- C. Output accurate data during operation
- D. User friendly and simple control and operation
- E. User friendly size and weight
- F. Built of in-house manufacturable components

Design Objectives

- A. Increase engine power output above determined baseline value
- B. Increase engine fuel efficiency by at least 1% of determined baseline value

Design Selection Process

Four possible designs were investigated:

- A. Pneumatic Rams and Solenoids
- B. Hydraulic Pistons and Solenoids
- C. Electric Actuators
- D. Dual Electronic Camshafts

After analysis of each design, only the pneumatic actuators and solenoids were able to achieve the necessary speed while falling in budget. Both electric options were too slow and the hydraulic system required custom ordered parts beyond our budget.

Baseline Engine Data

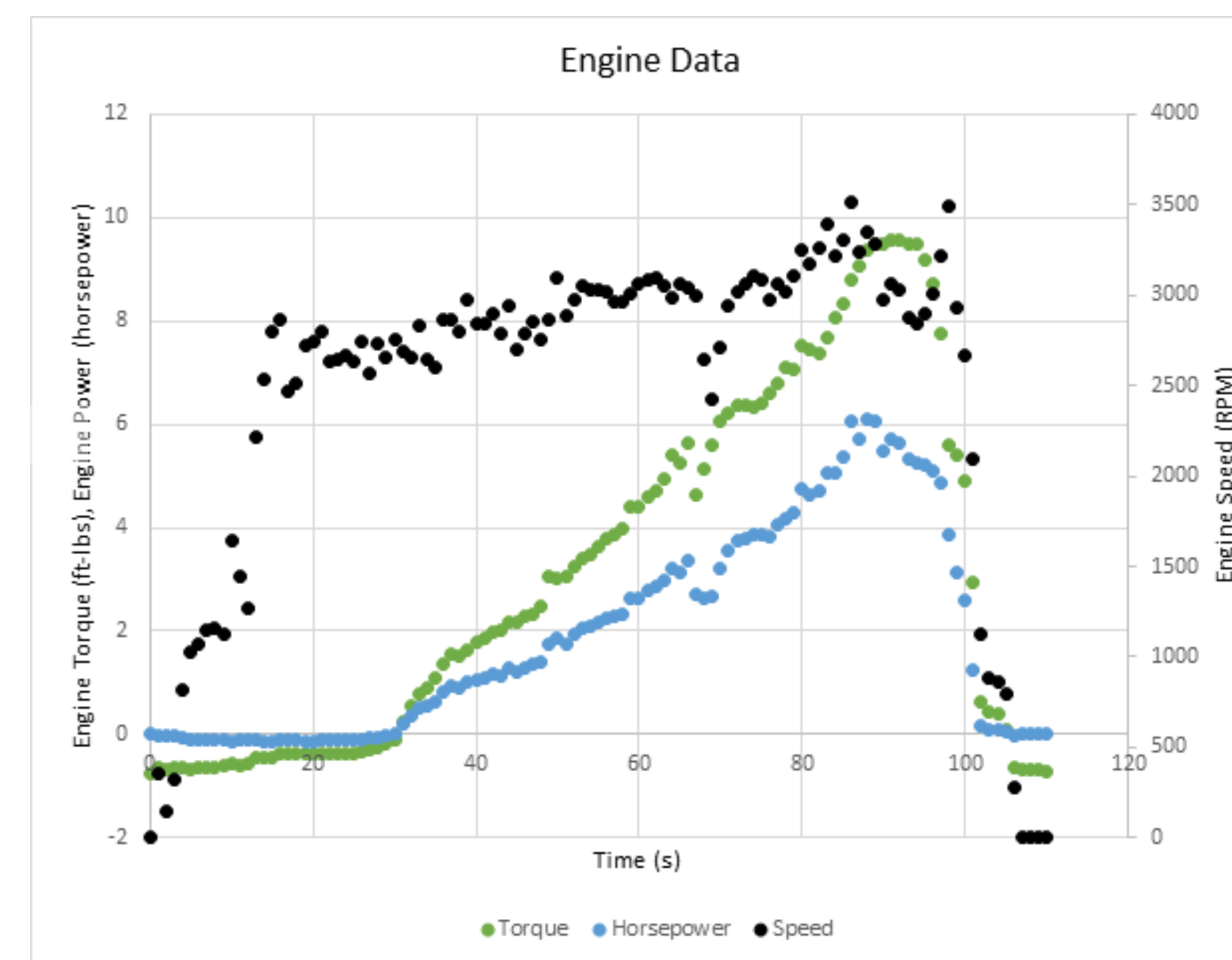


Figure 3: Engine Baseline Data

Table 1: Baseline engine data quantified

Quantity	Experimental Value	Reference Value
Maximum Power (hp)	7 (@ 3960 RPM)	9 (@ 3600 RPM) ²
Maximum Torque (ft-lbs)	10.7 (@ 2290 RPM)	14 (@ 2600 RPM) ²
Engine Efficiency (gal/hr)	TBD	1.3 (@ 3500 RPM) ³

EMV System Schematic

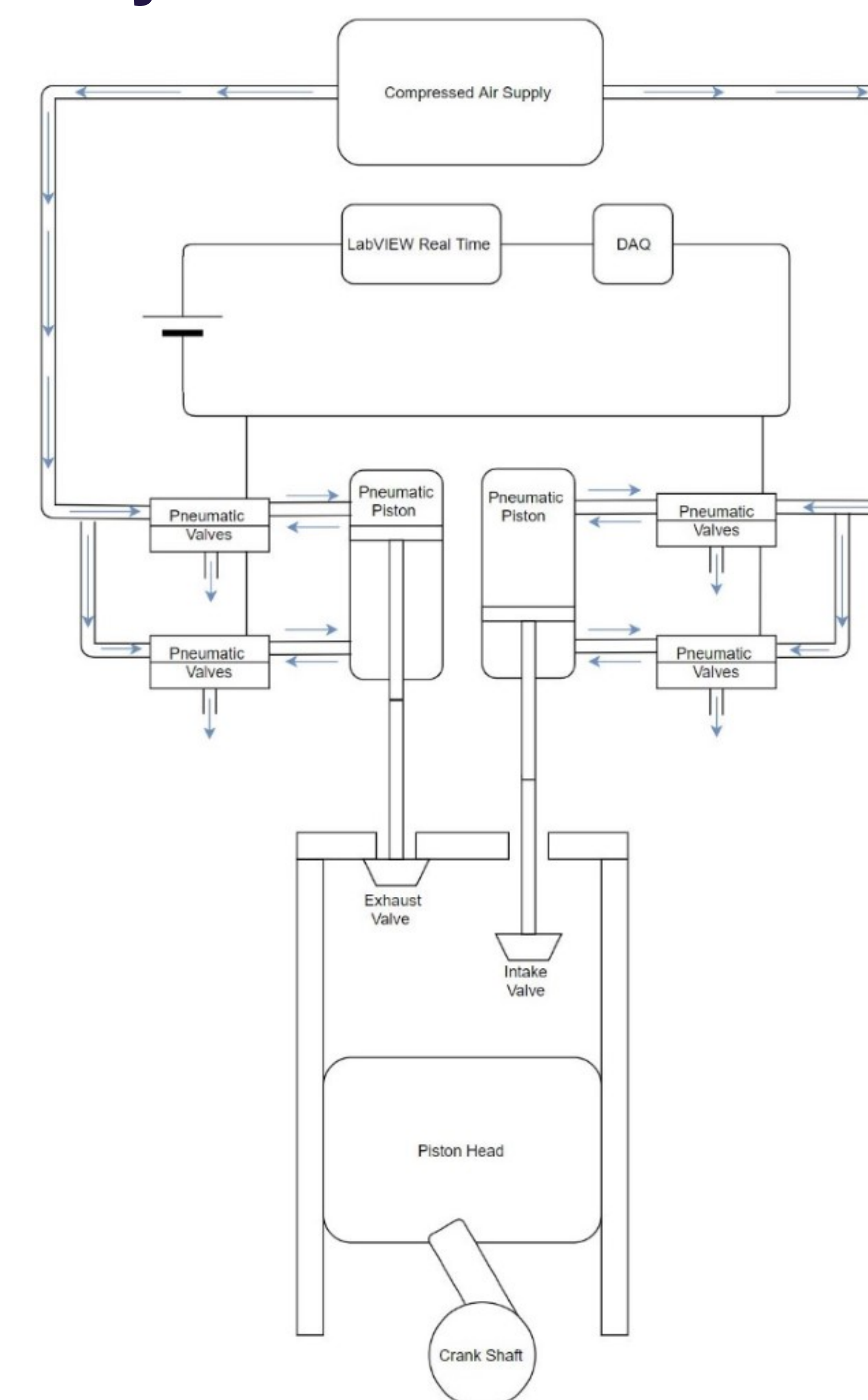


Figure 4: Electromechanical Valvetrain System Schematic

LabView Test & Control System

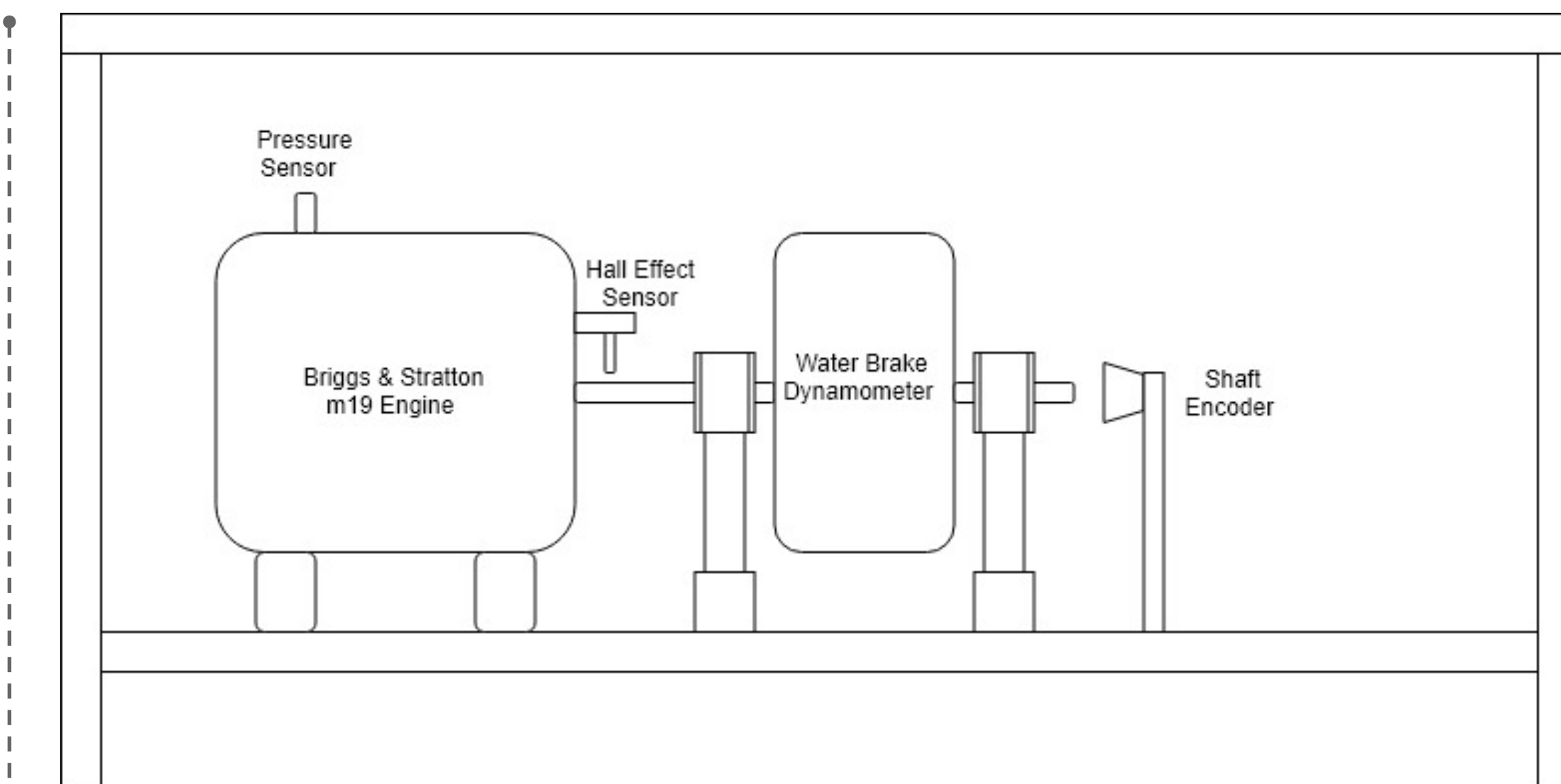


Figure 5: Engine test setup and sensor placement

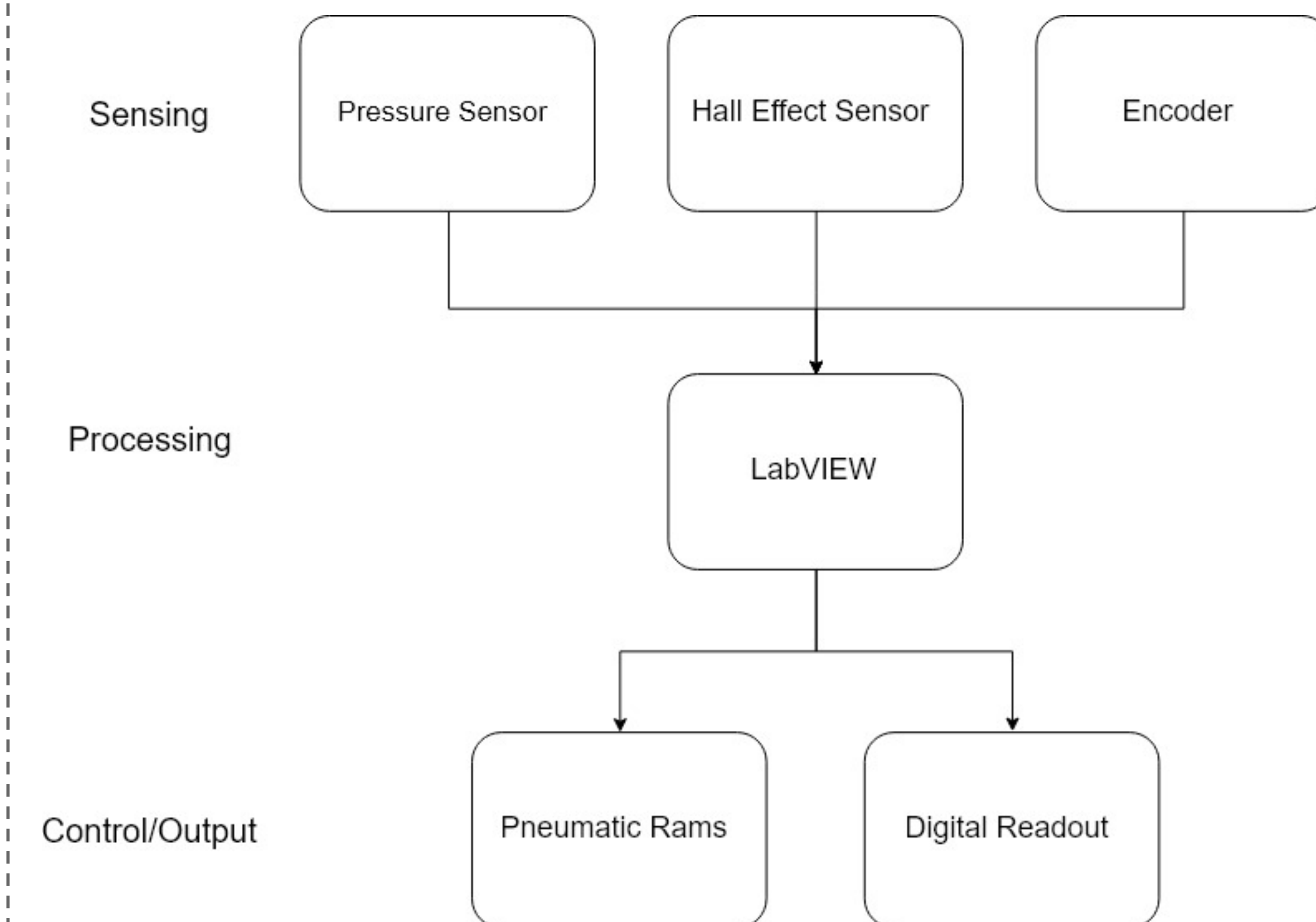


Figure 6: System control block diagram

Acknowledgements

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References

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