The Development of a Spring Powered Starter for a Motorcycle

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Development of a Spring Starter for an Internal Combustion Engine
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Introduction
• GM sponsored project looking into harvesting, storing, and releasing energy in an efficient manner
• Motivation: Reduce toxic waste created by automotive lead-acid batteries
• Goal: Design a coiled spring to replace the starter system for an internal combustion vehicle
• Vehicle: 1995 Yamaha XJ 600s motorcycle

Methodology
• Testing conducted to characterize starter motor and engine inertia
  \[ T_s = J_s \dot{\theta}_s + T_{ps}(\theta) + T_{fs} \]
• Simulink model created to determine spring stiffness and initial wind needed to replace starter motor
  ➢ Gear Ratio varied between 1:1 and 27:1
  ➢ Starting Time varied between 0.25s and 1.5s
  ➢ Engine speed minimum of 320 rpm

Spring Factor Relationships
• Torque increases with Gear Ratio and decreases with Starting Time
• Initial Wind decreases with Gear Ratio and increases with Starting Time
• Factor of Safety decreases with Torque and increases with Wire Thickness
• Length of the spring increases with Wire Thickness and Initial Wind

Future Work
• Development of a prototype that simulates the inertia of the engine and transfers power through a gear train from a designed spring

Excel based spring calculator developed to determine safe spring size and characteristics
➢ Inputs: Initial Wind, Stiffness, Wire Thickness, Coil Diameter, and Material Strength
➢ Outputs: Length of Spring, Number of Turns, and Factor of Safety

Simulink Dynamic Model Response

Simulink Dynamic Model Response

Rotational Inertia
\( J = 0.576 \text{ in}-\text{lb}-\text{s}^2 \)

Gear Ratio
\( k_1 = 6/1 \)

Garage Door Spring
\( k_0 = 5/8 \times 3.80 \text{ in-lb/nd} \)

One Way Clutch

Release Mechanism

Hand Crank