Testing of K'Nex Motors used in a Freshman Engineering Design Competition

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EXTENDED ABSTRACT

The freshman engineering class at Mercer University has participated annually in a competition in which K'Nex parts are used to build various types of vehicles. They have built these vehicles to perform specific tasks such as cable-car tug of war, hill climbing, and many others. The DC motor used in the K'Nex design kits uses a spring clutch to prevent damage to the motor. This clutch wears over time resulting in motors that can output significantly less torque than a new motor. The purpose of this project was to develop both a mechanical and an electrical method that students may use to evaluate the performance characteristics of their motors. The electrical method can be used as a preview to the electrical engineering courses that the students will be taking the next semester.

In an ideal motor, the maximum torque for pass-thru drive is 2.9 inch-pounds, and the maximum speed is 36.9 RPM. For end drive, these numbers are 1.1 and 36.4 respectively. The students will consider the motor acceptable if the pass-thru drive holds 2.6 inch- pounds and the end drive holds 1 inch-pound.

The mechanical testing method involves hanging weights off a string attached via a pulley wheel to the motor being tested. As the weight is increased, the motor's clutch will eventually kick out. At this point the applied torque will have surpassed the spring clutch's strength. Instructions will have been given to test the maximum strength of the motor by slowly increasing weight. This will have allowed the students to know the exact weight just before the clutch kicks out. Students will be provided with an acceptable performance range for their motors.
The electrical test method will also require that a mechanical load be applied to the motor and will allow the students to see what happens electrically when the motor's clutch is overpowered mechanically. The mechanical load will be applied via a spring scale with the acceptable ranges clearly marked. The application of a constant voltage to the motor will greatly simplify evaluation of the motor's performance, therefore a voltage regulator set at 3 V-DC will be used to supply power to the motor. An oscilloscope or multi-meter can then be used to evaluate the current drawn by the motor. In order to reduce the electric noise coming from the motor, a low pass filter will be added to the circuit and a gain of 100 will be used to magnify the oscillations when the clutch kicks out. When using a multimeter instead of an oscilloscope, a sample and hold circuit will be added and set up so that the maximum voltage is maintained for long enough for it register on the multimeter.