Gears
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# Make a Prony Brake to Analyze Motor Performance

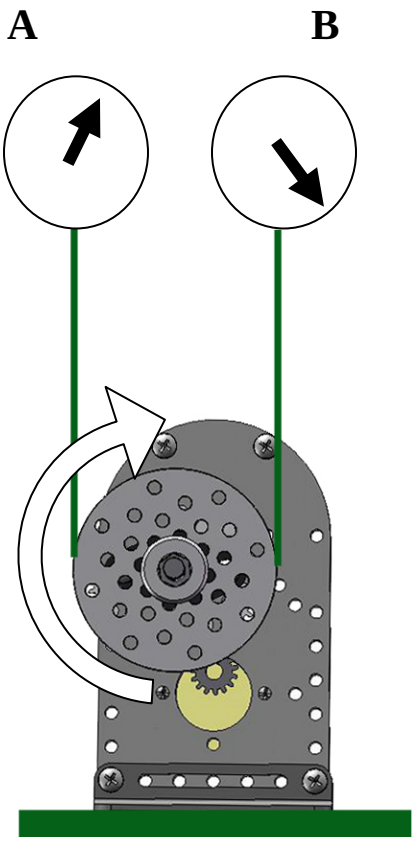


Fig. 1) Prony Brake Diagram

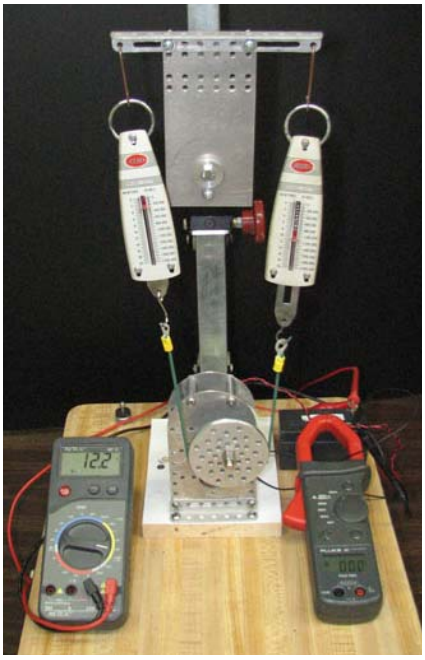

Fig. 2) Prony Brake in Use

**Materials:**

- 2 5lb. or 20 Newton Scales
- 1 Length 1/8" round belting
- 2 ¼" x 10ga screw eye connectors
- 1 GEARS-IDS™ Universal Transmission
- 1 Voltmeter
- 1 Ammeter (10 amps min.)

**Experiments:**

Determine the Torque constant ($K_T$) and voltage constant ($K_E$ ) for the gearhead motor and drive system.

Calculate gearmotor and drive system power.

Create mathematical models of motor and drive system performance

**Sample Lesson Procedure:**

1.) Set up a Prony Brake as pictured in Fig. 1 and 2.

2.) Place the cord under equal tension.

3.) Connect the volt meter and current meter.

4.) Connect the motor leads to a 9-12 volt source and power the drive wheel in a clockwise direction.

5.) Measure and record the data on the following page.

6.) Compare this experimental data to the manufacturers published motor specifications included with the GEARS-IDS™ transmission module. When you have become comfortable building and using this prony brake, you will then be able to successfully research and design methods to asses the performance of any DC motor and drive system.

*Note: Note: Because there is little commonality among motor manufacturer' choice of units, and measurement practices, it will be necessary to convert different systems of measurement (SI, Metric and customary US units) to a single system of units. Choose the system of units that best meets your needs.*

# Motor Analysis Data Sheet

**Name_____Date_____ Course_____**

Use the GEARS-IDS transmission module and prony brake to determine the back emf constant, torque constant and power of a gearhead motor.

## Gearmotor Data

_____ Gearhead ratio
_____ Manufacturer's rated current
_____ Manufacturer's rated power (watts)

## Transmission Data

_____ Final drive ratio
_____ Drive wheel radius

Fig 1.) Typical gearhead transmission

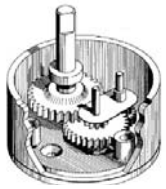

Fig 2.) Typical gear drive. In this example the drive ratio is 1.66:1

## Experimental Data

**These values are obtained by running the motor and transmission system on the prony brake, under load.**

_____ Force (scale) reading B
_____ Force (scale) reading A
_____ Force (Net) = scale reading B – scale reading A
_____ Voltage
_____ RPM
_____ Current (amperes)

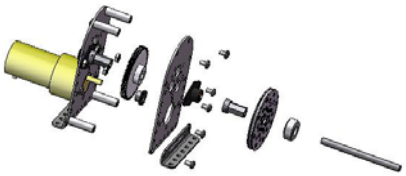

Fig 3.) Exploded view of a gearhead motor and gear drive.

## Calculated Values

_____ **Net torque** = Force (net) x Drive wheel radius.
_____ **Net horsepower =** Net torque (in.lbs.) x rpm x 0.000159
_____ **Net wattage** = Net horsepower x 746
_____ **Motor speed before transmission =** Output shaft RPM x final ratio x gearhead ratio
_____ **Motor torque constant $K_T$ =** Net torque/ final drive ratio/ gearhead ratio/ gearhead efficiency *(from manufacturers' specification)*/amperes
_____ **System torque constant $K_T$ =** Net torque/ amperes
_____ **Motor voltage constant $K_E$ = Voltage/ (rpm/1000) = Volts/1000rpm**

**Assignments**

1.) Use the torque constant and the manufacturers rated torque to compute the theoretical tractive force for a variety of wheel diameters. The table below provides some example problem sets.

| | Wheel Diameter | Theoretical Tractive Force |
|---|---|---|
| **#1** | | |
| **#2** | | |

2.) Is the motor power output affected by changes in the final gear ratio?

| | Final Gear Ratio | Calculated Power |
|---|---|---|
| **#1** | | |
| **#2** | | |

Note: The data obtained from this experiment is particularly useful for accurately matching motor and drive systems to specific mechanical applications. In addition, this information can be used to predict and specify the battery capacity needed for a specific application.